

THE GORKHA EARTHQUAKE IN KATHMANDU VALLEY

Post-earthquake correspondance to and from Randolph Langenbach

Sent: Tuesday, April 28, 2015 11:31 AM

To: icorp-l@lists.icomos.org; ISCARSAH-L@lists.icomos.org; Steve Kelley (new) 'Stavridis, Andreas' <astavrid@buffalo.edu>

Cc: 'Manhart, Christian'; vdw.csvpa@gmail.com; 'Kai Weise'

Subject: RE: [ICORP-L] Fwd: Latest from Nepal - Patan Durbar Square example

Dear colleagues,

In sorting through all of the data that is flooding the web following this tragic earthquake, I have begun to see some patterns that are interesting. This is just a glimpse, but here are three images mined from the web, which I have overlaid and printed to a similar scale so that one can see that they are of similar views. They reveal that the buildings that collapsed in 1934 are still standing after the recent quake, but the temple that appears only slightly on the left, while in 1934 it is clearly still standing as its roofs show in the 1934 shot, but it is pancaked in the recent quake as can be seen in #3.

Overall, it is beginning to appear that the frequency of the shaking in the two earthquakes may have been different, as the epicenters I understand were in different locations, and Kathmandu itself, being remote from the epicenters of both, has suffered from a soft soil response to the earthquake vibrations, which then singles out structures that have the same vibrations as the soil – similar to what happened in San Francisco and Oakland in the Loma Prieta earthquake (I barely felt the earthquake while the freeway on fill in Oakland, and buildings on fill in SF collapsed.) If our colleagues on site can see patterns like this, it will be helpful.

The example above can also, of course, be a result of the likelihood that the reconstructed buildings were improved when rebuilt, while the temples that fell are now 80 years older than they were in 1934, and perhaps not strengthened or well maintained.

Regards to all,

Randolph Langenbach





Photo by Kai Weise

From: owner-icorp-l@lists.icomos.org [mailto:owner-icorp-l@lists.icomos.org] **On Behalf Of** Alaa Hamdon

Sent: Tuesday, April 28, 2015 3:02 PM

To: ICORP Email List

Subject: [ICORP-L] Notice

Dear All

Through visiting the photos which have been demonstrated by Neelam Prdhananga, I have noticed three photos grabbed my attention, which are:[below]

.....and we can see from the above photos that the cultural heritage has been divided into two sides of the center. We can see the left side has been completely destroyed and collapsed while the right side dismantled, but still connect in somehow in the original structure. Also, we can see most of the wood of the architecture still connected in good shape slightly. I hope we can discuss this situation if you don't mind.

Thank you so much, Best regards

Alaa Hamdon





Photos by Neelam Prdhananga

From: Randolph Langenbach [mailto:rl@conservationtech.com]
Sent: Tuesday, April 28, 2015 5:14 PM
To: 'icorp-l@lists.icomos.org'; ISCARSAH-L@lists.icomos.org
Cc: Christian Manhart (c.manhart@unesco.org); Steve Kelley (new) (steve@kelleyaia-se.com); Kai Weise (pahar@mail.com.np)
Subject: RE: [ICORP-L] Notice

Dear All,

Most interesting photos – the best of an interior of a damaged heritage structure to come out of this earthquake yet. I had not seen them – so I will be grateful to know where you, Alaa, found them if on the web, or if you can circulate the whole collection to which you refer.

This damage in my opinion is the result of having a timber framework inside hard against the walls of a bearing masonry structure, but not extending into the structure as it would if it were timber laced masonry. Whenever I have seen this, the problem is that the masonry in effect is not allowed to fully bear onto itself below, as the load path is shared by the frame. The frame is flexible (note that it is not braced) so in the earthquake, the masonry weight responds to the vibration of the earthquake, but the frame then allows the top layers of the structure to sway – which cause the side walls in the direction of the sway to separate, as they have only the short (and rotted) ends of the timbers extending into them. In fact, the structural damage may tell us roughly what the primary wave direction is at this location.

What is interesting is to speculate whether the structure would have done better had it been laced only horizontally with timber, rather than have an internal timber frame. I would expect that it would have – so long as there was a timber ring beam in the walls, tied at the corners, at the level of the cornice and water table above the door at the base of the tall upper cone-shaped structure, and again about 2/3 or ¾ the way up to the top of the cone shaped roof structure.

On the other hand, since there seems to be a pattern of tall structures on narrow bases having collapsed in this earthquake, I suspect that they were collapsed often by rocking back and forth, causing compression as well as shear failure of the momentary overloaded masonry on the corners and walls at the base, as shown in the onset of damage in a photo circulated by Kai Weise (ICORP) below. This then narrows the base further, and the structures begin to tip over, which then at a certain angle, they pancake the rest of the way in place. This goes part of the way to explain why the pagoda temples which have graced the durbar squares for centuries have been particularly hard hit – and can be seen to have EITHER fallen down completely, or remain standing quite intact (with cracks we cannot yet see in photos, except for this one by Kai) – rather than as is often with masonry buildings, being damaged partly by the loss of parts of the upper walls or roofs.

On the question of what the vibrational frequency was, some of you may have noticed the video at the address below. If someone in Nepal or who recognizes the hotel behind can map where this swimming pool is, it may be interesting to see the map. Before you wonder why you think I am wasting your time with a swimming pool video, take a look. After the camera responds to the high frequency waves in the seismic vibrations, you can see the water respond to what is clearly a very powerful longer frequency waves. It is this that alerted me to the likelihood of a significant long period component to this earthquake at Kathmandu. (This is consistent with my comment in the last email about the likelihood of concentrations of damage in parts of Kathmandu.) Longer period vibrations tend to be less damaging to low-rise masonry buildings than shorter ones, but on the other hand, it can be consistent with the rocking hypothesis described above, as well as help to explain in part why the 9-story Dharahara Tower that survived the 1934 earthquake collapsed in this one.

<https://www.youtube.com/watch?v=9r-8O8YuUfM>

On the question of the difference between the 1934 earthquake and this one, I went looking for a map of their locations, and up popped up first was the map attached here. How uncanny it is that on this map is the clearest prediction of the earthquake that just happened – with its damage district marked almost exactly. Also, the closer proximity of the 1934 quake is an indication that the frequency of its vibrations would have been different in Kathmandu, than in the 2015 quake, which can partially explain differences in buildings that proved to be most vulnerable.

Any way – here are my quick thoughts and hypotheses – ready for other thoughts, question, and even disagreements from others.

Kind Regards,

Randolph Langenbach





Basantapur Durbar Sq - Drone footage by Kishnor Rana that has now circulated widely on the web. The Red brick building and the small shrine that are visible in your image are also visible in the attached image #2, and #1 one shows the columned building that is the most distinctive monument in Basantapur Durbar Sq., with the side square in the center rear of the image – with the red brick building visible.

Here is the video I got the screen prints from:

<https://www.youtube.com/watch?v=8Lfrxzd7dM>

Here is another that catches it from a different angle:

<https://www.youtube.com/watch?v=TMkRPWv4M8Y>

From: owner-icorp-l@lists.icomos.org [mailto:owner-icorp-l@lists.icomos.org] **On Behalf Of** Alaa Hamdon
Sent: Tuesday, April 28, 2015 11:56 PM
To: icorp-l@lists.icomos.org
Subject: Re: [ICORP-L] Notice

Dear Randolph

....

Referring to your analysis about the flexibility of the frame related to the solid structure, I agree with you and it is good analysis, but what I was wondering about is why the right side of the monument still slightly connected to the structure while the left of the monument completely collapsed. Also, I agree with you about your analysis that the damage can tell the wave direction especially in this monument.

Thanks for you and for any suggestion or correction for my idea.

Best regards

Alaa

From: Randolph Langenbach [mailto:rl@conservationtech.com]
Sent: Wednesday, April 29, 2015 9:50 AM
To: 'icorp-l@lists.icomos.org'
Cc: ISCARSAH-L@lists.icomos.org
Subject: RE: [ICORP-L] Notice

Dear Alaa (in reply to email posted below)

Your question on why both sides did not fall over is a good one, and being able to speculate just from photographs is difficult. I can only make a guess, which is this: On the left side, one can see that the inner portion of the wall at the first story level is still standing. It appears that the timber beam above it is resting on it, and did serve to confine this portion of the wall. Perhaps on the other side, however, the wall may have moved as a unit, rather than separating at that level, and this may have served to provide support for the wall above that the left side could not, once the base of the wall had separated into two parts. In that case, the outer thin layer of the wall simply buckled, and collapsed, bringing the whole side down with it. In the photo from the front, one can see that the lower part of the wall on the right side does not show cracks below the water table that is at the middle of the height of the door. One cannot tell from the ruins on the left side, but the point of rotation may have been lower down, or the bricks themselves may have been weaker or more deteriorated, leading to the collapse.

Best,

Randolph

From: owner-icorp-l@lists.icomos.org [<mailto:owner-icorp-l@lists.icomos.org>] **On Behalf Of** Alaa Hamdon
Sent: Wednesday, April 29, 2015 10:08 AM
To: icorp-l@lists.icomos.org
Subject: Re: [ICORP-L] Notice

Dear Randolph

Thank for your analysis which is a wonderful analysis and I think you have reached the point almost, but I have another question. On those photos I can see in the structure and in the rubble as well two kind of bricks, its seems new one (light brown) and old one (dark brown) and I believe that most of the collapsed bricks are from the new one. What do you think?

Best regards, Alaa

From: Randolph Langenbach [<mailto:rl@conservationtech.com>]
Sent: Wednesday, April 29, 2015 1:21 PM
To: 'icorp-l@lists.icomos.org'; ISCARSAH-L@lists.icomos.org
Cc: Richard Sharpe (richard.sharpe@beca.com); Christian Manhart (c.manhart@unesco.org)
Subject: RE: [ICORP-L] Notice

Dear Alaa,

Another interesting question. Again, I can only guess, but my best guess is that the darker bricks have been scooped up from another collapse site, and dumped there subsequent to the quake. Maybe Neelan can enlighten us on this. The pile just simply seems too big to be from the wall alone, and even more telling is the fact that the darker grey bricks all appear to have landed remote from the structure, all together in a pile, closer to the garden wall to the left. The collapsing wall would most likely leave a pile centered on the standing structure.

Generally speaking the lighter the brick, the less hard fired it is, with lighter bricks used for the interior parts of the wall and the more hard fired slightly darker ones used for the exposed exterior. (In this case, the darker ones are a dark grey, and thus seem to be from another structure.) As for discoloration of bricks, one can see that the interior of the ruin is blackened – probably from burning lamps and offerings within this small temple – but again, this would not explain a pile remote from the structure of grey bricks.

Best, Randolph

From: Richard Hughes <Richard.Hughes@arup.com>
To: "icorp-l@lists.icomos.org" <icorp-l@lists.icomos.org>
Sent: Wednesday, 29 April 2015, 10:12
Subject: RE: [ICORP-L] Fwd: Latest from Nepal - Patan Durbar Square example

Randolph

The immediate 'pattern' that I notice is the failure of what looks to be the mud mortars. The brick units in the debris look comparatively whole. If indeed it is mud mortar then probably was only in recent times working as a semi confined cushion and had no joint bonding capability. High frequency shaking would separate all the units (like shaking a pile of sugar cubes). Could it be that 1934 reconstruction used cement or lime based mortars?????

My other observation from ad hoc photographs is that the timber debris seems to indicate to me poor structural jointing.

I'm sure timber lacing would work as suggested in your next email (see my attached article on lacing from Karakoram to the west). However, there would be quite a dramatic change in cultural expression. From a few of my retrofitting projects it is extremely difficult to insert and analyse required performance.

Rohit: I hear of other teams that are thinking of undertaking missions. Perhaps ICORP could take a role in helping to coordinate and set agendas and avoiding duplication etc? Would also be better for safety and not getting in the way.

Regards
Richard

From: owner-icorp-l@lists.icomos.org [<mailto:owner-icorp-l@lists.icomos.org>] **On Behalf Of** john hurd
Sent: Wednesday, April 29, 2015 7:29 AM
To: icorp-l@lists.icomos.org
Subject: Re: [ICORP-L] Fwd: Latest from Nepal - Patan Durbar Square example

Richard you are right about the use of stronger mortars during the 1934 reconstruction, I analysed some in 2003.

The historic mortars can be just earth, though with an excellent clay fraction, however at an earlier date the earth often has a weak lime admixture.

All in all I have learned from the comment that you have made.

John

From: Randolph Langenbach [<mailto:rl@conservationtech.com>]
Sent: Wednesday, April 29, 2015 2:12 PM
To: 'icorp-l@lists.icomos.org'; ISCARSAH-L@lists.icomos.org
Cc: Christian Manhart (c.manhart@unesco.org); Kai Weise (pahar@mail.com.np); Richard Sharpe (richard.sharpe@beca.com); Eduard Sekler (Esekler@gsd.harvard.edu)
Subject: RE: [ICORP-L] Fwd: Latest from Nepal - Patan Durbar Square example

Dear Colleagues,

I opened today's copy of the New York Times this morning, to find that there is an article that you will find of interest on the subject of the losses of cultural heritage from pillaging of the ruins.

New York Times, Wednesday, April 28: [As Human Crisis Takes Priority After Nepal Quake, a Nation's Treasures Become Its Scrap](#)

When I went online to get the URL for the above article, I found this one, which for the Times, is very well done, and informative of which temples collapsed, and which are standing.

PHOTO PANORAMAS – before and after: New York Times: [Nepal's Historic Sites, Before and After the Earthquake](#)

The second photo in this website of the [Taleju Temple](#) is interesting. It is one of the few where the roofs are still visible in the debris of the fallen pagoda structure. It has been surprising to so rarely see the intact roofs in pancaked temples, but this is consistent with my hypothesis that the temples failed by falling over sideways because of failure at their bases. In the others, the roof when striking the ground on their edges, may have more usually fallen apart into the pile of timbers we have seen. Also, before much of the photography, people may have torn them apart to help survivors, or simply carried away the timbers as described in the New York Times.

As I mentioned, this rocking and tipping over mechanism of collapse, I think explains why there are so few that suffered partial collapses. Most (but not all) are either gone entirely, or still standing relatively intact (but presumably with cracks that will need to be repaired quickly)

Here I would like to respond to the good comments by DAVID YEOMANS, RICHARD HUGHES, and JOHN HURD.

David Yeomans raises the very relevant point about the deterioration of the mortar, and Richard and John have added important insights as well. The question of whether downward migration of clay mortar particles causes an outward pressure on the walls is very interesting and hard to evaluate in the specific cases of the causes of the collapses. In Italy, where rubble cores are common in masonry construction, the vibrations can cause a sudden compression of the internal cores, which can then burst the walls at the base, collapsing the structures, but compaction of the mortar particles themselves at the bottom of the walls is harder to evaluate.

This point though raises another one that is even more likely – the deterioration of the bricks themselves. In pictures posted by Neelam Pardhananga which I have attached here, one can see the typical damage from rising damp in the walls, as well as evidence of differential settlement damage. In observing the web photos of the collapsed buildings, I have seen quite a few broken bricks, and in addition, I am suspicious that a good deal of the dust and small particles are pulverized bricks, not just remains of clay mortar.

Since I have hypothesized that the collapsed temples have rocked back and forth prior to collapsing, if this was true, the weight bearing on the outside brick layers of the wall on each side in the direction of the rocking must suddenly momentarily bear the whole weight of the superstructure. When the bricks are degraded from salt attack from rising damp, this can mean that they can be easily crushed. This rocking process can also easily delaminate the stronger and harder fired face brick from the interior bricks of the walls. This crushing of the base of the walls with each cycle can rapidly result in the collapse of these tall structures with narrow bases.

The brick industry in Nepal is extremely interesting – and a walk back in time. It is an active tradition that is part industrial, and a larger part pre-industrial. I have attached a view of the landscape of brick kilns near Kathmandu which I took in 2000. The other attached images show the bricks. On average, the bricks are under-fired according to modern standards. Consistent with traditional practice everywhere before the invention of tunnel kilns and uniformly fired brick, the under burns are used for the interior of the walls. The pale red color of the bricks is consistent with the color of what would be considered to be weaker bricks when compared with fully fired bricks today.

Even more interesting is the shape of some of the bricks – as can be seen in image #02-29. They are wedge shaped on the short and long sides. These bricks are face bricks. They follow a tradition that I have only seen in Nepal, but may exist elsewhere. The wedge shape allows room for the mortar (in the absence of a frog in the brick such as is common today (a “frog” is the depression where you often find the name of the brick manufacturer)). This allows for the wonderfully smooth seemingly mortar-less look of the fancier facades of Kathmandu buildings – with their seemingly thin lines of mortar as seen in the façade of the 55 Windows Palace in #02-35. Also please note in the palace shot that with little exception, the bricks are in a running bond with no bond courses. Most of the bonding is done with hidden courses, but this may account for part of the reason for the easy delamination of the exterior brick from the core of the wall.

Over time, the kind of thing that David Yeomans describes of the migration of the clay mortar, is perhaps that the bricks end up being close to being dry laid, and the wedge-shaped bricks then begin to twist in the wall and become uneven and separated from the core of the wall, like the “sugar cubes” that Richard describes. The shot of the 55 Windows Palace (which was under restoration when I saw it again in 2005) gives some evidence of this.

Anyway, enough for now. I will log off and look for further contribution by others.

Best Regards,
Randolph



Photos here and below by R.L in 2000





55 Windows Palace in Bhaktapur prior to 2005 restoration.

From: Randolph Langenbach [<mailto:rl@conservationtech.com>]
Sent: Thursday, April 30, 2015 12:18 AM
To: 'Lucinda Fleeson'
Subject: RE: from Lucinda Fleeson

Dear Lucinda,

Please find my answers to your questions below in **Bold**. Please also note that I have attached emails that I have sent to my colleagues in an ICOMOS newsgroup – which also adds to the technical information I have reported on to you – that may be of interest as well. In the one about the collapsing wall, the photos are deep down in the message tree below my response.

From: Lucinda Fleeson [<mailto:lfleeson@msn.com>]
Sent: Wednesday, April 29, 2015 6:15 PM
To: ran2@conservationtech.com
Subject: from Lucinda Fleeson

Randolph:

The material you sent to me has been extraordinarily helpful. Thank you. I am going to write some questions here.

I think I now have a handle on how traditional timber-laced architecture, either in framing or as horizontal lacing, can make residential structures more resilient.

Also how Nepalese homes differ from other Himalayan building: They lack the timber lacing as well as employ carved window and door lintels that actually create a "belt" of weakness, as they don't extend to the building corners.

What I don't understand and I hope you can illuminate:

1. NCET and others are saying that residential houses can be made more earthquake-resistance at an additional cost of only 3 -- 10 percent. And that only a few strategically-placed wood beams can help. How? And where would these few beams be placed?

The Kashmiri earthquake-resistant construction system for load bearing masonry construction (as contrasting with dhajji dewari, which is an infilled timber frame) is a system composed of having a grillage of timber – in the shape of a ladder – laid into the walls horizontally. There are no vertical timber elements, because the weight of the masonry is designed to hold the system together. These timbers are notched together in the corners to form a ring beam around the exterior walls of the building. These “ladder” shaped ring beams are located at each floor level, and also at the top of the window openings. The floor level ring beams are doubled with the bottom one notched into the floor beams and joists to create a positive connection to each floor diaphragm, and the one above laid on top of the joists to spread the weight of the masonry onto the floor joists to secure the connection to the floor diaphragms to prevent the walls from spreading outward.

2. I understand that many of the palaces and temples in Kathmandu (Bhaktapur, Patan Durbar, etc.) are new, reconstructed since the 1934 quake. Those have now been damaged, or collapsed. Some others, perhaps, stood for many centuries, and withstood greater earthquakes, but have now been damaged -- perhaps due to weakening by age, erosion and lack of maintenance? But also did the reconstructed buildings lack traditional timber architecture?

It is my observation and understanding that the Nepali construction did not share the same timber-laced construction that exists in traditional construction in Srinagar, Kashmir. This does not mean that there were no timbers in the walls, but the coherent system of lacing that I described in answer to #1 I was not able to find. In fact, there are examples – one small shrine of which I wrote about from photographs I received just now (see attached email) – where the timber framing had vertical members attached to the walls, which may, counterintuitively, have made it more vulnerable to damage. The double level per floor series of timber ring beams is not something I have seen in Nepal (which does not mean it does not exist, but only that it was not common). (The same situation I have reported on in my writings about the GUJARAT earthquake of 2001. Bhuj was a Hindu city and Ahmedabad shared the same cultural connections as does Srinagar, Kashmir. Bhuj suffered many collapses – as has Kathmandu, while Ahmedabad’s historic walled city had almost none, yet many modern concrete multi-story buildings in Ahmedabad collapsed, killing thousands.

As I describe in my email about Patan Durbar Square – with the 1934 view – the buildings felled in 1934 are still standing, and the smaller temple which survived 1934, was collapsed. I describe my hypothesis of why this may be the case, but this indicates to me that the same buildings collapsed in 1934 are not necessarily

just as vulnerable again to collapse now. (Apart from collapse, please remember that I cannot evaluate or know what damage they have sustained as it does not show in the pictures I can find on the web.) From what I can tell, the historical monuments that have been rebuilt or restored recently have NOT fallen down in this earthquake. It of course will take some on-site research to determine this fully, but my email about Patan seems to show this for starters – and also, the recently restored 55 Windows Palace in Bhaktapur I can see has also survived intact. It was under restoration when I was in Nepal in 2005.

As you will see in one of my attached emails, I have seen evidence that the frequency of the vibrations from this earthquake may have been different (longer) than that in 1934, which from maps appears to have been closer. The swimming pool video (<https://www.youtube.com/watch?v=9r-8O8YuUfM>) gives an idea of how long the period (frequency) of shaking was. Buildings are at risk of collapse not just if they are in an earthquake, but if they resonate with the frequency of the earthquake vibrations. My hypothesis it that this has caused those smaller temples not to collapse in place, but to rock back and forth and tip over, which I have said can explain why there are very few that are only partially damaged. Most are totally disintegrated with little recognizable remaining.

When it comes to the historic residential buildings in Bhaktapur – the picture is different, as many there did suffer partial or total collapse – with evidence that they were deteriorated from a lack of maintenance from well before the earthquake. It is quite sad, as Bhaktapur prior to this earthquake was one of the most intact ancient historic cities left in the world.

My biggest fear is that this earthquake can set back preservation efforts in Asia by making people particularly fearful of masonry buildings of all types – even those with the earthquake-resistive features I have written about. People will find it hard to distinguish between the vulnerable and the sound. It is similar to what I found with earthen construction in Iran after the Bam earthquake, (which I helped to offset when I discovered that the collapsed historic Arg-e-Bam was infested with termites because of modern work, not original ancient work (see “[SOIL DYNAMICS AND THE EARTHQUAKE DESTRUCTION OF THE EARTHEN ARCHITECTURE OF THE ARG-E BAM](#)”). This is particularly poignant not only because of the heritage structures at risk, but also because in most of the serious earthquakes over the past two decades, it is the reinforced concrete frame buildings that killed by far the most people – not the traditional masonry buildings. In Christchurch, New Zealand, the second earthquake in the series damaged both masonry and concrete buildings, but one reinforced concrete building that pancaked accounted for almost 2/3 of the fatalities of the entire earthquake, including many young children.

Of course, my analysis is now only from what I can learn from the imagery on the web, so I cannot be definitive, but I hope this will enable you to finish your piece.

3. I'd like to offer the Philadelphia Inquirer a copy of your illustration/graphic of the two types of timber-laced construction that creates resilience. Do you have a high-resolution image that you can forward, and will you give your permission to use?

Yes. Consider this email to serve as a license for the publication in the Philadelphia Inquirer of the attached images specifically to accompany your article. SRNGR'07(06)2-01-REDO-4-FINAL copy is the image that is on the cover of my book (Did you get my book to download?) I will be grateful if you could mention the book, in addition to crediting me. It is the Jalali Residence in Srinagar, dating from about 1820, of Persian influence in its design. You can see the timber lacing on the exterior, except that the ring of timbers above the windows is invisible because it is set back and in the window openings forms part of the fenestration – as it runs across the opening at the spring of the arch.

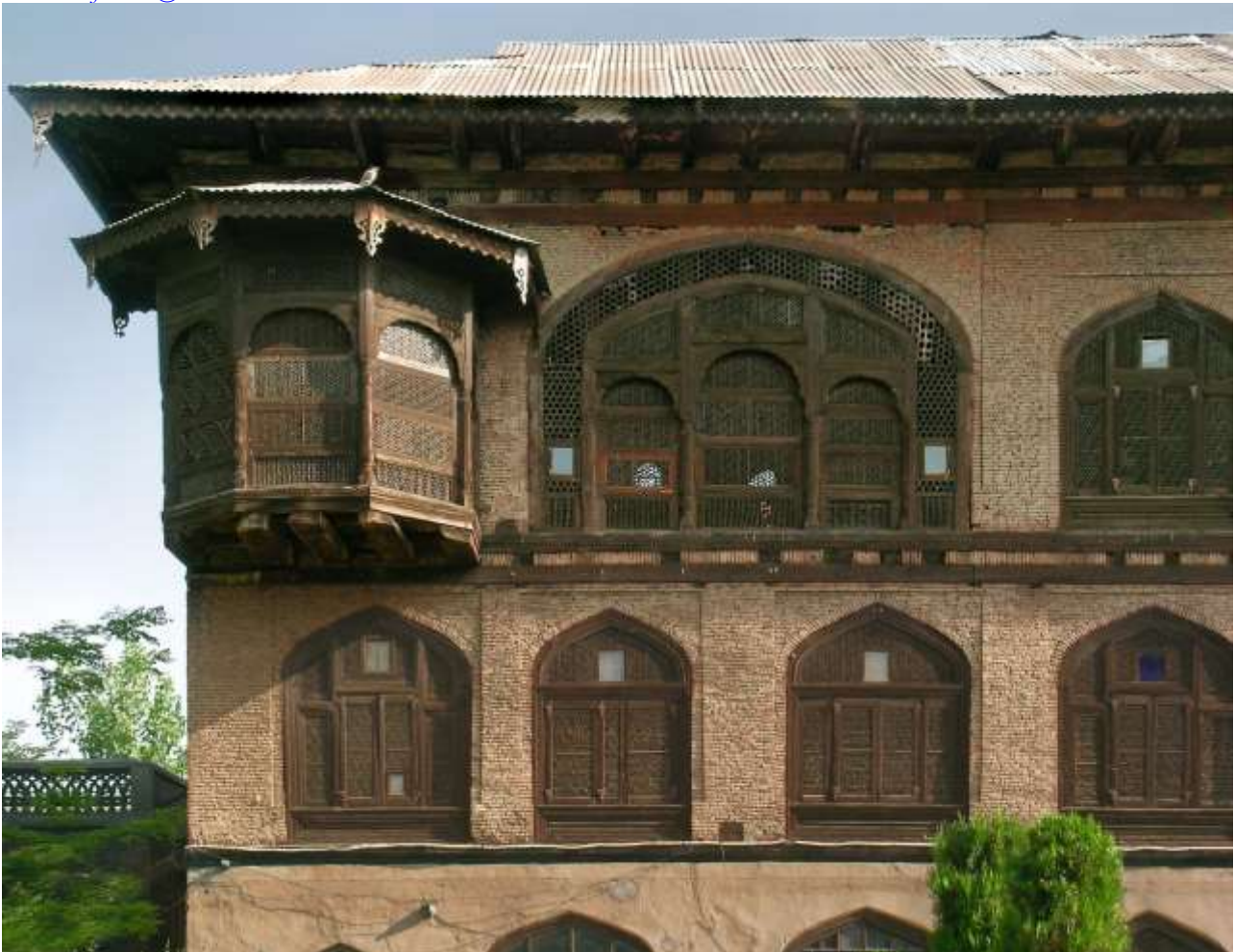
The second image (SRNGR'07(27)3-05-RT2) shows the “ladder shaped” timber ring beams extending out from the wall of a building being cut in half by a road widening project. You can see the floor level timbers, and also timber lacing above the windows. These examples contrast with Nepal which lacks them, and their absence leaves the masonry vulnerable to the kind of spreading that you see in the photo by Kai Weise and the damage you see in the third photo attached ('00Nepal-#04-01-RT copy) – which shows damage caused from settlement without an earthquake.

I hope this covers the questions for you adequately. I look forward to seeing you piece. I will be headed to bed now, but will try to get back online by about 8AM tomorrow (8:45 PM today your time) to look for any follow up. Please acknowledge receipt as this is a large email and I wish to be sure you get it.

Thank you, enormously,
Lucinda

Lucinda Fleeson

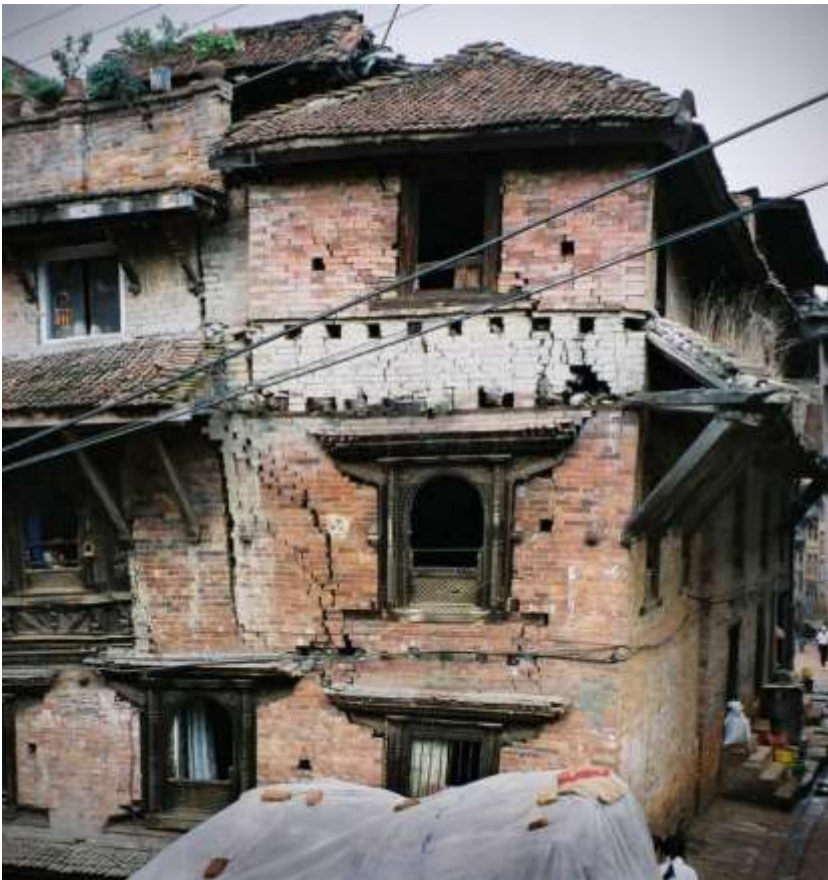
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Srinagar, Kashmir, © Randolph Langenbach



Srinagar, Kashmir, © Randolph Langenbach



Bhaktapur, 2000 © R. Langenbach

From: Randolph Langenbach [mailto:rl@conservationtech.com]
Sent: Tuesday, May 05, 2015 4:24 PM
To: 'Richard Hughes'; 'ISCARSAH-L@lists.icomos.org'
Cc: 'Steve Kelley (new)'; icorp-l@lists.icomos.org; 'Sahar Derakhshan'; 'Vincent Michael (vmichael@globalheritagefund.org)'; Vince Michael (2ndAddress) (vmicha@saic.edu); Lucinda Fleeson (lfleeson@msn.com); Christian Manhart (c.manhart@unesco.org); Amod Mani [NEPAL] Dixit (adixit@nset.org.np); Roger Bilham (Roger.Bilham@Colorado.EDU); Martin Hammer (mfhammer@pacbell.net); Aparna Tandon (aparna.tandon1@gmail.com); Raju Shrestha (rbshrestha@hotmail.com); Jitendra K Bothara (jitendra.bothara@gmail.com); 'Rohit Ranjitkar (rohitguru@hotmail.com)'; 'susannah robininson'; Robin Spence (robin.spence@carltd.com); Edmund Booth (Edmund@Booth-seismic.co.uk); 'Stephen Waite'
Subject: RE: [ISCARSAH-L] RE: [ICORP-L] Nepal

Dear Richard,

Thanks for your email and endorsement of the efficacy of using photos for research of earthquake damage. Your comment about ground motion data has prompted me to get in touch with EERI and USGS, (and perhaps you can get a hold of the European equivalent of USGS, as they may have access to seismic stations at different locations.) Attached is the main shock ground motion data, and I am now seeking getting a map that shows where the station is and the geology at that particular site – but as near as I can tell from Google Maps, it is not too far from the Kathmandu Durbar Square. The website for this data, with all of the aftershocks is:

<http://www.egclearinghouse.org/2015-04-25-nepal/category/topics/nepal-aftershock/>

As I had mentioned before, although less scientific, but empirically valuable, are videos, but only if one watches them several times to see if one can see and interpret the vibrations. Here are several that I have noticed that tell interesting stories.

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One last thing, when reading the above mentioned article in the New York Times, I opened the window that had reader's comments – something I rarely have time to do – and saw one that I moved me that I think worth passing on. Written by a Nepali with the pen name of “Ram”, it says:

“With all due respect, I wish Western media did not repeat words such as "poor," "impoverished," "poorly governed" etc. so many times in news stories about Nepal. It is especially hurtful at a time of crisis. Yes, we are poor, but is it a crime to be poor? We are also hard-working, peace-loving, kind people. Why not emphasize these aspects? Every country has its own weaknesses, and our major weakness is that we have not caught up with the rest of the world when it comes to hoarding money. We accept that. However, it adds insult to injury when repeated at every occasion.”

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This is enough for now. I am open to any and all thoughts, comments, further insights and criticisms.

Randolph Langenbach

From: Randolph Langenbach [mailto:rl@conservationtech.com]

Sent: Tuesday, May 05, 2015 4:24 PM

To: 'Richard Hughes'; 'ISCARSAH-L@lists.icomos.org'

Cc: 'Steve Kelley (new)'; icorp-l@lists.icomos.org; 'Sahar Derakhshan'; 'Vincent Michael (vmichael@globalheritagefund.org)'; Vince Michael (2ndAddress) (vmicha@saic.edu); Lucinda Fleeson (lfleeson@msn.com); Christian Manhart (c.manhart@unesco.org); Amod Mani [NEPAL] Dixit (adixit@nset.org.np); Roger Bilham (Roger.Bilham@Colorado.EDU); Martin Hammer (mfhammer@pacbell.net); Aparna Tandon (aparna.tandon1@gmail.com); Raju Shrestha (rbshrestha@hotmail.com); Jitendra K Bothara (jitendra.bothara@gmail.com); 'Rohit Ranjitkar (rohitguru@hotmail.com)'; 'susannah robininson'; Robin Spence (robin.spence@carltd.com); Edmund Booth (Edmund@Booth-seismic.co.uk); 'Stephen Waite'

Subject: RE: [ISCARSAH-L] RE: [ICORP-L] Nepal

Dear Richard,

Thanks for your email and endorsement of the efficacy of using photos for research of earthquake damage. Your comment about ground motion data has prompted me to get in touch with EERI and USGS, (and perhaps you can get a hold of the European equivalent of USGS, as they may have access to seismic stations at different locations.) Attached is the main shock ground motion data, and I am now seeking getting a map that shows where the station is and the geology at that particular site – but as near as I can tell from Google Maps, it is not too far from the Kathmandu Durbar Square. The website for this data, with all of the aftershocks is:

<http://www.egclearinghouse.org/2015-04-25-nepal/category/topics/nepal-aftershock/>

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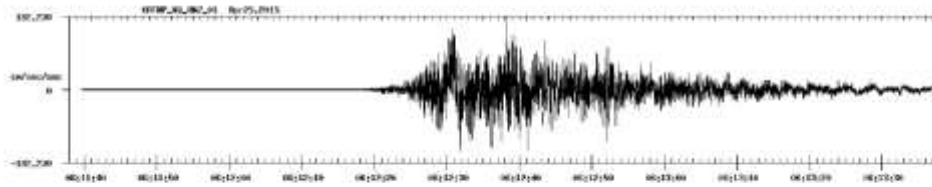
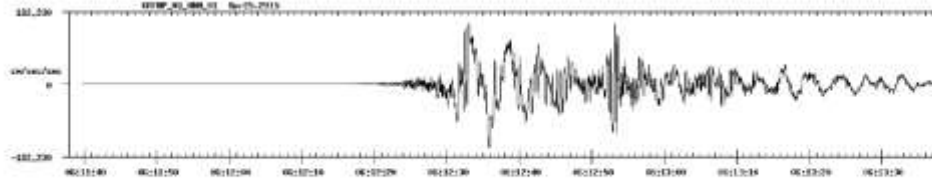
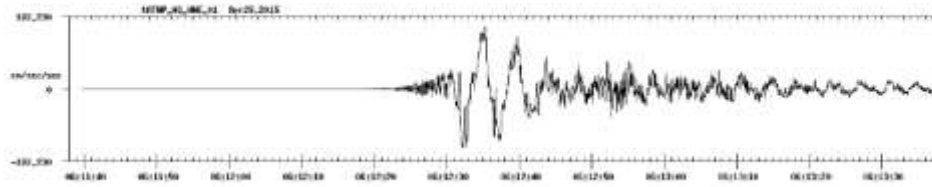
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Randolph Langenbach



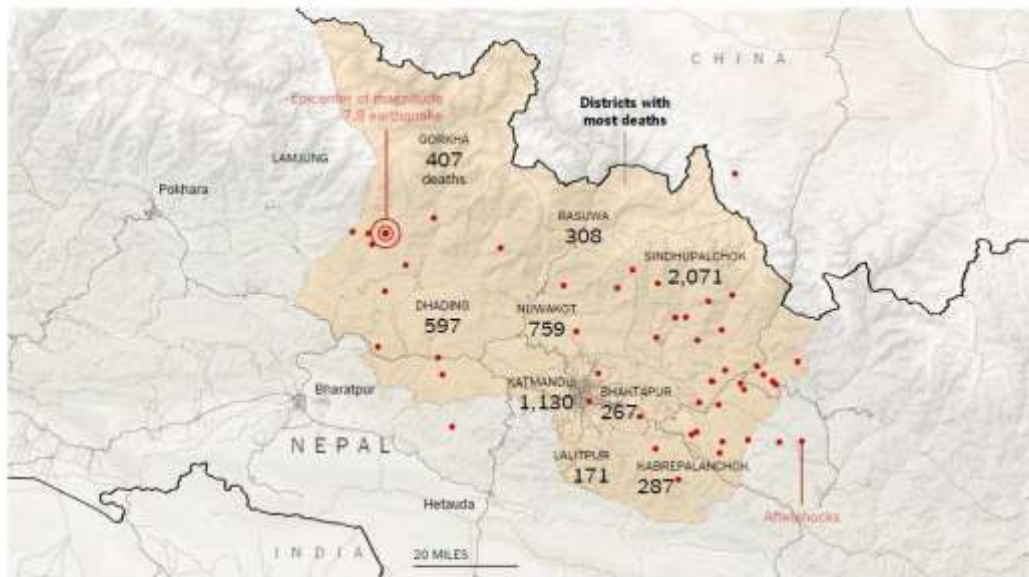
[Back to all data for this station](#)

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http://earthquake.usgs.gov/monitoring/netquakes/station/KATNP_NQ_01/0102104C0001108/

Tally of Deaths

As rescuers continue to search for survivors in the rubble of collapsed buildings, the number of the dead is expected to rise. The two districts with the largest tolls are Katmandu and Sindhupalchok, each with over 800 confirmed deaths by Monday evening. [UPDATED MAY 1 | RELATED ARTICLE »](#)



By The New York Times | Sources: Nepal National Information Technology Center, U.S.G.S.

Sindhupalchok District

The district has recorded the highest deaths and has the highest per capita death rate at more than seven deaths per thousand residents.

Katmandu

The densely populated capital district has the second highest death toll.

Gorkha District

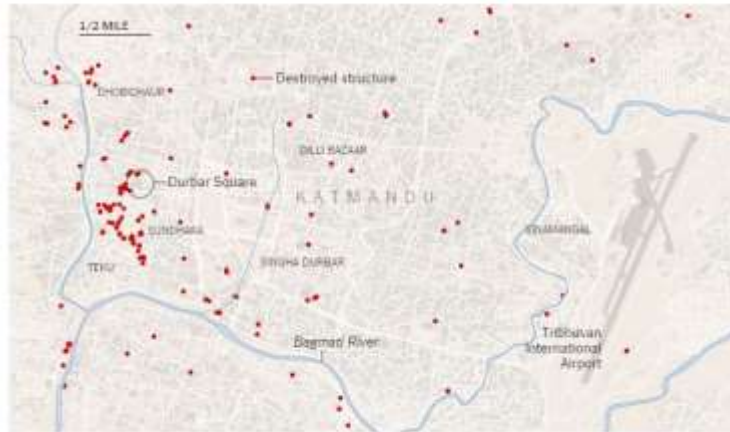
Some villages in the district at the epicenter of the earthquake reported that more than 70 percent of houses were destroyed.

Bhaktapur

Casualties in the district have been especially high in the dense center of the ancient temple city of Bhaktapur.

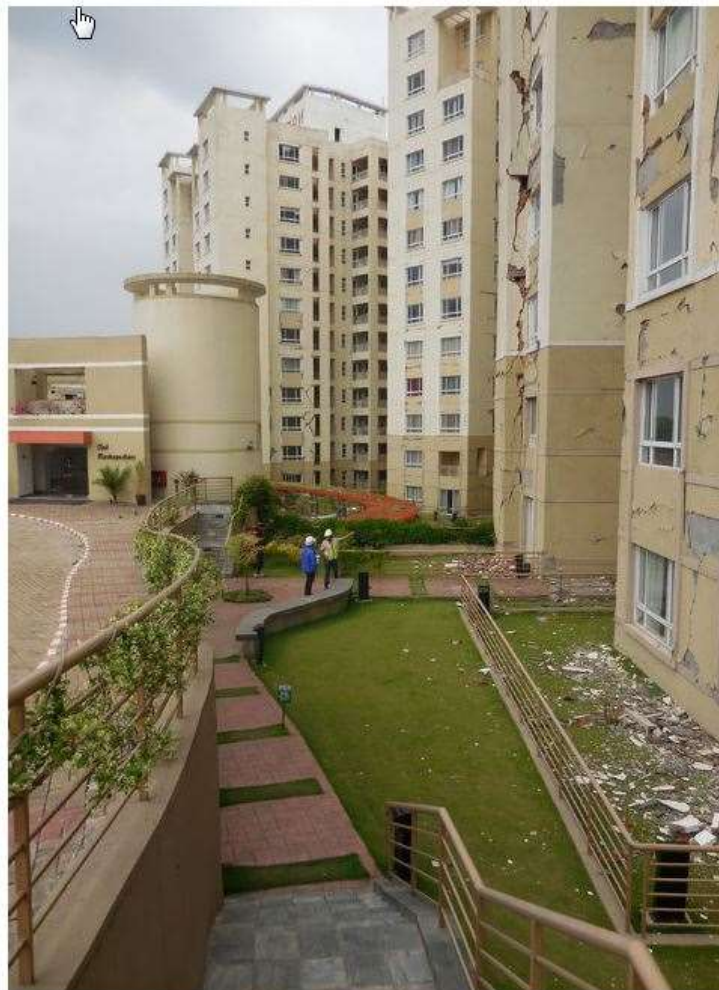
Estimate of the Destruction in Katmandu

The densely populated capital of Nepal, Katmandu, suffered extensive damage from the earthquake. An analysis using satellite imagery captured before and after the earthquake found that about 180 structures in the city's center were destroyed. The damage was most concentrated around Durbar Square, where many historical and cultural sites are located. Updated April 27



The New York Times | Source: European Commission Operational Emergency Management Service

N MAY 1, 2015 6:02 PM 13 Comments



Engineers inspected a high-rise residential complex in Katmandu, Nepal, that was badly damaged in the April 25, 2015, earthquake but did not collapse. Miyamoto International

From: owner-iscarsah-l@lists.icomos.org [<mailto:owner-iscarsah-l@lists.icomos.org>] **On Behalf Of** Dr. Ahmet Turer
Sent: Friday, May 08, 2015 1:58 AM
To: ISCARSAH-L@lists.icomos.org
Cc: icorp-l@lists.icomos.org; 'Christian Manhart'; 'Sahar Derakhshan'; 'Vincent Michael'; 'Rohit Ranjitkar'; 'Kai Weise (new)'
Subject: RE: [ISCARSAH-L] FW: Nepal post-earthquake video

Dear All,

It is interesting that some of the taller historic structures (4-5 storeys with large roofs) were not collapsed while shorter ones were on the ground. The soil conditions and frequency content of the earthquake might be on the shorter periods.

I have also noticed that there are many reinforced concrete structures standing while some timber structures were collapsed. This brings up the lesson that masonry, timber and R/C structures cannot be classified as earthquake resistant based on the construction material only. Some level of engineering is needed for all kinds to stand during a large earthquake.

Best regards,
Ahmet Turer.

From: Randolph Langenbach [<mailto:rl@conservationtech.com>]
Sent: Friday, May 08, 2015 10:45 AM
To: 'ISCARSAH-L@lists.icomos.org'
Cc: 'icorp-l@lists.icomos.org'; 'Christian Manhart'; 'Sahar Derakhshan'; 'Vincent Michael'; 'Rohit Ranjitkar'; 'Kai Weise (new)'; Andreas Stavridis (astavrid@buffalo.edu)
Subject: RE: [ISCARSAH-L] FW: Nepal post-earthquake video

Dear Ahmet and colleagues,

Thanks, Ahmet for your contribution. I think it is an important observation, and it contrasts with my initial conclusions that it was primarily a long period vibration. On this subject, last Wednesday, I did find in the New York Times a statement by Susan E. Hough, a seismologist with the United States Geological Survey when she said *"it appeared much of the shaking of the Kathmandu valley went into what seismologists call long-period energy. Like long swells in the sea. Each cycle took about five seconds, as opposed to more jittery high-frequency motion that would have been more damaging to local buildings."* The CCTV videos have seemed to indicate, as the USGS ground motion graph (attached) seems to confirm, that the waves had both short and long frequency energy.

What seemed to be most enlightening, in addition to the swimming pool video I first circulated several days ago, is this video: <https://www.youtube.com/watch?v=lgW1BrrL0TQ>. To see the people suddenly almost lose their balance when the ground shifted to the left, perhaps is when the sudden large waves visible in the ground motion graph came through. What do you think? I have attached a photo of some tall apartment blocks that was taken by Kit Miyamoto's team of engineers who are already in Kathmandu. It is clear from the X cracks that these taller buildings were rocked by the quake, but, unlike the ones in Islamabad after the 2005 quake, they are all still standing.

As you observe, what seems anomalous to the behavior in long period shaking is that the taller historic buildings are standing and shorter ones are down. I would like to suggest two other factors than simply size which may possibly be more operational in these cases: (1) maintenance and current condition, and, possibly even more important, (2) the width of the buildings at their bases relative to their heights.

In the case of (2) I think that there is strong evidence that those temples several stories high with small bases were rocked back and forth by the earthquake at their base, rather than swaying from deformations within their superstructure. One example where this is more clearly what happened is in the photo from the New York Times attached. Since the debris piles at some of the collapse sites were fairly concentrated, my suspicion is that most did not entirely tip over, but instead collapsed when their weight was shifted by the sway onto one side of their bases, where their masonry (compromised by the effect of rising damp on mud mortar and under fired bricks, and lack of maintenance) crushed and separated, causing a collapse of the entire structure. The evidence for this scenario is the noteworthy division of the damage to the pagoda temples into two distinct categories – (a) totally collapsed, or (b) still standing, and as best as one can see in photographs, visually intact.

In the case of (1) above, it is comforting to see that there is evidence that many of those heritage monuments which were collapsed by the 1934 earthquake survived this one. There is also evidence that some of the structures which had survived that earthquake were collapsed by this one. We know that a number of the major monuments felled in 1934, were not only rebuilt after that quake, but also, in the case of the 55 Windows Palace, and the Patan Museum, heavily restored and rebuilt once again over the course of the last 10 to 30 years.

Many of the smaller pagoda temples may not have been in these restoration campaigns, and thus in a more fragile state. Confirming this is the news from the Kathmandu Valley Preservation Trust, which in an email I received, has told me that *“Of the 45 buildings and monuments restored by KVPT over the past 20 years only 3 have major structural damage - the rest have only minor, repairable damage and have survived very well.”* This organization has been active now for many years, and has focused their attention on many of the smaller pagoda temples.

Ahmet, I look forward to your thoughts, and thoughts by others on this.

Kind Regards,

Randolph

Randolph Langenbach

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www.traditional-is-modern.net

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Oakland, California

(+1) 510-428-2252

From: owner-icorp-l@lists.icomos.org [<mailto:owner-icorp-l@lists.icomos.org>] **On Behalf Of** Kai Weise
Sent: Friday, May 08, 2015 9:10 PM
To: Forbes, Catherine
Cc: icorp-l@lists.icomos.org; Andreas Stavridis; ISCARSAH-L@lists.icomos.org; Vincent Michael; Sahar Derakhshan; Rohit Ranjitkar; Christian Manhart
Subject: RE: [ICORP-L] RE: [ISCARSAH-L] FW: Nepal post-earthquake video

Thank you for all your support.

We are going to have a meeting on Sunday to see how we can approach the task of stabilising the Hanuman Dhoka palace before the Monsoons in say 6 weeks. We hope to get detailed drone images soon. Will be in touch concerning this rather horrendous task.

We will also need to "rehabilitate" - not sure which word to use - towns like Sankhu (on tentative list) since they are said to be 95% damaged. What technology do we use for residential buildings? Just a point to start thinking about. As mentioned by Catherine there will be many villages that will need help for reconstruction. Will send some of my ideas in my next email.

Thank you, Kai

Kai Weise, consulting for UNESCO in NEPAL

From: Randolph Langenbach [<mailto:rl@conservationtech.com>]
Sent: Saturday, May 09, 2015 10:32 AM
To: Kai Weise (new) (paharnepal@gmail.com); 'Forbes, Catherine'; 'Christian Manhart'; Jitendra K Bothara (jitendra.bothara@gmail.com); Dipendra Gautam (strdyn33@gmail.com); Richard Sharpe (richard.sharpe@beca.com); 'Rohit Ranjitkar'
Cc: 'Andreas Stavridis'; 'Vincent Michael'; 'Sahar Derakhshan'; Jay Berger (jberger@eeri.org); 'Heidi Tremayne' (heidi@eeri.org); Amod Mani [NEPAL] Dixit (adixit@nset.org.np); Roger Bilham (Roger.Bilham@Colorado.EDU); Martin Hammer (mfhammer@pacbell.net); Eduard Sekler (Esekler@gsd.harvard.edu); Raju Shrestha (rbshrestha@hotmail.com); matt@smashon.com; John Hurd (hurdcon@yahoo.co.uk)
Subject: Nepal post-earthquake - REPLY to KAI WEISE & CATHERINE FORBES

Dear Kai, and also, Catherine Forbes, Christian Manhart, and Rohit Ranjitkar,

It is good to hear directly from you with your question on how best to proceed with rehabilitation and reconstruction work that can offer an improvement in seismic resistance – both for heritage structures and for reconstructed houses of stone masonry and unfired clay bricks.

To quickly respond with some ideas, I would like to direct your attention to what appears to me to be the most conspicuous element that was missing in those masonry buildings which have collapsed – looking at the damage from halfway around the planet (and thus seeing the images of it on the web). That element is **Timber Bands (ring beams)**.

....

My first suggestion is to point out that those very same features that Dipendra Gautam has written about were absent from many of the buildings – and wreckage of those buildings are what have given the world the impression that almost everything made of masonry in the damage district has either fallen down or been heavily damaged. It is important also to embrace and promulgate the New Zealand Building Codes – on which Dr. Richard Sharpe worked. These are very closely related to the building codes in India (I believe on which he also worked) – codes that are unique in the world in that they are NOT highly technical documents, and that they are specifically designed to address non-engineered construction using traditional pre-industrial

construction technologies. They are, as they are entitled, “RULES OF THUMB...” I have attached a cover, and one page from one of these codes to show a timber band. (I have copies of the English language versions, and, unless I learn that they are already on the web, I will be willing to post them on the web for download – let me know if you wish me to do this.)

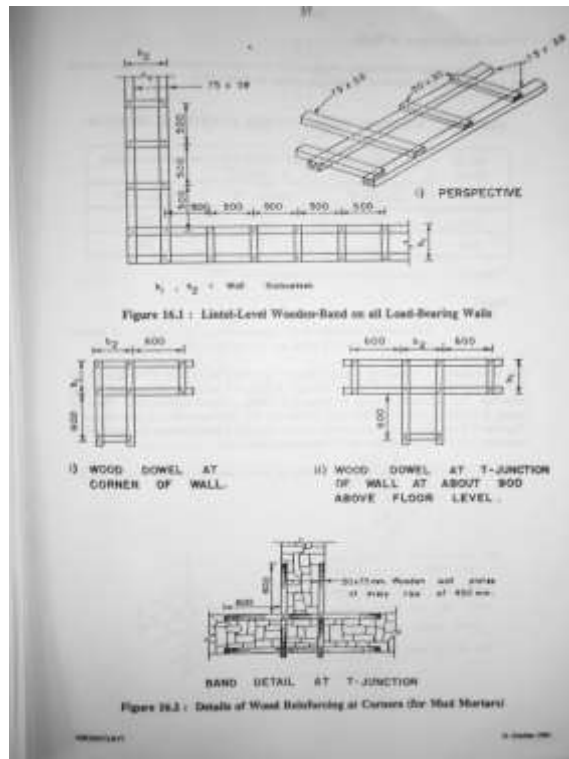
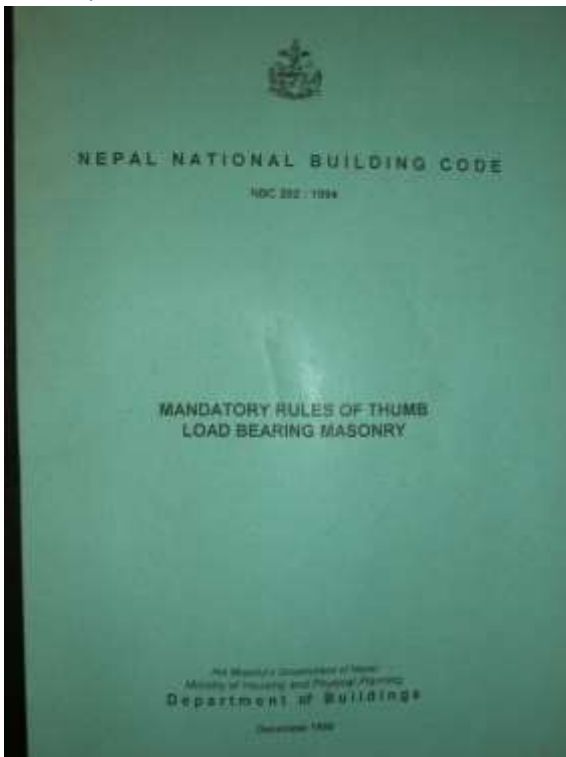
As I have mentioned, for bearing wall masonry construction, the existence or absence of timber bands at the floor levels, and, ideally also above and below the windows, or at a minimum, at the lintel level above the windows is crucial. I look forward to knowing– from Dipendra Gautam and other researchers – more about those buildings which have done well (ignored by the news photographers who only wish to photograph collapses).

The most important suggestion on this I can make – from what I learned in Turkey after studying 3 different earthquakes with different levels of destructiveness – is to NOT treat the cracking and fallen plaster in traditional masonry buildings as “failure” or “near to collapse”. This is extremely important because low-strength masonry construction responds to earthquakes by cracking and shifting, which dissipates energy. If it is restrained from simply being overturned or tossed off by the earthquake by timber ring beams, and the confining effect of window and door frames, etc., then such damage is nothing less than behavior consistent with the objectives of the building codes not only in Nepal, but in Europe and North America as well. I have seen such buildings condemned, the people told to move out (live in tents) and whole towns rebuilt with LESS earthquake resistant concrete block houses on sites that were unsuitable for farming, and thus end up entirely abandoned. I am not the first to report on this, as this has been written about years ago by Cambridge professor Robin Spence with Turkish colleagues.

I hope that all can be helpful, and let me know if I can be of further assistance.

Kind Regards,

Randolph



Hanuman Dhoka Palace

From: Kai Weise [mailto:paharnepal@hotmail.com]

Sent: Sunday, May 10, 2015 6:15 AM

To: Randolph Langenbach; Forbes, Catherine; Kai Weise G; c.manhart@unesco.org; Jitendra K Bothara; Dipendra Gautam; Richard Sharpe; Rohit Ranjitkar; Andreas Stavridis; Vincent Michael; Sahar Derakhshan; Jay Berger; Heidi Tremayne; Amod Mani [NEPAL] Dixit; Roger Bilham; Martin Hammer; Eduard Sekler; Raju Shrestha; matt@smashon.com; John Hurd; meltem vatan

Subject: RE: Nepal post-earthquake - REPLY to KAI WEISE & CATHERINE FORBES

Greetings,

We will have to see how we move forward on the monuments and what our philosophy will be for reconstruction or restoration or whatever might be required. This we will probably only start after the monsoon, since our immediate task would be safeguard and stabilize whatever might remain of the monuments. The next question would be concerning the structures within the historic towns - whether World Heritage, Tentative List or identified as ancient settlements. Large parts of Bhaktapur have been impacted. Sankhu is in bad shape. Beyond these, the question arises of the reconstruction of the villages which would need a different set of considerations.

I am not going to propose what exactly I would consider appropriate for each of these situations, but it would be great if we could figure out how best to approach these problems when considering appropriateness, sustainability, etc. I fear that we will go for concrete frame structures which when they age will be creating a major risk for future earthquakes. Whatever we use must be based on a system of cyclical renewal. Even if we use concrete, the elements need to be replaceable. With this, a certain focus on maintenance must be included and become part of the use.

In any case, we are right now wondering what to do with the Hanuman Dhoka palace structures. How do we stabilize them before the monsoon?

Thank you for your continued input and comments,

Regards, Kai

From: owner-icorp-l@lists.icomos.org [mailto:owner-icorp-l@lists.icomos.org] **On Behalf Of** Kai Weise .

Sent: Sunday, May 10, 2015 5:12 AM

To: icorp-l@lists.icomos.org; Gaia Jungeblodt; Gustavo Araoz

Subject: [ICORP-L] Fwd: Around Hanuman Dhoka photos for analysis

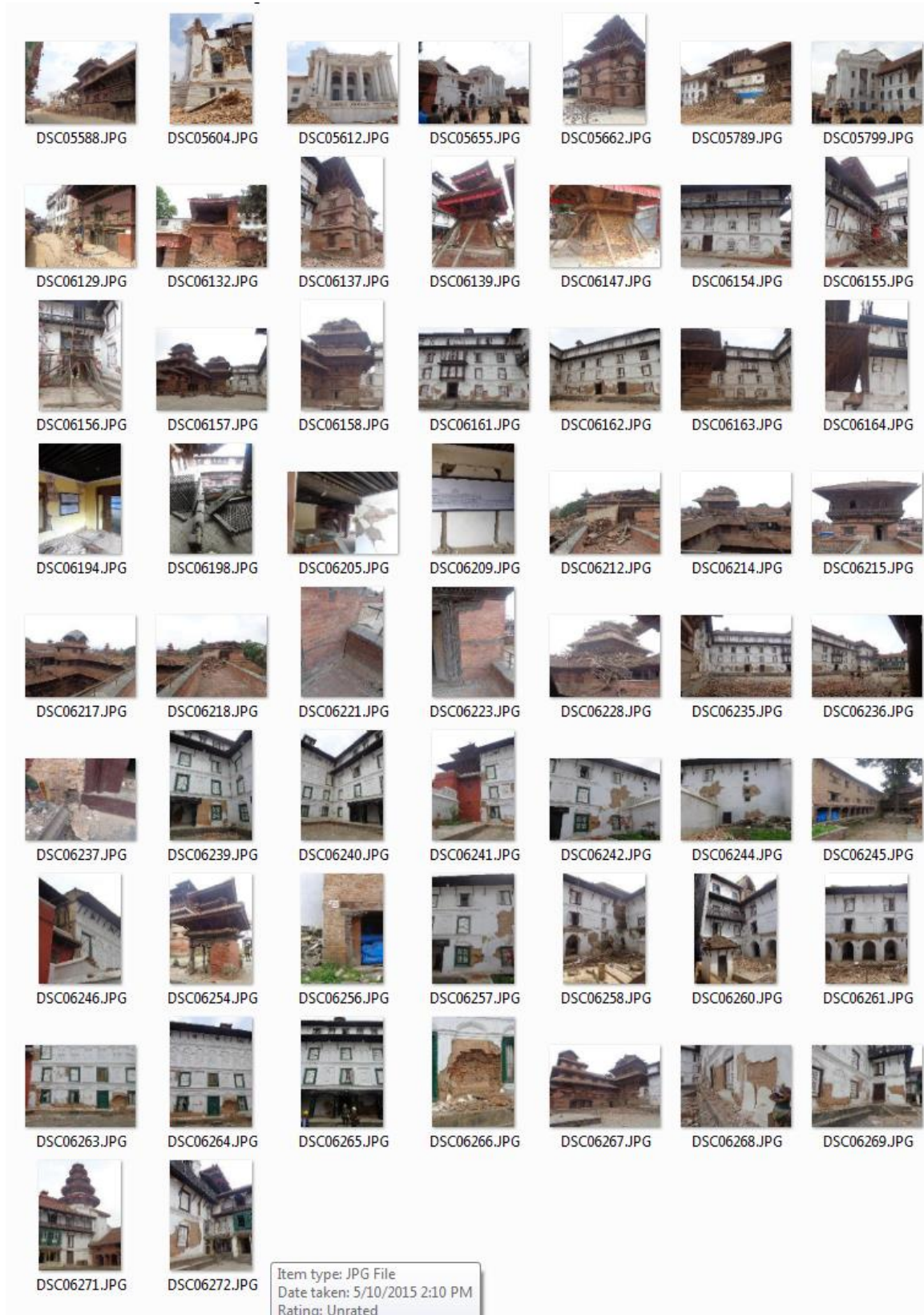
Please find some photos of still standing structures around Hanuman Dhoka Palace. For those who are interested I can send some 50 more of the palace itself. Should I send them to all or only the interested person?

We had an Italian team there this afternoon to help us begin thinking of how to deal with these structures in their precarious state (and before the monsoons arrive) and how to get the museum artifacts out.

Those interested in commenting please send me at paharnepal@hotmail.com these directly or with cc to a smaller group that we don't flood everyone's emails.

Thank, Kai

Hanuman Dhoka Palace



Photographs by Kai Weise after the earthquake



My text on this and the following pages is addressed to Kai Weise in Nepal

Dear Kai,

One Question: Your photo # 5662 taken on the 26th of April (a day after the quake, if the Date and Time setting of your camera is correct) shows the exterior brick wall of the same section of the palace as Photo 6177, taken today, the 10th of May. In between, I have seen this same wall published by the New York Times – showing before and after shots (attached between your photos), so I am familiar with it because I had an email conversation with Richard Hughes about exactly that spot.



Your earlier shot is striking because it shows, if I am not mistaken, that the lower roof collapsed in an aftershock, after you took the 1st picture! Can you confirm for me that this is the case – and if you know what happened to bring down the roof in what was a much smaller aftershock, than the original earthquake, or were there some large aftershocks?

Have there been any other examples of such a dramatic increase in damage between the main shock, and collapses like this days later?

The New York Times pair of images was published on April 28, New York City time, which means it went to press at about noon your time on the 28th.



Hanuman Dhoka Palace



Since you mention having an Italian team with you in Kathmandy, I wish to share with you these photos and recommendation.

A perfect solution for shoring of vulnerable outward leaning walls are used in Italy after earthquakes as seen here – polypropylene straps that can be wrapped and tightened around buildings with outward leaning damaged walls. This is far more efficient and less expensive than external bracing.

Try to get your Italian team to arrange to send these to you, or tell you how to get them.



Here (middle row) shows the same way of solving the problem, but with steel cables rather than polypropylene straps.



Bottom: The Italians are masters at the design and engineering of shoring. Here is an example of external shoring in timber.

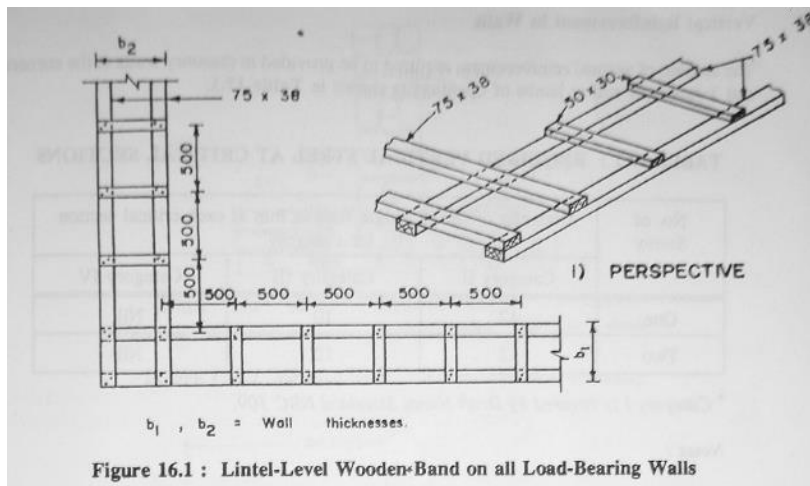
Hanuman Dhoka Palace



On page 5 I have pasted your photos that appear to show timber lacing in the walls of parts of the Palace. From your photographs, it looks like parts of the palace, but not all of it, had timber bands. It seems clear that the later classical revival parts of the structure, and also the long whitewashed range, do not have timber lacing. It also looks like that in some places – as can be seen in the last photo pasted on page 5, that the timber bands may not always wrap around the structure as can be seen here:



The two interior photos show that the timbers are on the interior surface as well as the exterior surface – thus they are probably configured not unlike those in Kashmir shown the Nepal Building code shown here, except that the cross pieces lie below the timber runners. These are the kinds of timber bands that are described by Dipendra Gautam, whom I am copying in this email.



These interior photos on page 5 serve to give evidence of the effectiveness of these timbers in holding the walls together to prevent collapse of the building. Notice how the plaster has fallen off of the wall. It is clear from this that the walls felt the strain from the earthquake shaking.

However, there are cracks visible in the remaining plaster, but they do not form a single large “X” as is characteristic of shear failure of the wall, which is the precursor of collapse. The timber bands on the inside and outside of the wall have served to stop these cracks, and keep the walls from spreading.



In my opinion, from looking at these pictures (without the benefit of being there to look more carefully), these parts of the palace with the timber lacing look quite sound, and not on the verge of collapse, although it suffered the loss of the tops of some of its pagoda towers.

One important survey that I recommend be conducted is to record onto the drawings the locations within the building that have the timber lacing, and inspect it carefully to see its condition. Also, make note of those areas where it does not carry around the whole structure. An important point: the bands at the floor levels are not visible in the photographs, but are of critical importance structurally, as they hold the floor diaphragms to the walls. It would be good to see during the restoration work where they are, and determine if the floor joists extend through the walls, and check to see if there is any decay in the embedded timbers.

Hanuman Dhoka Palace



It appears from the exterior that this wing has survived with little or no damage, so it would be good to determine if this is true, and what features of its structure and age may have contributed to this.

It does not appear that the classical revival section and the long white range of the palace, as well as the unpainted brick wing shown here have timber lacing in the walls. In the case of the classical revival wing, shoring is needed, and the strapping technique shown on page 4 may work well for this.

In the case of the long white range, it appears that the most strain was felt at the base of the structure where the plaster surface has fallen off. It appears that the bricks are under-fired, and thus weak, perhaps further weakened by rising damp. The strain may have been from the building rocking back and forth, which compressed the bricks and caused the plaster to shed.

There one particular feature to the traditional construction in Nepal which I wish to address once again – as I had mentioned it in one of my earlier newsgroup emails – is the traditional design of the face bricks. In Nepal, as I have not seen this anywhere else, the specially made face bricks for the more important buildings – temples and palaces – are manufactured with a wedge shape, which allows the mortar bed to be hidden, giving the facades their iconic pencil-thin mortar joints. Kai – perhaps you could help me learn about the history of this, but I have seen it on my trips to Nepal, both at the brick yards, and also at a restoration project of one of the temples next to the **Hanuman Dhoka Palace**, and at the restoration of the **55 Windows Palace**. These are photos I took of them in front of the Hanuman Dhoka Palace in 2005.



While this is both unique, and contributes to the architectural distinction of the Kathmandu buildings, I wish to point out a concern that I have about it from a conservation and earthquake hazard perspective that I have not yet seen discussed. As buildings age, the mortar – particular mud or mud/lime mortars, tend to erode and dry out and deteriorate in the walls. With ordinary rectangular bricks, the structure of the wall may weaken, but the position of the bricks does not change, nor their ability to carry the loads. With the wedge-shaped bricks, a loss of mortar can cause the bricks to rotate slightly, such that their fronts are no longer truly vertical. In ordinary circumstances, this may not be noticed, but as the compressive strength of the mortar weakens, and an earthquake comes, the added force can suddenly cause the face brick layer to pull away from the core of the wall. The shape of the bricks combined with the infrequency of having true bond courses, thus may account for some of the areas of delamination that we see.

It may be worth studying this feature in detail by surveying earthquake damage to try to recognize where this brick shape may have played a role in the damage. When rebuilding the walls, it may be worth considering the addition of a thin wedge or pencil-sized piece of fired ceramic into the mortar joints towards the rear of the bricks so that the vertical compression on the wall would not bear unevenly onto the facebricks. This is just an idea that will need further investigation, but I suggest a solution so that one can see a way to fix the problem without changing the traditional architecture if it can be determined to be a contributing cause of damage to the buildings.



This is a photo I took of the walls of the Hanuman Dhoka Palace in 2005. It is possible to see some crude repairs which may be where bricks fell out of the wall. Also, some have lost their front surface from spalling, and there is evidence of salt attack at the base from rising damp – which also serves to weaken the bricks. It is possible that the string courses visible on the wall are tiles which cover timber bands, so I will be pleased to know if this is true here.

In conclusion, there is much further study needed to know how best to restore the walls of the palace, and determine where it needs to be strengthened. It may be possible to grout the walls to consolidate them, but that will require serious on-site consulting. The one important caveat is to avoid any grouting with Portland cement as it would be highly destructive to the historic fabric in walls that appear to have survived the earthquake remarkably well.



This is a photograph from my collection of 160 photographs just of the Hanuman Dhoka Palace taken in 2005.

I will be pleased to contribute any and all of these photographs to you, to UNESCO, and the agency of the Nepal Government in charge of the restoration if they will be of help to the project. They are almost all of the exterior of the buildings, including views of the inner courtyards. Since many will need work in Photoshop, this is not without some significant time needed to do it, but let me know what you particularly need, and I will see if I have the views.