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A Rich Heritage Lost
The Bhuj, India, Earthquake

Last March 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 seemingly standing 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 odd 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 it still has both part of its original fortifications and many historical buildings within the city core. Some of the fort walls had survived the vicissitudes of time, only to now be heavily damaged by the earthquake. The battlements had fallen. Large areas of the facing stone had come off. In some places only the inner rubble stone core remained standing.

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.

Bhuj, India.

These waves of rubble were the result of the first phase of plowing of the rubble to clear the streets–which 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, by comparison, 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 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. The area is also 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, with palaces and all the trappings of royal kingdoms. Since India's independence in 1947, these palaces became the private homes of

Anjar, India

the now powerless Maharaja families. Despite the fact that they remained full of the art and culture of the region, nowadays they are not under any heritage protection and often they are not maintained. Now, the earthquake has turned many of these former palaces into ruins.

From the 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 that they were 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).

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 only explanation can be local differences in the ground shaking. Another interesting observation is that buildings with balconies often did dramatically better than ones without. In a scene which was repeated a number of times, lightly damaged balconied walls overlooked a sea of rubble of collapsed buildings around them. The only plausible explanation for this is 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 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 buildings with balconies that survived are just one example where one can learn that seemingly slight differences in construction can lead to significant differences in behavior. 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.

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Photos by the author.