

cross sections

Magazine for the Structural Engineers Association of New York

2015 VOLUME 20 NO. 3



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CONTENTS

- 3 **President's Message**
- 3 **Editor's Message**

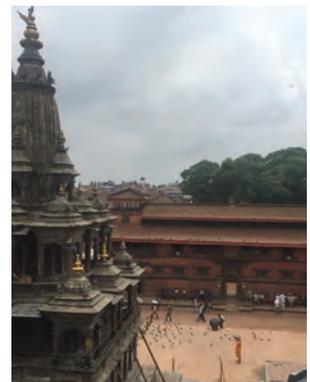
FEATURES

- 4 **CO-BUILD KATHMANDU**
A Post-Earthquake Journey to the Himalayas
By April Greene
- 8 **REBUILDING *with* HEART**
By Delia Shumway
- 12 **SAVING THE SACRED
WORKING WITH LOCALS
TO PRESERVE HISTORIC STRUCTURES**
By Evan Speer

ON THE COVER

A monk documents a temple in Patan Darbar Square post-earthquake.

Photo: Justin Den Herder





President's Message

As 2015 draws to a close we can reflect back on our accomplishments over the past year and more importantly look forward to continued growth of SEAoNY in the New Year. We continued to provide successful programs such as this year's Structure Quest which serves to encourage college students to join our industry. Our annual meeting featured speaker was Richard T. Anderson of the New York Building Congress, who gave us an update on construction trends in our industry which remains strong. We continued to collaborate with other organizations in order to forward our shared goals. We recently partnered with Open House New York to showcase the state of the art in structural engineering during Open House Weekend in October. Our members gave tours of significant New York City structures to the general public, highlighting the importance of our work in the built environment.

2016 is also shaping up to be a strong year. Our committees continue to be active and there is an exciting roster of monthly programs planned. It's important to note that we are a volunteer organization and rely on active participation of our members for success. I encourage our members to actively participate. This will strengthen our voice and highlight the importance of our work to the design and construction industry and the public at large. I hope to see you soon at one of our upcoming events.

Regards,
Alastair C. Elliott, PE, LEED AP



Editor's Message

Dear Friends and Readers,

As we come to the end of the year and have the good fortune to contemplate gratitude amongst family and friends, it behooves us to acknowledge that many, many others will not have the opportunity to do so this holiday season — a fact that, I hope, both humbles us and instills within us, a strong desire to help and serve those in need.

We are in a service-oriented industry, and it is our duty, amidst the chaos and pressure of end of year deadlines to remember this above all. Although this issue focuses on the efforts of three local engineer's journey to Nepal in the wake of the devastating earthquake they experienced last spring, the acknowledgement of our role here and now, in this city and beyond, does not mean that we must drop what we're doing, travel to another country and perform building assessments and seismic retrofits. Our actions, our designs, are preemptively preventing that from being necessary in the wake of catastrophic events, and in so doing, we are already providing a noble service to the public.

May that awareness be subconsciously planted within us and reinvigorate us. May our actions be filled with thoughtfulness and kindness in our daily lives. For if that becomes true, then those same traits will be embedded within our designs.

Wishing you all the best this holiday season,
Justin Den Herder, PE

UPCOMING EVENTS

- January 20 @ the CfA **The Statutes of Limitations and Repose: When is a Design Professional's Job Really Finished?**
Presenter: Kriton A. Pantelidis
- February 16 @ the CfA **Overview and Design of Helical Pile Foundation**
Presenter: Pat Haffert
- February 09, 2016 **All Day Seminar: Flood Mitigation**
Location and Presenters to be announced

Visit www.seaony.org/programs for additional information on these and other events!

CO-BUILD KATHMANDU

A POST-EARTHQUAKE JOURNEY TO THE HIMALAYAS

THE GORKHA EARTHQUAKE STRUCK NEPAL ON APRIL 25, 2015. Scott Francisco and Sarah Wilson, of the New York City-based design consultancy Pilot Projects, were there. Eager to help the many people in need, they established Co-Build Kathmandu, an initiative intended to encourage design professionals to travel to Nepal and volunteer their time and skills assisting with building assessments of damaged structures.

By APRIL GREENE

"I had wanted to go to Nepal for a long time, and thought my knowledge of structural engineering—especially with regard to existing buildings—could be helpful, so I responded to Co-Build Kathmandu's call for volunteers," said Justin Den Herder, a senior engineer at Silman. "And within a few weeks, I was there."

Justin spent the first three weeks of July in Nepal. "In many ways, I didn't know what to expect, which was exciting," he said. "I'd spoken to Scott about his overall intentions for the project, and he'd put me in touch with people there who I could work with and who could guide me. But we couldn't make very many plans. In some respects, I was doing recon work to establish a framework for others to follow after me. It was the kind of thing where I just had to go and see what was happening, meet people and ask around, go where I needed to be."

Co-Build's partners in Nepal—Pete Rausch, an American expat, and Bikash Singh, a Newar and Kathmandu native—picked Justin up from Tribhuvan airport when he arrived and took him to a rooftop cafe in Patan, Nepal's third-largest city. The three talked about their course of action over breakfast.

"I was really taken with Patan; I thought it was much more beautiful than Kathmandu," Justin said. "There's tons of wood latticework and metalwork; some of the best craftsmen in the world came from there. But sadly, most of the buildings were in really bad shape. Facades weren't properly tied back to floor structures; wood and bamboo braces were jutting out into streets; many buildings that hadn't collapsed were just leaning up against each other. My hotel was right across the street from Patan's Durbar Square, and unfortunately several ancient temples there—we're talking thousands of years old—had completely collapsed," Justin said.

"I'd estimate that 75 percent of the city needs to be rebuilt," he said. "It's such a shame because it's so beautiful."



A collapsed bearing wall and floor slab at a damaged home in Nagarkot, Nepal.



Pete Rausch, Aditya Kunwar, and Bikash Singh, friends and volunteers with Kathmandu Valley in the background.

But all was not lost; Justin could see hope for other buildings. “The ones that remained were propped up with temporary wood bracing,” he explained. “Years ago, Bob Silman had designed a seismic retrofitting strategy for some of the temples which were part of the UNESCO World Heritage Program. These structures fared better during the earthquake as a result. Hopefully, funds can be allocated to implement a similar strategy for the damaged temples that remain. It’s vital to the Nepalese that these temples be rebuilt because, not only are they historically and culturally significant, but they’re still actively used today.”

Every morning, to the sounds of prayer from those very temples, Pete, Bikash, and Justin would share breakfast at the same rooftop cafe and develop a plan of action for the day. On adjacent rooftops, young Nepalese men would smoke cigarettes beneath black plastic water tanks, propping their elbows on parapets with dislodged bricks. The crooked form of Krishna crowned a stone temple. Rising from the street was the endless honking of scooters and tuk-tuks; green mountains lined the perimeter of the valley; behind a layer of cloud—and above the clouds—sat the snow-capped summits of the Himalayas. Perhaps surprisingly, it turned out that Patan would be the least of their worries.

“Because some larger organizations had assessed and inspected many of the buildings within the city already,” Justin said, “we determined that the most useful approach would be to head out into the villages surrounding the valley and do some structural assessments there. Pete and Bikash had friends in one particular village, Ichangu, which is about 40 minutes outside of Patan. We decided that would be the first area we would target.”

“I had some engineering know-how,” Justin said, “but my relief work was limited to volunteering after Hurricane Sandy in New York, when I learned a little about FEMA and ATC. So before going to Nepal—and also on the plane, actually!—I read the ATC-20-1 Bhutan: Procedures for Postearthquake Safety Evaluation of Buildings. I was hopeful that I’d see some of the same building and

construction types in Nepal as were illustrated in that manual, which was compiled after a 2009 earthquake in Bhutan. And it did turn out to be quite valuable, in terms of knowing what was safe and unsafe and familiarizing myself with the conditions I could expect to encounter.”

“Much of post-disaster assessment is engineering judgment, though, to be frank,” he said. “There’s an assessment form that ATC has developed, and I found that very helpful, too. But a lot of it does come down to just personal experience and judgment. Each village, each house was a unique situation. Factors such as the location of the house, the location of the village, access to construction materials and tools, and who the inhabitants of a particular house were played a role in determining whether or not a building could be salvaged.”

In Ichangu, Pete and Justin found some houses perched on the steep terrain near the edges of town. There, they met Aditya Kunwar. “Aditya was the most amazing person I met in Nepal,” Justin said. “He was orphaned as a toddler, but was later taken in by a wealthy family with British ties who had some connection to the construction industry. So he spoke fluent English, and he knew something about building construction! It was incredibly fortuitous to meet him, especially on day one. He became a great partner for us.”

Aditya’s house had been decimated by the earthquake.

“He was at home when it happened,” Justin said. “He held his two-year-old daughter to his chest as the house fell down around them. By some miracle nothing hit them—nothing from this two-story house made of stones and mortar. He got out from under the rubble and then pulled five or six of his neighbors out of their homes. That shows you what kind of guy he is.” So, it was no surprise that, upon hearing what Pete and Justin were doing, Aditya



Earthquake damage at a home in Nagarkot, Nepal.

Each village, each house was a unique situation. Factors such as the location of the house, the location of the village access to construction materials and tools... all played a role in determining whether or not a building could be salvaged.

"dropped everything to come with us," Justin said. "He had his own house to fix, but he wanted to help. Starting that day, he took us around to home after home in his area. And once we found one person who needed an assessment, the neighbors would catch wind, and we'd wind up assessing the whole block!"

Each village, each house was a unique situation. Factors such as the location of the house, the location of the village, access to construction materials and tools... all played a role in determining whether or not a building could be salvaged.

The houses Justin inspected ranged from simple one-room huts to four-story concrete constructs with brick wall in-fills; many were handmade by laymen. The time he spent assessing varied depending on the house's size, who lived there, and the inhabitants' capacity to make repairs. "For example, if we went to a home that was occupied by two elderly women with no one to help them," Justin explained, "we wouldn't spend a lot of time talking about the repairs they'd want to make. In cases like that, we would just communicate whether we deemed the house safe for habitation or not. But if there were others nearby, neighbors or relatives with some construction experience, and the capacity to rebuild was possible, we'd talk through our recommendations and develop repair details and procedures with them."

"Aditya would translate for us," Justin said, "and his presence added credibility to my recommendations. People definitely wondered, 'Who's this guy from the other side of the world, walking around and telling me whether or not my home is safe to live in?' Aditya could explain."



Typical temporary bracing of buildings in Patan, Nepal

The extent of the damage varied: sometimes unreinforced exterior bearing walls would be cracked all the way through, or wood floor joists pocketed into walls would pull away, leaving a gap between the edge of the joist and the wall unbraced. Then there were geological concerns, like houses built on steep hillsides where the ground shifted during the earthquake and a retaining wall failed. In this scenario, a house might be two feet away from sliding down the mountain—which could also trigger a landslide and pose a threat to surrounding houses.

"Also, I should add that this was monsoon season!" Justin said. "For several hours each day there was a crazy downpour, a cloudburst; whole towns would become muddy rivers. It was really bad timing for doing construction—and for all the people who had to live in tents."

"But despite their hardships and my being a stranger, every family—really and truly, every person I encountered—was so nice, so kind to us," Justin said. "I probably drank enough tea there to fill Boston Harbor. They would always give us tea or offer us a snack, even though they had nothing. Tea or Nepali moonshine! That's potent

"I was able to experience a very beautiful, thoughtful, and compassionate culture in a most profound way."

stuff. I had to watch my intake!"

Justin assessed an average of 15 homes a day, for around 30 minutes apiece, as well as the occasional temple, monastery, or other structure. Sometimes his work turned from assessing to offering manual labor on the spot. "One day, I helped demolish somebody's house with my bare hands because they didn't have any tools," he said. "I just tried to do whatever I could."

"It was a lot of work," he said. "but I had plenty of fun, too. We'd work until sundown, then head back to the city and go out to eat

and see some live music, or sit in the living room of one of Pete and Bikash's friends and have passionate conversations on just about any topic. Pete is 50 and short, with flowing, 'surfer-dude' white hair. Bikash is 33, and always wears a fedora—even while playing soccer. So I think the three of us stood out a bit, but over the three weeks we became good friends. We had a great time together."

Justin's trip ended on an especially memorable note. He had

originally planned to spend his last few days relaxing at Pokhara, a popular lakeside town, but, “after weeks of seeing the devastation, meeting the kind-hearted Nepalese, and understanding how much help they still needed, that just didn’t feel right,” he said. So he contacted a small group of European volunteers he’d met earlier to see if he could help them distribute money or goods during his last days in the country.

“We wound up purchasing and donating 75, 70-pound bags of rice to people in a small village in Nagarkot,” he said. “One of the most impressive illustrations of Nepalese resiliency I saw during my trip—among many—was the image of old women coming to claim their bag of rice. I’d ask who was there to carry it home for them, and they’d just smile, take the bag from me, throw it over their shoulders, and walk straight up the mountain! I can’t imagine my grandmother doing that. I was struggling trying to lift these bags myself.”

“While I found that Nepalese people don’t show their emotions outwardly very much,” Justin said, “they’re very eager to show their warmth and loyalty. They’ll always tell you how much they



Local Nepalese unloading over 5,000lbs of donated rice from the back of a borrowed pick-up truck.

love you—even after just a few minutes! People started calling me ‘brother’ shortly after we met. They never want to say goodbye; they just sort of fade into the next room, or tell you to make

sure you eat something! I know there are a lot of social problems there, too—gender discrimination and conflicts between people of different regions—but that was almost hard for me to believe, as they’re so cordial and family-oriented.”

Justin is still in touch with several friends he made in Nepal, and knows from them that there’s still a great need for help. “The government has been slow to issue aid money,” he said. “It’s a relatively new government, and the population of the Kathmandu Valley has been exploding in recent years. New construction—especially quality construction that’s seismically resistant—just can’t keep up. Let alone financial restrictions, there isn’t the know-how nor the type of regulatory agency to provide proper oversight of construction processes.”

Justin said that’s where he can see the next batch of Co-Build Kathmandu volunteers really shining. “I think at this stage, the critical need for assessments is past, and it would be better to focus our attention on improving future construction techniques and increasing awareness of the importance of building seismically-resistant buildings, especially while the country is still in the immediate wake of this disaster,” he said. “Now is the time to convince the government that better standards need to be put into practice permanently. As it stands, there are too many ways and temptations to cut corners: watering down concrete mixes, lack of proper rebar detailing... There are no enforcement bodies there like there are here, and, currently, no good incentives to institute them.”

“They need so much help, in every capacity,” Justin said. “I was so thankful and glad to be able to go to Nepal. I’d never done anything like this before in my life. I was able to experience a very beautiful, thoughtful, and compassionate culture in a most profound way, and at a time when the people were so vulnerable but yet so strong. It was an inspirational, unforgettable trip, and I want to do more work like it.”

“If you’re the kind of person who likes life-changing things,” Justin counseled, “do it!”

If you have an engineering or architecture background and are interested in learning more about the Co-Build Kathmandu initiative or becoming a volunteer, please contact Scott Francisco at info@pilot-projects.org.

APRIL GREENE
is a writer at Pilot Projects

REBUILDING

with

HEART

By DELIA SHUMWAY

I BECAME INVOLVED WITH HOUSE WITH HEART (HWH) through Martin Loy, the President of New Line Structures. House with Heart is a non-profit, non-governmental organization that provides a home for abandoned children, an education center for impoverished women and children, and has an outreach program for needy families in Kathmandu, Nepal. Martin and his wife Julie have supported HWH for a few years.

After the 7.8 magnitude earthquake on April 25th, Martin met with Beverly Bronson, HWH's founder. Beverly explained to Martin that a Government engineer had visited HWH, declared their buildings unsafe and issued orders to vacate. In order to re-occupy the buildings, an engineer was needed to reassess their structures. Until that was done, all of the children (about 20) and staff would need to live in tents. At the time it was May and monsoon season was fast approaching. After meeting with Beverly, Martin asked me if I would be willing to go to Nepal to help. Having been trained through the DOB in first response building assessments (ATC-20 & 45) and having assessed many damaged, partially collapsed or fully collapsed buildings during my tenure at the DOB, I felt like I could help. Within a week, I obtained my Visa, inoculations, supplies, plane tickets and was off to Kathmandu.

Once there, I stayed at the Bairoling Monastery Guesthouse, which was walking distance from HWH. During my time in Kathmandu, I assessed the structures at HWH then traveled around the city, helping HWH friends, neighbors and family members with building assessments, and repair and shoring recommendations. Unfortunately, I did not have enough time to make it to the villages outside of the city, which were also in desperate need of assistance.

The most rewarding aspect of my trip was spending time with the children and women of HWH. The children were so curious, happy and grateful. I was grateful for having met them and for being given the opportunity to help in any way. The following photos and captions highlight some of the more typical conditions that were observed.



- 1 Typical buildings in Kathmandu are initially constructed 2 or 3 stories tall then vertically extended when the Owner can afford to do so. However, these vertical extensions often include horizontal expansions at the new additional stories, which unfortunately create unsymmetrical and inherently unstable, top-heavy structures. It was common for corner buildings to be extended in this manner. These buildings were particularly susceptible to collapse.



2 Buildings are typically framed with shallow wood joists running from front to rear (perpendicular to the front façade) with only a shallow (4"x4") beam and vertical posts spaced at 12-15 ft intervals. Because of this, the side walls are only braced at the 15 ft intervals, rather than being continuously braced. This resulted in many partial collapses.



3 Many buildings in Kathmandu have a store at the ground floor level. In order to achieve an open layout, masonry walls are replaced with large wooden doors, creating soft stories. As a result, the structures rack at the ground floor level, creating an unstable condition.



4 Nearly all buildings have water tanks on the roof with support structures constructed of under-reinforced concrete or masonry and plaster. A common failure mechanism was the cracking or failure of the columns supporting these water tanks, often resulting in full or partial collapse. Following the earthquake, many homes replaced these heavy structures with lighter, steel framed supports.



6 Typical construction consists of sub-standard bricks laid with mud mortar and covered with a thick layer of plaster, which provides very little lateral resistance. Lack of proper bonding and stitching contribute to failures within bearing walls.



5 Roof joists are often framed above doors and windows which do not have a lintel or bond beam. The wooden door and window frames end up being loaded unintentionally, resulting in local failures.



OTHER OBSERVATIONS:

7 Following the earthquake, many building owners placed timber shores against their buildings to give the impression that the buildings were braced and areas were safe. Many of these shores were just leaning against the buildings and not secured at all.



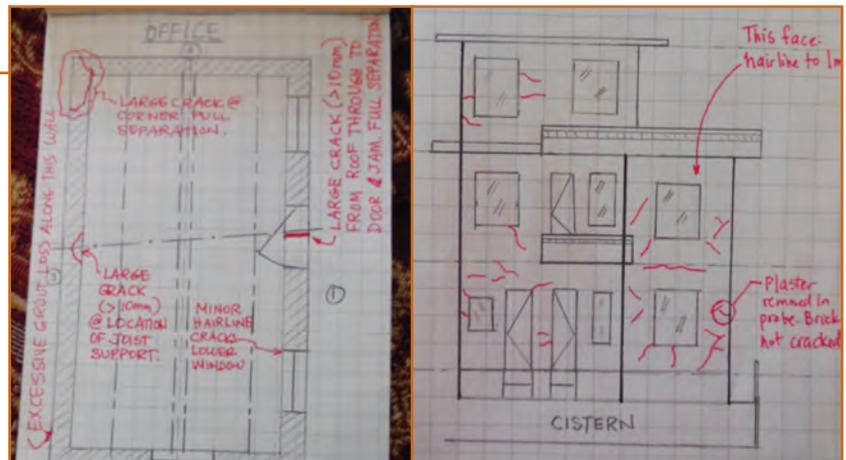
8 Safety during construction and demolition was all but non-existent. I only saw one large excavator the entire time I was in Nepal and that machine was sitting at the airport. All of the demolition was done by hand with workers standing on the unstable buildings.

RECONSTRUCTION:

9 Each building was assessed and the existing damage was documented in an effort to understand the extent of the structural damage. Depending on the existing condition, repairs, partial demolition or full demolition was recommended.



10 The recommendations were discussed with the homeowner, their staff and contractors to determine the best course of action while considering the available equipment, supplies and manpower.



11 Once I returned to NYC, the Owner of House With Heart retained an engineer who took my recommendations and prepared drawings to implement the retrofit. We went back and forth a few times but eventually a final design and contract was approved. They started the work last week. So far, everything looks great! New Line sent over some safety equipment (glasses, gloves, masks) along with books and other supplies for the reconstruction the HWH library building.



12 The children were very grateful that New Line was there helping out. This photo was taken the day before I left. The kids were saying "Namaste!", or "Thank you!".



13 This is a photo of me with some of the kids and staff of House With Heart. We are inside the temporary shed that was built by a relief team from Japan.

If you are interested in learning more about House With Heart or would like to donate, you can follow their daily chronicles at (<https://m.facebook.com/GharSitaMutu>) or visit their website at www.housewithheart.org.

DELIA SHUMWAY, PE
is Director of Projects at New Line Structures

call for writers (and nonwriters!)

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Saving the Sacred

WORKING WITH LOCALS TO PRESERVE HISTORIC STRUCTURES

By EVAN SPEER

IN JANUARY 2015, I TRAVELLED TO NEPAL TO FULFILL A LIFELONG dream to experience the mountains, culture, and architecture of the Himalayan region in Nepal. While there, I made connections with the Kathmandu Valley Preservation Trust (KVPT) through the founder of my firm, Robert Silman. I walked through several of KVPT's projects in the Patan Darbar Square in preparation for volunteering my services in the preservation efforts in Patan and the Kathmandu Valley. Since the earthquake, my tasks and goals have developed as I have been assisting KVPT in assessment, data collection, and planning for next steps, as their typical preservation efforts have multiplied in scope to include more seismic retrofit and reconstruction projects.

After months of coordination with KVPT staff in New York and Nepal, I flew to Kathmandu in August 2015 to assist the team on the ground. The photos included here were all taken during my visit in August 2015, with the exception of the "before" photos taken in January 2015. Over the span of two weeks, my main tasks involved visiting, documenting, and assessing damage to some of KVPT's current projects, including a variety of temples and structures in and around Patan Darbar Square that had not been previously preserved by KVPT. I also observed and documented the condition of previously preserved and retrofitted

KVPT projects to understand how they behaved during the earthquake and how to build off previous successes. KVPT's previously retrofitted structures fared extremely well through the earthquake. So it was a matter of determining what methods and strategies seemed to work best on the surviving structures, to make informed decisions during the upcoming projects. Along with the KVPT Team, I assisted in developing reconstruction and seismic retrofitting concepts for the current temple projects set for construction, historical research, and development of a crack monitoring regiment for the ground team to ensure that there is no residual movement in cracks that opened during the earthquake. While on the ground, I also traveled throughout the Kathmandu Valley to observe and document damage to historic structures throughout the Kathmandu Darbar Square, Bhaktapur Durbar Square, along with assessing damage to some single and multi-family homes.

I am continuing efforts from New York to aid in post-earthquake reconstruction and retrofitting concept design for the structures around Patan Durbar Square, and additional efforts to increase awareness about good building practices for safer structures in seismic regions.

BEFORE



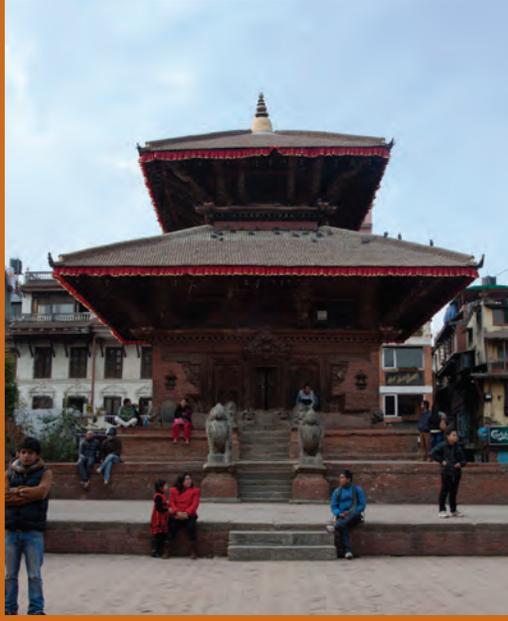
Visveshvara Temple, Patan Darbar Square, January 2015 - The Visveshvara, or Viswanath, Temple is a temple dedicated to the Hindu god Shiva and was originally constructed in the mid-17th century AD. Visveshvara is a two-tiered brick masonry and timber structure with tiled roofs laid in thick mud setting beds ranging from approximately 2" to 8" in depth. The temple's ground floor consists of a central sanctum surrounded by a carved timber and brick masonry core, surrounded by an open arcade lined with timber columns. The temple rests on a stone threshold atop a tiered plinth.



AFTER

Visveshvara Temple, Patan Darbar Square, August 2015, The main structure is still relatively intact, although the larger upper structure was torqued about the core during the earthquake. This led to severe damage to brick masonry and displacement of the timber columns and elements at the lower level of the structure. The upper levels were visibly more intact, although displaced.

BEFORE



Char Narayan Temple, Patan Darbar Square, January 2015 – Char Narayan is a temple dedicated to Narayan, a manifestation of the Hindu god Vishnu, and is one of the earliest known temples in Patan Darbar, having been built in the early 17th century. Char Narayan is also a two-tiered temple, mainly constructed of brick masonry walls with tiled roofs laid in thick mud setting beds ranging from approximately 2" to 8" in depth. The ground floor consists of a central sanctum surrounded by a brick masonry wall core, which is surrounded by an outer brick masonry wall. The temple rests on a stone threshold atop a tiered plinth.



AFTER

Char Narayan Temple, Patan Darbar Square, August 2015 – Char Narayan completely collapsed after the April 25, 2015 Earthquake. KVPT workers helped clear the plinth of debris and a tent has been installed atop the plinth to allow for the daily puja, or worship, of the deity Narayan. This was deemed critical to the healing of the population, and continues to be a vital part of daily life.

BEFORE



Mani Phalca (Mani Mandapa) Pavilions, Patan Darbar Square, January 2015 – Mud-brick masonry and timber structures, each supported on a grid of 16 sal wood columns. The structures were originally constructed in the 14-15th centuries, with some restorations done in the 18th century. The pavilions still included some columns thought to be original.

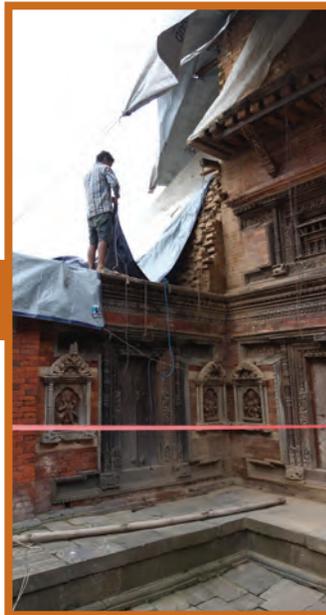


AFTER

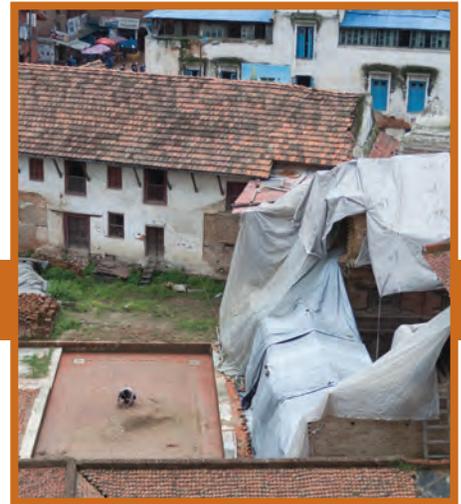
Mani Phalca Pavilions, Patan Darbar Square, August 2015 – Both Mani Phalca structures fully collapsed during the April 25, 2015 Earthquake. During cleanup and recovery, it was found that many timber columns remained fully intact during the collapses. This indicated that the structures failed at the connections between upper masonry walls and the timber columns.



Sundari Chowk, Patan Darbar – A KVPT worker surveys the temporary tarps protecting the remainder of the fallen East Wing of Sundari Chowk from the persistent monsoon rains.



Sundari Chowk, Patan Darbar – A KVPT worker reinstalls the temporary tarps protecting the remainder of the fallen East Wing of Sundari Chowk from the monsoon rains



Patan Darbar near Sundari Chowk – A lone KVPT mason works to restore the brickwork of the terrace where the East Wing of Sundari Chowk, the building around the southernmost courtyard of Patan Darbar, collapsed into the garden near the Bhandarkhal water tank.

DETAILS OF THE COMPLEX SAL WOOD CARVINGS AND HISTORIC FABRIC OF THE SEVERELY DAMAGED VISVESHVARA TEMPLE.



Visveshvara Temple - Column base dislodged from stone at the inner core. The original dowels and pins could not withstand the shear induced by the earthquake. Weak connections are a leading cause of displacement and failure of the historic structures in this building style.



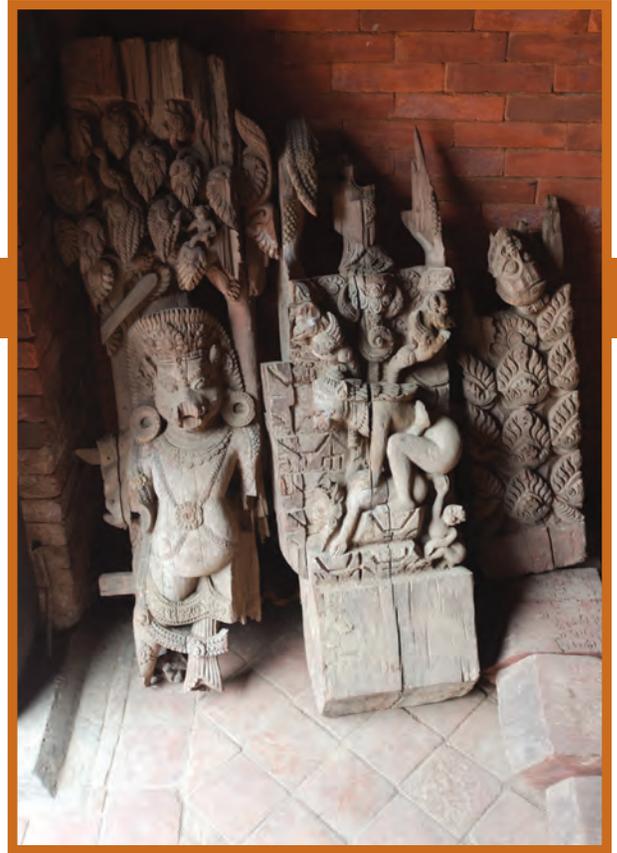
Visveshvara Temple - Eastern elevation of Visveshvara's core portal. The main load paths through the bottom floor of the temple are through the sal timber elements. The brick masonry here is, in fact, largely for aesthetics and not structural. The ability of the heavy timber elements to absorb the seismic motion and redistribute loads aided in the survival of the structure.



Visveshvara Temple - Detail of the main columns around the outer arcade. The timber columns shifted during the earthquake due to the movement of the brick masonry structure above.



Patan Museum, Patan Darbar - Details of carved sal wood struts from the fallen temples and structures around the Patan Darbar Square.



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