

BRIEFING ON THE 1994 NORTHRIDGE EARTHQUAKE EXPERIENCE: SEISMIC ISOLATION

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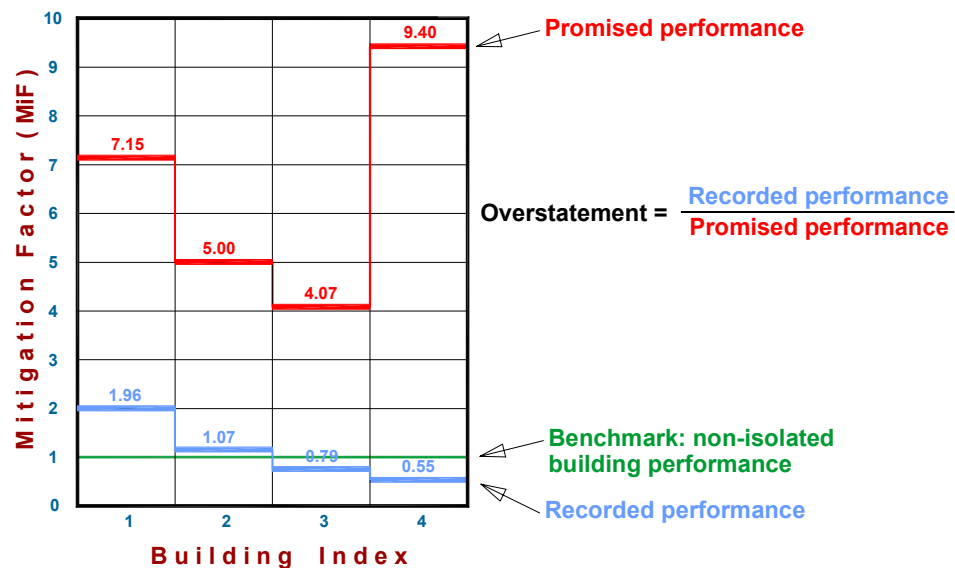
The objective of the current investigation was to determine how well four buildings employing the concept of passive structural control called seismic (base) isolation had survived the 1994 Northridge earthquake.

In order to score the buildings performances with the help of field records, a proper procedure for comparison of real base isolated structures with their hypothetical benchmarks had to be chosen. Thus, to compare the promise vs. performance, a mathematical model had to be reduced to a SDOF system excited horizontally in accordance with a recorded on a basement real time history. No sophistication is warranted because the performance expectations were expressed in terms of the maximum acceleration of a SDOF system. Besides, the recording instruments locations in the buildings were mostly random, scanty and they were, obviously, arranged in assumption that the superstructure would be rocking like a rigid body.

Performance summary of each of the investigated building may be found at the following web sites:

<http://www.ecs.csun.edu/~shustov/Topic2-b1.htm>
<http://www.ecs.csun.edu/~shustov/Topic2-b2.htm>
<http://www.ecs.csun.edu/~shustov/Topic2-b3.htm>
<http://www.ecs.csun.edu/~shustov/Topic2-b4.htm>

Total performance summary of all four investigated buildings is presented in the chart below.



FINDINGS:

None of the base isolated buildings performed up to expectations. In fact, they performed much worse, namely:

1. Los Angeles Fire Command and Control Facility - **3.6** times,
2. USC Hospital - **4.7** times,
2. Los Angeles townhouse - **5.2** times,
4. Rockwell International building (Seal Beach) - **17.0** times.

There are at least two of those buildings (see index numbers 3 and 4 in the chart above) where the seismic isolation techniques were misused. They performed, correspondingly, 1.3 and 1.8 times worse than their hypothetical non-isolated counterparts.

REASONS:

There are the following major reasons why the existing buildings, which incorporating seismic isolators, performed below the expectations during the recent earthquakes:

1. Predictions of their earthquake performances were made in assumption of the whole building structure acting as an absolutely rigid body rocking on their seismic isolators, while the higher natural modes of vibration were, practically, neglected.
2. Possibility of a negative effect of a heavy damping mechanism of those isolators, that could generate short pulses of a high intensity, was overlooked.
3. The buildings that were erected on seismic isolators remained essentially resonant systems in a wide range of earthquake frequencies.

CONCLUSIONS:

The results of this investigation cast serious doubts on the ability of the current base isolation research and engineering to predict accurately actual performances of the buildings targeted for earthquake protection and, which is even more important, to make this technology work.

At the same time, two base isolated buildings that experienced a considerable shaking during the 1995 Kobe earthquake, namely, the West building in the Ministry of Post and Telecommunications of Japan complex and the Research building of the Matsumura-gumi Technical Laboratory, performed quite well (BCJ, 1997).

Nevertheless, some state-of-the-art research centers in this country have, obviously, abandoned the dream of a five-ten-fold mitigation and concentrate now on more feasible, from their perspective, projects, which, in case of success, will just help to prevent an immediate collapse of buildings during a strong earthquake (see, e.g., PEER, 2001).

REFERENCES:

BCJ (Building Center of Japan), 1997, "Menshin Kozou Kenchikubutsu" (Base Isolated Structures), Tokyo, Japan (in Japanese).

PEER, 2001, "KRON 4 News broadcast from March 1, 2001 on the current Pacific Earthquake Engineering Research Center / UC Berkeley shaking table experiments, Project # 5051999", http://www.ecs.csun.edu/~shustov/KRON_broadcast_PEER.mpg, San Francisco, CA.

LINKS:

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