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Bringing Earthbags to the People – A New, Democratic Approach to Sustainable Building

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Abstract

Earthbag technology builds safe, appealing, and cost-effective structures out of ordinary soil. Stronger, cheaper, and less harmful to the environment than conventional building techniques like brick and cement, Earthbag technology is generally considered the most promising of sustainable building techniques. But despite widespread support among environmental groups and eco-builders, this method is shunned by governments and remains virtually unknown to everyday building professionals and the public. This paradigm, however, is changing in Nepal, where a catastrophic 2015 earthquake flattened much of the housing stock. Good Earth Nepal, a non-profit organization, has pioneered a three-pronged approach designed to overcome resistance to sustainable building and to, for the first time, make Earthbag technology accessible to the masses.

Keywords: Earthbag Technology, Sustainable, Natural Building, Pollution, Earthquake, Nepal, India, Government Acceptance, Earthbag Training

Introduction

In developing countries, the prevailing building scheme is economically unsustainable and environmentally destructive. Rural villagers build with locally-sourced but flimsy stone, mud, and clay or factory-processed cement, bricks, steel, and timber, which are costly to produce and process. Manufacture and transport of the latter also consumes precious fuel and natural resources and pollutes the air and water.

Both sides of this coin have taken their toll in Nepal, a South Asian country of almost 30,000,000. In April 2015 a 7.8 magnitude earthquake destroyed residences and communities, killing thousands and displacing millions. Structures of all types suffered catastrophic failure, whether constructed of traditional or more "modern" materials.

Meanwhile, Nepali citizens are subject to some of the most polluted air on Earth. Much of this pollution, including water contamination and deforestation, is caused by factories processing bricks, cement, and timber, and the thousands of trucks required for transport.

Earthbag technology, using ordinary soil gathered from the worksite itself, offers Nepal and other developing regions a sustainable, affordable, and disaster-resistant building technique superior to conventional construction methods. Until recently, however, this eco-friendly building practice has failed to meet its initial promise.

Good Earth Nepal, a non-profit organization, employs a three-tiered approach: Securing Government Acceptance and Support; Training Educated Professionals and Village Builders; and Building Grassroots Support. Its goal is to establish Earthbag technology as an everyday construction option for ordinary families, and as a critical tool in Nepal's push towards a more sustainable future.

A Country In Need

Nepal, tragically, is now ground zero for sustainable building, and an ideal testing lab for Earthbag technology. No other region is better suited to building with Earthbags, or more in need of them.

A 7.8 magnitude earthquake killed 9000, displaced 2.8 million, and destroyed approximately 600,000 structures, most made of conventional brick, cement, stone, or mud.[1] Almost three years later earthquake victims still live in temporary makeshift structures, and children still attend school in crude tin shacks open to the elements.

Nepal, home to verdant valleys and the mighty Himalayas, is also among the most polluted countries in the world, ranking 177th out of 180 countries for Air Quality as per the Environmental Performance Index (EPI). Kathmandu is the seventh most polluted major city in the world, with pollution levels 20 times higher than recommended.[2,3] A three-kilometer thick "atmospheric brown cloud" (ABC) composed of toxic ash, black carbon, sulphate, nitrates, and aerosols hangs over the Indo-Gangetic plain of southern Nepal, according to the United Nations Environment Programme.[4] This toxic miasma blocks the sun.

According to Nepal's Department of Health, respiratory diseases are the leading reason for outpatient consultations, with obstructive pulmonary disease the top cause of death among inpatients.[5] Dust from local cement factories even interferes with the chlorophyll content of plants, reducing their growth rate.[6]

Brick and cement factories in suburban areas around major cities are a chief contributor to Nepal's pollution problem, with a majority of structures in the country employing Mud-Bonded Bricks (44.21%), Cement Bonded Construction (17.57%) or Reinforced Concrete (9.94%).[7]

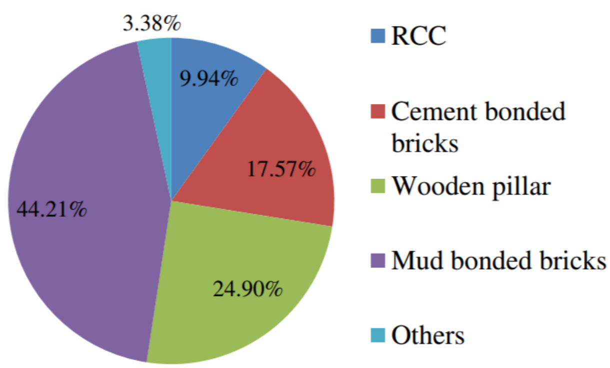

Figure 1: Distribution of housing systems as per types of structures in Nepal
Source: Dipendra Gautam, Jyoti Prajapati, Kuh Valencia Paterno, Krishna Kumar, Bhetwal and Pramod Neupane, "Disaster resilient vernacular housing technology in Nepal," Geoenvironmental Disasters (2016): 6, doi: 10.1186/s40677-016-0036-y.

According to a 1996 study by the World Bank, 36% of the Total Suspend Particles (TSP) in the Kathmandu Valley were caused by local cement factories and 31% by brick kilns. Brick kilns are the biggest source of the most dangerous particles, those under 10 microns. A household environmental survey revealed that 95% of respondents in the Kathmandu Valley suffered from some degree of respiratory illness.[8] Vehicle exhaust, including trucks transporting building materials, is also a significant contributor to air pollution in the Kathmandu Valley, and throughout Nepal.

Much of Nepal also lacks access to safe water. Liquid effluent from factories and kilns is a major source of pollution and runoff into lakes and over 6,000 rivers. Consequently, 10 Nepali children die each day from diarrhea and other water-borne diseases.[9] The Terai region in particular is vulnerable to arsenic contamination, and deep-water aquifers are at risk for being depleted.[10, 11] Smokestack emissions find their way into the water supply as acid rain, as do emissions from the multitude of trucks and vehicles used to transport building materials.

Timber used for building is a major cause of Nepal's crippling deforestation; between 1990 and 2005 the country lost almost 25% of its forest cover.[12] Fewer trees have resulted in a loss of topsoil, causing flooding and erosion. Loss of jungle cover has led to decreased biodiversity and reduced leaf litter, depriving the soil of needed nutrients.

Beyond the well-documented costs in sickness and death, overtaxing Nepal's ecosystems also creates daily hardships for impoverished and vulnerable families.

Pots of water lugged home from a well by Daya Laxmi**,** a villager displaced by the earthquake, are so dirty that when she washes rice the grains turn black. Jwala Devi Sahi receives clean water from a government-installed tap in her building but only once every eight days, for an hour. "Sometimes I wait and wait. Sometimes we are deprived of sleep while waiting and it affects our work, but there is still no sign of water", she says.[13]

Fewer forests mean less hunting and a diet with less protein. Nepali woman are forced to walk long distances to gather firewood. Topsoil loss and erosion (along with overpopulation) force farming families to move to less desirable and more mountainous land, further exposing them to landslides and extreme weather.[14]

Air pollution also takes a toll on Nepal's tourist industry, which is estimated to create one sixth of the jobs in the country. "We got one hazy glimpse of a snow-topped mountains in Pokhara on one afternoon. We never saw the mountains again", reported one frustrated traveler on a Lonely Planet website.

In sum, the engines of Nepal's massive industrialization, and now its rebuilding effort, risk further degrading the country's already tenuous quality of life.

Earthbag Technology

Earthbag technology is a sustainable and cost-effective method for using ordinary soil to erect disaster-resistant structures of superior strength and durability. Some call Earthbag technology "Rammed Earth in a Bag".[15] Though the technique currently in use is relatively "new", its true origin dates back thousands of years. Ancient structures built with similar rammed earth methods still stand, from the Alhambra palace in Spain to the Great Wall of China.

To build an Earthbag structure one first creates a rubble trench foundation filled with coarse gravel, an innovation first popularized by Frank Lloyd Wright.

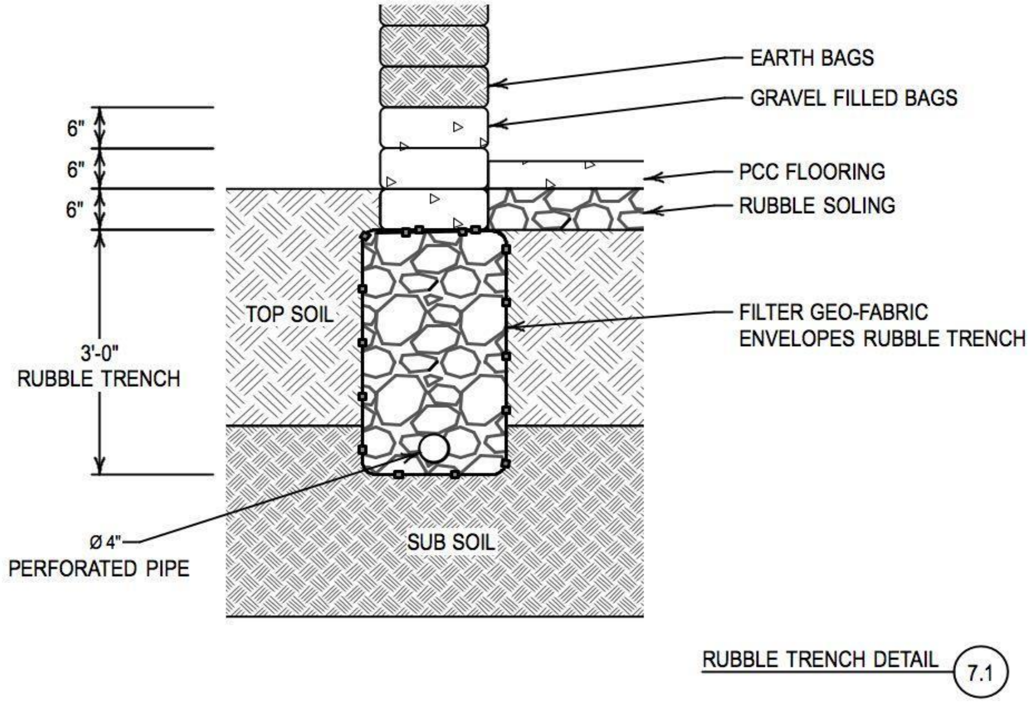

Figure 2: Rubble Trench Foundation
Source: Geiger, O. (2013). Natural Building Blog - Earthbag Building & Other Natural Building Methods. Retrieved January 10, 2016, from: http:// www.earthbagbuilding.com/

Workers then stuff ordinary soil gathered from the construction site into polypropylene bags. Staggered like masonry and tamped down, the bags become hard as brick in a month or two.

Figure 3: Earthbag Construction, Makwanpur, Nepal

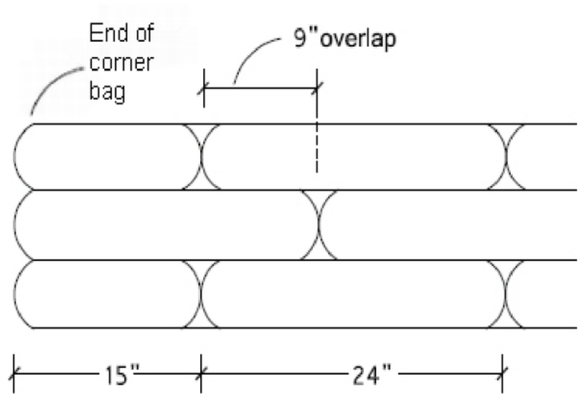

Figure 4: Earthbag wall. Source: Geiger, O. (2015, September). Earthbag Building Guide (Abridged and Adapted for Builders) – Special Edition by Osho Tapoban Publications.

Barbed wire laid between the layers of the bags serves as mortar instead of cement. In seismically active zones, reinforcing buttresses, rebar, and bond beams are added as needed.

As the walls go up, workers add doors and windows. When the building nears completion, a lightweight roof is installed and the building is plastered and painted. Inside and out, Earthbag homes and schools look and perform just like "normal" homes and schools.

Figure 5: Barbed wire layour. Source: Geiger, O. (2015, September). Earthbag Building Guide (Abridged and Adapted for Builders). Special Edition by Osho Tapoban Publications.

Figure 6: Completed Earthbag House, Gorkha, Nepal

Figure 7: Shree Jana Primary School, Nuwakot, Nepal. Built by Good Earth Nepal

Advantages of Earthbag Building

While Earthbag technology is stronger and less expensive than conventional building (as described below), the technique is best known for its role in promoting sustainable development, defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p.43).

Requiring no bricks or blocks and little to no cement, steel, or wood, Earthbag homes, schools, and clinics substantially reduce reliance on manufactured materials and the environmentally damaging factories, smokestacks, and kilns needed to process them.

While no large-scale comparisons of the environmental impact of Earthbag technology versus conventional construction have been done to date, rigorous studies have evaluated the environmental benefits of individual Earthbag structures.

A 2006 study, for example, evaluated the sustainable characteristics of an Earthbag home built in Crestone, Colorado.[16] Underwritten by the U.S. Environmental Protection Agency (EPA) and using criteria set forth by the U.S. Green Building Council's (USGBG) Leadership in Energy and Design (LEED) Home Program, the study evaluated the sustainable characteristics of an Earthbag home based on engineering inspections of the site, interviews, and design evaluation. The study found that Earthbag technology, in comparison to conventional construction, reduced waste generation, lessened demand for non-renewable energy sources, increased use of environmentally-friendly products and locally-supplied materials, minimized environmental impact on the building lot itself, and required less energy consumption due to superior thermal and insulation qualities.

Building with ordinary soil from the worksite also reduces the need to transport building materials which is of critical importance to developing countries like Nepal. This lessens fuel consumption, reduces emissions, and requires fewer transport vehicles, a significant boon for regions lacking good infrastructure and a strong highway system.

In developing countries, Earthbag construction has proven stronger and safer than conventional construction. It is noted for the ability to endure earthquake, fire, flood, wind, vermin, and even bombs and bullets. In fact, Earthbag technology first came to prominence in Nepal when all 55 of its Earthbag structures survived a 7.8 magnitude earthquake with no structural damage, some standing beside the ruins of conventionally built homes and schools.

Figure 8: Earthbag School in Basa, Nepal (Edge of Seven, Small World) next to a damaged stone building

Figure 9: Earthbag School Construction, Nepal

Key components that make Earthbag technology earthquake-resistant include:

• Rubble Trench Foundation: An Earthbag building "floats" on a rubble trench foundation, minimizing shock transfer to the walls.

• Resiliency of Earthbags: An experimental study performed by three Chinese universities (Hohai University, the Business School of Hohai University, and Hefei University of Technology) confirmed that Earthbags absorb vibration due to their high damping ratio

• Tensile Strength of Barbed Wire: During an earthquake, the barbed wire between bags resists possible outward expansion of the walls

• Thick Walls: Earthbag walls are generally 16-19 inches thick

• Bond Beam: A thick bond beam wraps around the top of the walls, further strengthening the structure

• Use of Polypropylene (PP) Bags: PP bags have a tensile strength higher than steel

• Reinforcements: In Nepal and other regions with high seismic activity vertical rebars, buttresses and corner reinforcements are added to increase strength

Outside of Nepal, Earthbag buildings have weathered all sorts of trauma, surviving various natural disasters that doomed structures built of brick, cement, wood, and other conventional materials.

Figure 10: The 'Sun House' in Haiti. Survived most recent earthquake.

Figure 11: House in Turkey that has withstood three earthquakes

Although it has held up in real-world situations, Earthbag technology has only undergone controlled testing in the past decade. Patti Stouter, a leading Earthbag builder and researcher, recently conducted a review of the literature and compiled a summary of studies authored by leading authorities in the field. These include laboratory analyses of Earthbag strength and durability, tensile strength of barbed wire, and projected performance of Earthbag structures during earthquakes.[17] Large-scale shake table tests, vital to a broader acceptance of the technology, are still required.

Tests completed in accordance with International Building Code (IBC) standards have also confirmed that Earthbag construction far exceeds Zone 4 standards, devised to protect against the very highest level of seismic activity. Numerous Earthbag structures have passed inspection in the United States, with Earthbag structures permitted by the California Building Code which is – due to extreme seismic activity – the most stringent code in the nation.

Due to reduced material and transportation costs, Earthbag structures are also less expensive than comparable conventional methods. In the table below, we compare the total cost of materials and labor for 3 different building methods: stone-masonry with cement mortar, brick-masonry with cement mortar, and Earthbag. The house design, material list, material quantities, and labor required to build with stone and brick masonry are taken from the Nepal government's "Design Catalog for Reconstruction of Earthquake Resistant Houses, Volume 1"[18], with material rates and labor rates from Nepal's Department of Urban Development published rate catalog[19]. Total Earthbag cost was calculated by Good Earth Nepal engineers based on an identical house design and using identical material rates.

Table 1: Comparing Costs of Building Technology

Technology	**Main Materials**	**Cost**
Stone Masonry with Cement Mortar	Stone, Cement, sand, Aggregate, wood, Rebar and CGI	8559 USD
Brick Masonry with Cement Mortar	Brick, Cement, Sand, Aggregate, Wood, CGI and Rebar	7663 USD
Earthbag with Wooden Truss	Earth, PP Bag, Barbed Wire, Rebar, CGI, GI Wire, Wood	6437 USD

Exchange Rate of 1 USD = 102.707 NPR as per xe.com as of Jan 22, 2018

Total cost does not include site management, administrative fees, or transportation costs. Because Earthbag structures use predominantly local materials and thus require less transportation, the cost benefits of Earthbag construction might be even greater than indicated in the table above.

Earthbag construction is also simpler than more conventional building techniques, and well suited to impoverished regions suffering from limited infrastructure and low literacy.

Building with Earthbags requires minimal expertise and relies almost entirely on unskilled labor. Thus, a typical Earthbag structure is easily built by a pool of unskilled workers and a single carpenter (for doors and windows), all supervised by a single construction manager. More conventional building techniques, in contrast, require skilled workers, often imported, to build a safe structure.

Figure 12: Good Earth Nepal construction of an Earthbag school, Makwanpur, Nepal

Brick construction, for example, requires the services of a trained bricklayer or mason, with the skill to reinforce a structure with cement bands wrapping around the walls, a necessity in a seismic zone like Nepal. The failure of untrained builders to employ these bands, and shoddy workmanship in general, substantially contributed to the high failure rates of Nepal's brick buildings, especially in rural areas.

Cement construction requires a person skilled in the highly specialized art of cement mixing and laying. As noted by Kishore Thapa, President of the Society of Nepalese Architects:

> "RCC (Reinforced Cement Concrete) structures… require strict quality control… It requires high quality workmanship in formwork, bar bending, mixing, transporting, pouring and curing of concrete. Failure to maintain quality may reduce the strength of the concrete, which makes the building structurally weak.[20]

> Therefore, we should be very careful while adopting RCC technology, particularly in rural areas of Nepal… "

Earthbag construction also requires only the simplest of tools – buckets, shovels, hoes and other similar materials. This makes Earthbag building ideal for rural villagers who wish to build for themselves but don't have the means to buy specialized tools and equipment, and sometimes even lack electricity.

This simplicity of methods and materials is perfectly suited to overcoming the economic and cultural obstacles most responsible for the catastrophic failure of rural Nepal's housing stock: a tendency to skimp on quality building materials in favor of cheaper, shoddier ones, and untrained villagers doing specialized building tasks for themselves, poorly.

Figure 13: Earthbag materials and tools

Earthbag construction also has a beneficial impact on the community, far exceeding that of conventional construction.

Since it relies almost entirely on local unskilled labor, it provides much needed employment to those without transferable skills. Almost all building materials are bought locally as well, a boon to local merchants and commerce.

Unlike the skilled trades, Earthbag construction is also easily taught, even to non-builders. Many Earthbag trainees without a formal building background but eager to learn have, with experience on a few sites, gone on to supervise their own Earthbag projects.

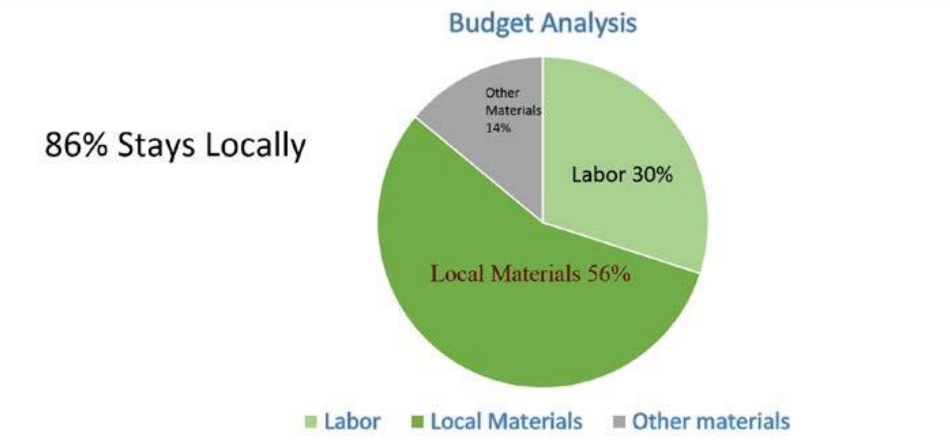

Figure 14: Chart showing breakdown of Earthbag Budget.

Community Building in Bolgaun - A Case Study

In central Nepal in the rural village of Bolgaun, families displaced by the 2015 earthquake are helping construct their own Earthbag homes in partnership with the Nimbin Health and Welfare Association and Good Earth Nepal.

After closely examining various building options, Nimbin ultimately opted for Earthbag construction based on considerations of safety, cost, practicality, ease, and benefits to the community and local economy. Reproducibility, ease of transference, and the ability to scale up given a successful project were also given attention.

Of particular concern to Nimbin was the remoteness of the worksite, which requires 10 hours of travel by bus. Moreover, the road is impassable much of the year due to landslides and floods. When the road is unusable, bricks and cement must be carried up steep slopes on the backs of porters.

Homes were to be small, strongly reinforced against earthquakes, and modular so that homeowners could later construct additions as desired. Designs were square-shaped and without curves, reflecting traditional Nepali values. Projected costs were $2,500-3,000 a unit.

Suitable families were chosen, many living in open-air shacks or lean-tos since the earthquake. Supplies were then purchased – almost all from local merchants – with a single small truck used to deliver outside materials. Prospective homeowners received training in Earthbag protocols from Good Earth Nepal construction managers, who lived in a tent near the worksite and closely supervised all subsequent work.

Working in such an environment was fraught with challenges. Construction, as is always the case in Nepal, required a flexible schedule: slowing down or stopping for monsoon season, landslides and floods, and for lengthy holidays, elections, weddings, or funerals. Subsistence farmers, barely eking out a living from the terraced mountainsides, sometimes spent construction time working instead of building. Erecting the houses was physically arduous, because of the digging, stuffing and lifting required by Earthbag construction. As with most Earthbag technology, the houses could not exceed one story due to the tremendous mass of the walls, limiting design choices.

Still, the Bolgaun community-based project has been a notable success, and bodes well for the future of Earthbag construction in Nepal. Participating families have validated the viability of the community building model. Costs have adhered to projections, and the construction quality is shown to be consistently excellent. With routine maintenance the structures should last for generations, if not centuries.

Families traumatized after seeing their village razed by an earthquake have also come to embrace this technology and trust in its strength and structural integrity, which is critical to the spread of Earthbag technology. Already, some owners are adding adjoining cooking areas to their homes, and neighbors and passersby now express interest in building their own Earthbag homes.

To date, 9 structures have been completed and two more begun, with more to come.

Figure 14: Villagers build their own Earthbag houses under Good Earth Nepal supervision in Bolgaun, Sindhupalchok.

A Failure to Launch

Despite its benefits and successes, Earthbag technology has failed to capture the imagination of mainstream builders and the public and has been actively rejected by local and federal governments suspicious of such a radically different building method. Earthbags and other sustainable building techniques remain mostly confined to eco- and design enthusiasts, first adopters, and natural builders and the relatively affluent owners they serve, mostly in the West. Rarely do sustainable building methods like Earthbag technology filter down to those who need them most: the rural poor.

A review of Earthbag building reveals that the technology has failed to establish a foothold due to government permit and licensing issues, the limitation of training opportunities to a relatively sophisticated few in the West, and a failure to adapt Earthbag designs to the local traditions and cultures of people they supposedly serve.

As a result, the initial promise of Earthbag technology has largely remained unfulfilled, with correspondingly limited benefits to the community and the environment. It is our belief that only the construction of thousands of simple Earthbag homes and schools for those in need, not eco-showcases for the relatively privileged, will make a true difference.

Earthbags For the People – A Three-Tiered Approach

1. Government Acceptance

Good Earth Nepal has developed a three-tiered approach designed to bring the promise of Earthbag building to ordinary families and communities. The first tier addresses the traditionally uneasy relationship between sustainable builders and government officials.

For decades, official hostility to Earthbag technology has led to the rejection of building licenses and permits, resulting in a dearth of Earthbag structures worldwide. It is so prevalent that when discussing potential projects, aspiring Earthbag builders tend to focus not on the advantages of Earthbag technology but rather on whether they can obtain a building permit in the first place.

Typical is the recent query of an aspiring builder published by the well-known Earthbag Builders Group.[21] "Hello all…I am looking for suggestions on places to buy reasonably priced acreage…where zoning and building codes will not be an issue…". Another sustainable building blog suggests building in Delta County, Colorado because it has no building codes. Other recommendations include constructing "off-road" in the jungles of Puna, Hawaii, or in Chile because enforcement is lax.[22] In his blog "EarthbagBuilding.com", Earthbag proponent Kelly Hart discusses this issue at length.[23]

In "A Sad Story of What Can Happen Without a Permit", Dr. Owen Geiger, head of the Geiger Institute for Sustainable Building and widely considered the world's leading Earthbag builder, describes the tragic plight of a licensed contractor who built an Earthbag cabin deep in the woods and was then forced by authorities to tear it down.[24]

In Nepal, however, this is changing. A year and a half of lobbying and dozens of meetings between Good Earth Nepal representatives and Nepali government officials and engineers have resulted in Nepal's federal approval and acceptance of Earthbags. For the first time, a sovereign country (population 30,000,000) has adopted this technology as a standard and recommended construction technique, suitable for large-scale building.

Formal approval by the Nepali government means that Good Earth Nepal designs for a one-story Earthbag house have been published in the *Design Catalogue for Reconstruction of Earthquake Resistant Houses, Vol 2*, printed by Nepal's Ministry of Urban Development, and that Earthbag designs are now being distributed to 3,000 Nepal Reconstruction Authority engineers. Critically, Earthbag building is also an official option for rural villagers receiving government reconstruction aid after the earthquake.

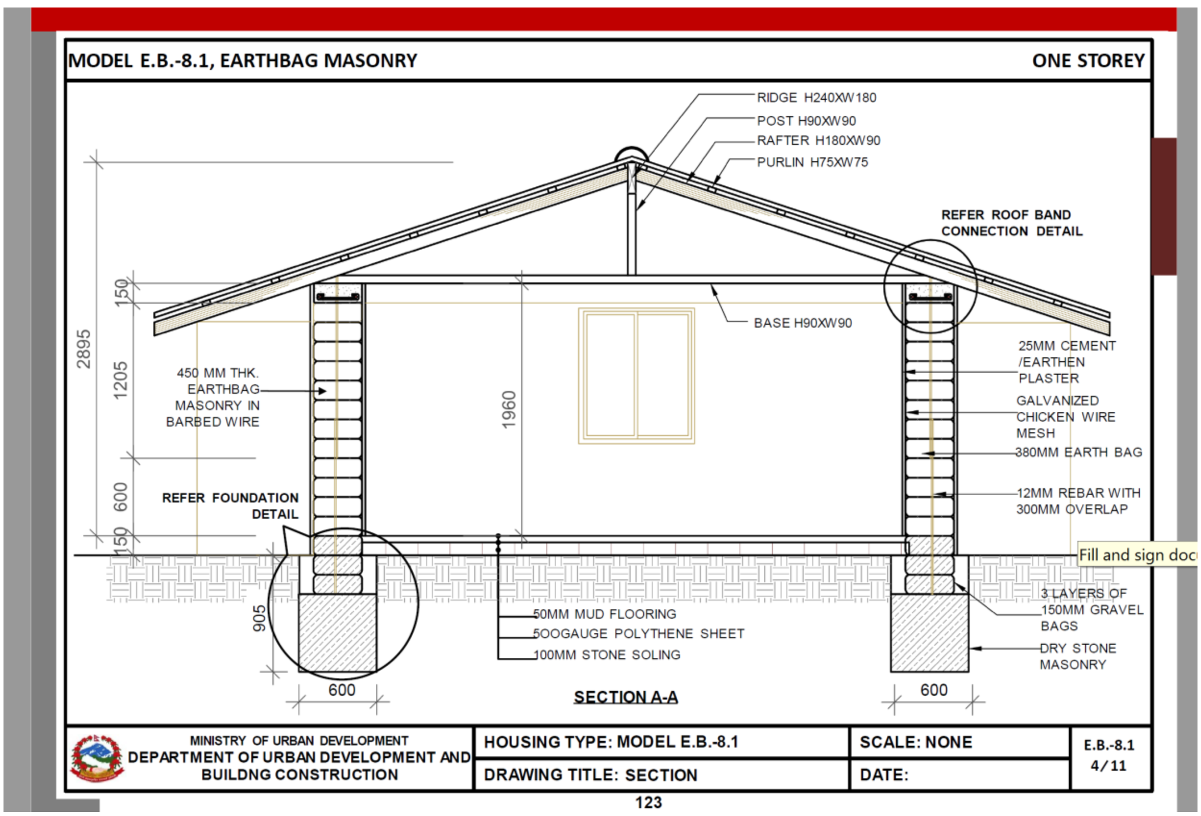

Figure 15: Government-approved Earthbag house design. Source: Government of Nepal, Ministry of Urban Development, Department of Urban Development and Building Construction, "Design Catalogue for Reconstruction of Earthquake Resistant Houses, Vol 2", (2017): 123.

Developments in Nepal could spawn similar outcomes elsewhere. For example, in India Good Earth Nepal is now meeting with government officials and has built an Earthbag structure on the campus of Anna University, a large government-sponsored technical school. Good Earth Nepal has also built Earthbag toilets as a part of Prime Minister Modi's Swachh Bharat ("Clean India") health and sanitation campaign.

2. Training a Rising Professional Class and Rural Village Builders

The training of everyday building professionals, in both the cities and rural villages, constitutes the second tier of Good Earth Nepal's strategy.

Recent decades have seen the rise of a passionate Earthbag building community. Judging from available literature, however, Earthbag training within this community is largely confined to a small and homogenous cohort of college students, design and architecture buffs, first adopters, and building part-timers. A few organizations sponsor training opportunities abroad, but generally only as an adjunct to foreign aid "projects" conducted by outsiders.

To remedy this, Good Earth Nepal is sponsoring training programs that specifically target a growing pool of young engineers, architects, and licensed builders from developing regions and nations. It is this platoon of everyday working professionals, not Western devotees, who will ultimately make Earthbag construction a viable building option for those areas most in need.

Good Earth Nepal's current training program consists of a standardized seven-day Earthbag workshop. The first day is taught in the classroom, using written curricula developed in conjunction with Dr. Owen Geiger. The next six days highlight practical, hands-on training, taught at active Earthbag worksites. At the end of the program successful trainees receive a Certificate of Completion. Many graduates go on to work at other Earthbag worksites, and some have even supervised their own Earthbag project

Figure 16: Earthbag Training at Good Earth Nepal office in Kathmandu

Figure 17: Earthbag workshop for villagers in Phulping Village, Sidhupalchok, Nepal

Good Earth Nepal complements these workshops with shorter conferences and lectures. Just a few months after Nepal's earthquake, it co-sponsored an Earthbag Summit in Kathmandu that drew over 300 attendees and featured staggered, small-group training sessions. In October 2016, Good Earth Nepal in conjunction with Anna University conducted a two-day International Earthbag Conference in Madurai, India, attended by over 350 people. The group also lectures before professional universities and societies and publishes in peer-reviewed technical journals. A more recent effort aims to instalL Earthbag technology into the standardized curricula at leading engineering colleges and universities, thus giving it parity with more conventional building methods.

Good Earth Nepal also teaches the technology to those living in Nepal's most remote, under-served regions. Rural villagers constituted a substantial portion of the trainees at the Earthbag Summit and have attended training sessions at Good Earth Nepal's Kathmandu headquarters. Presently, most rural training is conducted on-site, with hands-on instruction by construction managers.

Good Earth Nepal also sponsors workshops for junior and senior high students, and for young people in general. At a typical workshop, students might build a public toilet in a rural area, and then turn their handiwork over to local villagers.

3. Building Grassroots Support

Creating grassroots, indigenous demand for Earthbag technology in developing countries constitutes the third prong of Good Earth's approach.

Historically, Earthbag initiatives in developing regions have been limited to foreign-run aid projects. Many have featured dome-shaped designs first developed by Nader Khallili, the noted architect and founding father of Earthbag technology. Though strong, the resulting structures have disregarded local building and cultural norms and have often been regarded as cutting-edge curiosities, not everyday structures to be used or lived in. To cite one example of cultural dissonance, many stupas (Buddhist temples) in Nepal are dome-shaped, as are some tombs. Few, understandably, want to live in such structures. Perversely, these culture-blind designs, however well-intentioned, have stifled the spread of Earthbag building worldwide.

Good Earth Nepal takes an entirely different approach, striving to create simple, replicable designs that honor longstanding cultural traditions.

Figure 18: Earthbag House built by Good Earth Nepal, Kathmandu, Nepal

Figure 19: Earthbag Meeting Center built by Good Earth Nepal, Anna University Campus, Madurai, India

Conclusion

This three-tiered approach has succeeded in Nepal and made sustainable Earthbag technology accessible to a large population that desperately needed it. Lobbying and working with governments, the training of everyday building professionals, and creating grassroots demand seem to be an effective blend of strategies that together create indigenous demand for Earthbag construction and can bring its many benefits to a world in need of sustainable building solutions.

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