Eli Elinoff & Kali Rubaii (eds.)

The Social Properties of Concrete

THE SOCIAL PROPERTIES OF CONCRETE

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Fig. 1. Detail from Hieronymus Bosch, *Ship of Fools* (1490–1500)

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Acknowledgments

This volume emerged from a series of provocative panels, workshops, and conferences organized by different people between 2017 and 2021. Although not coordinated in a formal sense, these events produced a loose collective of scholars working in various parts of the social sciences and humanities on issues related to concrete and cement. Without these people and their hard organizational work this project would not exist. Thanks specifically to Cristián Simonetti and Denis Byrne's two-part panel at the Knowledge/Culture/Ecologies Conference organized by Universidad Diego Portales and Western Sydney University in 2017; Heid Jerstad and Julie Soleil Archambault's panel at the American Anthropological Association meeting in Washington, DC, also in 2017; and Victor Sacha Cova's brilliant three-day event entitled Concrete Anthropology, held at Aarhus University in 2018. Kali Rubaii also organized an adventurous multidisciplinary sequel to the Aarhus event at Rice University, "Ecopolitics of Concrete," under the auspices of a grant in 2019. At that workshop, a hands-on cement and concrete-making activity was led by Jon Chaconas. Finally, Rubaii and Eli Elinoff organized and hosted a multi-day online workshop that resulted in the outline and chapter drafts for this project in the beginning of 2021.

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INTRODUCTION

The Social Properties of Concrete

Eli Elinoff and Kali Rubaii

Surface Tensions

Chances are, you are surrounded by concrete. It is the foundation of your dwelling, the sidewalk on your street. It is the structural support of your nearest hospital or school. Concrete highways may deliver you to work or segregate your community. Concrete walls prevent you from seeing or hearing inmates in the nearest prison. Concrete might hold back or channel water for consumption and electrical production. It is likely a central part of future plans for your community in the form of real and imagined infrastructures responding to disasters past and still-to-come: wars, tsunamis, earthquakes, or coastal inundation. It surfaces roads that facilitate access to fundamental resources that drive our economies, composes seaports where container ships orchestrate trade across oceans, and forms the tarmacs at airports that ferry passengers across vast distances. Sometimes concrete narrates our contested pasts to us through monuments. Often, it stages our present in spaces of mass gathering, like stadiums and plazas, venues for sporting events, concerts, rallies, and protests that remind us of the ossified and emergent shapes of our polities. Recent studies estimate that by 2040, the total mass of concrete will outweigh Earth's biomass (Elhacham et al. 2020).

Wherever you happen to be, it probably appears that concrete is fixed, durable, and even permanent; this is an illusion. The longer you observe concrete the more you can tune in to its flaws. A crack here, a divot there. Perhaps a piece of aggregate stands out against the otherwise smooth surface. Or, maybe, you can see evidence of an errant flick of a trowel that was intended to erase itself but instead left traces of the worker that sculpted this surface. These imperfections erode the material's claims to universal permanence, highlighting, instead, its specificities and idiosyncrasies. They locate concrete in time, exposing its interactions with the ambient environment and insisting on its deeply human qualities.

How can this substance be impersonal and human, uniform and specific, futuristic and elemental, strong and fragile, enduring and short lived, inclusive and exclusionary all at the same time? How does concrete hold these contradictions together?

The answer to these questions requires turning to the material itself. In it, one sees stone, sand, and water, but also, inevitably, people. Concrete is composed of the labor of poorly paid construction workers, the audacious or banal visions of architects, the volatilities of real estate markets, the force of dispossession, and the politics of extraction. It is, as Max Woodworth and Cecilia Chu (2024, 1) have pointed out, composed of a "vast network" of connections. The physical tensions that hold concrete molecules together are saturated by these social qualities, which link specific instantiations of concretization to the material's history by tying processes of quarrying, manufacture, transport, and construction to the lived effects of concrete forms as they are used and decay. Attention to the intimate interrelationship between the material and its social contexts reveals that in whatever form it appears, concrete is not merely a thing, but is a moment, perhaps even an event, made possible by and through the continuously related unfolding of physical and social forces.

Concrete — and any individual component of it — is a process. Like Alfred Gell's take on art, concrete is "a system of action, meant to change the world not to simply encode symbolic propositions about it" (1998, 6). Its life-course incorporates many places at once, binding limestone from a quarry somewhere near you with the sand dredged from rivers far away. It brings together the cement mixing truck behind you on the road with the microscopic particles of its rubble in your lungs. Thus, to make sense of one of the most fundamental anthropogenic elements of this epoch (Elinoff 2022), we must acknowledge that concrete's social properties are inseparable from its material properties.

Anthropologist Nicholas D'Avella (2019) suggests that to understand how concrete holds itself together we need to begin with hydration. He describes the process in this way:

> After an initial dormancy in which it remains malleable, the cement grains begin to dissolve in water and release calcium silicate ions, which grow into needles and platelet-shaped crystals that hold rocky aggregates in place. Hydration continues long after concrete seems solid: typical cement cured in moist conditions will [reach] 80 percent hydration after twenty-eight days and continue to slowly hydrate and strengthen over the course of months or years. (D'Avella 2019, 22)

When water is added to cement, the disparate ingredients that form concrete begin to "grow together" (D'Avella 2019, 21). In doing so, they generate the specific bonds and tensions that hold diverse components in relation with one another. Such bonds produce connections across the material and, as D'Avella notes, offer insights into the ways social practices cohere as well.

Hydration is not a simple, closed process. It entails the coordination of a range of factors including materials, laborers, techniques, and the construction environment itself. According to civil engineering and cement chemistry researchers Jeffery Thomas and Hamlin Jennings:

> A large section of concrete cannot shrink uniformly — the surface dries out first while the interior remains moist. Due to the tendency for drying to cause shrinkage, the drier surface layer is put into a state of tension, like a stretched rubber band. But concrete cannot stretch like a rubber band, so the tension tends to make it crack. Cracks reduce the strength of concrete, make it less durable by offering easy access to water and corrosive ions, and of course are unsightly. For this reason, good contractors take careful steps to keep the surface of freshly placed concrete moist, often by covering it with plastic or moist burlap. This is important on hot, windy days. (Jennings and Thomas 2009, 11)

Without careful attention to a range of dynamic variables, Thomas and Jennings suggest, hydration can generate both obvious and latent factors that weaken concrete structures or even cause them to fail.

More than simply being indicators of potential instability, these variables also highlight concrete's openness to the world. The forms that concrete ends up taking are neither the result of straightforward physical processes nor are they the direct translation of engineering or architectural visions, instead, they are extensions of complex coordinated relations that compose concrete constructions including workers, sites, practices, and contexts. Rather than being fixed and permanent, concrete forms are delicate, contingent results of ongoing, occasionally incomplete, interactions between materials, environments, and humans that take place across space and time. Structures thus continuously enact their contexts in specific and subtle ways. Concrete is in this sense never inert, but instead always an embodiment of the tensions generated as human hands, materials, and environments converge. Architectural historian Adrian Forty (2012, 14) argues that these tensions are fundamental to concrete's pasts, presents, and futures. We follow this instinct, arguing that concrete is profoundly, irreducibly social.

Figure 1.1. Construction workers pour and smooth a concrete pier in Hpa An, Myanmar. Photo credit: Eli Elinoff.

The Social Properties of Concrete explores the implications of concrete's deeply human character through essays by anthropologists, geographers, archeologists, historians, artists, science and technology scholars, architects, and urban planners. Taking up a global set of case studies, this volume asserts a new conceptual language for talking about concrete's social and material properties and offers insights into the specific social tensions that hold this material together and pull it apart. In this way, the volume works as a socio-material handbook for making sense of contemporary forces that compose environments, built and destroyed of and with concrete.

In this introduction, we take concrete's tensions as our starting point for rethinking the relationship between the materiality of built environments and the social forces that compose and are composed by it. We show how the social properties of concrete are neither metaphors nor simple reflections of the social. Instead, they are modes of enacting social, economic, and political life in and through concrete. We do this by tracing, in broad strokes, the ways that concrete and its components — cement, sand, aggregate, and water — have been enrolled in the making of our worlds in big and small ways. We organize this introduction around two major tensions that hold concrete together: between singularity and multiplicity, and between endurance and fragility. We trace these tensions through concrete's production, consumption, and deployment across spaces and times to set the stage for the authors in this volume, who develop a materially grounded conceptual toolkit to think about the social properties of concrete.

Singularity and Multiplicity

Concrete is made up of cement, water, and aggregate. Cement and aggregate are themselves composed of other things like limestone, sand, stone, and other trace minerals. Concrete is both global and local; it is standardized, but never like itself; it is material, but also more than just that (D'Avella 2019, 6). What concrete is, at any one moment, is in the specificity of "the mix" (Harkness, Simonetti, and Winter 2015, 311). Below we outline the convergence of geological, ecological, and technological things and processes that give rise to concrete.

The central binding agent in concrete is cement. Portland cement constitutes the most contemporary cement formula. Although Portland cement was patented in 1824, cementing has a much longer history (Halstead 1961, 3). In its earliest form, cement enabled the rescaling of human civilization by generating new spaces of mass religious gathering more than twelve thousand years ago (Courland 2011, 38). Early cements have been found around wide swaths of Europe and the Middle East, dating back to 6500 BCE, produced from mud, lime, and volcanic ash (Harkness, Simonetti, and Winter 2015). Over the course of thousands of years, small modifications made by artisans, laborers, and builders in response to local geologies created the conditions and knowledge that led to the rise of Portland cement, which seems to have occurred in multiple places in the early nineteenth century.[1] Despite this diversity of innovation,

1 Rowan McCormick's chapter in this volume, "Improvisation," reveals how craftsmanship and artisanal experimentation continue among self-builders in Aotearoa New Zealand.

Joseph Aspdin, a bricklayer from Leeds is credited, however erroneously, with the invention of Portland cement, which was designed to cure underwater (Courland 2011, 184).[2]

The chief benefit of Portland cement was that it was a standardizable, patentable, replicable recipe. Unlike early cements, Portland cement was distinguished by an increased reliance on silicas mixed with lime and cooked at a very high temperature. The result was a durable and controllable substance with a standardized character (Halstead 1961). Portland cement offered a more replicable manufacturing process that could be applied to a wider range of geomaterials with relatively reliable and predictable results, including its infamous gray color. Portland cement was useful not only for binding stones, but, when mixed with aggregate and water, it became concrete. Concrete was stronger and less prone to cracking than cement and could be used in a wider range of applications, including the construction of larger, more complex objects.

The growth of the Portland cement industry led to revolutions in kiln technology, packaging, and other industrial processes that expanded industrial capacities to make and distribute cement globally (Skempton 1962, Pedersen 2022). For example, across the late nineteenth and early twentieth century, companies like the Danish F.L. Smidth & Co. adopted, developed, and exported rotary kilns which simplified the production process (Pedersen 2022, 28). The growth of the globalization of cement production was critical to a range of twentieth century phenomena, especially military practices and post-war developmentalism. It was also essential to the close associations between concrete and ideas of progress, development, and moderniza-

2 The actual inventor of Portland cement is a murky question. Robert Courland (2011) has argued that a number of other figures were responsible for many of the individual technical leaps. In this, the patent for Portland cement reflects much of the material's history, which was marked by small transformations over a long period of time (Halstead 1961).

tion.[3] Along with these technical advances, concrete's physical limitations introduced new challenges and new adaptations.

Despite its high ability to bear weight vertically (compression strength), concrete is brittle and has a very low capacity to manage horizontal stresses associated with bending and stretching (tensile strength). To account for these physical limits, new developments in steel reinforcement increased concrete's tensile strength exponentially. Such ferro-concrete ushered in new possibilities for infrastructures like bridges and buildings that began to rapidly transform the scale of urbanization and of human society simultaneously. In short, the development of contemporary cement and concrete was spurred along by developments in steel and other materials. In the process, concrete emerged as seemingly durable, fast, and cheap, lending itself to an array of both simple, rudimentary constructions and complex, large-scale applications (Forty 2012).

Because concrete is one thing composed of many, understanding it requires us to consider its many components. In this, tracing the social relations of sand and other aggregates, for example, is critical in engaging the political stakes of cement production. While aggregate mining is less explored (see Placino 2020, and Placino and Rugkhapan 2024), sand has become an increasingly sought after, and in some cases rare, commodity the world over, mainly because of demand in the concrete industry (Comaroff 2014; Lamb, Marschke, and Rigg 2019; John 2021; and Miller 2022). Some of this sand has gone to the creation of land itself for mass construction in places like Dubai and Singapore, but also to buildings themselves. Like cement, sand is geologically specific, resulting in buildings taking on local qualities in ways that are unexpected. For example, the granitic sand around Buenos Aires makes a coarser quality of concrete (D'Avella 2019, 6) than in Indonesia, where the fine quality of volcanic sand on Mount Merapi makes denser forms of concrete than river sand.

3 A range of contributions in this volume address this theme, including chapters by Julie Soleil Archambault, Claudia Gastrow, Emily Brownell, Gabriel Lee, Diana Martinez, and Mo H. Zareei.

Figure 1.2. Limestone quarry, Saraburi, Thailand. Photo credit: Eli Elinoff.

These physical characteristics generate unique value that is essential to local sand mining industries (Miller 2022, 83). Similarly, "informal" aggregate mining in the Philippines sits within complex small-scale economies on Manila's spatial and social edge (Placino 2020). The demand for sand has inspired illegal dredging and even sand mafias in certain parts of the world (Mahadevan 2019, and see also Lamb in this volume). Although sand and aggregate are often seen as secondary to the making of concrete, their economies reveal how understanding concrete's compound nature is essential to making sense of its many environmental, social, and political lives. This is because concrete ties together the highly local effects of extraction and the global networks associated with mass construction.

The tensions of concrete's singularity and multiplicity are also scalar: cement and concrete are both local and global, ubiquitous and highly situated at once. Concrete is rarely used directly where it is produced, as few urban centers situate themselves around a quarry. The gap between production and consumption thus links distances both vast and small, binding them in locally specific places like a sidewalk, a building, an overpass, or a prison. Read in this way, local construction conducted with distant materials does not just bridge locales in an abstract way, or as a metaphor, but instead links them materially; the stone, sand, and water used for construction must be physically moved in order to be resituated in their new setting in their new form. Similarly global networks of construction capital, state capital, and private investment bind together economic landscapes through the accumulation of space and the mobilization of labor locating an "ecology of practices" in the substance itself (D'Avella 2019, 6). Production and consumption are globally dispersed but locally connected. The relations across these different scales emphasize the strong tensions between concrete's global and local qualities.

Consider cement, concrete's binder. Cement production is extractive, and it is carbon intensive. Cement is produced by mining, crushing, and cooking geological formations that are rich in calcite like limestone, chalk, marl, and even coral. Because of their mass, the raw materials involved in cement production are usually mined near production facilities. The scale of the investment and space needed for cement quarrying, mining, and production has often meant that, in many parts of the world, the industry is dominated by nationalized cement corporations or tightly controlled by industrial monopolies. Like sand, the geomaterials used for cement production vary somewhat from place to place. For example, across Southeast Asia limestone karsts are often critical resources for cement production; in Europe it may be marl pits, in the UK chalk deposits, or in the Pacific coral reefs. In all cases, the production of urban life in one place entails the creation of new extractive landscapes in others. This means that cement production has specific local extractive effects — air pollution, water pollution, questionable land expropriation, and deforestation, to name a few — that are likely invisible where cement and concrete are consumed. That gap generates spatialized power asymmetries that are fundamental to the material's politics.

Local mining also has global implications. The industrial processes entailed in cement production contribute anywhere from 5–10% of global carbon emissions. In 2020, the International Energy Agency (IEA) reported that 4.1 gigatons of cement were produced. For every metric ton of cement, roughly 1.25 tons of carbon are produced (Andrew 2019). This ratio of 1:1.25 is helpful for understanding the basic chemical engineering required to address the industry's contributions to climate change. Clinker is the culprit. The IEA notes that decarbonization of the cement industry requires transformations both in the fuels used to produce clinker and in the recipes for cement. The former technological solution requires burning less fossil fuels or burning them more efficiently to initiate the chemical reaction to make clinker. The latter involves lowering the amount of clinker in cement to reduce the overall amount of carbon released per bag of cement.

The chemical reactions required to create Portland cement take place at 1450 degrees Celsius. As the "raw meal" — composed primarily of limestone and lesser amounts of clay, chalk, and other minerals rich in calcite — comes to temperature, the minerals transform. The materials release their stored water, calcium carbonate becomes calcium oxide, and a host of other chemical reactions take place that transform molecular bonds. As the minerals cool, they become "clinker" — stony gray lumps — that, when ground and mixed with gypsum, become cement. This chemical reaction must rank as one of the most important socio-technical developments in human history, with implications for global climate change.

The process of making clinker transforms the atmosphere, as carbon is released in two different ways. First, carbon is released in the production of heat produced by burning fossil fuels for cement kilns. Scale matters here: Because of the sheer mass involved in cement production, fuels need to burn hot and cheap. So, coal and fuel oil tend to be the main sources of fuel in cement production. In the shadow of climate change, work on new fuel sources for cement production has become an urgent but sticky engineering problem. Kilns are "inherently Promethean" actors, central to cement production but resistant to transformation (Förster 2023, 231). The second release of carbon occurs through the chemical reaction that transforms calcite-rich raw meal into clinker. Here, carbon stored within geological strata is released as cement's raw materials are cooked. The environmental implications of this reaction are somewhat ambiguous: it is inarguable that cement production involves the removal of carbon stored within limestone geologies, but some studies suggest that this is not a permanent process with as much as 48% of the carbon released during manufacturing returning to concrete via carbonation across several decades (Rissman 2018).[4] The possibility of carbon returning to concrete animates imaginaries of buildings as carbon sinks and debates about the material's carbon impacts. While engineers ask whether this effect can be sped up, carbon accountants (and savvy marketers) consider how to evaluate the material's interaction with our atmosphere.

Across its lifespan a certain amount of loose carbon returns to cement and concrete through processes of carbonation. This return of carbon can be problematic, especially in reinforced concrete construction, as the reintroduction of carbon molecules can weaken the bonds between concrete and steel. Yet, the observation has opened up possibilities for reimagining concrete ruins and recycled concrete as a potential carbon sink. New experimentation in concrete technology often takes up precisely this imaginary, refashioning it from an ecologically destructive force into a means of enacting a post-carbon future.[5] Despite this promise, the recapture of carbon back into the concrete from which it was released raises the question of how carbonization will synchronize (or not) with the increasing urgencies of decarbonization associated with anthropogenic climate change.

Concerns around climate change have meant that the cement industry — which includes both nationally owned entities and, increasingly, multinational corporate entities — has garnered increased attention, transforming both the makeup of cement

4 Rissman (2018, 5) reviews some recent research on carbonation, which describes the possibilities for carbon capture within cement, but also some of the methodological problems with measuring carbonation.

5 These material experiments are also important sites of social investigation: Michael Degani (2020) describes how experiments with aircrete in Africa are tied to wider shifts in the market reimagining African consumer spaces. Lukas Ley's (2024) engagement with new ecoconcretes reveals how material scientists, engineers, and ecologists are using the material to remake port spaces.

and the fuels required to create it. New sustainability initiatives in the industry aim to reduce emissions by up to 25% by 2050.[6]

This attention has also meant that carbon accounting has become the main public conversation about cement's environmental impacts, narrowing attention to the myriad other roles concrete plays in wider, but frequently more localized environmental transformations. For example, a focus on carbon emissions does little to engage the kinds of labor exploitation, health hazards, and displacement posed by the extractive industry. As with any technological solution to a political problem, the carbon-focused imaginary of the cement industry obscures the local impacts of concrete-based construction (see, e.g., Elinoff 2022, Harms 2021). As Lukas Ley (2017, 2021) has shown, mass urbanization in areas of coastal Indonesia has resulted in increased land subsidence and a rising threat from inundation. As the consequences of anthropogenic climate change and urbanization collide, the result is not that less concrete is being used, but rather more (see Vaughan in this volume). The construction of flood walls (Marks and Elinoff 2020, and Whitington 2019), sea walls (Littlejohn 2020), and other coastal infrastructures (Ley 2021) has increased, and so too has scrutiny of such projects from environmental activists and critics. Moreover, the radically changing topographies of land and sea that concrete often mediates is leading to increasing numbers of displaced people, some displaced by new infrastructures and others by rising waters.

Behind these local-global tensions lie the widespread nets of industrial capital and engineering knowledge that make up the massive cement and concrete industry. Well-known companies like Lafarge Holcim, Anhui Conch Cement, China National Building Material, and Heidelberg Cement have branded production facilities, distribution centers, and projects across the

6 The Cement Sustainability Initiative, "The Building Blocks of Transformation," *World Business Council for Sustainable Development,* https://www.wbcsd.org/Sector-Projects/Cement-Sustainability-Initiative/Cement-Sustainability-Initiative-CSI.

globe. They also maintain investments in a range of companies with lower international profiles. At the same time nationalized cement companies often remain central sites of investment and partnership between national governments, multinational corporations (MNCs), and international lenders. While some global distribution of expertise and engineering knowledge has occurred alongside economic growth, other kinds of investment and training are often deeply connected to colonial, imperial, and military geographies. Indeed, as we describe in the next section, the development of cement production capacity is often part of wider sets of strategic military relations that link the promise of peacetime building with the violence of war.

Whether one envisions enduring infrastructures imagined to generate temporal leaps toward post-developmental industrial futures, or scenes of capital investment in urban gentrification, concrete projects are deeply implicated within webs of power.[7] Here, the kinds of industrial capital we describe above merge with wider webs of state and non-state capital. Because cement is often a focus of primarily industrial investment and because it is often branded as a central infrastructure of other infrastructures yet to come, cement manufacturing projects and their chains of financial interest are deeply implicated in exercises of coercive power, both national and imperial. David Harvey (1985; 2008; and 2016) has argued that urbanization is both a scene for the freezing of capital and, increasingly, a mode of production in its own right. As he shows, the massively unequal pool of money emerging out of neoliberal urban restructuring literally takes the shape of buildings and construction projects (see also D'Avella 2014, and Nam 2017). Harvey also reminds us that the 2008 financial crisis sparked a massive increase in cement production across China as increased usage of concrete in mass construction became a "spatial fix" to global market col-

7 Appel, Anand, and Gupta suggest that making sense of the politics of infrastructure requires understanding the changing promises embedded in socio-technical systems across their long lifespans (2018, 18). The shifting material life of concrete is essential to these dynamics.

Figure 1.3. Cement bags, Yangon, Myanmar. Photo credit: Eli Elinoff.

lapse (Harvey 2016, 17; see also Shatkin 2017; Lam in this volume; and Oakes in this volume). Concrete served as a powerful engine for keeping economies moving and, at the same time, generating spatial and ecological transformation. Bonding local transformation with global capitalism, concrete's singular multiplicity converges with our second identified line of tension: the promise of permanence and the immanence of collapse.

Endurance and Fragility

Around the world, bags of cement are often imprinted with icons of power: Eagles, rhinoceroses, elephants, dragons, and the arms of well-muscled men are common features of cement marketing. These symbols emphasize strength and endurance, obscuring the fact that concrete can be surprisingly fragile.[8]

Formulated, installed, designed, or built in the wrong conditions or by inexperienced, inattentive, or subversive hands, concrete cracks, chips, erodes, decays, and fails long before its advertised lifespan. Spectacular examples of construction fail-

8 These animals are often used as national mascots to project similar images of permanence and strength.

ures — bridges or apartment blocks that collapse — can lead to political ruin and social upheaval. In more mundane cases, like fractured sidewalks or obdurate, unfinished projects, these failures often are read for insights into local power arrangements or even as indicators of political corruption (Elinoff 2017; Kim 2020; and Hartblay in this volume).[9]

Beginning in Europe, then spreading throughout the world via colonial and post-war developmental industrial pathways, the production of Portland cement and new engineering techniques associated with reinforced concrete produced new possibilities for the rearrangement of people, ecologies, and things (see, e.g., Holston 1989; Mrázek 2002; and Martinez 2017). As Diana Martinez's study of US "concrete colonialism" in the Philippines demonstrates, concrete's physical qualities were direct expressions of the moral politics of colonization. "Concrete, in other words, beyond being an agent of actual, material change, largely bore the burden of representing America's benevolent civilizing mission" (2017, 8). The tension between the material's endurance and its fragility fuses the foreshortened and uneven promises of progress with the inherent violence of colonization (see also Sur in this volume).

Aesthetically, modernists like Le Courbusier posited that concrete's apparent history-lessness, embodied in its blank, smooth, unadorned quality, offered possibilities to produce dwellings, buildings, and cities that were outside of time. In this, the material became a central point of investment binding together progressivism in the United States (Lee 2019; Lee in this volume; Fennell 2015; and Rubin in this volume), United Kingdom (Hatherley 2008), and Australia (Sur in this volume), with Communist and Socialist modernism in the Eastern Bloc (Fehérváry 2013, and Schwenkel 2020), and Modernizing Developmentalism across the non-aligned world (Holston 1989; Elinoff in this volume; Brownell in this volume; and Zareei in this volume). Brutalist architecture, Soviet Era modernism,

9 Bowker and Star have famously noted that infrastructure becomes visible when it breaks down (2000, 35).

and planned cities in places like India and Vietnam offer striking examples of the ways concrete was envisioned as essential to the crafting of futures that were premised on values of redistribution and public good. These histories were not isolated but interwoven: Construction practices in Chicago were essential to building the US imperialism in Manilla (Martinez 2020, and in this volume). Similarly, urban innovations in East Germany contributed to the redevelopment of post-war Vietnam (Schwenkel 2020).

In so called post-colonial states like Brazil, concrete offered a means of enacting a dual rupture, breaking from both from the colonial and pre-colonial pasts (Holston 1989). In Thailand, monarchs and early military-state-builders used ferro-concrete construction to generate what architectural historian Lawrence Chua (2014, and 2021) has referred to as "architectural grammar" for the modern state, which built racialized and gendered assumptions about proper citizenship into emerging public projects, buildings, and spaces. In Tanzania, Emily Brownell (2020, and in this volume) demonstrates how cement figured as a critical, but elusive material in the making of the post-colonial state and how its production was a complex socio-technical achievement, which marked it as a limited resource, distributed in highly uneven ways.

As our chapters explore, concrete construction was essential to the pursuit of modernities imagined and enacted in real time. Indeed, aspirations for modernity conscript concrete into mass infrastructural projects like dams as well as micro-scale projects of artisanal homebuilders (McDuie-Ra and Chettri 2020, and Menon 2023). At both large and small scales, uncertainties (Whitington in this volume) and risks (Archambault in this volume; Chettri in this volume; Cypher in this volume; Menon 2023; Menon in this volume; Stoltz in this volume; and Jerstad in this volume) pervade the pursuit of futures built in concrete.[10]

10 Rachel Cypher's chapter in this volume on the well-known Biosphere 2 project demonstrates precisely the limits of the material in the construction of both ideas of utopia and actually existing utopian projects.

Figure 1.4. Bullet-riddled wall repair, Iraq. Photo credit: Debra Ellis.

Adrian Forty (2012) asserts that concrete's capacity to be used by both amateurs and professionals is one of its most important, even democratizing, qualities. Forty argues that concrete has generated new possibilities for mass assembly and mass governance in built public spaces like large assembly halls, reconfigured plazas, and wide sidewalks and streets (2012, 145). Concrete walls and roads in turn have also been deployed to prevent such assembly (see Abourahme in this volume; Sharif in this volume; and Rubaii in this volume). In narratives that deploy temporal tropes of progress versus backwardness or modernity versus archaism, concrete lands on both sides and often lends itself to material conditions that, rather than liberate, democratize hierarchy.

Concrete infrastructures like roads promise new relations and possibilities (Harvey 2010; Harvey and Knox 2015; and Mains 2019). According to Harvey, these relations are not mere byproducts of travel (or as Fullilove [2016] put it, disenfranchisement) enabled by highways, but fundamental to the imaginaries and processes behind their creation and to the ways they

Figure 1.5. A new rail project takes shape next to the ruins of a failed project on the outskirts of Bangkok, Thailand. Photo credit: Eli Elinoff.

instantiate costly inequalities new and old. Attention to wide-scale infrastructural ambitions wrought in concrete exposes both the underlying ambitions of mass constructions and the means by which such ambitions might be achieved.

At the level of mass construction, the tectonics and aesthetics of concrete were fundamental to the infrastructures of architectural modernization in a range of forms: tall buildings, interconnected highways, electrical grids, and mass urbanization were outcomes of concrete-based construction. Such construction has made possible the emergence of new forms of spatial segregation (Caldeira 2000, and Abourahme 2015) and anchored speculative real estate capitalism that exacerbates existing regimes of exclusion (Harms 2016, and Shatkin 2017). By the turn of the twenty-first century, the world's cities transformed into engines of capital production powered largely by debt-fueled construction itself (Harvey 2008, and Elinoff, Sur, and Yeoh 2017). Waves of construction booms and real estate busts have peppered global cities with largely empty high rises, marking debates about the urban commons as a critical site of political struggle in this new era (Holston 2019).

Meanwhile, cheap cement and mass-produced concrete blocks enable millions to not only gain a toehold in the world's exploding cities (Archambault 2018), but also to make new claims to belonging through the forms of their houses (Elinoff 2016; Gastrow 2017; Stoltz 2019; and Menon 2023). Similarly, construction labor has been fundamental to both driving and receiving an increase in labor force mobility, as workers follow flows of capital into cities for work (Bowers 2019, and Mains 2019). Beyond the political economies of urban growth and construction, concrete labor reveals in both large and small ways the imprint of capitalism, and its inherent contradictions. In this, the materiality of concrete is an enactment of what Brian Larkin (2013) calls the poetics of infrastructure.

Where it does not fall apart on its own, concrete is often subject to demolition. Laborers equipped with mallets, bulldozers, backhoes, and jackhammers hasten the process of ruination as a means of generating new value where obdurate structures still stand. Concrete's afterlives offer intense scenes that generate forms of labor (Butt 2017), idioms of critique (Johnson 2014), and spaces for political debate (Elinoff 2017). In this always imminent state of collapse, remnants of old concrete constructions reflect both past and present sites of "imperial ruination" (Stoler 2013) and extractive exploitation left behind by powerful forces of political and economic transformation. Rubble, Gastón Gordillo (2014, 25) notes, is the "void that haunts modernity." For Gordillo, piles of rubble are evidence of the fact that capitalism does not merely produce space, it also destroys it. Piles of rubble are essential features of the production of new landscapes of value in burgeoning cityscapes (Harms 2016). Concrete waste itself is also subject to productive imaginaries transforming old walls, roads, and foundations into new construction projects as recycled aggregate.

Ironically, while it may promise to endure in one way — as a house or a bridge — what is most lasting about concrete is the ecological and geological remnants of its making. Concrete's role in the making of human social life is emblematic of the general timeline by which communities across the planet have struggled unevenly with anthropogenic climate change. The era "Anthropocene" marks a global geology defined by human activity. Debates abound about how this planetary geological condition is defined — including about which humans and which social formations it includes, and about its timeline — and include attempts to find historical, geochemical, or social markers in the earth's strata (Davis and Todd 2017). These markers include radioactivity unleashed by the invention and detonation of nuclear weapons, chicken bones that mark industrialized meat consumption, markers of carbon related to the deaths of Indigenous people, and the pile-up of technogenic materiality that compose the material context of the present. Matthew Edgeworth (2018; Edgeworth in this volume; and see also Simonetti in this volume) has noted that one of the key markers of the Anthropocene will be the (relatively thin) layer of human constructions, both surface and subsurface, that comprises what he calls the archaeosphere. Edgeworth's conceptualization is sensitive enough to register the fact that the archaeosphere is not a passive stratum, but a layer that, like all concrete, continues to act.

Carceral Concrete

Concrete construction and destruction are not merely manifestations of tension-filled social, economic, and political histories. Instead, we argue and the contributors subsequently show, that concrete is a maker and a method in these processes. Concrete manifests the uneven, tension-filled political forms that inspire the imaginary of modernity, while also generating the boundaries that include and exclude people in those projects. It also creates the spaces and infrastructures for such projects to be lived and struggled with as real. The elusive promises of modernity and democratic inclusion are often materialized through concrete itself, but so too are they linked intimately with the role of concrete in carceral landscaping. Concrete reinforces historical divisions between human and animals, deepens the historically racialized category of the human, and toxifies air, water, and soil for all (Netz 2004).

Thus, concrete is integral to legacies of militarization and carceral violence (Rubaii 2018, and Lambert 2013). In particular the legacies of post–World War II development were deeply militaristic: World War II's camps, bunkers, and bombs have had critical implications for shaping post-colonial life (Dvorak 2018; Mrázek 2020; Harvey and Smith in this volume; and Byrne in this volume). As Greg Dvorak (2018, and Dvorak in this volume) shows, whether through US and Japanese fortifications, bunkers, nuclear test sites, or logistics, World War II's indelible impact on the Pacific and its people arose by and through concrete.

The Cold War also drew together military and civilian infrastructures in unprecedented new ways. Roads, dams, and other development projects were built across the non-aligned "third world" to offer development in trade for the elimination of the perceived communist threat. In Thailand, dissident regions were opened up to the US military on the back of developmental trades of infrastructure for military access that had occurred during the American war in Southeast Asia. Thousands of kilometers of what DiMoia (2018) calls "security roads" were constructed to provide better access to US and Thai military forces seeking to stamp out communist insurgency along the Lao and Cambodian borders. These projects were not limited to road building but also entailed the construction of wider infrastructure including dams, air bases, and interrogation facilities, also built of concrete, requiring the expansion of domestic cement supplies along the way (Elinoff 2022). Indeed, the wars in Southeast Asia generated landscapes dedicated to rest and relaxation across Asia in Bangkok, Singapore, Kuala Lampur, and further afield in Tokyo, Seoul, and Honolulu (Ouyyanont 2001, and Phillips 2020). In Soviet aligned contexts, similar urban scale transformations occurred. For example, Christina Schwenkel's study of reconstruction in Vinh (2020) demonstrates how postwar reconstruction in Vietnam required an enormous investment from and collaboration between East German engineers and Vietnamese planners resulting in the construction of new, modernist, planned cities. This history reveals the way that concrete connected disparate visions of progress across Cold War divides.

The twentieth century's infrastructures of war enfolded themselves into an era of "less than lethal" combat during the "War on Terror" in the first decades of the twenty-first century (Rubaii 2018; Graham 2011; and Weizman 2007). Kali Rubaii (2022, and Rubaii in this volume) has shown how cement and concrete were critical to the unfolding of new military techniques in Iraq as "temporary" T-walls, installed to channel insurgent mobilities and surrounding military bases, and becoming permanent artifacts of the urban landscape during and after US occupation. In Palestine, cement and concrete generate forms of exclusion through the creation of a separation wall and the construction of illegal settlements (Weizman 2007; Fields 2017; and Sharif in this volume). At the same time, Nasser Abourahme (2015; Abourahme in this volume; and Rubaii 2016) demonstrates how concrete has become an essential tool for making life livable in spaces of exclusion and exception by troubling the boundaries between the temporary and the permanent.

As concrete continues to function as a technology of war, it also forges tenuous, uneven, and sometimes hegemonic peace. In Colombia, the long denouement of the "War on Drugs" has been wrought in new infrastructures (Zeiderman 2020, and Zeiderman in this volume). The trade of infrastructures for peace reflects the critical role militaries and militarization have played in postwar logics of concretization. In this, concrete's military histories not only precede capitalist openings, but structure them in particular ways: Military logistics have been fundamental to the creation of "emerging" markets, "newly developed countries," and new territories of extraction (Cowen 2014).

As Macarena Gómez-Barrias notes, prior to extracting lucrative resources, extractive zones must be resignified as *terra nullius* by removing people (2017, 6). Thus, the world over, struggles surrounding cement production tend to be violent. This violence, we argue, is not incidental but fundamental to understanding the modes of extraction fundamental to all concrete constructions. The environmental impacts of the cement industry are not merely a question of natural habitat loss or ecological transformation, but equally about a multispecies politics of ecological transformation tied to logics of dispossession.

In *The Culture of Cities,* Lewis Mumford (2016, 149–50) noted that all urban growth is bound up in a contrast between "up-building" and *abbau* (un-building). For Mumford, un-building was not only a result of cement mining, but was rather attached to a wide array of extra-urban environmental harm entailed in urban growth, including extractions like agricultural production and coal mining. This insight informs Neil Brenner and Cristian Schmid's (2015; see also Brenner 2016) notion of "planetary urbanization," which extends conceptual attention to urban growth beyond concentrated urban forms themselves. In Southeast Asia, mass urbanization has ushered in a wave of extinctions as flora and fauna endemic to the region's karst formations are decimated before most can even be documented.[11] In the Pacific, coral beds have been detonated in pursuit of raw materials for cement production. Elsewhere, deep pits mark areas where marl has been pulled from the ground: certain cement companies have launched new efforts to remake the voids left by quarries into new kinds of post-extractive habitat.[12] In other places, like Amman, Jordan, quarries serve as military training centers (Rubaii 2018). These areas not only suffer from land loss, but also from the wider effects of mining on water and air pollution, exposures that force adjacent communities into a range of potential toxic encounters with particles small and large.[13]

The links between concrete, militarization, and extractive economies are not simply logistical or instrumental; they are

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11 In Malaysia, Sumatra, and Thailand, recently documented species of snail, spider, and gecko are at risk of extinction due to mining. See Juniper 2014.

12 Cement Sustainability Initiative, "Guidelines on Quarry Rehabilitation: December 2011," *World Business Council for Sustainable Development,* http://docs.wbcsd.org/2011/12/GuidelinesOnQuarryRehabilitation.pdf.

13 Matthew Gandy's chapter in this volume offers a different angle on the environmental questions raised by concrete, showing how the material becomes a new kind of microbiome staging ecologies to come, as urban surfaces are colonized by lichens and other microorganisms (see also Gandy 2024).

also, always, political. Reminiscent of uses of walls in divided wartime cities like Berlin or Baghdad, concrete walls have become integral parts of the contemporary city. Teresa Caldeira's (2000) classic study on the emergence of fortified enclaves in São Paulo reveals the way democracy in Brazil generated new regimes of social exclusion premised on the proximity of wealthy and poor citizens. Mike Davis's (1992) reading of Los Angeles argues that carceral architecture extends the logics of detention into wider aspects of the built environment, generating both an aesthetic of exclusion and confinement, and a related arrangement of space in the urban fabric. The results of this emergent urban condition are the proliferation of walled and fortified spaces, but also the expansion of police violence (see also Low 1997 and Murray 2011).

The modern carceral state is one predominantly forged and contested by and through concrete (Jones 2018; Dillon 2012; Carlton and Russell 2018; and Earle 2020). Prisons are spaces intimately bound up in the violence of colonial domination, race, and dispossession. Ruth Wilson Gilmore's (2007) analysis of California's prison building boom reveals that prison construction has been an important solution to that state's political-economic crises. Gilmore describes how, beginning in the mid-1980s, debt-financed prison construction itself offered a solution to deal with the surplus land, capital, and people generated by the era's economic restructuring and its wider socio-political effects. Mass incarceration was, as Gilmore demonstrates, an effect of a new spending strategy that not only propelled new construction but also the radical transformation of the legal landscape in the form of new, highly punitive, racialized policing around drugs and gangs in particular; the concrete structures of prisons were thus spatializations of this carceral economic fix. Heath Pearson's (2021) study of prison towns in New Jersey shows how concrete construction, work release programs, and prison economies weave concrete's expansion of carceral frames into the very fabric of American cities.

Concrete's role in the production of the carceral state is political and economic but it is also deeply intimate. Lisa Guenther's (2013) phenomenological analysis of solitary confinement suggests that concrete is an essential medium of force in that expanding regime of punishment. As she argues, the visual uniformity produced by concrete walls painted in gray and white generates a "ganzfeld" that "exhausts the visual experience of space by emptying it of the distinctions that pattern our experiences in open-ended but consistent ways" (2013, 176).[14] Phenomenologically, the wall does not play a metaphorical or abstract role in incarceration: it is the punishment operating by suppressing the senses.

In conversation with each other, Juli Grigsby and Damien Sojoyner (2018) extend these insights to consider the intimate relationship between prison walls and the gentrification of urban space. As Grigsby and Sojoyner put it, Black removal from South Central Los Angeles is legible as "capitalist surveillances" that link, "policing, displacement, and economic decline": Concrete constructions tie together these logics by enacting racialized carceral force through other means. Echoing Michel Foucault's (1977) attention to the spatiality of the prison, Sojoyner (2016) argues that the same logics of enclosure that structure the prison (and the carceral city) are fundamental to the relationship between schooling and mass incarceration in Black communities in the United States. Here, the logics of racial capitalism (Robinson 2000) are embedded in the material form of both new urban projects and their associated disciplinary technologies.

Indeed, few better examples of the relationship between the militarization of everyday life, racial capitalism, and concrete exist than former and, once again, current US president Donald Trump's championing of a concrete border wall between the US and Mexico. As Åshild Kolås and Lacin Idil Oztig (2022) note, Trump's passion for the border wall was not what distinguished

14 Erik Harms's chapter in this volume offers a rendering of concrete's sensory qualities, suggesting how its grayscale has been transformed in Vietnam into a source of value. Marina Peterson's chapter in this volume studies the sensory effects of concrete overpasses in LA, challenging us to consider the sonic resonances of the material.

him from many world leaders who have sought to fortify the national boundary (Besteman 2020), but rather his rhetoric of the wall as a kind of monumental project tied to his personal history as a developer with a vision of governmental rule.[15] In other contexts, Elinoff (2021) has called this deployment of urban materiality in the service of authoritarianism "despotic urbanism."

This is not to say that all walls are unilaterally oppressive, but rather that they are always politically deployed. Scholars of murals (Sluka 1992) and graffiti (Ferrell 1993; Peteet 1996; Phillips 1999; and Ünaldi 2013) have shown how even walls intended to exclude can be scenes of liberatory political expression. Michelle Stewart and Chris Kortright (2014) argue that graffiti is a set of practices that opens up possibilities to contest enclosure and logics of private property. In this sense the connections between concrete, militarization, and the carceral, though powerful, are not closed: concrete's capacity to become text, speech, and expression destabilizes political formulations in ways that offer an invitation to think about other forms of incursive urbanism as scenes of politics (e.g., McDuie-Ra 2021, and McDuie-Ra in this volume).

The political implications of street art mirror the complex lines of strength and fragility that mark all concrete. Its capacities to enforce the violence of order and hierarchy are cut through by concrete's inability to guarantee the order that it appears to promise. It is the tensions between these possible outcomes that mark concrete as a scene of power and as a modal form of resistance.

More Than a Metaphor

The chapters in this book explore how the social properties of concrete are as essential to the making of concrete worlds as its material properties. This volume itself is the culmination of a multi-year, international, interdisciplinary conversation among

15 Malini Sur (2021) has shown similar dynamics surrounding walls and militarism at the India-Bangladesh border.

most of the contributors. Concrete has been world-building, inspiring us to travel across continents and to gather online to debate resonances and dissonances. In carefully attending to concrete's social character, our chapters emphasize that to think with concrete is not a poetic gesture but instead a mandate to attend to the bound relations of socio-material worlds. In this sense, the concrete is much more than a metaphor.

While concrete itself is a unique substance worthy of its own interrogation, to ask of concrete's social properties raises broader critical questions about the relations between materials and humans, and about humans themselves. Social thinkers as early as Georg W.F. Hegel and Karl Marx have noted that concrete is also more than a material. As Victor Sacha Cova (2018) noted in introductory remarks at his workshop, "Concrete Anthropologies, Anthropologies of Concrete," the Marxian usage of concrete does not refer to a singular reality as it is often assumed, but rather to the "concrescence" of many abstractions into a complex whole. Here, the Marxian usage of concrete suggests a homology with the thing itself, a singularity composed of irreducible multiplicity (see also Blunden 2013, and Il'enkov 1982, 137). The concrete in history is not only very much like concrete objects, but is, as we show, increasingly composed of it. At the same time, as many of the authors in this volume demonstrate, political economies saturate concrete constructions.

Claude Lévi-Strauss (1969) uses the notion of the "science of the concrete" to probe the boundaries between science, magic, and art.[16] In taking up the relation between these diverse modes of thought he puts forward the figure of the "bricoleur" — the handyman — who, in contrast to the engineer, engages in heterogeneous thought practices that defy the rigid lines between science and magic. Although Lévi-Strauss notes that the differences between science and magic — between the bricoleur and the physicist — remain important, the science of the concrete sug-

16 Traces of concrete's magical qualities are evident in Naomi Haynes's chapter in this volume, describing the uses of concrete in Zambian Christian ritual.

gests that the innate, heterogenous qualities of human thought foreground a diversity of affordances that are brought together in the making of things. By troubling the dichotomy between science and magic, the work of the bricoleur brings together the physical and the social in effective ways. Lévi-Strauss's handyman is very much like a clever contractor, builder, or engineer who must think across domains of social, political, economic, spiritual, and technical practice in the making of worlds cast in concrete.

This attention to the blurry boundaries between scientific and mythical thought in some ways sets the stage for Timothy Ingold's reversal of Aristotle's "hylomorphic" proposition. Hylomorphism emphasizes how creation requires the bringing together of form and matter. As Ingold notes, "In the subsequent history of Western thought this hylomorphic model of creation became ever more deeply embedded. But it also became increasingly unbalanced. Form came to be seen as imposed by an agent with a particular design in mind, while matter, thus rendered passive and inert, became that which was imposed upon" (2010, 92).

The result of the sense that design is the imposition of form on matter, Ingold argues, is that the processual, deeply socially enmeshed quality of creation, which requires an engagement between skill and materials, is obscured. This has important implications for both how the boundaries between humans and things have been conceived and for our understanding of the ways in which things themselves might act together. He notes that because human craft was removed from discussions of material, "the textility of building gave way to an architectonics of pure form" (Ingold 2010, 93). By this, he means that construction emerges as a field of expertise governed by rules, rationality, and technique which reduces the role and knowledge of the builder. In other words, bricolage, the heterogenous, richly embodied skill of the builder, is replaced by universalizing technique, technology, and epistemology. This shift, in turn, telegraphs a radical transformation in our understanding of materials themselves, which become passive and inert, waiting to be acted upon.

The New Materialist turn in the social sciences (e.g., Latour 1992; Latour 2005; Braun and Whatmore 2010; Bennett 2004; and Bennett 2010) has emphasized that "things" are deeply social even as they maintain their own autonomous qualities. This approach confronts the history of political theory which tended to "cast anything non-human out of the political fold" (Braun and Whatmore 2010, xv). The effect of excluding physical things from the purview of political analysis, as theorists Bruce Braun and Sarah Whatmore put it, has been to see objects as instruments of politics rather than constitutive of them (2010, xv). Instead of seeing "technicity" as supplemental to the human, Braun and Whatmore argue that it is "originary" (2010, xvii).

Jane Bennett's notion of "thing-power" pushes this insight in a different direction: even if technicity is original to the human, materiality is itself "a protean flow of matter-energy" that marks "the thing as a relatively composed form of that flow" (2004, 349). Things, Bennett reminds us, are "vibrant" retaining their capacity to act in ways that defy human expectation, anticipation, and understanding. On the one hand, materiality and technoscience are irreducible parts of the human. On the other, things are stubbornly autonomous, operating according to their own flows of matter-energy that may be known but cannot be fully mastered. Penny Harvey (2019) suggests that attention to concrete's "lithic vitality" forges possible connections between animist awareness of "living stone" and the unpredictable dimensions of concrete.

There are differences across these positions: Ingold, for example, pushes against assigning agency to things, suggesting on the contrary that they are "swept up in the generative currents of the world" (2010, 95) and yet, he also notes that they are "energized by cosmic forces" or that they "mix and meld with one another" (92). Taking up this approach to concrete, Rachel Harkness, Cristián Simonetti, and Judith Winter (2015) emphasize that human gestures responsible for the crafting of concrete are precisely those gestures that are erased in the making of its timeless smooth surfaces. The skilled flick of a trowel or the careful pull of the finishing screed appears to erase human hands, making the imposition of form upon matter appear complete. And yet, as Harkness, Simonetti, and Winter note, those hands are irreducible parts of a process that is "never fixed" (2015, 323). The interactions between the hands of laborers, the contexts — both climatic and political-economic — within which those laborers work, and materials themselves shape the ways concrete acts. As Julie Soleil Archambault (2024, 303) notes, to ask about concrete is to consider "acts of building" as "ways of being." Attention to the social properties of concrete thus opens insights into the structuring systems and lived realities of our contemporary world.

By taking these complex premises as our starting points for an investigation into concrete, this volume deliberately inverts most writing on the subject. Works like Adam Neville's *Properties of Concrete* (2012) seek to offer comprehensive understandings of concrete's material properties so as to better allow human actors to impose form upon it. Inverting these ambitions, our chapters ask what might be learned about both concrete and the contemporary world if we started from a different premise: How do concrete's physical qualities enact its social qualities? How do its social, political, and economic qualities shape its tangible attributes? Considering the social properties of concrete alongside its material properties allows us to investigate the way concrete generates and is generated by a range of forces that are present in our everyday political, economic, environmental, and social lives.

The chapters in this volume return to these tensions again and again, showing how concrete housing shapes, structures, and transforms social relations; how political movements assert themselves and fall apart through the construction and failure of spectacular projects; or how regimes of labor bear themselves out in and through the lives of workers enmeshed with the materials they mobilize. These insights emerge from detailed observations set within a range of locales and cases.

Read individually, each chapter develops a conceptual framework for thinking through one of concrete's social properties and offers insights into the ways it is being mobilized and imagined in different places at different times. Read together, the volume offers us a sweeping comparative frame to think through one of the most important anthropogenic materials. This volume focuses our thinking and expands our imagination to make sense of how the social is enacted materially and how the material is composed of the social. As the authors in this volume demonstrate, concrete is both not a metaphor and more than a metaphor; attention to the concrete's social properties enacts these theoretical insights not as though concrete were social, but rather *because* it is.

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AGGREGATE

Eli Elinoff

Aggregate (noun) often refers to the stone and sand added to cement and water in the production of concrete. Concrete also aggregates (verb) by drawing together human, ecological, and social ingredients to build certain conditions of possibility. This chapter explores how the aggregating qualities of concrete make human politics in Thailand. As an aggregate, concrete collects, extends, and intensifies material transformation, social relations, and political power.

On May 17th 1964, Thailand's Bhumibol Dam officially opened. The opening ceremonies were attended by a range of Thai officials, US dignitaries, and the Thai king himself, Bhumibol Adulyadej, after whom the dam is named. The project was the first multi-purpose dam in Thailand, promising both electrical power and new irrigation capacities. The World Bank provided loans of approximately 72 million USD for its construction (World Bank 1965). These loans reflected the deepening of the Cold War "military gift economy" (Klima 2002) that linked Thailand with the United States, who staged wars across Southeast Asia from within Thailand's borders (Chaloemtiarana 2007, 75). The dam's construction was thus an infrastructural and political milestone.

To commemorate the day, the Thai Newspaper *Siam Nikorn* published a large photo spread showing King Bhumibol and Queen Sirikit touring the facility, inspecting the dam's controls, and listening to speeches. The images, which I encountered in the National Archives in Thailand, are too faded to reproduce here, but one stands out: In it, King Bhumibol sits aloft on a throne atop the dam. A royal aide is crouched low beside him. The king wears a military outfit. His eyes, covered by sunglasses, gaze toward a distant horizon. Behind him, ceremonial offerings are visible. The dam divides the frame in half: above are mountains and sky, below, the vast sweep of gently curving concrete.

When it ran, the photo took up half of a page of print, offering a sense of both the king as a technical engineer and as a divine ruler on earth. Photos like these have circulated around Thailand for over half a century. They are mobilized to highlight Bhumibol as the "Development King," a man of science, religion, and technical prowess, bringing both modernity and enlightenment to his people (Ivarsson and Isager 2011, 22). The image tells us something important about the mid-century material politics of infrastructure in Thailand, where concrete was fundamental to the renovation and reproduction of royal power (see Elinoff 2020).

A second, more prosaic, image reveals what concrete contributed to these politics and how it might betray them: A sepia toned line of trucks snakes through vegetation (fig. 2.1). The backs of the trucks are loaded and covered with tarps. The caption tells us that the trucks are carrying cement clinker from a cement factory in Takhli city in Nakon Sawan province to the Yanhee (later, Bhumibol) Dam project site in Tak province. Clinker is an intermediary part of the cement making process. The stoney gray lumps are a result of cooking limestone, marl, or other materials rich in calcite alongside various minerals in a kiln at over 1400 degrees Celsius. When ground and mixed, clinker becomes cement. For the Bhumipol dam, clinker pro-

Figure 2.1. Archival image of the cement clinker being transported to the Bhumibol Dam construction site.

duced in Takhli was shipped over three hundred kilometers to the dam site, where it was ground and mixed with sand and other stone aggregates onsite to become concrete. In the photo, the line of vehicles stretches to the vanishing point, suggesting the project's material intensity. All potential here, the dam was tied to the possibility of marl becoming clinker becoming cement becoming concrete. Like the other image, this one is also permeated by a power but one less complete and more open. It suggests the dam as a convergence rather than a finished infrastructure.

Read together, what can these images tell us about concrete becoming power?

Construction projects bring together materials, people, money, and ecologies. Drawn together through the production and movement of cooked stone, these social forces remake space, time, and social life. What can this rather mundane image of construction logistics tell us about not only the relationship between concrete and political power, but also the material's wider social and environmental properties? The two images that launch this chapter thus draw our attention to the dam as a site of aggregation where the symbolic and the material converge.

Understanding concrete through aggregation reveals that the material does not strictly produce political power. Instead, concrete gathers relations in specific, malleable, but often unstable ways. Concrete's aggregations suggest how the material remakes social orders and transforms space, making both amenable to building power in the world or, potentially, to corroding it. Aggregation moves us away from asking what concrete *is* politically toward asking how concrete *accomplishes what it accomplishes.*

This chapter explores three different renderings of aggregation: collection, extension, and intensification. Specifically, I describe how the construction of the dam *collected* people, capital, and power; *extended* complex socio-political relations and ecological impacts; and *intensified* spatial transformations in Thailand far beyond the immediate impacts of the dam itself. These changes produced some forms of power and generated new kinds of uncertainty that are now playing out ecologically. While concrete's capacity to collect highlights the material as a generator of socio-material relations, extension and intensification emphasize concrete's anticipated and unanticipated effects.

An Aggregating Aggregate that Aggregates

In 1915, Siam Cement Company's kilns started burning. The company, and therefore Thailand as a whole, produced 20,000 tons of cement that year. Thailand now produces 40 million tons.[1] Though neither economic nor political history in Thailand have been linear, the rapid expansion of cemented envi-

1 Siam Cement produces over seventy-five percent of the country's total output, around 37.5 million tons of cement per year (Research and Markets 2024).

ronments there has increased exponentially across the twentieth and twenty-first centuries.[2] The massive growth in production capacity and in consumption implies a host of other radical environmental, social, and political transformations not simply caused by cement or concrete but accomplished through it.

Nicholas D'Avella (2019, 6) emphasizes that concrete is a composite material, a collection of things that always exceed the apparent singularity of the objects that they produce. Of course, concrete collects materials — sand, air, water, stone — but D'Avella's conceptual formulation asks us to think beyond the material, extending concrete's chains of relations outward toward the social, economic, political, ecological, and imaginative worlds drawn together and produced through building practices. Rachel Harkness, Christian Simonetti, and Judith Winter emphasize that "[c]oncrete-making is a *gathering* of elements, their *resourcing,* and the *pulling of them together* into a routine of mixing and turning" (2015, 311, emphasis added). The process of mixing is thus simultaneously material and social. As Malini Sur (in this volume) asks, what else gets churned up as concrete transforms the world?

Concrete is also composed of aggregate. Aggregates are the stone, sand, and gravel that comprise anywhere from sixty-five to seventy-five percent of concrete.[3] While cement binds together these materials, it is the aggregate's quality, size, composition, and proportion that are essential for determining the final strength, cost, and aesthetic quality of concrete construction projects. In this sense, then, concrete is always an aggregate of aggregate.

If concrete is not just a thing but a process (Elinoff and Rubaii in this volume) or an "ecology of practices" (D'Avella 2019, 16), then the material is also not an inert result of things coming together in finished or passive form, but rather a genera-

2 There were important disruptions in the production of concrete during World War II and following the 1997 Asian financial crisis. I do not explore those moments here.

3 "Applications of Cement," *America's Cement Manufacturers,* https://www.cement.org/cement-concrete/concrete-materials/aggregates.

tor of relations and, so too, of reciprocal effects. In this sense, concrete's capacity to aggregate isn't just an abstraction but a fundamental insight into the material's social properties that is deeply tied to the kinds of open-ended worlds it produces. Concrete draws together heterogenous elements — both material and social — generating a range of diverse intentional and unintentional social, political, and environmental processes; in this it is an aggregating aggregate that aggregates.

Collection

Collecting is the act of gathering and bringing together. Cement production brings together limestone, minerals, and heat. Concrete gathers cement, water, stone, and sand. Construction entails the mobilization of these materials (alongside others, such as steel and glass to name two) through labor and capital, bringing them from one place and using them somewhere else to generate a new built form. A project like a dam requires this kind of collection at a very large scale. This is evident in figure 2.1, the image of the trucks carrying clinker to the Bhumibol dam site. Collection is thus a primary way to think about concrete as aggregator.

Thailand's domestic cement production began in 1915 with a partnership between Danish industrialists and the Thai monarchy. For the next forty years the country's cement production was limited to a single company, the Siam Cement Company. During this early period, the material was used for major public works as the monarchy sought to remake its citizenry to reflect the kingdom as a modern nation-state (Chua 2021, and Pinai in this volume).

The scale of the proposed Bhumibol dam challenged the country's limited supply of concrete and required the founding of a second cement company, Jalaprathan Cement, which was to be a state-run enterprise owned and operated by the Royal Irrigation Department. The US-based Tudor Engineering Company, working on behalf of the International Cooperation Administration, a forerunner to USAID, determined that the Bhumibol dam alone would require over 250,000 tons of cement (Tudor Engineering Company 1958). To meet this demand, the US Government supplied an additional 1 million USD loan to help create Jalaprathan as the official supplier of the material for the dam. Tudor's planning documents demonstrate that the dam and the parallel founding of Jalaprathan Cement were not just shifts in the material economy of cement in Thailand, but also in the country's political economy as it became more deeply enmeshed with the United States and its Cold War politics. Cement was a medium for the transformation of loan money into political relations.

In 1958, Jalaprathan's kilns began producing approximately 360 tons of cement per day. Located a few hundred kilometers from the dam site in in the provincial city of Takhli in Nakhon Sawan province, Jalaprathan's factory had rail access and proximity to marl, which it used for its "wet-process" production kiln. The convoys of trucks pictured in the image at the beginning of this chapter transported clinker from this plant to the dam construction site in Tak province, where it was processed into cement and concrete.

Takhli city is also home to a Royal Thai Airforce Base airbase. In the mid-1950s, the US military used the Takhli base to launch clandestine missions to provide supplies to Tibetan rebels fighting against the Chinese government (Roberts 1997, 34). Across the next decade the airbase grew through additional US military investment in construction, developing the runway and other base facilities. For the US, the base became a node of strategic operations for both overt and covert warfare across the region. The proximity between the base and the cement factory may have been incidental, but it suggests the way strategic investments clustered through the US military's wartime militarized investment in Thai infrastructures. Here, again, concrete collects things, economies, and relations, transforming social life and exerting political force.

Extension

Concrete not only collects things, it extends their reach. Extension involves forging complex, sometimes obscure connections across a range of scales. Concrete's compound structure reflects the inherently extended quality of its impacts. The forms of material collection I described above — quarrying, sand mining, aggregate mining, water usage, and heat from fossil fuels — entail transformations across distant spaces.

Concrete constructions also extend and transform wider webs of sociality. The Bhumibol Dam was the second major dam project in the Chao Phraya River basin, central Thailand's main aquatic artery. Its construction was complex and required the cultivation of new forms of expertise that entailed collaborations between the US and Thai contractors, builders, and engineers. Jakkrit Sangkhamanee's (2018) analysis of the earlier Chao Phraya Dam demonstrates that these collaborations required a social "dance" between experts navigating a host of complex power arrangements. These kinds of expert negotiations were also present in the construction of the Bhumibol dam, which required new engineering expertise that entailed sending Thai engineers to the US, and US-based engineers to work in a remote part of Thailand (Chatikanavij 1994). As the director of the project, Kasame Chatikanavij, described in his autobiography, the project also entailed the bureaucratic consolidation of a range of government authorities responsible for overseeing the country's electric supply into a single entity (1994, 66).

This consolidation not only had implications for how Thailand's energy was generated and managed, but also how water moved around the country. The Chao Phraya, Bhumibol, and, later, Sirikit dams all contributed to the radical transformation of the Chao Phraya basin (Molle 2007). The dams changed the flow of water in the country, bringing its management within the purview of a range of government departments. With this, water became an increasingly political object, to be managed and distributed in ways that reflected local debates about power and generating important forms of collaboration and resistance as water was moved to serve some interests above others.

These dams also shifted the region's populations, as indigenous uplands groups were dispossessed in efforts to securitize, protect, and exploit watershed areas (Peluso and Vandergeest 2011) and as farmers left rural areas to find work in the booming capital. The political machinations that generated the dam were productive of other processes that suggest how the large project realigned both the Ping and Chao Phraya Rivers and the country's social relations simultaneously.

The Bhumibol project extended impacts in other ways too, some quite distant from the dam and its cement quarries. Excess supplies of cement from the Jalaprathan factory were slated for use in other construction projects. The Tudor consultants evaluated the viability of Jalaprathan plant extensions in 1958, determining that there was no limit to the country's potential demand for cement. Thus, new projects were initiated — bridges, roads, hotels, and government offices — that fueled Bangkok's rapid urban growth in the 1960s and beyond (Ouyyanont 2001). The capacity to produce excess cement was an impetus to develop more concrete-based building projects. Similarly the increased supply of electricity from the dam fueled new ways of working and living around the country.

Just as the creation of the dam required the construction of a new cement factory, the founding of the factory required a new source of energy which took the form of lignite, a less dense, moister form of coal. Discovered decades earlier, the Mae Moh lignite mine and the power plant founded adjacent to the mine in 1958 were expanded to supply power for Jalaprathan's kilns. Here, the transformation of fossil fuels into concrete is visible. The lignite mine acts is an extension of cement factory and the dam reflecting how the carbon intensive transformation of lignite into heat and heat into cement extended the ecological transformation associated with the expansion of cement and concrete production in Takhli.

The politics of extension are not straightforward. The mine and powerplant at Mae Moh have been at the center of important controversies surrounding pollution. Like industrial pollution elsewhere, these controversies generated harm and important environmentalist counter formulations (Elinoff and Lamb 2024). As Tim Forsyth (2004) describes, the Mae Moh mine has been a focal point of local organizing since the 1990s. Social movements resulting from a series of "desulfurization" events raised the specter of the entangled health impacts of the power plant and the mining operations in the region. Locals experienced high rates of respiratory illness after unfiltered toxic dust was released. These movements were influential locally and formed an important node in growing environmental resistance within Thailand nationally. At the same time, Forsyth argues that the movements revealed the limits of environmental knowledge production in the region, highlighting both the complexity of the pollution events and the lack of information available to those wishing to challenge the Energy Generating Authority of Thailand (EGAT), the agency that emerged from the consolidation of power that took place during the construction of the Bhumibol dam. Despite their limitations, Forsyth emphasizes that these movements were critical in formulating the tone, discursive strategy, and tactical approach for future movements against industrial pollution.

My point here is not to assert a causal link between the Bhumibol dam and its concrete and the protests at Mae Moh, or any of the other political shifts I describe above. Instead, I want to highlight the ways that cement production for the dam extended socio-spatial and political change across diverse geographies in Thailand, generating new effects. By attending to the ways concrete extends relations of various kinds, we are forced to consider the effects of cement production beyond their immediate surroundings. The dam was an essential part of building and extending US-funded anti-communist counterinsurgency, and it also formed the basis for expanding lignite extraction that resulted, through a long chain of events, in the protests at Mae Moh and the formulation of new Thai environmentalisms. The one did not cause the other. Instead, the protests reflect the extended, if oblique, ecological and social impacts of cement production itself.

Intensification

The consistent expansion of the Thailand's cement industry across the twentieth century demonstrates intensification of the urban transformation taking place there from the 1960s onward. As supplies of cement grew, so too did the range of users of and uses for the material. Time lapse photos of the country's urban centers demonstrate an ever-expanding reach of hardened urban surfaces, stretching into the countryside.

Even in the immediate surroundings of the dam there were more transformations that were intensified by the completed project. For example, the construction of the dam generated new opportunities to commodify Thai lumber as the forests around the dam site were opened for companies to log prior to construction. The bidding for rights to these resources became a massive scandal that revealed state plans to monopolize the lumber industry, forcing various ministers to resign (Chaloemtiarana 2007, 76). Although that effort failed, the Bhumibol dam entailed a larger effort to construct roads to access forest resources. These roads were also associated with the increasing deforestation as demand for lumber for housing and furniture increased (Hirsch 1987). Debates over logging emphasize the way the dam and the roads built in relation to its construction enabled intensified ecological transformation, both in the immediate area around the dam and in the adjacent forests in the region. Transformations in forest cover had reciprocal effects in the changing dynamics of water drainage in the Chao Phraya Basin, intensifying periodic floods both in the region and as far as Bangkok in the Chao Phraya's increasingly "cyborg delta" (Morita 2016).

The implications of this intense spatial transformation were made clear in the historic floods of 2011. That year the rainy season was unusually long. The results of that rain were that reservoirs at the Bhumibol and Sirikit dams were fuller than normal for a much longer period than usual. When combined with several intense, late-season storms; political decisions to hold back water to satisfy rural agricultural constituencies; and astronomic high tides, the conditions were created for historic flooding along the Chao Phraya that extended from July until January of the next year. By late September 2011, areas surrounding Bangkok were inundated. The water didn't completely drain until January 2012. The disaster cost an estimated 45 billion USD, as Bangkok's industrial periphery, itself composed of infilled canals and paved industrial estates, snarled global supply chains for everything from automobiles to hard drives.

As geographer Danny Marks (2015) notes, the mismanagement of the Bhumibol dam's reservoir was essential to these floods. According to Marks, late releases of water from the reservoirs stemmed from a political desire of the government to placate farmers, resulting in too much water being let go too late. These politics can be understood alongside the intensification of spatial transformation associated not only with the dam's construction but with wider kinds of urbanization that have taken place across the Chao Phraya basin over the last fifty years. Intense deforestation, the radical transformation of the river's tributaries and their ecosystems, alongside the proliferation of concrete encased urban spaces all increased the calamity of the river's mismanagement and the scale and duration of the floods themselves.

The weight of those political decisions brings us back to those long lines of cement trucks and the dam's creation that I described at the beginning of this chapter. Concrete did not cause the floods, but it played a key role in both the historical and proximal socio-spatial changes that distributed both the water and political decision-making for water management across the country during those days. Concrete aggregations intensified both the kinds of ecological shifts taking place across Thailand and the nature of the political control of water in the Chao Phraya basin. Rather than explaining the floods by blaming the concrete, as some Thai environmentalists did, attention to the work of aggregation offers us a sense of the diverse convergences of historical processes, material politics, and spatial transformations that undergirded the intensity of the event. In other words, this history suggests that it was not a specific project that caused the flood, but the aggregate effects of histories and ecological dynamics set into motion through the relations that concrete was fundamental in generating.

This analytic difference helps us understand the effects of urban materialities differently. Rather than seeing them as the result of fixed and finished processes, attention to aggregation forces us to consider the relations that compose concrete and are composed by it. Attention to aggregation helps us consider the character and effects of the new relations that the material might be composing as it draws things and people together in novel and complex ways. Thinking with aggregation thus helps us understand more clearly what sets concrete into motion and why what it sets into motion inevitably remains unfinished and deeply uncertain.

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BECOMING

Penny Harvey and Constance Smith

Concrete is always becoming something else. It transforms from rock into clinker and clinker into cement, cement into concrete and concrete into a range of built forms: even as concrete decays, it becomes something else. Indeed, tracing concrete's Cold War afterlives across Britain reveals how this becoming extends from concrete's surfaces to its subterranean material depths. Concrete's becoming also fuses Cold War histories with post-nuclear geologies.

After World War II, concrete took center stage in the reconstruction process. Tower blocks rapidly came to define European urban landscapes, and to symbolize a new, engineered future. At the same time, concrete was also extending underground, as atomic anxiety prompted the construction of a wave of subterranean Cold War defenses. Following an interest in how concrete is engineered to contain nuclear waste, we began to learn more about the deployment of concrete to shield human bodies from radiation. On the website of Subterranea Britannica, a UK-based society founded by people interested in exploring underground structures and spaces, we came across records of 1,563 monitoring posts that were built in the 1950s and 1960s in anticipation of a nuclear strike. Spread right across Britain, they were operated by volunteers from the Royal Observer Corps (ROC).

These underground structures were small reinforced concrete boxes, cast twenty-five feet into the ground, tanked with bitumen, and covered with compacted soil. Entry was by a steel ladder, clamped to the wall of a vertical shaft that opened into a small room, designed to accommodate three observers. A toilet compartment also housed a portable generator. Inside the main room there were twin bunks, a single bed, and a cabinet housing the instruments needed to measure air pressure and radiation levels, including a pin-hole camera to indicate the location and size of a nuclear blast. From above ground only the entrance hatch, the ventilation shaft, and the outlet for the instruments were visible. There was no heating, and the bitumen did not always prevent the seeping damp from the surrounding soil. ROC posts were part of extensive Cold War infrastructures, a national network designed to watch for something that could not be directly observed. The physical impact of a nuclear blast would be registered as data by the various instruments, scrutinized by uniformed volunteer watchmen stationed underground in rotating shifts, and distributed to central control centers over telephone lines and radio waves. The concrete bunkers are the remains of an anticipated war that never saw any live action. They form one small part of the globally distributed legacy of post-war military preparedness (Reno 2020). We focus here on these lingering traces of concrete's Cold War deployment to think about its subterranean future (see Edgeworth in this volume).

The local ROC observation post was not difficult to find, but it was also easy to miss if one was not looking for it. Penny had passed the site many times without noticing it. A hundred yards or so off a country road, in a rural field on the edge of the Yorkshire moors, concrete endures in a very particular way. Buried beneath the ground, the concrete bunker is a barrier, embedded in the landscape. Its material stability maintains a separation

Figure 3.1. ROC observation post, West Yorkshire, UK. Photo by the author.

from the rock and damp soil that surrounds it, and from the radiation that would not pass through the thick concrete walls. For Britain's Cold War planners, the bunker served as a particular kind of shelter, a concrete skin or carapace to protect the underground operatives from nuclear fallout at the surface. In his elegiac writing on the concrete remains of the Nazi fortifications that constituted the "Atlantic Wall" during World War II, Paul Virilio (1994) was fascinated by what he described as "the atavistic quality of the bunker — the basic form of human shelter." He observed that these bunkers indicated that, "it was no longer in distance but rather in burial that the man of war found the parry to the onslaught of his adversary; retreat was now into the very thickness of the planet and no longer along its surface" (Virilio 1994, 46).

Facing the ROC bunker today, the overwhelming impression is a sense of abandonment: it is hard to imagine both the fear and the logistical practicalities that must have framed life in the bunker during its active service. Like many ROC posts, its useful life was short: deemed to be over in 1968, when other surveillance techniques replaced its relevance. This station has not been in official use since. The space was partially decommissioned, the instruments removed, but the concrete structure and the few basic furnishings had simply been abandoned. Yet the decay was slow. Penny's investigations found gates and a broken-down fence surrounding the bunker, but no serious security. The cover to the access shaft was no longer there, but the steel ladder seemed secure enough. From the information posted on various ROC enthusiast websites, we knew that others had ventured down the hole into the bunker in recent years. She climbed down into the total darkness. The light on her phone revealed the small room. There were rusting bed frames and a broken cabinet, water on the floor. With no cover to the access shaft, water had come in from above. But according to the various recorded visits from 2006 onwards, the levels had not risen significantly over the past few years, suggesting that the water was seeping away into the ground, the concrete "skin" no longer impermeable. Otherwise, the concrete was in good condition, smooth and relatively unblemished.

The concrete bunker had been designed as a container to protect human life, but now contains primarily rubbish. This accumulation of residues and detritus provides a record of the bunker's discovery by other groups of people over the years. There were discarded cans and crisp packets that suggested some kind of past conviviality and it was not hard to imagine that kids might have found the place an exciting den — not least because it was dark, cramped, and hidden away. One blogger who had visited the bunker on a previous occasion had found a whip, a dress, and some handcuffs and speculated that the bunker might have been used to shoot pornographic images. Though it now feels hard to connect this space with a nationwide network of volunteers in uniform, hidden underground anxiously waiting to map and register the traces of a nuclear blast, the ROC post still feels secret and vaguely threatening. Virilio observed of the bunkers on the northern French coast that though such structures may now be worthless in terms of the intentionality that drove their construction, in their endurance they retain some sense of protection and keep alive some trace of threat. In our ROC post, it is this atmosphere of threat and protection, in a domain out of sight, that persists alongside concrete's materiality: enticing as a site of exploration, ideal as a venue for illicit or forbidden activity.

This interplay between the surface and the underneath opens up questions of what happens in the land beneath our feet, and what happens as concrete ages. The ROC posts were created as a form of temporary burial to shelter from a world where a single weapon is so powerful that there is nowhere on the surface far enough away to constitute safe retreat. The concrete structures — as well as other debris — remain buried, and there are no plans to remove or dispose of them. They were built to ensure stability, but in many ways turned out to be quite fragile: not only was the political landscape of which the ROC posts were born less stable than it believed itself to be, but as the leakiness of the bunker Penny visited suggests, they also became porous in other ways, available for new kinds of underground activity. Concrete is in part a desirable and ubiquitous material because of its aura of stability and permanence, and it is the case that it decays slowly. But even as the concrete form or structure endures, its chemical structure changes, and it becomes less reliable over time. From a chemist's point of view, the concrete evolves. In practical terms, it degrades as it loses its primary functionality. We are intrigued by this afterlife and what this means for ideas about containment and protection, as well as future geologies.

Though the threat of the Cold War may have receded, anxieties about the uncontrollable capacities of nuclear energy still generate strategies and infrastructures that turn to concrete as a means of entombment. The concrete legacy of the Cold War looks quite different from the perspective of the contemporary nuclear industry, where concrete is understood to be vital to the stabilization of nuclear futures in a different way. The Sellafield nuclear power station on the northwest coast of England was also integral to Britain's Cold War infrastructures. It was built in the 1950s with the explicit purpose of producing the plutonium needed for the construction of nuclear weapons. Subsequently the nuclear program turned to the generation of electricity, and in more recent years, as the active life of the reactor has come to an end, Sellafield's business has centered on the reprocessing of spent nuclear fuels and the monumental task of decommissioning. By contrast to the abandoned underground structures of the ROCs, the encapsulation and burial of Sellafield's radioactive waste is the continuing focus of teams of scientists and engineers who are charged with the task of un-building the facility, and the design and construction of containment technologies that will ensure safe disposal with a time horizon of tens of thousands of years. Concrete is central to these strategies.

In our desire to understand more about how concrete ages, we asked a nuclear industry engineer about the timescales across which concrete might decompose. His response was that concrete "evolves" in a process of chemical transformation that depends on many factors, including its interaction with its environment as well as the makeup of the aggregate. Stabilization is not about producing a static or unchanging state but is about the management of material evolution. In the case of radioactive materials, the aim is to produce processes of immobilization that slow the material transformation down. The engineers and chemists involved in this work focus primarily on "grout": cement powders designed to maximize fluidity while minimizing water content. Hydration levels are critical because the aggregate used is the radioactive waste itself. This waste comes in many different forms. Spent fuel is vitrified and then placed in concrete containers. Less highly radiated solids such as metal claddings, discarded containers, or building materials are immobilized by becoming concrete. The grouts required for this immobilizing concrete have to be fluid enough to reach into all the corners and cracks of the radiated aggregate, but water content has to be minimized, as excess hydrogen introduces dangerous instabilities. Working with the chemical properties of the waste materials, including the rebar from concrete structures, and the saline qualities of sea air, the chemists and engineers conduct experiments in accelerated aging to test how the concrete will evolve over time. Immobilization of the most highly active wastes is further enhanced by embedding the concrete in very stable (i.e., slowing evolving and non-reactive) geologies, through forms of burial deep in the terrestrial subsurface. Here the ambition is to create an engineered technology of passive safety, whereby the rock itself will ensure that no further human care is needed once the materials are sealed deep underground. The stabilization of nuclear waste is thus imagined in terms of its rock-like horizon.

Geologist James Underwood (2001) has proposed a fourth class of rock, in addition to igneous, metamorphic, and sedimentary. He called it "anthropic rock," to acknowledge humans as geomorphic agents shaping the substance of the Earth. Concrete is one type of anthropic rock; bricks and glass would be others, according to his classification. As this debris compresses and condenses, deep in the geological time of the future these residues — with concrete foremost among them — will form their own stratum (Zalasiewicz 2009). Contemplating the concrete debris of nuclear infrastructure, from Cold War bunkers to geological disposal facilities, we are struck by the practice of concrete burial as a form of safekeeping: a way to mitigate the unpredictable energies of human experiments with nuclear fission by going underground. Beneath the earth's surface, imperceptibly slowly, the traces of concrete's pasts are becoming part of the planet's geological future. Or as our engineer colleague put it, somewhat more poetically, the Sellafield site might in the end "eat itself," as the buildings become rubble, become aggregate, and ever so slowly, become rock.

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BELONGING

Claudia Gastrow

Belonging is a material condition. This chapter describes how in Luanda, Angola, cement opens possibilities for imagining belonging through the built environment. In its malleable form, cement allows for experiments with place-making, while once hardened in concrete, it often forecloses residents' futures through development projects that displace populations, destroy environments, and leave behind chunks of material that cannot be repurposed. An unresolved contradiction therefore dwells in the material: while cement might bind, concrete often restricts, suggesting that cement's material qualities are an ambiguous site for building belonging.

Adalberto[1] moved to Vamos Andar[2] in 1998, shortly after being discharged from the army. Located in Cazenga, Luanda's most densely populated municipality, Vamos Andar is made up of a mix of colonial-era houses and more recently constructed

1 Interview with Adalberto. Cazenga, Luanda, May 11, 2011.
2 Pseudonym

concrete-block homes. A friend of his had given him the land, which was largely swamp. Adalberto used sand to fill it up and cultivated sweet potatoes that still grow on the property. With little money and no jobs, he and his wife baked small cakes to begin saving toward construction materials. They were lucky enough to get their hands on cheap bricks through a factory in Boavista, a neighborhood near Luanda's port. With this, they built a two-room home. Once the basic house was completed, Adalberto had a stable base from which to seek employment, and he took on work as a mechanic as well as getting involved in a fishing venture. These activities allowed him to gradually purchase supplies to add on to the house, one concrete block at a time. As his fortunes improved, the concrete blocks of the home echoed this. He added two bedrooms for his children, an outdoor kitchen, a pantry, and a large lounge. He was hoping eventually to build a second story and expand the kitchen to make it more "modern." His house connected him to the city, opening up the possibility for official recognition of his right to land and housing. From this dwelling, his family grew, creating relationships of care and inclusion that stretched from the home into the neighborhood, and into institutional spaces such as churches, markets, and schools. Adalberto's incremental building process materialized aspirations of urban belonging, of having a stable home and place to dwell, into long-term investments in cement (Melly 2010).

Belonging is a material condition. Passports and identity documents perform and produce belonging to the state. Embodied rituals, sartorial practices, and food choices mark affiliations to ethnic, religious, and national imagined communities. In contemporary cities, few materials are as important for thinking through the materiality of belonging as cement. Cement has transformed the material basis of the urban and with that, how urban belonging is imagined. In the form of concrete, this material revolutionized twentieth-century urbanscapes, allowing volumetric reimaginations of cities, the expansion of freeways, and the construction of mass housing. These reshapings of the built environment troubled established hierarchies by providing novel perceptual experiences and material opportunities that enabled a reimagining of class, racial, and gender relations (Brown 2017). Nevertheless, while cement has historically opened up new possibilities for imagining belonging through the built environment, its product, concrete, often forecloses opportunities when development projects displace populations and destroy environments, and when the material itself cannot be repurposed. While cement might bind, concrete often destroys or limits. An unresolved contradiction of belonging and exclusion therefore dwells in cement.

The abovementioned ambivalence is evident in cement's remaking of post–World War II Luanda's urbanscape. During this period, the rise of colonial Angola's financial fortunes along with rapid white settler immigration led to a construction boom in its capital. The constant building transformed Luanda into a city characterized by "towers of cement and iron" (Amaral 1968, 25). The planned, predominantly white, settler city center became colloquially known as the cidade cimento (cement city), describing not simply the materials that constituted its modernist high-rises, but the imaginations of modernity and permanence that concrete inspired. The name contrasted with the unofficially planned and built largely African areas of the city, known as musseques, a term derived from Kimbundu, meaning "place of sand." In these neighborhoods concrete-block homes were comparatively rare. Given high rates of demolition in a growing city, musseque residents viewed concrete blocks as a risky material. It attracted the ire of authorities and was difficult to recycle if houses were destroyed (Monteiro 1973). Following independence in 1975, however, when antagonistic landowners and authorities ceased to be of major concern, musseque residents increasingly sought out cement in order to build concrete-block homes.

Concrete use boomed with the end of socialism in Angola in the early 1990s, as the liberalization of the economy provided new opportunities for accessing it. Luandans came to refer to concrete-block construction as *construção definitiva* (permanent construction). This term distinguished *casas de bloco* (concrete-block homes) from houses built using wood or zinc which were referred to as *construção provisória* (provisional construction) (Gastrow 2017). Cement marked permanence, linkages to global chains of exchange and capital, and financial security, even as it had historically also been a marker of exclusion. Concrete, then, has a history of expanding and contracting the material conditions of belonging in Luanda, one which it enacted yet again in the early 2000s as the city experienced a new moment of accelerated urban expansion.

Following the end of Angola's civil war (1975–2002), Luanda, the capital, became a site of rampant land and real-estate speculation in the midst of surging demand for housing. In a country whose primary source of revenue was oil, speculation was further fueled by record-high oil prices that began to surge in 2003, just a year after the end of the war. Petrodollars poured into Angola, enabling the post-conflict state to enact construction projects that had long been stashed away in office drawers and to attract private investors from across the globe who hoped to profit from the oil boom (Cardoso 2016, and Gastrow 2020). New middle-class and elite housing projects as well as post-conflict redevelopment schemes such as road extensions and beautification initiatives involved the destruction of thousands of informally constructed homes. The destruction of musseque areas disrupted longstanding practices of informal occupation and construction through which people had come to build homes, lives, and futures. Most pointedly, it refused to recognize the primary material substance through which people now created a link to the city — concrete.

The rise of cement, and its compound form, concrete, is a global story. In the last two decades, concrete consumption in Africa has steadily risen. This is partially due to major state-driven and private sector construction initiatives in the form of new infrastructure projects and satellite city investments, but equally to concrete's increasing affordability and popularity with self-builders such as Adalberto, who have turned African cities into "cemented worlds" (Choplin 2020, 1981). Across Luanda's urban edges, house-builders have transformed the landscape into a metamorphosing construction site, as they fervently store the materials for concrete buildings — bags of cement, piles of sand, iron rods, and crushed rock — on their journey to becoming homeowners. What were once rural small holdings are now urban spaces. Concrete-block houses created the city as they rapidly popped up on the landscape. If in the past adobe, reeds, wood, and other more "traditional" materials characterized such autoconstruction, concrete has rapidly outstripped them as the material of choice (Archambault 2018). The reasons for this are multiple. Scholars studying cement and concrete on the African continent have noted that it is associated with modernity, and therefore speaks to aspirations of personal progress and membership in a global community (Archambault 2018, and Degani 2020). It has also become an index of status and financial success (Choplin 2020).

In Luanda, cement binds together sand, water, and rocks to produce the concrete blocks of the much-desired casa de bloco. Cement materially binds those who build their homes to the city. As people build, they begin to mark out a space of ownership, property, and recognition through legal contracts, administrative relations, and neighborhood relationships. They thereby not only become urban citizens, recognized as being in place and therefore entitled to rights accorded by official and unofficial regulations and norms (see also Holston 2008), but they also make place by building affectual relationships to sites and people through newly situated forms of belonging. In a city where laws rarely protect the poor from the impunity of the wealthy and where title-deeds are almost impossible to come by, the concrete-block house is the primary means through which residents claim space, make place, and demanded recognition — by building links to state institutions, neighborhood organizations, and city infrastructures it becomes the object through which belonging is materialized (Roque 2009, and Gastrow 2017).

Yet, concrete can also be uncannily fragile as Luanda's demolition victims discovered. As bulldozers toppled the city's

Figure 4.1. Construction materials, including concrete blocks. Mundial, Luanda. October 15, 2011. Photo by the author.

musseques, residents' sense of material belonging was gradually undone, the move to *chapa* (corrugated iron) or, even worse, *tendas* (tents) indicating the material unmaking of belonging through the loss of concrete forms (Gastrow 2017). It was this material unmaking about which many Luandans worried. If the government was coming to "redevelop" Cazenga, an act that had been threatened for years and that largely envisioned the relocation of residents to other places in the city, Adalberto wanted compensation for the value of his concrete house, which he felt was worth more than other house forms. He explained that his house took dozens of bags of cement to build and thought that the house would now probably cost 50,000 USD to construct. Thus, he argued that if the state demolished it, his single house was worth, at minimum, three of the low-cost "social houses" supplied by the state to demolition victims. His concrete-block house, erected through years of incremental investment, had, in his eyes, generated claims to recognition and compensation, that is, to a stake in belonging to the city. In practical terms, concrete unmaking needed to result in a comparable replacement so that the material making of belonging could begin again, through rebuilding.

The story of autoconstruction in Luanda is both that of making and unmaking belonging through concrete. As people are expelled by the cement of state and private investments in real-estate and infrastructure, concrete-block houses pop up ever further on the urban periphery as the forcibly removed seek a space of refuge. The material, geographic, political, and racial histories that run through cement constructions in Angola hold together the material's contradictions — its existence as a sign of exclusionary colonial modernity, musseque dwellers' embrace of it as indicative of post-colonial modernity and urban belonging, and its role in displacing Luanda's poor, both pre- and post-independence. These qualities of concrete can lead people to feel their exclusion from the city, from the elite's political concerns, and from global circuits of wealth and imaginations of modernity (Degani 2020). Cement's situational existence opens and forecloses possibilities of belonging as it finds itself complicit in moments of extreme repression and disappointment, as well as optimistic world-making.

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CHURNING

Malini Sur

To prevent premature curing, concrete must be churned continuously. Laying wet concrete also entails the churning of histories; new urban landscapes mix ongoing social turmoil with legacies of competing territorialities. This chapter explores the convergence of these forms of churning. Concrete gathers political force, mixing old and new terrains of struggle by recombining unsettled layers of Indigenous, migrant, and colonial peoples' presence on the land in new built forms.

As cranes pierce the sky heralding Sydney's new concrete horizons, the massive arch of the Gladesville Bridge and the recognizably round shape of the Australia Square stand the test of time as Sydney's iconic concrete architectures. Designed by British and Australian engineers, the arch of the Gladesville Bridge was, in the 1960s, the longest single-span concrete arch in the world. Constructed with 78,000 tons of concrete, this bridge marked Australia's transition from steel bridge technology to concrete design. A huge floating crane carefully placed the concrete slabs in position over the Parramatta River (Cole 1983,

Figure 5.1. Gladesville bridge. Photo by the author.

and NZ Engineering 1963). Four years later, the Australia Square became both Sydney's first skyscraper and the world's tallest lightweight concrete building. From the 1000-foot Gladesville Bridge that spans the Parramatta River near the Sydney Harbor, to near the river's source in the city of Parramatta, the site of Sydney's emergent second business district, concrete is intrinsic to urban transformations. Australia uses 29 million cubic meters of pre-mixed concrete every year (Cement Concrete & Aggregates Australia). Perennially under construction, conical concrete mixers ferry materials and enter sites in Sydney and Parramatta to find their designated spots in the queue. Humming motors churn concrete. Churning is essential to the making of cities.

Churning — the spins and stirs that make concrete a fundamental material for city building — is far more than a mechanical process that binds together cement and aggregates. Churning exceeds concrete's material forms; it foregrounds

Figure 5.2. Parramatta under construction. Photo by the author..

the political forces that make and unmake new territories and identities. What can we learn from histories of city building and accounts of contemporary life that revolve around concrete modernity? What can attention to churning tell us about the changing social and material forces that re-order the bush, farmlands, and cities? Churning invites us to rethink the historical potency of concrete, its surreptitious violence, and its contemporary ubiquity through spirals of dispossession and exploitation — of Indigenous Lands, of convict labor, and of urban life — in multicultural Australia. As a material process, churning has implications for the ways histories of violence resurface and play out in the present. Churning sets into motion new cities on sovereign Indigenous lands and heralds unknown futures.

Churning Concrete

In 1896, concrete first appeared in the then-colony of New South Wales in the form of a bridge over the Black Bobs Creek. Engineers regarded concrete as a practical building material because structures could be constructed with rudimentary tools, unskilled labor, and mostly local materials (James and Chanson 2000). For example, concrete was used to line the insides of cast iron piers, which provided support and protection against alkalinity (Ash and Henricks 1996). Experiments in cement-making in New South Wales began in 1889 (Fenwick and Homes 1993). By the end of the first World War, cement imports had tapered off as local technologies expanded. During the 1920s, new technological advancements in Australia increased the size of rotary kilns, developed compartment mills for grinding limestone, and mechanized the entire process of manufacturing, from quarrying to packaging and distribution (Lewis 1988, 8).

Adrian Forty has productively analyzed concrete's intrinsic relationship with modernity as well the ambivalences that define it. Part of this ambivalence, Forty argues, rests on a tension between concrete's progressiveness as a modern material and what he calls its "residual primitivism." As concrete's primitive elements — such as mud — merge with its modern industrial form, they become a specific kind of matter that moves between the natural and the built environment (Forty 2012, 14–16). This amalgamation of natural elements and new technological advances lend concrete its ambivalent symbolism: at once ultramodern and spatially violent (McDuie-Ra 2018). In New South Wales, concrete's "primitive-ness" exceeded its material forms. Concrete's arrival, adoption, and legitimacy came to reorder prior relationships with land and water in ways that tried to erase and render invisible Indigenous sovereignty and culture. Over time, concrete became a racial and punitive marker of civilizational hierarchies between British officials and their convict laborers, as well as among settled peasants and Indigenous nations.

Long before modern transit networks existed in New South Wales, what is today known as the Parramatta River flowed through Burramatta, Darug Land. It served as a vital life source for Indigenous sovereignty, providing food, water, and materials to construct shelters, weapons, and canoes, and it held immense cultural significane for ceremonies (Cole 1983, 7, and Franklin 2014). Soon, the river transformed into a passageway for settlers and colonial officials moving inland from Port Jackson to Parramatta, as well as for farm produce to be sent downriver. In the early colony, both wheat cultivation at Parramatta and the demand for water were fundamental to the survival and flourishing of New South Wales. By the mid-nineteenth century, Parramatta had become the colony's food bowl. In 1856, a dam was constructed out of sandstone blocks on the Parramatta River to meet the water supply needs for rapidly expanding claims on Parramatta's land and produce. In 1898, the single-arch ashlar masonry dam wall was raised by a two-meter-high concrete "layer" to cope with increasing demand for water to cultivate food (Ash and Henricks 1996).

Old concrete infrastructures like bridges were far more than emblems of colonial modernity. Similarly, they were not simply infrastructural conduits built by convicts and settlers over which horse carriages, and later motor and rail traffic, would channel people and goods throughout the colony. They were also a means of dispossession and violence. In her work on the violent cultural history of Aboriginal incarceration in Parramatta, Corrinne Sullivan, Indigenous scholar from the Wiradjuri Nation, recounts how Aboriginal girl children were forcefully removed from their families and imprisoned in institutions like the Parramatta Girls Home under the guise of education and moral reform (Sullivan 2017, 90). She suggests "a powerful convergence of a shared history" where all residents — Aboriginal and non-Aboriginal alike — experienced violence and shame, yet also managed to find solace and comfort in one another (Sullivan 2017, 90). Officials inflicted pain, abuse, and torture, and the management of the buildings, grounds, and walls included hard labor and punishments. The large buildings that were in poor condition, and the high walls that enclosed them made the institution "prison-like," generating feelings of "foreboding and trepidation" among the girls (Franklin 2014, 160).

Notably, the Home's polished concrete floors feature throughout the testimonies of its former residents:

> Ask any Parragirl why the concrete on the covered way shines so well and she will tell you it's because of the skin worn from her knees as she scrubbed it night after night. [...] If girls at Parramatta were caught sleeping facing the wall, they would be dragged out of bed and taken to scrub the concrete walkway on their knees with a bucket of water and a brush. [...] Scrubbing concrete, floors or rafters, sometimes for more than 12 hours, was a common form of punishment. (Parry 2015)

Concrete's domestication churns memories of the brutal reconfiguration of space as penal institutions incarcerated unruly residents, marking Aboriginal girls through what Sullivan calls a "categorial devaluation of culture and identity," both within and beyond the premises. This re-ordering and gendering of urban space attests to colonialism's lingering impacts, Sullivan writes, surfacing through an imperceptible urban presence (2017, 93). The area where the girls were incarcerated and the Parramatta River that flows alongside it — which were historically sites of women's ceremonies — continues to be of great significance to the local Indigenous Darug peoples (Franklin 2014, 159).

Cities for Multi-Nations

Today, several residential mega-developments dot the northern bank of the Paramatta River. The Promenade, one such development, houses 774 apartments spread along 1.2 hectares of landscaped, foreshore, open space. A pedestrian bridge links it with the river, which is lined in several parts with carefully preserved mangroves, all secured with a neat concrete bank. This construction project, like several others scattered across

Parramatta, embodies the significance of both concrete and the riverfront to the city's urban renewal.

The Promenade adjoins the wetlands named after Baludarri, a Darug youth who mediated early contact with British officers. Baludarri's life, his travels to England, his conflicts with resettled convicts, and his presence in the bushlands today are all stories of churning. Consider one such story: After convicts encroached upon Baludarri's livelihood as a fisherman, he speared one of them in customary retribution. Outlawed after this incident, Baludarri took up residence on the fringes of Parramatta until his sudden death from smallpox during an epidemic. Following Baludarri's death, the emergent fishing trade ended abruptly (Goodman n.d.). Baludarri's enduring presence alongside the concrete Promenade — in the form of two sculpted canoes — gestures to restituting Aboriginal histories on the land.

Poet Gabriela Coronado (2022) gives expression to the Baludarri Pathway, concrete-lined pavements located in a landscape of old mangroves and trees, against the din of new construction: "I overhear birds / And voices / And laughter / And footsteps // And squeaking / Bicycles / Getting closer / Making me shake." The poem conjures a contemporary, cacophonous churn of birds, bicycles, river, ferries, and construction noise. The expanse of old trees with "ancestral wrinkles" has a shortened sky as high rises encroach on its horizon. In a landscape haunted by old silences and new sounds, Coronado channels Baludarri's spirit and absence: "The canoes / Also await him / But are deserted / He doesn't come anymore // Perhaps / He was frightened off / By the constructions // Their annoying / Hammering / And shouts" (Coronado 2022, n.p.). With every ferry arriving from Sydney, the waters of the Parramatta River ripple and cascade alongside the mangroves lining the craggy concrete skyline. The low levels of dissolved oxygen in the waters kill fish.

In Parramatta at midday, sounds from construction eclipse human voices. Long gone are the elderly Chinese chess and table tennis players near the Town Hall that is under reconstruction; in their place, at a distance from the construction site, Falun Gong protesters clutch images of harvested organs. But in the evenings, after the commuter crowd hurriedly departs Parramatta for Sydney and other suburbs, the old square comes alive with the sounds of diverse languages. Youthful and exhausted workers speak to their families in South Asia, the bright screens of their mobile phones flickering in the dimming light. At a distance, neon illuminates the concrete slabs that support the railway tracks, generating a glare designed to dissuade unhoused people from taking shelter here on cold winter nights. With every upbeat celebration of multiculturalism — with every carnival and every whiff of curry — Parramatta gets more and more distant from Sydney, even as the cities remain twinned in concrete.

From Sydney's iconic skyline to Baludarri's pathway, the making of concrete in complex landscapes entrenches rather than erases manifold forces of violence and resistance. The humming motors of concrete mixers anchor pasts as well as futures yet to come. The process of churning circulates dust, as old buildings and the ground itself are razed and broken. As cities continue to rely on extraction, construction, and frontier imaginaries, concrete fills and moves new layers of urban history (Sur and Kerr 2019). Churning unsettles the language of sedimentation; the palimpsest of history sets itself in a way that is inconclusive, likely to be stirred up by new construction. This is exactly what concrete does: it recalls divergent pasts of violence and erasure, and sets them in motion in the present. The changing forms that concrete takes — from stratified geology to infrastructures of connection, and feats of colonial engineering to the building of multicultural cites — rely on the extraction of labor, and the grazed knees of young girls. Fragmented histories are cast into the air in the present. Stirred up, and built into concrete, these settle uneasily on Indigenous lands and water.

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CONNECTIONS

Austin Zeiderman

Concrete forges connections, not all of them good. In Colombia, infrastructures like bridges not only link commercial nodes, but also serve as vectors for violence and peace. These built forms have the power to evoke collective memory and to produce conditions of mobility that enable new connections and threaten to sever old ones. This chapter explores the question of connectivity near a river town whose violent past and uncertain future both hinge on concrete in infrastructural form.

Concrete infrastructures are storehouses of memory that connect past to present. They may conjure biographical minutiae, but their size and scale suggest histories that are shared, not only with those near and far, but also with those before and after. The capacity of infrastructures to summon collective histories is magnified for those whose lives unfold around them. People with intimate knowledge of a stretch of highway, for example, can be especially attuned to events that once transpired along it. In Colombia, where the following account is based, concrete in infrastructural form is inextricably linked to people's experi-

Figure 6.1. New bridge over Magdalena River under construction, Puerto Berrío. Photo by the author.

ences of armed conflict, as connectivity produces new kinds of relations and severs others.

For a septuagenarian whom I will call Don Raúl, concrete infrastructures like bridges and their constituent materials give shape to memories of violence endured over half a century. As I was leaving Colombia's oil capital of Barrancabermeja at the break of dawn, the night watchman at my hotel, in a gesture of kindness, gave me the phone number of his father-in-law, Don Raúl, who happened to live in Puerto Berrío, the town where I was headed. Puerto Berrío was an epicenter of violence, the site of numerous massacres and countless disappearances—a place where knowing whom to speak to is vital. Don Raúl, I was told, knew the area better than anyone. I pocketed the scrap of paper with his number and made my way to the bank of the Magdalena River. I bought a ticket for a motorboat and climbed aboard, wedging myself into place for the three-hour journey.

Once the passengers were seated, the pilot fired up the outboard motor. The boat skimmed the water's surface, whizzing past farms and ranches that had seen more bloodshed than al-

Figure 6.2. Piles to be filled with concrete, Puerto Berrío. Photo by the author.

most anywhere in Colombia. As we neared our destination, the site I had come to see appeared on the horizon: a new bridge in the early stages of construction. A flagship project in the National Infrastructure Agency's "Highways of Prosperity" plan, this bridge spanning the Magdalena River would facilitate travel between the departments of Antioquia and Santander, while connecting to a major transport corridor known as "Route of the Sun," which runs for over 1000 kilometers from the interior to the sea.

As one of the regions most affected by the armed conflict, the Middle Magdalena has been a priority for the national government, and significant funds have been invested in infrastructures of mobility and connectivity. The ideal material to enroll in this transformative process is concrete, for it offers the smoothness and continuity necessary to move valuable things quickly and efficiently (Harvey 2010, 32). Significant delays have been a chronic problem, however, and corruption scandals have severely damaged the public perception of large-scale infrastructure projects. Nevertheless, despite recurring denunciations, lawsuits, and convictions, these megaproyectos, as they are called, and the materials required to build them, remain integral to the goal of constructing what in Colombia has frequently been called a "concrete peace."

Construction on the bridge had begun the year before, and the cylindrical piles that would serve as its foundation were close to completion. Thin-walled steel tubes had been sunk vertically into the riverbed and floating nearby was a pontoon barge carrying heavy machinery tasked with filling the tubes with reinforcement cages and wet concrete. The abutments that would eventually support the approach, also made of concrete, had been installed. Piles of rock and sand were standing by, waiting to be mixed with water and cement to produce the additional concrete needed to complete the project. We arrived in Puerto Berrío a few minutes after spotting the bridge.

As the department of Antioquia's riverport, Puerto Berrío once handled all goods coming from the coast or from overseas on their way to the industrious city of Medellín. Many of the coffee exports that fueled Colombia's modernization were loaded onto riverboats at these very docks. To facilitate access to national and international markets, the department of Antioquia signed a contract in 1874 with the renowned Cuban railway engineer, Francisco Cisneros, to build the Ferrocarril de Antioquia. The railroad, which traversed the rugged mountains between the interior of Antioquia and the Magdalena River, brought connectivity, and therefore wealth and status to the town.

Puerto Berrío's golden age materialized in the construction of the majestic Hotel Magdalena, which hosted travelers, tourists, and industrialists in unparalleled comfort. Even the United States Trade Commissioner, Purl Lord Bell (1921), was "favorably impressed" by the hotel, praising it as a "comfortable, modern, and hygienic stopping place for travelers." In his 1921 "Commercial and Industrial Handbook" for Colombia, Bell rated the Hotel Magdalena the best in the country outside Bogotá and expressed admiration for the materials used in its construction: "Among its features are the modern white-tiled baths—a great boon to the river passengers. […] The building was designed by an American architect and is constructed of reinforced concrete, with all interior fittings of hardwood. All floors are of tile laid in cement, and all features are specially adapted to the tropical climate" (1921, 395–96). Indeed, the Hotel Magdalena was the first concrete building in all of Colombia, and it symbolized global connectivity for local and foreign visitors alike.

I reached Don Raúl on his mobile phone and he agreed to meet at a riverside gas station. I arrived early and was immediately waved down by a man whose sprightly walk and sporty attire defied his age. We sat in an open-air saloon by the docks, shouting over blaring vallenato music. I ordered a coffee, Don Raúl a beer. He began by telling me how he had spent his working life: first in command of commercial riverboats and then in the fluvial inspector's office. He was now semi-retired, occasionally taking the helm of smaller vessels carrying shipments to nearby destinations. He recalled the days when Puerto Berrío was the region's commercial hub, when barge convoys and passenger steamers would stop over on their way upriver. As the inland head of commercial navigation had since moved 100 kilometers downstream, and river traffic in these parts was now limited to small watercraft, I asked what had happened to bring those boomtimes to an end. His response: "The bridge!"

Don Raúl was referring not to the new bridge being built downstream, but to one on the other edge of town, dating back to the late-1950s. Enabling vehicle traffic to cross the river with ease, the Puente Monumental reduced demand for fluvial transport. One kind of connection severed another, hindering the movement of goods and people along the waterway, which led the government to defer maintenance on the navigable channel. Before long, Don Raúl told me, this stretch of river filled with sediment and larger boats were unable to pass. "The river dried up," he said, referring as much to the flow of water as to the flow of goods. With Puerto Berrío no longer a strategic riverport, much of the commerce once concentrated there began to bypass the town altogether. Other factors contributed to this reversal of fortune, but Don Raúl's attribution of agency was significant.

Ese puente es lo que mató al pueblo, he lamented. "That bridge is what killed this town."

This statement initially struck me as an exaggeration—Puerto Berrío may no longer be prosperous, but it was not dead. However, Don Raúl's invocation of the relationship between infrastructure and violence had a dual meaning. He was also alluding to the decades in which the waters surrounding Puerto Berrío were overflowing with dead bodies.

The town was once a stronghold of the National Liberation Army (ELN) and other leftist groups, where rebel flags could be seen flying from the highest point on the bridge. This lasted until the right-wing United Self-Defense Forces of Colombia (AUC) and the Colombian military, with support from the United States, began their systematic annihilation of anything resembling insurgent activity. Another paramilitary group, Death to Kidnappers (MAS), eventually launched its own counterinsurgency war, assassinating "subversives" to protect its wealthy patrons from abduction. When the paramilitaries officially demobilized, criminal organizations composed of their former members infiltrated the port, capitalizing on its strategic location for the distribution of drugs, weapons, and other contraband. Coinciding in space and time, the economic decline of the town became inseparable from the cloud of death that hung over it, and both were linked to the construction of the bridge. Concrete, here, fostered infrastructural connectivity, though with deleterious effects.

When he was working on the water, Don Raúl said, he saw things he would rather forget. I chose not to push him further, but I knew what he meant as I had read numerous accounts of Puerto Berrío's fishermen and riverboat pilots finding floating body parts from corpses dumped upstream, often from the bridge itself (Nieto 2012). During the twenty-six years he spent enforcing fluvial transport codes, Don Raúl also came across situations he simply had to ignore: "Did you see something? No. Did you hear something? No. That's it. That's how it was in those days. If you opened your mouth, they'd shut it for you." Don Raúl asked me whether I'd visited the town cemetery. I hadn't, but I had seen a documentary about the residents of Puerto Berrío who visit the graves of anonymous victims, give them names, and pray for their salvation. Many of those interviewed in the film reference the bridge's macabre history. A man who has taken it upon himself to communicate with the dead surmised: "If that bridge could talk, good God, it would tell us how many have been thrown from there" (Echavarría 2015).

The bridge was clearly something Don Raúl thought about often, not only because he blamed it for the decline of fluvial transport and for attracting armed groups. As a young man, he also had a hand in the bridge's construction. Born in 1940, he was coming of age when the bridge project began, and at 17 was hired as manual laborer. He spent two years on the job and said he felt great pride when President Alberto Lleras Camargo presided over the inauguration in 1961. But it was bittersweet, since by that point he had already taken up the vocation of riverboat pilot and could sense that the bridge might threaten the livelihoods of watermen like himself.

Having spent nearly two hours talking, Don Raúl suggested we walk to the central plaza. Upon arrival, the first thing to catch my eye was a decommissioned locomotive of the now-defunct railway elevated on a concrete pedestal. Surrounding this monument to the town's prosperous past was an installation of black-and-white photographs mounted on concrete frames. Here concrete was the backdrop to a project seeking connection to the past, but in fact it revealed disconnections. As we examined each image, Don Raúl provided explanations, since everything on display was now out of operation: cranes and warehouses along the pier, seaplanes, the train station, the cinema. Apparently, some townspeople criticized the mayor for the memorial, but Don Raúl thought younger generations should know what the town and the river once were. Eventually we arrived at a photograph of the bridge Don Raúl helped build. He explained it was built in phases, with the first (the one he worked on) involving the mixing of aggregate from the riverbank with cement to form the concrete columns that would serve as its base.

We resumed our walk and soon passed the grand Hotel Magdalena. The buildings and grounds appeared well-maintained, but the entrance gates were locked. The only way in was through a security checkpoint with "Decimacuarta Brigada" inscribed across the top. Don Raúl told me that, for the last thirty years, the once-illustrious hotel had functioned as a military base for the Fourteenth Brigade of the Colombian Army. The Fourteenth, according to their website, was established in 1983 to confront the critical security situation in the Middle Magdalena and Northeast Antioquia region—a jurisdiction of 20,000 square-kilometers. The regiment's initial mandate was "to counteract the subversive escalation that was taking over the Magdalena Medio," whereas today the Fourteenth is dedicated to "the mission of maintaining peace and tranquility." In Don Raúl's lifetime, the country's first concrete building had become a critical infrastructure in a counterinsurgency war, and then subsequently an agent of peace.

At what seemed to me like a remarkably brisk pace for a 77-year-old, Don Raúl led me uphill on the road heading out of town. As we approached the bridge, the railroad tracks came into view, but instead of wagons carrying freight, the rails were now used by makeshift motorcycle-powered trolleys ferrying passengers across. Although the bridge once accommodated both trains and automobiles, the railway ceased to run soon after the bridge's inauguration due to an accumulation of debt and competition from trucks. The bridge now has two lanes, yet is so narrow that automobiles have to straddle the barrier that once separated road from rails. We took the pedestrian walkway to the bridge's middle point, where Don Raúl fell silent, gazing pensively at the river with head in hand. I eventually broke the silence by asking for his current thoughts on the Puente Monumental. Echoing his earlier comment, he said he felt both pride and lament, since the bridge he helped build had "killed the town he loved."

We met again the next day for a journey downriver on his friend's motorboat to visit the site of the new bridge. Don Raúl gave me a lesson in reading the river while his friend guided the watercraft between sandbars. Along the way, we passed machines installed on the riverbank to extract sand and stones from the boats of *areneros* (sandmen) who make a living by submerging themselves to collect raw materials needed for concrete construction. Nearing what Don Raúl referred to as *la cuestión del puente* ("the matter of the bridge"), I noticed the machinery was no longer active. The steel tubes that would form the bridge's foundation were now filled with concrete and the next phase of construction had begun.

We idled alongside the semi-submerged pilings to allow us time to talk. I asked my companions about the motive for the project and got a refreshingly straight answer: a four-lane bridge will be a huge improvement on the current situation. I then asked whether they thought it would bring big changes. They responded affirmatively but referred only to a tiny riverside settlement built on dredge spoil, which will abut the base of the bridge. "El Aterrado will come to life," Don Raúl said with optimism for the fate of this humble homestead. More worthwhile from his perspective was the government's plan to improve navigability on the river and revive commercial shipping. But neither project seemed to promise a peaceful and prosperous future. After all, not all infrastructure projects possess transformative potency, and for those that do, that potency may be neither controllable nor desirable.

This story highlights the power of infrastructures and their constituent materials to connect and disconnect. Walter Benjamin so strongly felt the power of the built environment to bring people together that he dedicated much of his life to the study of one iconic example—the Parisian arcades. Benjamin described how the arcades once promised "dreamworlds of mass utopia," but their subsequent decline was also a unifying force, which could awaken the masses to truths about their history (1978, and Buck-Morss 1995). The vestiges of these structures juxtaposed with memories of their former grandeur, Benjamin thought, could stimulate not only a critical excavation of the past but also a collective reckoning with the future. Don Raúl's reflections on Puerto Berrío's bridges and their concrete foundations perform similar political work: they simultaneously confront Colombia's history of violence and scrutinize the aspiration to transcend that history through infrastructure building.

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CONTRACTING

Pinai Sirikiatikul

Contracts organize construction projects down to a granular level. Although they orchestrate flows of labor and materials, they also mediate wider shifts in law and politics. Thailand's shift from absolute to constitutional monarchy precipitated new contracting arrangements, which, in turn, created constraints and possibilities for architects. Such possibilities generated new labor arrangements which were fundamental to producing the country's nationalist aesthetics. This chapter highlights how politics, materiality, and regulation converged in the making of a new aesthetic for the Thai state.

Designed by Phra Phrombhichitr in 1935 and completed in 1936, Sawasdisopha Gate is known for its austere cement decoration. It is widely regarded as a prime example of modern Thai architecture, built in cement and concrete, from the era that coincided with the end of the absolute monarchy. The style of Sawasdisopha Portal, which keeps the ornaments to a minimum, was interpreted as a deliberate attempt to represent the "equality of right"– a social value heavily promoted by the People's Party, responsible for changing the ruling system of the country from an absolute monarchy into a constitutional monarchy, in opposition to the hierarchical structures of the previous regime (Prakitnonthakan 2020, 23–28). Another interpretation is specially related to the material. Concrete as an industry began domestically in 1913, started by the Siam Cement Company. Although from the start of the business its shareholders were predominantly Thai, it was not until after 1932, when the People's Party government actively carried out the policy of economic nationalism to resist foreign domination of its entrepreneurship, that concrete was promoted as an indigenous product and became preferable to other materials for the construction of governmental buildings and monuments (Sirikiatikul 2010, 40–45). In this regard, the architectural use of locally produced cement and concrete for post-1932 architecture, including the Sawasdisopha Gate, could be seen as a visible element of nationhood (Chua 2021, 136–41 and 160–62). While the idealistic, political, and economic significance of this architectural style and its material has been widely discussed, the construction processes underlying the aesthetics are just as significant. Indeed, the contracts dexterously employed by Phra Phrombhichitr reveal an unspoken groundwork developed within the building process. This chapter explores how contracting processes enabled the architect to establish a framework that facilitated the coordination of labor and production, ensuring greater precision in control and execution than otherwise possible. In doing so, it shows precisely how concrete's aesthetics emerge in relation to specific regimes of labor, technology, and expertise.

Initially built in King Mongkut's reign during the mid-nineteenth century, Sawasdisopha Gate serves as the northeastern entrance to the Grand Palace complex in the center of Bangkok's old quarter, Rattanakosin Island. It offers direct access to Wat Phra Kraw along the main axis leading to the Royal Panthenon called Prasart Phra Debidorn.

By 1935, however, the gate had severely deteriorated due to foundation problems, prompting the Fine Arts Department to task architect Phra Phrombhichitr with its restoration. Instead

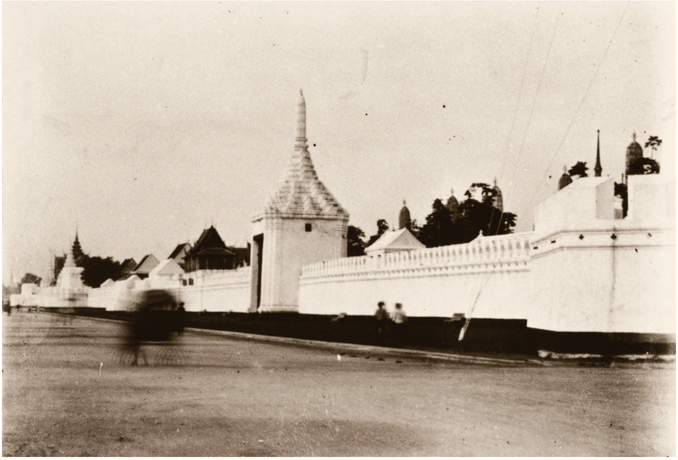

Figure 7.1. Sawasdisopha Gate before reconstruction. Source: National Archives of Thailand.

of replicating the original design, he applied his master Prince Narisara Nuvadtivongse's ideal of *som-plaeng,* which means "to repair and modify," to improve the building's stability and aesthetics.

His plan replaced the gate's old brick and mortar structure with concrete and cement. Its decorative elements were redesigned to be geometrically simple. Made from precast cement, they created a wholly new Thai architectural vocabulary. Simplistic though they may seem, these ornamental motifs were well-fabricated, indicating a high degree of craftsmanship involved in the production process. Yet, it wasn't the craft that was revolutionary but the terms under which it was applied.

The production of these seemingly simple, yet well-crafted pieces of cement decoration is intriguing, especially considering that the architect had to work within the constraints of a general contracting system. This system was first introduced to Thailand by European contractors working for the Siamese Court in the 1870s. While general contracting was originally intended to guarantee the price of buildings, the lowest tender was not always chosen. Other factors, such as the reputation and skill of

Figure 7.2. Restored and modified by Phra Phrombhicitr between 1935 and 1936, Sawasdisopha Gate is the main entrance to Wat Phra Kaew on the eastern wall. Faculty of Architecture, Silpakorn University. Archival material in public domain.

tradesman, often played a part in the selection process (Sirikiatikul 2023, 99).

After the end of the absolute monarchy in 1932, the situation changed in response to the rise of a new bureaucratic system. While competitive tendering had existed before, the economic-minded People's Party, composed of civil and military officers, declared that selecting the lowest bids was essential to minimize building costs. This shift recast thrift as a public virtue. Increasingly, contractors quoting the lowest price secured work, often diminishing the architect's authority to select quality tradespeople. These changes in labor and procurement practices imposed new constraints, pushing architects to adapt — an effect crucial to fully realizing a new aesthetic.

Under this new regulation, the government entered into contracts with a single general contractor who was responsible for overseeing the entire project for a fixed sum. That contractor estimated the total expense of the work in advance, in agreement with the client. Once agreed, the general contractor supplied all building materials, hired and managed the necessary tradespeople, set pay rates, and handled worker payments. As a result, the general contractor had near-complete control over the entire building process and its outcome.

While the general contractor gained many advantages from this organizational system, architects were put at a disadvantage, having far less control over the building work. Before 1932, architects like Prince Narisara Nuvadtivongse had some influence to select skilled building labor and artisans even when using general contracting; however, under the post-1932 regulations, their ability to supervise the work was largely restricted, though not entirely eliminated. Once the lowest bid secured the building contract, the architects' role in the post-1932 period was limited to providing detailed drawings and specifications as the basis for a legal agreement.

As this separation between project design and execution became clearer, most architects found themselves spending more time in their offices rather than directly supervising builders on site. This shift led to a sense of unease among some architects, who perceived the growing influence of general contractors as potentially diminishing their control over the construction process. Despite these constraints in post-1932 Thailand, few adjusted to the changing labor dynamics as successfully as Phra Phrombhichitr. This is evident in his employment of separate contracts of cement and concrete works at Sawasdisopha Gate.

After being appointed architect for the rebuilding of Sawasdisopha Gate, Phra Phrombhicitr's primary responsibility was to prepare the design and produce the necessary drawings and specification documents for the contract. These documents specified how the work that was described in the drawings and written instructions should be executed. Serving as a substitute for the architect's direct, on-site supervision, they became essential tools for ensuring the project's completion. Because of this arrangement, where the paper plans substituted for direct onsite supervision, architects were deprived of active participation in building work.

Anticipating that the separation between the architect and workers might affect the quality of craftsmanship, Phra Phrombhicitr introduced a calculated contracting approach. He proposed a separate contract for casting the cement decorations, considering this the most effective way to ensure high-quality work. Meanwhile, the structural work of rebuilding the gate was awarded to the lowest bidder — Nai Suiki Yi-Hor Eiymlee — who signed the contract for 4745 Baht.

Phra Phrombhicitr employed a work delegation method similar to "nominated sub-contracting" to oversee the decorative elements (Ministry of Education 1936–37). While this practice was commonly used for specialized tasks, his deliberate application here allowed him to separate the structural work from the decorative work. The casting of the cement decorations — for which 300 Baht was allocated for labor costs while materials and tools were fully supplied by the Fine Arts Department — was exempt from competitive tendering. This exemption facilitated the nominated sub-contract independent of the general contractor's contract.

With the combination between the nominated sub-contract and the general contract, Phra Phrombhicitr ensured greater control over the selection of skilled craftsmen for the cement ornamentation, rather than leaving all responsibilities to the general contractor. Had the decorative work been included under the general contract, he would have relinquished near-complete control over this aspect of the design. Since the cement decoration was tendered and conducted separately outside of the general contract, Phra Phrombhichitr could exert more influence over its execution. The adoption of nominated sub-contracting was more than a universal generic mode of contracting; it was a calculated strategy to mitigate potential issues within the general contracting system. As we shall see, this approach allowed the architect to re-establish a more influential position with respect to the builders.

With his authority over the design and parts of the contracting process, Phra Phrombhicitr divided the production of the decorative cement work into four distinct stages, thus creating a clear division of labor. Each stage was carried out by an individual specialist over whom Phra Phrombhicitr could maintain significant control and influence around the quality and execution of each phase of the work.

The first stage involved Phra Phrombhichitr designing the building's decorative elements on paper, which were to be cast in cement. In the second stage, the task was handed over to modelers, all of whom were students trained under the Italian sculpture Corado Feroci at the Fine Arts School, which became Silpakorn University in 1943. Their task was to transfer Phra Phrombhicitr's drawings into 150 plaster models in preparation for molding and casting (The School of Fine Arts 1936). Phra Phrombhichitr greatly benefited from their expertise and Feroci's supervision, which ensured the appropriate depth of relief and the delicacy of the modelling. If the modelers had been less practiced and skilled at translating Phra Phrombhicitr's two-dimensional designs into three-dimensional models or unable to produce a perfect form for the molds, the subsequent stages

Figure 7.3. Feroci's students in sculpture and painting, similar to those who were instrumental in the cement casting at Sawasdisopha Gate. Source: Silpakorn University.

of molding and casting the cement ornamentation would have been unsatisfactory.

The next stage of the decorative cement-making process involved casting multiple exact blocks, a task assigned to the nominated subcontractor. Of the available cement molders and casters at the time, the Chinese subcontractor Nai Pengkun Yi-Hor Pengheng was selected for his exceptional skill in cement casting. He had previously supplied plaster casts for the renovation of the Chakri Maha Prasat Throne Hall interiors (The

Royal Academy, Fine Arts Department 1929). Nai Pengkun Yi-Hor Pengheng began by creating molds from each clay model, then cast the precise cement blocks from these molds. Once the blocks were ready, they were transported to the site, where the general contractor affixed them to the structure of Sawasdisopha Gate in the final stage of the process.

Here, the cement's capacity to be mixed, poured, molded, and transported from one place to another also contributed to the split between the structural and decorative components of the gate. It enabled Phra Phrombhichitr to mobilize highly skilled artisans for the intricate decorative work, while the general contractor could rely on lower skilled builders for other tasks. This ingenious use of the new arrangement was essential to the composition of the gate's aesthetics.

By dividing the work into four distinct components — drawing, model making, molding and casting, and then fixing — Phra Phrombhicitr was able to maintain a relatively large degree of control over each stage, particularly the crucial visible elements: the cement ornamentation. Without this level of control, the result might have been less than satisfactory. Phra Phrombhicitr's application of the division of labor can be seen as a device developed to strengthen the architect's control over the execution of the work.

Throughout Phra Phrombhicitr's involvement in the contracting process, particularly with the cement decoration, his goal was to take full advantage of the general contracting while retaining control over the craftmanship. The key difference between the general contractor and the architect lay in their respective authorities: while the general contractor controlled most aspects of construction, Phra Phrombhichitr, through the use of nominated subcontracting, ensured that the general contractor had little authority over this specific, and highly significant, part of the work.

Phra Phrombhicitr's approach to cement decoration production necessitated adjustments in both nominated subcontracting and architectural practice. His distinctive style of "Thai Architecture made in concrete," where different groups of builders worked independently on the concrete structure and cement decoration, was shaped as much by his optimization of the contemporary building methods as by his idealistic design vision. This is evident in the front elevation drawing of the gate, where Phra Phrombhicitr precisely specified the cement ornaments to be cast by the nominated subcontractor. Additionally his decision to wrap the decorative cement elements around the rebuilt concrete structure — managed by the general contractor — indicates an intent to conceal the work over which he had less control, while prominently displaying the decorative covering over which he maintained authority. The remarkable aspect of the cement ornamentation at Sawasdisopha Gate is how it acts as an architectural camouflage, allowing Phra Phrombhichitr to achieve coherence throughout the entire design.

While Phra Phrombhicitr's new architectural vocabulary has been regarded as providing a significant shift in turning Thai architecture toward a new phase under the People's Party, it was contracting that realized these new forms. What comes out of this discussion of one architect working on a specific building is an answer to the general issue of what social properties of concrete were established through the practical exigencies and material relations of post-1932 Thailand. It is a surprise to find this issue embedded in the cement and contracts of Sawasdisopha Gate. It reveals the ways that wider political economic shifts — from absolute monarchy to constitutional monarchy — not only precipitated new aesthetic forms, but also emerged in relation to shifting practices of government contracting mobilized in and through cement.

Figure 7.4. Decorative elements made of cement cast wrapping around Sawasdisopha Gate's concrete core. Photo by the author.

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CORRUPTION

Cassandra Hartblay

Few materials are more closely associated with corruption than concrete. In fact, concrete is itself often considered corrupt, raising the question of its own moral qualities. This chapter probes issues related to infrastructure, accessibility, and inaccessibility through a case study of a bridge closure in the Russian city of Petrozavodsk. This chapter probes the outer limits of concrete's moral agency, and the human habit of assessing the material as good, bad, or adulterated, emphasizing the always political qualities of design.

In common parlance, *corruption* is usually understood as a moral property of a particular person, or, perhaps, as a way of describing an exchange between corrupt individuals. In contrast, anthropologists argue that corruption is a relational category: something can only be corrupt relative to something else. Invoking corruption is also a rhetorical manner of marking injustice, asserting personhood, or claiming a moral high ground (Gupta 2005; Rivkin-Fish 2005; and Haller and Shore 2005). In a separate usage, material objects might be *corrupted*. Things can be badly made, cheaply constructed, or adulterated; this suggests a moral judgment about the human agents' intention behind the object's construction and design. But can things themselves, or concrete as a substance, be corrupt in the agentive sense?

Here, I attend to this dovetailed variegation in the meaning of corruption by thinking through a story about public access and urban infrastructure maintenance in Petrozavodsk, Russia, where my broader fieldwork focused on the life experience of people with disabilities is based (Hartblay 2017). I apply observations about mobility and access in the built environment from this research on mobility disability access to a more general case: the closure of Gogolevskiy Bridge, a major thoroughfare between the center of the city and an outlying region. In this brief disability anthropology meditation on the social life of concrete, disability is not an object of study, but a social position from which theoretical insights arise.

Assemblages and objects, by their very form (such as lack of maintenance or faulty design) can serve as material evidence of social patterns that define corrupt systems. Things acquire social meanings, including evidence of corruption; in some cases, designed objects and material structures come to stand for corruption (Elinoff 2017). Yet, despite this strong association between corruption and the built environment, I argue that the thing itself is never quite corrupt. Instead, I think of things as having a property of *dysintentionality,* by which I mean, *a point at which intentionality cleaves, breaks, or is laid bare,* even as the things themselves may be actants without human moral intention. Others have considered the effects of nonhuman actors. Jane Bennett (2010) asserts that storying things and the ways in which assemblages of things come into being, instrumentalize or cause effects, degrade, break down, and become otherwise, offers a way to understand moral worlds without allegiance to hierarchies of being. Langdon Winner (1980, 123–24) suggests that objects of infrastructure may be "deliberately designed to achieve a particular social effect," observing that the construction of certain bridges effectively excluded bus traffic, and therefore those who ride buses, from certain highways. In Winner's example, intentionality is placed with the human actors, even as

Figure 8.1. A lone pedestrian crosses the Gogolevskiy bridge on foot, more than a year after the bridge was blocked off to motor traffic with a caution barrier. Photo by Renald Shchetinin.

the infrastructure produces social effects in the world. I argue that objects — like a bridge constructed from reinforced concrete — cannot be corrupt, because corruption, as both a normative category and a social fact, belongs to the realm of human moral action.

In winter of 2013, I returned to my field city, Petrozavodsk, after a month away, moving into an apartment in a populous residential area about three miles from downtown. The neighborhood, Drevlyanka, was a twenty-minute ride from the city center by bus or mashrutka (mini-bus group taxis that ran along set routes, but only stopped at the request of passengers already on board). Or rather, it had been a short twenty-minute ride when I left a few weeks earlier; however, upon my return, I found that the central route to Drevlyanka was cut off, as the central passage over the town's railroad tracks, Gogolevskiy Bridge, had been closed to traffic.

The closing of Goglevsky Bridge created a major inconvenience for residents of the Drevlyanka region (including, now, me) — often doubling commute time to and from the center of

Figure 8.2. The bridge on a typical snowy afternoon in 2012 prior to closure, with heavy car, marshrutka (taxi bus), and foot traffic. Source: *Guberniia Daily.*

the city by public transit. When I asked about the bridge, friends, interlocutors, and acquaintances shrugged helplessly. Journalists diligently covered new developments, but for the duration of the spring of 2013, there was no news to report: the bridge had been deemed unsafe due to aging materials and would remain closed until renovations became possible, which depended on budgeting. One dismayed, cynical interlocutor told me that he wouldn't be surprised if the bridge would be closed forever.

After returning from the field, as I worked through my data about disability access in the post-Soviet built environment, I often thought about Gogolevskiy Bridge as an example of nondisabled residents experiencing the city's infrastructure as inaccessible. When I returned to my field site again in 2014, the empty roadway on the bridge had become a popular footpath. Children rode bikes and sleds in the open space. In 2016, during a follow-up trip, the bridge was still closed three years later. Public transit routes had changed beyond the preliminary "alternate route" response, adapting to the altered flow of traffic. Several businesses in Drevlyanka had closed, presumably because only residents now frequented the district.

When I asked friends and interlocutors in Petrozavodsk about how the bridge had come to be closed for so long, they often invoked the idea of corruption as shorthand to reference entangled bureaucratic and private enterprise processes. Invoking *korruptsia* (corruption) shut down further discussion, at once indexing a sense of a situation beyond control of regular citizens, and the frustration with the inconveniences caused by the bridge's closure. While invoking *korruptsia* in this way indicates a broader pattern of injustice, it defers a consideration of specific responsibility, implying that the actual mundane details of infrastructure and industry deals are too boring or complicated to bother tracing. The attitudes seemed to gesture to something deeper than a common truism about post-Soviet politics circulating in United States media and political discourse: that Russian citizens are too passive to participate in democratic processes, which allows corruption to flourish.

In fact, one could also take the opposite reading: a truly corrupt government response would have been to leave the bridge in operation, disregarding public safety. The closure seemed to reflect some consideration of safety standards, capriciously invoked or not.

The inconvenience and injustice of the bridge closure for residents of the cut-off district echoed the moral outrage of disability activists discussing inaccessible infrastructure in the city. I observed that for wheelchair users, the moral implications of design are already apparent. Design is always a moral undertaking. As Keith Murphy (2016) puts it, design is an intervention, in that it seeks to change something about the world, about the social, through a manipulation of the material. The built environment is at once designed in response to and cultivates a normative assumption of what bodies ought to and might reasonably be expected to move through a given space (McRuer 2006). As disability studies research makes clear, designers always exclude some bodies — the question that disability advocates challenge, then, is where the boundary delineating which bodies are included and which ones are excluded from a particular design is imagined (Hamraie 2013). Additionally, in any consideration of infrastructure, design tilts into maintenance. Maintenance, like design, can be good (sufficient), or bad (insufficient). Maintenance or neglect reverberates with what Ar-

Figure 8.3. Screenshot from a live feed of construction on Goglevskiy bridge, broadcast online on the local city news page by internet service provider Sampo.ru. "Гоголевский Мост - Мой Город Петрозаводск" [Gogolevskiy Most - Moy Gorod Petrozavodsk], https://moigorod.sampo.ru/stream/174.

turo Escobar (2018) calls the question of design: good or bad *for whom?*

Although inaccess appears to be an inevitable, quotidian — harmless, and everyday — side effect of infrastructure, it is actually a social and relational crisis. Thus, inaccess appears inevitable and hard to address through human rights because of the "thingness" of infrastructure: inaccess frequently appears to be a crisis without a perpetrator. Like Gupta's (2012) structural violence, inaccessible infrastructure gestures to a vast web of bureaucratic responsibility too diffuse to settle on a single agentive decision responsible for harm caused to citizens suffering as a result of bridge closures, faulty ramp designs, poor maintenance, or poorly planned construction.

In my research, Russian wheelchair-users' descriptions of how inaccessible ramps came into being highlighted the nuanced ways that they understood what an outsider would gloss as corruption. Elsewhere (Hartblay 2017), I describe how activists deployed a kind of moral logic of *diffuse accountability* to

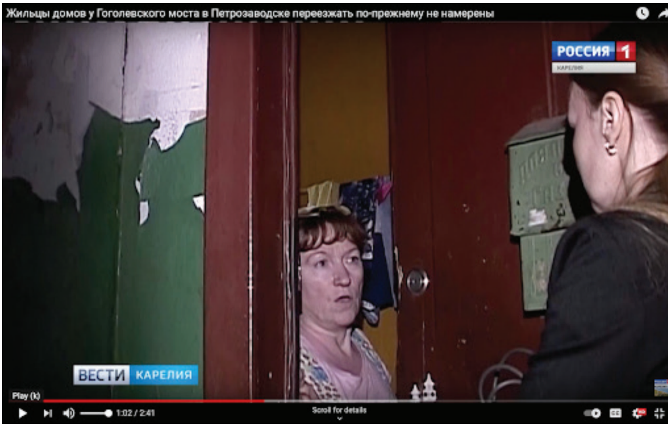

Figure 8.4. A resident of one of the houses in the footprint of the bridge demolition responds to questions from a Channel 1 news reporter at her apartment door. Screenshot from Rossiya 1 Vesti Karelia, *YouTube,* https://youtu.be/xts8TFXBL-E?t=62.

explain how bad ramps get built and maintained. Their descriptions of how inaccessible accessibility ramps come into being never pointed to a single responsible individual, but instead were comprised of speculations about decision-making within government hierarchies and business bureaucracies. Rather than looking for a responsible individual, my interlocutors suggested that the hierarchical system of implementing design standards was to blame. Infrastructure as a collective project is always the product of diffuse accountability requiring the choreography of a great many people, technologies, and material elements.

The same complexity, exceeding the simple notion of corruption that posits a single bad actor, turned out to also apply in the case of Gogolevskiy Bridge. The bridge's infrastructural lifespan helps to narrate its closure in 2013.

> 1957–1961 – The bridge was built as a footbridge over four years, opening in 1961. Two lanes for vehicular public transit were added subsequently.

1970s and 1980s – The housing stock in the Drevlyanka region was built to replace postwar barracks housing in other regions, and the population of the residential region boomed.

1994–1997 – The bridge was declared structurally unsound and partially reconstructed.

2013 – The bridge was closed to vehicular traffic after the district attorney brought evidence to the regional court to demonstrate that the bridge had deteriorated to the point of being structurally unsound.[1]

2015 – The bridge was closed to the de facto foot traffic, which had still been using it daily.

2016 – The bridge was closed, and a contract for demolition and construction was awarded to Arasar, a St. Petersburg firm. Demolition began.

2017 – The bridge reopened to local fanfare, following reconstruction.

The bridge's demolition had significant implications for the low-income residents of a few blocks of old wooden houses owned by the state directly next to the bridge's footprint. Residents told television reporters that their windows were broken by falling debris; subsequently, residents were given notice that they would have to vacate the premises as their houses would be

1 This closure could have been a moment for corruption to emerge, in the sense that the DA's motivation to bring evidence to the court may have been "influenced" by unknown but powerful interests, for instance, hoping to discredit or cause problems for the city's mayor, or hoping to gain the lucrative contract for reconstruction. However, the details of such a possibility are beyond the scope of the present research. More to the point, in the popular logic of Russian accusations of corruption, the problem is not that the law worked to appropriately close the bridge in this case, but that the law works in some cases and not in others, in the interest of some and not of others.

closed for the next phase of construction (Vesti Karelia 2017). Although they were promised monetary compensation, they were not relocated to new apartments, and the compensation was far from sufficient to rent an apartment in the competitive housing market in the city.

The bridge's platform, numerous news reports document, was held aloft by 16 support structures of reinforced concrete. A bridge built using reinforced concrete in any region is subject to what Bennett calls "the becoming of things" (2010, 8). Reinforced concrete is structured around metal rebar, which, if exposed to moisture, begins to rust. The rusting action of the metal causes the concrete to crack, undermining its structural integrity and load-bearing capacity. Structures built of reinforced concrete will last as long as cracks are promptly sealed and rust prevented, but any piece of public infrastructure is built with the understanding that materials degrade over time, and will likely need to be replaced or wholly reconstructed. The fifty-year lifespan of the bridge, in this sense, was not necessarily the product of human corruption. But perhaps, a moment of corrosion of metal — a spontaneous organization of matter — led to a series of events. Of course, the corrosion of the material suggested "corruption" as a metonym, similar in many ways to "aging infrastructure" concerns that circulate in United States political discourse. This effect was complicated by the fact that the systems for financing infrastructure maintenance and repair in Petrozavodsk underwent a cataclysmic shift when Soviet central planning, premised on a supply of materials in a closed economy, was jettisoned in favor of transition to the current market-economy.

In this light, simple corruption, particularly moral misconduct on the part of the bridge designers or the engineers and city planners who might be tasked with maintenance, seems less substantiated than at first glance. If corrupt human intention is discernible, it seems more likely to have to do with the details of how the contractor that performed the demolition and repair was chosen, and how and why the district attorney came to take the case in that particular political moment. Still, the matter of the bridge matters: the properties of the reinforced concrete degrading are deeply entangled in the corrosion that presented the evidence for the closing of the bridge. Yet, it is human actions, with moral consequences, that register as corruption for my interlocutors: the temporal slog of waiting for state bureaucracy and private enterprise to rebuild the infrastructure, daily commutes lengthened in the meantime, the expulsion of residents from their homes with insufficient compensation. Petrozavodsk news media installed three livestreaming cameras on the unfolding construction, so that residents could watch the slow progress of the live feed from their own homes, and the construction company posted promotional footage of construction on YouTube (APACAP 2017).[2]

So, can concrete — or any matter — be corrupt? Although matter cannot have malintent, or morally corrupt intent, particular assemblages might suggest or offer a starting point to story moral injustices. Concrete's infrastructural presence and physical aesthetic offers a convenient symbolic container for citizens compiling evidence of structural violence. As my interlocutors navigating the inaccessible infrastructure of Petrozavodsk in wheelchairs laid bare, construction, design, maintenance, and diffuse human activity across a variety of systems in which human actors make individual moral or immoral choices may lead to an object of infrastructure that appears to be corrupt. Or, conversely, a corrupt process may lead to what appears to be a just result, a functioning infrastructure.

At the same time, political, economic, and ethical worlds are not epiphenomenal to the built environment but deeply materialized through it. Designs include and exclude certain people. Materials and maintenance are part of wider webs of governance and economies. These may show up in a material form but do not necessarily make materials moral or immoral. Trac-

2 The live feed once played here: "Петрозаводск. Гоголевский Мост. Онлайн-Камера," [Petrozavodsk. Gogolevskiy Most. Onlayn-Kamera]," *Каммерия* [*Kamteriya*], 2017, https://tufaq.com/ru/russia/petrozavodsk/gogolevskiy-most_cam_10483.

ing the ethical worlds that emerge from the knotted relations of matter may offer an important vantage point from which to think and rethink the moral implications of bodies navigating dysintentional matter. In the case of Gogolevskiy Bridge, the social concept of *moral intention* colors how humans understand and relate to the reinforced concrete structure as matter in the world, and how the bridge comes to matter socially. Concrete, reinforced concrete, and cement as designed and (un)maintained structures contain and create ethical worlds. Such worlds are not, however, simply concrete. Rather, as disability studies and design theory alike assert, designed objects in sociomaterial worlds always already contain moral inclusions and exclusions.

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CURING

Rachel Cypher

Concrete does not dry, it cures. Curing is a chemical reaction that allows concrete to settle and strengthen. Carbonation — the ongoing absorption of CO_2 after curing — creates carbonates, which can increase the risk of corrosion in reinforcing steel. CO_2 is thus generally considered unfavorable for concrete. This chapter explores Biosphere 2, an experimental closed ecological system constructed in Arizona in the early 1990s to test how humans might make lives on other planets in enclosed conditions. Although imagined as a means of curing social and environmental ills, concrete's material curing and carbonation processes posed unanticipated problems for the artists and scientists involved. Attention to curing and carbonation reveals the limited human capacity to anticipate and manage our environments.

The first time I saw the ocean "cliffs" I was seven years old. I stood above them while the ocean lapped quietly below me. The concrete cliffs stretched across the length of the ocean, which was the size of an Olympic swimming pool. In the corner, where they were still doing construction, chicken wire and steel beams

Figure 9.1. Biosphere 2 from the outside, Saddlebrooke, Arizona. Photo by Rio Hahn.

exposed an elaborate infrastructure holding up the concrete façade.

I was standing in southern Arizona's Biosphere 2, the largest closed ecological system ever built, designed to test whether humans could live in enclosed spaces for long periods of time. Biosphere 2 was named after the first "Biosphere," our earth, the planetary sum of all ecosystems. Besides an ocean, the three-acre greenhouse also included a desert, rainforest, savannah, farm, and human habitat. Biosphere 2 was thus imagined as an ark and an experiment to bring earth's biomes to another planet where we might begin anew. That was where the problems eventually emerged, leading to the extraction of the main group who had built the experiment, an extraction that included my stepfather Rio Hahn and was orchestrated by media executive and future Trump advisor Steve Bannon. This strange series of events is the subject of this chapter, in which I tack back and forth between my childhood memories of Biosphere 2 and the

Figure 9.2. Ocean biome with concrete cliffs on the right. Photo by Rio Hahn.

conundrum of concrete curing that eventually emerged from these ocean cliffs.

Curing plays an important role in the strength and durability of concrete. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature. The massive ocean cliffs that I had been staring at were a composite material that had been poured into molds and bonded together with a lime-based cement binder. When the molds were first created, they tried to shape them into what they thought "cliffs" looked like. The structure was reinforced with rebar to provide tensile strength, and then a fluid slurry of water and Portland cement — heated limestone, clay, and sulfate — was poured in. Over 90% of a mix's final strength through curing is usually achieved within four weeks, but the remaining 10% can take years or decades. This process is called carbonation. It is a chemical reaction, wherein the calcium hydroxide is formed into calcium carbonate through the absorption of CO_2.

During this period, it is essential to maintain controlled temperature and humidity, as carbonation can eventually cause corrosion once it reaches the rebar.

On September 26, 1991, several months after the final concrete was poured, eight Biospherians were enclosed in Biosphere 2 to see if they could survive in it for two years. Sixteen months into the first enclosure, oxygen levels had dropped so significantly that the Biospherians were having sleep apnea and had begun having significant health problems, the sorts of complications found at high elevations of 13,000 feet or more. One member of the crew, doctor Roy Walford, administered oxygen injections while at the same time noting that air pressure can trigger human adaptation responses. In the meantime, oxygen continued to plummet while CO_2 was on the rise, making life more difficult for the Biospherians. They began organizing harvesting times according to the amount of CO_2 recorded in the atmosphere, they continued to lose weight, and the boundary between their sealed world and themselves began to blur. Scientists on the outside suggested that the manure-filled soils were too rich and photosynthesis was not keeping up with respiration, but the corresponding increase of carbon dioxide was not correlative, which made the problem confusing.

They began testing different hypotheses in order to try to find out what could be going on. John Allen warily showed geochemist Wallace Broecker the information, and it was Broecker's student, Jeffrey Severinghaus, who finally solved the mystery. His father, who was a building engineer, recommended that they core the concrete to see what it revealed. He explained that concrete undergoes carbonation after being poured and cured, absorbing carbon dioxide. The Biospherians took cores from concrete within Biosphere 2 and sent them to the laboratory. The isotopic analysis from Columbia University's Lamont Doherty Earth Observatory revealed that carbon dioxide was reacting with exposed concrete inside Biosphere 2 to form calcium carbonate, thus sequestering carbon dioxide. Carbonation was occurring ten times faster inside Biosphere 2 due to elevated CO_2 levels in the sealed structure. The ocean cliffs, those strange

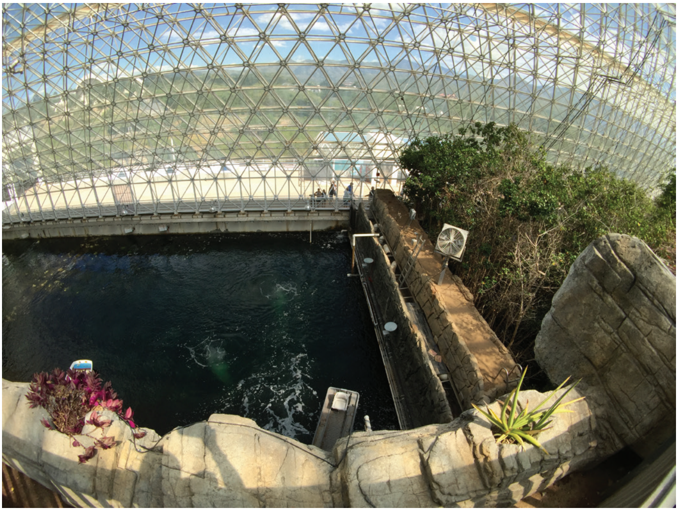

Figure 9.3. Standing on top of the cliffs looking down on the ocean. Photo by Rio Hahn.

approximations of "cliffs," had thus been absorbing CO_2, leading to the unidentified carbon sink that was throwing off scientists' equations. Once they understood this, they were able to conclude that it was indeed the manure-rich soils removing oxygen and emitting CO_2. To help the struggling Biospherians, oxygen was pumped in and filtered inside, immediately causing the eight humans to feel better.

At the same time that oxygen was plummeting in Biosphere 2, something else was happening in Biosphere 1, the outside world. Like any closed-system experiment, there are always people on the inside of the experiment and on the outside. The people on the outside, of which my stepfather was one, were part of the group investigating the circumstances of air quality and concrete, as well guiding public tours, managing the daily operations of the massive complex that was monitoring Biosphere 2, and sending out news reports to the public. Public opinion in Biosphere 1, however, had begun to turn against Biosphere 2. When oxygen was pumped into Biosphere 2 to help the Biospherians breathe, rumors began circulating about how they were "cheating" the experiment and how it was not really science. Stories had also begun to appear in local newspapers such as Tucson's *Arizona Daily Star* that described the curious practices of the group in charge of the mini-world. The group, it was revealed, was originally a theater troupe, and they still practiced drama exercises and put on performances, much to the horror of scientists who seemed to believe that no poets should be allowed on Mars. Movie spoofs were made of it, most notably 1996's *Bio-Dome* with Pauly Shore and Stephen Baldwin.

In the midst of all the drama concerning what their purpose really was with Biosphere 2, who the Biospherians were, and whether or not their experiment was really "science," the group on the outside decided to put on a play. They used drama to expose and deal with group traumas and conflicts. My sister Zodiac and I attended the play on August 14, 1993, a date I know only because I kept the program. They performed an adapted version of *Prometheus Unbound* by Percy Shelley, which was in turn an adaptation of a trilogy of plays attributed to Aeschylus. Dealing with age-old questions of what humans do with their technologies and how those technologies make us who we are, the play raised the question of human striving and the quest for scientific knowledge. In both Shelley's and the Biospherians' version of the play, the Demogorgon speaks the last and final words, which are in praise of love. Through the adaptation, the Biospherians sought to act out the tension emerging from their relationship with new technologies in order to come to grips with the unintended consequences emerging from Biosphere 2. The cliffs' sequestration of CO_2 seemed to be a metaphor for their conundrum, in which concrete was a technological adaptation and an aesthetic decision. It was both a means of generating the landscape of Biosphere 2 and a way of making the biomes look like Earth's actual geologies. Although they appeared to look like stone, the cliffs were a human construction that produced unforeseen effects, resulting in an ecological dilemma that played out within the confines of the enclosed space.

Figure 9.4. Synergia Theater Promotion from the 1970s. My stepfather Rio Hahn stands to the back and right. Photo courtesy of the Theater of All Possibilities.

Less than a year after I attended the play, on April 1, 1994, Ed Bass of the oil-rich Forth Worth Bass family that had been privately funding the experiment, hired Steve Bannon to take over and sent in the Federal Guard to forcefully remove the group. Rumors had for a long time been circulating in the local press, and the public had grown increasingly hostile to this group of people who blended art and science so unabashedly. As a child I did not know all of this. That fateful April Fool's Day, my sisters and I were living in France at a boarding school run by the group. The story in this article took decades for us to piece together.

Later, when Columbia University took over, visiting scientists were forced to examine deep-seated beliefs that they held. Rebecca Reider describes a meeting she attended after the breakup, in which Biosphere 2 continued to flummox scientists. "They were wrestling with a paradox at the very heart of experimental science: how could one really understand nature through a contrived experiment?" (Reider 2010, 245). In one camp of scientists, control and replication were the keystones for a good experiment, and it was impossible to have these things in Biosphere 2. In the other camp, experiments had to actually mimic the world, and in this sense Biosphere 2 was not *natural* enough. The cliffs were concrete, the soil was filled with cow manure, the ocean was artificial, everything was contrived. And, above all, they had violated the experiment by pumping oxygenated air into the closed system.

As a child I often longed for Ed Bass to simply give Biosphere 2 back to the adults. There is nothing interesting about witnessing your parents and non-biological kin group suffering from severe depression for years because everything they had worked for in their lives was snatched out from underneath them. But certainly there was a lesson to be learned. The scientist's question circles around this tension that wants an *outcome,* a takeaway. What was the finding? Was it that art and science do not mix? Was it, as so many NASA reports reveal, that human behavior alters outcomes?

Perhaps a main finding was quite simple: if we ever decide to build a small capsule on Mars to house humans, we had better make sure to control CO_2. In this, Biosphere 2 as a scene of anthropogenic dilemmas was perhaps more interesting than the findings demanded by scientists who wanted a control, or by those who wanted it to be more natural had imagined. As the play emphasized, the experiment exposed the limits of our knowledge about our own technologies and highlighted the invisible boundary between ourselves and the world. The concrete continued to carbonate and the rich soils continued to spew CO_2 because Biosphere 2 was an environment that promoted possibilities unforeseen by the engineers, the funding agency, and the Biospherians themselves. They had planted a rainforest with manure-rich soils, they had constructed ocean cliffs with cement. This transformed the atmosphere and, in turn, the hu-

Figure 9.5. Overgrown concrete cliffs in the rainforest biome. Photo by Rio Hahn.

mans attempting to live within it. Art and science mirrored and tugged at each other in ways unimagined by those who wished to keep them apart.

As a child, I asked a different, perhaps unanswerable, question: *why?* For example, why did everyone find the mixing of art and science to be so repugnant? I still want to know why the acceptable capsule in which to sequester humans on another planet looks less like the earth and more like a bunker, as with the NASA Mars simulation capsule on Hawaiʻi. Why, the child asks, was her world ripped apart? And because the child's question is unanswerable, it can be met with a mythic response. Because there is another interpretation: What if the cliffs and the rainforest were a stage set, and the experiment simply social? Because who would actually pour concrete to create fake cliffs in a capsule on Mars? What if the Biosphere 2 theater troupe was re-enacting Greek tragedy? In Greek tragedy, the kind that Aeschylus wrote, the true dramatic relations are between the chorus and its actors — it is metaphysical and social. What if Biosphere 2 heightened this tension between the chorus — the public, the Exxon-Mobiles, the nuclear family, the mega-consumption — and the actors, those who held up a mirror to the chorus? For there was never another enclosure, despite being passed into the hands of Columbia University, an Ivy League institution with a large endowment and excellent scientists. If the entire experiment was a social performance, then the Demogorgon does not have the last word.

No Poets on Mars

Who might we be? Children of Biospherians, of synergy?
We are the Born Ones, Chthonic and earthbound,
Soil heavy with the pressing weight of human misery.
To grow up on an Ark, to touch one's feet to the ground.
To see the sixth Extinction pass before our eyes
To be swept up in the shrill of the chorus
To be torn from Mother with the anger of a thousand cries.
To become an organism of the second Biosphere
To see the acidifying ocean both far and near,
To dig beneath for the tangled rhizome
To see in the prism of our sphere a panicked fear.
Demogorgon, you must by now know what I will say:
There is no cure, no second home.
The chorus is loud, but they know not what they say.
You ask: who are we, children of Biospherians, of synergy?
We are earthbound, chthonic, born, unfree.
Take back your fire.
We will make our own destiny.

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DEMOLITION

Tim Oakes

Concrete neither lasts forever, nor does it disappear entirely once it has been demolished. Sometimes, concrete rubble is recycled. Other times, it ends up in the landfill. Many times, demolished concrete just ends up on the side of the road. This chapter explores the varied meanings of concrete debris in China. It reveals the ways that demolition and rubble are not simply the inverse of progress, but instead productively bond ideas of progress with the material and political force to propel new projects forward.

✣

The Rubble of Rural China

Along the sprawling edges of urbanization in China, new towns and cities are platted out with a vast grid of empty concrete roads long before anything resembling a city appears. Sleek new highways and bridges offer up the smooth surfaces and clean lines of modernity, gesturing toward the shiny city-to-come. Yet these infrastructures for the imagination traverse landscapes still cluttered with rubble. Beyond the guardrails and landscaping of ornamental shrubs and trees, abandoned fields are filled with piles and piles of mostly concrete rubble. Rubble tumbles down nearby slopes; it collects under bridges. It's what is left of the villages that once stood where the grid of roads has now been built.

Those villages were once built of stone and timber, the building materials of an earlier era. In the 1990s and early 2000s, after villagers began sending cash home from working on construction crews and assembly lines in the booming industrial zones of China's eastern seaboard, these older houses were torn down and replaced with concrete structures. Concrete was desired for its clean modern aesthetic and its accessible assertion of newness, even though villagers would often admit that the older stone and timber houses were more comfortable to live in. They were warmer in the winter and cooler in the summer, and generally drier in the subtropical climate. But concrete homes were not just new and modern; they also suggested permanence and stability in a way the older houses did not, since older houses were so often in need of repair and rebuilding. A concrete house was an investment and a statement, conveying the stature and authority of its inhabitants.

And yet, as the distant cities continued to expand outward swallowing thousands of villages in their paths, these concrete houses were themselves demolished, in less than a decade in some cases. If a concrete house suggested some sort of permanence among villagers newly flush with migrant-labor cash, concrete rubble became a mark of *impermanence,* an expression of the *ephemerality* of modern China. A pile of rubble that was once a village is a testament to the inevitability of progress and the constancy of change (fig. 10.1).

As the editors have noted in their introduction to this volume, concrete often fails long before its assumed lifespan. But in China, it seldom even reaches the point of failure, let alone its assumed lifespan, because it more often gets demolished to make way for something even newer. In much of the urbanizing countryside, piles of rubble are less the result of material failure than of simply being in the way of change. And while rubble is often produced by large bulldozers, excavators, and cranes

Figure 10.1. Piles of rubble adjacent to a new construction project in Guiyang, China. Photo by the author.

swinging menacing steel balls, it is also attacked by teams of laborers with sledgehammers, wearing conical straw hats, colorful sweat-stained singlets, and green canvas sneakers. Sometimes they wear only flipflops. They painstakingly pound at the concrete, separating it from rebar, which, unlike the concrete rubble, can readily be reused.

"Concrete is a paradoxical material," the anthropologist Penny Harvey has observed. "Its combination of plasticity and inflexibility, the synthetic origins that link it to human intention, and its particular mode of decay, which speaks of a bleak incapacity for absorption into the wider environment, collectively provoke complex associations of hope and despair" (Harvey 2015). This paradox of hope and despair embedded in the materiality of concrete is maintained when it is reduced to rubble. Rubble is left to record a passing moment of demolition, and it tells us much about the powerlessness and precariousness of villagers in the face of the "infrastructure maniac" that is the Chinese state (Oakes 2024; see also Lora-Wainwright 2012, and Chu 2014). But the piles of rubble one sees beyond the empty grid of new roads encasing the countryside are also left to remind the people who continue to live there in a suspended state of anticipation that improvement is visibly and materially present, and that the city-to-come is still coming. Asa Roast (2022, 391) has thus proposed that such empty, rubbled lands — referred to in China as *kongdi* — be understood temporally, as spaces "awaiting an imagined future of urban development."

The anthropologist Gastón Gordillo has pointed out that early twentieth-century critical theorists Walter Benjamin and Theodor Adorno valued ruins as *nodes of negativity* with the power to disturb the incessant positivity of capitalism. "Adorno had argued that the dominant common sense under capitalism emphasizes the positivity of social and material reality, while erasing what these things negated and destroyed in order to acquire their positive form" (Gordillo 2014, 13). Benjamin held a similar view of history defined by interruption, debris, constellations, and catastrophe in opposition to the "homogenous, empty time" (Gordillo 2014, 20) embodied by the ideology of progress. For Gordillo, this means that the social formations emerging from capitalist development "are made of not only inhabited places but also of the nodes or rubble they are enmeshed with" (Gordillo 2014, 20). Demolition and debris, then, are part of the make-up of any given place within the developmental regime of capitalism. This perspective can be useful in making sense of the rubble of rural China as well, where the positivity of urbanization — and the social progress it ideologically proclaims — is undergirded by an incessant drive for demolition.

Unlike almost everything else in China, concrete is not typically recycled. That may help explain the piles of rubble everywhere. Nobody is sure what, exactly, to do with all of this broken-up concrete. Most other building materials are recycled, but concrete often just sits there, as if on display. Concrete rubble is there to remind everyone that progress is underway, that construction is happening, that a new China is always in the process of being built, and that anything standing in the way will be summarily pulverised.

Bulldozer State

Each year, China produces at least 1.5 billion tons of waste from construction, demolition, and renovation. Wilson Lu, at the University of Hong Kong, estimated as much as 2 billion tons of waste in 2011 (Ramzy 2013). The journalist Anna Sophie Gross (2019) estimated that 2 million tons of this waste was concrete rubble. Since 2003, China has famously poured more cement every three years than the US managed in the entire twentieth century (Smil 2020); China today uses half the world's concrete. Despite the Chinese being master recyclers, less than 5% of China's concrete waste is recycled. While recycling concrete is difficult, other countries — like Japan — do manage to recycle a large portion of their concrete construction waste. Is there something else going on in China that discourages the recycling of concrete?

Concrete's powerful association with "newness" suggests one answer. The historian and visual artist Tong Lam has observed that in a country where the new is fervently embraced, even the ruins are new (Lam 2019). By constructing buildings that are never occupied or never quite finished, new towns in China can fall into ruin before ever being used. New buildings in China are typically torn down every 25–30 years, compared to a 75-year average in the US and Europe. This suggests a kind of built-in obsolescence in China's cities and towns, for economic reasons. The writer Wade Shepard makes this point, claiming that "houses that can last a century are not nearly as profitable as ones that can be demolished, rebuilt and sold three times over within this span of time. As 40 percent of construction land in China is created every year by the demolition of old buildings the financial incentives for these urban upgrades is evident. Demolition, too, increases GDP" (Shepard 2015, 16).

China has a demolition economy and a bulldozer state. Demolition is an economic stimulus, not simply because it clears the way for new construction as argued by Shepard, but more fundamentally because of the land-lease fees promised by new construction. Such fees are "extra-budgetary" and thus kept by the municipal government. They routinely account for 30% to 70% of city government revenues in China (Ren 2014, 1083). Statecraft in China has a built-in incentive to demolish. And in China it was legal in the 1990s and early 2000s to demolish urban houses without the owner's consent. While residents could appeal decisions to condemn their houses, demolition was nevertheless allowed to proceed during the appeal process.

Urban development has become the primary mechanism through which the local Chinese state builds its legitimacy, authority, and power. Before the 2000s, industrial development played this role, but that is no longer the case. Revenue generated through land-lease conversions, through demolition, and through annexation means that the city has become a power machine for local state leaders. In the process, local governments have shifted from their primary role as managers of social welfare to a new role as entrepreneurs seeking to enhance urban revenues.

Demolition is a big part of how the city plays this role for local state leaders. According to Wade Shepard, 40% of the construction land created every year in China comes about through demolition. The writer Yu Hua (2011) once claimed that the fondness of city leaders for demolition has its roots in the violence of the Cultural Revolution, but it seems that a better explanation for the bulldozer state comes from the *productiveness* of demolition. The bulldozer state isn't just about destroying the old; it's also about making money. Demolition is the most important lever at a leader's disposal if they want to take advantage of the city as a state-making tool. One of the reasons for China's breakneck pace of urban renewal is that once demolition occurs, there is no alternative but to build something new. Demolition resets the clock; it cannot be reversed, even if it's illegal. It creates facts on the ground that can only lead toward the new plan (see also Abouraheme in this volume, and Sharif in this volume).

Visibly Forgetting

There is also, perhaps, a certain *fondness* for demolition. On the one hand, this is evidenced by the way demolition in China has itself become a spectacle of urbanization. Large-scale, controlled demolitions, such as the one that brought down fifteen concrete apartment towers near Kunming in 2021, have become online video sensations in China. In 2013 a two-mile stretch of concrete viaduct in Wuhan was demolished with a choreographed precision that recalled the spectacular opening show for the 2008 Beijing Olympics. Such spectacle demolitions have their symbolic value. Here is the powerful, implacable hand of the state, sweeping away the chaos and excesses of unchecked urbanization. Sometimes this hand wipes sites clean in the name of the environment, as it did in May 2021, also in Kunming, when over 1000 new villas on Changyao Mountain were demolished. In 2019 over 2000 villas were demolished in a nature reserve in the Qinling Mountains in Shaanxi Province. Demolition is a means by which people may be soothed by a sense that some sort of ordering is afoot, that somewhere someone has a plan.

Yet on the other hand, there's also a sense that demolition, and the piles of rubble left behind, is some sort of cultural motif for contemporary China. Artists have, in particular, fixated on the Chinese character *chai* (拆), which means "to demolish," as a cultural symbol, a morbid marker of the times. Wang Jingsong's 1999 photocollage *Chai: One Hundred Signs of Demolition,* which offers up 100 decontextualized images of this character painted on the condemned buildings of Beijing, is just one case in point. Another is Huan Rui's "China/Chai-Na" photo series, which focused on the demolition leading up to the 2008 Olympics in Beijing. Sociologists Zhao Xudong and Duran Bell (2005, 490) argue that underlying the meaning of chai is a "logic of social construction that is based on destruction and a social memory based on forgetting." But chai, they point out, refers more to replacement and progress. It marks, ultimately, a positive force. And this, then, is something rather different from the negativity invested in ruins by Benjamin and Adorno. If chai marks a kind of progress represented by destruction, it also represents the *eagerly forgotten*. There is, in the end, a certain political enthusiasm symbolized by chai. The anthropologist Alessandro Rippa (2019) has observed something similar in his explorations of the rubble left behind in the city of Tengchong. Rippa claims that rubble in China is not purely negative. It is a pre-condition for the new; rubble is an aspiration for modernization and development. Rubble suggests a future to be made, of high-rise apartments, of shopping streets, of sleek new cities. In China there is no time to dwell on the negative.

To return to Harvey's words, concrete's "bleak incapacity for absorption into the wider environment" is, I would suggest, responsible in part for the emergence of rubble in China as a cultural marker of the visibly forgotten. The material qualities of concrete, in other words, are fundamental to understanding the kinds of social and political processes generated by China's rapid urbanization. In the borderlands of Chinese urbanization, the concrete poured and smoothed into the empty new highways is but one material manifestation of the city-to-come. The broken concrete remains of villages, piled into the fields that nobody bothers to farm anymore, is another. Both are equally powerful reminders of a future to be made. Both visibly forget the village as a space in which lives that did not revolve around the urban were lived.

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DEPTH

Matt Edgeworth

As well as extending horizontally to cover much of the Earth's surface, concrete also penetrates down far below ground level, leaving substantial stratigraphic traces in deep strata. This chapter examines the buried vertical dimension of concrete. Deep concrete will last much longer in geological time than shallow concrete because it is protected from surface forces of erosion by layers above. Depth in space, it is argued, ultimately correlates with depth in time.

The horizontal spread of concrete, covering increasing areas of the surface of the Earth, is plain to see. So too is the upward rise of this material, in the form of skyscrapers, tower blocks, and bridges. Not so visible, however, is the spread of concrete downwards into the subterranean world and its incursions into deep strata.

In 2017 I was working as part of an archaeological team on the A14 road widening and construction scheme in Cambridgeshire, England — one of the largest infrastructure projects in Europe at the time. Our team was excavating Bronze Age field systems and ritual monuments that were in the path of the new

Figure 11.1. Preparation for the largest "Mat Foundation Pouring" in Southeast Asian history at Bangkok One, Bangkok, Thailand. In February 2020, 23,725 cubic meters of concrete was poured during a 33-hour period. Photo by Eli Elinoff.

road. Our job was to excavate and record these remains as fast as possible. It was a race against time, with bulldozers and mechanical excavators at work all around us.

The corridor of the new road stretched from horizon to horizon. Hundreds of thousands of tonnes of earth were being scraped away from the tops of hills to make deep cuttings, while in low-lying valleys that same earth was piled up to make embankments. Road surfaces were being laid and road bridges constructed. On a piling platform next to our site, drilling rigs were cutting cylindrical boreholes 28 meters deep, to provide support for a motorway bridge, which would carry the A14 over the A1 or Great North Road.

It was a spectacular sight. The massive augers were boring down into clays deposited in shallow seas during the Jurassic period, over 145 million years ago. As these drilled deeper the splintered fossils of ammonites, belemnites, brachiopods, and other extinct sea creatures were churned up, embedded in a matrix of silvery-gray clay. Steel cylindrical cages were inserted for the purpose of reinforcement. Then the boreholes were filled with liquid concrete.

While the concrete was being pumped in, it occurred to me and my archaeological colleagues that these were not just intrusions into strata, but stratigraphic formations in their own right. What we were witnessing — while excavating an ancient archaeological site — was the laying down of archaeological strata of the future. Furthermore, in penetrating so deeply into the ground, these substantial traces of contemporary construction activity would last much longer than the shallow surface traces of Bronze Age farmers we were investigating nearby. The rectangular formations of concrete piles are likely to survive in the ground for more than just a few thousand years.

Deep concrete, then, is a term that refers not just to depth in space, but also to depth in time. How long will the steel-reinforced concrete pillars endure in the stratigraphic record? Concrete is especially long-lasting when deeply buried and protected from erosional forces on the surface. The buried concrete columns will be there long after this new bridge and the motorway itself have been swept away by the ravages of time. Is it conceivable that they will still exist in millions of years, perhaps even hundreds of millions of years? Could they survive as technofossils (Zalasiewicz et al. 2014, 34) for as long as the fossilized remains of ammonites and belemnites and other extinct sea creatures have been encased in their matrix of soft clay?

To talk of concrete fossils is more than just a metaphor. Take the stone mines at Combe Down, near Bath, UK, where shallow sub-surface mining was carried out from medieval times to the nineteenth century. The method of mining was called "room-and-pillar," excavating voids but leaving pillars of stone to support the roof. Voids created were up to 9 meters high, with an average of only 6 meters of cover, while often the depth of ground between the roof of artificial caverns and the ground surface above was as little as 2 meters. In the late nineteenth century, roads and houses were built on top. By the late twentieth century, 300 houses or more over an area of forty acres were at risk of subsidence. To solve the problem, 600,000 cubic meters of foamed concrete were pumped into the subterranean voids to stabilize the ground.

When hardened, the concrete effectively formed a cast of the shape of the mines — a giant trace fossil of human underground activity. The process is similar to fossilization of soft-bodied animals through the seeping of mud into cavities left by the mold of their decomposed remains, except that here it was done as a deliberate act, using a manufactured material and an artificial means of injection. Should surrounding material ever be removed and the concrete exposed, it will retain the precise shape of the mine interior — the negative voids of the shafts and galleries — preserved and fossilized in positive form.

One is reminded of the investigation of an abandoned mound of a colony of leaf-cutter ants in the rainforests of Brazil, as depicted in a documentary film (Thaler 2004). Scientists pumped tons of concrete into small tunnel entrances, waiting several days for it to harden, then excavating the surrounding soil away. This revealed an intricate network of tunnels connecting with chambers over an area of eighty square meters and eight meters deep — an underground ant megalopolis of the natural world transformed into a concrete technofossil.

Underground megalopoli constructed by humans, of course, have similarly labyrinthine networks of shafts, tunnels, and vents, but on a vastly larger scale, taking concrete much deeper into the Earth.

Consider the forty kilometers of tunnel built by Crossrail for the new Elizabeth Line running east-west under London. At an average depth of twenty-five meters below ground, these were lined with prefabricated concrete segments manufactured in factories above ground and imported into deep strata through engineering shafts. The near-cylindrical tunnels were dug out by giant tunnel boring machines (TBMs) with powerful rotating cutter heads. As the TBM progressed forward in short advances, the excavated material — in this case mostly Eocene clays laid down in shallow seas approximately 55 million years ago — was transported via conveyors up to the surface. Segments were assembled to form complete rings, preventing collapse of tunnel sides. Each ring was formed of seven concrete segments weighing 3000 kilogrammes each, and a concrete keystone weighing

1000 kilogrammes. The rings locked into other rings on either side to form the continuous tunnel lining.

Another method adopted by Crossrail engineers for shorter tunnel sections used sprayed concrete. Once the TBM had excavated a new stretch of tunnel, the sides were sprayed with a thin sealing layer of concrete about 75mm in thickness in order to consolidate it, followed later by a more substantial primary layer about 350mm thick to effectively form a double-shell lining. The sprayed concrete contained steel fibres to enhance its tensile strength, enabling it to withstand forces of compaction and to resist warping.

The new Thames Tideway Tunnel takes concrete even deeper into the Earth's outer crust. The twenty-five-kilometer-long super sewer follows the course and gradient of the River Thames at a depth of up to sixty meters below the surface. It uses drop-shafts to intercept the shallower Victorian sewers built of brick that now struggle to cope with the effluent of modern London and its growing population. Like the Crossrail tunnels, the artificial shadow-river is lined with prefabricated concrete segments made in above-ground factories. During construction, in order to get large TBMs and concrete segments down there and to be able to remove the excavated spoil, a series of large vertical shafts were made along the line of the tunnel. The deepest one at Battersea is thirty-two meters wide and over seventy meters deep. Picture how high a twenty-story building is to get some idea of how far it goes down into the ground.

The circular concrete walls of the shafts were installed to their full depth before the actual holes were dug. A suspended rotating cylindrical cutter-head was lowered gradually into the ground, churning and excavating and removing material as it went, but leaving the bulk of material in the middle unexcavated. When the full depth of the shafts was reached, concrete was pumped in to form the walls. Up to 10,000 cubic meters of concrete went to make the walls of just one shaft. Only when these were fully formed was the rock and soil on the interior of the cylinder removed to create the hole. When the massive hole was finally excavated, more concrete was pumped into the base to provide a secure foundation to the whole underground structure.

It was noted earlier that deep concrete refers to depth in time as well as in space. Temporal depth and spatial depth are two sides of the same coin. In general terms, the deeper concrete goes the longer it is likely to survive embedded in strata. As part of an infrastructural system, the Thames Tideway Tunnel and associated shafts might be expected to remain in use for hundreds of years. But as part of the archaeosphere (Edgeworth 2017, 159) and the geosphere it will last for much longer than that. It will endure on geological timescales as well as historical ones. In the longer term, the shaft may get filled in and the tunnel will be subject to partial collapse and inundation. But the concrete will still be there. How long it will be preserved in the stratigraphic record is a matter of speculation.

Once in the ground, concrete becomes a geological material and is subject to geological processes. This might not be noticed when infrastructure is regularly maintained but becomes apparent when it falls out of use or is abandoned. Imagine the surprise of an urban explorer when he ventured into an abandoned tube tunnel under the River Thames to find that thin stalactites over two meters long extended down from the tunnel roof, with stalagmites beginning to form from the ground up. What was once an artificially constructed tunnel with trains going through had become in at least this respect more like a natural cave.

The tunnel was formerly part of the Northern Line, the southern end of which then looped around under the River Thames. Built in the early twentieth century, this tunnel section was damaged by a German bomb in World War II and flooded. It was repaired at the time but sealed off and never brought back into service, remaining out of use and largely forgotten for the next seventy years. The tunnel was lined with metal segments backed by concrete. It is surmised that the stalactites are comprised of calcareous deposits formed from carbonates in the concrete which have leached through. However, stalactites in natural limestone caves typically take hundreds of years to grow to anything like this size. It seems that, in the artificial environment of the abandoned tube, geological processes have greatly sped up.

It is tempting to think of deep concrete as a near-permanent monument to humans which will survive long after our species has vanished from the face of the planet — an enduring signal of the Anthropocene, the human epoch in Earth history. But the experience of the urban explorer gives us the merest glimpse of a future of buried concrete that is not quite so human-centric. Whereas human lives take place on historical timescales, concrete exists on geological scales of deep time, too. It may be part of the human world now, with social dimensions and properties. Yet it has the capability to transition easily into a post-human world. It can endure and interact in its own right with materials and processes in ways we never envisaged and beyond any human control.

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EDGEWORK

Lukas Ley

Concrete plays a central role in coastal dramas. As cities built on shores prepare for rising sea levels, their coastal infrastructures and styles of fortifications heavily rely on concrete to prepare for and weather incoming storms. This chapter describes the work of Géocorail, a biotechnical compound that produces a concrete-like structure out of pre-existing elements in seawater. Material innovations like Géocorail highlight the necessity to engage in coastal edgework. They are experiments aimed at replacing unsustainable forms of concrete while reproducing the sociomaterial edges and speed of urbanization.

On a sunny day, too warm for March, I visited the offices of a small start-up located in Marseille-Fos Port, France's leading seaport. Founded in 2012, with a current staff of eight, Seacure reinforces sand beds and prevents abrasion to counteract the destruction of port structures, such as breakwaters, docks, or embankments.

Seacure produces Géocorail, which is the brand name of a patented electrochemical process that the company applies to

Figure 12.1. A piece of "natural concrete" produced in the harbour of Marseille. Photo by the author.

fix marine infrastructure. The process was originally designed by former employees of Gaz de France in the 1990s. It allows sediment found in seawater to aggregate and form a stone-like, solid mass, or, in more technical terms, a "calcareous mineral agglomerate." This agglomerate has properties similar to limestone or concrete. Géocorail can thus patch up cracked or fissured underwater foundations of docks or piers. The company's *in situ* "germinative" process uses available nonorganic material, such as sand or shells. It also binds anthropogenic wastes like glass shards, transforming them into a durable support compound for rock, harbor, and even offshore infrastructure, such as wind farms.

To kick off this germinative process, engineers submerge metallic cathodes in seawater and send a low current through it. Reverse electrolysis then leads particles to gravitate to the grid and accrete. The company has tried to generate whole breakwaters from "scratch" using this procedure. Setting itself apart from the concrete industry, the company calls its product "natural concrete."

When research and development manager Alaric Zanibellato hands me a specimen of this natural concrete, I am strangely mesmerized by it. This eerie skeleton has grown underwater, particle by particle, layer by layer. I turn it around in my hands, feel its mass and its coarse surface. The touch of my skin causes the artificial rock to crumble a little, suggesting evanescence.

Zanibellato holds a PhD in Marine Corrosion and Electrochemistry. He wrote his dissertation on Géocorail. He tells me that this sample stems from a test site in the port of Marseille. Here, under water, the subtle alchemy of Géocorail transformed a slim piece of rebar within hours into a thick, durable matter with a stone-like texture. The process would have taken the polyps that build corals in the shallows near coasts years, if not centuries, which is still a blink of an eye compared to the time that it took the sea and tectonic forces to form cliffs from compacted sediment.

Mass-producing Géocorail would allow coastal engineers "to act at the speed of Earth," as Elinoff (2019) cogently put it when he referred to the temporal affordances of cement. In a similar vein, the opening statement of Zanibellato's PhD thesis (2016, 1) suggests that human ingenuity and deep ecology have met on the same temporal plane: "researchers may have found a solution to the receding of dunes and beaches; a solution that will provide safety to coastal residents."

I read Géocorail's promise and effort to extend the life spans of human-made coastal infrastructures as an example of what Stephanie Wakefield and Bruce Braun (2019, 213) call the practice of "inhabit[ing] capitalist ruins in a more-than-human world." These practices are often arduous and marginal edgework (Tsing 2017) in which materials and social relationships with nonhuman others get reassembled. Sociologist Stephen Lyng (2004, and 2005) originally proposed the term edgework to explain the human experience of and desire to defeat bodily and social limits. He used the concept to ground risky behavior, such as illicit BASE jumping, to the embodied experiences of social control within liberal regimes. Being on the edge, as a leisure activity, marks the opposite of an externally imposed lifestyle requiring constant compliance with work ethics or moral expectations. By seeking out and testing limits, edgework challenges accepted norms and sets new affective and experiential standards. Géocorail's "natural concrete" is the result of re-assembling and thereby valorizing oceanic matter and seawater to challenge scientific limits and conventional meanings of concrete. Underwater synthesis of concrete-like matter signals a new temporality and politics of infrastructuring and repairing along the coast. Géocorail is more-than-human edgework. While building and protecting the literal edges of terrestrial regimes, it expands the productive edge of concrete to watery environments.

Géocorail's technology enrolls oceanic species, vital matter, and the fluvial nature of water in an economic and material experiment. My point here is not to say that natural concrete is edgework and building with concrete isn't; indeed, as I have explored elsewhere (Ley 2021a, and 2021b), a range of practices engaged in the maintenance of human life and coastal ecologies could broadly fall under the rubric of edgework. Thus, my point is rather that living on shores has always been a practice of edgework. As a uniquely utopian material, concrete continues to test the very limits of space by pushing the boundaries of the city — horizontally and vertically. Attempts to design and re-engineer coasts still rely on and use concrete structures to reproduce life and generate profit. The concrete edge of coasts sutures moments in the history of human coastal life by engendering materially different types of edgework in the name of nature-making feats that continue to challenge all kinds of limits.

In one case, in fact, Géocorail was used to build an access road for a land reclamation project in the Pacific Ocean. As an auxiliary, Seacure's engineered calcification brought land formation "up to speed" with human existence (Elinoff 2019). Together, old and new types of concrete partake in the acceleration of other environmental changes "by expanding fossil fuel extraction and facilitating automobility." Géocorail and older types of concrete merge and interact up to a point where it is difficult to tell them apart. While Géocorail is smoothing off conventional concrete's technological edge, both are designed to resituate the edges of human life. In doing so they also refigure and blur the edges between nature and culture; if natural concrete is delivering infrastructure's infrastructure at the same speed as concrete once did, these materials force us to return to the increasingly fundamental question of what nature is, is not, and might yet be.

Can we conceive of concrete as a creative and even progenitive actor in the production of more than human natures? As Vince Beiser (2018, 46) has put it, "concrete has a way of leading to more concrete." Indeed, the ways in which concrete has edged its way through time and continues to suffuse imaginaries of coastal development suggest that it is part of an "ecology of materials" (Ingold 2012) that makes up human lifeworlds. In a sense, Géocorail reveals that preserving the "human shore" (Gillis 2012) depends on becoming more like nature *and* more like concrete. There is certainly the discomfiting fact that this nature of concrete produces largely asymmetrical relations between humans and underwater others — framed as plentiful resources and assistant species that can be reliably harnessed to sustain the speed and durability of coastal infrastructuring.

As an actor, then, concrete not only allows us, but perhaps forces humans to stay up to speed with environmental changes. Since the sheer velocity of urban becoming and the depletion of the planet's sand resources are entangled from the beginning, the rush for alternative ways to confront the fluctuations of the coast cannot be understood as an effort to escape this temporality. Rather, it gestures toward how we project the possibilities of concrete onto ecological frontiers, looking for new admixtures — notably, sediment and seawater — to sustain speed while responding to the anthropogenic destruction of coastal infrastructures.

Today, all coastal cities display a concrete "edge" consisting of breakwaters, dams, jetties, port infrastructure, and waterfront development. Humans have tended to barricade themselves behind this concrete edge, even though the Dutch "Meebewegen" experiment aimed at accommodating and retreating from the sea as well as imaginaries of urbicide in Miami (Wakefield 2021) suggest a departure from this handling. The material seems to absorb or disperse the force of the ocean, its currents and tides, and its expansions and contractions. Yet, as we know, these infrastructural edifices do not resist the forces of nature forever. They too age, wither, erode, and collapse. Rather than its permanence, it is this temporal cycle of durability and collapse that enrolls concrete in the perpetual task of "edgework." Like other forms of edgework, coastal edges entail forms of risk-taking that introduce possibility but also create the illusion of safety. Despite the well-known inadequacy of concrete anti-flood infrastructure, it is fundamental to attempts to assemble more urban land for investment (Li 2014). Concrete has not lost its edge, so to speak, but pushes the material, spatial, and ontological edges of capitalist urbanization ever further.

My recent explorations in the port of Marseille illustrate how concrete's social, material, and temporal properties inform the development of a niche economy that enrolls sediment and other marine non-humans in new versions of a very old practice: human attempts at mastering the seashore. This emerging economy's goal is to create more or less durable compounds in situ that emulate the endurance of stone and concrete in the aim of fortifying and maintaining human coastal edges. Concrete here works not just as a mode of preservation, but as an active link, a "binder," between traditions of urbanizing shores. This new concrete not only sets forth to fix topographic elements of the coast but also shows how humans have begun to naturalize the fully urbanized coast itself. As Boyer (2018, 223) has pointed out, broken concrete expresses a sense of "evaporating futurity." Géocorail literally patches up and transforms this futurity into value by repairing broken coastal infrastructure and restoring its promise. It doesn't invalidate the politics of coastal fortification that installs hard edges but bolsters it, promising to protect cities against rising seas.

So, beyond firmly reestablishing itself as the utopian building material par excellence, concrete has managed to pull off another trick: by binding the protection of coastal lifestyles to the geophysical properties of ocean shores and the life cycles of nonhuman others, Géocorail has outperformed nature while suggesting that it is nature. Géocorail in fact suggests the ultimate naturalization of concrete.

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ENTOMBMENT

Greg Dvorak

Since the turn of the twentieth century military history has been written in concrete. From bunkers, to bases, to T-Walls, concrete constructions serve as lived-in memento mori that drag histories of militarism into the present. This chapter describes the author's reconciliation with the fact that his childhood playland was a crypt, entombing violent, unfinished histories of empire on the Marshall Islands. Through its social archaeology of militarism in the Pacific, it calls for an excavation of these tombs.

I spent the first decade of my life in the 1970s–1980s playing among war ruins at the intersection of American and Japanese Empires in the Pacific. This was on the colonized and militarized land of Kuwajleen (Kwajalein) Atoll in the Marshall Islands, the largest inhabited atoll on earth. Its twentieth-century concretescape was a peculiar fusion of defense fortifications built by the Japanese during the Pacific War in the 1940s and rust-stained fallout shelters and radars built by the Americans during the Cold War after the 1950s. Like these entangled postwar histories, the detritus on this perennial battlefield all looked the same to

Figure 13.1. A Japanese bunker from the 1940s sits on the American golf course on Kuwajleen. Photo by the author, 2016.

me, regardless of who made it and why. The brilliant turquoise lagoon, reef at low tide, and breezy pandanus and palm trees were interrupted by concrete bunkers, barriers, blockhouses, docks, pylons, and runways.

Kuwajleen's concretescape is relatively new: the atoll's human histories stretch through at least two millennia of Marshallese navigation and settlement by brave and resilient Islanders long before European colonization began (Beardsley 1994). Only in the past two hundred years did invaders from Spain, Germany, Japan, and the US start laying claim to the nearly thirty central Pacific atolls of the Marshall Islands, coating ancient and enduring coral beneath layers of quick-drying cement—reshaping and reappropriating ancestral land. In this, cement and concrete were quintessential technologies of imperial struggle in the Pacific.

Once a coconut plantation and then a major Japanese naval base, Kuwajleen was taken by the United States in 1944 and turned into a support base for atomic testing at Bikini and

Enewetak Atolls. Later, it became a site to develop the missiles that would carry those bombs; today it remains a site for testing and space surveillance by the United States.[1]

The son of a radar engineer who worked for a defense contractor, I lived with my family on the main islet of Kuwajleen Atoll in a highly restricted US Army installation. It was fashioned to look like suburban New Jersey so that its middle-class and largely civilian workforce felt comfortable carrying out day-to-day operations required for testing and intercepting the unarmed intercontinental ballistic missiles that would streak across the night sky and plunge into the lagoon once every few months. Sometimes we would watch them like fireworks, with popcorn (see also Dvorak 2016).

Concrete was a part of the environment to me, friendly and familiar as the moon reflecting upon the lagoon at night. Japanese fortifications from World War II were so ubiquitous in our everyday lives that we took them for granted. On other islands throughout Micronesia the ruins of pilot dormitories and air defense posts that remained standing had been converted into homes, community gathering places, or schools. As these bunkers and bomb shelters aged and weathered in the salty tropical air, their blackened and mossy surfaces blended in with the natural environment. In games of hide and seek we would mount their warm sun-baked backs or slip between their bullet-pocked walls sprayed with graffiti.

I was blissfully unaware that the mound near the northern tip of the island, where we kids played king of the hill, housed one of the last bunkers where Marshallese sheltered as US soldiers killed or captured the last of the Japanese resistance. Whole families had huddled for days without food and water in utter terror as they endured the tropical heat, the deafening blasts of exploding ordnance, and the unnerving cascade of sand as earth shifted around them. I had no idea that the remains of most of

1 The eleven islets leased throughout the atoll to the United States together house facilities that currently comprise the Reagan Test Site and a base called US Army Garrison Kwajalein Atoll (USAG-KA).

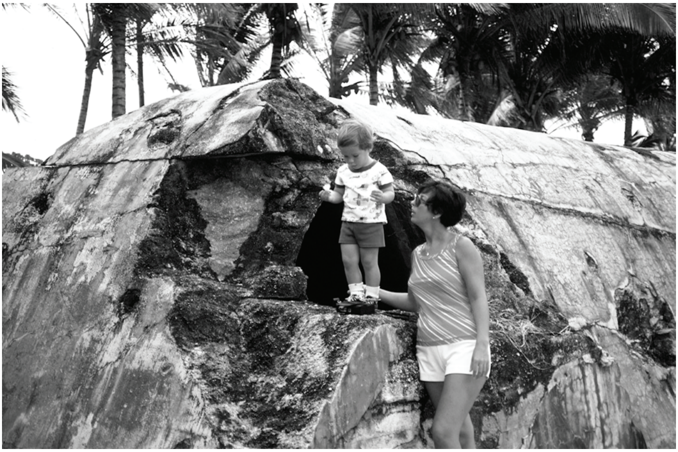

Figure 13.2. The author with his mother on a Japanese bunker on Roi-Namur islet in 1976. Photo by the author.

the nearly 5000 Japanese killed on Kuwajleen islet still lay buried beneath my elementary school, our supermarket, and our swimming pools. Indeed, one of the most vicious battlefields of World War II was covered entirely by the cement of our idyllic hometown.

After laying claim to the Marshalls in October 1914, Japan had colonized these islands for thirty years, along with most of Micronesia as a League of Nations mandated territory known as the Nan'yō Guntō (the Southern Islands). Japanese and Okinawan settlers outnumbered Indigenous populations all across a vast stretch of Northern Oceania, and when civilians were sent back to Japan as the Pacific War broke out, even more soldiers were dispatched to these islands in their place, including almost 10,000 sent to Kuwajleen alone (Hayashi 1964, 22–23). Construction battalions were tasked with preparing the concrete needed to fortify the atoll and build defenses, water catchments, airstrips, barracks, and even several Japanese communal baths. They mined the shoreline for coral aggregate — destroying sacred Marshallese ancestral fishing grounds and blasting large rectangular holes in the oceanside reef (Dvorak 2018, 26).

Among these men were almost 1200 young Korean laborers, forcefully drafted from Busan and Jeju to labor in the hot tropical sun, so worried they would die without ever seeing their families again that in some places they etched their names in Hangul into the undried cement (Dvorak 2018, 182). Racing to build the base before US forces arrived, and in short supply of cement, the walls the Japanese built were thick and infused with iron rebar but not completely hardened, ironically giving them the elasticity to withstand much of the coming bombardment without crumbling — so much so that American soldiers lamented the Japanese "invincible concrete" (personal communication with archaeologist Leslie Mead, 2005, cited in Dvorak 2018, 269).

In the wake of Japanese defeat, to convert Kuwajleen into a forward base in Admiral Chester Nimitz's stepping stone campaign toward Japan, American soldiers hurriedly tended to what they called "mopping up" exercises, which included interring the war dead. They recruited Marshall Islander men, still traumatized by the destruction of their land and loss of loved ones, to help lay to rest thousands of bodies of their former colonizers (Poyer, Falgout, and Carucci 2001, 239). Swiftly recolonizing the former Japanese territories of Micronesia under the US flag, American engineers also dynamited their own deep quarries in the reef to mix more concrete to bury these mass graves and the charred earth that was once lush jungle. For decades they would keep dredging the coral and enlarging the main island of Kuwajleen to build a high-tech and secretive base for use in the emerging nuclear arms race.

Beginning in 1946, less than a year after the bombings of Hiroshima and Nagasaki, the US Department of Energy inaugurated Operation Crossroads, the atomic testing program that would lead to sixty-seven devastating atmospheric nuclear tests over a span of twelve years in the Marshall Islands, designating Kuwajleen as the main support base. The residents of Bikini Atoll, whom American officials falsely asserted were "nomadic peoples" (Weisgall 1994, 162) were told that their displacement would be temporary and that their home would be used "for the good of mankind and to end all wars" (Niedenthal 2001, 30).

American soldiers descended upon this atoll, building new kinds of concrete bunkers, this time to protect against the radiation of atomic blasts. Their various explosions, targeted at first on captured Japanese ships loaded with goats, pigs, and other animals, would go on to vaporize whole islands and puncture gaping, deep holes into the core of the atoll. Transfixed by the "sublime" powers they had unleashed, the US proceeded to displace yet another Marshallese community from Enewetak, an atoll located roughly 350 kilometers to Bikini's west. The people of Bikini and Enewetak, uprooted from their beloved homelands and exiled to live on the barren islands of Rongerik and Ujelang, waited in vain to return to atolls that were systematically contaminated and destroyed. Meanwhile, on March 1, 1954, the fifteen-megaton Bravo blast in the Project Castle series was so monstrous that it reached high into the stratosphere, and when winds shifted and blew a blizzard of fallout all across inhabited Rongelap Atoll and several other atolls to the east, whole villages of people were sickened immediately but left to suffer for two days before they were rescued. The Japanese *Lucky Dragon 5* fishing boat was among at least hundreds of ships irradiated at sea that day, but the plight of its ill-fated crew made headlines, reviving atomic trauma back in Japan, spawning a widespread nuclear resistance movement, and inspiring the film *Godzilla* (Ōishi 2007).

All totalled, the sixty-seven atomic tests conducted in the Marshall Islands between 1946–1958 amounted to roughly 7000 times the Hiroshima explosion, the equivalent yield of 1.6 Hiroshima blasts per day over those twelve years. US officials repeatedly insisted that it was safe to resettle these irradiated islands, but those Islanders who returned to Bikini, Rongelap, and Enewetak soon discovered to their horror that they would become ill as the months and years passed. In the Compact of Free Association augured between the new Republic of the Marshall Islands and the US in the 1980s, a payment of $150 million was agreed to support all victims. Yet this did not take into account all of the people actually affected by the testing, or ongoing health problems for present and future generations, let alone the true cost of displacement, relocation, and cultural loss. The US has since neither formally apologized to nor fully compensated the Marshallese people for its actions.

Following on this nuclear testing, beginning in the 1960s, Kuwajleen was converted to a missile test and interception site whereby multiple antennas, radars, lookouts, and control rooms would be built on islands all through the atoll from north to south, displacing Indigenous communities from their homes on central islands and moving them onto a cramped urban islet called Ebeye, the town where Marshallese laborers from the base also lived. Evoking the grandiose narratives of a new era of space defense, the Cold War geography of Kuwajleen included a launch site on an artificial hill at the southern tip of the main islet, dubbed "Mount Olympus" after the ancient home of the Greek gods as it contained the silos for a series of deadly missiles named Nike-Zeus (Remick 2015). Nearby, the looming Defense Control Command Building, a then state-of-the-art hexagonal concrete structure, was built to withstand atomic Armageddon while still deploying further weapons. By the time my family lived on Kuwajleen, its funding cut and no longer serving a defense purpose, this nuclear fortress had been converted into a warehouse. Yet, to us it was an oddly comforting neighborhood monument to our domestic security, silhouetted on the horizon each evening against one flamboyant sunset after another.

Marshallese have little reason to feel comforted by concrete, especially in nuclear-affected atolls where it spells danger and death. Between 1977 and 1980 in Enewetak Atoll, US soldiers removed 85,000 cubic meters of highly irradiated topsoil and debris from six different islets. Mixing this radioactive waste with concrete slurry, they buried it in the nuclear blast crater from the 1958 Cactus test on the island of Runit. Sealed under a 45cm-thick cap made of 358 concrete panels, the gargantuan Runit Dome is yet another rotting American monument to the Cold War (Gerrard 2015, 89). As the dome cracks and leaks into the environment it also poses significant danger to the community

Figure 13.3. Unused Cold War–era American nuclear shelter and command center at the southern end of Kuwajleen, 2016. Photo by the author.

of Islanders who resettled their land across the lagoon, though a 2013 study by the US Department of Energy outrageously claims that structural failure of the dome "will not necessarily lead to any significant change in the radiation dose delivered to the local population," since there is already more radioactive material outside the dome in the lagoon and around the atoll than there is within (Gerrard 2015, 93).

It makes sense that this concrete behemoth is known locally as "The Tomb." In Marshallese and most Pacific Islander cosmology, land is contiguous with the body — it is a living ancestor, an eternal mother. In the Enewetak Tomb, beloved land was buried alive, along with another "living" substance: plutonium has a half-life of at least 24,000 years. And all of this is heaped atop the remains of almost 1000 Japanese and Korean war dead, who were killed in the same campaign as those who perished in the bombardment of Kuwajleen. Marshallese poet Kathy Jetñil-Kijiner voiced the grief and anger of Marshallese land as she performed a poem atop the tomb and implored, "My belly is a crater empty of stories and answers / only questions, hard as

Figure 13.4. Kathy Jetñil-Kijiner recites "Anointed" on Runit Dome, 2018. Photo by Dan Lin.

concrete. / Who gave them this power? / Who anointed them with the power to burn?" (Jetñil-Kijiner 2018).

The concretescape of the Marshall Islands was built with the promise of security and protection, but ultimately it is the stuff of violent death — an unmarked graveyard. Flattening and amalgamating, coating and covering, smoothing over contradictions, concrete buries the complexity of nature and our very humanity. We must acknowledge these trespasses, tend to these tombs, and excavate buried truths. As an adult returning to my childhood home, I wander through this archaeology at once universal and personal, nightmarish and nostalgic, Japanese, American, and Marshallese. I am overwhelmed by these entwined colonial and military destinies that killed and wounded and scarred. And the entombment continues: climate scientists predict the entire country may soon be submerged underwater. Yet, I find hope in the lush jungles that spring forth through cracks in the bunkers, and beneath the surface of the lagoon, out of the crumbled concrete of bygone battles, the new reef that is beginning to entomb the concretescape. Marshallese resistance, survival, perseverance, celebration, and commitment to life continues despite these layers of history, and Islanders continue to campaign to honor and care for their lands and genealogies, whatever lies ahead.

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ERASURE

Nasser Abourahme

Concrete can both build and erase. Such erasures occur not only through the dispossession and demolition of old structures to make way for new ones, but also through the uses of the material as a means of covering over the past. By describing how Palestinian citizens of Israel contended with architectural aesthetics introduced to them by two waves of colonization, this chapter explores the material's complex role in the aesthetics of settler colonial erasure. It demonstrates how practices of seeing and desiring are fundamental to enacting the politics of settlement. The concealment of indigenous stone houses with cement, and their subsequent restoration by removing cement from stone walls, reveals concrete's role as a key aesthetic partner in historical erasures.

I still distinctly remember my father's response when I mentioned to him that I might be interested in the history of concrete in Palestine: a deep breath and a long, weary sigh. We sat there for a little while, in silence, while it hung in the air before we resumed talking. It was a sigh that came from somewhere subterranean, a kind of cumulative fatigue — concrete had somehow indexed far more than it should, like it had seeped onto his spirit and weighed it down.

He had spent the last decade restoring his family home in the western Galilee, an almost 300-year-old single structure built of solid stone in the interlocking arches and vaulted ceilings that were the hallmark of the mid-eighteenth century vernacular architecture of the area. This was a restoration that started with removal. To restore, he had to first remove a thick layer of concrete that had been poured or slathered on the exterior and interior walling as a kind of superimposed shell. Eventually, three truckloads of concrete plastering were removed from the surfaces of the building, inside and out. It took days of persistent hammering, pounding, and scraping.

In the 1960s and 1970s, as the military government imposed on Palestinians in Israel eased, it had become common not only to build new structures in now more readily available concrete bricks, but also to plaster over older surfaces of stone with a concrete spread. Stone walling, the most pronounced object of local building aesthetics, was regularly covered in cement. For Palestinians inside Israel after 1948, unmoored, isolated, militarily occupied, heavily surveilled, and reeling from loss, navigating the new world their country had just become involved a fraught movement between the remnants of indigenous social order and the colonial structures of practice built atop them. In a very real sense, along with Palestine's many refugees, the Palestinians who remained in place also experienced displacement: they were cut off both from the wider Arab world in which they had always located themselves and from the land that was the entire basis of their social reproduction. Acute disorientation marked those first decades. Frantz Fanon writes that the colonized has "two frames of reference within which he has to place himself for his metaphysics have been wiped out because they were in conflict with a civilization imposed" (1968, 110). The colonized subject becomes a comparison with no inherent value of their own, but is always contingent on the presence of the colonial other. In Fanon's understanding of the psychopathologies of colonial life, this produces an inferiority complex that thrusts the colonized into a neurotic situation.

In 1966 most Palestinians in Israel were incorporated into formal citizenship and a more open mobility regime. In contrast to the treatment of Palestinians in territories that would be occupied less than a year later, this arguably produced certain types of identification with and even attachment to the colonial order. While Fanon was interested in a conscious modality of assimilation and was keenly aware that this responds to the often-unconscious effects of the psychic wounds of colonialism, he somewhat neglected the less-mastered, less-directed but equally sensorial ways in which people approximate to and mimic colonial norms. That is, the redirections and inflections of behavior, taste, sensibility, value, and so on. For Palestinians in Israel, this included construction and its aesthetics. If "construction fills the role of the unconscious," as Walter Benjamin (2019, 156) was fond of saying, then it becomes easier to see the connections between the concrete structures and the uncoded flows of desire and fear that might have underpinned them. That this happened through the medium of concrete is no coincidence.

In Palestine, concrete has a specifically vexed history. Mass exposure to concrete in Palestine begins with the British imperial administration — "the formative stage of cement's Palestinian biography" (Ben Zeev 2019, 40). But, arguably, this encounter takes its strongest political shape with the quashing of the 1936 "Great Revolt," one of the largest counter-insurgencies of its kind that not only killed five thousand Palestinians but also initiated a violent re-ordering of space, the traces and reincarnations of which still mark the landscape today. Peter Lagerquist points out that these spatial changes laid the foundation for Israel's modern security state. One of the most enduring interventions by British colonialists was the construction of a series of massive concrete forts under the aegis of Sir Charles Tegart, the Empire's leading counterinsurgency expert. Some fifty-five structures in all, the forts spread out across hills and high points in the landscape. This was, in effect, one of native Palestine's earliest exposures to mass concrete, and it was to be a lasting one. Indeed, it is not difficult to (literally) see the continuities — Israel's security state "congealed in the trace cast of this imperial structure" (2009).

In northern Palestine, the Tegart forts themselves became the liaison offices for the Israeli military government — which had simply renewed the Emergency Defense Regulations that the British deployed in 1936. For the Palestinian population living in the new Israeli state, obtaining permits to travel between towns or renewing any number of licenses meant a trip to one of these concrete forts. "Perched on hills that commanded the country's main regional towns and roads and surrounded by expanses of barbed wire, they towered over the surrounding countryside, *rendering power and prerogative in concrete*" (Lagerquist 2009, emphasis added). Concrete in Palestine is itself indissociable from the mechanics and aesthetics of colonial power.

Concrete was to fortify and signify the strength and lasting presence of British and later Israeli governmental power, but it was also in the process to undergo a change itself. Concrete still carries this force, not only because it transformed people's lives but also because it formed the medium through which these transformations were, at least in part, understood. I do not mean this in the sense of how concrete acts on the world, but in the slightly more circumscribed sense that emphasizes how concrete got into the way people saw the world around them. The concrete landscape that surrounded what was left of native Palestine, modern but portentous and peremptory, was in some senses the only spatial "glossary" or "guidebook" people had access to. That is to say, concrete — as the material that rendered Israel's self-image in form — was part of a shift in *techne* and visibility. In addition to its military functions, it was part of the introduction of new building techniques and technologies that did not exist outside of the new forms of visibility and aesthetic sensibility they produced.

Concrete *mediated* racialized visions of both labor and space. In Zionist discourse, it was concrete as a modern building material reliant on "exclusive Jewish expertise" and a natural Jewish superiority in skilled work that was (wrongly) hoped would enable fulfilling the doctrine of the "conquest of labor" (Ben Zeev

2019, 42). In time, an emergent Israeli architectural discourse adopted concrete as a privileged material. At one level, concrete was simply an architectural aesthetic. Israeli architecture in the late 1950s became closely associated with one iteration of Brutalism, understood "as a generic title for exposed-concrete architecture and as an architect's password for the ritual of material and constructional sincerity" (Efrat 2018, 608). This status of concrete, however, was by no means limited to a strictly architectural common sense — the Israeli settler-national project as a whole saw itself *in* concrete. Concrete marked and reproduced the very qualities of Zionism's masculine frontiersman self-image: modern, strong, durable, hardy, coarse, instinctual, direct, and practical (Ross 2019, and Efrat 2018).

But the aesthetic of concrete was also entangled with a pragmatics that went to the heart of the challenges facing settler-colonial nationhood. Concrete structures responded to an urgently felt need for a sense of durability and solidity. The architect most associated with Israeli Brutalism, Ram Karmi, would channel this explicitly: "For us, concrete was the Israeli material. Concrete gave a sense of stability: once you implant it in place, nobody can move it" (cited in Efrat 2018, 613). There was also an expedience to concrete: it allowed for a speed and technical replicability indispensable to an expansive settlement project. The entire frenetic and state-led building sprees in the 1950s and 1960s — in which thirty new towns and 400 rural settlements were built, the majority atop the ruins and lands of depopulated Palestinians villages — would not have been possible without the expedience of concrete.

As opposed to stone, which was initially — at least until the late 1970s when it too would be appropriated — so immovably associated with a Palestinian architectural vernacular, concrete was to be the naturalizing and nativizing medium of modernist-settler building practice and its subjects. But conscripted into settler imperatives, concrete was also meant to replace stone-masonry and stone as the new "indigenous" building material: it was to be the sign and medium of the settler's indigeneity. Concrete was to be Israel's stone.

Yet, the ambiguous affinity between concrete and colonialism is both its effects on and its reworking by the colonized. As much as the concrete-driven building was intended as part of a refashioning of settler subjects, it also had real impacts on the Palestinians left in what had suddenly as much as brutally become the State of Israel. Whether it was the romantic, rural, agricultural settlements of early statehood, or the urbanized, industrial society captured in the image of the Hebrew City, political Zionism's built project was premised on its "ability to 'overturn' the existing modern(izing) geographies in favor of specifically Euro-modern topographies of power and identity" (LeVine 2005, 1). In this sense, the Palestinian city posed a particular challenge to Zionism as pioneer modernization. Where the colonial project sought to construct settled, sedentary, propertied, and circulating forms of life, it had to also produce the nomadic, the place-less, and the un-urban: Palestine's coastal cities, often before its villages and towns, were subject to systematic, pervasive destruction. Large parts of Jaffa, Haifa, and Acre were systematically razed, and Majdal-Asqalan and Asdud almost entirely levelled. Jaffa, the major urban center of Palestinian life, was targeted with particular ferocity; barrel bombed numerous times in attacks that left scores of people dead. By the time the city fell on May 13, 1948, huge swaths of it had been destroyed.

For the Palestinians who remained, now also cut off from Arab urban centers in Beirut, Damascus, Baghdad, or Cairo, the only access to urbanity after this point was in the Israeli cities that had emerged to replace their own. Concrete, then, as the privileged material of the built practices of the colonial state, when taken alongside the discourse this state produced about itself and its architecture as the very apotheosis of modernity in the region, was part of the grid of spatial intelligibility, part of the conceptual frame through which colonialism was "read." Concrete mediated between the seen and the said, as both that which is sensory and that which is made to make sense. Concrete, in short, was colonialism's common-sense.

Yet concrete ultimately exceeds its own coloniality here, even if it never shakes the association entirely. Concrete is the single most prevalent material in Palestinian built life. On the one hand insisting on presence and durability in the face of settler erasure; and on the other, mimicking that very settler project to do so. Concrete carries this doubleness as it straddles over perhaps the most important of abstractions here — that between life and politics. This much is clear in the way concrete has been classified by Israeli authorities as a "dual use" material, such that cement in Gaza (and not for the first time in the history of Palestinian camps) has become the most monitored and policed of materials. In its very slipperiness, concrete gives us a sense of — for it itself partakes in — some of the ways in which colonialism and its contestation course through the very built blocks of everyday life, in ways neither entirely immediate nor intended, but nonetheless determinate. That it remains a material that effortlessly slips and crosses over between categories and emotive responses here only underlines the point that subversion and flight, drift and mutation — potentiality itself — abound in the very same materialities of control.

My father — who regularly visited a Tegart Fort to get the permit he needed for daily travel to school in Haifa — carried these associations with him. For him, the cement plastering of stone walls was a distinct form of violence that carried with it all the archival traces of the incremental colonization and erasure of his landscape. Though it had the outward signs of a certain developmental-modern step forward, what he saw was a kind of self-effacement, a surface-level expression that in the end mediated only the lack at the center of the colonized subject. He saw in cement not only something like the confirmation of the Fanonian loss of metaphysical self, but also the subsequent mimetic moves to suture that wound through the very epistemic and material tools of dispossession. He recognized — because he felt — cement as a medium of trauma. The possibility, however chimerical, of a kind recovery or return through concrete's removal was, no doubt, part of the enthusiasm and commitment with which he threw himself into his restoration project, despite

Figure 14.1. Interior of the house in the town of Shefa'mer in the Galilee after most of the concrete plastering was removed. Photo by the author, 2010.

having almost no money or institutional support to do so. It might also be why so many people in his town became involved in this project, and why so many others began to do the same to their own houses. In the cracks in the concrete are more than meets the eye. If you look closely enough there is also a reminder that erasure is always incomplete, maybe even reversible.

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EXOSKELETON

Denis Byrne

Human flesh is soft, vulnerable to both the world around us, and often, to the violence we inflict on each other. Unlike insects, spiders, millipedes, crustaceans, and shelled mollusks, we lack an exoskeleton. Across the twentieth century, concrete has often served that purpose, remapping our body's relations with the world and one another as a mode of protection by taking on the function and form of an exoskeleton. This chapter traces out this logic, traveling from bunkers in Normandy to sea walls in Sydney to reframe our thinking about the organic materiality of concrete and shift our senses toward the ways concrete constructions become with us and the planet.

✣

In 1945, at the tender age of thirteen, social theorist Paul Virilio took a train to the Normandy coast and had his first encounter with the sea. The Atlantic littoral had been out of bounds to French citizens during much of the German occupation (Virilio 1994, 10). He became a frequent visitor to the Atlantic coast and got to know intimately the derelict concrete bunkers of the Atlantic Wall, the coastal defense system which Germany had

Figure 15.1. A World War II bunker fallen from its original position onto a beach, Normandy. Public domain.

constructed between 1942 and 1944 against the possibility of an Allied amphibious invasion. "I would hunt these grey forms," he tells us, "until they would transmit to me part of their mystery" (Virilio 1994, 11).

In all, there were 15,000 bunkers making up the Atlantic Wall. Housing artillery and machine guns, they were constructed in the dunes overlooking the beaches and on headland promontories. They stretched along the coast from France's Atlantic border with Spain through Belgium, Holland, Germany, and into Scandinavia. Despite the massive reinforced concrete architecture of the bunkers, using construction techniques developed on the battlefields of World War I, the Atlantic Wall failed to hold for more than a few hours during the Allied Normandy landings on June 6, 1944. Virilio would describe the Atlantic Wall bunkers as "funerary monuments of the German dream" because they represented a static defensive strategy by a military whose initial success had been based on offensive speed, or *blitzkrieg* (Virilio 1994, 29). With the sheer weight of the concrete comprising them, they were the embodiment of stasis. According to Virilio, in modern warfare, "stasis is death" (Virilio 1986, 67).[1]

One of the ways the bunkers persist is that, like concrete seawalls, asphalt roads, and the paved expanses of the container port, they are elements of the anthropogenic "artificial ground" that now covers a significant proportion of the Earth's surface. The geologic aspect of the Atlantic Wall bunkers lies also in the fact that often they were partly buried in the foredunes of beaches to camouflage and protect them from aerial and naval bombardment. Subsequently exposed to view by aeolian changes to the dune morphology, the bunkers now sometimes resemble outcroppings of bedrock.

The bunkers were not designed to defend the Atlantic coast so much as to protect the soldiers inside the bunkers from air and naval bombardment and from the rifle and mortar fire of Allied soldiers arriving on the beaches. So, although their rounded corners, designed to deflect incoming shells and improve structural strength, lends them a boulder-like appearance, their hollowness points to their function as a carapace that offered the kind of protection for their soft-skinned occupants that the calcareous shells of mollusks living on the beaches below the bunkers offer the soft part of the organism inside.[2]

To theorize concrete as part of an organic process is to recover its participation in suffering and death, something too easily lost when the bunkers are treated only as military ruins or architectural structures. Comparing the bunkers to seashells is more than metaphorical: with sufficient weight on them, shells deposited on the seafloor are cemented together and become limestone, a key ingredient of concrete. In this, the seashells and the bunkers partake of the same matter.

On the morning of June 6, 1944, the bunkers allowed their Wehrmacht occupants to continue firing into the bodies of Al-

1 For Virilio's interest in the bunkers' context in architectural modernism, see his *Bunker Archaeology* (1994). See also Beck (2011).

2 "…as if they had forgotten their helmets, badges, here and there along our shores" (Virilio 1994, 13).

lied soldiers wading ashore, who, lacking any carapace of their own beyond their steel helmets, were subject to sudden death or lingering suffering in the shallows. Their blood, running back down the sand with each retreating wave, formed a thread of suffering linking them to mothers, children, and lovers back where they had come from. For their part, many of the Wehrmacht soldiers, including non-German draftees, perished within the bunkers, the security promised by their concrete carapace having proved to be illusory.

Seeing the bunker as an exoskeleton helps define the kind of object it is. We ordinarily think of material culture as consisting of objects as separate entities produced by us and arranged around us. But in the philosophy of Gilbert Simondon and Bernard Stiegler, human artifacts are considered mechanical extensions or prostheses of our bodies. The stone tools used for cutting and scraping by hominids from around 2.6 million years ago can in this way be considered extensions of their hands and arms. They externalized their gestures. In this way the bunker is a type of prosthesis which, unlike the bulldozer or the car, lacks moving parts. In fact, concrete's aspiration is toward immovability. The concrete bunker belongs to that simple class of tool which, like a hut of sticks and leaves, provides a kind of second skin, a protective layer that mediates between the body and its environment. Other such technical supports include the concrete seawalls, which defend many present-day coastlines from encroachment by a sea whose impetus they resist, although the sea endlessly wears down the concrete surface of the walls as it laps, heaves, and breaks against them.

For Virilio, the history of speed — in the immediate case, speed in the form of aircraft — had "shipwrecked" the Atlantic Wall: "These concrete bunkers were in fact the final throw-offs of the history of frontiers" (Virilio 1994, 12). Not quite. Concrete's allure is as dangerous to us now as it was to the builders of the Atlantic Wall.

Exoskeletons Crumble

There are photographs that show German prisoners of war and conscripted laborers building the Atlantic Wall bunkers. They stand inside the wooden formwork for the bunker walls, typically three or more meters wide, surrounded by the thicket of upright steel reinforcing bars they are wiring together, which create the odd impression that the workers are standing inside some kind of cage. The steel reinforcing will lend tensile strength to the walls while the formwork provides the form of the structure.

It is the ambition of those who work with concrete that the surface of the finished product will be smooth and relatively free of the small cavities formed by air bubbles. This smoothness of finish, which arguably reaches its apogee in the haute concrete architecture of Tadao Ando, can lead to the impression that concrete's matter is entirely and permanently encaged in the form imposed by the wooden formwork. In what Tim Ingold calls a "crusade against hylomorphism," Gilbert Simondon, Gilles Deleuze, and others have attempted to dispel the embedded illusion in Western culture that we *make* objects by imposing form on inert matter which is incapable of self-organization (Ingold 2013, 25). The alternative view, in which objects are open-ended assemblages, posits form as something emerging as a more or less transitory equilibration in a field of forces (Ingold 2013, 25). Form and matter merge together in a continuous process of becoming. Here, the bunker is less an alien incursion into the environment than an exoskeleton produced of, decomposing in, and merging with it.

Anyone observing *in situ* concrete surfaces that are more than a few years old, particularly where they are exposed to the weather and especially where exposed to the sea, will know that, however perfect their surfaces are when newly minted, concrete will soon erode. Particles of cement and grains of sand fall away to leave the gravel aggregate standing out in relief. The concrete object — a bunker, say, or a seawall — begins to shrug off its old form as its matter incrementally disperses back into the surrounding world, the way a shell's substance slowly disperses into the sand.

The essential wildness of concrete, so easily forgotten while its form holds, becomes visible in the process of disaggregation. It disaggregates much the way that stone does. An illustration of the latter is seen in the erosion of the sandstone blocks used in the 1880s construction of a seawall on the edge of Sydney Harbour. The wall was built to protect a small land reclamation that was imposed over the foreshore of an embayment by covering a former beach with several meters of infill (Byrne 2017). Over the years the harbor waves and sea spray have caused the seaward face of the rectangular sandstone blocks to erode, allowing the sea to advance inland a millimeter at a time. If we concede that the waves hitting the wall "intend" not to end there but to run up the sandy surface of the former beach, just as they did in the days before the reclamation was constructed and the wall was built, then it would seem to follow that the eroding wall is responding to the sea's intentions as much as it is to ours.

And as global warming causes the sea to expand in volume it rises up the sides of our seawalls, whether of stone or concrete, and in time will inevitably cause many of them to be overtopped by the sea or to fail structurally in the face of the sea's force. The sea will then flood inland, as the Allied forces flooded over Normandy in June 1944, leaving behind the derelict Atlantic Wall bunkers, those "littoral boundary stones" that had provided the reassurance, or at least the hope, that this edge of Europe could be rendered a hard boundary, a concrete frontier, even when fighter planes and bombers had already rendered the idea of such boundaries meaningless (Byrne 2017,11). The seeming immovability of a concrete seawall, for instance, and its persuasive promise of holding the line of the Holocene land-sea frontier, a promise which is no more than a projection of our hope, distracts us from the prospect of the sea simply going over or around them.

We face interesting choices at this point in time. Do we choose to live in a bunker, marshalling the technologies of hard engineering to face down environmental changes we have triggered? Should we continue to deploy reinforced concrete as a protective carapace around us, investing our hopes in it, or should we find other ways to live with the wild, unruly propensities of things? In this, the exoskeleton might offer another way of pushing us to consider how concrete is integral to its organic origins and its geologic becomings, once and always of the same earth.

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EXTRACTION

Vanessa Lamb

Sand is a critical part of all concrete production. As this chapter's exploration of sand mining in Myanmar shows, the sand industry is much more than extraction. It links the complex ecologies and economies of extractive zones to the spectacular sites of urbanization where concrete gets deployed. As sand moves it transforms ecologies and creates economies, redistributing people, capital, and nature simultaneously. In some cases, sand extraction produces new grounds for local contestation. In others, it limits people's ability to make a living and some choose to depart in search of work through which they might rebuild their lives elsewhere.

Mingalaba! Welcome! Having travelled upstream this morning on a converted wooden paddy boat called a *laung-zat,* you have now arrived in Hpa An, a small state capital town along the free-flowing Salween River in Karen State, Myanmar.[1]

1 This chapter and the research shared here was written prior to the military coup in February 2021 in Myanmar. The 2021 military coup has introduced new challenges for the gardeners and farmers quoted in this piece as well

Figure 16.1. A pagoda along the Salween River that was the subject of many sand stories. Photo by the author.

As you wait for your turn to alight from the boat, you notice that the boat docking directly next to your vessel is full of vegetables, like squashes and tomatoes, that were cultivated along the river's banks and will be sold at the local market. They grow from the same sediments and sands that flow through the river; these are deposited on the river's banks when seasonal flooding occurs during the monsoon. The river then recedes in the dry

as for the country's pro-democracy movement. The restrictions on trade and migration have rerouted migration networks, remade local economies, and altered sand flows, although these same restrictions have also meant that research on extraction in Myanmar remains untenable.

season, leaving behind sandy and fertile farmland that local gardeners rely on for producing food.

Yet, you have also just heard that there is much concern here about how the river sands are changing now. Many residents, like the gardeners, make a living from the river — others also practice fishing and use the river for trade and travel — and their livelihoods are negatively impacted by sand extraction for use in concrete and construction.

As indicative of these changes, you take note of a Buddhist pagoda positioned right along the water's edge (fig. 16.1). You've already noticed throughout the trip this morning that many of the river's sandy banks seem to be collapsing into the river. Added to that, you note this pagoda's precarious position, which looks like it just might tumble into the river. Was this intentional, or is it linked to the other instances of extensive erosion you saw and that villagers explained was impacting their livelihoods? Or, to the newspaper headlines of "lost" land and islands resulting from the sand mining boom? There are many ecological, political, social, and cultural stories situated in this locally rooted problem.

You have many questions. A local porter looks at you curiously as you disembark. "Can I help you?" he asks, in English. You indicate to the porter that you only brought with you a few items. Instead of helping you with your things, you ask their permission to speak about this stunning and curiously positioned pagoda. It is a quiet morning, so he obliges, and you both move to the nearby shaded café. He begins to answer your questions by exclaiming, "We have lost a bit of the riverbank every year. Some years we lose more than five meters! It can make navigating by boat difficult. The river has become unpredictable."[2]

He also says that the riverbank gardeners, whom you had seen along the way cultivating vegetables on the river, now "have to take care with their land!" The riverbanks are eroding erratically, they are losing more land than usual. He explains, "We are

2 Interview with the author, May 2017.

used to some kinds of riverbank change, every season the water rises and then lowers, but this, this is different."

While you might think of a river as mostly water, rivers are interconnected flows of, for instance, water, fish, plants, sediments, sands, and even "land" (Ivars and Venot 2020, 519). In Hpa An, sand's extraction from the riverbed or bank impacts fisheries, habitats, and spawning areas, thus impacting fishing livelihoods. Removal of vast amounts of sand and sediments also impacts formation of alluvial islands, impacts water flows and fluxes, increases rates of sedimentation and erosion, and, in other sites, has been shown to contribute to "sinking" deltas and increasing salinity (Jordan et al. 2019), which is no good for growing vegetables.

We rely on extracted sand every day to construct the cities in which we live and the technology we use throughout our lives. Sand is a key component of concrete, and despite growing concern over the problem of sand extraction, little is known about the places from whence sand is extracted, where it is sent, who moves it, and how sites of excavation and consumption are connected to one another across great geographical distances (Lamb, Marschke, and Rigg 2019). This is a critical research gap, given that the sand trade is worth up to $70 billion globally.

This chapter, however, takes a different tact. It presents sand extraction as a "rooted network" (Rocheleau and Roth 2007, 433), documenting sand's use and life *in situ,* to its life away from the river, for instance to urban development of major cities. Rather than classify sand as "fine aggregate" and a resource or additive to concrete (cf. Neville 2011, 108), the main idea is to illuminate the multitude of links between "local and transnational realities" from markets to migration that comprise the substance of sand, to "challenge geography's ability to explain and address the changing postcolonial and social-ecological landscapes that we simultaneously co-create and inhabit" (Neville 2011, 108). In short, sand is *beyond* extraction.

Back at the café, a woman in formal Myanmar attire approaches you. By way of introduction, she explains that she is the local elected official for this district, and that she watched you arrive just moments ago from her river-adjacent home nearby. She has already heard that you are studying sand. Her district is situated along the river's bank here. Many of the residents who live here have told her they are worried about riverbank erosion. Some years, they lose land to the river unexpectedly, and it is getting worse. Sand mining operations, she notes, started shipping sand from the river to faraway places, including, she heard, Singapore.

Her mention of Singapore is key. Analysis of data from the UN Comtrade database shows that Singapore is the most significant trading partner with more than 12 million tons of sand shipped from Myanmar to Singapore during 2014–2017.[3] In the same years, Myanmar also shipped sand to a range of international countries, such as the Netherlands, Nicaragua, India, Thailand, and Australia (Lamb, Marschke, and Rigg 2019). Singapore, it turns out, is literally "built on sand" (Comaroff 2014); it is the largest importer of sand worldwide. Sand is required for both concrete construction and land reclamation, both necessary for the country's growth. Since 1965, Singapore has expanded the country's land area from 224.5 to 276.5 square miles, and by 2030 the government has targeted a further increase of three square miles (Comaroff 2014). As such, it has been a central site for the study of sand demand and consumption.

In *Lost World* (2019), filmmaker Kalyanee Mam illustrates the path of extracted sand from mainland Southeast Asia, starting from her hometown of Koh Sralau, Cambodia, to the city-state of Singapore, where the mangrove sands of Koh Sralau are piled up high, ready for extending Singapore up and out. While in Singapore, Mam suggests that almost everything she sees in the built environment she can trace back to sand.

3 These amounts are internationally traded amounts that were available on the UN's public database in 2019; they do not include domestic amounts of sand extracted nor do they include what many refer to as the illicit sand trade (see Lamb, Marschke, and Rigg 2019 for further explanation). The current database can be accessed at "Trade Data," UN Comtrade Database, https://comtradeplus.un.org/TradeFlow.

That the same sand is an essential component of both rural agricultural practice worldwide, and its extraction has elicited a range of responses. In India and Cambodia, for instance, residents in impacted communities have staged protests against sand extraction from rivers and coasts. Sand mining bans have been introduced, shifting the connections of broader sand extraction networks.

In Hpa An, local gardeners are continuing to contest sand extraction and its impacts. One community along the Salween River is working with a community-supported organization to document their management of these sandy lands and islands and the significance to their way of life. Others here sought to have their claims to sand formally recognized by the government: they have applied for formal recognition of their alluvial islands under the National 2012 Farmland Law. With legislation, the state and its multiple authorities are involved in keeping sand "local," in addition to other national-scale responses.[4]

Still others, some gardeners and fishers, have responded by leaving their alluvial homes for the very cities that require their sand. They migrate to other cities, or to nearby Bangkok, Thailand, to work in factories. Some are even making their way to Singapore. We do not know the precise numbers of people because information on the nationality of workers in Singapore is not publicly available, but we do know that thousands of women and men from Myanmar and across the region work in construction, shipping, and in homes throughout Singapore. These workers send remittances back home. Sand is not simply extracted; it extends beyond a project of unilateral taking.

These connections, then, are not simply unidirectional (Lamb, Marschke, and Rigg 2019, 1518). Singapore's urban growth extracts both migrant labor and sand from Myanmar. At the same time, remittances sent back home often support the

4 This is far from straightforward; at one scale the laws and officials might help protect livelihoods and the river sand they depend on, but at another scale authorities may be involved in the industry or developing policy to encourage investment in businesses responsible for extraction.

construction of building new, sometimes concrete, homes for their families within Myanmar.

These responses and broader connections are an important aspect of understanding sand extraction as a rooted network; its grounding in places not only means sand becomes part of those places, but in turn, is also generative of new relations, further shaping these networks and complex flows of goods and resources. This is, of course, not to undermine the evident destruction of local economies and ecologies that sand extraction propagates.

A myriad of additional responses and connections are focused not only on the loss of agricultural land, but also on the linked cultural and material significance of these losses in places. The potential loss of the precariously sited pagoda you saw upon arrival is a good example. As the porter subsequently explained, "The pagoda is meant to protect the nature of this area." Concern to protect the pagoda, and to stop sand extraction along that area, is linked to similar campaigns for many of the temples and pagodas in Karen State. Sacred sites of worship, constructed from decades up to a full century ago, they act as protection against environmental destruction and as sites for communities to come together. Who would desecrate a pagoda and its surroundings?

Sand extraction requires attention beyond the fixed locality of neighborhoods along the river as a rooted network that reveals how a range of materials, actors, and sites, such as agricultural "land" and cultural markers, are simultaneously connected and rooted in place.

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FEAR

Mona Chettri

Concrete's promises of durability, progress, and development also bring with them new anxieties and fears. In Sikkim, India, even as concrete is sought after in the rush of infrastructural, housing, and industrial development, the material has also expanded the threat posed by earthquakes, floods, landslides, and economic shocks. Environmental and economic turmoil is thus felt through the possibility of crumbling concrete, which generates new fears in the process.

On September 18, 2011 an earthquake measuring 6.9 on the Richter scale hit east Sikkim, India. While the earthquake itself lasted under a minute, it generated a mortal fear for life that lingered in the minds of locals for many months afterwards. In the capital city Gangtok, which was located close to the earthquake's epicenter, the deeply visceral, collective experience was part shock and fear of the earthquake itself, and part fear of being buried alive, trapped under the rubble of their own homes. Fear and pandemonium were drawn out over the next few weeks. Every small aftershock sent people running out of their homes toward open spaces, camping in football fields and sleeping in their cars. Although Gangtok had been spared much of the destruction, the paucity of open spaces to seek shelter from crumbling concrete amplified the fear of earthquakes. Surrounded by multi-storied buildings in all directions, there was nowhere to run out to. Like Gangtok, most Himalayan towns and cities are undergoing rapid urban population growth, temporary and permanent migration, infrastructural development, and the increased dependence on tourism and extractive industries as a source of revenue and employment. All of these factors in turn are dependent on and cause the proliferation of concrete — in buildings, bridges, hydro-power dams, factories, and giant statues that are scattered across the hills for touristic consumption.

As the wet concrete is poured and gradually solidifies, the landscape too is set, seemingly made permanent, spatially fixed. Hope, desire, and aspirations take the shape of homes, buildings, bridges, factories, dams, and tourist attractions. However, once set it is, paradoxically, the solidity of the structures that becomes dangerous. Blocks wriggle themselves loose, escape, and kill. Concrete cracks, crumbles, disintegrates, and collapses. When it does, the sheer intensity, visibility, and tangibility of destruction — from cracked walls, lopsided houses, and damaged bridges to collapsed houses, buried under soil and rubble — evokes fear. While the desire for concrete is constant, the fear is temporal, triggered when concrete's claims to permanence betray themselves. These fears are evoked by certain calamities and often quickly forgotten.

The Himalaya region is geologically and seismologically sensitive. Landslides, flash-floods, and earthquakes are common and frequent. The natural and built environmental contexts within which they occur, too, have been changing rapidly. In the eastern Himalaya concrete is unavoidable, and especially so in the urban and peri-urban areas that house the increasing numbers of people who have congregated in towns and cities for employment and education. These urban and peri-urban spaces are lined with layers of concrete in its many forms — in buildings, pavements, or drain linings, or holding up loose earth on

Figure 17.1. Concrete wall, Gangtok, Sikkim, 2018. Photo by the author.

the sides of the hills. The undulating slopes, it seems, are held together by concrete, made possible by the circuitous feedback loop of easy finance (bank loans, corruption) and the unrelenting construction boom (McDuie-Ra and Chettri 2020).

Concrete is desired. It is popular, and its popularity is understandable; it is reliable, strong, stable, and easily available, and it outlasts any other traditional building material like bamboo, stone, or wood. More importantly, it is a tangible display of "moving up," of success that can be seen and measured, usually by the size of the building. Irrespective of the size, however, a concrete "pukka" house is far more desirable for the permanency that it delivers in social status, than a "kutcha" house made of wood, stone, etc. Concrete cements social status, literally. However, concrete and natural calamities like earthquakes or landslides make uneasy friends, especially in areas of unprecedented and often un- or ill-planned urban growth; and judging by the towering buildings on hillslopes, any form of structural resilience or collapse-prevention measures do not seem to be part of the architectural blueprint.

Yet, for all the aspirations, modernity, durability, and stability that concrete engenders, concrete also provokes fear through its latent potential to harm, damage, and kill. Its inherent characteristic as a strong, resilient building material also compounds the impact and cost of natural disasters. The fear is simply not of a landslide or a flashflood; fear lies in the increased and near certain probability of losing life or limb when concrete structures collapse or give way, along with the loss of all the positive attributes — stability, safety, hope, permanence, and status — that are associated with concrete. Furthermore, given the exponentially higher construction costs associated with concrete structures, usually financed through loans (either through banks or private money-lenders), the cost of natural calamities can be ruinous, even for those with smaller houses.

Concrete homogenizes. With the rise in demand and desire for concrete, hill towns and cities are beginning to look the same: spaces with layers and layers of buildings. This brings with it the very plausible possibility of the loss of identity of peoples and places with distinct histories and characteristics. Ironically, this gradual dissipation of identity is sought to be remedied with more concrete with the specific focus on creating new modern subjectivities, especially crafted around changing consumer patterns in the hills. More shopping malls, cinema complexes, resorts, hotels, parking complexes, etc. are supposed to convey modernity and modern lives in spaces that were once considered "backward" and "remote."

Concrete is to be feared, not only for its capacity to escalate the danger, cost, and impact of natural calamities, but also for its proven potential to subjugate and destroy the natural environment. In eastern Himalaya, the material's signature combination of malleability and strength has been harnessed to alter the course of rivers through a network of hydropower dams and tunnels that run deep through the hills. The green-washing of big hydro and its potential to generate vast amounts of revenue — almost exclusively for the power companies — has led to the construction of numerous hydropower dams on the river Teesta and its tributaries in the Sikkim-Darjeeling Himalaya.

Dams at different sections of the river system have converted fast-flowing mountain rivers into stagnant, sluggish lakes, while other rivers are now completely dry as a result of water diversion. The natural flow and volume of the water have gone, and along with it the native flora and fauna of the river valleys. There is very little of the nature or anything "natural" left in the natural environment in the low-lying valleys.

With dams come new things to fear. Every monsoon, as the Teesta rages through the series of dams, local communities, who have already lost access to the river and many of their livelihoods along with it, live in the fear of being washed away, or being buried under a landslide triggered by the rain and the deforestation resulting from dam and tunnel construction. Local communities have come to fear the unpredictability of the once predictable Teesta; with no efficient warning systems in place, it is an everyday cycle of fear of the river and hope for their safety. The negligence of power companies, abetted by pliant governments, has enabled this destructive transformation of the environment and of the lives and livelihoods of local communities along with it. National policies aimed at privatization and de-regulation have encouraged private investors to acquire land, and have facilitated labor migration to areas that have extensive and strict regulations around migration, employment, and the sale, transfer, and use of land. Changes in access or in land use patterns, therefore, pose multiple threats to communities whose cultural or religious practices are deeply entwined with the environment. With irreversible damage to the natural environment, also comes cultural loss and gradual dissipation of tradition, all of which have been enabled by concrete (Bentley 2021).

Pharmaceutical factories too combine concrete and environmental degradation: agricultural fields have been replaced by massive factories, owned and run by private companies all in the name of development. Pharmaceutical factories, enclaved behind high concrete walls, dominate the hill landscape with their imposing buildings, releasing possibly toxic effluents in the air and river systems on a daily basis. For communities living near the factories, the plumes of smoke from the factory chutes bring with it fear and anxiety about unknown health implications, and the actual cost of this "development" which has been imposed on them by the government. And for those working in these factories, in the assembly lines for very little money and scant economic security, breathing in air interspersed with pharmaceutical particles, there is a placid acceptance that working in the factory also comes with potential economic insecurity and health risks in the long run (Chettri 2020).

People continue to live near these factories and work in them, simply because they have no choice. Fear of immediate unemployment, continued poverty, and homelessness is recalibrated and weighed against the fear of possible health issues in the future. People adapt to the fear and risk, with no control over mitigating conditions that create fear and risk in the first place. Concrete, therefore is more than just a manifestation of modernity and success; it also represents the nexus between political and corporate power, and it represents domination and subjugation of the environment and local communities who have no viable recourse to alter the situation in their favor.

Concrete is so firmly tied to the notion of progress and development that it is celebrated even if it fails or is at the risk of failing. Greenfield airport in Sikkim is a classic example of the importance of "tangible development," and the pivotal role of concrete in holding up (literally in this case) this supposed vision of development. Greenfield airport can be considered an engineering feat, an expensive folly, or both. The airport has been built by excavating one side of the hill, with the lower end being propped up by a wall of concrete. From the road below, a wall of concrete rises high above, often evoking awe and fear, almost simultaneously, for what the engineers and builders had managed to achieve and for what might befall if the concrete walls were to give away. Also, since the transformation of agricultural fields into an airport, the risk of landslides has increased in the entire area. However, Greenfield airport, the supposed gateway to the eastern Himalaya, inaugurated in 2018 by Prime Minister Modi as a jewel under the Union government's UDAN (*Ude Desh ka Aam Nagrik* / The common man of the country flies) regional connectivity scheme, remains unused for the major part of the year on account of numerous technical and commercial reasons, further illustrating how concrete bestows prestige even when it fails.

Every monsoon, photos, videos, and news of landslides, flashfloods, rivers overflowing their banks, buildings collapsing or being buried under a landslide, etc. are circulated widely in the social media. And every monsoon, travelling anywhere in the region entails calculation of time for detours and roadblocks. Every year there is a momentary recognition of the fragile environment being overburdened with concrete in different ways, and its dangerous consequences for life and property when it cracks, collapses, crumbles, or is washed away. Yet, the fear and anxiety seem to be short-lived and easily forgotten. There seems to be an acceptance of the proliferation of concrete and the inevitability of associated environmental and socio-economic problems. The relationship between concrete and fear is varied in its manifestation and affect, just as it is unique. The fear lies in concrete's potential, and most of the time this fear is not even realized till the actual destruction of the material itself. Fear is also generated indirectly, through all that concrete enables: from ruined environmental and cultural landscapes, to failed and abandoned infrastructural projects, low quality of urban life, etc. All of these can be read as metaphors of ruptures, transitions, and failures in the socio-political history of a place. The solution to problems created by concrete, it seems, is more concrete. And in environmentally sensitive spaces like the eastern Himalaya, this uneasy relationship between concrete and fear seems set to continue for the foreseeable future.

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FOUNDATION

Rebecca Bowers

Gaare kelsa *(concrete work) can be a precarious foundation for many women's economic lives. As concrete creates the infrastructural foundations of mega cities like Bengaluru, it sets in place labor relations and gendered inequalities. This chapter demonstrates how Bengaluru's concrete foundations shape and are shaped by hierarchies within the construction industry that promote and entrench gendered labor norms, excluding women from higher pay and positions while simultaneously exploiting their work.*

Channamma is wearing a rust-colored cotton sari with a checked border, a common style among the older women of the Yadgir colony, although Channamma's sari and stained blouse are more careworn than most, and I have never seen her wear another. Like many of the women in the colony, Channamma started working as a laborer in Bengaluru, India when she arrived there as a child. "There were no schools for us, work was everything. Back then we didn't know about education. We were ignorant. This [cement work] is what we knew. We didn't study. This is what we did," she informed me. "Are there many people still working *gaare kelsa* [cement work] in the colony?" I asked. Chewing tobacco wedged firmly in her cheek, Channamma pauses, "Until the end, that is what our people do."

The rupture of skylines, obliteration of greenery, and caustic dust clouds constitute the more visceral sensory effects of concrete. As Channamma's account attests, concrete shapes lives as much as it shapes cityscapes. Concrete is embedded in landscape, aspiration, and the materiality of urban politics. Following economic liberalization and the opening of India's property market to global business and investment, it constitutes the beating heart of urban development and the foundations of real estate speculation. Fundamental to economies of concrete are productive and destructive foundations of precarious futures: the fluctuating fortunes of real estate developers, the emergence of local sand mafias, subsequent collapse of riverine systems, and the lives and labor of millions of workers whose sole occupations have become its namesake. Foundational encounters with concrete produce imminent physical and environmental threat and socioeconomic mobility and immobility.

Bengaluru, southern India, is a prime site for exploring the socioeconomic implications of the concrete economy. The former "garden city" has altered irrevocably, with estimates that "India's Silicon Valley" will be 95% concrete by 2025 (Times of India 2018). While reactions of the city elite to the concretization of Bengaluru include blocking proposed projects, re-greening the city, and lobbying for sustainable architecture (Frazier 2019), for the laborers whose lives intersect with cement work, or *gaare kelsa* as it is known in the state language Kannada, their recourse to the futures it generates is ambivalent.

Gaare kelsa is positioned at the bottom of the skills hierarchy alongside interlinking *coolie kelsa,* or helper work, and is dominated by scheduled caste (Dalit) and indigenous Adivasi workers, who remain overrepresented in the most dangerous and devalued work across India. Many workers are women. *Gaare kelsa* involves unloading, mixing, curing, molding, and laying slabs for foundations and flooring. Through this work, concrete embeds itself within social and economic life, through

Figure 18.1. A woman worker strides across a campus construction site in Bengaluru. Photo by the author.

generations of gendered labor norms. Utilizing ethnographic data from fieldwork in Bengaluru from 2014–2016, I explore how *gaare kelsa* maintains labor hierarchy through the situation of a former migrant housing colony. Specifically, I reveal how concrete de-skills and devalues women, while simultaneously binding them to it.

Tucked away down a dusty lane in the south of the city, the Yadgir colony consists of hundreds of low-rise two-room apartments in faded hues of blues, greens, pinks, and oranges.

It is populated by families from the northern districts of Karnataka state, including Raichur, Yadgir, and Gulbarga. Displaced by drought some decades prior, the families sought their incomes in construction work several hundred miles south. Home to over five hundred families, the colony's population is rapidly growing; out-migration is low, while in-migration from village relatives remains high, with continued drought and decline of the rural economy. Some residents reside under communal stairwells due to overcrowding and prohibitive rental deposits.

The colony's entrance is scattered with tempo trucks, wheelbarrows, and cement mixers, alluding to residents' primary occupation and to the dwindling employment within it. It is the ostensibly settled status of colony dwellers that contributes to the idleness of their equipment. Since Karnataka-born residents are considered harder to exploit by employers, the former migrant workforce increasingly finds itself replaced with another. While their foothold in the city remains precarious, the Yadgir colony is now an indisputably foundational segment of Bengaluru's urban population. The decades-old establishment of the colony vis-à-vis its shared occupation of cement makes it an ideal site to consider the ways in which *gaare kelsa,* while initially enabling physical and fiscal forms of mobility, may now leave colony dwellers, especially women, "stuck" (Krishna 2013) within this occupation, as vital and yet readily replaceable cogs in India's concrete economy.

(Re)Producing Workers?

The following section explores the perspectives of women I got to know through the colony's Sangha, or Self Help Group. Within the colony, relations are densely intertwined and it is rare to encounter someone who is not related by kinship, marriage, or both. For colony women, other than lower-paid domestic work, there are few opportunities outside of *gaare kelsa*: their close-knit networks having little reach beyond these occupations. For later generations of girls born within the colony, schooling remains low and underinvested in, due to the continued albeit illegal practice of dowry[1] and the fact they are destined to leave

1 A number of informants also had to work for their dowries, entering construction work in their teens to do so.

the familial home through marriage. As a result, girls are considered less of a reliable investment for the family, and still receive lower rates of education. Returns from education in the form of better work are also doubtful, since the scheduled caste population is increasingly excluded from India's limited formal sector employment market (Deshpande and Palshikar 2008; Jeffrey, Jeffrey, and Jeffrey 2008; and Thorat and Attewell 2007) due to ongoing caste discrimination and interlinking structural inequalities.

Though women expressed their desire for children's futures outside of construction (see also, Bhattacharjya 2004, and Shah 1996), this was frequently unattainable, and even for those who sent children to school; any misfortune could readily pitch the children into *gaare kelsa.* As Mariamma, whose children picked up her work duties when she fractured her back on site, asked: "What can we do if we fall?" Rising prices and stagnant wages meant colony children continue to enter helper and later cement work, at relatively young ages, although this is interspersed with school. Reflecting the erratic rhythm of construction and building materials in the city, children may be encouraged to absent themselves from school during a rare overabundance of work and shortage of workers from the colony. Since colony labor is organized through densely interwoven relations between kin and contractors, such calls prove difficult to refuse.

As evidenced, the reproduction of future workers is shaped by contingencies for colony residents. For Channamma, whose son had died in a worksite accident, the prospect of her three grandchildren completing their education was uncertain, since there was only one active earner in the house, her daughter-in-law. Channamma's grandchildren were the first generation to be enrolled in school and she had mixed feelings about whether this would be successful; "God knows if it's for the better or not," she concluded. When I asked Channamma if she thought colony girls could become doctors or lawyers, some of whom expressed such aspirations, she replied: "It's possible, but we can't give them that level of education. It's enough if they study until the eighth standard and know how to write four letters. We have lives to lead, if we just educate them, where is the money going to come from?"

Colony perceptions of skill and possibility are informed by the limited options women viewed as available to their children, and themselves. Soumhya Venkatesan posits that "acquisition of a skill is embedded in larger social knowledge about the value of the skill based on ideas about the body, gender, identity, politics, and economics. Acquiring, utilizing, or depending upon a skill positions individuals or groups in particular ways, not necessarily of their choosing" (2010, S158). Indeed, the association of *gaare kelsa* with low value, low skill, low education, and gender, led to various internalizations and reinforcements about capability among colony women and employers.

Devaluing *Gaare Kelsa*

Entrenched gender discrimination within the construction industry and beyond ensures that women never progress beyond *gaare kelsa* or helper work. Industry-wide beliefs that women are unable to learn or perform "skilled" tasks beyond cement work were echoed within the colony, internalized through generation, gender, and an interlinking lack of formal education. When I asked informants if there was anything else they could do, I was often greeted with incomprehension or irritation for making such a naïve inquiry: "Learning is out of question! We have only learned to do hard, physical labor, how can we be expected to learn anything else now given that we aren't even literate?" "This is all we know how to do!" exclaimed another interlocutor.

Nevertheless, there was still the acknowledgement that cement work was something that did require learning. Recalling the first time she worked construction after moving to Bengaluru following her marriage, Mariamma, since retired, described how she learned the process: "There were both men and women. We were a big gang. The whole family. My husband has two brothers. So the brothers and us, their wives, we all went together. I was scared. The first time you hold a pen, can you write everything perfectly? No. Just like that, we watched and observed the others. They did it. We followed." Such descriptions should invite the listener to reconsider distinctions between skilled work and that typically considered unskilled, such as *gaare kelsa*. Further, these descriptions deserve particular attention given their significance in a community previously considered to be lacking literacy.

Despite the persistent labelling of this work as "unskilled," *gaare kelsa,* like helper work, requires agility, strength, and speed — of the lone body and coordination with others. Indeed, as Trevor Marchand elucidates in his research on labor apprenticeships and embodied learning (2008), actions which must be learned and require worker coordination are skilled, even if perceived otherwise (263). Although this significance was widely unrecognized by the upper echelons of the industry, *gaare kelsa* forms the pivotal components of a building — foundations, floors, and ceilings. When an entire "slab" or floor was completed, some *maistris* (labor contractors) would provide food for their team to mark the occasion. *Gaare kelsa* thus constitutes one of the most integral parts of the construction process, even if its value is not acknowledged.

Women's positions within this work are further underplayed, as evidenced by their own internalizations, and also employers'. While Praveen, a real estate company owner, once declared, "The women who work out here are really, really strong, you know?," he added, "Men are more efficient [....] It's not a gender bias, it's true. So we prefer to have more men." Further highlighting this tension, any positive qualities attributed to women workers are dismissed in the face of industry hierarchy and assumption: numerous employers claimed women were more reliable yet inferior. They would come to work on time, take shorter breaks, rarely absent themselves, and did not drink. And yet, this was unbeneficial in increasing their share of working days or advancement into trades. When I asked Praveen if he believed women could learn trades, he replied, "Of course they can do it, but I feel they don't train themselves — they don't want to."

Praveen's assumption negates the fact entirely that many women, as a colony interlocutor Lakshmi stated, were "willing to learn, but there is no one to teach [them]." Moreover, women did not have the necessary tools or social capital to "train themselves," which required serving as an apprentice to a (male) tradesperson. Like Praveen's prior statements, such comments reveal contradictory views of women's capabilities. They obfuscate the fact that the construction industry refuses to accommodate female workers in higher-skilled "male" jobs, even on the rare instances when women do ask (see also Shah 1996), or outside organizations attempt to intervene in upskilling (see Bowers 2019). Consistently underemployed, as Praveen's above statement suggests, women also remain excluded from all industry trades: the laying and layering of bricks, the exterior and interior plastering, wiring, plumbing, tiling, roofing, and scaffolding. At the same time, concrete work wears down the working body faster than other trades. Working *gaare kelsa* thus affects many areas of women's life outside of the immediate construction site, as the final section explores.

Somatizing *Gaare Kelsa*

With their reliance on bodily strength for income, health was a frequent concern for the female residents of the Yadgir colony. Working construction shaped the body: many interlocutors had gray hair, shuffling gaits, stooped backs, and an array of health problems by their thirties. Women shouldered daily routines of wage labor and domestic chores while experiencing health problems and injuries — such work simultaneously exacerbated these problems and injuries. Given the deaths and injuries that had befallen many households working *gaare kelsa,* there were few options but to maximize the full potential of bodily labor before time or misfortune eroded it, leaving women to trust in medical and, at times, divine intervention.

Interlocutors routinely suffered bad health, often aggravating old injuries while creating new ones to put off hospital visits and the prospect of lost earnings. As a last resort, many women

Figure 18.2. A group of retired construction workers protesting outside Bengaluru city hall for the reinstatement of the *bisi oota* (hot meals) scheme for the elderly. Photo by the author.

sought pain-dulling injections, continuing to work at the cost of long-term health. When such methods lost their efficacy, younger family members stepped in, entering but seldom leaving construction once they had given up their schooling to support the family. Durgamma expressed her acknowledgment of this lack of options when we were discussing the potential consequences of not seeking appropriate medical care for her hip pain. "God is there. What can you do? God should not let me live till that long, he should take me away from here before that. He shouldn't let me suffer." Others cured their pains through more immediate encounters with God, as Radha, a teenager working *gaare kelsa,* informed me: "My legs were hurting. I had a pull so I couldn't walk at all. I got an injection but it didn't help. Sunday I went to church and everything became alright."

While women called upon both injection and divine intervention to prolong working lives, the income-generating efficacy of a young, healthy body inevitably diminishes over time due to old age and weakness or accidents. For Basamma, in spite of her intentions to continue saving for her daughter's marriage, her days working *gaare kelsa* were limited. Basamma frequently complained of pain — experiencing aching legs whenever she placed any weight on her head, a common ailment for women in the industry who regularly carried headloads of bricks. When I asked Basamma how long she would continue working for, she answered, "for as long as God allows." While the working body does not exist in a physical, social, or cultural vacuum, the burden of cement work is somatized in both overt and insidious ways: under fingernails, or in aching bones, peeling skin, difficulty walking, and the gasping of lungs for air. Just as lives may be enabled by the waged labor of *gaare kelsa,* so too they can be shortened.

Conclusion

Historically forged forms of discrimination shape labor relations while shifting to meet the increasing needs of property developers to build cheaply and sell swiftly before Bengaluru's real estate bubble bursts. Concrete lies at the base of these processes, as material, mediator, and, increasingly, a signifier of precarious bodies and lives. While dense networks of colony labor conversely may prove valuable, ensuring the reproduction and longevity of households by the non-existent mobility of *gaare kelsa* itself, for women concrete reproduces their position within an expendable labor force, keeping laborers stuck in the economic basement with a singular employment option. Bengaluru's rapid expansion and prolonged real estate boom has enabled the initial establishment of the Yadgir colony, but for better or worse, its foundations remain tied to concrete.

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GRAYSCALE

Erik Harms

Cement is an iconic shade of gray, recognizable universally. It is often associated with a drab, subdued affect, so much so that engineers have worked hard to find a way to infuse cement with color. But in the alleyways of Saigon, the color of concrete evokes "alleyway attitude," a feisty mood reflective of the city's class politics, collective participation, and the general sense of urban place and conviviality.

Vietnamese urban alleyway neighborhoods are the color and texture of concrete. This may sound like a criticism, and for some obvious aesthetic and environmental reasons it certainly could be.[1] But the concrete hues and material properties of Saigon's alleyways also evoke unexpected intimacies and human

1 As I have noted elsewhere, the environmental problems associated with the expansion of impermeable surfaces include increased heat island effects and increased vulnerability to flooding: see Harms (2021). For important studies on the problem in Ho Chi Minh City, see Dinh, Trung, and Toan (2015); Duy et al. (2018); Garschagen (2015); Van, Y, and Bao (2015); and Van and Bao (2010).

connections that deserve more subtle attention. The grayscale color of concrete evokes a mood, to be sure, but it is not to be confused with gray skies. The mood might be called a grayscale alleyway attitude. This attitude, like Saigon's cement alleyways, can certainly be blunt and hard-edged, but it pulses with vibrant expressions of sentiment and social solidarity — gray, like concrete, but not drab.

Important new directions in urban studies and anthropology have shown how the color of a city can offer a window into its politics, affect, and history. But it is also important to remember that the affective meaning associated with scales of gray cannot be understood without careful attention to local contexts and meaning (Sur 2017). As Victor Turner demonstrated long ago, the meaning of color, while central to symbolic life, is never fixed. It changes according to the social context (Turner 1967). It has often been assumed that color evokes vibrancy, the heat of *calor,* but it has also been said that to "advocate such a sense of color is not to say color is really this or really that" (Taussig 2006, 30). The same attention that scholars have applied to color, then, must be applied to the polyvocality of grayness.

In some contexts, such as post-socialist Hungarian factory towns, or in the now increasingly dilapidated vestiges of Vietnam's twentieth-century experiments in collective housing, the gray color of concrete evokes the once triumphant but now more roundly criticized history of state-imposed central planning.[2] The grayscale alleyways of Saigon, on the other hand, evoke something very different. They are spaces of local pride that often evade state capture — not only undermining the

2 "In Hungary," writes Krisztina Fehérváry, "gray is far more than a color. It is an aesthetic quality that powerfully links material environments with political affects." She goes on to add that, "For Eastern European dissident intellectuals and émigrés [. . .] the grayness of the material world during the socialist period was iconic not so much of deprivation as of political repression" (2013, 1). See also Schwenkel's (2020) masterful study of the Vietnamese city of Vinh, gray with the concrete blocks of East German socialist collective housing.

Figure 19.1. The three images on the left are screen grabs from the music video "Khu tao sống" ("My hood") by the Vietnamese hip hop artist Wowy, *YouTube,* July 20, 2010, https://www.youtube.com/watch?v=UZ2M12BeKX4. The grey rectangle on the right represents the "average color" of the screengrabs. The average was created using the blur filter in Adobe Photoshop.

agents of bureaucratic socialism but also frustrating real estate developers and other bearers of top-down utopian fantasies.

In order to approximate the sensory world associated with the vibrant grayscale mood of a Saigon alleyway, it is useful to watch and listen to one of the most popular Vietnamese hip-hop music videos of the early 2010s, produced for a song called "Khu Tao sống" ("My hood").[3] Like concrete, the song itself is blunt and hard-edged, but it also brims with sentiment. Despite its roughness, the video and the song thump out a classic homage to a neighborhood brimming with familiar figures and social types. Uploaded to YouTube in 2010, the video now has over thirty million views. It was filmed in color, but viewers might

3 "Khu Tao sống" was one of the breakout songs for Wowy, who is now one of Vietnam's megastar rap artists. The video is available at https://www.youtube.com/watch?v=UZ2M12BeKX4. A careful translation of the lyrics into English is available on the author's website: https://seasia.yale.edu/anthropology-360/khu-tao-song-translation.

be forgiven for thinking it was filmed in black and white — the frames are all stylistically overexposed, and the alleyways flood the screen with grayscale hues. If a song could be said to have a color, the color of this song would be the color of concrete. It is rough and at times even violent, but unexpectedly tender too. This concrete tenderness captures the mood of a Vietnamese neighborhood. Despite its tough words, the song is an anthem of alleyway pride, a kind of love song to the grayscale attitude.

The gray box on the righthand side of figure 19.1 has been filled in with the "average color" of several screengrabs from the video. The average color was calculated using Adobe Photoshop's "blur --> average" filter operation. As this exercise shows, the average color of the video clearly evokes the gray of cement. We might call this color, roughly, the average color of an average Vietnamese alleyway. THIS is the color I refer to when speaking of Saigon's grayscale attitude.

In Saigon, alleyway pride is real, and a *hẻm xi măng* (cement alleyway) is something to be especially proud of. Saigon real estate advertisements selling neighborhood homes often open like this: *Bán nhà hẻm xi măng* ("House for sale in cement alleyway…").[4] Cement is a sign of value, quality, and durability. Cement sells. The high value of cement is even institutionalized in official government schedules for calculating official land values and taxes. By law, a dirt road can only be valued at 80 percent of the total value of a similarly located road paved in concrete, cement, or macadam (Thiện and Nhung 2005). Vietnam's official classification system for housing, which ranks all houses according to six *cấp* (quality classes), also places explicit importance on the use of *bê tông* (concrete, from the French *béton*). The top four categories — which include *biệt thự* (villa), class one, class two, and class three houses — must be built with load-bearing steel-reinforced concrete. The lowest quality houses, which include class four houses and *nhà tạm* (temporary houses), are ranked so low because they are built of unreinforced brick, wood, or wood and *lá* (palm leaf) (Linh n.d.). Even the most

4 *Xi măng* spells "cement," but is often a gloss for concrete as well.

industrious of the fabled three little pigs, with a house of brick but not cement, would only be a fourth-class pig in this scheme.

The color of cement is the color of class. The color of the upper class, it turns out, is the particular gray of Pooclăng. What is Pooclăng? This curious-sounding word appears on most bags of cement in Vietnam. (The word is visible on the bags of cement seen in Schwenkel's chapter in this volume, figs. 36.1 and 36.3.) But despite being printed on bags of cement across the country, the word sounds funny even to a Vietnamese ear. It is so strange that a major building supplies company was compelled to explain the word on the FAQ section of their webpage, by way of responding to a question from a customer:

> Question:
> The name Pooclăng[5] sounds really strange to me, but all the cements have this word "Pooclăng." Why is it called Pooc lăng?[6]

The building supply company solves the mystery by explaining that the word Pooclăng refers to "Portland," as in Ordinary Portland Cement (OPC), "the most common building material in the entire world."[7] So common, yet so unknown. The website then explains the short history of Portland cement by plagiarizing a passage taken from the Vietnamese Wikipedia page, *Wikipedia tiếng Việt:*

> Portland Cement officially entered history on 21 October 1824 when Joseph Aspdin was awarded the patent for the process of producing a cement he called Portland Cement.

5 The syllables mean nothing in Vietnamese. The *oo* here is used to approximate the English "or" sound, which is almost unpronounceable in Vietnamese, and *clăng* simply clangs with onomatopoeia in the ear.

6 "Xi măng Portland là gì? Tại sao lại gọi là Xi măng Pooclăng?" ["What is Portland cement? Why is it called Pooclăng?"], *Thanh Cong Group,* https://tcgvn.com/vi/faq/xi-mang-portland-la-gi-tai-sao-lai-goi-la-xi-mang-pooclang.html.

7 "Là loại vật liệu được sử dụng phổ biến nhất trên toàn thế giới." Ibid.

> The name was given because the type of stone from the Isle of Portland in southern England had the same gray color as his cement.[8]

The word "Portland," especially when used in the original patent for cement, was intended to evoke a regal, classic style associated with stately buildings built to last (Hall 1976, and Halstead 1961). When originally patented, the now ubiquitous color of cement was something worth celebrating — it was a conscious attempt to fake a regal style and make it affordable. Aspdin had hoped that even the most humble builders would be able to enjoy the sturdiness of what he patented as an "artificial stone" (Hall 1976, 223).

In other words, the color of Portland Cement was part of a nineteenth-century English effort to fake luxury building materials and make them available to the masses, a way to deliver the aesthetics of the upper class to the working class. In Vietnamese alleyways, the use of Portland cement is also a conscious attempt to distribute what is considered to be a modern, sophisticated building material to a broad public. To be of a certain class in modern Vietnam, you need to live in a world of cement. Today, as more and more people join the cemented classes, the color of Saigon is the color of Pooclăng.

The concrete alleyways of Saigon do not simply appear — they are molded in specific ways guided by Vietnamese hands. The living, breathing human beings attached to these hands are intimately aware that their own hands must either join with other Vietnamese hands in the places they live, or otherwise curl their hands into fists to fight over collective space. Cement thus becomes the center of battles over the "right to the city," which is

8 The full passage reads: "Xi măng Portland chính thức đi vào lịch sử ngày 21 tháng 10 năm 1824 khi Joseph Aspdin được cấp bằng sáng chế cho quá trình thực hiện một xi măng mà ông gọi là xi măng Portland. Cái tên được đặt như vậy là do loại đá ở đảo Portland miền Nam nước Anh có màu xám giống màu loại xi măng của ông." Ibid. The same exact wording opens the entry in "Xi măng Portland," *Wikipedia tiếng Việt,* http://tcgvn.com/vi/faq/xi-mang-portland-la-gi-tai-sao-lai-goi-la-xi-mang-pooclang.html.

fought with poured cement, which allows people to occupy and demand space. Concrete can be a land grabber when it occupies and usurps cherished spaces, when it gets in the way. But laying concrete also offers the opportunity to express social solidarity. People often pour concrete together in an expression of collective acts, of *"chung tay làm,"* "joining hands to do" things together.

A concrete alleyway may appear fixed and solid, like a series of petrified channels. But time-lapse images taken over the years show that for all the roads and alleys that stay fixed, there are also alleyways that seem to undulate and grow. The arteries thicken and clog, but also sometimes widen and become unblocked. There is a reason why *the* most common sign to be found on a concrete wall in a Vietnamese alleyway is the stenciled advertisement for *khoan cắt bê tông,* concrete drilling and cutting.

Concrete alleyways are collective projects that emerge from the competition and cooperation of neighbors — mixing sand with cement to make concrete and pouring and laying concrete through collective spaces carved out between individual homes. The solid surfaces that emerge can be fashioned by hand, cut, broken down, and remade. A single person can carry a bag of cement, but it takes a neighborhood to lay out an alleyway. Out of this mutable, sometimes spontaneous solidarity, a sense of place and space emerges, moving to social flexibility that can be reworked and rejiggered to fit the constantly changing shape of a hard-edge city that is always in motion.

The grayscale color of Portland Cement is not so drab after all. For many, it is the color of home. The Portland Stone for which gray cement is named may have originally been intended to evoke elite buildings, but bags of *Xi măng Pooclăng hỗn hợp* (Blended Portland Cement) invite anyone — with a little bit of grit, both literally and figuratively — to hold on to the aspiration that they too might play a role in building the city in which they live.

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IMPERMEABILITY

Rosalie Stolz

Concrete urbanism seems to be governed by impermeability: boundaries between people and ecologies, the line between the inside and outside, is cast in concrete. Concrete walls produce barriers between kin and strangers and, often, suggest the line between friend and enemy. This chapter explores the transition from permeable dwelling logics to impermeable ones by tracing the rise of concrete housing in the uplands of Laos. By considering what passes through the walls of new houses and what is kept at bay, this chapter demonstrates how concrete is reshaping social boundaries in subtle and not-so-subtle ways.

Houses in Southeast Asia have been discussed as key arenas of kinship and sociality, marked by their malleability, flexibility and, above all, permeability. The increasing and widespread usage of cement in areas in which bamboo and timber have prevailed as building materials poses questions of wherein the attractiveness of concrete lies, and what the unsocial or impermeable properties of concrete are. In the Khmu village that I call Pliya, located in the uplands of northern Laos, an ever-increasing number of concrete houses are emerging. These new houses exhibit an enormous diversity; there is not one concrete house that resembles another. This variety is no surprise given that the concrete houses are usually completely self-built by the inhabitants, albeit often under the direction of those who have gained the reputation of being particularly skilled at building them. The resultant variations on the theme of the concrete house are added as the most recent newcomers to the otherwise village scene otherwise predominantly filled with bamboo and wooden houses.

In this village, amidst a forested landscape, albeit with encroaching plantations of cash crops, the boom of concrete houses might appear out of place. Yet, the rising number of "dream houses" or compromises thereon mirror the desires that are currently flourishing among the villagers of Pliya, as elsewhere in Laos and beyond. Here, as elsewhere, concrete has been taken up as a material mode of enacting one's aspirations. In considering these ambitions through the lens of concrete's (im)permeability I ask, alongside the Khmu villagers I have been working with, whether these aspirations are all they imagined them to be.

Concrete appears to contradict many of the characteristics of Southeast Asian houses that anthropologists have highlighted: their liveliness, permeability, and flexibility. Wooden and bamboo houses are permeable to sound, light, and smells, but potentially also to the curious gazes of neighbors and haunting spirits. Christine Helliwell (2006) has prominently deployed the notion of the "community of voices" to express the sonic connectedness of the residents of rural areas, who can more often than not easily overhear their neighbors' conversations and participate in the aural social sphere that a village of wooden longhouses constitutes. In fact, (inadvertently) noticing the presence of others is a shared condition of village life and anyone who has already spent nights in a bamboo house can certainly fill the term "village soundscape" with her own lively memories. Dogs barking, coughing, the sound of rice being pounded or of electric rice mills, the roaring of motor bikes, etc., all contribute to the sonic

Figure 20.1. Interior of a relatively impermeable concrete house in northern Laos. Photo by the author.

rhythm of the village. Concrete transforms this experience enormously. While bamboo houses are bathed in light during the daytime despite their lack of windows, a concrete house whose windows and doors are shut almost calls for electric lights to be turned on. The sounds of life outside of the house are muffled and seem distant. The awareness that one has of being in the midst of things when sitting in a bamboo house stands in marked contrast to the feeling of distance that one develops in a concrete house. Concrete, we could agree with Geoffrey Gowland (2020, 138), "creates a sealed, impermeable envelope."

Among my interlocutors' statements about their experiences of having moved into a concrete house, one notion struck me: the best thing about concrete houses was that in them *pəə a hntrəəy* ("there were no winds"). Wind, it should be added, is not the main problem of dwellings. Only the roofs of provisional communal buildings in a state of disrepair might be carried away by strong winds in the monsoon season. Arguably, the notion of wind is not so much about winds and storms in the meteorological sense. Rather, it has a vital metaphorical side to it: in concrete houses, neither ventilation nor anything else coming from outside, such as sounds, passes easily through concrete walls. Inside the concrete house, the inhabitants are enclosed in a way that makes the boundary between inside and outside appear as a self-evident, experiential fact. This is not an accidental by-product of concrete's material properties. Instead, some scholars have shown, the cultivation of an independent self in its private realm is tied to travelling ideas of modernity that might motivate a person to build in concrete (Telle 2007, and Gowlland 2020).

With concrete houses only just becoming a firm part of local vernacular modes of building, the inhabitants of Pliya are not yet used to entering concrete houses and show that they have certain reservations. The sitting in the houses of close kin and neighbors in the evening hours to watch television, do handicrafts, and chat, which is common in wooden houses, appears to be virtually non-existent in concrete houses. Tied to this trend in what might become an emerging idea of "home" as "one's own four walls" in which one can "enjoy" a certain degree of privacy is the increase in elaborate doors and door locks. Locking one's door was fairly uncommon in 2015; five years later, in 2020, locking the door had become a common routine and thefts and rumors of thefts abounded. As the number of guests decreased in concrete houses, the fear of uninvited, dangerous guests such as thieves increased.

Interestingly, however, the open log-fires around and in front of houses flourish. Yoŋ Khwaay who lives in one particularly conspicuous concrete house rarely is to be found inside it. When not out walking in field and forest, he sits at the fireplace or visits other fireplaces and workhouses. In general, although houses are of key socio-ritual importance, and affiliation to a particular house marks one's social persona and relations to other houses and to ancestor spirits, able-bodied persons rarely spend much time in their houses during daytime (Stolz 2021b). However, the significance of houses on social and cosmological levels is not called into question by the little time spent in them. The impact that concrete houses have on the village's soundscape include the built outdoor environment as well. Yoŋ Khwaay and other residents of impressive concrete houses spend most of their leisure time at fireplaces in the public spaces of the village. Without regular, often closely-related guests coming in and joining in nightly television watching, the new concrete houses are simply too deserted to be enjoyable to stay in. As Ma Sen told me, the people are not used to concrete houses, they hesitate to enter them but prefer to meet their kin and neighbors outside. This is also not without a certain irony from the local point of view. Self-deprecating comments on one's house are a common theme of traditional song in the context of weddings: It is usually the bride's kin who pretend not to let the bridegroom's kin enter the house during weddings on the grounds of their house being, as they self-deprecatorily pretend in traditional songs, a "broken house, a house the wife-taker [the bridegroom's kin] would not like to stay in." In fact, even the smallest bamboo hut can become the liveliest of spaces during wedding feasts. The conspicuously constructed concrete houses, by way of contrast, have not yet become places one enjoys staying in, in contrast to what they promise to be. These dwellings are too impermeable for social life.

This then raises the question of what a good house is. The inauguration party of Sii's house, a hybrid mixture of bamboo and concrete, has shown nicely that a good house is first of all a house that is a whole produced by various ritual and social means. To become prosperous and happy, a housegroup needs support from kin and neighbors. Even if concrete is fashionable, we can be confident that the Khmu of Pliya will find ways of outdoing some of its impermeable properties in order to preserve certain valued social characteristics of houses, while at the same time using it to help in getting rid of others.

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IMPROVISATION

Rowan McCormick

The application of cement and concrete include a wide range of construction skills and experience, as well as improvised and experimental methods. This chapter considers how the inevitable uncertainties of concrete quality and composition are mediated by improvisations that bring together material relations and social practices. Exploring these sometimes speculative and creative improvisations from the perspective of small-scale, "off-grid" self-builders in Aotearoa New Zealand casts reflective light on the ways all concrete constructions rest upon human judgment.

Considering the messy, imprecise nature of concrete alongside improvisations aimed at mediating its vagaries provides opportunities to rethink our relationship with and beliefs about the now-common building material. From initial batching to final curing, human estimation, error, skill, and working knowledge are all instrumental in establishing how concrete is constituted and consequently hardens over time. The standardized ingredients in a batch of concrete are stipulated proportionally and, according to the script, with precise measurements in either weight or volume. However, in *The Properties of Concrete,* Neville (2011) explains that because of the physical qualities of the materials used, and of the concrete itself, it is difficult to ensure accurate or consistent strength of concrete, or even to assess its actual strength in practice. Whether concrete is produced on site or in a laboratory, it is a variable quantity *and* quantity, and any structural design "is based on the assumption of a certain *minimum* strength of concrete" (Neville 2011, 732). One reflection of quality control, then, is what Neville (2011, 640) calls the "standard deviation," within which a mean strength of the overall pour is targeted higher than the minimum strength required for that specific application. What this means in practice is that human experience, judgment, knowledge, and, often, improvisation are an irreducible part of working with concrete.

This is especially true for off-grid owner-builders using concrete for small-scale building projects. While Neville asserts that the quality of a pour depends largely on experience-informed human estimations, his incorporation of "standard deviations" into calculations does not account for the many off-grid applications, which challenge the outer limits of what constitutes concrete. Drawing on recent ethnographic fieldwork with over twenty-five autonomous builders in Aotearoa New Zealand, this chapter progresses through a range of "non-standard deviations" that extend at times to "absolute departures" with regards to batching, transporting, mixing, placing, and curing. I discuss some ways that off-grid builders reconcile ethical, economic, and practical concerns by flexibly integrating "concrete standards" into local social, environmental, and political contexts through labor and improvisation. Alongside explanations of my research subjects' practices, I include various phrases and words grafted and aggregated from the comments and doings of building colleagues, researchers, and friends over a longer period of working in the presence of concrete. Printed in italics, these reflect some of the subjective beliefs and speculation about how the material does or doesn't work.

Figure 21.1. T & A's off-grid home built on various improvised footings. Photo by the author.

As much as any creative act, mixing concrete involves improvisation and absolute mastery of the material is impossible. As Elizabeth Hallam and Tim Ingold observe, whether the creative act is considered prescriptive or improvisational, "the difference lies in their aims. The former is, as it were, centripetal, aiming for the bull's eye; the later centrifugal, seeking to cast wide" (2007, 13). For example, when mixing concrete onsite, professional builders use conventionally sourced materials, ordering these proportionally, usually by volume. Counting by ratio, they thrust the shovel into the mounded materials, then lever, lift, swing, and flick each load rhythmically into the wheelbarrow or mixer and fold them together. Water is then added incrementally, with appropriate viscosity approximated by recollection of other batches, and in response to a complex combination of visual, kinesthetic and audible cues. Describing the relationship between materials and maker, Lambros Malafouris introduces the term "tectonoetics," signifying a "form of *enactive knowing through* that characterizes human self-awareness in the context of material management" (Malafouris 2008, 1998, original emphasis). In this embodied process, mixer and mixture are co-constituted, and results differ between builders, batches, and methods. Dry cement lifted gingerly from a paper sack will heap differently to damp aggregate on an inexperienced mixer's shovel. If, halfway through a pour, the remaining materials are visibly out of proportion, builders may revise mix ratios responsively. As a result, the latter half of a pour may be constituted and may cure differently from the former, sometimes leaving a discernible line documenting the moment of amendment.

Where more predictable results were crucial — for example, casting a 20,000-liter ferro-cement water tank — off-grid builders carefully researched and sourced consistently graded materials following prescribed quantities and methods. However, for less crucial building applications my builders, like Claude Lévi-Strauss's bricoleur (1966), sometimes took an ad-hoc approach, improvising creatively throughout the building process. Using materials at hand, they "cast wide," mixing toward the margins rather than aiming for target ratios. They made graduated decisions relevant to the application and based on factors that might never enter standardized equations for engineers. For example, builders asked: *Who will live in the building, and for how long? Will I be physically capable of remedial work in twenty years? Can this half-bag of cement stretch much further, and will it even bind with this uneven creek ballast? Can I spare the time to get into town? Is concrete even necessary?* Ultimately, the answers to these questions drew ethical, economic, ecological, and pragmatic considerations into the mix. They sometimes deployed an inventive "She'll be right" approach, invoking a Kiwi vernacular that is ingenious yet nonchalant in style and attitude (Smith and Straight 2015). Assuming wide margins of error in the recipe, the phrase signals a task's *overall* completeness and adequacy, regardless of inherent imperfections and failings.

Much of my research with off-grid builders involved building lightweight timber-framed "sleepouts": unfussy cabins clad in plywood, roofing iron, or other salvaged materials. These commonly begin as temporary or short-term shelters, but often eventually become more permanent dwellings. In parts of a country susceptible to occasional seismic activity and sub-tropical cyclones, builders proceed based on their best efforts and an assumption of probable adequacy. We would dig approximately twelve holes, estimating *sufficient-looking depths,* and plumb up the "H5" copper-chrome-arsenic treated piles, or "H4" fence posts, in a stiff mix of concrete. Once *somewhat cured,* we cut them level, usually the next morning. Building on inclines, we braced longer piles and bearers together to increase rigidity, then began floor framing.

The evolution of construction in remote contexts can involve long periods of mental and social mapping. Whilst designing structures and selecting a site, builders develop a geographical inventory of potential sources of materials from "non-standard" suppliers. They do this by scouring the bush, roadsides, riverbanks, beaches, shop noticeboards, and a nearby shed or farmer's quarry, mediating construction plans within local social, material, and geographical ecologies.

Steel reinforcement for a concrete pad might include offcuts of chicken mesh, irreparable machinery or tools, discarded bicycles, or old steel bed frames. This opportunity to utilize scrap also enacts a "waste-not" ethic while reducing costly trips to the "tip" (refuse station). Fencing wire and staples tie framing to piles, and straps and brackets are cut from scrap metal. If steel reinforcement is not necessary and rust is not a concern, beach sand can be used for concrete. Sometimes, at a pinch, a child's sandpit may be raided for contributions to a mortar mix. Later, that same child may benefit from repatriations of leftover sand after a pour. As they go, builders learn to sift or pluck out cat shit, Lego blocks, and garden bark.

Toward the end of the financial year — as councils utilize their remaining budgets — stockpiles of loose gravel are left near highways. Locals attuned to the seasonal rhythms of road maintenance may reclaim the previous year's roading metal laying partially concealed beneath kikuyu grass, nasturtium, or other roadside weeds, or accumulating from runoff in drains. Doing so saves time and money and reduces waste and fuel consumption. Although not consistent with "high-grade" concrete standards, this material is ideal for DIY building, drainage, paths, and driveway jobs, mostly because it is conveniently accessed. It is also paid for by local taxpayers. In this, builders may consider reclaimed aggregate a form of moral ballast.

"Making do" — also moral labor — extends the builder's field as they engage with other local ecologies. Sources of aggregate may include farm quarries and local works where generous "cubes" are bought at "mate's rates." Nearby riverbanks are monitored for accessible sand and gravel deposits, particularly after heavy rains. Here, builders seldom go to the trouble to grade or sift out impurities, instead assessing adequacy and ratios by sight and feel. Gravel beds invariably retain sand and silt, and sandbanks often contain stones, as well as humus, leaves, seeds, and other organic matter. Neville refers to such variably sized material in "low-grade concrete" as *"all-in* or *pit-run* aggregate" (2011, 108, original emphasis), with which mixing ratios accurately is not possible. Because materials heap, clump, and cling differently depending on moisture and dust content, or on the coarseness of the grain, a spade is seldom a spade. Improvisation is the rule, not the exception.

In some off-grid applications, I noted how builders merged processes and materials that, in controlled commercial concrete operations, are intentionally kept distinct. For example, already wet creek deposits require no additional water during mixing — which for all intents and purposes commences when everything is shoveled into the one vehicle to be transported together. As a dripping wheelbarrow or trailer furrows its way back toward the build, any pretense of attaining near-purity or accurate proportionality is left by the wayside.

Despite these and other material improvisations, the addition of Portland cement is a near-constant. It is added incrementally, by estimations based on a range of factors, starting with quantities. Bought by the bag for a specific project, a mix may also include "lumpy leftovers" remaining after a previous mix. While some builders fastidiously follow the script, others spread a set quantity of cement proportionally to complete a given project. With the difficulty of distributing dry cement evenly through sodden aggregate, attempts at mixing accurate proportions may be thwarted.

Seeking a satisfying textural consistency, builders may add cement until the color *looks about right.* A comforting iridescent, near-anthracitic glow *seems* to denote adequate levels of chemical activity appropriate for *any* conditions. As Neville explains, quality control "is a management tool *comforting* to the owner of a structure" that does not on its own "produce concrete appropriate for the given conditions" (2011, 1099, original emphasis). Where supplies are abundant, correlations may be observed between the desire to *feel* comfortable and confident about a mix and the addition of excessive cement — which may bear little relation to the concrete's actual strength.

Other times, utterances come into the mix as builders make ongoing modifications. While offering little to reinforce footings, verbal assurances may performatively bolster the builder's confidence in the structure, enacting certainty. Refrains include: "The specs are overkill anyhow," and, regarding the building, "It's unlikely to go anywhere, is it?" Builders vary in their respect for the building code, and their sometimes-comedic routines simultaneously draw attention to and distract concerns away from scriptural deviations. They are suggestive of an interplay between the materials and cognition: while it cures, builders mediate beliefs about the concrete's integrity. When assumed secure, solid, and permanent, dweller-builders may feel assured. Skimping on cement can unsettle dweller-builders laboring with the burden of uncertainty. Treating non-compliant, non-standard practices as temporary, experimental, and ecological can offset anxieties around uncertain footings.

Sometimes frugality takes on an explicitly moral, ecological character. In discussions about cement-related carbon emissions, some builders weigh a sense of moral responsibility against inclinations toward adhering to specifications. However, other builders insist that skimping on cement reduces longevity and reinforces a false economy. Frugal builders dig holes "neat" and tapered so that footings dovetail in the ground, forming a wider footprint and relying on the compressed earth to resist uplift. Large rocks and old broken concrete (urbanite) may be added to a footing, increasing its weight while reducing the volume of concrete required.

These improvisations have uncertain effects. One of my informants, Craig, measuring with a strong ecological bias, *stretched* a sack of cement beyond the manufacturer's intentions. The next day, notching a central timber pile with my handsaw, I felt the creek-aggregate footing crack in the ground. To stop it wiggling like a loose tooth, we attached the bearer and shored it up triangularly with extra bracing, then tried to forget about it. As our confidence in the structure shifted in response to the cracked footing, we redistributed it across the entire foundation. Where improvising, risk assessment and building practices are temporally bound, informed by (usually minor) failures witnessed elsewhere. An occasional sinking pile may not be noticed for decades. Builders hedge both structurally and verbally: "I can replace a failed footing when the time comes — meanwhile, the framing will hold it in place." While believing prescribed standards are excessive, builders have no means of calculating by how much. As Neville exclaims, "It is not possible to discriminate absolutely between satisfactory and unsatisfactory concrete, short of testing all of it!" (2011, 734).

Avoiding mentioning the wiggly-tooth pile, three years later I quizzed Craig about cement use. The cracked concrete footing seemed foundational to a shift in his building practice: he now excludes cement from his footings altogether. "I tamp beach shingle firmly under and around each pile footing," he explained. "Well-compacted aggregate is free-draining, resists uplift and can absorb movement, and in my opinion is actually *better* than concrete. I stopped using concrete a few years ago and I'm yet to see any loss of structural efficacy." Replacing a cracked concrete footing is a difficult prospect; excluding cement, an unstable pile can be (more) easily repaired. In effect, tampering with ratios *beyond* the point of failure, Craig tamped cement out of the mix, displacing an active chemical agent with the action of human labor. As with other builders driving piles directly into the ground, bearing on boulders, or forming stone trench footings, a sense of assurance, confidence, and security was affected by setting foundations in a more flexible, relatable, and pervious medium.

Improvising and using materials at hand led some off-grid builders to alter their belief structures and values alongside building practices. Structural shifts inform and are informed by ethical choices around best practice, and "good" materials. As Trevor Marchand explains, this kind of "knowledge-making is a dynamic process arising directly from the indissoluble relations that exist between minds, bodies and the environment" (2010, 2). Sourcing materials unconventionally requires time, effort, and measured consideration: the discerning labor of locating, lifting, and shifting aggregate contributes simultaneously to the making of both moral buildings, and moral persons (Carsten and Hugh-Jones 1995). Laboring intensely and attentively, "the body is a prime site for establishing an education for social citizenship" (Marchand 2008, 266).

Where sand and gravel extraction have environmental and social impacts, and cement manufacturing contributes significantly to carbon emissions, conscious divergences and mindful mediations reconciled builders with places, materials, morals, processes, and results from which they might otherwise have been alienated. Removing cement altogether, builders remediated their temporal relationship with buildings, shifting reliance away from engineering norms and toward human-scale practices and contingencies — judgment, discernment, and improvisation — to establish and maintain footings responsively over time. Including "non-standard deviations" and "absolute departures," their improvisations present opportunities to reconsider our desires for, ideas about, and expectations of "quality," "strength," "permanence," and "stability" once considered chief constituents of concrete — both the substance, and the word.

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INCOMPLETENESS

Siddharth Menon

Concrete is never finished. For millions of marginalized people, the perpetual incompleteness of concrete infrastructures, and the ongoing project of their incremental construction, lend themselves to dreams of equality. They also generate unique forms of governance and profitability. Like microloans and other accessible forms of participation in capitalist enterprise, artisanal uses of concrete also have the power to induce protracted incompleteness, stunted upward mobility, and partial inclusion. This chapter explores how one man living in northern India begins, but cannot complete, his concrete home.

It was a warm summer day in July 2017. I was in Kandbari village on the outskirts of Palampur city in the Kangra district of Himachal Pradesh in northern India. While walking along the cobblestone path adjoining the village school, I admired the quintessential *peepal* tree that adorned its spacious courtyard. Just then, the metal bell rang, signaling the end of another school day. Hordes of students, dressed in white shirts and navy-blue shorts and skirts, rushed out of its gates all at once.

Figure 22.1. Beherchand, standing in front of his incomplete *pucca* house. Photo by the author.

While trying to navigate my way out of this crowd, I noticed someone gesturing to me from afar. It was Beherchand, a local carpenter, with whom I had previously worked during my stint as a site-architect in Kandbari from 2011 to 2014. He greeted me with a tight hug, held my wrist, and led me up a narrow winding trail along the slippery embankment of a stream. Beherchand wanted to show me his brand-new concrete house that he had begun to construct for his family. After precariously navigating our way up the trail, careful not to fall into the chilly water, we took a sharp left through a thick grove of guava trees and stood in-front a modestly sized brick and concrete house (see fig. 22.1).

The house had three rooms including a kitchen and was built on a high stone plinth. Piles of brick, bamboo scaffolding, and empty cement bags lay strewn around the construction site. Wet jute bags, soaked in water, had been wrapped around the concrete pillars for curing. Kiln brick walls had been built up to the lintel level of the house but had been left un-plastered. Wooden door and window frames had been fastened to these

Figure 22.2. A *kuccha* house in Kandbari village. Photo by the author.

walls using metal holdfasts, but they lacked any shutters. Steel rebar was protruding from the column tops, gently swaying in the mountain breeze, signaling Beherchand's intention to construct a reinforced cement concrete (RCC) roof or an additional floor above. A feeling of pride had engulfed Beherchand when he showed me his new concrete house.

Until now, Beherchand had lived in his ancestral *kuccha* (raw, uncooked, or impermanent, in Hindustani) house with his ageing parents and his brother's family. But his expanding family needs and his desire to showcase a high social status in the village had spurred Beherchand into building his own *pucca* (ripe, cooked, or permanent) house. In Kangra, *kuccha* houses signify social backwardness and poverty, and are associated with a caste-based, feudal lifestyle filled with the drudgery and precarity of primary-sector jobs, like agriculture or forestry (see fig. 22.2.). In contrast, *pucca* houses denote values of progress and modernity, and are associated with a post-agrarian, middle-class lifestyle filled with the social security and stability of secondary and tertiary-sector jobs, like manufacturing, tourism, or information technology (IT) services (Menon 2023).

After building his *pucca* house, Beherchand thought he was finally able to portray himself as a middle-class citizen of modern India. However, he had exhausted the resources needed to complete construction and his initial enthusiasm for a *pucca* house had slowly given way to feelings of uncertainty and anxiety. While he now had a house built with permanent *pucca* materials that he thought would last a lifetime, the high costs of procuring these materials had left him with an incomplete *pucca* house. In other words, while he chased the dream of a permanent *pucca* house, which would showcase his middle-class status, he instead got a *pucca* house in a permanent state of incompleteness. Consequently, his quest for middle-class status had also been left incomplete and fractured. Triggered by these observations, I ask what kinds of temporalities and futures are being conjured by India's incomplete concrete infrastructures, by whom, and to what effect?

Since India's economic liberalization in the 1990s, there has been a rapid transformation in house construction materials from locally sourced, natural *kuccha* materials like mud, bamboo, and wood to market procured, industrial *pucca* materials like concrete, steel, and glass. The scale of this transformation is exemplified by the fact that, today, India is the world's largest producer and consumer of cement after China. Ninety-eight percent of its domestic cement market is monopolized by a few transnational companies, including the Switzerland-based Holcim group, and the Indian multinational giants Ultratech Cement and Adani Cement (Sharma 2017). Moreover, the country is expected to add another 400 million new urban residents by 2050 (UN Population Division 2018) for whom it is projected that an additional 9000 million square feet of concrete houses, buildings, and infrastructures will be constructed each year until then (Sankhe et al. 2010). In addition to the globalization of India's construction materials market, there has also been a flurry of state-led development programs, like the Pradhan Mantri Awas Yojana (PMAY)—the Government of India's flagship affordable housing scheme, which has doled out subsidies

Figure 22.3. Incomplete *pucca* houses in India. Photo credit: Atikh Rashid, *The Indian Express.*

to socially and economically "backward" communities living in *kuccha* houses for building new *pucca* ones.

This transformation from *kuccha* to *pucca* houses has not been smooth. A cursory glance at any of India's rapidly urbanizing small towns and peri-urban regions will reveal a skyline littered with partially built *pucca* houses with rebar sticking out into the air, promising a future of economic growth, prosperity, and upward mobility (see fig. 22.3). Official figures indicate that out of the 6.7 million *pucca* houses that were sanctioned for construction by the PMAY scheme since 2016, more than 5 million are either unfinished or have shown no signs of construction activity (Rashid 2020). Faced with bureaucratic delays in the release of earmarked subsidies, coupled with the meagre financial savings of first-time homeowners, most of whom have precarious and irregular jobs in rural India, many residents, like Beherchand, have come to repent their decision to build *pucca* houses.

Scholars have argued that infrastructures are in a state of constant temporal flux. They are always in the process of being made or, in other words, they are forever in the making (Anand, Gupta, and Appel 2018). This fluctuating temporality of infrastructure is witnessed in Beherchand's case as well. While he started building his *pucca* house with aspirations of being a modern, middle-class citizen, he soon ran out of financial resources to complete his house. Now he plans to finish his house construction incrementally as and when he gathers additional funds to procure cement bags and other materials, as is often the case in many parts of the world (Simone 2020). But while the proposition that infrastructures are always incomplete might be theoretically compelling, stopping analysis at this point elides the important political work being done by infrastructure's incompleteness.

An analytical focus on the incompleteness of infrastructures can highlight the agency of marginalized communities to reshape their materially deprived surroundings and address their future aspirations. It can foreground new "improvisations and adjustments" (Amin and Thrift 2017) that marginalized communities practice in response to fractured infrastructures. However, it can also shed light on the ways in which incomplete infrastructures inhibit the agency of these communities by creating new, disempowering subjectivities that discipline them to follow specific political-economic agendas. And it can also point to how incomplete infrastructures are mobilized by the state to govern the futures of marginalized and oppressed communities.

In recent years, the paradigm of "inclusive growth" has emerged as a new way through which those in power manage those populations they deem surplus. By using similar discourses, state and corporate elites harness the aspirations of marginalized communities of partaking in India's growth narrative to make visible and monetize their own agendas (Roy 2016). Inclusive growth, then, becomes a key strategy to create new frontiers of capital expansion, and in Beherchand's case, these frontiers are literally the materials of his house. While residents in India's rapidly urbanizing small towns and peri-urban regions might be free to determine their economic futures, the widespread concretization or "*puccafication*" of their houses subverts their agency by converting them into neoliberal subjects whose everyday lives become dependent on price fluctuations and volatilities in the markets for global cement and construction materials. The construction of *pucca* houses also extends the biopolitical authority of the state into remote places like Kandbari village where until recently, one did not need the government's permission to dig up earth and build mud houses on their property. Through the deployment of state-led concrete housing programs like the PMAY, basic necessities like shelter and housing become new technologies of government which are used to control the lives of the rural poor and the marginalized

As an embodiment of progress and modernity, *pucca* materials like concrete allow marginalized communities to partake in India's growth narrative, both materially and symbolically. But while India's economy has consistently clocked more than six percent annual GDP growth rates since the 1990s, it has only created two percent growth in formal sector jobs during the same period (Ahsan et al. 2008). This stark imbalance between rapid economic growth and almost stagnant formal sector job creation has meant that people, like Beherchand, who are routinely employed in informal and casual work, do not have the financial means to concretize their middle-class aspirations. Such aspirations remain fractured and incomplete, bending like rebar in the breezes of economic vulnerability.

The case of Beherchand's incomplete *pucca* house highlights the politics of futurity. It sheds light on the processes through which the future is always constructed as something that is better than the past, something that is desirable and must be aspired to by marginalized communities the world over. It reveals the actors and institutions, like governments and transnational cement corporations, who create these singular, dominant representations of the future and who thus profit and gain power from the same. The case of Beherchand's incomplete *pucca* house also points to the fact that the materiality of infrastructures, in this case concrete, is important for determining the degree to which this desirable and aspiration future is attainable for oppressed communities in the world.

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KINSHIP

Heid Jerstad

Concrete not only binds together buildings but also generations. This chapter shows how cement and concrete draw together changing weather patterns with modes of dwelling, regimes of laboring, and practices of kin-making. The chapter demonstrates how concrete has become a central site of social investment in the Indian Himalaya as it enables the continuity of polyandrous households, despite the comparative discomfort of these new homes, which the production of the cement exacerbates.

✣

We sat in the empty kitchen, Poonam Devi with mud on her red sleeves, as she built the *chulha* (wood-burning stove). Piling bricks along the hot water pipes, she slopped and smooshed clay mortar between them. We could hear chanting — her husband and the Hindu priest were conducting a house inauguration ritual. Poonam Devi lives in a village on the mountainside in the Indian Himalaya and has five adult children, four sons and a daughter. The family had been living in two rooms in the wooden and stone house split between her husband and his two brothers, but now their new concrete house (on contested land, but that is another story) was ready.

Why did they need a new house when they had their old one? Although three sons had left the village to find work, the continuity of the household is dependent on bringing in a daughter-in-law who would live and work in the village. Much is expected of a daughter-in-law but she would expect to have her own room. This need for continuity drives kin-building decisions in many parts of the world (see, e.g., Reece 2019). In India most agricultural work is done by women, and Anupriya, Poonam Devi's surviving daughter, is expected to join her hypothetical husband's household upon marriage. Poonam Devi's eldest son has married, but his wife lives with him in town. On the rare occasion when she visits the village, far from helping out, she instead eats food she brought with her, quite an insult to Poonam Devi, her mother-in-law. This is, from the point of view of household continuity, the kind of outcome that leads elders to be skeptical about an educated daughter-in-law. In a rival household, a prestigious daughter-in-law works as a policewoman, but the dairy buffalo kicks when she tries to milk her, as she so rarely does farm work. Poonam Devi is hoping to gain a more practical daughter-in-law through one of her younger sons.

Polyandry is the traditional mode of reproduction in this region — with several brothers marrying a single wife the same fields feed one household. Although a lot of labor falls on that one wife, polyandry avoids dividing the land into ever smaller parcels, which would mean poverty even when the rains have been good. This polyandry, as well as occasionally polygynandry (i.e., the taking of several wives into a marriage with several husbands) has been practiced somewhat flexibly. It is possible that Poonam Devi was originally married to all three brothers, but by 2012 when I arrived, the younger two had been married to another woman for several decades, and their house and fields were divided.

In Poonam Devi's village men mostly work outside the village as drivers, laborers, and in the army. Women work in the fields and with dairy buffalo. This is hard, unwaged work, and not everyone will do it. Girls coming back from longer visits to relatives or from studying elsewhere sometimes claimed that they did not know how to work, or that they had forgotten how. One day Anupriya was cutting leafy branches for fodder, and I was collecting them into bundles ready for carrying. From up in the tree she told me she had joked on the phone with a boy, saying she doesn't know how to work, and the boy responded quoting a well-known story: "A girl went to be married, saying 'I don't know how to work,' and they said, 'well we have others in the house who can do the job of eating, we don't need you to do that job.'"

The work Anupriya and Poonam Devi were doing for their household — fetching fodder for the dairy buffalo and cow, drying firewood, harvesting, de-stoning the fields, making tea, and a thousand other essential tasks, will need to be done in the future too, and cannot be done by a man. Without a room for the newly married couple, however, a family will be less able to attract a daughter-in-law who will live in the village. The new concrete house Poonam Devi and I sat in had several large bedrooms.

The clay that Poonam Devi was using as mortar between the bricks of the *chulha* had been fetched from the hillside nearby before being pounded with chopped straw and water into this mixture by her tiny, bad-tempered mother-in-law. The cement in the fabric of the house that stood tall and gray-walled had also come from the mountain, but by a more circuitous route.

In this village one occasionally hears a sound like thunder even when the sky is clear. This is a detonation at the limestone mine across the valley, visible as a white gash in the mountainside. Men from nearby villages work in the mines and as truck drivers ferrying the white stones down the winding mountain roads to the cement factory by the river. There the stones are crushed and heated, processed into the familiar gray powder.

The cement is packaged in plastic sacks and sent up the mountain again to the building supplies shop where a rather faded ad shows an improbably muscled man clutching a mighty dam. These ads, plastered across shop-fronts in the plains and in the hills, imply strength, stability, and the superiority of this synthetic stone. The contractor who built Poonam Devi's new house collected the sacks from here. When the laborers had finished mixing the cement with water and sand to make the concrete, Anupriya took the empty sacks, washed them, and sewed them into neat squares for sitting on.

It was these squares Poonam Devi and I sat on in the new kitchen while she made the *chulha*.

The kitchen had been painted a cheerful blue, and tiling around the taps added a fancy touch. The rest of the house, however, was a dusty gray inside and out. The limestone may have looked equally inert as it was hacked loose from the mountain. But these white stones were once alive, the bones or exoskeletons of tiny marine organisms who, having lived their little aquatic lives, fell to the seabed and were squashed by the ocean into rock. And their bones, like my bones and your bones, contain carbon. When the limestone is heated to produce cement, this carbon is emitted into the atmosphere.

The emission of CO_2 as well as other greenhouse gases is causing global temperatures to rise (Pachauri and Meyer 2014). Global temperature rise leads to changing weather systems as well as higher average temperatures. In the Himalaya, where Poonam Devi lives with her family, the temperature is rising. The winter rain of 2012, the year I arrived in the village, was late, and the monsoon of 2013 was early and particularly heavy, but the weather in general, people told me, was changing. The old wooden house had no fan, but in Poonam Devi's new concrete house there were empty fan sockets in every ceiling.

Concrete, once dry, is an inelastic substance, prone to cracking. I was told in the village that concrete houses "don't last many days." Poonam Devi's husband said that his new concrete house will "go bad" after 50–60 years, while the wooden houses remain "good." Their eldest son and daughter-in-law, down in the city, lived in a rented flat whose roof had a large crack in it. They solved this problem by pouring new cement over the crack. On another occasion, an old lady, senior of two co-wives, no longer able to work due to lameness and blindness, invited my father and me to lunch. We were bundled inside the tidy

Figure 23.1. Concrete house with crack, Indian Himalaya. Photo by the author.

upper wooden room, sitting on white plastic sacking. Her son Hari, who works building concrete houses, said that the new houses are cold and hot at the wrong times. The wooden house, he told us, is "like air conditioning." He told my father that the concrete kitchen he had built for his mother fifteen years ago had "gone bad" while the wooden house built by his grandfather seventy years ago in which we were sitting was still going strong.

However, there is plenty of work for Hari, as people like Poonam Devi's family are still building concrete houses, in this village and across the world. As an uphill neighbor with a similarly newly built concrete house told me, acknowledging the serious cost of both measures: "I asked my children what they wanted, marriage first or the new house first, and they said the new house first." His concrete house, like Poonam Devi's, is built to ensure the future. This future is necessary, and thus the building becomes necessary.

Poonam Devi and I sat together in her new blue kitchen, her hands deftly shaping the clay of the *chulha* into a smooth rounded form with an opening in the front for the fuel sticks and two holes for pans on top, with the noise of the ritual coming through the open doorway. When she had finished the

Figure 23.2. Cracked concrete interior, Indian Himalaya. Photo by the author.

priest called her to stand by the ritual fire to participate in the final stage of the inauguration.

That evening Anupriya found me in the kitchen watching as the first fire in the new *chulha* burned down into embers, laughing because I was sitting in the dark watching the glow. She switched on the light and showed me how the heat had already dried the clay closest to the flames, while the darker portion on the outside was still wet.

From the path going past Poonam Devi's new concrete house one may look across the valley to see the white hole in the mountainside. Closer at hand, the village is a mix of older slate-roofed timber houses and the new concrete houses, one painted a chalky green, another with fancy reflective windowpanes. Closer still are the spiky steel rods that poke out of the flat roof of Poonam Devi's house. Rods that hold out the promise of a second story, the addition of further bedrooms to enable the welcoming of additional daughters-in-law. The walls themselves hold the burned and solidified dust that came from the mountainside not far away, but in a new form and subtly tied to the changing of the seasons they will encounter. The building of these walls has influenced the conditions for the work in the fields which Poonam Devi does and with which she hopes for assistance.

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MAGIC

Naomi Haynes

Moving through phase changes from stone to powder to liquid and back, cement's capacity to transform at speed is fundamental to its power. Situated along the Zambian Copperbelt, this chapter explores how cement is wrapped up in other forms of magic, like when the material is enrolled in rituals that might speed up the always uncertain process of home building. This chapter explores how aspirations for material, social, and spiritual mobility bring concrete's innate characteristics to bear on more spiritual possibilities.

The last Sunday of 2008 Key of David, a small Pentecostal church on the Zambian Copperbelt, held a "Thanksgiving Service." This special Sunday worship service culminated in the presentation of thanksgiving offerings by members of the congregation. One by one believers walked to the front of the sanctuary and presented their gifts to the church's leaders, who I call Pastor and Mrs. Mwanza. There were envelopes of money and small plastic bags containing foodstuffs or items of clothing, which were

Figure 24.1. Concrete in Lusaka, Zambia. Photo by Sana Ginwalla.

carefully dropped into a large cardboard box covered in green fabric, prepared specially for the occasion.

As the giving progressed, a few young men began to drag 25-kilogram sacks of Chilanga brand cement to the front of the church, straining slightly in their Sunday best, taking care not to muss their clothes with the gray powder. There were six sacks in all, and piled together they formed an impressive heap. Since cement falls into the category of commodities that, along with maize meal and cooking oil, people always know the price of despite fluctuations (cf. Archambault 2018), everyone in the room knew exactly how much this gift cost, and this knowledge further contributed to the power of the display. After the service I was told that the offering of cement came from a man called Moses, a contract worker at Barclays Bank who the church held up as a prophet. Moses and I both rented rooms in Pastor Mwanza's home, which is how I knew that he was slowly amassing an impressive array of domestic goods, including a dining table and a television set, items that he expected to use in his own home in time.

Moses's gift of cement raises questions that highlight the particular properties of concrete in urban Zambia, especially among Pentecostal Christians. Why would someone who was also saving for his own home spend a considerable portion of his income on building a church? And why give cement, rather than money, since this made the gift more expensive by requiring a taxi to transport the heavy bags to the Thanksgiving Service?

While one answer to these questions is surely found in the display power of this contribution, the status that it incurred is only part of the story of Moses's offering. Unpacking this gift further requires us to look a bit more closely at house and church construction on the Copperbelt, and more specifically at how the similarities between these two processes serve as a point of magical connection. This connection in turn allows efforts toward building God's house to count as efforts toward building one's own house as well, at least as far as Pentecostals are concerned. In this context, Moses's gift of cement emerges as a powerful religious token, imbued with the potential to supernaturally propel him along the frustratingly slow process of building a house.

In Nsofu, the neighborhood where Key of David was located, there are houses under construction everywhere. On almost every street one finds heaps of sand and cement piled in otherwise empty yards or in partially finished houses with half-built walls and tarpaulins tied across openings left for windows (fig. 24.1). Sometimes a family will build a small "cabin" at the rear of their property and live there while they slowly build the main house; later they can rent the cabin out to supplement their income. Other home-builders live elsewhere in the city until their house is ready, perhaps letting the unfinished structure to tenants who provide a measure of security for the construction site in exchange for affordable rent. Either way, house building is a long process undertaken over the course of many years, as people first construct a cabin, then a foundation, walls, a roof, windows, and so on. Of course, some owners never finish their houses, but wind up selling them while they are still in process, and even those who keep their property might never finish the building completely, always waiting for the day they will have enough money to put in the windows or add ceiling boards in the sitting room. Construction is therefore an endeavor haunted by the possibility of failure (Nielsen 2011). Urgent needs like school fees or funeral expenses, along with the general precarity of Copperbelt life, jeopardize progress at every turn.

Faced with the inevitably slow, halting process of building their houses, it is no surprise that people on the Copperbelt are attracted to the possibility that divine intervention might shorten the timeline of construction. Here is where Pentecostalism comes in. One of the unique features of this form of Christianity is a special set of ritual mechanisms through which believers aim to compel what they call "breakthroughs" that might, for example, speed up construction.

While all of the offerings presented at the Thanksgiving service had the potential to be effective toward this end, Moses's bags of cement were especially powerful because they employed what I have come to think of as Pentecostal "magic." In *The Golden Bough,* anthropologist James Frazer distilled what he called the "principles of magic" down to two observations: "first, that like produces like, or that an effect resembles its cause; and, second, that things which have once been in contact with each other continue to act on each other at a distance after the physical contact has been severed" (Frazer 1998, 116). Frazer summarizes this central distinction as one between "imitative" and "contagious" magic. Imitative or "homeopathic" magic acts through relationships of resemblance, while contagious magic acts through previous physical contact. Imitative magic might involve using a person's image to cast a spell on him, while contagious magic might attempt the hex using a lock of his hair.[1]

Putting Frazer's observations in semiotic terms, we could say that imitation operates on the basis of iconicity and contagious magic on the basis of indexicality. This semiotic language is helpful in the Pentecostal case, as Pentecostal magic derives its efficacy in part from symbolic, often metonymic, relationships between a person's action and what she hopes to receive from God. So, for example, a believer may try to compel God to bless her with a child by buying diapers even before she is pregnant, while another may seek the capital for trans-border trade by preemptively applying for a passport. In both of these cases, Pentecostals mobilize a portion of the hoped-for blessing in an effort to secure it in its entirety. Through these performative actions, articles like diapers or a passport are transformed into powerful tokens, material vectors of expected, miraculous ends that also constitute the first step toward their realization.

While Moses and the other believers at Key of David would not describe such actions as "magical," a label they would read as an accusation of religious syncretism, approaching Pentecostalism in these terms highlights how believers attempt to make God act by turning the biblical text into a formula for miraculous results. Seen from this angle, the Bible is magical because it maps out a "succession of events [that] is perfectly regular and certain, being determined by immutable laws, the operation of which can be foreseen and calculated precisely" (Frazer 1998, 144; also see Haynes 2018; and Haynes 2020). It is in this frame that we are best equipped to make sense of Moses's offering.

By helping build "God's house," Moses's gift tapped into the symbolic principles of homeopathic magic in a way that he hoped would also help him to build his own house. More specifically, his offering of cement, the same material used in the

1 We do not need to follow Frazer in his assertion that magic is "spurious" and "fallacious" (1998, 117), or indeed, his broader evolutionary argument that pits magic against religion, and both of these against the ultimate triumph of science, to make use of this helpful typology.

construction of both homes and churches, represented an attempt to supernaturally shorten the timeline of the former by expediting his congregation's efforts toward the latter.

Like house building, church construction in Nsofu is a long process, particularly among independent Pentecostal congregations like Key of David. These small groups get their start meeting in private homes or rented classrooms, and most never manage a building of their own. Those that do begin with a temporary wooden structure over a concrete slab before eventually adding cinder block walls, then a better interior floor, windows, and plaster. A few very successful groups are able to go beyond these basic steps, painting the exterior and interior of the building, adding a ceiling below the corrugated roof, perhaps even tiling the floor. This process usually takes many years, and in the interim Pentecostals will gather in unfinished structures, stringing lace curtains across gaps left for windows, peeping over half-finished walls, and sweeping and polishing bare concrete floors every week before the Sunday service. Moses's gift of cement brought his church closer to the point of completion, and the homology between this progress and progress toward his own house, mediated by their common material component, therefore represented a point of magical connection through which he hoped to advance his own efforts at house construction.

Moses's gift could also be read as employing aspects of contagious magic, whereby magical power is transmitted through previously connected objects. In contrast to diapers or a passport, the material vector of blessing that Moses employed did not remain in his possession, but rather became part of his church building, specifically as plaster for the exterior walls. Nevertheless, as an eponymous, inalienable gift, Moses's cement stayed connected to him even after he gave it up (Coleman 2004), while also bonding, literally, to the church. The material remainder of Moses's religious action therefore functioned as a religious token similar to a prayer flag or a lit candle, standing as an ongoing petition on Moses's behalf and further increasing the efficacy of his offering.

As an instance of both imitative and contagious magic, then, Moses's gift sought to exploit the similarities between the church building and house building processes, moving one along in hopes that God would move the other along as well. His offering was therefore not just an impressive display, but also and more importantly a strategic effort to jumpstart his own house-building ambitions. Once employed toward this end, the cement he gave became a magical object, infused with transformative power even as it was itself transformed from powder to liquid to hardened concrete.

That cement would serve this purpose is perhaps not surprising; the magical qualities of this infinitely adaptable substance are not difficult to see (e.g., Kelley 1924). As Michael Taussig (2004, 162) writes about cement's evolution from stone to powder that, when mixed with water, becomes "stone" again, "It sounds like magic but we call it technology." The symbolic multiplicity of Moses's gift, with its various modalities of magical engagement, echoes the polysemic nature of cement, stacked in sacks at the front of the church, then stored in a secure cupboard before being mixed with water and sand and applied to the exterior walls, smoothed with a trowel, and dried in the equatorial sun.

Paradoxically, on the Copperbelt the open-endedness of cement—its capacity to take innumerable forms—is often subsumed by an aspirational uniformity in which a cement house is a key marker of middle-class achievement (Hadjri et al. 2007). It may be therefore that in the Pentecostal case, at least, the magic of cement is found as much in its capacity to produce a universally recognized form as in its multivalent potential. If cement is magical because it can be made into almost anything, it is also magical because, by employing it toward established material ends, it can make those who use it into the person they hope to become.

While gifts of other commodities can similarly serve as vectors of Pentecostal blessing (Haynes 2013), cement seems an especially productive means of intervening in the otherwise unpredictable process of Copperbelt house construction by shaping the built environment in a way that will compel divine intervention. For Pentecostals like Moses, cement becomes magical when it is made into a literal concrete reminder of human actions that they hope will compel divine action as well.

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MICROBIOME

Matthew Gandy

This chapter examines the presence of life forms that have flourished on the concrete surface of one of London's best examples of "brutalist" architecture. The conceptualization of concrete as a microbiome brings an entropic sensibility to urban environmental discourse, emphasizing different scales and temporalities that are routinely overlooked within conventional readings of urban nature. It considers how concrete presents something of an ecological paradox: while its production is a significant source of environmental degradation, the gradual weathering and decay of the material itself can support an abundance of microorganisms. It reveals how surface ecologies are a vibrant dimension to the multi-species city.

There is a block of striking university buildings on Bedford Way in central London designed by the modernist British architect Denys Lasdun. This massive structure, completed in 1976, is among the finest examples of "brutalist" architecture, marked by its extensive use of concrete materials (see, for example, Clement 2018). For many years I worked in part of this complex, but

I didn't reflect very much on the building's surface ecologies: my encounters with urban nature were dominated by interstitial landscapes, nearby squares, or the occasional glimpse of an urban fox from my office window.

In order to carry out research for this essay I decided to return to take a closer look at the concrete surfaces that form part of the architectural design for these buildings. As I approached the site on a warm and cloudy July morning, I felt a strange sense of curiosity and expectation. From a distance the buildings presented a familiar gray appearance but as I got nearer I could see a variety of discolored streaks, including rust-colored lines extending below metal bolts and other fixtures. In places the surface of the concrete had become heavily pitted with coarser kinds of aggregate becoming visible. On some of the gently sloping slabs of concrete nearer to street level there were microbial rainbow effects comprising different shades of green and gray. The concrete surfaces displayed a variety of patterns of microscopic life in response to contrasting degrees of exposure to sun, wind, rain, and atmospheric pollutants.

How might we consider concrete to be an ecosystem in itself? The production of concrete forms a part of the multiple extractive frontiers and operational landscapes associated with late modernity (see, for example, Keulemans 2016, and Watts 2019). The abandonment of concrete structures has also formed part of a "ruin aesthetic" with its characteristic assemblages of ruderal and adventive plants. But what I am interested in here are the unseen dimensions to the ecology of concrete: in other words, the diversity of microorganisms such as algae, archaea, bacteria, fungi, and protists that live on the surface of the city. These complex communities of microscopic life constitute what has been called an "urban microbiome," which is a rapidly expanding field of scientific research (King 2014).

These surface ecologies are ubiquitous yet largely overlooked. Sometimes the presence of these organisms is only revealed by visible traces such as "ink stripes" beneath dripping pipes or greenish discoloration produced by chlorophyll. Systematic interest in these urban microbiomes has thus far been dominated

Figure 25.1. Bedford Way, London (July 2021). An urban microbiome has formed across the surface of the concrete with clear signs of biodeterioration caused by organic acids secreted by microorganisms. Photo by the author.

by concerns with the preservation of buildings and other types of concrete structures. Studies have shown how specific organisms such as *Chaetomorpha antennina* (a kind of algae) can colonize concrete surfaces and secrete organic acids that begin to dissolve cement to release calcium, aluminum, silica, and iron needed for the organism's metabolic development. Similarly, the fungus *Aspergillus niger* breaks down concrete through the production of a range of organic acids, leading to the formation of soluble compounds such as calcite and calcium oxalate in a form of "bioinduced chemical degradation" (Roux 2018, 281). In many cases these processes only cause superficial damage rather than structural deterioration but where more complex ecological assemblages develop — such as the presence of biofilms inside pipes — there is the potential for pathogenic organisms such as the gram-negative bacteria *Pseudomonas aeruginosa* to flourish (Roux 2018, 281).

Figure 25.2. Bedford Way, London (July 2021). The greenish dark lower band of coloration is likely caused by algae. Photo by the author.

More recently, as part of a wider upsurge of interest in all aspects of urban nature, there has been closer attention directed toward these unseen ecologies. The study of urban microbiomes has become a focus of scientific fascination exploring hidden dimensions to urban biodiversity including air, soils, a variety of different surfaces, as well as the human body itself which contains trillions of microorganisms. The microbiologist Gary King, for instance, has highlighted how "microbes undoubtedly constitute the greatest reservoir of urban species and genetic biodiversity, exceeding the diversity of all urban plants and animals combined" (2014, 723). The focus on urban microorganisms forms part of an emerging emphasis on "multi-species cities" as an expanded conception of synanthropic ecologies that moves beyond the presence of more familiar organisms that have become adapted to urban life, such as pigeons, rats, or cockroaches.

Urban microbiomes play a significant role in geochemical processes: there are specific physio-chemical properties associated with assemblages of microorganisms. In this sense we are moving away from concerns with the "biodeterioration" of materials toward a recognition that these organisms play a variety of roles within urban ecosystems (Acosta 2021). Examples include naturally occurring bacteria or algae that are capable of "fixing" atmospheric pollutants so that microorganisms might be welcomed within an expanded conception of urban nature on account of their ability to deliver "ecological services" such as better air quality. In this sense we could say that the metabolic activities of microorganisms provide an example of non-human work within the modern city. Yet we encounter a tension in the literature between an anthropocentric emphasis on the usefulness (or otherwise) of nature, and more critical perspectives that explore the affective and ethical dimensions to co-habitation with non-human others. A narrowly utilitarian conception of surface ecologies ignores the aesthetic dimensions to urban entropy and also the possibility for microorganisms to reveal new insights into the ecological characteristics of urban space as a focus of scientific curiosity in its own right.

Microbial traces have been referred to as the "signature" of urban space: they can provide complex information about the material characteristics of specific parts of the urban environment. The surface of the city can provide insights into what has been termed "microbial community metagenomics" as part of an expanded conception of urban ecology (Alberti 2014). The term "metagenomics" encompasses a suite of novel analytical and methodological approaches that can be used for the transformation of the microbial realm into a knowable field of concern. The genetic sequencing of urban space moves beyond the limits of taxonomic knowledge since many microorganisms remain unknown at the species level. There are interesting connections here with debates over the use of DNA barcoding to provide quicker and more accurate appraisals of the living world. Yet the articulation of post-Linnaean classificatory schemas for microorganisms, in which the idea of relations between species is replaced by a matrix of nucleotide patterns, is also suggestive of

Figure 25.3. Bedford Way, London (July 2021). The darker patches are likely created by cyanobacteria. Photo by the author.

a degree of distance from existing modes of ecological research rooted in field observation and relations between organisms.

A fascination with urban microbiomes includes the "swabbing" of the surfaces of the city, including concrete, in order to discover genetic traces of both human and non-human life. Research programs such as the MetaSub project have targeted the microbial ecosystems associated with subway systems, for instance, linking with urban epidemiology and public health concerns (Zolfo et al. 2018). In the context of the coronavirus pandemic there has been intense interest in the longevity of viruses and other potential pathogens that can live on urban surfaces ranging from unseen networks to elements of architecture that are repeatedly touched such as buttons or handrails on public transport infrastructure. The dabbing of "urban swabs" on the multiple surfaces of the city also holds connotations of forensic science practice and the linking of specific sites with the high-tech analytical realm of the laboratory. There is a collaborative and experimental dimension to these new aspects of urban ecology that unsettles existing distinctions between "field" and "non-field" forms of knowledge.

In the case of concrete surfaces, a microbial signature can also be interpreted in terms of the visible hieroglyphics of microscopic life. My aesthetic encounter with the diverse microbiomes of the Bedford Way building brought to mind examples of twentieth-century art. The blocky patches of black, gray, and green coloration can be compared with the later monochrome works of Mark Rothko such as *Untitled (black on grey)* (1969–1970) produced shortly before his death. Similarly, the rough textures and striations caused by microorganisms hold similarities with the cracked and multi-layered canvases of Alberto Burri. In his *Mold (Muffa)* paintings, for example, completed in the early 1950s, Burri sought to emulate the living matter of mold-encrusted surfaces. His sculptural use of ridges and excrescences of paint conveys a dynamic interface between the organic and inorganic dimensions to modernity. The discoloration of urban surfaces illustrates a kind of environmental entropy whereby non-human temporalities intersect with the cyclical dimensions to the production of space.

The idea of a microbial signature can be likened to an urban language inscribed into the surface of the city. These lines, blotches, or swirls of color reveal traces of non-human life that are otherwise invisible to the human eye. In this sense, looking carefully at the concrete surfaces of the city is a kind of "close

Figure 25.3. Bedford Way, London (July 2021). The darker patches are likely created by cyanobacteria. Photo by the author.

reading" that allows the realm of urban microbiomes to be connected with expanded conceptions of urban ecology. The urban microbiome illuminates a zone of intersection between multiple discourses spanning aesthetics, architecture, epidemiology, critical theory, and many other fields. An enlarged conception of urban nature that extends to invisible life forms has the potential to enrich public culture in multiple and unexpected ways.

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PLASTICITY

Elihu Rubin

Concrete holds a tension between being rigid and plastic at the same time. Attention to the material's plasticity at one stage raises the question of what to do with it once it becomes fixed and obdurate, posing new challenges for how we reimagine our cities and their futures. This chapter explores the material's plasticity through a careful examination of a monumental icon to twentieth-century automobility, the Temple Street Garage in New Haven, Connecticut. This project occurred under the banner of forward-looking optimism, but also enacted a kind of brute force on the city and its residents, displacing city blocks in the aim of wrenching the city into the future.

It can be difficult to explain my reverence for the Temple Street Garage in New Haven, Connecticut. Garages rarely evoke the degree of awe usually reserved for cathedrals or skyscrapers. Despite its ubiquitous presence in cities large and small across the United States, the municipal parking structure is an unsung and overlooked component of the built environment. The Temple Street Garage, however, elevates this ordinary edifice to an

Figure 26.1. Temple Street Garage, facing North toward the New Haven Green, 1996. Photo: Robert Ellickson, Yale Visual Resources Collection #301068.

epic, almost confrontational format: spanning two city blocks (760 feet long) in the city's central business district and made almost entirely out of poured-in-place concrete, the Temple Street Garage is a modern monument to the mid-twentieth-century preoccupation with parking as an expression of the public interest.

Designed by the noted modernist architect Paul Rudolph, the building was intended, from the start, to be spectacular and optimistic. When it opened in 1962 the garage was a confident symbol of a time when cities advanced bold proposals to modernize the urban environment. After sixty years of service, however, the garage is beginning to show its age. From today's vantage point it can be difficult to recreate that sense of buoyancy and excitement. The building is still owned and operated by New Haven's Department of Transportation, Traffic, and Parking, but exhaust and grit stain its surfaces. Nets have been installed in a few places where the concrete is flaking to catch falling debris.

The sheer scale and material monotony of the garage can be overwhelming. In a 2008 video reflecting on the work of Paul Rudolph in New Haven, the architectural historian Vincent Scully put it this way: "As it is on the street, I think it's very unsympathetic. It overwhelms the street with its dark presence; [it has] none of the scale of the street, none of the invitation that streets have. It's a brutal image on the street, I think" (Taylor and Rubin 2008).

That sense of brutality has come to describe an entire generation of concrete structures from the 1960s, and it has been elevated to a moniker of architectural style: "Brutalism." Derived, at least in part, from the French *béton brut,* meaning "raw concrete," the term evoked an unvarnished manifestation of the material's substance. For some advocates, an exposed concrete structure expressed a kind of honesty: it had no "façade" in a traditional sense; no false, decorative applications of historicist bric-a-brac. To lay hands on the building was to commune with its very essence.

To the layman on the street, however, academic pronouncements about material honesty did little to soften the image of a gigantic concrete garage that dominated a relatively narrow street. My sense of admiration comes not from the "brutalism" of the garage but from the way that Rudolph exploited concrete's amazing plasticity — its receptivity to the diverse forms that contain it. Having arrived on site as mud, the concrete was poured into a great ark of thin wooden boards, reinforced with steel rods, where it made the transition from malleable to fixed.

The building's form is composed of long, flat trays held aloft by a series of paired vertical supports, or piers. Accentuating the continuous, flowing quality of the concrete, Rudolph united the unfurling parapets with the structure of the building. These low barriers — arranged in a dynamic, A-B-A-B (or dash-dot-dash-dot) pattern — curl outward, held aloft by vaulted forms that created the illusion of a series of arches. It was an effect made possible by the local ship-builders who were hired to assemble the wooden forms that molded and shaped the concrete. An early reviewer called it "Rudolph's Roman Road," because of the apparent likeness to an arched aqueduct. But Rudolph's expressionist forms masked what was essentially a trabeated structure of posts and lintels (McQuade 1963, 108, and see also Rohan 2014, 67–75).

Indeed, despite the supposed honesty of exposed concrete, Rudolph embedded in the garage a large degree of artifice. Concrete is not only plastic but also impressionable. The concrete of the Temple Street Garage is impressed with the grain of the thin boards used to make the forms, and in places the building appears to be composed of petrified wood. Thin ridges, where the wet concrete oozed between the seams of the boards, express the weight of the structure pressing down. Frozen in place, the ridges catch the light and generate a striated texture that may have been Rudolph's attempt to integrate an element of ornamentation into the body of the structure.

The overall spatial experience that Rudolph created is both exhilarating and full of contradictions. The staggered parking trays, connected by short ramps, seem endlessly long; but the ceilings are quite low — better suited to the ground-hugging cars of the 1960s than to the high-clearance SUVs of today. The garage feels at once expansive and cramped, futuristic and antique, elemental and elaborate, brittle and elastic, massive and quaint.

The other awesome element of the Temple Street Garage is the hubris of it — the fascination of the very idea that this amount of effort and space would be given over to car parking. In post-World War II America, cities throughout the United States were fighting a battle to defend their preeminence against expanding suburban sprawl. And in the age of the automobile, if cities were to be places to live, work, visit, and shop, there needed to be ample space to park. In this way, the Temple Street Garage — and thousands of other municipal garages built in the 1950s and 60s across the United States — ushered in a radical transformation of what a city was and how it worked. Today, it forces a reckoning with the choices that urban leaders — politicians, planners, property owners, and policy-makers — made in their efforts to rescue cities from a perceived crisis of viability in an increasingly diffuse and car-oriented metropolitan environment.

It was a heady time for charismatic mayors like New Haven's Richard C. Lee, who fully embraced modern architecture and urbanism as both instruments and symbols of progressive investments to modernize the central city. Lee was under the spell of advisors like Maurice Rotival, a professor of city planning at Yale and an acolyte of the famed modernist Le Corbusier, who proposed extensive urban clearance and rebuilding around a new organizing structure of high-speed, limited-access highways. The garage was part of Richard C. Lee's slate of monumental building projects that represented New Haven's stature as a leader in the field of urban redevelopment. And for a building as central as this one to the mayor's plan, he sought to hire Paul Rudolph, a modernist luminary who was then the Chair of Yale's Department of Architecture (see Cohen 2019, 65–66).

New Haven's first major experience with federally-funded Urban Renewal was the condemnation and clearance of the Oak Street neighborhood to make way for an urban connector highway that provided the city with its own on-ramp to the I-91 and I-95 Interstate Highway interchange. For Lee, the Oak Street Connector was a "Dream Come True" and the culmination of two distinct goals: the elimination of a notorious slum and the installation of a gleaming new piece of infrastructure intended to give idealized suburban shoppers and office workers direct access to the city (see Rae 2003, 312–60, and Jackson 2008, 28–51).

In cities across the country, urban districts like this one — poor, racially and ethnically diverse, and characterized by a mix of land uses, including light-industry, warehousing, and an active commercial landscape of hotels, restaurants, stores, and services, as well as housing — were targeted in a wave of demolition that condemned all of that activity with a single phrase: "slums and blighted areas."[1] It was a devastating sacri-

1 Over six hundred municipalities displaced families through federally funded Urban Renewal projects. Families of color were far more likely to

fice of an entire neighborhood and an unambiguous statement about the city's intended users: they would drive cars and arrive by expressway. In this context, the garage was much more than a place to store cars. "It is a symbol of the city's revitalization" (McQuade 1963, 108, and see Ammon 2016, 140–81).

And for Rudolph, too, there was excitement in the parking garage's role in the city's evolving morphology. He thought of the garage as "throughway design," an extension of the emergent highway network of which it was a part. "I wanted to make it look like it belonged to the automobile and its movement[, …] a system of bridges over large open spans" (*Architectural Record* 1961, 152). Cars traveling on the Oak Street Connector could access the garage directly from the highway without having to navigate city streets.

The architect was intent on solving the problem of the "joint" between the new landscape of high-speed mobility and the traditional urban fabric (Rudolph 2008a). "Many of our problems arise from the automobile. There is a double scale now that has never existed before: a scale for pedestrians and a scale for automobiles," he wrote, "and we have to learn how to make the transition from one to the other" (Rudolph 2008b). The Temple Street Garage was Rudolph's attempt to make this transition through the plasticity of concrete.

Part of this effort can be understood by the two sides of the garage. The interior-block side led directly to two new department stores that anchored the Church Street Redevelopment Project; visitors could avoid city streets entirely. But on the Temple Street side, Rudolph used the supporting piers and overhanging parapets to create a giant portico, or covered walkway,

be displaced; in many large cities, two-thirds or more of those displaced were people of color and African American neighborhoods were destroyed at disproportionate rates. In the Church Street and Oak Street redevelopment areas in New Haven, 671 families were displaced of which 588 were white. For project-by-project statistics and visualizations of family displacements, see Digital Scholarship Lab (n.d.). The statistics in "Renewing Inequality" do not include single people, nor do they include the extensive displacement of businesses and institutions.

that was lined with street-facing storefronts and restaurants on the block between Crown and George Streets.

Despite this seemingly gracious and urbane gesture, bringing a massive pile of bare, unsanded concrete to the city, had a tragic side as well. In the view of Vincent Scully, the architectural historian, the problem was the wholesale discarding of large swaths of the existing city and the sacrifice of the rich social and architectural worlds that had developed there over time. “The planning ideas of modernism couldn’t have been more cataclysmic. You just raze the whole city, and make it new” (Taylor and Rubin 2008).

Scully joined others who lamented the physical and social upheaval caused by Urban Renewal. “How we could believe that that’s what you could do to a city, to human beings. I mean, urbanism is moral. It has to do with the way people live. And that’s why you can’t invent urbanism. You cannot invent it!” (Taylor and Rubin 2008). Yet this is precisely what Rudolph attempted to do: to invent a new urbanism, one focused on highways and garages, despite his astute appreciation for its critical juncture with the existing urban fabric.

How do we hold them both in our heads at the same time? How do we reconcile the optimism of urban rejuvenation — the automobile zooming into the central city — with the displacement that such a move implied? How do we square the restructuring of urban space that deepened residential segregation and marginalized the poor with the raw appreciation, even reverence, that we feel for such monuments as the Temple Street Garage? It requires a cognitive plasticity that may only be possible for those with the privilege to observe the changing city from a secure vantage point.

As with many issues in architecture and urban development, we must face stark contradictions. One reaction, as understood by Paul Rudolph himself, is to acknowledge that our cities are shifting and restless terrains that require adaptability over time. “One thing is certainly clear,” Rudolph wrote, “our cities constantly change. This suggests that those buildings which form the bulk of our cities, such as housing, and office, and commercial buildings, should be open-ended and capable of being modified, expanded, converted, et cetera" (Rudolph 2008a).

In 1962, Rudolph said that despite urban change, cities would never get rid of automobiles. He may be right; they continue to dominate in the vast majority of American cities (Rudolph 2008b). But there are now distinct opportunities to diminish the impact of cars on the built environment, and New Haven's Temple Street Garage — along with countless other concrete garages in other cities — would be a great place to start. Considering adaptive reuses for the long, flat trays of the garage, starting with its often-empty roof, calls for a different kind of plasticity; and I believe it's something Paul Rudolph would have welcomed.

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PROGRESS

Julie Soleil Archambault

Concrete blocks can be objects of personal and financial investment. In Mozambique, young people embed their visions of progress and upward mobility in the strength of concrete blocks. At the frontlines of both global economic and environmental precarity, the material's promise to bring transformation is uncertain. This chapter takes seriously Mozambican aspirations and probes the local and global limits of such hopes, emphasizing the ways concrete's durability sits at the edge of people's imagined futures.

There is a growing pile of neatly stacked concrete blocks on Mariano's property. The branches of thorn trees scattered over the blocks are meant to keep the children at bay. Every month, after receiving his paycheck, Mariano buys four or five bags of cement to make more blocks. He tries to do this straight away, before other needs and demands on his modest yet relatively stable civil servant salary "appear." When I first met him, ten years ago, Mariano was despondent about the future. *Não há emprego* ("there are no jobs"), Mariano and his friends lamented. No jobs, not even for young adults like him who had graduated from secondary school. *Paciência…* ("patience"), they would add — a call for compassion and a note to self. What Mariano worried most about was whether he would ever be able to build his own house. His family and girlfriend were putting pressure on him to live up to ideals of masculinity that cast men as independent and as providers. Without a job, however, living up to these ideals was practically impossible. His family had moved to the city of Inhambane in southern Mozambique during the height of the civil war in the late 1980s and had found refuge in a densely populated inner-city neighborhood where there was little space for the next generation to spread its wings.

The house that Mariano eventually built was small and a bit crooked. It was not, in his words, "the house of [his] dreams." But it was his own house — something he could be proud of — and, unlike the reed house in which he had grown up, it was made of concrete.

For about a decade, I listened to young people like Mariano complain about their bleak prospects and heard them daydream about a better future. As they spoke of their aspirations, they often described a feeling of stasis, relying on spatio-temporal metaphors to capture the stalled forward progression that they had hoped their lives would follow. Often, they extended this assessment to Mozambique as a whole, as the expectations of post-war reconstruction on which the country earnestly embarked with the support of international aid and investment which poured in following the signature of the peace accords in 1992, appeared to have benefitted only the lucky few. Even then, under the layers of gloom, always lay the conviction that things would get better, eventually; that they would see progress. I remember one young man telling me that perhaps he would not "feel modernization" himself, but that surely his children would. Despite the many setbacks they were facing, my young interlocutors' confidence in narratives of progress remained unscathed. Hope is, after all, as Mozambicans like to point out when things are not quite, or not yet, going their way, "the last thing to die." Like in other parts of the continent, there is a "deep attachment" to narratives of progress (Mains 2019, 52).

Figure 27.1. Building blocks in Inhambane, Mozambique. Photo by the author.

This time did eventually come, if not for all of them, then at least for a good number of them; a time when they started seeing their dream of building a house, a key marker of adulthood in the region, finally materialize. Before long, "everyone" was making concrete blocks. These young adults were at last able to enjoy the status and everyday comfort derived from one of the most enduring markers of modernity. I had never seen them so grounded and focused. They were excited. So was I.

As I investigated further the political and affective economies of concrete in sub-Saharan Africa, the continent hailed as having the fastest growing cement market in the world, the British newspaper *The Guardian* published a series of articles on concrete which traced the social history of this ubiquitous building material, with particular attention to its devastating ecological toll on the planet (Watts 2019). A friend of mine who sent me the link to the newspaper articles wrote: "I never knew concrete was so bad."

Alongside ecological critiques of concrete, we also find critiques framed in moral-aesthetic terms that center around the replacement of traditional building materials with concrete. Thatched mud huts that blend into the landscape are what representations of Africa are (still too often) made of, while auto-constructed concrete structures come across as unfortunate bad copies of a modern prototype. Without downplaying the environmental impacts of concrete — one of the most damaging effects of concrete production in Mozambique comes from sand mining — my intention here is to situate the concrete aspirations for durable futures of my Mozambican interlocutors within a broader discussion about progress and to ethnographically qualify a critical political ecology lens.

Shortly after the publication of *The Guardian's* "Concrete Week," Mozambique was hit by cyclone Idai, one of the most powerful tropical storms ever recorded, and the second deadliest to hit the southern hemisphere. Cyclone Idai took the lives of an estimated 602 people in Mozambique and resulted in the displacement of around 200,000 across a vast area which stretched as far as neighboring Zimbabwe (*World Health Organization* 2019). The country then held its breath as a second cyclone struck again further north only a few weeks later. Scores of people lost everything: their homes, their personal possessions, and their crops and livestock. Many also lost loved ones. Observers were quick to draw a connection between the frequency and intensity of these extreme weather events and climate change.

Specialists also predicted that such weather events would become more frequent and intense in the future. According to the 2020 *Ecological Threat Register,* Mozambique, with its 2300-kilometer-long coastline, ranks second among countries facing the most ecological threats.

The destructive cyclone duo offers a glaring case of "climate injustice" whereby a country that has only made a marginal contribution to climate change is hit the hardest by its devastating effects. Despite Mozambique's relatively low carbon footprint — it generates about 0.14% of the world's CO_2 emissions — the country is particularly vulnerable to the harmful impacts of global warming, a position of climate precarity that has been exacerbated by a long history of capitalist extraction going back to the colonial period.

When cyclone Dineo made landfall in the city of Inhambane in 2017, Nadia and Micas sat with their two children in the living room of their small concrete house. They had secured the tinned roof with blocks before the storm and now all they could do was sit tight and hope for the best. The wind was making the rain fall sideways. The palm leaf fence around their property was the first thing to blow away. A couple of hours into the storm, some of the blocks securing the roof started falling into the house, one narrowly missing their daughter, as several of the iron sheets were taken by the storm. They could hear people in the distance, their shouts muffled by the wind and the rain. When the storm settled just before sunrise, Micas headed out with his son to see if anyone needed help. He was also hoping to recover at least some of the roofing. In the distance, they saw two men piling debris onto a pickup truck, salvaging building materials that they would later sell to those like Micas whose houses had been damaged by the storm. For many, it was a disaster, for some, an opportunity.

Mozambique's growing demand for cement and its climate precarity are not connected in an immediate causal way. Thinking about the two together, however, does put into relief the power of progress as a resilient organizing trope and the limitations of critiques of concrete's enduring ecological impacts.

Critical political ecologists have blamed humanity for its devastating impact on the planet and have asked us to rethink not only how we produce and consume, but also what we hope for; that is, to reconsider our obsession with progress. As anthropologist Anna Tsing (2015) asserts in her brilliant ethnography of multi-species entanglements, our very survival on this "damaged planet" calls for new ways of being and relating and new ways of projecting ourselves into the future. Tsing encourages us to look around rather than ahead, to question our tendency to imagine the future through the trope of progress, that is, through "the conception of a collective temporal trajectory from an inferior past to a qualitatively different and superior future" (Karlström 2004, 597). But is this important critique one that can only realistically emerge from a position of privilege? Or should we expect everyone, including those living in contexts of precarity, to rethink how they project themselves into the unfolding future? Would denying the latter the ability to do so be even more injurious than expecting everyone to think and act "sustainably" (Hecht 2018)? There is another popular saying in Mozambique that goes:

> Being born poor is bad luck
> Dying poor is stupidity

Mudança (progress, transformation) is what drives people like my young Mozambican interlocutors to hope for, and work toward, a better future. The dream of building a concrete house, even a small, modest one, is central to how Mozambicans project themselves into the future, of how they hope to avoid "dying poor." In "emerging economies" like Mozambique where demand in cement and concrete is soaring (Davidson 2014), building materials are embedded in political and affective economies that bring together kin, neighbors, the state, and transnational actors. When the mayor of Inhambane embarked on an ambitious project of urban development which involved paving several of the city's dirt roads with locally produced concrete pavers, residents were enthusiastically hopeful: "One day we'll no longer have to walk on sand!" some told me. If progress requires patience and often sacrifice, it stands firm as an unwavering expectation.

Concrete has arguably contributed to the improvement of the living conditions of scores of people. It feels good to live in a concrete house, both sensorially and socially. It is durable, both physically and economically. In Mozambique, concrete is not only a potent symbol of progress, it is progress.

How, then, can we reconcile ecological critiques that denounce our obsession with progress with the hopes of the world's less privileged to see their living conditions improve? If thinking ethnographically about concrete dreams and cyclones does not provide a definitive answer to this question, it should, at least, help complicate the discussion.

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PROGRESSIVISM

Gabriel Lee

Taking us to the turn of the twentieth century in North America, this chapter demonstrates how progressive ideals were given material form through the deployment of concrete housing. Rather than argue that the material was merely a symbolic demonstration of such ideals, it shows us how the material qualities of concrete were central to the expansion of progressive politics and policy. It suggests the way that early twentieth-century North American progressive thinking about materials foregrounded the mid-to-late-twentieth-century visions of developmental progress described elsewhere in this book in other parts of the world.

Thomas Edison emerged from his workshop in the summer of 1908, "with a satisfied smile on his rugged face," to announce that he had again invented the future. The "concrete house" he presented was more than just a technological marvel; it was "a solution to the slum and tenement problem." Edison sought to offer villages of cheap homes to the working poor as a means of social uplift. "In the palm of my hand, I hold the electric cement cast, necessary to cheapen the building of cement houses

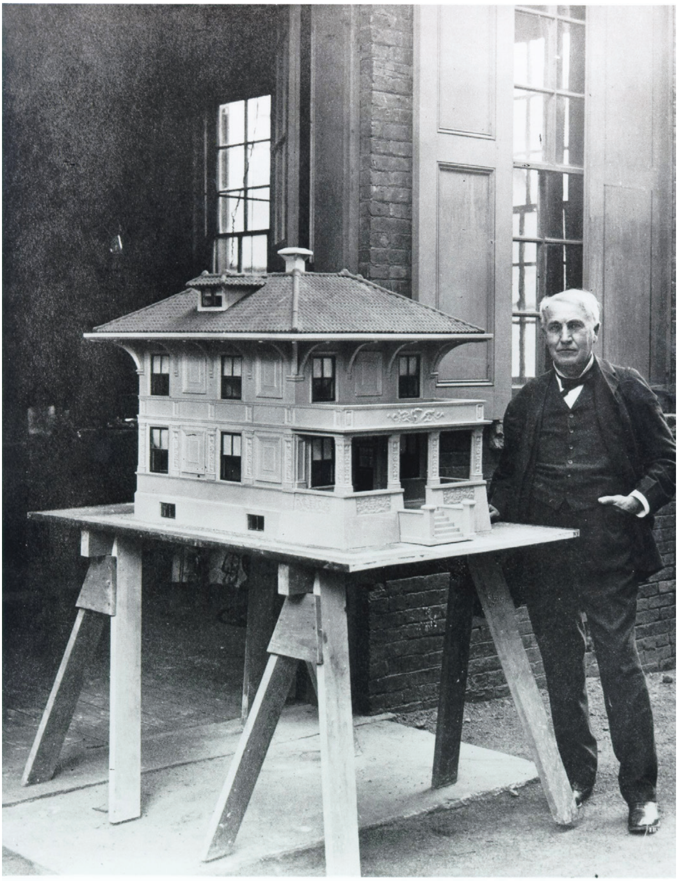

Figure 28.1. Edison's model concrete house, c. 1909. Source: United States National Park Service, Edison Papers. Public domain.

to such an extent that the poorest can afford to have a roof over his head," Edison beamed. "So much for the man in the ditch" (Edison 1987a).

In promoting poured concrete houses, Edison consciously appealed to contemporary reform impulses that historical actors labeled "progressivism." Progressive reformers engaged in a variety of agendas, but they were unified in their attempts to rectify the social, economic, and environmental problems produced by industrial capitalism. They sought to use efficient order and good governance to save capitalism from its worst results. While progressive reformers characteristically concentrated on immigrant social education and corporate regulation, many scholars have ignored the degree to which progressives gravitated to the built environment as a mode of social and economic reform. By altering geographic infrastructures, progressives sought to improve the conditions of industrial capitalism for the working class through some combination of technological ingenuity, efficiency, public planning, and environmentalism. The peculiar material qualities of concrete made it an essential component of projects ranging from urban sanitation, budding state highways, and federal reclamation projects that defined the progressive built environment agenda. With his housing scheme, Edison used mass-produced concrete castings to aim at the heart of progressive reform: the working-class home.

While poured concrete houses enjoyed limited commercial success, reformers extolled their potential over two decades when cheap, reinforced concrete seemed to offer real solutions to structural social problems. Multiple liberal reform ideas converged in the imagined possibilities of concrete housing, enabling liberals to articulate those ideas. Put differently, it is not simply that progressivism allows us to understand concrete houses; rather, concrete houses enable us to fully understand the culture of Progressive-Era built environment reform. Concrete housing projects, exemplified by Edison's, can elucidate the ways that Americans thought with the novel technology of reinforced concrete as a means of social reform; they can provide insights that extend to other contemporary public projects like urban sanitation, state highways, or federal dams.[1]

1 For the social ideals embedded in contemporary highways and dams, see Lee (2019)

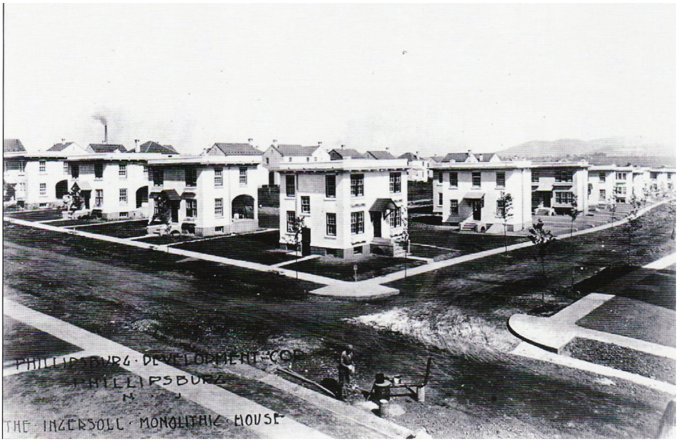

Figure 28.2. A view of the Ingersoll-Rand company village in Phillipsburg, NJ, c. 1919. Source: United States National Park Service, Edison Papers. Public domain.

Over the first decades of the twentieth century, reformers and public figures projected social ideals onto a novel means of casting stone that enabled them to imagine new possible futures. By providing a window onto liberal built environment programs, the history of concrete housing projects, both imagined and built, suggests the possibilities and limits of structural reform during the Progressive Era. It also suggests how early uses and meanings of architectural concrete reverberated in the post–World War II liberal built environment.

Edison's contemporaries immediately embraced his concrete house. For over a decade, newspaper headlines extolled the possibility of cheap concrete houses for the working class. Contractors and public officials from around the world sent Edison requests for patent rights. Henry Phipps, the steel magnate-cum-philanthropist, and Henry Ford each considered building a "city of concrete" for the working class. Several contractors and architects offered ideas for casting cheap concrete homes, always weighing them against Edison's commonly-discussed project. Each found in concrete houses a means of achieving multiple aims of built environment liberal reform.[2]

Mass-produced concrete houses aligned with the "gospel of efficiency" that, for Sam Hays (1959), characterized progressive liberalism. When Edison designed his house, he imagined a factory turned inside out. His invention was less a house than a manufacturing system. In addition to molds, he developed a movable concrete mixing plant with steam-powered hoists, hoses, and pumps to pour in concrete from the top. Mechanized concrete production would allow him to cast everything — from basement to roof, including ornamental trim — in a single day. As a cast material, concrete possessed the peculiar quality of endless replicability and systematic production. Using six sets of molds, Edison believed he could rotate the reusable forms in endless reproduction, lowering the price of each unit to around $1200, cheap enough to rent out for $10 per month, the same rent paid in downtown New York for a two-room apartment in a tenement hovel (*Scientific American* 1907, and *Record and Guide* 1910).

Efficiency tied social reform to working-class suburbanization The $1200 price tag assumed not only mass-production methods but also large tracts of cheap suburban land. Cheap farmland at the urban edge both provided the space that made mass-produced homes possible and, as Edison put it, permitted "the common laborer to get out of the tenement and live in a beautiful house along a trolley amid trees and flowers" (Benson 1909, 423). Edison homes held the potential to extend suburban real estate consumption to the working class. Without redistributing wealth, new technology and capitalist efficiency would make available to the teeming masses of industrial workers "a delightful country home, with plenty of fresh light, a garden,

2 For the many requests for information and patent rights, see the "Cement House" reels in the *Thomas A. Edison Papers: A Selective Microfilm Edition,* Part IV (1899–1910) and also Part V (1911–1919). Edison received many inquiries every year between 1907 and 1915, after which the select microfilm edition ceases to include the subcategory "Cement House." See also *The Washington Post* (1907), and Bryan (n.d.).

and lots of room for [their] children to romp in" (Heinl 1908, and see also Edison 1987d).

Progressive Era built environment reform went beyond extending home ownership. For turn-of-the-century liberals, social and environmental reform was inherently connected. Progressive "environmentalists" believed that the type of space in which one worked and lived produced social and moral outcomes. For these reformers, natural surroundings stood alongside home ownership as a means of social improvement. Echoing a common refrain, University of Chicago Settlement House founder Mary McDowell argued that "Homes where sunshine, fresh air and space [abounded] with a touch of beauty," were "necessary to conserve the national health and morals of family life" (McDowell, quoted in Wortman 1978, 554). Newsmen reporting on Edison homes invoked similar arguments. Cheap concrete suburban houses, *The Washington Times* (1907) editorialized, "will provide the improvements of a house for each family, of air and light and play space all about" and "room for the family spirit to thrive." "[D]elightful homes in the country, where [...] there is out of doors and flowers and the green of the hills," agreed another journalist, "means longer lives for wasted little bodies and cramped, hungry souls. It means comfort and a taste of pleasure, and above all, freedom" (*Albuquerque Citizen* 1908, 6). The new technological regime of electrification and concrete promised to harmonize the machine in the garden (*Record and Guide* 1910, and Marx 1964).

Reinforced concrete was particularly suited to perform this socio-environmental alchemy. The central problems of tenement housing were fire and disease. Structural concrete gained ground in early-twentieth-century cities to the degree that Americans believed it a solution to both threats. Engineers used concrete to modernize water and sewage systems; produce sanitary roads, sidewalks, and basements; and to fireproof buildings (Evans 1908, and *The New-York Tribune* 1912). Popular discourses surrounding urban concrete shaped its social value for use in housing. Making arguments that would become commonplace, Edison pointed to recent conflagrations in Baltimore and San Francisco to stress that concrete was "indestructible by fire." "From a sanitary point of view," Edison argued, his houses "will be perfect" — they could be easily cleaned, and solid walls and floors would leave "no chance for rats, mice, water bugs and cockroaches" (Benson 1909, 423). Updating a nineteenth-century descriptor for stone structures, Americans also deemed concrete "permanent." It would produce "a home that will last centuries" (*The Washington Times* 1907).

Fireproof, sanitary, and "permanent" concrete also benefited from falling cement prices at a time when other material costs skyrocketed. Between 1900 and 1910, a perceived timber crisis (which propelled the formation of the National Forest Service) inflated the real price of softwood framing lumber more than threefold (Olson 1971). A wooden house that cost $3500 to build in 1901, one architect remarked, cost $5,000 just six years later (Wright 1907). Brick-framed houses, always more expensive than timber, "advanced in sympathy with the rise in the cost of frame construction" (*Los Angeles Times* 1920a). Meanwhile, between 1899 and 1910 the average price for a barrel of cement fell from $1.48 to 89¢ (Handlin 1979). Cheap cement allowed concrete block to find wide use in home construction after manufacturers' automated production in the 1890s, but nothing held the same potential to cheapen working-class houses, and to embody liberal values, as mass-produced reinforced concrete.

Progressive architects often experimented with the new medium. Several built expensive concrete houses for wealthy clients around the turn of the century, typically featuring ornamental castings that imitated cut stone; others began stripping down ornamentation to build cheaper concrete cottages that could serve a middle-class clientele (*Cement Age* 1908; *Architectural Record* 1906; and Perry 1908). Frank Lloyd Wright offered his design of a poured concrete "Fireproof House" in *The Ladies' Home Journal* in the spring of 1907. The original homes built at Letchworth — the world's first "garden city" built in Hertfordshire, England — featured a poured concrete house (*The Observer* 1907, and Wright 1907).

Over the decade following Edison's popularization, several American developers employed mass-produced concrete houses to construct garden cities and working-class suburbs. Grosvenor Atterbury's Forest Hills Garden project, begun in 1909 for the Russel Sage Foundation, was the most famous. To construct a type of English garden city in Queens, Atterbury embraced mass-produced concrete to bring the houses within reach of the less affluent, using pre-cast units that reportedly lowered unit costs by 20% (Handlin 1979). Multiple contractors who more consciously took up the Edison mantle were more widely successful (Edison 1987b). Milton Dana Morrill independently developed collapsible and movable steel molds that both systematized onsite form work and eliminated expensive wood. Planning to "build sanitary suburbs near all large cities," Morrill began pouring houses in "Virginia Highlands," a suburban development near Arlington, Virginia, across the Potomac from Washington DC in 1909 (*The Washington Post* 1910). Inspired by a visit to Edison's lab, Frank D. Lambie, a New Jersey real estate developer, dedicating himself to "building poor men's homes" of moldable stone that he likened to the Model T (Edison 1987c). He established the New York Steel Form Company in 1908, poured a couple small developments in Montclair and South Orange, New Jersey, and set out make to make it big by spreading the gospel of concrete homes (*The New-York Tribune* 1911, and see also Gray 2009).

Despite the social visions behind early concrete housing projects, industrial corporate housing dominated the concrete housing market over the 1910s. Between 1910 and 1912, the American Sheet & Tin Plate Company, a subsidiary of US Steel, commissioned 200 concrete houses for workers in the new steel town of Gary, Indiana using methods "similar to that originated several years ago by Thomas A. Edison." (*Los Angeles Times* 1910; *Concrete* 1910; and *Concrete* 1911). Several other industrialists followed the example of Gary. By the end of World War I, the American Steel & Wire Company had built 100 concrete houses at Donora, Pennsylvania; Eastman Kodak Co. had built 80 houses in East Rochester; in Youngstown, Ohio the Modern

Homes Co. had built 100 concrete houses for its workers, while East Youngstown Sheet and Tube Company had constructed 261; and Ingersoll-Rand was in the process of erecting 100 concrete laborers' houses in Phillipsburg, New Jersey. Scores of other industrialists built one or two dozen concrete homes for workers over the same period (Aberthaw Construction Company 1919; Portland Cement Association Library n.d.; and Smith 1922).

Those who had hoped to shift the social terms of industrial capitalism with cheap concrete suburban developments found themselves beholden to corporate agendas. Within two years of breaking ground on Virginia Highlands, Milton Morrill could monetize his intellectual property only by mass-producing bare-bones housing for an anthracite mine owned by the Delaware, Lackawanna, and Western Railroad (*The Washington Post* 1911). By 1915, Frank Lambie had fulfilled sizable contracts — all of them to mass-produce corporate housing — in New England and Pennsylvania, including the houses for American Steel and Wire. Grosvenor Atterbury's precast system found its widest domestic use in building the "workingmens' colony" of cheap houses for Youngstown Sheet and Tube (Herding 1918). Another developer used it in the early 1920s to produce "[h]ouses that are literally concrete boxes" in Monrovia, California (*Los Angeles Times* 1920b).

Many corporate housing planners did invoke the ideals of built environment liberal reform. Youngstown Sheet & Tube was typical. When company managers began building one of the nation's largest working-class housing developments to address the "terrible housing conditions" in East Youngstown in 1916, they turned to cheap concrete housing not simply to shelter a local workforce but also to enhance the "health, happiness and efficiency of the workman." The company's owners purchased forty acres and laid out four developments to house 600 families in a "colony in country like character, mostly one family houses of permanent fireproof construction." They provided "a garden for economic use and pleasure" with each fully-equipped modern home. Extending the logic of progressive reform, Youngstown Sheet & Tube managers believed such environmental improvements would produce social and moral uplift, "developing among the alien employees American family ideals and standards of living" (Herding 1918, 383).

Because many of the large industrial villages borrowed at least some of the planning models of the garden city movement, progressive planners like John Ihlder and John Nolan often saw them as a hopeful development (*The Washington Post* 1910). Some, like landscape architect George W. Chance, believed industrial housing needed only to be bolstered by regulatory legislation. For Chance, "the one-family house, built of concrete [...] with community playgrounds, located near the factory, and with schools close by, is the present need in the outlying districts" (*The New York Times* 1910). Chance outlined that vision for New York City's Committee on Congestion of Population in 1910 and lobbied for building codes that would mandate working class suburban housing. As late as 1919, dedicated housing reformer Edith Elmer Wood, who later denounced corporate housing, found industrial suburbs "an important factor" in raising working class housing standards (Wood 1919).

In their promise to facilitate working-class garden cities and industrial villages, concrete houses appealed to a growing liberal consensus. Progressive-Era liberals, who sought to raise the living standards and moral constitution of working-class Americans by transforming their material conditions, placed great faith in the power of technological ingenuity, mass-production techniques, and cheap land to improve workers' lives. But built environment reform appealed only to the degree that it reaffirmed governing socio-economic power structures. Liberal built environment programs repeatedly iterated tropes of engineering prowess and socio-environmental uplift within industrial capitalism. This was evident in the American "garden cities" that were largely built by industrial manufacturers. The more radical aspect of the British garden city movement, in which municipal associations retained legal property rights and leased the land occupied by both industries and residents, was anathema in the United States, where private property and home ownership were the central means of self-making. American housing reform organized around the assumed necessity of private property.

By aligning public welfare with private economic interests, liberals left built environment programs vulnerable to usurpation by local or national power brokers. State highway bureaucracies, created to enhance farm economies, quickly became beholden to the automobile and oil industries and federal reclamation gave up on family farms to appease large landholders and to underwrite regional economic growth. Concrete houses can, in this sense, serve as a metaphor for the progressive built environment writ large. According to urban planning scholar Margaret Crawford, the industrial settlements built after 1910 "significantly raised the standard of living" for the working-class Americans who gained access to them (Crawford 1995, 205). They did so at the cost of greater corporate control (Rogers 1998).

In their Edisonian iteration, concrete houses did not long survive World War I. During the war, large industrial contracts created widespread housing shortages as manufacturers constructed dozens of new plants, often several miles from existing settlements. Washington met the housing need with an unprecedented $175,000,000 worth of low-interest loans to corporations like Bethlehem Steel and Newport News Shipbuilding to construct make-shift industrial villages. The projects provided models for cheap mass-produced housing, commonly using reinforced concrete. A National Conference on Concrete House Construction held in Chicago in early 1920 looked enthusiastically on the prospects of filling what organizers claimed to be a shortage of a million homes. Company towns, however, were made in and for the age of rail. The spatial dynamics of a simultaneous automobile and concrete highway revolution soon rendered them obsolete. Timber markets rebounded as highways, a new trucking industry, and farmland reforestation provided new access to timber, averting the widely-feared "timber famine" that never came. Few industrialists developed concrete housing after 1925 (Wood 1919; Turner Construction Company

1918; *Los Angeles Times* 1920c; Crawford 1995; Steer 1938; and Olson 1971).

Mass-produced concrete houses, as imagined and built, nevertheless provided germs of influence that shaped liberal housing policies and public architecture after World War II. In private housing, concrete's social qualities fell away as it receded into the substructure, but the model of mass-production that concrete contractors helped pioneer foreshadowed the postwar suburban explosion, which emphasized standardization, efficiency, cheap land, and low final cost. Suburban concrete reflected a larger shift in American domestic policy from public planning to a politics of growth as a means of social equity. Concrete's association with progressive social policy nevertheless thrived in the modernist public architecture that defined the postwar decades. Brutalist libraries, university buildings, and government structures emphasized concrete's materiality in a way intended to convey workaday, democratic values. Across the Atlantic, massive concrete public housing projects, often brutalist or built of prefabricated systems, composed, as John Grindrod has noted, "much of the fabric of our welfare states" (2018, 40). Where architecture connoted utilitarian state planning and public service, concrete retained its progressive signifiers.

Edison was, in this sense, a visionary. His concrete house moved contemporaries because it enabled them to articulate an ideal of social regeneration in an industrial wage economy through mass suburbanization rather than economic redistribution. Concrete working-class suburbs, like their postwar replicas, represented the highest ideals of built environment liberal reform. They also suggest American liberalism's fundamental conservatism.

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RESONANCE

Marina Peterson

Concrete vibrates. It echoes, amplifies, and reverberates sound. This chapter takes us into the acoustic space of an underpass along the Los Angeles River, interspersing an account of the sensory field with efforts at making audio recordings. By exploring how the underpass feels, who moves through it, and what it sounds like, the chapter engages the resonant qualities of concrete, bringing the sound of concrete into dialogue with wider infrastructural configurations of overpasses and underpasses.[1]

A resonant boom overwhelms. Felt more than heard, it is totalizing — enveloping and imbuing. The road above our heads rattles, the clang of moving metal plates and friction of wheels on asphalt blurring in their auditory encounter. The movement of vehicles becomes an acoustic assemblage of road-bridge-concrete-steel-underpass-tire-weight-speed. Here in the space of

1 An earlier version of this essay, entitled "Underpass," appeared in *Fieldsights: Visual and New Media Review,* October 3, 2019, https://culanth.org/fieldsights/underpass.

the underpass it is all light and shadow and volume, reverberating qualities rather than any particular thing. The birdsong that accompanies my child and me as we walk along the Los Angeles River bike path from our home to the park is no longer audible.

I listen with steel and concrete and dirt. I listen with the water of the river that pools at the bottom of a sloping bank of concrete. I listen with the chill of a dirt embankment shielded from sunlight. I listen with air that holds the rank scent of compost and a chemical smell of the cleaning solvents used just upstream in the waste treatment plant that provides most of the Los Angeles River's water. Plants and trees grow on islands of sediment where herons, egrets, ducks, and other water birds with thin, spiky legs make their home.

What we hear is concrete's movement. Its solidity that makes it useful for blocking sound with freeway noise walls also resonates and reverberates. And while concrete allows cars to cross the river, suspended, as it were, in the air, it is itself less solid than it may appear. Once a liquid goop, in its hardened form it decays, cracking and chipping, and becoming, if not sand, at least rubble.

My microphone picks up sounds but fails to capture these acoustics. It renders sensible what is perceived as "infra" — "that which slips through" or "escapes," the "unqualified[,...] vanishing[,...] scarcely noticeable, faintly sketched things" (Bonnet 2017, 84). Instilling a clarity to the frequencies that make it possible to distinguish one sound from another, the microphone brings a layer of legibility to the space — the ability to read it, to rationalize its features. It seems to me, listening to recorded audio of this soundscape, that a bass frequency in the resonance of the bridge itself is what gives the space its distinct quality — a bass frequency that is felt more than heard, and that is not easily sensed by the microphone.

It is dark and dank here, cooler than in the open air. Infra, inchoate, and indefinite, it is liminality as such, "a realm of pure possibility whence novel configurations of ideas and relations may arise" (Turner 1967, 97). Or, as McLean offers, "a superabundant plenitude, overflowing our received explanatory cat-

Figure 29.1. Underpass, Los Angeles. Photo by the author.

egories" (2013, 62). This underpass is not outside or under or even between — it is just right here where we are.

An underpass is intrinsic to the freeway, present whenever it has to go over anything — another road, a river, itself. Overpasses assert the totality of the freeway, arching into the air. Though the underpass designates the freeway's aeriality, less is said about this side of it. Ubiquitous yet off limits, it is nonetheless well used. It is a canvas for graffiti and sometimes sanctioned murals. If acknowledged, the underpass might be cast as abject — an overlooked space of abandonment, its inhabitants glanced at peripherally if at all, whether out of a sense of compassion or discomfort. These days the sidewalks of most underpasses in Los Angeles are lined with tents.

Though its form is that of "underpass," there is something unique about this one: this underpass is also a bridge. The dirt, the booming resonance, the steep concrete bank of a river now part of an extensive flood control system of storm drains and channels and reservoirs. On a stretch of the Los Angeles River now traversed by cyclists, walkers, and kayakers, the space is more heavily policed than others might be. The fence is a barrier to habitation, and regular "cleaning" removes traces of human presence.

As my eyes adjust to the darkness, a variegated texture of matter becomes more apparent. A hill of dirt rises from the bike path to the undersurface of the freeway as it spans the Los Angeles River on its way to the Pacific Ocean. There are things on the slope. Today the ones that differentiate themselves are an empty prescription bottle, a cigarette pack, a few pieces of blue cloth hardened with mud, and some discarded spray paint cans. A yellow rope hangs from a bar overhead; looped around and around, it ends in a tangled knot.

Two small gullies are riven into the hill, de facto storm drains where water is allowed to flow. A small collection of objects remains where the water runoff pools: the sole of a shoe holding on to scraps of its covering, a plastic milk bottle, an iced tea can.

I listen to the recording I made. At the moment when I turned up the gain on the mic, my ears feel a pressure that exceeds the sounds as such. Perhaps an audio recording can convey something of this place, or at least create a certain sensation of its own. Because a representation is also a composition. Not the acoustic space of the bridge per se, the recording is nonetheless sensed, bridging or "interweaving" (Whitehead 1938, 45) the sensible and its remainder, the latter a "surplus" that "runs through us and insinuates itself into our relation with the world, without ever submitting itself to identification, without ever taking on sufficient form to be named" (Bonnet 2017, 79). A man's reverberating voice amplifies the acoustic space, conveying something of a perceptual quality not captured by the recording.

We don't like to linger here, though some people do. A flat lip of concrete at the bottom of the riverbank provides a place to sit and fish, or write, or think. When we do stop, the palpability of the sound withdraws into a sea of vehicles, some heavier than others, some faster, some slower. The traffic never lets up, but it is differentiated — there is a texture to it, and differences in the way various vehicles move the bridge. Some weigh heavily on a metal plate that clangs, others ride on the surface, the friction of wheels and road less.

I ask sound artist Byron Westbrook for help. His own work emphasizes the performative process of field recording, drawing attention to the person holding the microphone, the act of listening with headphones part of a transducing apparatus rendering ambient sound in the form of recording. He brings his blimp and audio interface (Westbrook 2024). We point the microphone toward the crevice of the embankment. He explains that it picks up more high end, which along with the bass creates something closer to the sense of the space, an auditory approximation of the somatic. The dirt absorbs and sounds become resonant.

Last week a shopping cart was left near the farther gully. One cart became a wall of two shopping carts, a suitcase, and a baby stroller, all overflowing with clothes and blankets, objects proliferating across the bike path in a pile. A hole in the chain link fence was restitched with sun-bleached tree branches, making a cross in the gap where dirt had been dug out, still too small for a person to crawl through. A few days later the only thing that remained was a stroller shade designed to look like the upper part of a shark head, red with black eyes and a row of pointed white teeth.

On the way home the sun is setting and the concrete supports glow. In these golden rays, the concrete appears square by square by square, alternating dark and light like a single line of a chessboard or a Donald Judd wall piece tipped on its side. Formal resemblances rather than metaphor. Lit, they shimmer, resonating in their radiance.

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RISK

Tyson Vaughan

Risk is often understood as a series of calculations that seek to make sense of the likelihoods of possibilities, potentialities, and probabilities of events occurring. This chapter defies this sense of risk as mere abstraction by showing how risk calculations are materialized in the built environment through volumes and configuration of concrete. Seawalls, bridges, and buildings are not just reflections of design intentions, but also physical instantiations of the ways people codify, legislate, imagine, and construct risk at any one point in time. In this sense, Japan's concrete seawalls are more than engineered responses to tsunamis, but instead crystallizations of Japanese regimes of risk management and their genealogies, logics, and limits.

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In engineering, finance, and other technical fields, *risk* is often defined as a product of probability and undesirable consequence. That is, the higher the possibility of an event occurring, the higher the risk; likewise, the greater the stakes, the greater the risk.

Although it is rarely stated in such terms, it is nevertheless a truism that ways of living necessarily entail ways of risking. Fishermen who make their living from the sea face a variety of dangers specific to their occupation and their milieu: violent waves, inclement weather, equipment for catching and processing the fish, etc. Some of the most significant exposure to environmental hazards incurred by fishermen stems from the geographic location of their homes: near the shore, where they face the dangers of coastal storms, erosion, tidal inundation, or tsunamis.[1] Analogous statements apply to everyone from Punjab farmers to Shenzhen factory workers to Jakarta taxi drivers. In short: *lifeways are riskways.*

Similarly, it could be said that any construction material may reflect some of the social dimensions of risk. The location, design, and configuration of all built structures reflect decisions about balancing needs against risks. This is equally true for a yurt on the steppe, a mud-brick hut in a fertile valley, or an apartment building in a suburb. However, the unique properties of concrete make it an especially effective medium for crystallizing the social dimensions of risk, including the diverse ways that risk is conceptualized, measured, managed, politicized, and institutionalized (cf. Elinoff and Rubaii in this volume). Concrete enables conceptions and calculations of risk and policies of risk management to be translated into physical form with a facility unmatched by any other building material.

As a simple example, consider a new bridge over a river. It has been designed and constructed in compliance with building codes that ensure the bridge will easily be able to support the weight of the traffic it is expected to carry for a certain number of years. Building codes dictate a design that will enable the bridge to withstand seismic shocks up to a certain magnitude and duration of any potential shaking. The starlings must be robust enough to withstand erosion from debris in the flowing riv-

1 *Hazards* are defined as the proximate agents of destruction: the tornado's winds, the tsunami's waves of water, the explosion's heat and shock wave, etc.

er and impacts from watercraft. The span must be high enough to allow boats to pass underneath. In short, the bridge's design and construction address multiple hazards and thus risks.

The bridge's construction specifications change depending on the nature and scale of risk. When authorities recognize a higher probability of stronger earthquakes, they formulate more stringent codes and, thus, more robust construction. Likewise, the expectation of larger boats on the river translates to more robust starlings and a higher span or even a drawbridge. Thus, the size, composition, height, and design of the bridge become the physical embodiment of risk, not merely its symbolic expression.

But the risk that is embodied in the bridge is not necessarily the sum total of ontological risk representing all of the probabilities and consequences of every possible untoward event. Rather, it is the risk that has been *identified* by scientists, *calculated* by engineers, *codified* by lawmakers and regulators, *translated* by designers, and *built* by construction crews, all constrained by fiscal considerations, through the medium of concrete. And since no structure can eliminate all risk — whether known or unknown (cf. Whitington in this volume) — some "residual risk" will always remain.[2] Thus, concrete structures preferentially address certain varieties of risk, foregrounding these to users, while bypassing and obscuring others.

In the years following the tsunami of March 11, 2011, people along the devastated northeastern coast of Japan developed plans for the recovery of their communities. The process, which I followed through ethnographic research into the recovery from 2011 to 2013, involved debates over the feasibility and appropriateness of structures such as seawalls and levees (figs. 30.1 and 30.2). A community in Miyagi Prefecture called Tadakoshi

2 Programs to address residual risk not only exist; they are not cheap. The US Army Corps of Engineers spends millions of dollars per year on its Dam and Levee Safety programs, much of which is devoted to communicating risks to communities and guiding them through the process of formulating emergency action plans for what to do in the event of overtopping or structural failures.

had been a fishing village for centuries. Its residents had moved their domiciles to higher ground after previous tsunamis, only to return again to the shore each time. Thus, when government planners told residents that they wanted to use seawalls to protect the community's way of life, it was not surprising that residents protested, saying, "When you use the term 'way of life,' what that really means to us is *umi* (the sea)." Seawalls, they said, would only separate them from the foundation of their economy and culture, the source of their income and their very identity. Moreover, the residents pointed out that they would no longer be able to see the telltale signs of an incoming tsunami if the sea was hidden behind a massive, concrete levee. They noted that people walking or children playing on top of these 11-meter high structures — where they would inevitably go in order to see the water — might fall and injure themselves. In other words, the concrete seawalls would not only materialize the planners' perceived risk of future tsunamis, their design and construction would also conspicuously ignore and even produce other risks (such as falling down the sharply sloping side of a seawall), and disrupt other ways of managing risks (such as watching for tsunami signs and running for high ground after earthquakes). After a series of planning workshops, the Japanese government's solution for Tadakoshi was ultimately to elevate the entire town by 11 meters, demonstrating a remarkable commitment to the use of concrete on a massive scale as the preferred solution for the Japanese "Construction State" (Johnson 1982).

Another example makes this dynamic even more starkly apparent. Before the tsunami in 2011, 10-meter-high seawalls had guarded the Tarō district of Miyako. Homes and businesses had sprung up behind these walls which conferred a sense of security. The walls had lowered the community's risk by reducing the likelihood that a tsunami would inundate the area; but then development had heightened the risk by increasing the consequences, should a large enough wave ever strike. On March 11, the tsunami reached as high as 17 meters at Tarō, destroying much of the district and leaving 181 residents dead or missing. In the aftermath, many in Japan felt that a salient lesson of Miyako's experience was that, no matter how high humans build walls, nature can always top them. They learned that no structure, no matter how large or robust, can ever completely eliminate risk.

On the other hand, larger seawalls can reduce tsunami risk further, albeit at a cost. Thus, newer and more robust walls are now being constructed in Tarō, 14.7 meters in height. Why not 17 meters? Why not even larger? The size and design of the new walls is based on calculations, not of the roughly once-in-a-millennium tsunami that the 2011 event is believed to have been, but of the once-in-a-century tsunami that is much more likely to occur during the serviceable lifetime of the structure. No project's budget is infinite, and planners and engineers have to balance considerations of cost against projections of risk over time. The concrete of the wall itself — its thickness, height, and arrangement — thus enacts this thinking about risk, its histories and its compromises.

Terms like "once-in-a-century tsunami" and "100-year storm" are vernacular language for what experts call a 1% annual exceedance probability (AEP) event. In the late 1960s, the Water Resources Council, a cabinet-level committee of the leaders of American land and water resources agencies, pronounced that the 1% AEP event would henceforth be the standard used for flood risk management projects across all federal agencies. The decision was essentially an arbitrary one by a group of experts and bureaucrats who had debated the question on behalf of the Council. The 1% AEP event landed somewhere in the middle of commonly used standards at the time, and it seemed a reasonable — and aesthetically pleasing — compromise. Over 50 years later, the practical consequences of this somewhat arbitrary policy decision have become so far-reaching that they have been reflected in the physical infrastructure of the built environment across the United States and beyond. Due to Cold War-era American influence in politics, science, and engineering, many other nations followed suit in adopting the 1% AEP event for their standards, including Japan. The arbitrary policy decision to standardize on the 1% AEP event has become ubiquitously manifest in the civil works infrastructure and built environment of contemporary industrial societies.

Pegging the design of Tarō's seawall to the 1% AEP standard illustrates that the structure of the concrete seawall crystalizes not just the real or perceived risk of tsunami, but the entire risk management regime of the Japanese Construction State: politically inflected policy decisions about balancing costs and benefits; technical experts' models of event probabilities, expected losses, and calculated costs; the contested yet conventional assumption that seawalls are the most effective approach to mitigating tsunami risk; the consciences of bureaucrats; the calculus of politicians who feel pressured to support familiar yet visually spectacular measures; the complex web of general contractors and local construction firms that comprise a significant portion of the Japanese economy; and so on. Each of these is as essential a component of the seawall as its physical design or the particular type of aggregate used in the concrete mix. Without any one of them, the seawall would be physically different — or might not exist at all (cf. Winner 1980). The walls are not merely symbolic of risk; they are precise materializations of all these calculations manifested in concrete.

Note that the consequences of policy decisions such as standardizing on the 1% AEP event have also become manifest in physical infrastructure. The Water Resources Council's decision occurred well before the science and politics of climate change began to inform fields such as civil engineering or flood risk management. Basing the 1% AEP event on records of past events makes sense when climatic and hydrologic regimes remain essentially stable, but in a dynamic environmental regime such as that of rapid climate change, the last century's 1% AEP event may become the next century's 5% or 10% AEP (a.k.a., 20- or 10-year) event.[3] Ignorance of this enhanced and dynamic risk regime is, thus, also solidified in concrete structures such as seawalls and levees. Furthermore, even in a stable hydrologic regime, deter-

3 Experts dryly refer to these changes as "non-stationarity of the hydrograph."

mination of the conditions resulting from the occurrence of a 1% AEP event is based on limited, imperfect data as well as models that necessarily incorporate a number of assumptions. Thus, the resulting built infrastructure also incorporates and physically manifests the assumptions, limitations, and imperfections of these technical processes.

This chapter opened with a common definition of risk in technical fields. Indeed, in most contemporary societies, risk has become profoundly "rendered technical" (Li, 2007), conceptualized through technical ways of knowing that are the near-exclusive domains of experts. Likewise, the "science" of risk management has been rendered technical. Hence, fields such as risk communication have arisen, through which experts and authorities learn how to frame and discuss risk with the lay public in such a way as to endow audiences with a simplified understanding of technical concepts and to elicit appropriate risk-managing behaviors. Concrete structures can thus serve as instructive objects of inquiry for the sociology of knowledge and related fields. They literally concretize technical ways of knowing, representing, and managing the world, embodying and enacting risk in their very structure.

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SPECULATION

Tong Lam

Few places are as deeply associated with concrete and cement as twenty-first-century China. The material has been central to both its domestic growth and to its international, Belt-Road, infrastructure-driven diplomacy. These projects are efforts to build China's present, but they are also modes of enacting future visions of Chinese prosperity at home and power in the world. As such, these projects are speculative, resting uneasily at the boundaries of the real and the imagined. This chapter considers the precarious futures produced by concrete in China as the material acts as a medium of speculation that teeters between possibility and ruin.

China's high-growth economy over the past four decades has expressed itself, literally, in concrete. In particular, the massive urbanization and infrastructure-building accelerated by the shift from a planned economy to a mixed-market system in the late 1970s and later to a growing state-led neoliberal system in the 2000s was accompanied by the rising demand for cement, a key ingredient for concrete production. Indeed, as early as 1985, China had already emerged as the world's leading producer and user of cement, and, since the early 2000s, its cement production has exceeded 40% of the world's total. Moreover, in this period, a main driving force behind the upswing in China's concrete production and consumption has been speculation both in the financial and geopolitical senses: Financially, concrete construction has formed the foundation of a massive state-driven sector of economic growth, producing housing for some, wealth for others, and circulating money around the economy. Likewise, China's ambition of becoming the global leader in infrastructural development, itself a form of geopolitical speculation, has led to an enormous consumption of concrete far beyond its borders.

The arrival of concrete on the Chinese coast at the end of the nineteenth century signified China's integration into the global colonial order. Among the early users of concrete were multistory buildings, colonial waterfronts, lighthouses, and fortified military structures along the southern and eastern coast where the Western industrial powers had first landed. These early deployments of concrete initiated the rapid and large-scale transformation of the Chinese coast and hinterland alike under successive regimes. The regime that formed the People's Republic of China in 1949 especially regarded concrete as a pillar of socialist revolution and construction. In fact, concrete was indispensable in the making of socialist spectacles, although these spectacles were not framed in terms of the modernist aesthetics prominent elsewhere in the world. Nowhere was this socialist building imperative more evident than the transformation of the vast open space in front of the Forbidden City from the imperial era into the concrete-paved Tiananmen Square, the world's largest of its kind. It could also be seen in the construction of nearby giant public buildings in blended Soviet and Chinese architectural styles, and the erection of numerous hydroelectric dams, spectacular railway bridges, and giant factories at the peak of the Cold War.

The beginning of the postsocialist era in the late 1970s did not only lead to the decentralization and proliferation of cement plants as a result of rapid urbanization, but also to a major transformation and reorganization of the cement industry itself. Increasingly, older state-owned cement plants were outcompeted by those outfitted with newer equipment imported by Japanese and Western investors. In response, state-owned cement enterprises, much like those in other industries, began to privatize en masse, and by the late 1980s over two-thirds of state-owned cement plants had undergone various degrees of privatization. Moreover, Chinese companies also became the dominant force in the Chinese market, edging out foreign-invested companies. Between the early 1980s and the early 2020s, China's urbanization rate surged from about 20% to well over 60%. The past two decades have also seen financialization and proliferating infrastructure projects. Unsurprisingly, China's use of cement increased by more than 400% during this period. Colossal quantities of sand and gravel have been mined in every imaginable place to support the breakneck growth of China's cement industry. At present, the highest demand for concrete is in the most urbanized and developed areas: the Pearl River Delta region in southern Guangdong, the Yangzi River Delta region near Shanghai, and the Bohai Rim region near Beijing. Since urbanization and infrastructural development in postsocialist China are routinely carried out through brutal displacement and dispossession, concrete has become a primary material witness of forced evictions, violent standoffs, and further accumulation of capital (Lam 2022). In short, the link between concrete and speculation cannot be more obvious today as concrete consumption is concentrated in regions where problems of financialization, conspicuous consumption, and real estate speculation are most acute.

The latest wave of urban renewal since the turn of the millennium is also characterized by the phenomenon of hyperbuilding (Ong 2011). From airports to seaports, from the world's longest bridge to the world's largest highspeed rail network, China's mega-infrastructure projects are more than just functional in the narrow economic and logistical sense. Not unlike those of the socialist era, these projects are also cultural and political spectacles designed to legitimatize and extend the power of the party-

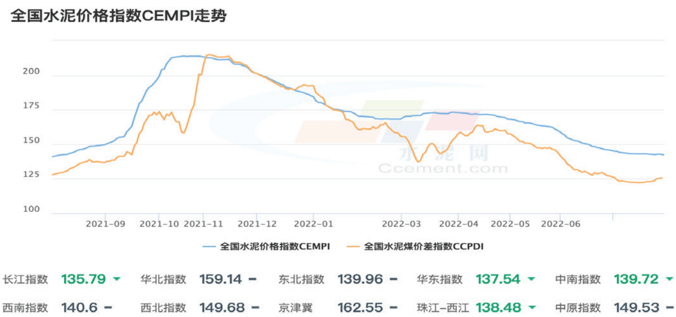

Figure 31.1. A chart of China's Cement Price Index as of July 31, 2022, which visually resembles charts of the financial market. Published by the Ministry of Industry and Information Technology, the online index provides a range of real-time data such as prices, storage and circulation volumes, sales volumes, and historical trends both at the national and regional levels. Ministry of Industry and Information Technology, People's Republic of China, 2022.

state. However, unlike in the socialist period, these new urban and infrastructural spectacles are also capitalist commodities. In other words, the leveraging power of these spectacles derives from speculation and capital accumulation. An obvious example of this is the so-called Chinese ghost city. Many of these instant and empty cities, sometimes designated as new districts, have been built outside of existing urban centers. Kangbashi District near Ordos in Inner Mongolia and Binhai New District in Tianjin have received widespread and sensational media attention, but others can be found nationwide at various scales. Many of these new cities and districts have remained unoccupied for years, as investors big and small commonly use them for parking money. The spectacular collapse of the Chinese property giant Evergrande and other small- and medium-sized developers in 2021 and 2022 is yet another indication of the flip side of China's bursting real estate bubble. Concrete figures centrally in eerie images of empty cities or in uncanny scenes of imploding unfinished buildings, offering a material manifestation of China's spectacular and speculative growth.

Figure 31.2. A 1987 advertisement for a brand of white silicate cement designed especially for luxury buildings produced by a cement plant in Guangxi Province. With the body of a Caucasian female office worker set against a collaged modern skyline, the image indicates how race, gender, consumption, and urban spectacle are mobilized to sell cement in the waning days of China's mixed-market reform and the onset of state-led neoliberalism and consumerism. Advertising pamphlet, ca. 1980s, private collection.

If the arrival of concrete on the Chinese coast at the end of the nineteenth century represented China's integration into the global colonial order, China's influence on the global stage since then has also been noticeable in the form of concrete. Despite China's relative isolation from the global system during its social-

Figure 31.3. Not far away from Beijing is Tianjin's Binhai New Area, a massive real estate project at the heart of the Bohai Rim. Its financial district, photographed here in 2013, is branded by the local government as China's Manhattan. After many pauses due to financial troubles, the debt-fueled development is now near completion. Yet, most buildings, including those that were completed years ago, have remained empty or underused. Photo by the author, 2013.

ist era, technology transfer associated with cement production was an important part of the country's assistance to nonalliance states such as Cambodia, Albania, and Rwanda, even though China's own cement plants were built with assistance from the Soviet Union and the Eastern blocs. Since the 1980s, China has moved from assisting foreign countries with cement production to investing and economic cooperation with them. While the number of cement plants China has set up in these countries is tiny compared to the number of domestic ones it has built, the amount of cement produced by capital of the Chinese state has increased significantly in the past two decades.

What has been largely overlooked is the amount of concrete needed for China's offshore infrastructural projects. To the extent that China today is no longer just a territorial state but a global phenomenon, concrete is a material manifestation of that de-territorial and global China. More specifically, China's recent "going out" policy as a way to manage its surplus capital — the world's largest foreign reserves — and overcapacity in production has changed the world's environmental landscapes. The management of surplus capital is also vital in alleviating the pressure on Chinese currency, which has important implications for the country's global competitiveness and political stability. The massive global infrastructure development strategy branded as the Belt and Road Initiative (BRI), which covers nearly 70 countries on multiple continents, is certainly the most visible expression of "going out" through heavy duty construction. Driven mostly by state-led capital, the BRI is a political project in addition to an economic and financial one, since it is partially motivated by the belief that China's global influence should be on a par with its rising superpower status.

The BRI thus also amounts to geopolitical speculation: by leveraging infrastructural spectacles globally, China hopes to reshape the global order in its own favor. The cement used in these initiatives is not wholly reflected in China's domestic statistics because cement and concrete are generally sourced and produced locally. Therefore, if China today is already consuming nearly half of the world's cement domestically, the amount of cement generated outside of China due to China's state capital is even greater.

Today, the financial market is trading at a lightning speed limited only by the latest fiber-optic technology. The Chinese demand for concrete in the past four decades has also mirrored that of the "China speed" of construction and GDP growth. Likewise, even when China's global geopolitical bet through the BRI is based on a longer-term calculation, its underlying motive is still driven by a floating political desire that is negligible in the span of the *longue durée*. What is permanent, persisting beyond the sound and fury of China's growth and influence, however, are the environmental impacts of concrete and the human footprint of development in general. Paradoxically, the long-term consequences of concrete production have nothing to do with the illusive idea of permanence associated with the materiality of concrete. In fact, despite the resilience and longevity of concrete, concrete structures are often quite short-lived in an economy that is on steroids, as in China. Notwithstanding all attempts at recycling demolished buildings, the environmental devastations caused by the industrial extraction and processing in the production of concrete is inevitably long-term, if not permanent. In this respect, the significance of the story of concrete in relation to China's recent rise is more than world historical; it is also planetary due to its profound environmental and geological ramifications. Yet so far, the human imagination has found it difficult to grasp this deep time of geology and ecology. Instead, it hurtles along, accelerated considerably by the sweeping speed of financial and geopolitical speculation powered by "China speed," which generates momentum through taller buildings, longer highways, and larger airports, speculations made manifest in concrete.

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SCARCITY

Emily Brownell

Taking in the skyline of Manhattan or Chicago, the "concrete jungle" of urban life can seem inescapable, ubiquitous, and commonplace. The material's histories in other parts of the world suggest something else: the affect of concrete may be felt just as acutely in its absence. This chapter examines the scarcity of concrete in twentieth-century Dar es Salaam, Tanzania to highlight how the material can be a political and economic achievement of enormous importance in the post-colonial world, and how its absence mirrors the wider exclusions of colonialism.

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In 1948, at a moment of dramatic postwar urban migration and transformation across East Africa, the provincial government of Dar es Salaam wrote down their observations about the swiftly changing city, hoping to justify the urgency of conducting a more thorough sociological survey. Such surveys were part of a larger postwar trend to train the lens of social science on urban Africa in order to justify ongoing colonial interventions in the name of development (Silberman 1954). Along with more quantitative observations of dramatic demographic change, the unnamed author's notes on Dar described people's clothing and habits of borrowing and lending, and included a section detailing "What is a House?" First sketching out for readers the traditional "Swahili style house," the author describes a classic six-room square building, where all walls were made of "clay dressing to make a smooth finish or take a whitewash. All floors are of trodden earth rather lowered by constant use and sweeping and falling away from the walls' original level. The roof is still mainly coconut thatch, but there are some sheets of corrugated iron dotted around to stop leaks where they have occurred." Within these six rooms, sometimes in excess of 20 people lived — often including many recent arrivals in the city — making these modest structures central to the rapid expansion of the city's population, while also cultivating a certain "type" of city dweller, seemingly uninterested in privacy. "This lack of privacy is felt less when a man is on his own, or poor, or uninterested in a high standard of comfort," the author writes. And it is "felt the more when he is better paid, better educated, more ambitious of improving his lot; it is felt particularly by the upcountry Christian educated man with a stable marriage which he is loath to lose, and a tendency to put money into comfort and food. It is this type which prefers the 'government quarters.' But they are in a minority. The majority are coast Muslims, uneducated and illiterate, many of whom have no ambition for a permanently improved standard of life, only ready spending money, which they are loath to 'waste' on food and rent" (TNA n.d.).

In a few brief paragraphs we learn a lot about the colonial city and those who sought to control its demographic transformation. Dar was a dynamic mix of more proximate migrants from the coastal area as well as those coming from much further afield. There were both Christians and Muslims and each were seen in particular ways by the colonial authorities. And the landscape of "African" parts of the city was marked by two different kinds of housing. There were self-built homes made of mud and waddle and quarters made of concrete and subsidized by the government. It is clear that colonial administrators saw where one "chose" to live (though access to government quarters was not open to just anyone) as revealing to what kind of "native" they were. The mud and waddle Swahili-style house, seemingly overflowing and always in disrepair, came to typify the "lazy," unmotivated urban resident whereas those who sought out the comfort of government quarters were more civilized and productive.

These ideas were not just reflected in building types but in their materials: the colonial state saw different materials as able to imbue values in those who lived in them. Concrete made more modern subjects and shaped stable, nuclear families. And yet, until the construction of these government quarters in the 1940s, access to building materials generally fell along racial lines. In colonial Dar as in many cities across the African continent, neighborhoods were divided by race and thus so was housing. But rather than inscribing racial discrimination in town bylaws, planners achieved a segregated city by embedding racial distinctions in building materials. European and Asian neighborhoods in the most desirable locations were required to be built in bricks or concrete, whereas most African neighborhoods could only be built with "impermanent materials" such as mud, palm thatch, and sticks. Thus, certain materials were seen as reflective of racial characteristics and traditions. But labeling mud and palm thatch "impermanent" also meant that African urban residents did not enjoy any security of tenure: the planning department could at any time call for their removal to make way for "planned" neighborhoods. Allowing Africans to live in "temporary" neighborhoods created a labor pool without having to invest in permanent urban infrastructures. Race, class, and materiality converged to generate a politics of urban precarity bound up in mud and concrete.

By the 1940s, when colonial administrators realized they needed to enact development in order to defer the existential question of empire, one mode by which Africans were deemed "developed" was by gaining access to concrete houses like the government quarters in planned neighborhoods. But beyond the scarcity caused by regulating access to building materials along racial lines, concrete was also expensive. Its material scarcity became an additional bulwark against building a "permanent" home in the city (see Gastrow in this volume). Relegating African colonies to the production of raw materials meant that even as late as independence, most new nations did not have their own factories, including cement plants. The heavy building material was imported at great cost, making it untenable for nearly all home building by Africans.[1]

With independence in 1961, Tanzania's first president, Julius Nyerere, sought to redress the deep material inequalities created by colonial rule. In Dar es Salaam, this meant eradicating the "impermanent" neighborhoods — a move considered "slum clearance" at the time — with the hope of building better housing for all residents of the city and erasing its segregated past.[2] Considering the political and social work of exclusion that concrete did in demarcating race in the colonial city, promoting concrete as a ubiquitous and accessible building material became a way to usher all Tanzanians into modernity and to rewrite a legacy of exclusion (see Schwenkel in this volume). In the first decade of independence, a new cadre of architects also began designing some of the nation's most iconic buildings using concrete as their chosen material.[3] Meanwhile, across the socialist and "Third World," concrete became the building medium of choice to embody the rapid "catching up" and utilitarian style of a new, emerging world order. As in many African cities, concrete became domesticated by the new state and remade as the key material in creating a new cosmopolitan African aesthetic. But erasing the colonial legacy of uneven development in Dar es Salaam was one of many efforts to remake the fledgling

1 There was an ongoing conversation about how to build "permanent" houses more cheaply. See for example *East Africa and Rhodesia Newspaper* (1953).

2 By the early 1970s, slum clearance was abandoned and replaced with a major attempt to upgrade housing in Dar. This also required residents to build with bricks and concrete, and upgrading housing was such a bureaucratic maze it remained inaccessible to those who might have benefited the most.

3 For more on postcolonial architecture in Tanzania see Hollander (2007); for more on postcolonial architecture in Africa, see also Hoffman (2017).

Figure 32.1. Construction of Magomeni Housing Scheme, 1962. Courtesy of the Tanzania Information Service.

nation. Promoting concrete houses in Dar es Salaam might have been an attempt to redress racial segregation, but it also risked worsening a different inequality between city and countryside, where concrete remained nearly nonexistent.

Beyond its signification, concrete was also an essential tool for the literal task of "nation building." All major infrastructure projects began with concrete. In light of this, Nyerere insisted on the necessity of Tanzania having its own cement plant. Producing it domestically was an essential step in repairing the legacy of uneven development that relegated Tanzania to the economic peripheries. Localizing the production of cement and other essential products, known as Import Substitution Industries, was a step toward economic independence. Located on the outskirts of Dar es Salaam, the new cement plant, colloquially called Wazo Hill, opened in 1966 to great fanfare. Around the same time, the state also initiated a massive educational campaign to "build better homes," arguing that cement and bricks were superior to wattle and daub construction. While now tied to decolonization efforts, associating certain building materials with developmental progress still echoed the not-too-distant colonial discourse about homes as civilizing spaces.

By the early 1970s, Tanzanians were remaking the geography of the nation through the creation of ujamaa villages, sometimes willingly, and sometimes compulsorily.[4] Over the course of a few years, millions of Tanzanians were relocated, compounding the necessity for building materials, even if most communities turned to locally sourced wood and mud. At the same time, Tanzania also faced the devastating effects of an extended drought and the beginning of the oil crisis in 1973. These two events created a balance of payments crisis when failing crops forced the state to import food relief. This left very little foreign exchange for importing oil at skyrocketing prices. Among other side effects, this derailed cement production. While the Tanzanian state could domesticate the production of cement by sourcing their own lime and nationalizing the plant, they could not domesticate the necessary oil to operate the factory or manufacture their own spare parts. As one newspaper article noted, despite its domestic production, 40–50% of cement was made up of "foreign exchange content" (Mbaga 1975). In the wake of the oil crisis, production at Wazo Hill faltered and would never rise above the production levels of 1972 in the following decade. What was supposed to be a ubiquitous commodity, made locally, had volleyed back to becoming scarce. Until the end of the

4 Ujamaa was Julius Nyerere's political and social philosophy of African socialism. Ujamaa's most essential physical manifestation was the reorganization of rural life by establishing concentrated villages around collective agricultural work.

socialist era in 1985, cement was mostly available through illegal channels, despite the veneer of state-controlled distribution and prices. The downturn in production at Wazo Hill highlighted the ongoing dependencies that Tanzania was subject to, despite their attempts to overturn the old economic order.

What was to be done? The state had made building with permanent materials a priority of development and yet massive cement shortages complicated these plans. In response, both the President and Prime Minister began to vigorously promote the production of burnt bricks. In addition to home building, all public buildings after 1973 were slated to be built with bricks whenever possible. Perhaps most importantly, this included the new capital city of Dodoma where a massive new brick factory was slated for construction. The turn to bricks fit within a longer tradition of research on tropical building materials in the face of austerity and scarcity, but this time it was shaped by a socialist politics. What made bricks a compelling alternative material in the eyes of the state was not the creation of more factories, but the fact that bricks could also be made communally in villages. By digging up clay, mixing it with water, using a mold and then firing them in a kiln fueled by wood, bricks required the opposite inputs of a cement plant, which was a site-specific enterprise dependent on oil and capital. Capturing the socialist nature of ujamaa, brickmaking relied on considerable amounts of community labor and natural resources available on site virtually everywhere.[5] With a history of brick making at Catholic mission stations around the country, there was also a sense that the technical knowledge already existed in communities. Newspapers printed instructions for making burnt bricks and they became valorized in the media as an appropriate technology for Tanzania within the context of its membership in the "Third World," escaping the capital-intensive development schemes of the West. By 1977, still trying to nudge Tanzanians away from cement, Nyerere even spent time in his national address marking

5 However, the necessity of trees for fuel meant brickmaking could lead to deforestation quite quickly.

the first ten years of Ujamaa to chastise people for their "addiction" to it. After suggesting that Tanzanians had sought "to be modern at all costs," he complained that people were waiting to build in cement when it is "basically earth." Why not use burnt bricks and baked tiles, he admonished, rather than waiting for "European soil" (Nyerere 1977)?

With this dismissal, a material that the state had domesticated was now rendered once again foreign for homebuilders. The hope for a new, alternative modernity began to take shape — at least rhetorically — around the humble burnt brick. But for most Tanzanians, the inaccessibility of concrete was nothing new. Indeed, its scarcity made it seem ever more meaningful to procure and certainly made it evocative of an increasingly elusive "modernity" that kept retreating into the middle distance for most Tanzanians. Scarcity in the colonial period allowed the state to control who had access to permanent tenure in the city and was a means for segregating urban space. For those who obtained a concrete house, it had real material benefits beyond those four walls (see Abourahme in this volume and Archambault in this volume). And while scarcity was certainly not a goal of the socialist state in the 1970s, the arduous process of procuring cement nevertheless compounded its aspirational qualities, as did its association with the city. Cement signaled good fortune and privilege but could also make you into a suspicious "hoarder" in the eyes of your peers or the state. Biding one's time and resources to accumulate and surreptitiously build a concrete house was both a subversive way of seizing space in the city and a time-honored mode of staking a claim to the supposed fruits of being modern. In this way, modernity has always been marked by material scarcity as much as material excess. Cement's potent role in postcolonial African urbanism comes through absence as much as presence.

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SETTLER COLONIALISM

Lila Sharif

Concrete is an instrument of ecological and cultural erasure and oppression: it can erase and ancient olive trees, bar farmers from their land, contain people, and build settler outposts and colonial bypass roads. In the context of Israeli settler colonialism, concrete materially and symbolically eclipses the historical presence of indigenous Palestinians on their lands. By appropriating olive lands and confining both people and trees within an increasingly vanishing landscape, concrete and its accompanying carceral technologies become essential tools to build the settler nation-state.

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One of the oldest olive trees in the world is in the Palestinian village of al-Walajah. Thought to be perhaps *the* most ancient olive tree, it is over 5000 years old and serves as a living, breathing reminder of the generations of indigenous Palestinians who harvested olives there. The tree is massive, creating a natural canopy of shade beneath its thick branches. The roots are buried so deep it looks like a family of trees bursting midway out of the soil. Villagers, tourists, and guests alike come here to pray, eat, organize, share stories, host gatherings, meditate, and harvest beneath its

Figure 33.1. Al-Badawi. Photo by Anne Paq/Activestills.

shade. Shepherds have long led their following to the natural springs that surround the tree, and prophets, nomads, voyagers, wanderers, and messengers alike have taken shelter in its stone caves, especially because it is just four kilometers northwest of Bethlehem — the ancient Palestinian city believed to be Jesus's birthplace, and now under Israel's military occupation. Perched atop a hill, al-Walajah overlooks the southern outskirts of another holy place — al-Quds, or Jerusalem — offering a breathtaking vista of Palestine's layered crimson soil, glistening white stone, and verdant green terraces. Alongside olives, these lands were planted with pomegranate, carob, and almond trees, as well as vegetables and fruits exchanged at the local market.

I visited the lush hills of al-Walajah as part a Palestinian-led olive tour. Tucked and embraced by the tree's ancestral branches, I could not help but feel embraced by her splendor.

Soon, the village and the ancestral olive will be completely encircled and trapped within a nine-foot concrete block.

The olive tree reveals a central contradiction in Palestinian Indigenous life: on the one hand, there is rootedness, steadfastness, what Palestinians call *sumud;* on the other, there is an ever-present threat of annihilation of Palestine by burying it in concrete. In 2002, Israel began the construction of the 400-mile, nine-meter-high wall that now pierces through al-Walajah. The hideous gray slab of concrete is buttressed with technologies of surveillance and containment including armed watchtowers, electric fences, trenches, state-of-the-art cameras, body sensors, and armed military patrols operating 24/7. The Israeli state has legitimized its bloated military apparatus — supported in large part by US taxpayer monies — in the name of "counterterrorism" in spite of its location on stolen land and in contravention of international law. In a tragic display of *concrete settler colonialism,* the olive tree has become emblematic of life obstructed by concrete.

Concrete settler colonialism in Palestine is part of a larger, ongoing process of settler colonialism that officially began with the establishment of Israel's statehood on indigenous Palestinian lands in 1948. In October that year, al-Walajah was raided by an armed, colonial militia composed of European Zionists[1] wanting to establish an exclusive, Jewish-only state on Palestinian lands. Seventy-five percent of the village was raided in "Operation HaHar," a violent, weeklong colonial campaign. Initially, the Palestinian and Egyptian fighters — who had joined in the effort against the European Zionist takeover of Palestine — drove out the heavily armed militia, but ultimately al-Walajah was captured and its people dispossessed. Al-Walajah saw its 18,000 dunums[2] of land reduced to 4,500. Most villagers were forced to flee to makeshift refugee camps installed by the United Nations Relief Works Agency (UNRWA); many others refused to leave, taking shelter in the village's remains, awaiting return. Half of the remaining lands of al-Walajah were confiscated and integrated into Israel in contravention of international law. Palestinians living in the freshly conquered part of the village were

1 Zionism is a nationalist colonial migration movement that emerged out of Europe in the nineteenth century, that sought to create an exclusively Jewish state in Palestine at the expense of the indigenous Arabs who lived there. Israel-Palestine is also called the Holy Land. For more on Zionism as a settler-colonial ideology, see Khalidi (2020), Masalha (2012), and Sa'di and Abu-Lughod (2007).

2 A dunum is a unit of measurement used in Palestine that equates to 0.25 acres.

not informed of Israel's new expanded colonial boundaries, and found themselves in the new legal category of Indigenous aliens while still residing in their homes (Volpp 2015). Because settler colonialism "destroys to replace" (Wolfe 2006), two years later, villagers saw their lands transformed into the Israeli settler colony of Amanidav, making their displacement permanent. In the 1970s, Israel built the Gilo and Har Gilo settlements, as well as a "bypass road" for the exclusive use of Jewish Israeli settlers connecting them to so-called "Greater Jerusalem," which it continues to expand.

Today, the concrete wall continues to encircle, partition, penetrate, and steal Palestinian land and life, including the olive trees that were harvested there for generations. According to Israel's blueprints, the concrete wall is to surround al-Walajah from its east, west, and north sides, with a military road controlled by the Israeli government on its southern side. This military road will be fortified by a 2400-kilometer wall with ditches, barbed wire, trenches, and surveillance technology. The remains of the village and its people will see a swarm of settlers in the expanding Gilo and Har Gilo settlements encroaching further into al-Walajah.

Upon completion, the wall will encircle the the village by 360 degrees, with the remaining hills to be transformed into a national park for the exclusive enjoyment of Jewish Israelis in nearby settlements.

The wall is projected to cut across al-Badawi at its roots.

Israel's Nesher Portland Cement Company (hereafter "Nesher") has benefitted greatly from Israel's concrete settler colonialism of Palestinian lands. Founded in 1923 by Russia industrialist and entrepreneur Michael Pollack, the company has not only supplied the concrete for the construction and expansion of the wall, it has also been instrumental in expanding Israel's borders and burying actual villages beneath it (Ben Zeev 2019). Nesher provides the majority of cement for the Israeli market as well as the Palestinian Authority in the Occupied Palestinian Territories. Its website claims it is the sole producer of cement in the settler state (*Nesher Israel Cement,* n.d.). Its concrete is seen in most settlements and military infrastructures that surround the village. It provided the material to expand the settlement providing and profiteering from the constantly expanding housing development units. Nesher has also provided the material for Israel's Jerusalem light rail — a transportation project connecting various colonial settlements surrounding al-Walajah (Who Profits Research Center 2021).

Concrete settler colonialism is often entangled with militarized violence. Taavura, a subsidiary of Nesher, transports extremely heavy cargo for the Israeli army. It transported aircraft and watercraft, and has practiced moving tanks for the Israeli army. During the eight-day attack on Gaza in November 2012, it was Nesher and its subsidiaries that transported tanks to the front lines of the raid on captive Palestinians, which ultimately led to the murder of 170 Palestinians, and to the injuries of 1400 others.

The company provides the cement that will choke the ancient green lungs of an increasingly shrinking Palestine. In a shameless display of corporate opportunism, Nesher continues to profit from Israel's concrete settler colonialism, with genocidal effects on Palestinian land and life. At the same time, it sells concrete to Palestinians to rebuild infrastructures destroyed by the Israeli state, thus profiting from the state's settler colonialism and from Palestinian economic isolation

Miraculously, al-Badawi is still on what remains of the "Palestinian side" of the village — now the militarily occupied West Bank.

Every fall, the remaining villagers harvest its olives as they have been doing for decades, taking pride in their rich heritage, olive landscapes, and ancestral connection to the land, while rallying for their Right of Return[3] and the repatriation of

3 The Right of Return for Palestinians has been systematically denied by the state of Israel despite the fact that it is a universally recognized right in international refugee law, human rights law, the law of nationality, and the law of state responsibility. It is provided for in Article 13 of the Universal Declaration of Human Rights and Resolution 194 (III) in the UN General Assembly.

Figure 33.2. Israeli army blows up parts of a mountain in al-Walajah to continue building the wall, November 2011. Photo by Anne Paq.

their indigenous lands. They also fight against the wall through the Israeli courts and through grassroots mobilization efforts, Palestinian-guided tours, and environmental initiatives that attempt to disrupt the ongoing building of the wall. They invite international visitors and activists to participate in the endeavor. By 2011, the Israeli military was already bombing the mountaintops surrounding the verdant and lustrous hills to clear a route for the wall.

Shireen al-Araj, a Palestinian land protector, native of al-Walajah, and human rights activist leading the effort to stop the expansion of the separation wall, has called al-Walajah a "microcosm" of the entire Palestinian struggle (TEDX Talks 2011). It reflects the sinister process of disappearing, burying, transforming, and displacing Palestinian land and life. Today, the village has been reduced to 2800 dunums and less than 10% of its original population. 97% of its remaining villagers are refugees living on a fragment of their land, and under a settler colonial military occupation that denies them the right to return to their homes and continues to entrap them in a wall that snakes through their lands and holds the tree hostage.

Israel continues to target Palestine's trees. Israeli settlers often chainsaw Palestinians' olive trees to the ground or steal

Figure 33.3. The building of the separation wall continues at the entrance of the village of al-Walajah, December 2010. Once finished, the village of al-Walajah will be completely entrapped with a single checkpoint controlled by Israeli forces. Photo by Anne Paq.

their harvests at the peak of their season, costing them an entire year of precious oil, food, and medicine. The military has used bulldozers to “level” Palestinian orchards and make way for the wall’s expansion. Olive trees have been dug up by settlers using axes and chainsaws, by Israeli military using bulldozers, and by private companies like Nesher. They are sold for hundreds of dollars to Israeli developers and planted in settler colonies. At the same time, Zionist tree-planting programs have also worked to supplant territorial markers of Palestinian presence on the land. The Jewish National Fund — a global Zionist organization established in 1901 for the sole purpose of appropriating Palestinian lands — has planted hundreds of millions of pine trees surrounding Israel’s new settler communities, offering people around the world “tree certificates” for birthdays, bar and bat mitzvahs, graduations, and weddings as acts of charity in the service of Zionism.

Kali Rubaii writes, “concrete is a life inhibitor, inhabiting space so that other things cannot” (2016). In Palestine, concrete links the materiality of Israel’s transformation of indigenous lands with the “logic of elimination” (Wolfe 2006) that characterizes territorial expansion. It also reveals a dual nature of settler colonialism: on the one hand, it strives to dissolve Palestinian lands and life to erect a new settler state; on the other, it seeks to expand and normalize Israeli society through a fusing of limestone and aluminosilicates, erecting walls, settlements, military installations, and surveillance apparatuses that continue to displace and colonize Palestine. With Israeli companies like Nesher profiting from the "big business" of concrete settler colonialism, the expansion of the separation wall and illegal settlements, and the weaponization of the olive tree — Palestine's sacred signifier — one wonders what the future will hold for al-Badawi, the community that returns to harvest her fruits every fall, the displaced generations who come to marvel at her, and the lands that continue to nourish her. Salah Abu Ali, a self-appointed guardian of al-Badawi recalls, "[When the wall was erected], the Israeli occupation forces used a large number of explosives, without caution to the tree […] but [the tree] persisted, as it has for thousands of years." He adds, "an occupation that has been around for tens of years will not uproot it" (Hammad 2019).

For now, as though in silent agreement with Salah, al-Badawi continues to burst from her ancient roots.

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SHREDDING

Duncan McDuie-Ra

The practices and vernacular of concrete worlds is highly specific, reflecting different orientations to its material qualities. As skateboarders move through built spaces, they navigate cartographies of concrete differently than others. For example, they shred concrete edges of ledges and benches, changing the contours of concrete surfaces. In their material play amidst concrete spots, skateboarders also generate social encounters with other people, sometimes in conflict and sometimes in ways that elicit recruitment into a new form of interface with collective urban spaces.

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Skateboarders hunt for concrete. Concrete undergirds what skateboarders refer to as "spots." A spot is an assemblage of objects, obstacles, and surfaces desired by skaters for the possibilities to perform skate tricks, what skateboarders refer to as "shredding." Shredding refers to moving along the surface of a spot, especially an angled or rounded edge — a concrete block, a steel handrail, a painted concrete curb — with part of the skateboard other than the wheels. Many skateboard tricks involve

Figure 34.1. Simon Lyddiard noseblunts on concrete blocks in Newcastle. Photo by Andrew Nash. Courtesy of Sprawlers.

shredding, and overtime shredding changes the appearance and form of concrete edges.

Skateboarders hunt for spots to shred. There are thousands of spots, and once you know what to look for you can imagine almost endless spots nestled in built environments the worldover (McDuie-Ra 2021). As long as there is concrete there will be a spot: a concrete slab, an embankment down the side of a carpark, a steel handrail aside concrete stairs going into the local government office. To have value in skate culture, spots should not be produced for skateboarders, rather they need to be found in the built environment and repurposed (Chiu 2009).

There are other materials that make good spots, including asphalt (ground surfaces), steel and aluminum (as in handrails and flat-bars), marble (as ledges and embankments), ceramic tiles (surfaces and ledges), timber, and certain brick finishes. While some spots may be entirely devoid of concrete, it is unusual. Even at a spot where the main attraction is marble ledges or a kinked steel handrail, these are likely affixed to concrete. Concrete is part of the roll up and roll away, because the assemblage is relational. Concrete is relatively durable, so even after decades of use and misuse from all kinds of human and non-human actants — including the titanium trucks of skateboarders grinding away at edges and angles — it still holds together desired spots.

There are many different ways to think about shredding concrete. Here I offer three: modifying concrete, cartographies of concrete, and concrete encounters.

Modifying Concrete

Skaters modify angled surfaces of concrete with wax, resin, and paint to make it easier to slide or grind with parts of the skateboard. Wax, caked and baked onto surfaces along with chipped edges, paint marks, and scuff marks, leaves a trail in urban landscapes across the world. Vivoni argues that these scuffed surfaces "represent an alternative vision of the city in which the market value of built forms is contested by the emergence of new urban experiences" (2009, 133). At some spots the heavy coating of wax is interrupted by skate-stoppers — metal clamp-like objects spaced along an angled surface to prevent skateboarding — suggesting that skaters once flourished at the spot before their intentional obstruction by property owners or local authorities. The smooth surfaces of concrete must be interrupted to prevent shredding; the lines of possibility along and through the material itself are so inviting that extra effort and expense goes into making them hostile. In a few cases there will be wax, skate-stoppers, and holes where skate stoppers have been illegally removed to allow skateboarding to continue along the concrete: a mini-battle recorded on/in an otherwise mundane assemblage. Sometimes skaters even fill the empty holes with fast-drying concrete to remake the surface.

At the Newcastle Museum in coastal Australia, the area once occupied by a train station has been reborn as a pedestrian plaza. The plaza has a series of long concrete ledges ranging in height from four inches to three feet scattered around the landscaped area, joined by smooth granite pathways. The edges have been shredded. They have been worn down by constant use from skateboarders. The otherwise white concrete is black along these edges, covered in wax and a mixture of paint from skateboard decks and wear from titanium trucks. For a while, authorities sunk metal skate stoppers into the concrete to deter skaters. Skaters removed them, causing the surfaces to be further destroyed. After some back-and-forth the custodians of the space decided to allow skateboarding in the plaza. They even installed new metal edges over the most damaged parts of the concrete to make them skateable again.

As I watch from my window in an adjacent building in the middle of a weekday, a local skateboarder pushes hard along the granite toward one of the horizontal concrete ledges, about three feet high, and pops a backside 180-degree ollie from the ground up onto the ledge, landing the front truck (axle) on the corner of the concrete ledge and shredding the edge of the concrete for two feet or so, before dropping off onto the ground. Dissatisfied, the skater steps off onto the ground, walks to the edge of the plaza and pushes back toward the ledge, trying the same trick again, landing on the same part of the concrete ledge and shredding it once more. This time, skater and board nosegrind all the way to the end of the ledge but the skater falls off when trying to land back on the ground; the skater picks up the skateboard and rubs it against part of the ledge to smooth out a bump or crack in the concrete — I'm too far away to see exactly. The skater goes back to the edge of the plaza and pushes again. Same trick. This time the nosegrind is held all the way to the end of the ledge and a clean roll away. Satisfied the skater sits on an adjacent concrete ledge in the shade and rolls a cigarette. In four minutes, the combination of body and board has shredded the assemblage, grinding down microscopic layers of concrete. In this spot, with no harassment, shredding is repeated, day after day, hour after hour, modifying the concrete form over time.

Cartographies of Concrete

As a material of desire, concrete draws skaters to different locations near and far, producing an alternative cartography of cities and regions. The search for spots is connected to the growth of

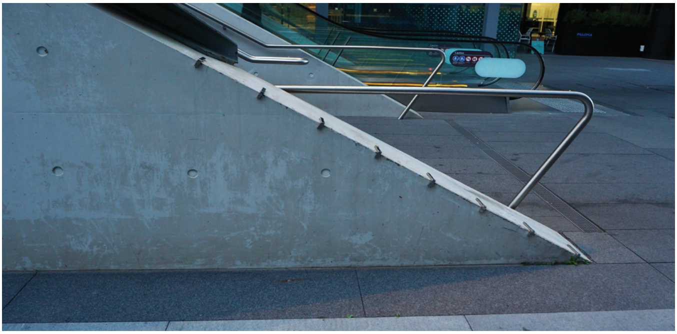

Figure 34.2. Concrete up-ledge disturbed by metal skate-stoppers to prevent shredding in Sydney. Photo by the author.

cities, especially public infrastructure and the concrete that materializes it. Skaters become an adjacent public for the creation of new infrastructure insofar as it produces spots; even incomplete or abandoned infrastructure projects have value if they gather together elements that make a good spot. Skaters use infrastructure for play — and livelihoods derived from play — for purposes other than intended.

Over time these spots change along with the urban landscapes around them. Spots age. Some disappear. Some reappear. New spots can bring entire cities into skateboarding's global map for the first time. New infrastructure, building booms, and gentrification create new spots and upgrade old spots, while also leaving corners of a city untouched. Assemblages are rearranged: a handrail blocked off by a gate, an access ramp added, skate stoppers and other defensive architecture placed on an embankment. Some spots are demolished. Furthermore, looking up from below, the city itself changes in the background; buildings, graffiti, advertising billboards, fashion, cars are all time-stamped as a backdrop to the performances in the foreground.

Skaters adapt. They are constantly seeking out new spots as established spots are demolished, surveilled, or rendered unskateble. Skateboarding is restlessness embodied. It is motion generated by the itch, the need, the compulsion to roll through

Figure 34.3. Concrete ledges patched up with metal after being worn down. Civic Plaza, Newcastle. Photo by the author.

the urban landscape, to discover and repurpose its surfaces, obstacles, shapes, and objects. They need the concrete to keep pouring. This perpetual searching, these "concrete dreams" that "blur the lines between the actual and the possible" (D'Avella 2019, 7), map cities and networks of cities according to their spots. This cartography is continually being created and recreated; spots added, spots taken away as they are destroyed or policed, spots obscured lest they become too popular. This way of mapping cities re-sets relational and comparative hierarchies of urbanization based on the proliferation of concrete, blurring distinctions like Global North and South, First and Third Worlds, world and regional urbanisms. To confess, the skater's approach to comparing urban landscapes is rarely consistent or sophisticated. A good concrete plaza puts a city on the map, whether in San Francisco or Santiago.

Locating spots within a city is topological by "mapping out how such objects change and how they relate, in this process, to other changing objects in multiple, relational spaces" (Shields 2013, 140–41). Crucial for this cartography is detailing the particular three-dimensional assemblage beyond a two-dimensional depiction of a street or plaza by gathering information about the concrete surface, the arrangement of obstacles, the foot traffic, the best time of the day and year to skate the spot, and the prospects of being harassed or evicted. Cartographic knowledge of spots and the urban landscapes that host them is circulated, rapidly, to millions of people through personal and digital exchanges and online resources, while also being amended, improved, and sometimes withheld to protect spots.

Skate spots re-map cities through the skater gaze (Borden, 2001). The skater gaze is not aimed at the usual trappings of place: people, wilderness, cultural artifacts, landmark buildings, and sanctioned performances or spectacles. The skater gaze is directed downwards, focused on the concrete underfoot, or under wheel to be more accurate, scouring the landscape for good spots. It evokes desire, creativity, and intimacy. And while intimacy may be a strange way to describe a cultural activity built on phrases like "shredding," "grinding," and "skate and destroy," skaters spend hours, sometimes days at spots attempting tricks. They imagine the motions, they calculate the timing, they fall, they leave behind skin, teeth, and blood on the concrete.

Concrete Encounters

Chasing concrete brings skates and filmers into contact with other skaters, authorities, and urban dwellers from different walks of life creating an alter-sociality of concrete (McDuie-Ra, 2022). Attempts by skaters to perform tricks amidst the multiple rhythms of everyday life in a particular place and time generate social encounters. These encounters vary. Perhaps the most common type are hostile encounters. A hostile encounter usually involves members of law enforcement, private security, property owners, or passing citizens challenging skateboarders and their repurposing of concrete. This can involve conversation and negotiation to allow skaters more time to skate the spot or at the very least to avoid harsh penalties such as fines or arrest. Hostile encounters can involve physical altercations, like security guards attempting to physically obstruct skaters by moving into their path, spraying water onto the concrete to make it slippery, or throwing objects at skaters.

Encounters can also be curious. Bystanders may crowd around the skaters and the spot to watch the attempted tricks. If there is a filmer shooting video this adds to the draw, even if these bystanders are not entirely sure what they are witnessing. As skateboarding has travelled to cities around the world — both in the form of skateboarders travelling to find spots and shoot video/image and in the form of local skate communities taking shape — there are more inter-cultural elements to these encounters. As I have argued in work on skateboarding in China, encounters in spots popular with foreign skateboarders may be replete with cultural stereotypes, inappropriate behavior — most skateboarders are trespassing and damaging property to begin with — and misunderstandings, yet there is mutual curiosity, mutual wonder (McDuie-Ra 2023, 10).

There is also mutual playfulness. Some bystanders cannot help but have a try on a skateboard or share a beer from the cooler the skaters have propped up against the concrete ledge to get through a session on a hot day. Some join the revelry when a complicated trick is landed while others capture the moment on cell phones or pose for selfies with the skaters. Some bystanders help skaters clear the spot of traffic, or shift obstacles out of the way, while others will volunteer to tow the skater on a motorbike into the spot, allowing them to pick up rapid speed. And, occasionally, despite a culture ethos that seems antithetical to civic mindedness, skaters show gratitude to the public in encounters.

They repaint surfaces they have damaged, gently clear wayward toddlers out of the way, and donate product to kids standing around witnessing the "spectacular urban festivity" (O'Connor 2020, 194) generated by the provision, form, and possibilities of endless concrete. These moments reveal the rich social life of concrete that were never part of the plan when the material was poured, plans were drawn up, and sand was dredged.

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STABILITY

Diana Martinez

Concrete is a symbol of stability. The material's perceived durability and strength connect concrete constructions with projects that aspire to produce strong and stable social and political orders. These qualities made the material a fundamental part of American imperial strategies abroad forged in buildings, bridges, highways, and dams. This chapter suggests how advances in concrete engineering in Chicago's soft soil were fundamental to efforts to secure US hegemony in the Philippines.

> All Government construction should be of permanent and durable material. A building if worthy of construction is worthy of good construction. Our people are too poor, our resources too slender, our need of money too great to admit of our wasting any of that which we have. The Government buildings and bridges should always be of reinforced concrete; the roads should be built upon strong foundations, with durable surfacing, and guarded from hour to hour by roadmen to see with jealous eyes that no sign of deterioration is allowed even to appear. (Forbes 1909, 14)

On Wednesday, November 24, 1909, William Cameron Forbes delivered his inaugural address shortly after being sworn in as the fifth American governor-general of the Philippines. In that speech, he emphasized the importance of reinforced concrete construction as one of the defining policies of his tenure. Evading the consistent and popular demand for national sovereignty, Forbes presented his colonial policy as one shaped to cater to the demands of capital, which, he argued, did not care for the symbolic trappings of nationhood. As Forbes put it, "capital is not particularly interested in the color or design of the flag," but rather only demanded "stability" and "security" (1909, 12).

That Forbes prioritized stability over democracy was neither novel, nor without sequelae — it is arguably the most common activity for US military forces throughout history (Chido 2018). The US government's doctrine of stability, as understood and presented today, is a set of actions or missions intended to fill vacuums of law and order and to rebuild areas destroyed by war, plagued by "sectarian" violence, or suffering the after-effects of natural disaster, which, I argue, is subterfuge for the maintenance of US Empire. Diane Chido, the President and founder of DC Analytics, an NSA-funded private intelligence contract company, traces the origins of stabilization doctrine to post-Civil War Reconstruction — a mission that, Chido argues, was intended to "translate military success into political victory" (Chido 2018). Fleshing out her assertion, Chido asks us to

> Picture the scene: widespread famine, millions displaced, towns destroyed, transportation and sanitation infrastructure ruined, agricultural land and property abandoned, livestock rotting, violent insurgents and dangerous brigands roaming the landscape, education and healthcare nonexistent, corruption flourishing[....] [I]s this Ethiopia in the 1980s Sudan in the 1990s? [...] Northern Syria today? It is all of these, but this scene was also the reality across much of the American South in the summer of 1868. (Chido 2018)

Chido's analogy elides a crucial point. Lincoln's goals were explicitly political — aimed at reconciling and reintegrating the South with the Union. Chido ultimately refers, however, not to territories within US borders. What then, is the actual goal of stabilization operations abroad?

According to the Bureau of Conflict and Stabilization Operations (established in 2011) its mission is to "anticipate, prevent, and respond to conflict that undermines U.S. national interests" (US Department of State n.d.). Though government agencies present vital "national interests" as including "major global systems (such as) trade, financial markets, and supplies of energy" (Allison, Simes, and Thomson 2016), none would so frankly frame foreign policy as pursued according to, as Forbes put it, "the demands of capital" (1909, 12).

The goals of "stabilization" however, remain the same. The difference between early twentieth-century practices of stabilization and those of today are that they were more conspicuous, taking the form, as they did in the Philippines, of often monumental concrete infrastructures. Today infrastructure is usually lighter and more flexible and in the case of wireless communication, largely invisible. And when they are heavy, they are not heavily advertised. This constructive work offers us an alternative view of the nature of US empire, which I will examine here through the colonial settlement of the continental US. Here, I refer not to the romanticized frontier of Daniel Boone and the covered wagon, but of a second occupation of the land — by concrete.

In Chicago this began around 1833, in the immediate aftermath of the coerced signing of the Treaty of Chicago. The Anishinaabe peoples had settled in the area because of its proximity to a portage that opened the midwestern prairie lands to the greater water systems of the Mississippi and the Great Lakes, allowing them to establish trade relationships with both French beaver merchants and other Native American communities. By carrying their boats a short distance overland, the Anishnaabe peoples could paddle to the St. Lawrence or Allegheny Rivers in the east, south toward the Gulf of Mexico or toward the foothills of the Rocky Mountains in the West. During seasonal flooding the portage was entirely navigable by boat and opened great swaths of productive land to international commerce. In short, the Anishnaabeg's deep understanding of the complex environment gave them specific advantages in terms of trade and commerce (Nelson 2023).

American signers of the Treaty of Chicago viewed the portage through a different lens — as an engineering problem. They envisioned transforming a seasonally navigable passage into a permanent link between the two river systems. The Illinois and Michigan Canal was a cut in the earth only a mile and a half long, and lined with stone and mortar. Despite its relatively small size the canal instantly accelerated the rate of Chicago's growth, a growth, however, still encumbered by the condition of its soil.

Chicago's flat, flood-prone, non-porous terrain was only slightly elevated above the surfaces of Lake Michigan and the Chicago River. Surface water cut large gullies known as sloughs into the soil, the largest of which was 80 feet wide at the Chicago River, an increasingly fetid tributary of human effluence and industrial waste. Chicago's exploding population miserably coped until the early 1850s, when Chicago's 60,000 inhabitants experienced a series of cholera and dysentery outbreaks. On February 14 of 1855, a Chicago Board of Sewerage Commission organized to address the problem, hiring Boston's then-current city engineer, Ellis Sylvester Chesbrough to design what would be the United States' first comprehensive sewerage system. Undertaking a public works project of unprecedented scale, Chesbrough's first move was to establish Chicago's new City Datum — a low point toward which the water would be directed. He set elevation "0" to be level with the surface of Lake Michigan. The sewers were built above the city's datum and down the center of the city's gridded streets. Fill was sourced from the bed of the Chicago River, which was being dredged to widen, deepen, and canalize its meandering course. This fill was packed around the new sewer vaults, while a thin layer was placed atop the sewer itself. These streets were significantly higher than the land that surrounded it, facilitating drainage. All vacant lots were filled to meet the new level of the city. Existing buildings, both lighter wood-frame buildings and heavier brick and stone ones, were either demolished or raised to the new level with mechanical jacks — a Herculean task that extended through 1864. The final result was a new, dry, and carefully graded surface that sloped gently toward Lake Michigan's unbound horizon.

Chesbrough's system — a deep and engineered surface shot through with concrete — eventually allowed for Chicago's unrestricted urban growth, enabling the city's early industrial capitalists to occupy and develop a location that, though unparalleled in terms of geographic advantages, had been initially unfit for either commercial activity or human inhabitation. However, though Chesborough's remediated surface accommodated structures built in the mid-nineteenth century, these structures did not typically reach beyond five stories. By the turn of the century, population pressures and rising real estate values drove investors to demand even more of Chicago's soil — soil that architects and engineers were only beginning to discover was even more precarious than previously understood.

In 1871, in the aftermath of the Great Chicago Fire, engineers were presented with a unique opportunity. As the entire city was being demolished, they were able observe foundation performance and settlement patterns. Following a systematic survey of dozens of foundations, the engineer Frederic Baumann discovered that if the great fire had not destroyed Chicago, its soil and poorly designed foundations would have led to its slow demise. Unbeknownst to Chicago's earliest white settlers, the city sat atop one hundred feet of unstable subsoil. The only thing keeping Chicago's buildings from sinking into the ground was a thin crust of hardened clay or "hardpan," a layer between ten and sixteen feet thick that acquired its stiffness by desiccation during a temporary low water stage of the geological forerunner of Lake Michigan. Baumann's solution to this new engineering problem was the method of isolated pier foundation, which introduced conservative values for allowable soil pressures in addition to specifying that loads across the building should be as even as possible.

Baumann's method of isolated piers became standard practice in Chicago until one day in 1883 when John Wellborn Root, junior partner of the young architecture firm of Burnham and Root, presented his design for the Montauk building to Owen F. Aldis, a real estate lawyer, property manager, and liaison between Root and the building's owners, Boston Brahmins Peter and Shepherd Brooks. Considering the catastrophic losses of 1871, the Brooks brothers tempted fate by proposing to build the tallest building ever built atop Chicago's precarious surface. With plain confidence Peter Brooks wrote in a letter to Aldis: "Tall buildings will pay well in Chicago, and sooner or later a way will be found to erect them" (Condit 1964, 52). Calculating the pier size using Baumann's method, Root specified piers that were fourteen feet tall and fourteen feet square at the base. They tapered to form a one foot square column base that would sit a full three feet above the finished floor of the building's ground level. Besides seriously obstructing the first floor, these massive pyramids would have also taken up most of the volume of the basement. Aldis's immediate reaction was to balk at the size of the building's foundations. Committed to the inclusion of every modern amenity, Aldis (assuming that the building should have its own reliable source of electricity) stated matter-of-factly, "we must make room for the dynamos!" (Monroe, 1986, 114). Root headed back to the office to consider a new and different solution to accommodate what were then unprecedented loads.

Two days later, Root met again with Aldis to present his "floating raft foundation." He had replaced the massive pyramids with a shallow twenty foot square and twenty foot thick "raft" of concrete embedded with criss-crossed layers of old steel rails. Root's early experiment in reinforced concrete was fashioned out of an urban ore that accumulated in Chicago's increasingly rare open corners. Working according to the Archimedean principle of displacement, the raft prevented the uneven settlement of the building by distributing the load as evenly as possible across the building's entire footprint. It was on top of this foundation that Root built what would be the tallest secular building in the world. The Montauk building's height earned it the nickname the "Chartres of High Commercial Building."

Reinforced concrete's victory over the unstable subsoils of Chicago had important implications for the kinds of stability the US wished to produce in other more distant colonial frontiers. It would not be long before floating rafts appeared in the Philippines. There they buoyed large American buildings in Manila Bay's unstable silt. In 1902 William Cameron Forbes invited Root's partner, Daniel Burnham, to re-envision Manila as a whole. Though Burnham was most famous for being a man with "big plans," perhaps Root and Burnham's greatest achievement was to liberate architecture from a variety of environmental contingencies. This liberation was a new form of colonization, characterized not only by the conquest or acquisition of commercially advantageous territories, but by transformations in the material conditions of the land itself. These transformations were fundamental to enabling the US to realize its visions of stability through infrastructure within these territories. As I argue elsewhere (Martinez 2017), concrete construction was essential to the exertion of US force in the Philippines. Attention to the revolution in construction practices in Chicago thus reveals the ways that the mobilization of concrete to stabilize buildings in Chicago's soils was reimagined as a means of materially stabilizing American power in Southeast Asia.

Building tall in what were extremely challenging environmental conditions, Root began to grasp the contours of what he called "A Great Architectural Problem" — the title he gave to a lecture delivered to the architecture class of the Art Institute of Chicago in 1890. Root's lecture was a detailed account of the various technical issues associated with constructing the modern tall office building. This included exhaustive descriptions of advances in fireproofing, costs per cubic foot of a "general plan," positioning of piping and shafts, the spacing of windows, the placement of burglar proof vaults, and most importantly a "general theory of foundations" (Root 1967, 139). Root acknowledged that all of this was information related to those "portions of the building with which the public at large can have but little interest, but," he interjected, it is this set of concerns that forms "the inner and significant principle about which every external aspect (of the building) must arrange itself" (1967, 141).

By forging a distinction between what the expert does in the "public interest," and what he sees as knowledge so esoteric it could be of little interest to the public, Root suggested the inevitability of the public's alienation from certain types of technical knowledge — the very stuff that shaped not only Chicago's growth, but the material form of cities across the globe. Despite this, what was happening underfoot was nothing less than, to use Root's words, a "*material revolution*" (Root 1967, 130). Consciously rendering expertise as an apolitical concern, Root's contributions are further obscured by the fact that they are buried underneath the earth, and below the level of public consciousness. Though invisible this knowledge was the fresh domain of a new class of stabilization experts charged with securing the ambitions of a new empire settled by the pioneers of an American developer class.

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STANDARDIZATION

Christina Schwenkel

What can be learned from a bag of cement? Taking us to Vietnam, this chapter highlights the ways that the dreamworlds of modernity attached to cement have produced a range of technical standards and certification processes. It shows how Vietnamese cement bags link national branding and global standards, thereby producing notions of quality that supersede questions of manufacturing processes and material strength, speaking to the contested dilemmas facing many post-colonies in the global order.

Melting the Solids

In his book *Liquid Modernity,* Zygmunt Bauman (2000) describes the liquefaction of substandard, pre-modern forms in the quest to build a modern social and geopolitical order that would render the world manageable and predictable in order to ensure "lasting solidity." Cement, the primary ingredient of concrete, proved central to that effort, insofar as it came to symbolize the archetypical "melting of solids" as a standard feature of modern landscapes formed through the violent extraction and crushing of limestone heated at high temperatures to transform its porous properties into the basis of a "truly solid" modernity.

This obsession with solidity, and with conquering vernacular deficiency through durable material forms, formed the benchmark of colonial imaginaries of a progressive "concrete" futurity. While the history of cement in colonized countries is closely tied to extractive capitalism and its modalities of labor exploitation to enable industrial expansion, the production of standardized technologies like cement to produce a modern — sturdy and enduring — built environment would remain a symbol of postcolonial possibility.

This essay focuses on standardization in the building materials industry as a contested terrain of formalizing practices, conventions, and forms that are "built into infrastructure" (Star and Lampland 2009, 3). Using the example of Vietnam, I show how decolonization was bound to concrete aspirations not unlike its colonial predecessors, but in accordance with the material practices of Vietnam's own standardizing institutions and authorities. After its war for independence, state officials called for the mass production of quality cement at an unprecedented scale and speed to rebuild vital infrastructures and lay the foundations for the road to socialist modernization.

And yet, by no means was the relationship between cement and modernity natural or inevitable, despite being a politically and affectively charged matter. While spectacular concrete structures like dams, bridges, and buildings are often perceived to be visible markers of progress — the grander, the more modern — *too much* of this versatile, composite material risked allegations of being haplessly *not-yet*-modern, as in the gray, brutalist landscapes of socialism considered inhumane and substandard. Moreover, the symbolic association of non-Western cement worlds with inferior quality — the cracks in concrete surfaces suggestive of corruption and criminality in unregulated construction projects that fall short of global standards (Elinoff 2017) — shows the ways in which the meanings of concrete are neither fixed nor detached from novel forms of racial and temporal Othering.

Figure 36.1. Empty bag of blended Portland cement grade 40 at a construction site in Yên Bái province, 2020. Photo by the author.

For postcolonial countries, in particular, the connection between solidity and modernity through anthropogenic agents like concrete had to be established and maintained, also to challenge Eurocentric notions of progress that mapped ascribed standards onto civilizational hierarchies. Rather than look to vertical cities, as much of the ethnographic literature does, or limestone quarries as sites where postcolonial claims to modernity are made and contested, I shift my gaze elsewhere, to the mundane infrastructural objects at the center of material life that traverse the fault lines between national autonomy and global political economy: bags of cement (fig. 36.1).

Modernity is a Bag of Cement

Like piles of baked clay bricks (see Schwenkel 2013), bags of cement are ubiquitous in postcolonial landscapes — and not only at construction sites that showcase the booms and busts of "development." Embedded deeply in social relations of power and production, laminated paper or woven polypropylene sacks are standardizing objects that circulate widely, even globally, while continuing to serve multiple purposes at various scales, often beyond their intended utility (fig. 36.2). Nationally, cement bags point to the built and unbuilt projects of modernization that mark cycles of growth and stagnation. Individuals, on the other hand, often transform empty sacks into versatile materiality, filling them with organic matter like sand and soil for flood control or perimeter fortification, marking private property. As industrial kitsch, entrepreneurs have "upcycled" cement bags into backpacks for sale to international tourists, promoting the durability of the lightweight, plastic-mesh bags that traders salvage to transport bulk commodities to bustling markets, also clandestinely across international borders.

Historically, cement sacks were objects of imperial encounter that bespoke of colonial dispossession and a loss of state sovereignty. In Vietnam, construction of Indochina's first cement factory on the outskirts of Hải Phòng in 1899 marked one of France's largest extractivist projects to supply an expanding global construction market. The circulation across Asia of bags of *xi măng con rồng* (dragon cement), imprinted with a red serpentine logo to signify imperial strength and power, provided the material and technological scaffolding of French modernity to deliver the region from premodern backwardness.

Today, bags of cement speak to the project of decolonization as an ongoing negotiation between national and global

Figure 36.2. Landscapers fill discarded cement bags with fallen leaves in Hà Nội park, 2021. Photo by the author.

interests that inscribe state legitimacy through alignment with international standards deemed rational, objective, and befitting of modern nation-building. As such, they are objects of bureaucratic regulation and discipline that transmit symbolic information about how postcolonial countries stake a claim to modernity and carve out a place in the modern world, while contributing to global supply chains. These countries aim to do so, however, on their own terms and in adherence with their own regulatory regimes that have been similarly extractive and ecologically destructive. As standardizing objects at the nexus of power asymmetries, bags of cement express diverse values and practices of compliance and accountability. They provide insight into the "harmonization" of multiple governing agents at work in standardizing the building materials industry.

Harmonization

Cement bags do more than carry the powdery binding substance that, when mixed with aggregate and water, produce the universal construction material known as concrete. The bags themselves act as modern bureaucratic artifacts that document *what* the intended contents are, as well as *how* those materials are expected to perform. Scholars of new materialism are quick to remind us that matter does not always behave as predicted; cracks in foundations may appear owing to atmospheric changes or to pilfered materials, for example. To mitigate uncertainty about the manufacturing process or about material strength and performance, bags of cement communicate signs to certify the reduction of risk of unruly substances. Regulatory institutions of "extrastatecraft"—marked by overlapping sovereignties where "domestic and transnational jurisdictions collide" (Easterling 2014)—govern this process. Bags of cement are thus authenticating objects essential to the making and validating of international procedures and standards that discipline the global construction industry. As such they are sites of both power and resistance.

The history of cement production in Vietnam is a transnational story of locally sourced materials (sedimentary rock and labor, often female) that act with global technologies (imported machines and equipment) to build modern concrete worlds. It is closely tied to shifting geopolitical interests and economic imperatives: from French conquest and export-oriented production to state-led industrialization—initially dependent on imported cement from allied socialist countries until newly built, pre-cast concrete factories could serve the needs of regional socialist development—to market-oriented production to supply a rapidly growing commercial construction industry. Vietnam's current eighty-six plants exported an estimated 11.4 million tons of cement in 2019 (34 million including clinker), with construction of factories with larger domestic production capacity underway (*Vietnam Cement Association* 2020).

Inclusion in export markets for products like cement is not an inevitable outcome of capitalism. Postcolonial countries like Vietnam face strong pressure to ensure their commodities meet the "normative" standards of quality management and assurance set by global regulatory institutions. This pressure has been acutely felt in late- or post-socialist countries, where standardizers sought to correct the flaws of socialism and its disorderly state enterprises that produced substandard goods. And yet, standards are not only about improving quality control to reduce inconsistencies in manufacturing. They are also about improving how firms are run. As Elizabeth C. Dunn (2005, 76) has noted of Eastern Europe, the introduction of EU standards to countries moving from centralized planning to a market economy also aimed to mold newly privatized firms to "more closely resemble the organizational forms of their Western counterparts." Standards, in short, also work to ensure capitalist discipline and geopolitical hierarchies threatened by a "rising Asia."

Although compliance is rendered "voluntary," there are clear power asymmetries at work in the global governance of standards. Cement bags affirm harmonization of national practices with international norms and expectations — and not the other way around. They do so through legitimizing inscriptions that guarantee conformity through rational economic and technological performance. A typical, fifty-kilogram bag of cement in Vietnam contains certain stock information to verify accreditation (see figs. 36.1 and 36.3): First is the stamp of "Xi măng Poóc Lăng," or Portland cement, the type that meets criteria as a binding agent for making concrete. In Vietnam, Portland cement is classified according to three grades — 30, 40, or 50 — depending on the strength and durability of the material and its intended use in civil construction. This grade is assessed in accordance with Vietnamese specifications laid out by its certifying body, Quacert, the quality mark of which is typically centered on the front of the bag. Adherence to *tiêu chuẩn Việt Nam* (Vietnamese national standards), reflected in this TCVN stamp, is not meant to displace but complement or *hài hòa* (harmonize) with international standards in an effort to show best managerial and quality control practices.

Harmonization — and integration — of Vietnam's domestic cement industry with the global market is legitimized through the highly sought-after certification stamp: ISO 9001. Based in Switzerland, the International Standardization Organization (ISO) exemplifies a form of quality imperialism that rewards

Figure 36.3. "Sustainable quality confirmed": Imperial Dragon cement from Hà Nam province, produced with "European technology," 2021. Photo by the author.

economic actors for adoption of management systems and tools to improve productivity through the transfer of organizational practices and standards touted as internationally agreed upon by quality experts or "equals" (ISO 1997). For Vietnamese enterprises, ISO certification promises to increase competitiveness and improve access to international markets and global supply chains. This market "edge" is not only tied to a set of quality improvement techniques, however. Bags of cement connect product quality and predictability to the material foundations of production with mottos such as "Công nghệ Đức" (or Nhật or Pháp) — Made with German (or Japanese or French) Technology — featured prominently on the front of bags (fig. 36.3). This marketing strategy demonstrates incorporation of advanced technological machinery and conformity to international norms.

Conclusion: Discipline and Defiance

It might be easy to conclude that the "harmonization" of standards in the production of durable concrete worlds is but another modality of neoliberal governmentality that facilitates the flow of capital and goods through consensus rather than coercion. Bags of cement, however, are also commonplace objects that deploy potent cultural symbols to express nationalist ideals and sovereign sensibilities to mitigate external standardizing forces, while contributing to the overall goal of nation building — both materially (through concrete structures) and ideologically (through articulations of autonomy). Company logos, for example, draw on powerful imagery associated with origin narratives and struggles for sovereignty, from mythic animals, like royal dragons or war elephants used to fight against Chinese invasion, to infrastructural objects, like the famous Hàm Rồng bridge that withstood relentless US air raids (fig. 36.3). We might then see such expressions of resilience, together with the constellation of actors that comprise both international and domestic standardizing institutions, as reflecting a convergence of governance strategies at work in socialist societies, that is, as a negotiation between capitalist globalization (or "Westernization") and economic sovereignty, rather than simply the former encroaching on the latter. This contention is best conveyed in the large, block-letter stamp found on all bags of cement: *Tiêu chuẩn Chất lượng Việt Nam:* Vietnamese Quality Standard.

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TIME

Cristián Simonetti

Concrete is both a historical achievement and a temporal process. It interrupts time, but also takes place across time. In a material sense, this means that the "thing" of concrete becomes more concrete until it no longer is such. This chapter considers how, in Chile, concrete comes together through standards, regulations, and seismic events and, in so doing, links the bodies of laborers, engineers, urban migrants, and even mischievous citizens as they create and erase their own Anthropocenic gestures within the planet's geologies.

Rupture and Regulation

The image below corresponds to a standard concrete cube that has been recently tested for its compressive strength. These cubes are examined around the world in specialized laboratories before any building starts to ensure the mix will endure earthquakes. The cube came out of a customary fifteen-centimeter cubic mold, which are known in Spanish as *probetas* (test tubes), and had been waiting for the past 48 hours in an atmosphere-

Figure 37.1. "Concrete Test Cube." Photo by Cristián Simonetti.

controlled chamber. The hourglass shape resulting from the test signals that the ingredients — cement, gravel, sand and water — were correctly balanced, mixed, and cured. This particular cube — a Chilean example — is a local instantiation of a global phenomenon: it is a product of modern engineering, cemented in the western hylomorphic tradition, according to which inert matter acquires meaning and purpose through form. I followed this example in November 2017 in the company of Claudio, chief engineer of a concrete laboratory at Melón, the first company to mass produce and sell cement — concrete's glue — in Chile. It initiated its operations in 1908 at La Calera, a town 115 km away from Santiago.

From its very origins, concrete has been represented as a material capable of enduring environmental disasters, a key concern driving Melón's operations. Compared to traditional materials such as wood, concrete is capable of repelling fire. Compared to adobe, stone, or brick, reinforced concrete can resist earthquakes. The latter has been particularly significant for the recent history of Chile, where concrete has contributed to enduring the violent movements of an earthquake-prone geography. Reinforced concrete was adopted in response to major seismic events at the start of the twentieth century.

Ever since, the recurrence of such events has forced the industry to periodically revise regulations and standards for concrete-building. Regulations now specify every aspect of the material's role in construction processes, from the quality and quantity of ingredients to the gestures involved in the mixing. Geological events such as the 2010 earthquake — an 8.8 earthquake on the Richter scale, the fifth highest magnitude ever recorded in human history — can impact regulations globally as engineers study the strength of mixes in dialogue with research networks distributed across countries. The ongoing improvement of such regulations has maintained and materialized some of the most intimate aspirations of modernity around the globe.

Eternal Gestures

Safety regulations thus make the aspiration for modernity material, allowing it to be crafted in the daily gestures performed by workers mixing, molding, and finishing the surfaces that compose the built environment. Workers in charge of finishing the upper surfaces of concrete forms, including those who work at Melón, labor to trowel away the very gestures that create these forms, pretending that the finishing of surfaces has not resulted from the movements of the trowel. In short, they work to erase their own hands from the final form. In doing so, they craft a seemingly ahistorical platform that implicitly claims the present for modernity. Ironically, the mirror image of this work of erasure often occurs as random urban dwellers who, in discovering fresh concrete, leave their own marks on history by placing their hands into the smooth surfaces of the fresh, still-wet mix.

Each test cube sent to Melón's laboratory replicates this play of gestures on a small scale. The cubes echo actual construction processes, claiming the present and, perhaps, modernity on a microscale. Such gestures, standardized like the form and content of the cube, are phenomena that mingle, partially unconsciously, with global narratives of progress. Melón was founded at the start of the twentieth century just as migration to Santiago began increasing exponentially. The company's slogan was *lo bueno es eterno* ("The good is eternal") (Booth 2018). This motto not only survives until now as engineers working at research and innovation laboratories strive to extend the life of these "artificial rocks," but it also resonates with how contemporary archaeologists refer to the ways in which Romans built their vast empire using concrete, as the title of the Brandon et al. (2014) book *Building for Eternity* suggests.

The aspirations of urban migrants were similar. They arrived in Santiago to come closer to modern hopes for an everlasting present, leaving behind traditional materials such as wood. In Chile's case wood comes mostly from the Araucanía region located south of Santiago, where a large part of Mapuche indigenous territory is concentrated and which Santiago elites often publicly regard as backwards. But travelling outside the surfaces of Santiago rapidly connects urban dwellers with their rural origins and with nature. Indeed, the vast concrete surfaces of mega cities, such as Santiago, have created an impermeable platform that has prevented, quite literally, the growth of organic matter from below ground and has elevated modernity above tradition.

Despite its ubiquity in modern times, concrete presents itself often as a stranger to inhabitants of the urban landscape. Only a percentage of the people living in Santiago — mostly males related to the building sector — have mixed concrete. Indeed, concrete is an extremely gendered substance. In the particular case of Melón's laboratories, women's presence is often secretarial. Workers and engineers involved in the mixing, testing, and transport of concrete are exclusively men, with a few rare exceptions. However, concrete is a stranger in yet another, perhaps more fundamental sense to many inhabitants of the built environment, including those working directly with concrete, such as the workers and engineers at Melón laboratories. Concrete is one of the big contributors to global carbon emission. Cement production alone contributes between five and eight percent, figures that can go up to ten percent depending on the source, which Claudio confessed to having learned only recently, and as a complete surprise, when we met in early 2017.

Concretocene?

From a geological viewpoint, concrete is intimately related to the Anthropocene, a term proposed by geologists to name the current geological epoch, to highlight humans as a geological force currently driving changes in earth history. Concrete is, according to geologists in charge of formalizing the Anthropocene proposal, the most abundant human made rock in earth history, practically all of which has been produced after the material was rediscovered and patented by Joseph Aspidin in Victorian England in the midst of the Industrial era (Waters and Zalasiewicz 2018). Taken globally, the vast amounts of concrete poured for infrastructure and megacities like Santiago now constitute one of the most distinctive human-made stratigraphic layers visible at a geological scale. Humans have poured enough concrete to cover the entire surface of the planet with a few millimeters of the material.

Accordingly, concrete is a candidate to signal the start of the Anthropocene. Yet, unlike any other potential marker proposed by the geologists in charge of formalizing the new epoch, concrete may be the only marker that has the potential to provide a clear, distinctive clue as to who might be responsible for the current environmental crisis (Simonetti and Ingold 2018). Clearly, rural areas outside Santiago cannot be blamed equally for the environmental damage caused by global warming, as economies across the north and south hemisphere cannot be placed on equal grounds. Over the past decades concrete production and consumption has correlated with developmental indicators such as those of the World Bank, with the result that most of it has been concentrated on the Northern Hemisphere. Concrete — baptized by Aspidin as "artificial rock" in his patented formula of 1824 — creates a planetary stratum that is simultaneously geological and social, the diachronic formation of which provides an archaeological record of the uneven distribution of environmental responsibilities that lead to the Anthropocene predicament. Perhaps the new epoch could also be named the *Concretocene* (Simonetti 2023).

Yet, concrete and humans share even deeper roots with the Earth's forces, as geologists from Melón, working on the extraction of ingredients for the production of cement, suggest (Fonck and Simonetti 2020). A reason behind concrete's large contribution to global CO_2 is that producing cement requires burning limestone — a sedimentary stone made mostly of fossilized seashells — at temperatures of between 1400° and 1900° Celsius. To achieve such temperatures, cement kilns require huge amounts of fossil fuels. In other words, producing cement involves burning fossils with fossil fuels. Curiously, the shells that compose the limestone share their origins with the emergence of vertebrate bones, including those of humans. Both of these resulted from a process of calcification started 542 million years ago that resulted in what is called the Cambrian Explosion, where most animal philia known today originated in the oceans. Just like our vertebrate ancestors, who slowly crawled out of the ocean to populate the earth, the conglomerates of seashell that compose limestone had emerged slowly from the seabed in response to the intense and slow seismic movements that still shake Chilean coasts.

Who would have imagined it? Just as Friedrich Nietzsche had referred once to the *human self,* the material that is most familiar to humans in this human epoch is the strangest surrounding humans. Like the forms, mixes, and gestures involved in the making of a concrete test cube in Melón's laboratory, humans in the new epoch belong simultaneously everywhere and nowhere, in that the "anthropos" of the new epoch tends to remain unspecified, as humanities scholars have systematically critiqued. Concretes, just like the humans who inhabit the new epoch, are a testimony of how the boundaries of the global and the local, as well as the long and the now, blur in the Anthropocene. In the effort to protect their soft bodies from the forces of nature hoping to transcend it, modern humans have contributed unconsciously to invert earth history, releasing in an instant all the CO_2 accumulated slowly, over millions of years, in the fossilized seashells that compose limestone. As a result, humans have created their own coral reefs on land to shelter themselves from the forces of nature. Yet, as the cube in the above image testifies, sooner or later, just like the dreams that sustain modernity, this coral reef will have to yield to the passage of time and the steady forces of Chile's seismic environment. Ultimately, no concrete mix remains impervious to decay, ethereally sealed off from the ongoing transformations of the environment.

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UNCERTAINTIES

Jerome Whitington

There is an important paradox to concrete construction: On the one hand, concrete is generally reliable, predictable, and scalable. Humans successfully build an incredible array of complex things with concrete. With maintenance, proper materials, and sound construction techniques these projects can last a long time and perform in a reliable manner. On the other hand, the results of any concrete project are profoundly uncertain. Sometimes these uncertainties are spectacularly violent and disruptive, as in massive infrastructure failures; other times they are more subtly destructive, legible only at the scale of everyday life. In Laos, even where dams perform in the ways they are expected, the social, economic, and ecological changes they inspire are wide-ranging and profoundly uncertain.

✣

Imagine a twenty-seven-meter-high dam spanning a narrow cleft in a low mountain ridge. The setting is central Laos, where a series of rivers descend from the Annamite Cordillera, which forms the border with Vietnam, toward the Mekong River that forms the border with Thailand to the west. The curved arc of the dam's crest presents a convex surface of concrete grace, interrupted as if by gothic ribs regularly spaced to provide added strength to this critical body of infrastructure. We sit across from the dam, myself and a research assistant being offered a tour by a local village leader. Looking upstream, the reservoir is brimming with energy during this monsoon-season afternoon. The clouds in the distant mountains are moody and foreboding, the river churning with its own power as it flows over the concrete spillway into an expanse of whitewater below the Theun-Hinboun Dam. For this relatively modest project, "the imaginary and the real figure each other in concrete fact" (Haraway 1997, 2).

This dam spans some 250 meters across the mountain cleft, holding back a volume of water weighing millions of tons. The design matters. Hydraulically, the Theun-Hinboun Dam is a transbasin diversion scheme — the water is channeled from a high elevation river through a five-kilometer tunnel beneath a mountain ridge, for an elevation drop of some 230 meters before it exits the turbines into a much smaller river that carries it on to the Mekong. The elevation difference is crucial for its power-generating capacity because it provides remarkable pressure — some 28 atmospheres — to power the turbines. The tunnel itself is lined with 28cm-thick, pre-cast concrete segments that are just over seven meters in diameter. Concrete offers "the promise of permanence" (Elinoff and Rubaii in this volume). Engineers described some of the challenges which the concrete tunnel lining was meant to address. These included friction from the rapidly flowing water, which would substantially reduce available energy for power generation, and the possibility of a "water hammer event," that is, a potentially catastrophic pressure wave that can cause the structural failure of the engineering works.

Hans Blumenberg argues that societies ascribe to image and metaphor whatever it is they cannot comprehend about themselves (1997, 1). Hence, it is worth noting two especially salient metaphors that attempt to capture the significance of large hydropower dams. On the one hand, they stand as temples of modernity that herald a vision of secular progress. Concrete perhaps more than any other material stands as an image for the mastery and control over the brute forces of nature. On the other hand, dams promise to harness the unconstrained power of rivers, as if the social order has been bound to powerful forces of the earth barely restrained. If these two metaphors present a paradigm of riparian domination, their dissonance also presents a paradox: the apparent solidity of concrete precipitates a cascade of open-ended transformations in ecologies and lives, thrust into an unknown future. In what follows, I sketch hydropower's cascade of concrete uncertainties across three terms that link the affective and the cognitive, the imaginative and the real: promise, apprehension, and commitment.

In the early 2000s, the Lao hydropower industry, with major support from the World Bank and Asian Development Bank, was attempting to establish the social basis through which large dams could be publicly negotiated, funded, and built. Following the 2006 decision to move forward with the highly controversial Nam Theun II project, this basis for legitimation was more or less established and a torrent of new projects quickly flooded the country's numerous highland valleys. "Public negotiation" in this context largely refers to the negotiations of development NGOs as well as transnational advocacy networks that significantly targeted the industry and its multilateral funders in the 1990s and 2000s. In other contexts, advocacy networks worked in alliance with substantial popular movements, as in the case of India's Narmada River project, but in Laos any form of popular mobilization was promptly routed by the authoritarian government.

Thus, people and other living beings along Laos's rivers needed to contend with an industry used to getting what it wants while it burnished its new "green" image. But those riparian lives also needed to learn to cope with a form of neoliberal development finance interested in regulating and disciplining developing country governments through environmental mechanisms, and with an authoritarian state rightly concerned with its own autonomy and development yet convinced that modernity entails moving people away from hills and rivers toward roads and towns. Modernization and development are social projects that project a future. Jan Pieterse (2000) has described development as the management of a promise, and a promise is a kind of opportunistic speech act that takes advantage of the unstable possibilities at hand.

Promise

Large dam projects are like strange attractors or magnets that pull all kinds of people into their powerful orbit of desire. Asking what people want from dams — what is the locus of the power built into their hydrology and mythology — already foregrounds the trembling uncertainty apparent in terms like anticipation (Adams, Murphy, and Clarke 2009) and promise (Fortun 2008). Promises are the first thing to arrive when developers start making plans. These quickly turn at least some villagers into project spokespersons often prominently featured in public venues to tout the commoners' apparent desire for modern houses, roads, and possibly education and even jobs. Promises help demonstrate that uncertainty cannot be reduced to expert risk calculation even if, for example, some experts develop interesting methods such as scenario-based reasoning as alternatives to prediction and control schema (Samimian-Darash and Rabinow 2015). The uncertainty is rather the topography of an earth politics that experts, engineers, and propagandists attempt to sculpt into a future.

But how does one evaluate a promise? In one meeting in Vientiane, project developers were courting MIGA, the political risk insurance arm of the International Monetary Fund, which required a public consultation to assure everyone that villagers consented to the project. Public consultations are designed to fulfill due diligence for international lenders, and they function strictly as calculated, performative rituals of state. A panel of three villagers spoke to attendees in the conference room of a prominent hotel, while in the wings a pair of creepy state security officers made sure they knew what was expected of them.

"Yes, of course we want to support the government's aims in exchange for new houses and education," the villagers told the assembled audience. There was not and could not be any suspicion of their sincerity. One technician from the department of agriculture and forestry asked the only question of note: How are you going to feed yourself if you no longer have any rice fields? The villagers had no answer, suggesting the power of a well-targeted question to disrupt the performance of state.

The question resonates for me in several registers, without settling down. How are *you* — you hill rice farmers who live in a remote mountain valley far from any major road, going to make it on marginal land in the lowlands? *How* are you going to do it — concretely speaking, where is that food going to come from? And how are you going to *eat?* By what strategy will you survive? Do you have any idea what you're getting into? The issue concerns the demise of your whole livelihood strategy, upon which your autonomy and your comprehensive way of being depends. Who will you be when your sons leave first for the city and then to find seasonal work in Thailand — when your daughters migrate for service work or listlessly earn a few kip selling at a roadside kiosk?

Uncertainty is a diagnostic mode of experience that can form the basis for learning how to ask better questions and demanding greater responsibility from promoters of things like large dams. If we understand concrete sociotechnical objects as transformative and powerful, then uncertainty helps assess how their powers constantly exceed the forms of knowledge available for comprehending them. Whether vernacular or expert forms of knowledge, the forms of comprehension and experience they engender are not characterized by predictability, confidence, or calculation but by something more akin to apprehension (Shapiro, Zakariya, and Roberts 2017). One might pause to consider how an affect such as apprehension can enable potentially life-sustaining questions.

Apprehension

Hence uncertainty is neither a gesture of helplessness (as if we do not know anything) nor a simple absence of predictability or lack of clarity (cf. Birkenholtz and Simon 2022). It is not a narrative move in which things seem "indeterminate," when serendipity and seemingly unpredictable conjunctions mark the end of inquiry (Tsing 2015). Rather, uncertainty situates inquiry at those breaking points where knowledge fails and forms of life must reconstitute their capacity for existence. The villagers' future dispossession is surely predictable but that tells nothing about what kinds of lives they will make for themselves, or indeed the calculus they invoke when they must decide whether to accept the terms of a promise and commit to the unknown future it betokens. Most importantly, uncertainty is not an argument against understanding the systemic effects of transformed environments. Rather, by holding open diverse ecological futures attentive to their potentiality, uncertainty offers an ethnographic mode for the multiplicity of powers swirling around novel earth relations (Whitington 2018, 146–52, and Whitington and Oguz 2023).

Indeed, uncertainty demands attention to the specificity of real relations, whose causal forces are life-determining yet neither indeterminate nor determined. Apprehension, evoking a structure of feeling and the attempt to grasp the actuality of a dangerous situation, describes an unstable relation to matters of fact that can be neither taken for granted nor interpreted transparently.

Downstream from the powerhouse of the Theun-Hinboun hydropower project, the Hinboun river complex has suffered extensive and continuous erosion since the dam was opened in 1998. The dam's pulsating effluent cuts against the banks of the river, steadily eating away the land as soil sloughs off the banks, now undercut and inaccessible. Once gardens were planted here in the fertile flood zone. Now the river is progressively wider and much shallower. The turbid waters carry heavy loads of sus-

Figure 38.1. Naa siang (risky paddy) in central Laos. Photo by the author.

pended solids, sharply reducing photosynthesis at the core of the aquatic food web.

Thousands of tons of sand and gravel pulse downstream as moving waves of sediment that smother rapids and fill deep pools that were once breeding grounds and prime fishing habitat. Since these sand banks move, the annual flooding of adjacent rice fields now varies dramatically, even as the monsoon rains are supplemented by the continuous output from the dam. During the time of my research, floods lasted longer and were less predictable. Villagers described certain fields as *naa siang* (risky paddy) to index the dilemma over whether to plant them. *Naa siang* might not flood for three years, slowly seducing farmers into trusting their temperament, only to suffer devastation. Moreover, the silt-laden water reduced the number of days the rice plants could stay submerged. The silt induced a slimy bacterial growth on the plant stalks, leaving them matted, wet, and rotting after the water receded.

Apprehension indexes a structure of experience that is tightly linked to the articulation of powerful material-semiotic relations. *Siang* (risky) here carries much of this connotation since it directly voices the problematic of decision — "should we plant or not?" — yet does not evoke the forms of probabilistic reasoning central to debates about expert knowledge and risk society. What the dam threatens is to disable villagers' specific form of life. I like the term apprehension because it invokes knowledge and affect without presuming mastery, and lets expertise articulate with vernacular knowledge in unexpected ways. Indeed, apprehension suggests that one knows just enough to understand that looming possibilities may be disastrous, and carries the connotation of grasping toward a viable future. Such grasping might be figured in term of commitment.

Commitment

How does one live on a river that has been transformed in ways fundamentally difficult to assess? This question of viability concerns the difficulty of assessing in advance shifting ecological and economic possibilities, but it also concerns any personal and social transformations that may be required to conform to powerful new sociotechnical dynamics. I use the term "commitment" to capture the difficulty of knowing in advance *who one might become* when one is given over to relations that far exceed the conditions for knowing them (cf. Cohen 2013). Commitment thus describes the terms of assent when people affirm power relations whose obligations cannot really be assessed at the outset.

The question of viability was especially germane in the context of the hydropower company's sustainability efforts, which sought to recast village life in opportunistic, aspirational, and motivational terms. The ongoing transformation of the river placed tremendous emphasis on experiments with dry season rice, for it was the possibility of benefitting from a second harvest each year, without the threat of flooding, that captured the imagination of farmers and technicians alike. This involved village credit schemes, provisioning of fertilizer and high yield seed, and especially the promulgation of a new ethos of motivated, market-oriented entrepreneurialism. From the hydropower company's technical standpoint, they could not imagine ongoing village life outside of an entrepreneurial, market-based future. Yet regardless of that entrepreneurial future, the sustainability efforts required commitment to new power dynamics — seductive yet murky and frequently unintelligible.

Keovilay, a young farmer who had already been planting some dry season rice, had been enrolled in the pilot program and was involved in the push to expand. He was eager at the outset, speculating aloud about being able to buy a hand tractor if the crop was good. Later, when the company technician made his rounds, they argued: the seed given to them smelled bad out of the bag, and it never sprouted. The technician suggested he had let it soak too long or bruised the seed by treating it roughly, but Keovilay and his neighbors rejected that argument and demanded new seed, only some of which germinated. The fertilizer had also been damaged — the fifty-kilogram bags had turned to hard bricks when it should have been a fine powder.

Many farmers readily embraced the possibility of commercial production through enhanced methods. Their mode of affirmation was built upon their commitment to expertise and a new domain of material relations that in turn required an elaborated relationship with the company and its technicians. Like many farmers, Keovilay was convinced the fertilizer was the problem. They had been instructed to put on too much, and they were unable to spread it evenly. What had been promised as technical wizardry had shifted to a different kind of imaginative uncertainty in which they had to finesse a cruddy product. Using a hammer, they smashed the bricks of fertilizer into chunks as best they could, wondering if it would release its magic into the soil or perhaps burn the plants for being overly concentrated. The rice then grew beautifully with full, lush tillers, but it failed to flower properly and there was very little grain. His fields yielded only about one ton per hectare, a far cry from the grandiose promises of the company technicians.

Meanwhile, the technician insisted that these problems were caused by a parasite that had affected farmers across the region. Keovilay laughed heartily, or maybe it was bitterly, when I suggested perhaps next time the advice will be better. “He won’t be back,” he said. “He said we might get 10 tons!” Yet the debate with the company had shifted. Saiphong, another field technician, had come by several times, badgering them to repay loans taken out for the failed crops. The villagers mocked her in gendered tones. “She’s like a busybody auntie trying to find out what you spend your money on,” one said. They simply did not feel responsible for paying back the loans, but Saiphong’s argument was different: “if they don’t make payments into the fund, where will they borrow money next season?” A former village chief, who had been involved in setting up the project, showed me a list of all the farmers and their debt commitments he had signed when the original disbursement was made. He expressed regret for helping sell the dam project to his village. “We believed the company and followed all the directions — now there is no trust.”

Like the boundary between water and soil that refused to settle into a stable relation, villagers’ lives were thrust into new domains of technical and economic expertise. Commitment to the rules of the game meant entering into a pact with far-reaching consequences, especially the requisite entrepreneurial ethos, the demand for trust in expertise that nonetheless refused to take responsibility for its mistakes, and the threatening horizon of new debt relations. For Keovilay and his neighbors, commitment implied holding on to the thin possibilities of a personal transformation, but it produced a chaotic unraveling of its own premises. Commitment is a wager, the subjective stakes of which cannot be known in advance. After all, it is plausible that joining the ranks of intensified market production just might work through a big sociotechnical push like this. In that sense, commitment implies imagining a future that might be possible, but only if everything works just right.

Promise, apprehension, and commitment are just a few possible terms to open up what might be called an onto-epistemic approach to concrete uncertainties. Focus on the limits and breaking points of knowledge — holding open ethnography to what is not known — demonstrates how this dynamic, anthropogenic earth is not a thing possessed or even a disaster zone, but a kind of delicate, embodied relation having its own histories and infrastructural possibilities. This is especially true for ecological knowledge such as the generations of vernacular expertise through which farming communities fine tune the possibilities of living in some relatively stable configuration. Social scientists have long been accustomed to the idea that human knowledge is built into seemingly natural landscapes in myriad ways, yet what we do not know is also expressed ontologically. More than 52,000 dams have been built since 1950, altering about 75% of all rivers and comprising 96% of impounded reservoir volume (Syvitski 2022). The frequent negative environmental consequences associated with large-scale ecological transformation, toxic ecologies, or planetary climate change seem to be characterized by a profound denaturalization in which what we do not understand about ourselves is expressed in the concrete uncertainties of the emergent earth.

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UNIFORMITY

Mo H. Zareei

Concrete is a mimic, often mimicking itself. Its uniform capacities generate structural predictability and endless repetition. The material's uniformity was fundamental to its embrace in early- and mid-twentieth-century Brutalism. In both progressive and developmentalist contexts, Brutalist architecture emphasized the material's expression of itself as an expression of publicity, accessibility, and social democracy. Although often derided, concrete's uniformity in Brutalist public housing in Iran also generated artistic inspiration. Consider its sonic aesthetics.

Scene One

Ekbatan (Sharak-e Ekbatan) is a Brutalist residential complex located five kilometers west of Tehran's city center (fig. 39.1). It was developed in the 1970s as part of the city's master plan by a mixture of international, domestic, public, and private partners, developers, and architects. The complex spans 200 hectares and is "one of the most extensive and innovative Middle Eastern public housing projects" (Sedighi 2018). For nearly five decades,

Figure 39.1. Ekbatan: block A1 entrance with city backdrop (left), promenade and gardens (middle), and building close-up. Photo by Hoda Zareei.

it has accommodated thousands of blue-collar and white-collar families in more than 15,000 apartments. Divided into three main phases, the apartment blocks form a series of concrete megastructures that are interconnected through shared integral gardens. Ekbatan's development was kickstarted amidst a period of urbanization that was a part of a broader land reform and industrialization program initiated by the Shah (monarch) of Iran. Although an avid anti-communist and a friend of the US, the Shah launched this program in part as a preventative effort to counter the potential political mobilizations that were shaping up in socialist projects across the globe. Nevertheless, a key outcome of such progressive public programs was a substantive growth of the middle class, one that played an inevitable role in scaffolding the social movements that led to the 1979 revolution and the toppling of the monarchy.

I grew up in Ekbatan. My earliest childhood memories were formed amongst the giant Lego-like blocks of concrete and glass. Born after the 1979 revolution and in the middle of the war with Iraq, I took my very first steps on what seemed like an infinite terrain of perfectly identical zig-zag paver blocks. The bunker-like expression of these concrete giants carried a sense of security. As I grew taller, so did the assortment of plane trees and pines outside my window. I experienced my first spring blossoms, summer leaves, autumn colors, and snowfalls there. Through the change of seasons and years, the buildings remained the same. They conveyed a sense of stillness and steadiness. Like many of my friends and classmates who grew up there, I developed a strong attachment to the sensibilities of these concrete structures, their parallel lines, strict geometries, and material uniformity. Ekbatan was a haven of coherence amidst the chaos of the city's ever-expanding sprawl and rapid post-war development.

Scene Two

After completing an undergraduate degree in physics at Shahid Beheshti University of Tehran, I moved to California in the summer of 2010 to study at the California Institute of the Arts (CalArts). I chose to study music technology, which seemed somewhat connected to my physics background. Rather than start with traditional instruments, I learned to synthesize sound from scratch, using codes and circuits. By custom-designing both hardware and software, I got to work with the most low-level building blocks of music production, basic oscillators and soundwaves, figuring out various ways to combine and process them. As someone with limited experience or interest in traditional notation and theory, I found this alternative approach to music education deeply motivating and empowering. My background in physics also sharpened my understanding of the acoustics and electronics sides of things.

One of the major sub-disciplines within the music technology program at CalArts was musical mechatronics, sometimes referred to as musical robotics: an interdisciplinary combination of electromechanical engineering, microcontroller programming, industrial design, and music. Musical mechatronics involves the augmentation of conventional musical instruments with automated mechanisms that replace the role of the human performer. This was an area that I became very interested in, and used as a stepping stone for the ideation of PhD research, when I moved to New Zealand in late 2012 to study at Victoria University of Wellington.

Scene Three

When it came to the aesthetics of sound and the style of music, what I had in mind differed from the standard use case for musical robots. I developed an inclination toward the type of independent experimental electronic music in which the conventional musical elements of melody and harmony were superseded with broader modalities of texture and structure. Typified by genre neologisms such as glitch and microsound, the source materials employed within such musical practices were often stripped back to the sonic artifacts of the technological mediums that enabled them. The noise of a CD skipping, the crackling of a bad connection, or the blips of a software error were aesthetically elevated to replace the role of notes, melodies, and harmonies in musical expression. Although conventionally "non-musical" in their essence, such sonic material was embraced as fertile ground for artistic exploration and expression within post-digital experimental music. In some sense, the movement has historical parallels with the one led by the Italian futurists, such as Luigi Russolo, who called for expanding the limited boundaries of musical sound and an artistic investigation of noise in the wake of the Industrial revolution at the dawn of the twentieth century (Russolo 1986).

Inspired by such aesthetic approaches, I set out to develop my own mechatronic instruments in which the conventional musical instruments were removed and the musical output was stripped back to the sonic by-product of the medium itself: the inbuilt noise of the electromechanical machines.

Scene Four

Why was I so drawn to this stripped down, reductionist, and "anti-beauty" sense of aesthetic? What compelled me about the

Figure 39.2. Ekbatan: rooftop view. Photo by Hoda Zareei.

type of radically minimalist works championed by artists such as Ryoji Ikeda, Pan Sonic, or Zimoun, and their textural and temporal uniformity? Walking around my childhood neighborhood, surrounded by its immaculate geometries and austere material palette, it all came back to me during a visit back home. The answer was Ekbatan, and the strong sensibilities behind its uniform arrangement of concrete, glass, and gardens (fig. 39.2).

Scene Five

Realizing the impact of my deep-rooted topophilia on my aesthetic preferences set me on the path to research Brutalism. A post-war architectural movement, Brutalism's original mission statement was defined by Reyner Banham as "1. Memorability as an Image; 2. Clear exhibition of Structure; and 3. Valuation of Materials 'as found'" (Banham 1955). In some sense, Brutalism was architecture's response to the art world's radical modernist ethos such as the modernist appreciation of raw material, emphasis on functionality, and rejection of ornamentation. In Brutalist architecture, the building's raw material is valued not only for its function, but also its aesthetics.

Concrete was an essential medium for the Brutalist ethos. As Simon Henley articulates in *Redefining Brutalism,* concrete's capability "to express structure and potency of matter in building" (Henley 2017, 49) played an important role in its dominance in an architecture that was very much concerned with imagery and sculptural qualities. Though important to the Brutalist aesthetic, the style has wrongly become synonymous with any large building made of concrete. Nonetheless, it is important to underscore that Brutalism is by no means limited to style, fashion, or any singular building material. A rebellion against the lightheartedness of modern architecture, Brutalism's first generation was a call for material honesty, whether that was concrete, brick, timber, or steel. Though for decades to come it would be mostly reduced to certain polarizing stylistic features in the public eye, Brutalism originated as an ethically and politically driven architecture that was guided through the anti-beauty and anti-academic aesthetics of the time (Banham 1955).

Expansive discussions on why and how Brutalism gained, lost, and regained popularity over the past six decades are beyond the scope of this short chapter. In brief, Brutalist projects were expressions of twentieth-century progressivism. The style and the values it expressed were synonymous with the large public facilities that were dismantled in the 1980s. The rise of neoliberalism targeted both the political economies and the values Brutalist buildings asserted. Yet, instead of highlighting the effects of "socio-economic inequalities, increasing poverty and the onset of neoliberalism" (Mould 2017, 707), Brutalist projects received blame for inner city decline. Dismissed as concrete monstrosities epitomizing the perceived failure of the crumbling welfare state, many buildings were demolished.

Despite being deemed a failed movement by some, the architectural style has made a tangible comeback over the past decade, and its revival, much like its origin story, goes beyond an aesthetic trend. "Whilst much of the profession [of architecture] is drawn further and further into the 'business' of architecture and the assembly of buildings from manufactured components" Simon Henley writes on Brutalism's resurgence, "there is a community seeking a material, sometimes monolithic, at times heavy, structural and constructional and consistently visceral social architecture" (Henley 2017, 226). Oli Mould suggests that this revival can be explained as a critique of the past decades of neoliberal urban practices and gentrification processes (Mould 2017, 701).

Its exact cause aside, the increasing number of books, publications, media features, blogs, and dedicated social media pages over the past decade speaks clearly to Brutalism's resurgence. This revived movement gave me an interesting window into what I had broadly recognized as a rejection of post-modernist tendencies within post-digital sonic arts. Although not explicitly linked in any manner, there seemed to be some parallels between the Brutalist aesthetics and ethos and the expanding body of independent sound-based practices that inspired my research into what I defined as "sound-based brutalism."

Scene Six

I utilized Brutalism as a frame of reference for the type of sound art that celebrates the materiality of basic raw material — whether that is an unadorned digital soundwave or "non-musical" sounding object. In an article titled "Sound-Based Brutalism," I define the term as "reductionist, minimalist and functional qualities which provide form for the provocative 'anti-beauty' aesthetic wherein noise replaces the concrete and other physical materials of Brutalism" (Zareei et al. 2016, 57).

I had grown up in a culture where formal complexity was traditionally regarded as a virtue when it came to art and architecture. It might be partly due to this fact that despite its significance as an architectural and social project, Ekbatan did not received the critical attention that it deserved in Iran, at least on the academic level. As such, my appreciation for Ekbatan and its aesthetic principles was driven primarily through lived experience and guided through a self-motivated academic endeavor.

In parallel to this, while relevant in the contemporary discourse of sound art, most of the independent and experimental music practices that inspired my research had few ties to the Western Art Music establishment and received very little attention from music academia. In fact, my initial encounter with this music came about through friends and self-guided research, and fell entirely outside of my university studies. Therefore, a motivation for my PhD research was to counter this academic inattention by formalizing the conceptual and aesthetic principles that connected these works of independent music.

Historically, these musical aesthetics share the formal simplicity and rigorous repetition of early musical minimalism. They also have connections with the experimentalism and noise of Futurism and Fluxus. Ranging across different artistic mediums, styles, and practices, such post-digital experimental sound works seemed particularly connected through their direct and uncompromising use of conventionally non-musical or "anti-beauty" source material. Another one of their shared features was clear expression of formal and compositional processes within the organization of this material across temporal and spatial axes. Whether a sound installation or a fixed media composition, a clear, audible — and also visible, in case of audiovisual works — formal structure could be immediately identified. Using simple beat-based rhythmic units and remorseless repetition, the uniformity of sonic materials that are often limited in their palette and devoid of complex harmonic or melodic maneuvers extends into a sense of temporal stasis: "one can enter the gallery, or click the play button at any point in a piece, and the audible structure reveals itself within the next few pulses, beats or bars" (Zareei et al. 2016, 53).

Scene Seven

Having established a conceptual framework, I recontextualized and completed the development of my mechatronic instruments with a mind to an explicit realization of this sound-based Brutalism. Titled *Brutalist Noise Ensemble* (fig. 39.3), the project en-

Figure 39.3. Mo H. Zareei, *Brutalist Noise Ensemble.*

tailed a series of mechatronic sound-sculptures that expressed the sonic and visual qualities of their constituent components — that is, electromechanical machinery — as found.

By expressing but regulating the sound of the instruments' raw material in terms of rhythm and timbre, and structuring them through strictly metric rhythmic patterns, the aggregation of these sound-sculptures as an ensemble affords the composition of a temporal grid of noise constructed from various timbral units and rhythmic layers. In doing so, what is normally hidden inside the black box of a machine is brought back to the foreground in a fully visible and audible form. A sonic equivalent of the visual memorability of Brutalist architecture, this audible structure is established through the use of a steady-state sonic palette and purely grid-based rhythms (Zareei et al. 2016, 57–58).

My current art practice continues to place emphasis on the visceral materiality of sound, extending the Brutalist approach toward the organization of sonic material. My latest project, *Material Sequencer,* re-investigates one of the most elemental tools of electronic music production: an 8-step rhythmic sequence generator. The sound-sculpture takes the entire sequencing process into the physical realm, where an electromechanical

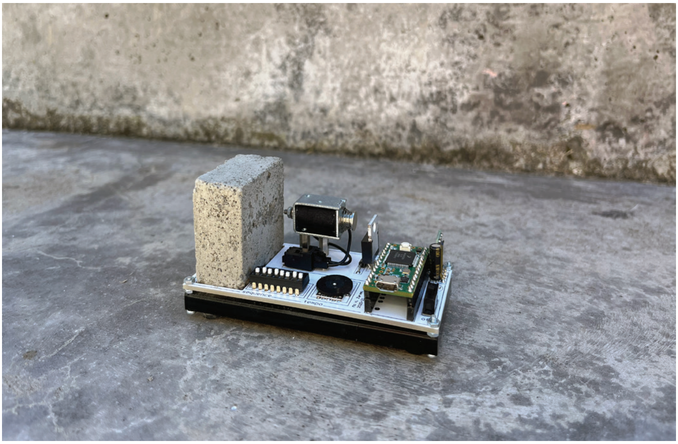

Figure 39.4. Mo H. Zareei, *Material Sequencer (Concrete edition).*

actuator that is presented on a fully exposed, custom-designed circuit, strikes a block of solid material — that is, steel, brass, wood, etc. — to generate sound. Using a number of basic controls, the user can change the rhythm and rate of the sequence and interact with the sonic output in a tactile and physical way. In this way, what is normally a process hidden inside the machine and experienced through loudspeaker amplification is brought to the foreground, where what you hear is what you see and what you see is what you hear. Contrasted against the fabricated electronics, the organic materiality of the solid block shines as the centerpiece, with its sculptural uniformity symbolizing the formal aesthetics of the resulting sound: a series of constantly repeating rhythmic units devoid of melodic and timbral variations. In a special edition developed for the purpose of this publication, the material block is made out of concrete, paying homage to the architecture that has inspired this work (fig. 39.4). Grains of gravel and cement form a solid block reminiscent of Brutalist concrete slabs; but here, the concrete is used to make sound, from a series of repetitive pulses that extend the aesthetics of uniformity across the temporal domain.

Scene Eight

In the portfolio of sound-based artworks developed over the past decade, my affinity for a congregation of raw concrete has been expressed as a certain aesthetic sensibility for basic — and conventionally perceived as extramusical — sonic material. Growing up in Ekbatan, I remember the sense of unease the complex's monolithic Brutalism induced in many visitors. Guests would often be lost in the neighborhood, confused by the uniformity of structures across the various blocks. Nevertheless, what they would see as bleak homogeneity, my peers and I experienced as a unifying identity that shaped, and was shaped by, a form of social democracy.

We lived amongst identical concrete structures. Our apartments had the same design, the same doorknobs, the same water taps, the same built-in wardrobes, and the same wall-to-wall double-glazed windows. We shared the same playgrounds. We walked on the same concrete walkways surrounded by the same gardens. We went to the same schools and shopped at the same shops. We congregated around the same benches and adopted the same slang. And for the most part, we were raised in the same class of middle-income families. This democratized sense of uniformity, although not all-encompassing, prevailed over many social hierarchies and connected us through a strong bond; one that the Brutalist concrete monoliths that surrounded us embodied themselves.

In the same vein, when it comes to what I have identified as sound-based brutalism, there is a balancing of the hierarchical musical structures on multiple levels. From the source material standpoint, the noise of a DC motor is embraced as having no less artistic potential than a well-tuned violin. There is also a democratization of means of production for the practitioners whose creative practice primarily relies on internet tutorials, DIY tools, and laptop computers. And on a broader level, within this sound-based brutalism, the ivory tower of academia does not reign over what sound is worth listening to; what is, and what is not music; or who is, and who is not, an artist.

When initially formalizing the framework for sound-based brutalism, my focus was primarily on the aesthetics of material choice and formal structure. On reflection, now I wonder if this sound-based brutalism — like its architectural counterpart — might be viewed as extending beyond aesthetics and style, and onto the political front of the art of sound organization. In the same way that Brutalist architecture sought to generate social democracy through its uniform structure, sound-based brutalism attends to all materials as potentially musical. After all, it was through Ekbatan's uniform concrete that the possibilities of music itself were extended and expanded for me.

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WARSCAPING

Kali Rubaii

Modern warfare is constructive: militaries build as they destroy. These constructions reflect prevailing ideas about how violence should be waged, and they structure the meanings and experience of peacetime. Concrete has been particularly essential to wartime construction in Iraq. Like other battlefields in the War on Terror, urban space in Iraq was transformed to wage a war based on logics of containment and surveillance. Tracking the figure of the t-wall, this chapter demonstrates the precise role concrete played not only in remaking space for war but also in shaping everyday life and its political possibilities in the putative aftermath of wars.[1]

A warscape is a landscape transformed in the image of, and for the production of, ongoing warfare. Militarized wall formations, like t-walls, are essential to the production of a warscape. T-walls weaponize concrete by creating contemporary battlefields (COIN 2007, Shane III 2016).

1 Much content from this chapter was previously published in Rubaii (2022).

Figure 40.1. T-wall factory, northern Iraq, 2021. Photograph by the author.

Standing inside a t-wall factory in Erbil in the summer of 2021, I am struck by the fact that, nearly twenty years after the US invasion of Iraq, these military walls are still in production. T-walls are six-ton steel-reinforced, blast-proof concrete wall segments named for their upside-down T shape (fig. 40.1). They were introduced to Afghanistan and Iraq in the early 2000s. Derivative of the Berlin wall's design, they are recognizable to those who have witnessed the Israeli separation wall, which is composed of thousands of t-walls lined up (fig. 40.2).

T-walls are sometimes called "concrete soldiers," nonhuman beings that do the world of warscaping: they turn a landscape into a militarized place, one conducive to the logics of warfare. T-walls operationalize logics of remote-imperialism, speed, and social division.

Figure 40.2. A t-wall in its mold, northern Iraq, 2021. Photograph by the author.

Over the past few years, the demand for t-walls has expanded from exclusively military consumption on bases and to form checkpoints, to include embassies and municipal compounds, a shift reflective of how the War on Terror weaves itself into increasingly ordinary architectures. In Iraq, the "War on Terror" is no longer just a set of doctrines and methods integral to US invasion and subsequent occupation, but also a landscaping project shaping material encounters far beyond the immediacy of war and counterinsurgency. In fact, the "War on Terror" has become a paradigm by which not only contestation but also "peace" is conceived and constructed through ongoing militarization accomplished through concrete.

When the US military securitized Iraq's landscape for its own bases in the 2000s, it also walled off neighborhoods in urban areas in response to sectarian violence. In fact, this process materialized a sectarian landscape by dividing Iraqis into deeper segregation. The carceral logic of military landscaping reflected a derivative of siege warfare: instead of attacking to break through fortified barriers, the US imposed a siege on the enemy by building walls. In other words, in order to use the method of a siege, they had to first produce conditions of seigability, to generate an environment that made sieges possible. At night US forces walled in the borders of cities, as well as neighborhoods like Sadr City in Baghdad, with twelve-foot-tall t-walls.

Walls were not the only function of these carceral objects: traffic could be stopped or funneled within minutes of setting up t-walls, changing routes of mobility and lines of separation with minimal lethal force. With t-walls, checkpoints could become permanent valves in the arterial flow of roadways: instead of stopping movement, such barriers could leverage the direction of movement by funneling people, vehicles, and goods in certain directions and not others. T-walls could just as readily be moved to the side to make space for passage, temporarily. T-walls thus extended military spatial dominance, infusing logics of coercion and confinement into the landscape itself. Over a short time, t-walls transformed Iraq into an archipelago of enclaves (Neimark et al 2023). These walled enclaves might appear as if they offer protection from the very militarized world such walls have produced. In such a warscape, peace appears to be predicated on separation, on the diminishment of mutual exposure (Robbens 2010).

Concrete, and the characteristics that come with it, were essential to this project. Concrete barriers can be quickly erected and quickly moved compared to brick or stone walls, which take time to build and remain in place once constructed. The precast character of a t-wall enables these barriers to be mobile and modular, allowing the carceral state to reconfigure the warscape where and when it needs for specific purposes. For example, t-walls can be put in place for specific operations and then temporarily removed when a diplomat comes to visit.

Concrete can be poured into almost any shape, filling almost any desired contour, from a sidewalk or curb to a monument or a non-descript prison wall, blurring the boundary between weapon and world-making material. Concrete also performs the sensory function of cutting off the capacity to imagine or access what might be on the other side. The material limits our capacity to see and hear one another, narrowing the possibilities for conviviality that would be possible with more porous barriers like fences. The relative malleability of concrete makes it easy to activate in a wide range of forms, while its heavy weight, sensory opacity, and material density make it solid enough to partition spaces and people with lasting effects.

Thus, while concrete can be militarized as a feature of urban warfare and counterinsurgency, like to limit armed Iraqi resistance to military occupation by the US, concrete is also be deployed as a "peacetime" segregation instrument to limit popular resistance against wealth accumulation, privatization, and corruption (Caldeira 2001). In other words, the carceral capacities of concrete limit exposure to accountability for social and economic violence caused by and beyond combat. In Iraq today, the Green Zone has transformed from a military base to a place where political and economic elites can come and go without intimate contact with daily life in Iraq. Meanwhile, as traffic flows past them in Baghdad, t-walls stand ready for activation at almost every street corner: within hours, the flow of daily life can be shut down. Rather than the fixed, bunkered landscape of battlefields, t-walls transform warscaping into an active set of practices that militarize space by constantly manipulating it. The implications of this new, flexible approach to warscaping are that a high degree of proximity does not necessitate intimacy; high-flex portability does not mean temporariness; and pop-up zoning does not require fixedness to make security regimes permanent. The warscape becomes the cityscape, made permanent by and through its very flexibility. This accounts for how the t-wall and its forms of militarization are now part and parcel of daily life in purportedly post-war contexts like Iraq.

This insight reflects a broader truth about how, when approached materially, warfare extends itself into peace via constructive violence: the model of peace offered by the "War on Terror" is a landscape built for potential war at all times in all places. Just as the trenches and bunkers of the first two World Wars (see, for example, Byrne in this volume) and the dams of Cold War development (see Elinoff in this volume) reflected ideas about war and peace, the warscape composed by t-walls is shaped by domesticized carceral architectures that reflect particular visions of the contemporary world, not unique to Iraq but part of a prevailing spatial logic that reaches a distilled pinnacle here. Iraq's warscape suggests how its peace is shaped by military detritus in waste spaces and public spaces that absorb t-walls as well as barbed wire barriers and surveillance technologies (fig. 40.3). These post-war material constructs aggregate global diffusions of violence in ways that point back to geopolitical actors like the state or global systems like supply chains: as a universalist project like the "War on Terror" intersects with capitalism,[2] landscapes become cluttered with objects like drones, militarized police gear, t-walls, and military bases.

T-walls and their ongoing production reveal the myriad ways postwar construction manifests a militarized vision of peace in which the bunker is a haven (see Dvorak in this volume). That which is constructed appears as a source of security, rather than as a central mechanism for social disruption. What t-walls really do is constitute the material framework for structural violence, branded as peaceful, defensive, and the norm.

Military leaders like generals David Petraeus and James Mattis, architects of US counterinsurgency in Iraq, are aware of how landscapes are multipliers of force, and how human relations are situated in material landscapes. They used a Human Terrain System, which was oriented to both geographic and social cartographies, to engage in winning Iraqi and Afghani hearts and minds, but also to map the relationship between social groups and Iraq's diverse ecologies. In other words, the practitioners and theorists of the "War on Terror" both imagined and made Iraq's landscape in the image of a warscape.

But, the warscape, a spatial arrangement of things like bodies and carceral objects, produces lived social conditions on the ground that are unique from how they may be imagined from warplanes above. For those who are colonized, this infusion of geopolitical war and peace into the landscape makes the "War

2 Catherine Besteman refers to this dynamic as "militarized global apartheid" (2020).

Figure 40.3. T-walls in Baghdad, 2021. Photograph by the author.

on Terror" more granular, and more lasting, not as an aftermath of battles, but rather as a core component of the project.

In Iraq, the "War on Terror" infuses militarism into daily life, not necessarily in new ways. As some of my interlocutors in Iraq mentioned, t-walls not only disrupt their navigation, they also signal disinvitation. In Baghdad, one cannot get anywhere without t-walls carving off elite spaces from the public, or preventing public spaces from being public: at minimum they are a nuisance. The fact that t-walls are now being ordered by municipalities, embassies, and other spaces that were formerly accessible public institutions speaks to the stratified and limited condition of democratic potential. Since the 2018 protests in Iraq—which called for an end to imperialism and corruption in a country where government institutions do not feel accountable to the people—more t-walls are on order to maintain the prevailing spatial modality of "peaceful" public life in which all landscapes can be activated as warscapes. In this way the "War on Terror" echoes in forums of public life, integrated into coercive landscapes via construction.

The "War on Terror" echoes many imperial landscaping projects that militarize order and peace by infusing structural violence into construction. T-walls are but one example of how the warscape constructs peace by stabilizing warfare as a basic condition of order, an order whose disruption is framed as violence.

Construction for the sake of structural violence upholds the imperial logic that dismantlement and destruction are problematic whereas creation and construction are always good. This logic normalizes structural violence, fetishizing construction and its objects while criminalizing destruction and dismantlement (Osterweil 2020). What statues and monuments are protected and why? What are the costs of tearing them down? Purely constructive paradigms of "peace" respond to destruction as inherently violent, even as such systems are undergirded by the threat of state violence (Nader 2005). Meanwhile, abolitionist paradigms of justice recognize that dismantlement is a prerequisite for justice (Shange 2017). As I write elsewhere, "When war becomes stabilized, it may be called a state of peace for those who benefit from its structural stability. Thus, the term 'peace' might always be read as 'order' and interrogated with the question, 'for whom?' (Virilio and Lotringer 2008)" (Rubaii 2023).

T-walls make visible how built into the architecture and landscape of the so-called postwar period is perpetual potential for the next war. Construction reveals the priorities set on a landscape. In Fallujah today, a new shopping mall just opened, but many homes remain bullet-pocked or dilapidated. Checkpoints are everywhere, surrounded by t-walls and operated by al-Hashed militias and the Iraqi army. Concrete abounds, whether as crumpled walls of bombed houses or brand new wall installations for freshly securitized private spaces.

I look at t-walls, at these concrete columns and the resources that go into their being made "blast proof," "defensive," and also "soldier-like," and I wonder what happens to our conception of peace when we think materially about the violent relationship between peace and construction?

As the "War on Terror" conceals itself in forms of constructive continuity, camouflaged yet embedded into the very fabric and architecture of spatial and social order, it becomes increasingly urgent to highlight and make visible what it does. One thing it does is to weaponize the contours of material and social life, to build a warscape.

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Contributors

Nasser Abourahme is a writer and teacher, and currently Assistant Professor of Middle Eastern and North African Studies at Bowdoin College. He's the author of *The Time beneath the Concrete: Palestine between Camp and Colony* (Duke University Press, 2025).

Julie Soleil Archambault is an associate professor of Anthropology at Concordia University. Cutting across much of her research is an interest in how materiality and temporality intersect in the crafting of lives worth living. Her book, *Mobile Secrets: Youth, Intimacy, and the Politics of Pretense in Mozambique* was published by the University of Chicago Press in 2017.

Rebecca Bowers is an LSE Fellow at the Department of Anthropology, London School of Economics. Her research focuses on gendered and inter-generational experiences of inequality, globalization, labor informality, and the present socioeconomic effects of pandemic-related policy.

Emily Brownell is a senior lecturer in Environmental History at the University of Edinburgh. Her book, *Gone to Ground: A*

History of Environment and Infrastructure in Dar es Salaam, was published by the University of Pittsburgh Press in 2020.

Denis Byrne is a professor at the Institute for Culture and Society, Western Sydney University. With a focus on Asia and Australia, he works across the fields of archaeology, critical heritage studies, and the environmental humanities, currently with a particular interest in coastal reclamations as technofossils of the Anthropocene

Mona Chettri is the co-founder of Reading Himalaya, a research and policy consultancy focusing on the eastern Himalaya. She is the author of *Constructing Democracy: Ethnicity and Democracy in the Eastern Himalayan Borderland* (Amsterdam University Press, 2017), and the co-editor of *Development Zones in Asian Borderlands* (Amsterdam University Press, 2021). Her current research focuses on Himalayan urbanisation, gender, and migration.

Rachel Cypher is a PhD Candidate in the Department of Anthropology at the University of California, Santa Cruz. Her research examines life in agro-industrial landscapes, specifically soy plantations in Argentina.

Greg Dvorak is a professor in the Graduate School of International Culture and Communication Studies at Waseda University. His book *Coral and Concrete: Remembering the Kwajalein Atoll between Japan, America, and the Marshall Islands* was published by the University of Hawaiʻi Press in 2018.

Matt Edgeworth is a field archaeologist working mainly on large infrastructure projects in the UK. He is also an Honorary Visiting Research Fellow at the University of Leicester.

Eli Elinoff is a Senior Lecturer of Cultural Anthropology at Victoria University of Wellington. His research explores the intersection between politics, urbanization, and environmental transformation in Southeast Asia. His book, *Citizen Designs: City-Making and Democracy in Northeastern Thailand,* was published by the University of Hawaiʻi Press in 2021.

Matthew Gandy is a professor of Geography at the University of Cambridge and an award-winning documentary filmmaker. His most recent book is *Natura Urbana: Ecological Constellations in Urban Space* (MIT Press, 2022).

Claudia Gastrow is an assistant professor in the Department of Sociology and Anthropology at North Carolina State University. Her research focuses on processes of city making in central, southern, and eastern Africa. Her book, *The Aesthetics of Belonging: Indigenous Urbanism and City Building in Oil-Boom Luanda,* was published by the University of North Carolina Press in 2024.

Erik Harms is a professor of anthropology and Southeast Asian studies at Yale University. His book, *Luxury and Rubble: Civility and Dispossession in the New Saigon,* was published by the University of California Press in 2016.

Cassandra Hartblay is Associate Professor in the Department of Health and Society at the University of Toronto, Scarborough, and in the Department of Anthropology and the Centre for European and Eurasian Studies at the University of Toronto. Their book, *I Was Never Alone or Oporniki: An Ethnographic Play on Disability in Russia,* was published by the University of Toronto Press in 2020. A second monograph will be published with Cornell University Press in 2025.

Penny Harvey is a professor of Anthropology at the University of Manchester. She works on infrastructures, materiality, and state practice, and is currently writing on “Nuclear Life” in the UK.

Naomi Haynes is a Senior Lecturer and Chancellor's Fellow in Social Anthropology at the University of Edinburgh. Her research examines the intersection of religion and political economy. Her first book, *Moving by the Spirit: Pentecostal Social Life on the Zambian Copperbelt,* was published by the University of California Press in 2017.

Heid Jerstad is a social researcher working on transport in the public sector in Scotland. She founded the *Weather Matters* website and supports PhD students and others looking to build research careers outside academia.

Tong Lam is an associate professor of history at the University of Toronto, with research projects on infrastructure and the politics of information. His most recent project focuses especially on Cold War mobilizations in China and elsewhere, and their environmental consequences, as well as China's postsocialist transition.

Vanessa Lamb is an associate professor in the Department of Social Science at York University and a Senior Research Fellow (Honorary) in the School of Geography, Earth and Atmospheric Sciences at The University of Melbourne. As a geographer, she studies social, political, and environmental change with a long-standing focus on rivers and water governance in the fields of political ecology and political geography. Dr. Lamb completed her dissertation, *Ecologies of Rule and Resistance,* in 2014, and in 2019 co-edited with Carl Middleton, *Knowing the Salween River: Resource Politics of a Contested Transboundary River* (Springer, 2019).

Gabriel Lee is a history teacher at The Putney School in Putney, Vermont. He has a PhD in US History from Stanford University. His current research examines the environmental history of Portland cement in the United States in the first half of the twentieth century.

Lukas Ley is an environmental anthropologist at the Max Planck Institute for Social Anthropology in Halle, Germany, where he leads the DFG-funded Emmy Noether research group on the infrastructural lives of sand in port cities of the Afrasian Sea. His research is concerned with urban marginalization, temporality, and material environments. Ley's first book, *Building on Borrowed Time: Rising Seas and Failing Infrastructure in Semarang,* was published by University of Minnesota Press in 2021 and was awarded the Social Science Prize by the European Association for Southeast Asian Studies.

Diana Martinez is an assistant professor and Director of Architectural Studies in the Department of History of Art and Architecture at Tufts University, where she holds a secondary appointment in the Department for the Study of Race, Colonialism, and Diaspora. Her book manuscript, *Concrete Colonialism: Architecture, Infrastructure, Racial Capitalism and the American Colonial Project in the Philippines,* is under contract with Duke University Press. Her work is published in *The Avery Review; Comparative Studies of South Asia, Africa and the Middle East* (CSSAAME); *Architectural Theory Review*; and in *Architecture in Development* (Routledge, 2021).

Rowan McCormick is a builder and PhD candidate in cultural anthropology at Te Herenga Waka – Victoria University of Wellington. He is presently researching in the field of autoconstruction of alternative housing in Aotearoa New Zealand.

Duncan McDuie-Ra is a professor and head of School of Arts and Social Sciences at Monash University Malaysia. Recent books include: *Insurgent Play: Social Worlds of Urban Disruption* (Anthem, 2025); *Skateboard Video: Archiving the City from Below* (Springer, 2021); *Skateboarding and Urban Landscapes in Asia* (Amsterdam University Press, 2021); and with Dolly Kikon *Ceasefire City: Militarism, Capitalism and Urbanism in Dimapur* (Oxford University Press, 2021).

Siddharth Menon is a PhD Candidate in the Department of Geography at the University of Wisconsin, Madison. His research interests lie at the intersection of economic and urban geography, political ecology, critical development studies, and science and technology studies (STS). His doctoral dissertation project examines how the rapidly transforming built environment of cities in India intersect with wider circuits of transnational migration, capital investment, and resource extraction in the era of global climate change.

Tim Oakes is a professor of geography at the University of Colorado, Boulder. From 2018 to 2023 he was Project Director for China Made, an international research collective exploring the sociotechnical dimensions of China's infrastructural model of development. He has held recent visiting faculty positions at the University of Oslo, the University of Hong Kong, and the National University of Singapore. His forthcoming book is *Living in Nuclear Asia: Sociotechnical Perspectives on Nuclear Power Development, Risk, and Vulnerability* (University of Toronto Press, 2026).

Marina Peterson is a professor of Anthropology at the University of Texas, Austin. Her most recent book, *Atmospheric Noise: The Indefinite Urbanism of Los Angeles,* was published by Duke University Press in 2021. She is also the author of *Sound, Space, and the City: Civic Performance in Downtown Los Angeles* (University of Pennsylvania Press, 2012), and co-editor of *Global Downtowns, Anthropology of the Arts: A Reader* (Routledge, 2016), and *Between Matter and Method: Encounters in Anthropology and Art* (Routledge, 2017).

Kali Rubaii (https://www.kalirubaii.com/) is an assistant professor of anthropology at Purdue University. Her research explores the environmental and health impacts of militarism in Iraq, and along the supply chain of war.

Elihu Rubin is the Henry Hart Rice associate professor of Architecture and Urban Studies at the Yale School of Architecture. His book *Insuring the City: The Prudential Center and the Postwar Urban Landscape* was published by Yale University Press in 2012. He directs the Yale Urban Media Project, a place-based public scholarship initiative in New Haven..

Christina Schwenkel is professor of anthropology at the University of California, Riverside and author of *The American War in Contemporary Vietnam: Transnational Remembrance and Representation* (Indiana University Press, 2009) and, most recently, *Building Socialism: The Aftermath of East German Architecture in Urban Vietnam* (Duke University Press, 2020). She has published widely on architectures of memory and the material politics of infrastructure decay and destruction during and after the Cold War.

Lila Sharif (https://www.lilasharif.com) is a creative writer, educator, and researcher based in the Phoenix area. She is Assistant Professor at the School of Social Transformation at Arizona State University. She is a co-founding member of the Critical Refugee Studies Collective as well as the Palestinian Feminist Collective.

Cristián Simonetti is Associate Professor in Anthropology at the Pontificia Universidad Católica de Chile. His work has concentrated on how bodily gestures and environmental forces relate to notions of time and has engaged in collaborations across the sciences, arts, and humanities to explore the environmental properties of materials relevant to the Anthropocene, particularly concrete.

Pinai Sirikiatikul is an assistant professor at Silpakorn University, Bangkok, focusing on Thailand's construction history from the late-eighteenth to twentieth centuries. His recent work, *Unpacking the Archives: Amorn Srivongse* (The Association of Siamese Architects under Royal Patronage, 2020), sheds light on the often-overlooked contributions of architect Amorn Srivongse to Thai modern architecture, offering new perspectives on the country's architectural development.

Constance Smith is Senior Lecturer in Social Anthropology at the University of Manchester. She researches the afterlives of architecture and planning in the UK and East Africa, and how these endurances act on the future.

Rosalie Stolz is a postdoctoral researcher at the University of Cologne where she leads the project *Construction Pioneers: Building Innovation in Upland Northern Laos*. In her research, she focuses on house transformations in mainland Southeast Asia and beyond. She is the author of the book *Living Kinship, Fearing Spirits* (NIAS Press, 2021) and co-editor of the volume *Houses Transformed* (Berghahn, 2024).

Malini Sur is a Senior Lecturer in Anthropology and a Senior Research Fellow at the Institute for Culture and Society, Western Sydney University. She is the author of *Jungle Passports: Fences, Mobility, and Citizenship at the Northeast India-Bangladesh Border* (University of Pennsylvania Press, 2021).

Tyson Vaughan is a civil works and water resources policy analyst and a scholar of the social dimensions of disaster recovery. He has conducted research on participatory recovery planning in post-disaster Japan and "citizen-science" in his hometown of New Orleans. As a Sociologist at the Institute for Water Resources, US Army Corps of Engineers, he works to improve federal policy, engage the public, and enhance the resilience of American communities facing environmental risks. With Eli Elinoff, he co-edited *Disastrous Times: Beyond Environmental Crisis in Urbanizing Asia* (University of Pennsylvania Press, 2020). He holds a PhD in Science & Technology Studies from Cornell University.

Jerome Whitington is a clinical assistant professor at New York University, where he teaches anthropology and environmental studies. His book *Anthropogenic Rivers: The Production of Uncertainty in Lao Hydropower* (Cornell University Press, 2019) offered a new materialist reading of late industrial ecologies in Laos. He has also published on climate change and related issues in journals such as *Public Culture, American Anthropologist,* and *Environmental Humanities.* He is currently working on a book manuscript titled *Experimental Earth: A Speculative Anthropology of Climate Change.*

Mo H. Zareei (https://millihertz.net) is an Iranian sound artist and researcher based in New Zealand. Drawing inspiration from scientific, physical, and architectural principles, his artistic practice ranges from electronic music composition to kinetic installations. He is a senior lecturer in Sonic Arts at Victoria University of Wellington and publishes his music through Room 40 (AU), Important Records (US), LINE imprint (US), and leerraum (CH).

Austin Zeiderman is Associate Professor in the Department of Geography and Environment at the London School of Economics. He is an interdisciplinary scholar who specializes in the social and political dimensions of urbanization and the environment in Latin America and the Caribbean, with a specific focus on Colombia. His books include *Endangered City: The Politics of Security and Risk in Bogotá and Artery: Racial Ecologies on Colombia's Magdalena River,* both published by Duke University Press.