Rebuilding efforts in Nepal continue: Earthbag building proves a promising building method for redevelopment

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Figure 1: Earthbag rebuilding project in Dhading, Nepal. Source: Kathryn Kaspar (2015)

The Ghorka Earthquake: April 25, 2015

On April 25, 2015, a magnitude 7.8 earthquake shook the entirety of Nepal, and was felt in parts of India, Pakistan, and Myanmar. It is estimated that nearly 9,000 people died and approximately 22,000 people suffered injuries due to building collapses, smoke inhalation, and flying debris. (Barry, 2016). Despite the staggering losses, some believe that many more lives could have been taken had it occurred during the nighttime. At 11:56 AM on Saturday when the earthquake first struck, rural farmers were out tending to their fields while many Kathmandu residents traded in

the outdoor markets. It was immediately evident, however, that the Nepali landscape would be forever scarred by this powerful event.

The aftershocks of the earthquake continued over a month after the initial quake, with one aftershock on May 12, 2015 registering at 7.3 magnitude. The prolonging aftershocks left many afraid to clear out the rubble and rebuild, resulting in thousands of people seeking refuge in the streets and fields. After the two significant earthquakes, nearly one million homes were destroyed and approximately $10 billion USD in damages was estimated (USGS, 2015). Worst still, some of the country's most cherished structures, including the UNESCO World Heritage sites of the Boudhanath stupa, Kathmandu Durbar Square, and Dharahara Tower were severely damaged in the wake of the disaster.

Fortunately, $4.1 billion USD was pledged by countries worldwide to assist in immediate and long-term relief efforts; however, the Nepali government had difficulties allocating the funds to its constituents and as a result almost 800,000 households were still waiting for promised aid as of April 2016 (Barry, 2016).

In the interim, immediate relief projects brought temporary shelters made of tin and bolts to thousands of families, as shown in Figure 1. These structures can be assembled quickly and provide some moderate shelter for the families, but are insufficient in protecting against earthquakes, monsoon winds, and harsh winter temperatures.

Figure 2. A typical temporary shelter in Dhading, Nepal. Source: Kathryn Kaspar (2015)

Rebuilding efforts are further complicated because of Nepal's proximity to the Main Himalayan Thrust fault, leading to the eminent prediction of future earthquakes in the region (Morelle, 2015). To properly allocate resources and rebuild the country effectively, governmental and non-governmental organizations have been exploring alternative building techniques that are both affordable and seismic-resistant.

Earthbag building: an innovative, affordable, and sustainable building technique

Earthbag building has gained considerable traction in Nepal, with organizations including Good Earth Nepal, Woven Earth, and First Steps Himalaya leading trainings and coordinating the rebuilding of homes, schools, and health clinics.

The earthbag building technique was originally derived from sand bags that were used as bunkers during World War II, after it was discovered that these earth-filled bags had an incredible capacity for resisting high impacts. The earthbag technique involves filling a polypropylene or burlap sack with earth, and then using a heavy metal or wood tamper to pound the earth into a level surface. In between layers of bags, barbed wire is placed to provide the necessary tensile strength to resist earthquakes, as shown in Figure 3. Lastly, the roof of the structure is connected deep into the core of the bags to provide adequate rigidity throughout the structure.

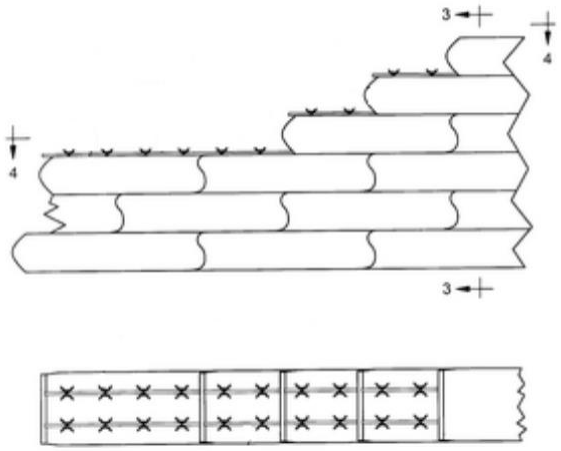

Figure 3: Elevation and plan view of earthbag layers. Source: Khalili (1999)

One of the most appealing elements of earthbag building is that the core material, soil, is heavily abundant in rural areas. Polypropylene sacks are readily available throughout Nepal due to the high quantity of rice being produced and imported, and supplies of barbed wire and various roofing materials can be found at all major towns. With just a few simple tools, proper technique to place the earthbags can be taught to the local communities, making this construction technique

highly suitable to regions with limited accessibility. The earthbag houses are also designed such that the size and shape is appealing and familiar to the recipients; it is possible to use the same clay mortar that is used on the traditional masonry buildings of Nepal, as shown in Figure 4.

Figure 4: Preliminary plaster layers on an earthbag structure. Source: Kathryn Kaspar (2015)

Most importantly, the performance of earthbag buildings under seismic conditions has shown to be very promising. Studies done at Cal-Earth, a pioneering company in earthbag technology, allowed for earthbag structures to successfully receive code approval for the most dangerous seismic zone (Khalili & Vittore, 1998). Similarly, the outstanding performance of existing earthbag buildings and years of lobbying resulted in the official adoption of the earthbag technique into the March 2017 Edition of the *Design Catalogue for Reconstruction of Earthquake Resistant Houses*, thus opening doors for future earthbag projects (Government of Nepal, 2017).

With the promised government aid of approximately $2000 USD, it is possible to construct a small earthbag home for each family affected by the earthquake. At the least, these homes would provide a safe shelter for the families as an upgrade from the current temporary shelters. For many, however, it is likely that the families would use the earthbag homes as their permanent home.

Nepali culture and the potential of earthbag

The local culture and lifestyle of rural Nepal is what makes the earthbag building highly appropriate as a rebuilding technique. Many Nepalis are subsistence farmers, working heavily through the summer in their fields to provide food for the rest of the country. In the winter months, however, these families have time to dedicate towards rebuilding efforts.

Villages are often made up of 10-20 homes originating from just a few distinct families. Strong familial ties provide the foundation for organized, coordinated labor projects in which the community comes together to rebuild collectively. Some organizations, including a joint effort by Woven Earth and Loving Arms Mission, have successfully carried out projects in which one member of each family worked on the construction of multiple houses in exchange for receiving one of the houses upon completion.

Teaching the locals not only provides them with useful skills but also greatly reduces the cost of labor for the project. The local acceptance and understanding of a new building technique is also more likely because the recipients are involved in every step of the construction process.

Looking to the future, Nepal will need to adopt a multi-faceted approach towards rebuilding efforts; however, a cooperative system at the community level could be the best way to help as many people as soon as possible. With the new adoption of earthbag into the national building code, organizations are hopeful that this construction method will be implemented nationwide to continue supporting rebuilding efforts throughout the country.

REFERENCES:

Barry, E. (2016, April 30). A Year After Earthquake, Nepal's Recovery Is Just Beginning. *The New York Times*. Retrieved from https://www.nytimes.com/2016/05/01/world/asia/nepals-earthquake-recovery-remains-in-disarray-a-year-later.html

Government of Nepal. (2017, March). *Design Catalogue for Reconstruction of Earthquake Resistant Houses*. Retrieved from https://static1.squarespace.com/static/5583171fe4b0329e24785056/t/58e7164f29687f9246135d4c/1491539555216/DUDBC-DESIGN-CATALOGUE-VOL2.pdf

Khalili, E.N. (1999). *U.S. Patent No. 5,934,027A*. Washington, DC: U.S.

Khalili, N., & Vittore, P. (1998) *Earth Architecture and Ceramics: The Sandbag/Superadobe/Superblock Construction System*. Retrieved from http://www.earthbagbuilding.com/Testing/superadobe.htm

Morelle, R. (2015, August 7). Risk of future Nepal-India earthquake increases. *BBC*. Retrieved from http://www.bbc.com/news/science-environment-33807791

United States Geological Survey (USGS). (2015, April 25). M7.8-36 km E of Khudi, Nepal. Retrieved from https://earthquake.usgs.gov/earthquakes/eventpage/us20002926#pager