OPINION

A Rich Heritage Lost: Observations on the Effects of the Bhuj Earthquake, India

In March of 2001 I flew into Bhuj, the city in Gujarat, India that was the center of the area devastated by the earthquake of January 26, 2001. From the air the view of Bhuj belied its true condition. From that distance the city seemed quite normal, with many tall blocks of apartments standing seemingly unharmed. On the ground, however, the scene was quite different. The first close-up view of those same large apartment blocks showed them to be leaning at crazy angles, with their first floors collapsed and their upper walls laced with cracks like a crazed china pot.

While the city now contains many modern reinforced concrete buildings, Bhuj was originally an ancient walled city and still has both part of its original fortifications and many historic buildings within the city core. Some of the fort walls had survived the vicissitudes of time, only to be heavily damaged by the earthquake. They looked as if they were cheese nibbled by a giant mouse. The battlements had fallen. Large areas of the facing stone had come off. In some places only the inner rubble stone core remained standing.

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The first view of the inner precincts of the walled city of Bhuj was shocking. In the area immediately inside the city gate, the buildings had almost totally disappeared into rubble piles that lay along either side of the road like great waves. Riding on these waves were the still whole pieces of the upper floors of broken newer concrete buildings, leaning at crazy angles as if they were riding in surf.

These "waves" of rubble were the result of the first phase of plowing to clear the streets, which at that time, five weeks after the earthquake, were still only narrow tracks between the piles. The scene was so awesome and foreign to one's experience that the only familiar metaphor that came to mind was a scene further north after a great blizzard when the streets are first cleared, leaving mountainous piles of snow as walls on either side. This rather benign image came to mind largely because the comprehension of the vastness of the total devastation of this section of the city had no precedent. Earthquakes seen before in the United States, and even also in Yugoslavia, El Salvador, and Mexico City, had left damaged or even collapsed buildings here and there. Here, by contrast, one was confronted with a view of total devastation. As far as one could see, everything within view had either totally or partially collapsed.

This same scene was repeated in the nearby smaller cities of Bachau and Anjar, and in many of the smaller villages of the Kutch District of Gujarat. The city of Bachau was even worse off—there, close to 100% of the buildings in the city had collapsed, killing approximately 25% of the population. Stone and timber, or reinforced concrete—it did not seem to matter. The earthquake destroyed them all.

Earthquakes have visited this district of Kutch repeatedly over the centuries. The last great earthquake was in 1819, but smaller ones have damaged and destroyed buildings a number of times in the 20th century. Nonetheless, the area remains rich with cultural heritage, and the earthquake was particularly cruel to many of the architectural relics that embody that heritage. Many of the cities and towns across western Gujarat had been independent princely states, each with its own maharaja, many of whom still own palaces with all the trappings of the former royal kingdoms. When India gained independence in 1947, these palaces became the private homes of the now powerless maharaja families. Despite the fact that they remained full of the art and culture of the region, they are not under any heritage protection and are often not maintained. Now the earthquake has turned many of these former palaces into ruins.

From a technical standpoint, the survey of the ruins of both houses and palaces revealed some interesting facts about the older traditional construction. What seemed most startling was the fact that, despite the local history of seismic risk, there was so little evidence of any mitigation of that risk. Of those buildings that were not now formless heaps and thus could be examined, it almost seemed as if they had been designed to fall down. The walls were constructed mostly of random stone rubble rather than bedded ashlar. They were laid up with mud mortar with little keying together at the corners and no through-wall bond courses. These walls sometimes were extended up to over 15 feet in unbraced height, simply to support the ridge of the roof to avoid the use of wood necessary to build a roof truss. Floor joists were often laid into the walls in pockets only a few inches deep, so that collapse was inevitable with only the slightest of sway.

The construction near the earthquake's epicenter in Kutch contrasted with that found in nearby Ahmedabad, where the construction tradition more closely resembled that found in Turkey, and even in Kashmir. In Ahmedabad, many of the traditional buildings within the Old Walled City area had timber lacing in the walls and exhibited other elements that have proven to make them more resistant to earthquake damage than the stone construction found in Kutch. As a result, only one building is reported to have collapsed in the Old City of Ahmedabad, and the damage there was far less (although the shaking of the earthquake was significantly less than in Kutch, but nonetheless strong enough to collapse a number of reinforced-concrete high-rise apartment buildings of recent construction, with high rates of casualties).

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Even in Kutch, however, there were a number of interesting anomalies. In Bhuj, while certain areas were totally leveled, even a few blocks away one can still enter parts of the city that were comparatively unscathed. The most plausible explanation appears to be local differences in the ground shaking. At a recent workshop in New Delhi (International Conference on Seismic Hazard with Particular Reference to Bhuj Earthquake of January 26, 2001), a number of the presenters described the likely variations in ground shaking that occurred in this earthquake because of the unusual high saturation of the substrata, with some areas subjected to liquefaction. Some of these researchers also reported their own observations of the significant variations in the observed damage to buildings within blocks of each other.

Another interesting observation is that buildings with balconies often seemed to fare dramatically better than ones without balconies. In a scene that was repeated a number of times, lightly damaged balconied walls overlooked a sea of rubble of collapsed buildings around them. The most plausible explanation for this appears to be that the floor joists which extended through the rubble stonewalls to support the balconies were more successful at stabilizing the walls than were joists terminating in pockets.

What these surviving buildings illustrate is that, in the end, a significant amount of seismic mitigation can perhaps be achieved from small differences in construction methods. These few surviving structures were not strengthened with shotcrete, and they lacked the strong diaphragms and wall ties that even the most basic upgrade requirement in the United States would mandate. But seismic safety does not depend on absolutes. It exists as a continuum. When one looks at the vastness of the problem of dealing with seismic safety in poor regions of the world, high-tech and expensive techniques are worthless if they cannot be executed because of their cost and disruption.

The Bhuj earthquake illustrated the fact that India shares construction technology problems with many other parts of the world where both resources are limited and technical knowledge is inaccessible to most of the population. Standard present-day engineering and construction methodologies common in the West fail to provide a means for ensuring safe construction in the local context. The problem is not a lack of engineering know-how at universities and the top design firms, but rather the fact that there is no inspection process, no enforcement of a building code, and an unregulated construction industry.

The Bhuj earthquake demonstrated that many buildings, both new and old, were extremely vulnerable. However, it also demonstrated that examples of comparatively successful older construction exist, some of which performed better than many of the modern buildings constructed in modern materials. The reasons for their success should not be ignored. Embodied in these buildings may be ideas which could lead to improvements in construction practice that are born out of the local economy and culture, rather than imported from distant parts of the globe. These techniques, which would combine improvements in the use of masonry with an adaptation of the current reinforced concrete construction methods, have the potential of being more effective than what in the West would be more highly technical methods because they can be more easily understood and carried out.

The buildings with balconies that survived are just one example suggesting that slight differences in construction can lead to significant differences in building behavior. The timber-laced buildings of Ahmedabad further illustrate the potential risk mitigation that might be achieved via incorporation of traditional building techniques into modern masonry construction. It is knowledge and recognition of these differences that may in the end be most useful in saving lives and preserving the cultural heritage of seismically active regions of the world.

Randolph Langenbach
FEMA

Randolph Langenbach is a Senior Analyst in the FEMA Public Assistance Program and a member of the Board of Trustees of US/ICOMOS. He surveyed the damage from the Bhuj earthquake in India under a UNESCO mission to survey and report on damage to historical buildings at the invitation of the Government of India. Further information on this mission, including the UNESCO Report and over 300 photographs, can be seen on the Web at http://www.conservationtech.com.