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

Nathan Belofsky, Co-Founder, Good Earth Nepal
nathan@goodearthnepal.org
+1 917 675 1685
360 W 55 St, #4T
New York, NY 10019, USA

Kateryna Zemskova, CEO & Co-Founder, Good Earth Nepal
kateryna@goodearthnepal.org
+1 718 578 2500
901 Ave H, #5D
Brooklyn, NY 11230, USA

Abstract

Earthbag technology builds safe, appealing and cost-effective structures out of ordinary soil and is generally considered the most promising of the sustainable building techniques. But despite widespread support among environmental groups and eco-builders this and other sustainable building methods have remained on the fringes, shunned by governments and barely known to everyday building professionals and the public at large. This paradigm is changing in Nepal, where a catastrophic 2015 earthquake flattened much of the housing stock. There 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, bring it to the masses.

Keywords

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

Introduction

In developing countries the prevailing building scheme is economically unsustainable and increasingly toxic to the environment. Rural villagers build with flimsy stone, clay and straw, or use factory-processed cement, bricks, steel and timber, costly and difficult to bring to market. 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 of 2015 a 7.8 magnitude earthquake destroyed much of the housing stock, killing thousands and displacing millions. Structures of all types suffered catastrophic failure, whether built of traditional or more “modern” materials.

Meanwhile, Nepali citizens breathe, and die from, some of the most polluted air on Earth. Much of this pollution, and the fouling of Nepal’s rivers and streams, is caused by factories producing bricks and cement, and thousands of trucks used for transport.

Earthbag technology offers Nepal and other developing regions a sustainable and disaster-resistant construction method. But until recently this and other sustainable building practices have failed to meet their initial promise.

Good Earth Nepal, a non-profit organization, employs a three-tiered approach (Government Acceptance, Training a Rising Professional Class, Building Grassroots Support) aimed at establishing Earthbag technology as an everyday construction option for ordinary families, and as a critical tool in Nepal's push towards a more sustainable building future.

Earthbag Technology

Earthbag technology is an inexpensive, simple and sustainable method for erecting structures. Earthbag buildings are notable for their ability to endure earthquake, fire, flood, wind, vermin, and even bombs and bullets. In Nepal, all 55 Earthbag buildings survived a 7.8 magnitude earthquake with no structural damage, often standing beside the ruins of homes and schools built of stone, brick and cement.

Though Earthbag technology is relatively "new", its true origin dates back thousands of years. Ancient structures built with similar rammed earth techniques still stand, from the Alhambra palace in Spain to the Great Wall of China. Some call Earthbag technology "Rammed Earth in a Bag".

Earthbag technology presents the following benefits over more traditional construction techniques:

• Fewer Materials and Less Pollution - Building with soil means fewer factories, reduced need for fuel and transport and less depletion of scarce natural resources

• Safety - Earthbag technology is stronger than more traditional building techniques

• Ease of Construction - Earthbag technology is easily learned by rural villagers, and requires only the simplest of tools

• Reduced Cost - Earthbag structures cost less than traditional structures

Earthbag building is simple. Soil taken from the construction site is stuffed inside polypropylene bags, which are then staggered like masonry. Tamped down, the bags become hard as bricks in a month or two. Barbed wire, instead of cement, serves as the mortar. In seismically-active zones reinforcing buttresses, rebar and bond beams are added as needed; during an earthquake the building superstructure "floats" on an innovative rubble trench foundation, minimizing shockwaves.

As 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, making them desirable and culturally acceptable. With routine maintenance, they will last for centuries.

Earthbag construction does not require any special tools or machinery; structures are

generally built by a group of unskilled workers under the supervision of an experienced construction manager. With proper training village builders can learn to build with Earthbags for themselves.[1]

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.[2] Two years later earthquake victims still live in temporary, makeshift structures, and children still attend school in crude tin shacks open to the elements.

Meanwhile Nepal, home to verdant valleys and the mighty Himalayas, is 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.[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.

As per 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]

Air pollution also takes a toll on Nepal's tourist industry, said to create one out of six 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.

Brick and cement factories located in the suburban areas of 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]

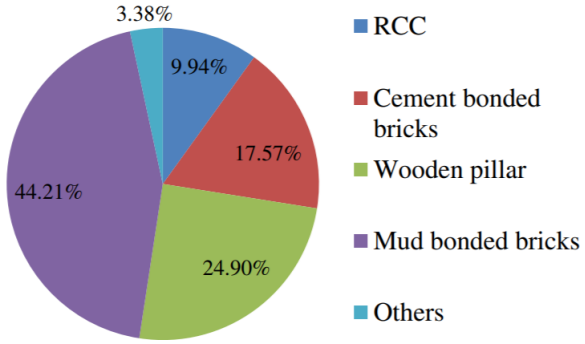

Fig 1: Distribution of housing systems as per types of structures in Nepal

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, with brick kilns being the leading 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.

A Failure to Launch

Despite its obvious benefits Earthbag technology has failed to capture the imagination of mainstream builders and the public at large and has been actively rejected by local and federal governments, suspicious of such a radically different building method. These days Earthbag technology and other sustainable building techniques remain mostly confined to eco and design enthusiasts, first adopters, 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 in particular over the years 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 been squandered, 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, for the first time, bring the promise of Earthbag building to ordinary, everyday families. 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 required building licenses and permits, resulting in a dearth of Earthbag structures worldwide. Indeed, when discussing potential projects aspiring Earthbag builders tend to focus not on the advantages of Earthbag technology but rather on whether they can obtain an Earthbag building permit in the first place.

Typical is the recent query of an aspiring builder published by the well-known Earthbag Builders Group.[9] "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[10] suggests building in Delta County, Colorado because it has no building codes, or "off-road" in the jungles of Puna, Hawaii, or in Chile, because enforcement is lax. In his blog "EarthbagBuilding.com" noted Earthbag builder Kelly Hart's talks at length about this issue.[11]

In "A Sad Story of What Can Happen Without a Permit", Dr. Owen Geiger, head of the Geiger Institute for Sustainable Building and 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.[12]

In Nepal, things are different now. 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 approval and acceptance of Earthbag technology at the federal level. For the first time ever a sovereign country (population over 29,000,000) now adopts Earthbag construction 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.

Developments in Nepal should 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 university. Good Earth Nepal is also building Earthbag toilets as a part of Prime Minister Modi's Swachh Bharat ("Clean India") health and sanitation campaign. Other developing regions await.

2. Training a Rising Professional Class

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

Recent decades have seen the rise of a passionate Earthbag building community. But judging from available literature 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", run by outsiders.

Good Earth Nepal is now taking things in a new direction, sponsoring training programs that specifically target a growing pool of young engineers, architects and builders from developing regions, hungry for sustainable building solutions. It is this platoon of everyday working professionals, not the usual group of devotees in the West, 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 projects.

Good Earth Nepal complements these workshops with shorter conferences and lectures in developing countries. Just a few months after Nepal's earthquake it co-sponsored an Earthbag Summit in Kathmandu attended by over 600, featuring staggered, small-group training sessions. In October of 2016 Good Earth Nepal, in conjunction with Anna University, conducted a two-day International Earthbag Conference in Madurai, India, attended by over 350. The group also lectures before professional universities and professional societies, publishes in peer-reviewed technical journals and gives hands-on training to local builders in the villages.

Seeking to pass along fundamental precepts of sustainable building to a younger generation Good Earth Nepal also sponsors workshops for junior and senior high students, and for young people in general. At a typical workshop students will, for example, 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 run by outsiders. 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, would 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, building plain, not fancy, and striving to create simple, replicable designs that honor longstanding cultural traditions. See, for example, the design for a one-story Earthbag house published in the *Design Catalogue for Reconstruction of Earthquake Resistant Houses, Vol 2.*

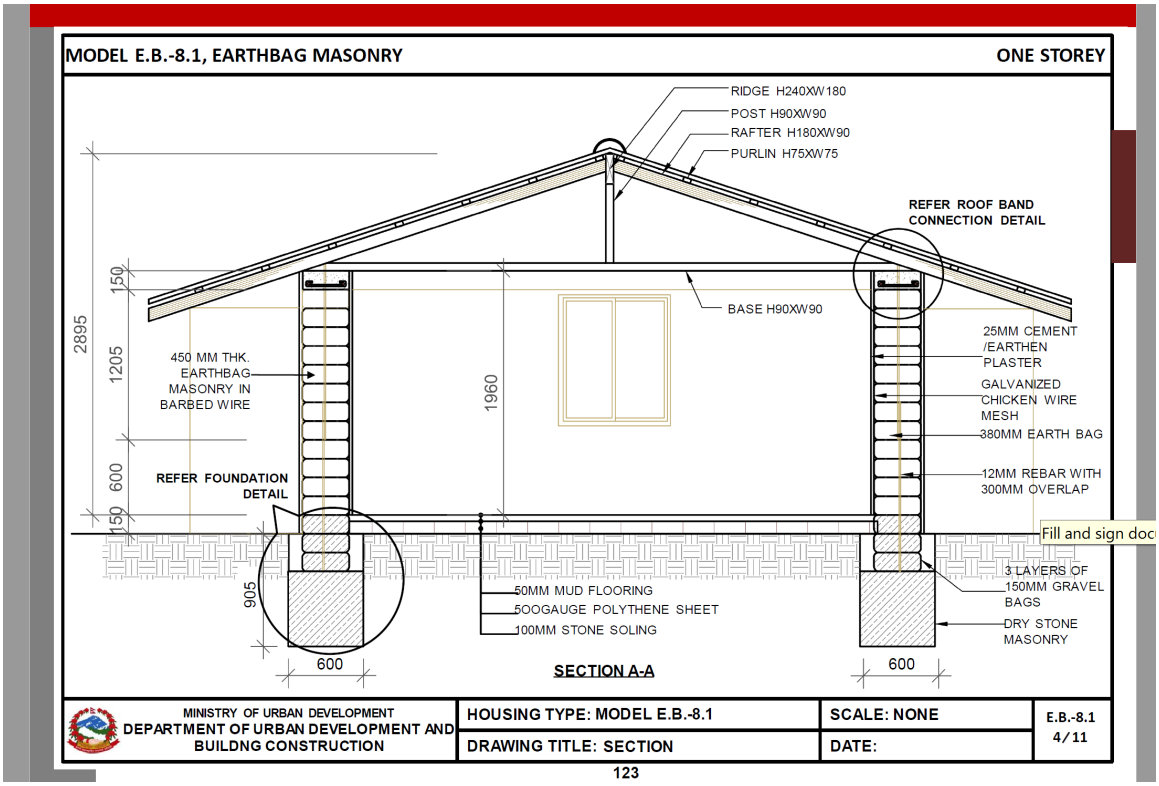

Fig 2: Government Approved Earthbag House Design
Source: Government of Nepal, Ministry of Urban Development, Department of Urban Development and Building Construction, "Design Catalogue for Reconstruction of Earthquake Resistant Houses, Vol 2", (2017): 123.

Conclusion

This three-tiered approach has succeeded in Nepal and made sustainable Earthbag technology accessible to a mass population. Lobbying and working with governments, the training of everyday building professionals and creating grassroots demand is the only strategy that will create indigenous demand for Earthbag construction, and bring its many benefits to a world badly in need of sustainable building solutions.

References

1. Owen Geiger and Kateryna Zemskova, "Earthbag Technology – Simple, Safe and Sustainable," Nepal Engineer's Association Technical Journal Special Issue on Gorkha Earthquake 2015, Vol XLIII-EC30-Issue1 (2016): 78-90.
2. John P. Rafferty, "Nepal Earthquake of 2015," Encyclopedia Britannica, April 27, 2015, accessed June 05, 2017, https://www.britannica.com/topic/Nepal-earthquake-of-2015.
3. Slok Gyawali, "Air Pollution Taking a Steep Toll on Kathmandu Residents," Earth Island Journal, November 28, 2016, accessed July 15, 2017, http://www.earthisland.org/journal/index.php/elist/eListRead/air_pollution_taking_

toll_on_kathmandu_residents/;
"Nepal's Capital 7th most polluted city in the world," The Himalayan Times, February 05, 2017, accessed June 24, 2017, https://thehimalayantimes.com/kathmandu/kathmandu-listed-as-7th-most-polluted-city-in-world/.

4. Slok Gyawali, "Air Pollution Problem Could Disrupt Nepal's Tourism Industry," Earth Island Journal, February 8, 2017, accessed July 15, 2017, http://www.earthisland.org/journal/index.php/elist/eListRead/air_pollution_problem_could_disrupt_nepals_tourism_industry/.
5. Om Kurmi, Pramod R Regmi and Puspa Raj Pant, "Implication of Air Pollution on Health Effects in Nepal: Lessons from Global Research," Nepal Journal of Epidemiology, (2016): 525-527, doi: 10.3126/nje.v6i1.14733.
6. Narahari Chapagain and Min Raj Dhakal, "Vegetation record around a cement factory and the impact of dust pollution on crop productivity," Nepalese Journal of Biosciences 1 (2011): 55-62, doi: http://dx.doi.org/10.3126/njbs.v1i0.7472.
7. Dipendra Gautam, Jyoti Prajapati, Kuh Valencia Paterno, Krishna Kumar, Bhetwal and Pramod Neupane, "Disaster resilient vernacular housing technology in Nepal," Geoenvironmental Disasters (2016): 1-14, doi: 10.1186/s40677-016-0036-y.
8. Joshi SK and Dudani I, "Environmental health effects of brick kilns in Kathmandu valley," Kathmandu University Medical Journal, Vol 6, No 1, Issue 21, (2008): 3-11, https://www.ncbi.nlm.nih.gov/pubmed/18604107.
9. Adam, posted on March 11, 2017, Earthbag Builders Public Group, accessed July 14, 2017, https://www.facebook.com/groups/39495056171/.
10. Anonymous, posted in 2011, "Areas that allow earthbag construction?," Permies, accessed July 14, 2017, https://permies.com/t/6363/Areas-earthbag-construction.
11. Kelly Hart, "Permits and Codes for Earthbag Buildings," EarthbagBuilding.com, undated, accessed June 20, 2017, http://www.earthbagbuilding.com/faqs/codes.htm.
12. Owen Geiger, "A Sad Story of What Can Happen Without a Permit," Natural Building Blog, May 10, 2011, accessed June 20, 2017, http://www.naturalbuildingblog.com/a-sad-story-of-what-can-happen-without-a-permit/.