GeoHazards International

December 2013 Newsletter

GHI Addresses Severe Landslide Risk in Aizawl, India

May 2013 landslide in Aizawl, India. PHOTO: RINPUII TLAU

Landslides wreak havoc all too often in Aizawl, the ridge-top capital of northeast India's Mizoram state. Unstable slopes, heavy rainfall, and active faults create potent risk, but land use practices add to the problem. GHI is helping Aizawl understand why and where landslides will likely occur and is helping the city plan for safer development.

Funded by reinsurer Munich Re, GHI's work brings technical and policy experts to support and mentor Aizawl's planners, engineers and geologists. "One of our top priorities is to help the city implement land use policies based on sound geoscience," said Janise Rodgers, GHI's project manager for Aizawl.

A major landslide killed 17 people in their homes in May 2013, highlighting the urgency of this work. The slope that failed (shown in photo) had a dangerous geologic condition: contacts between rock layers, called bedding planes, slope in the same direction as the slope itself, making it susceptible to sliding when an excavation removes supporting rock, or when water weakens the contact.

Unfortunately a large concrete building and several residences had been built on this slope without regard to the risk. In fact, the May landslide occurred in an area zoned for further residential development.

Without prudent land use, dangers will escalate in this fast-growing city of 300,000. How? Heavy rainfall triggers landslides every year. Adding to the risk, uncontrolled development packs precarious buildings onto steep slopes. Once disturbed, marginally stable slopes will fail more readily. In addition, the city's several steep ridges will amplify seismic energy, so even a moderate earthquake would cause landslides and massive damage.

"We intend to bridge the gap between policy makers responsible for land use decisions in Aizawl and the professional engineering geology community that has technical knowledge of landslide hazard and mitigation measures," said Dr. Rodgers.

In April, GHI convened a technical assistance panel in Aizawl with local professionals and renowned professionals from the US and India. The team includes geophysicist Vineet Gahalaut of National Geophysical Research Institute Hyderabad; geologists Leonardo Seeber of Lamont-Doherty Earth Observatory and Kevin Clahan of Lettis Consultants International; structural engineers William Holmes of Rutherford & Chekene and Pradeep Ramancharla of IIIT Hyderabad; urban planners Ajay Katuri of CEPT Ahmedabad and Larry Mintier of Mintier Harnish; and GHI policy specialists Thomas Tobin and Hari Kumar. This team drafted immediate recommendations to protect residents as well as an earthquake scenario that pinpoints potential landsliding and infrastructure damage.

The scenario paints a stark picture of devastation that awaits Aizawl: a M7 earthquake causing moderate shaking would collapse a quarter of Aizawl's buildings, trigger nearly 1,000 landslides and kill more than 25,000 people. In October, GHI re-convened the technical assistance panel to present the draft scenario to the public and policy makers, seek feedback and advise policy makers.

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MAP: BOB WENZLAU

Concept to Prototype: Innovative Tsunami Evacuation Parks

Conceptual rendering of a Tsunami Evacuation Park in Padang, Indonesia. KORNBERG ASSOCIATES

The coastal city of Padang, Indonesia faces one of the highest tsunami risks in the world, due to strain in the thrust-fault just offshore, flat terrain, and dense population. Half of Padang's 900,000 residents live within the inundation zone at less than 15 feet above sea level.

There is high probability that a tsunami will strike Padang within thirty years. The 15-30 foot waves will pound shore thirty minutes after a major earthquake.

Earth shaking will provide scant warning to seek high ground. In fact there is little high ground in much of Padang. If a tsunami occurred today, several hundred thousand people would die, because they could not reach safety in time. GHI, our international partners, and Stanford University have studied options for improving this situation.

Tsunami Evacuation Parks (TEPs) proved the most practical option for Padang. Man-made hills, each the size of a soccer field and resistant to earthquake and tsunami forces, would be topped with parks. People would use the TEPs daily and seek safety there during a tsunami threat. Each TEP could hold masses of people arriving on foot from different directions. GHI and Kornberg Associates developed a conceptual design.

These elevated safe havens have the potential to save lives, are simple to build and maintain, invite daily use, and have attracted Indonesian government support as a means to manage the nation's tsunami risk.

A group of Indonesians led by Mr. Irman Gusman, chairman of the Indonesian Regional Representatives Council (equivalent to the U.S. senate), started SPIN Foundation to design and build the prototype TEP. Mr. Alwi Shihab, former foreign minister of Indonesia and a former professor at Harvard Divinity School, organized the foundation.

"I saw and sensed the magnitude of agony and suffering as well as the loss of lives in Aceh after the tsunami disaster of 2004, as the highest ranking Indonesian official supervising the rescue and evacuation of victims. This painful experience motivated me to support the noble endeavor of constructing a Tsunami Evacuation Park that will save more lives and mitigate more suffering," said Mr. Shihab.

SPIN raised $500,000 at its first event in November 2013. This enables work to start on a detailed design of the TEP. GHI acquired permission to build a prototype TEP in the north part of Padang that would accommodate 25,000 people. Construction would cost about $2.4 million, amounting to a cost-per-life-saved of ~US$100. The cost to replicate should be even less.

Construction of TEPs, if adapted for other vulnerable coastal cities, would potentially save thousands of lives. Vertical evacuation structures are relatively new tools in preparing for tsunamis. (Preparation efforts traditionally focused on horizontal routes.) Many survivors of the 2011 Japan tsunami were saved by walking to the top of reinforced concrete buildings or man-made mounds.

Funding for this project also came from Swiss Reinsurance Company, Stanford University's Blume Earthquake Engineering Center, Earth Observatory of Singapore, Nanyang Technical University, Stanford Engineers for a Sustainable World, Geoscientists Without Borders, Kornberg Associates, The Benchmark Group, and individual supporters of GHI.

SPIN Foundation board members Erwady Gunawan, Alwi Shihab, and Budi Adiputro with GHI president Brian Tucker (2nd from left) at a fundraising event in Indonesia.

Many Thanks to You, GHI's Sponsors

We hope these stories of current GHI efforts will inspire you as they do us. Truly, your generous support makes this work possible. As GHI enters its 23rd year, we remain dedicated to working with vulnerable communities before disaster strikes, in order to save lives, reduce suffering and build enduring, prosperous societies.

\- *Brian Tucker, President*

Network Drafts Guide to Improve a Vulnerable Building Type's Design

In the last decade, tens of thousands of people died when concrete frame buildings with masonry infill collapsed during earthquakes. Poor construction or lack of engineering sometimes caused the structures to fail. But in many cases blame lies with the design itself.

GHI formed a group of international specialists, called the Framed Infill Network, to improve how this common building type is designed and built. The Network developed earthquake resistant, affordable techniques that, if adopted, would advance global earthquake safety. "Framed infill" refers to the new, better construction systems. GHI recently drafted a design manual to help engineers understand and apply these techniques.

Infill construction combines a reinforced concrete frame with numerous unreinforced masonry walls. Used extensively for housing, offices, shops, and schools, this type of building is common in earthquake-prone urban regions of Asia, Central and South America, and the Mediterranean. Construction typically uses local materials and labor, keeping cost low. Buildings can range from one to 20 stories high.

A major problem is that the design often ignores the infill's impact on structural integrity. For example, when a building has few walls in the ground story shops or parking, but many walls in housing above, damage concentrates at the weaker, more flexible ground story that was not designed for such forces. The frames may lack integrity as well, which increases the building's vulnerability.

GHI's new manual presents five strategies to help engineers confidently design new frames with infill, or determine when it makes more sense to switch to another structural system. The document explains when each strategy will or will not be effective, and it explains essential design concepts. Variables such as available materials, local skills, seismic hazard, building location, and building use will affect the design choice.

"The key is to work with infill walls, including them in the lateral system where feasible and advisable, and always considering them as structural elements during the design process," note the authors Shabnam Semnani, Janise Rodgers and Henry Burton.

Members of the Framed Infill Network are spread around the globe. Geoscience researchers, practicing engineers, architects, builders, and building officials collaborate electronically in small groups. Their fruitful exchange has bred cost effective and innovative approaches such as applying a rocking spine to the design.

A building constructed with a concrete frame and brick masonry infill walls in Thimphu, Bhutan. PHOTO: JANISE RODGERS

With funding from the Earthquake Engineering Research Institute (EERI) and the Thornton Tomasetti Foundation, two Stanford University graduate students helped draft the engineering guidance manual. They worked closely with GHI's Project Manager Janise Rodgers, team members at Stanford's Blume Earthquake Engineering Center, and members of the Network. Stanford professor Greg Deierlein originally proposed the Network during a GHI-led workshop. Seed funding was provided by the Pakistan-U.S. Science and Technology Cooperation Program, implemented by the National Academies.

This project provides feasible technical solutions and will build local capacity to design seismically-safer structures in developing countries. Going forward, GHI envisions that existing concrete frame structures with infill walls would be retrofitted using solutions developed by the Network.

After review by an international group of engineers, the final manual will be available online at www.framedinfill.org, www.EERI.org, and www.geohaz.org.

***AIZAWL,** Continued from Page 1*

GHI is working with geologists from Lettis Consultants International, the Geological Survey of India, and Aizawl to create more detailed landslide hazard maps and a landslide inventory of Aizawl. Local agencies will then have a critical planning resource. During the coming months, GHI's policy experts will guide the Aizawl Municipal Council's Landslide Policy Committee for Aizawl City. This committee will develop land use policies and regulations using the new landslide hazard information.

Based on strong experience in geo-risks, Munich Re's steady and enlightened support for GHI's work is helping Aizawl manage major risks. It is also provideing much needed encouragement to local professionals. These planners, engineers and geologists have worked hard to make initial progress, and they will advocate for safety as the city expands.

Thanks to sponsors, GHI brings world expertise in natural hazards to the local level, where preparation will save lives. Our innovative approach empowers communities to prevent disasters.

Students take cover at Dr. Tobgyel School in Thimphu, Bhutan. PHOTO: KARMA DOMA TSHERING

Bhutan Inaugurates Annual School Earthquake Drill

On a single day in September of this year, every student in Bhutan took shelter under a desk. They were practicing what to do when an earthquake strikes, as part of Bhutan's first nationwide school preparedness drill. GHI and our sister organization in Delhi, GeoHazards Society (GHS), coordinated the effort.

"This is a dream for me. To organize the mass earthquake drill and get it institutionalized is exactly why GHI exists!" noted Hari Kumar, GHI's Asia coordinator based in Delhi. Mr. Kumar and Karma Doma Tshering, head of GHI's Bhutan office, coordinated the training and drill in which all 500 schools in Bhutan participated—all the teachers, students, and district education officers. Bhutan is possibly the first country to conduct a drill simultaneously in every school.

Seismologists warn that a major earthquake could occur at any time in this stunning, mountainous country. Because children are especially vulnerable in disasters, Bhutan resolved to help them prepare. "I am not just passionate about the safety of our children, I'm *emotional* about it," said the Minister of Education, a former teacher, as he briefed the press about the drill.

Bhutan's M6.1 earthquake in 2009 killed twelve people and destroyed one school. That quake and another in 2011 damaged a total of 258 schools. Had classes been in session those days, many children would have died. At our suggestion, Bhutan chose to commemorate the 2009 disaster by creating an annual earthquake safety day, with initial focus on schools.

The extensive, nationwide preparation was funded by the Czech Republic Embassy of New Delhi and our donors. Bhutan's Ministry of Education and Department of Disaster Management were deeply engaged in the process. Each school incorporated resource materials into lessons, confirmed evacuation plans, assigned disaster response roles, and planned for special needs students. Educators used a Facebook page to plan and to post photos, and they used a group Gmail account to share advice.

The day began with class lessons about what causes earthquakes and what people can do to minimize losses. Then on the anniversary of the 2009 earthquake, special bells and sirens sounded in all of Bhutan's schools. Students sought shelter under desks, waited for a signal to leave, and evacuated to an assembly area.

Children chosen prior to the drill to go "missing" stayed behind in the schoolrooms. Teachers took a head count at the assembly area. Teams conducted search-and-rescue drills to find missing children, and they administered emergency first aid. The nationwide drill took 30-45 minutes.

In a follow-up workshop, educators and observers from across Bhutan discussed lessons learned. For example, they saw the need for child release policies, for a uniform siren sound, and for coordination with national Search and Rescue. They wanted additional stretchers and fire extinguishers on site. Teachers requested more training in counseling, first aid, and fire safety. One principal, explaining why Bhutan needs ongoing preparation, said, "I need a clear direction on what to say. I am responsible for these children! Until I receive clear instructions on what to tell them, I cannot sleep."

The education minister took part in the review workshop and exhorted participants to ensure that every child in every school is safe. With such evaluation—and practice—Bhutan will continue to improve school preparedness.

Schools for visually challenged and special needs children will be included next year, building on our experience in India. Some hospital administrators, encouraged by attention to safety, want to participate as well.

The reach of Bhutan's training program begs the question: where next? GHI has already introduced drills in northern India, reaching 51,000 school children last year. Many more schools could benefit. We invite you to join us in this effort.