Chapter 1

The History of Cob

Earth is one of the oldest and most common building materials. It has been used in one form or another wherever the local geology provides clay soils suitable for construction—which is most places on most continents. The known history of earthen building goes back at least 10,000 years: adobe houses dating from 8000 BC have been discovered in Turkmenistan, rammed earth foundations from 5000 BC exist in Assyria, and the 4000-year-old Great Wall of China was constructed primarily of rammed earth. Many surviving earthen buildings around the globe have been in use continuously for centuries and provide living laboratories for what techniques and designs work best in each region. And the earthen building tradition is far from dead. The UN estimates that 30% of the world's population today live in homes made of unfired earth.[1] People in many parts of the world find building with earth to be a practical way to meet their present-day needs, and, as we will see, these techniques are still evolving and adapting to a modern context. This book focuses on cob, and especially on the ways information recently acquired through scientific testing of this ancient building system can be used to improve the durability, performance, and acceptance of cob buildings.

Villagers in the Indian state of Punjab building a cob house in 2020. This is one of many parts of the world where ancient earth-building traditions have been passed down generation to generation to the present day. Credit: Sanskar Hardaha/Alamy Stock Photo

To contextualize cob within the field of traditional earthen building, it is useful to look at the three major approaches that have developed over the millennia for constructing load-bearing walls primarily from earth. Perhaps the simplest system, variously called *cob, monolithic adobe*, or *coursed adobe* in English, is to mix clay subsoil with water, straw, or other fiber, and sometimes sand or gravel until it is firm but still workable, and then shape the resulting compound into a wall while still wet. Historically, each layer, or *lift*, of this fiber-stabilized mud was allowed to dry before the next one was added. The second technique is known in English as *adobe* (a word which derives from the Middle Egyptian via Arabic and then Spanish), or *mud brick*. A very similar combination of clay soil, water, and fiber is mixed to a plastic consistency, then formed into blocks using simple molds. These mud bricks are left to dry in the sun and then stacked to make a wall, with a thin layer of earthen mortar in between. The third system is *rammed earth*. Slightly dampened earth, usually with a high proportion of sand and/or gravel, is compacted inside a sturdy form. When the form is full to the top it can be removed immediately and reassembled upward to construct the next section of wall.

Cob, adobe, and rammed earth are all still viable today, and each of them is currently enjoying a resurgence in various parts of the globe. Of these three systems, cob is probably the least well known in North America and has been the last to receive serious attention in the areas of engineering research, code development, and modernization of the building process to make it more accessible to contractors and comprehensible to building officials. Recent efforts have begun to address that lack. But before delving into the present and future of cob construction, we'll take a quick glance at the history of this remarkable building system.

The First "Age of Cob"

The term *cob* (probably from the Old English for a *loaf* or *lump*) originally referred to monolithic earthen building methods native to Devon and the West Country of England. The clay subsoil there is particularly well-suited to earthen building and provided the raw material for many of the iconic whitewashed, thatch-roofed houses that are popularly associated

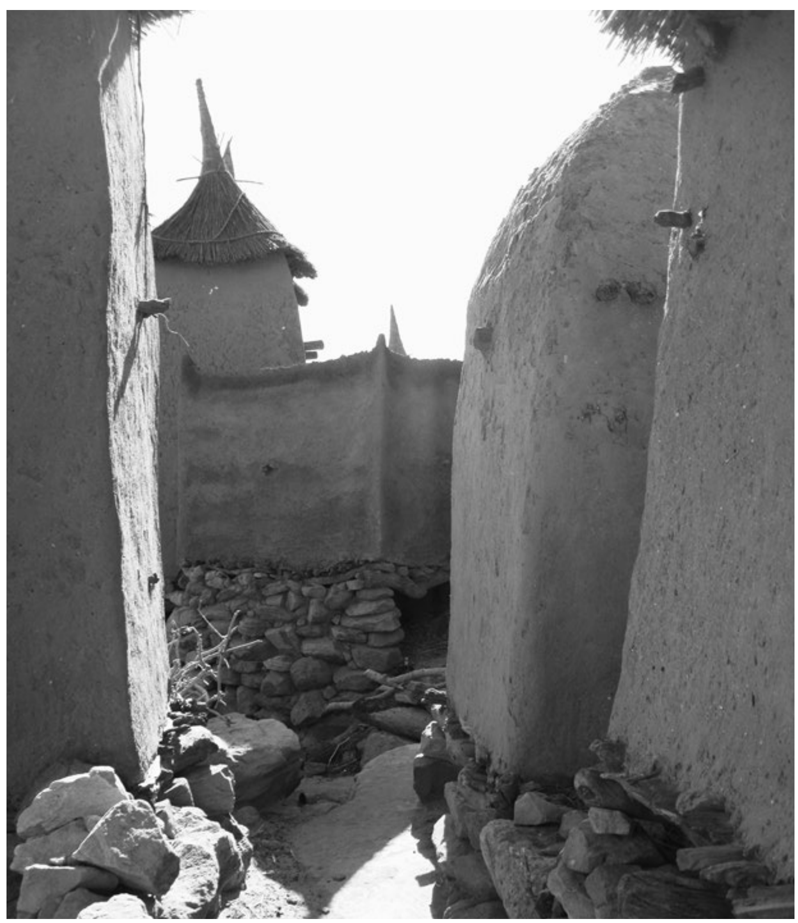
This picturesque cottage in Lincolnshire, with its decorative reed thatch, hip roof, and whitewashed lime plaster, is typical of cob houses in England and southeastern Ireland.
CREDIT: FÉILE BUTLER

with the UK countryside. It is estimated that there are still at least 20,000 cob houses in Devon, and an equal number of barns, outbuildings, and boundary walls.[2] These structures were built by mixing clay soil with water and straw in a pit using people or cattle as mixers, shoveling it up onto a stone foundation and compacting it in place by walking on the fresh cob and beating the sides of the wall with a paddle, then trimming and finishing the walls with lime plaster. The buildings constructed in this way were very thick-walled (2' to 3' thick, [60–100cm] or even thicker) and were usually one or two stories tall.

There are many other living (and extinct) traditions of earthen construction in which moist straw-reinforced clay soil is used to build a wall without additional structure or formwork. These systems have many names in different parts of the world: *mud wall* in Ireland, *bauge* in France, *tourton* in Belgium, *lehmweller* in Germany, *daga* in Mali, *swish* in Ghana, *tamboho* in Madagascar, *zabur* in Yemen, *pahsa* in Turkey, *tawf* in Iraq, *chineh* in Iran, *dorodango* in Japan, and *coursed adobe* in the American Southwest. Building systems similar to English cob evolved in countless regions, including much of Northern Europe from Ireland to Ukraine, France and Germany (in both countries, at least 50,000 cob buildings remain in use today [3]),Spain, Portugal, Italy, many parts of Africa, including the Maghreb and the Sahel, the Middle East and the Arabian Peninsula, parts of East Asia, and Mexico. Because the terminology is so diverse and poorly understood and the earthen building techniques in many areas have been little studied by academics, the architecture of these regions is often erroneously said to be of mud brick—and in some cases, the techniques of cob, adobe, and rammed earth overlap in the same region or even in the same building, making the situation even more confusing. The West African nations of Morocco, Mauritania, Mali, Niger, and Burkina Faso are especially renowned for their mud architecture, which ranges from simple one-room homes and granaries to majestic mosques and public buildings such as the Great Mosque of Djenné in Mali, which is believed to be the largest earthen building in the world. The 16th-century walled city of Shibam in South Yemen, known as the "Manhattan of the Desert," contains hundreds of mud "skyscrapers" (towering up to 11 stories tall) built out of both cob and adobe brick. In Afghanistan, Pakistan, and India, people continue to build cob homes and public buildings following traditions that are many centuries old.

Indigenous peoples in what is now the Southwestern US built with coursed adobe from at latest 1200 AD until the 17th century, when the Spanish introduced the adobe block.[4]

In a Dogon village in Mali, these granaries are constructed with cob walls, which help maintain even temperatures and humidity levels for the storage of millet and other grains. CREDIT: SCOTT HOWARD



The Taourirt Kasbah in Ouarzazate, Morocco. This fortified complex of almost 300 rooms was built with a combination of cob, rammed earth, and mud brick from the 17th through 19th centuries. It served as residence and administrative center for a powerful ruling family. CREDIT: CATHERINE WANEK

By the 1300s the method was sufficiently developed to allow the construction of pueblos with walls 1' (30 cm) thick and up to five stories high. The earliest parts of Taos Pueblo were constructed this way approximately 900 years ago, making this multi-story apartment building the oldest continuously inhabited building in North America.[5] Many archaeological sites and surviving structures in New Mexico, Arizona, and Utah show clear evidence of coursed adobe,[6,7] including Casa Grande in Arizona and Horsecollar Ruin in Utah.

English colonists carried the technique with them to New Zealand, Australia, and the Northeastern US, where a number of cob homes were constructed in the 18th and 19th centuries.[8] Cob buildings have proven practical in many climates, ranging from windswept northern coastlines to hot arid deserts.

Cob building remained a vigorous tradition throughout much of the UK until the late 19th century. By then, the construction of new cob homes had begun to wane due to rising labor costs, the increasing affordability of industrial materials such as brick and concrete block, and the growth of building codes focused on standardized, rather than vernacular, building practices. One of the last major pre-revival cob buildings built in Devon was a house designed by the Arts and Crafts architect Ernest Gimson and completed in 1912.[9] After WWI, the war economy turned to reconstruction, and, on both sides of the Atlantic, newly industrialized construction methods quickly supplanted what remained of traditional ways of building. Decades passed with no new cob construction in either the UK or North America. After flourishing since time immemorial, the cob tradition in the UK appeared to have come to an end.

A Cob Renaissance

The dearth of new cob construction in the UK led to a loss of associated knowledge and skills. Cob houses are durable, and many beloved English cottages remained inhabited after maintenance ceased, but nearly a lifetime intervened between the end of World War I and the resurgence of interest in traditional building techniques in the 1970s, '80s, and '90s. As a result, much local knowledge of how to build and maintain cob was lost and had to be relearned. In the UK, where the cob revival was motivated first by the needs for historical preservation and deferred maintenance, this re-learning was largely a resurrection of the old practices combined with more mechanized mixing and other adaptations.

In 1978, restorationist Alfred Howard built the first new English cob building in several decades—a bus shelter in the Devon village of Down St. Mary. Howard and many other builders first honed their craft by restoring old cob structures before venturing into new construction. The first cob house of the revival (actually a part-cob reconstruction of a crumbling stone barn) was built by Kevin McCabe in 1995. Known as "the King of Cob," McCabe has since tackled increasingly ambitious projects, culminating in the 2010s with Dingle Dell, a 13,500 ft^2 (1,250 m^2) complex for which he mixed over 2,000 tons of cob and built a quarter of a mile of cob walls 3' (1 m) thick and up to 29' (9 m) high. The building was designed to PassivHaus thermal standards and achieved Code for Sustainable Homes Level 6, the highest level of certification in the UK.

In parallel with the revival in the UK, a new cob tradition was born on the West Coast of the US. Welsh-born landscape architect Ianto Evans, along with Linda Smiley and Michael G. Smith, started the Cob Cottage Company in Oregon in 1993 with the goal of researching and teaching earthen building techniques adapted to the Pacific Northwest. Since cob knowledge was traditionally passed down orally and little had been written down, and because information about contemporary global earthen building traditions was hard to access in a pre-internet world, US cob techniques were essentially reinvented based on limited historical information from the UK and considerable creative input from early adopters in the US.

"The Laughing House" at Cob Cottage Company headquarters in the Oregon rainforest is a typical example of Oregon Cob: small, highly sculptural, and constructed largely of site-harvested and salvaged materials. CREDIT: MICHAEL G. SMITH

Oregon Cob therefore diverged substantially from traditions in the UK and elsewhere, emphasizing manual small-batch mixing for maximum quality control and artistic expression through sculptural designs. Another innovation that distinguishes Oregon Cob from most other cob traditions is that each lift is not allowed to dry completely before the next is added. The top of the wall is kept moist during construction, which allows manual integration of each lift with its neighbors. This produces something approaching a truly monolithic wall, which is better able to resist lateral forces, such as earthquakes.

Interest in the US was initially sparked by environmental concerns, the high cost of conventional housing, and the desire for healthier lifestyles, so the first generation of Oregon Cob buildings tended to be small, owner-built, non-permitted, and constructed largely of found and salvaged materials. In the final years of the 20th century, builders trained by the Cob Cottage Company introduced Oregon Cob in many parts of the world, notably in Canada, Mexico, Argentina, and Thailand, where the technique took root and prospered.

Over the last three decades, builders in the US, UK, and around the world have been experimenting with new techniques, borrowing knowledge from other earthen building traditions as these become increasingly connected, and sharing their successes and failures through workshops, conferences, publications, and on-line forums. More recently, researchers at nonprofits and universities have begun systematically testing the structural, thermal, and other properties of cob in an effort to understand best practices for cob construction and to write building codes and standards. Hundreds of new cob homes have been built—in many countries and climate zones—both by owner/builders and, increasingly, by professional builders as well.

The CRI and the IRC

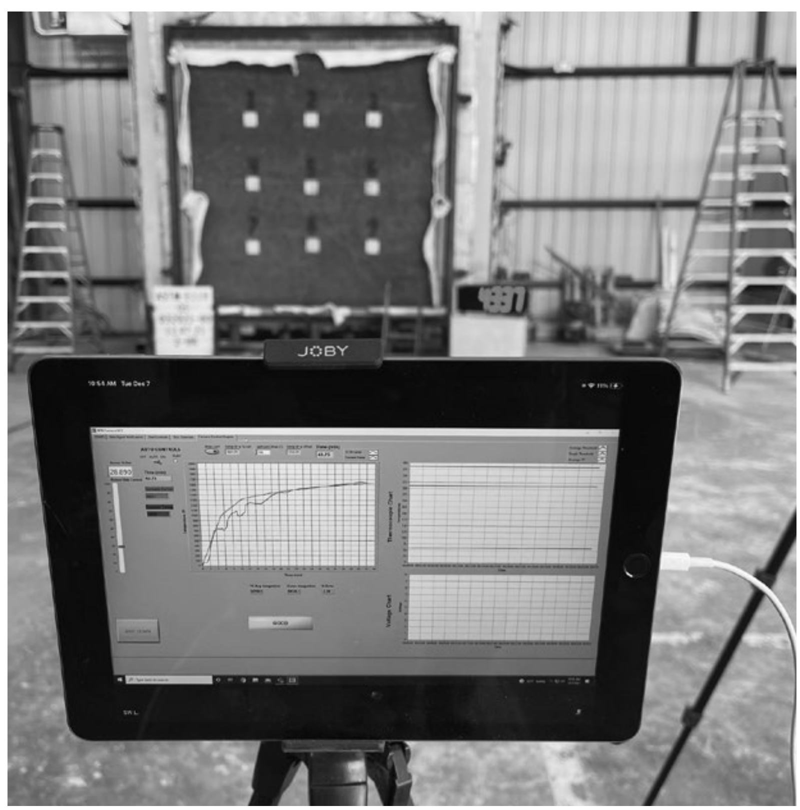
The Cob Research Institute (CRI) is a nonprofit organization started in 2008 with the mission to make cob legally accessible to all who wish to build with it. It was founded by California architect John Fordice, who fell in love with cob after attending a hands-on Cob Cottage Company workshop in 1996. Frustrated by the difficulty of obtaining legal permission for cob buildings, Fordice passed the hat at a Natural Building Colloquium and raised enough money to file for official nonprofit status. He assembled a volunteer Board of Directors and began combing through the international literature on the engineering and regulation of earthen buildings, while researching the necessary testing and other steps toward approval of a cob code.

In 2013, CRI Board members Massey Burke and Anthony Dente collaborated with engineering faculty and students at the University of San Francisco to study physical properties such as compressive strength and modulus of rupture of cob mixes with varying amounts and lengths of straw. This was the start of a series of research collaborations with dozens of individuals, universities, and testing facilities. An express intention in all of CRI's research is to find safe ways to build with cob that meet the strict evidence requirements of building codes while maintaining cob's character as a user-friendly, low-environmental-impact building system. Modern cob builders avoid the use of stabilizers such as Portland cement and asphalt emulsion, both of which are commonly added to rammed earth and adobe walls. A major goal is to codify building techniques that require minimal external inputs and little or no mechanization so that they are accessible to people in a very wide range of socio-economic conditions, and can be legally implemented by people and communities with limited resources.

Our initial foray into cob structural testing stimulated our interest in taking a cob building through a full Alternative Materials and Methods (AMMR) permit application in a Bay Area jurisdiction. Our motivations were: 1) to set a precedent for permitted cob in a relatively stringent permitting context, so that it would be likely to be useful in other less-demanding jurisdictions; and 2) to practice translating vernacular cob knowledge into the formal language and numbers required by a building department. The opportunity for such a project was provided by the Tong family in Berkeley. After nearly three years of collaboration between Massey, Anthony, and David Lopez of the Berkeley Building Department, we secured a permit for a small backyard studio in 2016. We suspect that this building permit holds the world record for the most intellectual capital invested per square foot. The results of the process were compiled into a white paper that can be found on the CRI website.[10] This process helped clarify what kind of information and further testing would be needed to create a complete cob code, as well as helping us understand how to communicate about cob with building officials.

In the last few years, CRI has collaborated on the construction of eight full-scale cob wall panels for testing. These employed a range of reinforcing strategies—from straw-only to steel mesh to a rebar grid similar to those used to reinforce concrete walls. Each panel was attached to a testing frame that applied force to the tops of the walls in back-and-forth cycles to simulate the effects of earthquakes. Some were also tested for resistance to out-of-plane forces. Two additional full-scale cob walls were built in a laboratory in Texas and subjected to rigorous fire testing. Many smaller samples have been tested for density, compressive strength, flexural strength, and insulation value. Outstanding contributors to these efforts include Art Ludwig of Oasis Design, Sasha Rabin of Quail Springs Permaculture, and students and faculty at Santa Clara University and the California Polytechnic State University, San Luis Obispo.

This ongoing program of laboratory testing and the collection of existing earthen building standards from around the world gave CRI the data necessary to write and defend the first prescriptive building code for cob anywhere in the world. In 2019, under the direction of lead code writer Martin Hammer, CRI submitted their code as a proposed Appendix to the International Residential Code (IRC). The IRC is a model code published and updated on a triennial cycle by the International Code Council (ICC). It is the basis for building codes for one-and two-family dwellings, townhouses, and accessory structures throughout the United States (except Wisconsin). CRI's proposal was approved by a two-thirds majority vote of International Code Council voting members, most of whom are building and fire officials.



Ancient materials meet modern technology when cob is tested in a laboratory. In this photo, the cob wall in the background is being tested for fire-resistance in a facility in Texas. See more on this test in Chapter 3. CREDIT: ANTHONY DENTE

The result was *Appendix AU: Cob Construction (Monolithic Adobe)* in the 2021 IRC (referred to in this book simply as "Appendix AU"). This model building code is reprinted in its entirety in the appendix of this book, along with official commentary intended to make it more comprehensible.

Unlike the main body of the code, adoption of Appendices to the IRC is optional; each Appendix must be specifically adopted by a jurisdiction such as a state, county, or city in order to become a part of its building regulations. The public can influence this process by expressing a need for such a code to their local building department, elected officials, or overseeing state agency. Other natural building systems, including strawbale and light strawclay, have undergone the same process, first becoming Appendices to the IRC, and then being adopted into state and local building codes. For example, *IRC Appendix AS: Strawbale Construction* was approved as part of the 2015 IRC and has since been adopted by at least six states and nine city or county jurisdictions.

Groups such as this one at Spirit Pine Sanctuary in Southern California have come together at hands-on workshops all over the world to learn cob construction. Cob Cottage Company founders Linda Smiley and Ianto Evans are reclining in the foreground.
Credit: Art Ludwig

As board members of CRI, all three authors of this book were intimately involved with the last decade of cob testing and with the writing of Appendix AU. Anthony was a major contributor to much of the testing design and was the primary drafter of the structural sections of the code. Massey was involved with early testing of cob's physical properties. Michael was an integral part of the code writing and editing process; as a founding director he played a critical role in the formative early years of the Cob Research Institute. We all continue to be involved in ongoing testing in an effort to refine the code to make it more useful to designers, builders, homeowners, and building officials in more diverse geological and climatic areas.

The Next Age of Cob

We hope that this book will help pave the way for a new golden age of cob. The time seems right. Climate change, devastating wildfires, and the desire for affordable, healthy housing are among the strongest forces driving renewed interest in this ancient technique. New scientific information is available which in some cases validates and at other times allows us to improve on traditional earthen building methods. The model building code, which will continue to evolve through amendments supported by further testing, will reduce legal and bureaucratic barriers to cob construction in the US (and hopefully elsewhere, by example). We hope you will choose to design and construct beautiful buildings out of this amazing material, and in so doing join the growing global community of cob advocates, specialists, and enthusiasts.

Chapter 2

Rationale and Appropriate Use

Frequently Asked Questions

What is cob? Cob, known also as *monolithic* or *coursed adobe,* is a mix of clay soil, sand, and straw. It is mixed onsite to a wet, doughy consistency and shaped in situ in vertical layers called *lifts*. Sourcing the materials for cob is usually hyper-local: clay soil often comes from the building site and/or from nearby excavations or quarries, straw comes from local or regional grain farms, and sand comes from regional quarries and local aggregate yards and/or is inherent in the clay soil.

Why build with cob? The UK cob revival and the birth of a US cob-building tradition were driven in great part by the growing awareness of several interwoven ecological problems—notably, climate change, global deforestation, and wildlife habitat loss. Other factors include the rising cost of housing and the proliferation of illnesses associated with toxic building materials and unhealthy interior environments. Cob can offer many personal benefits as well: opportunities for artistic expression, biophilic materials, healthy living spaces, and the satisfaction of making your own shelter are just a few. It is very easy to sculpt the material into almost any desired shape—curved walls and arched openings and niches are simple to shape with cob, as are more elaborate three-dimensional forms. The ease with which even novice builders can express themselves artistically is one of the primary attractions of cob—especially in its North American variation, which emphasizes careful handwork for greater control of the material.

How much does it cost? Cob has a reputation for being radically inexpensive. The hard costs of making cob walls can be kept very low because cob is relatively easy to learn, takes advantage of low-cost raw materials, and doesn't require a lot of expensive tools. However, this is only true if you are using your own or volunteer labor, and not assigning it a monetary cost. If you are planning to pay for labor at normal construction rates, costs for building with cob will be comparable to conventional building. Additionally, the walls of a building only account for a fraction of the overall budget; other components such as site prep, design and permits, foundation, roof, and mechanical systems typically require skilled labor and are responsible for the lion's share of a project's cost.

Does this mean that we are discouraging a community approach to cob building?

Cob lends itself to curvilinear forms and whimsical designs. Kindra Welch designed this mountain retreat for family members in northern New Mexico. The cob walls were built primarily in work parties by previously untrained volunteers. Credit: Clay Sand Straw

Absolutely not! Cob is a fabulous material for community engagement. Just be aware that there are considerations and tradeoffs with this approach, as with any building system.

Cob is an especially viable option for those with access to land and plenty of available time and/or community support, but limited building skills and financial resources. Because cob is labor intensive, a contractor-built cob house may not be less expensive than a conventional custom home, but a much higher proportion of the construction funds will go to local artisans rather than supporting industries with dubious labor practices and environmental impacts. Locally harvested materials are immune to supply chain disruptions stemming from global politics and interruptions in international manufacturing and transportation. So, building with earth is a choice to support one's local community and ecology while reducing impacts in both nearby and distant areas of the globe.

How long does it take? One of cob's main disadvantages compared to either rammed earth or adobe—let alone conventional building systems—is that the speed of wall construction is constrained by drying conditions. The amount of wall height that can be added in a day is generally limited to between 1 and 2 feet, depending on the specifics of the mix, wall thickness, and weather. Cob construction is easiest, fastest, and most pleasant in warm, dry weather. However, it is not limited to those conditions: even in cold, wet weather, a lift of cob that sits overnight protected from rain gains a surprising degree of stiffness and resistance to slumping.

Although it is possible to erect the walls of a single-story cob building in a week, most experienced builders prefer to leave more time between lifts in order to reduce problems such as slumpage and cracking. Building more slowly can reduce the amount of trimming and remedial work needed, which brings down the total labor needed for the walls. Depending on climate, design, size of building crew, and other factors, professional builders typically take between three and eight weeks to complete the cob walls of a building.

Environmental Benefits

All construction has a significant environmental impact, but cob building is one of the gentlest methods from the perspectives of both climate effects and resource conservation. The materials used in cob construction—clay subsoil, sand, and straw—require very little fossil fuel or electrical energy to extract, harvest, transport, and refine compared with most other building materials. This means that cob has very low embodied carbon (also known as *upfront carbon emissions.*) Cob walls replace what would otherwise typically be wood, concrete, or brick—all of which embody or emit considerably more carbon and create far more damage to forest lands and other habitats. The clay soil that forms the bulk of a cob wall can often be harvested close to or on the building site (sometimes simply from excavation for foundations and site work), reducing the energy spent on transportation. At end-of-life, cob components can be composted and/or returned to earth. In short, a cob building's ecological footprint is typically quite small compared with almost any conventional building material.

Table 2.1 indicates that cob is slightly carbon-negative (i.e., carbon-storing) due to the carbon-storage capacity of straw. However, these figures do not include any carbon calculations for cob mixing, so mechanically-mixed cob is likely carbon neutral or slightly carbon-emitting. In addition, these figures only apply to the cob portions of the building, so close attention to minimizing the embodied carbon in other parts of the building is still

Table 2.1: ICE (Inventory of Carbon and Energy)[1] Values for Embodied Energy and Carbon in Materials Relevant to Cob Construction

Material	Embodied energy in MJ/kg	Carbon storage in kg: CO_2/kg	Embodied CO_2e (CO_2 equivalent) in kg: CO_2e/kg
Clay soil	0.083	0	0.0052
Sand	0.081	0	0.0051
Straw	0.24	1.62[2]	-1.61 (stored)
Cob[3]	0.085 to 0.094	0.016 to 0.113	-0.011 to -0.108 (stored)
Concrete block	0.72	0	0.08

required. This is especially true for concrete foundations, which have a very large carbon footprint and are often larger in cob buildings than in conventional buildings due to wall width and mass.

Performance of Cob

Cob and moisture: In general, cob is moisture-resistant when it is kept off the ground, has a good roof, and is finished with vapor-permeable materials that do not trap water inside the walls. Exposed cob erodes slowly in wind-driven rain and other weather conditions, but it does erode, so weather-resistant finishes may be needed depending on the exposure of the building site and the owner's appetite for maintenance.

Structural qualities: When each lift of cob is carefully integrated with the previous layer, cob

The living area of Bliss Haven, a cob home designed by Kindra Welch and built by her company Straw Clay Wood. An exterior view is shown on the cover of this book. For its energy and water efficiency, low-impact materials, and indoor environmental quality, this building received a 5-star rating from Austin (Texas) Energy's Green Build Program. Credit: Kindra Welch walls become *semi-monolithic,* with an almost continuous matrix of straw linking the whole wall together into a single structural mass. The weakest points of the system are the boundaries between lifts, though these junctions are not as weak as in masonry buildings built of the same materials, such as adobe. In high seismic zones, cob generally requires added reinforcing, usually in the form of rebar, mesh, or other tensile materials inside the walls.

Thermal performance: Cob can be mixed to a range of densities, which yield different thermal behaviors, but in general cob is a *thermally massive* material. This means that it acts like a thermal battery that needs to be charged. A good thermal design for cob is climate-specific: in some climates, cob works well as a standalone material, but in many contexts, an energy-efficient cob building requires additional insulation. Cob also complements and benefits from passive solar design strategies. We dive deeply into cob's thermal performance in Chapter 3.

Fire resistance: Cob is extremely fire-resistant; it has a 2-hour fire rating under ASTM E119. This makes it appropriate for use in situations where fire safety is of utmost importance, such as boundary fences and the shared walls between dwelling units in a multiplex.

Appropriate Uses

When compared to other earthen building systems, cob has both advantages and disadvantages. Unlike adobe and rammed earth building, cob doesn't require forms or molds, which makes for a very simple, low-tech construction process. On the other hand, cob is labor-intensive, which makes it either expensive or slow to construct. It is also physically massive, which limits design options in seismic areas. Because it is thermally massive, cob is not suited to all climate zones without additional insulation. Considerations for when to use cob include access to suitable clay subsoil, climate, building size and purpose, and seismic zone, as well as the culture of the local building department (if permitting is required).

Soil availability: Cob is one of the most clay-intensive forms of wall construction, and even a very small building can use a full dump truck's worth of clay soil. Fortunately, clay soils that can be used for cob construction are common in most regions of the world. By some estimates, clay soils suitable for earthen building make up 74% of the Earth's crust.[4] Exceptions include regions that are very young geologically, such as most of the Hawaiian Islands. In these areas, there hasn't been enough time for bedrock to weather into clay minerals. Other places where clay can be scarce or unavailable include glaciated areas, where the earth's surface has been churned up in unpredictable ways, and in river valleys, where clay-bearing strata in alluvial soils may be buried under many feet of clay-poor deposits. The mere presence of clay in the soil is not the only consideration: some clay soils make stronger cob than others, and some require extensive processing (sifting to remove rocks or soaking to soften and hydrate clay), so both the qualities of the resulting cob and the efficiency of mixing vary depending on the clay source.

Climate: Cob is a dense, heavy material with relatively poor insulation qualities. In areas where temperatures remain cold for long periods of time, or remain hot even at night, cob will need to be insulated to perform efficiently. Passive solar designs that take advantage of winter sun to heat the interior of the building make a big difference in a cob building's efficiency. Current building code energy requirements

One of the entrances to the central Medina in Marrakesh, Morocco. Thick cob and adobe walls like these surround the entire historical center of the city. In hot desert climates, massive earthen structures help to cool and shade adjacent streets and buildings. Credit: Catherine Wanek

for mass walls in most climate zones in the US require added insulation for typically-sized cob walls in residential buildings.

Seismic zones: Cob reinforced with straw fiber alone may not perform well in strong seismic events. Since building mass magnifies seismic forces on a building, appropriate attention to structural design is required. According to the current cob code in the US, cob buildings in high seismic areas require an engineered design and added reinforcing, such as steel rebar or mesh.

The local building department: Before there was a cob building code, supportive officials within building departments could often be found who were willing to help shepherd projects through the approval process. Unfortunately, these individuals can't be found in all building departments. Since cob is radically different from conventional building systems, cob projects are sometimes met with resistance by building officials. The existence of the cob model code and its future adoption by more jurisdictions should make the permitting process much more routine. However, at the current juncture, it is still wise to take the culture of your building department into consideration when deciding whether to seek a permit for a cob building.

Building size: Because current cob construction methods are relatively slow, modern cob techniques have been used primarily for smaller structures. This is partially cultural: many contemporary cob practitioners are drawn to the simplicity of hand mixing and placement and the unique opportunity for community participation that a less-mechanized, labor-intensive method of building offers. However, in this cultural moment, cob's minimal carbon impact, inherent supply chain resilience, and demonstrated resistance to wildfire have the potential to transform the demand for cob construction more rapidly than we might anticipate, and the technique has unexplored potential at larger scale. We expect that further advances in technical research combined with completely new innovations like 3D printing will radically transform the cob landscape in the next decades. However, at least until we have more data on reliable reinforcement strategies, the size of cob buildings should be limited to one or, at most, two stories. Structural testing of cob wall systems is ongoing and recommendations will be adjusted over time.