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Retrofit System to Enhance Earthquake Resistance

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Experimental and analytical investigations of a retrofit-system to enhance the earthquake resistance in existing buildings and structures have been conducted in the University of British Columbia, Department of Civil Engineering, Earthquake Simulator Laboratory. The system consists of a combination of well known base-isolation techniques, a new base storey design, and newly developed miltidirectional energy absorber made of mild steel. The research results indicated the usefulness of this system and proved, that it can be implemented in existing buildings without reduction of the structural integrity of the building and without major modifications of the original design.

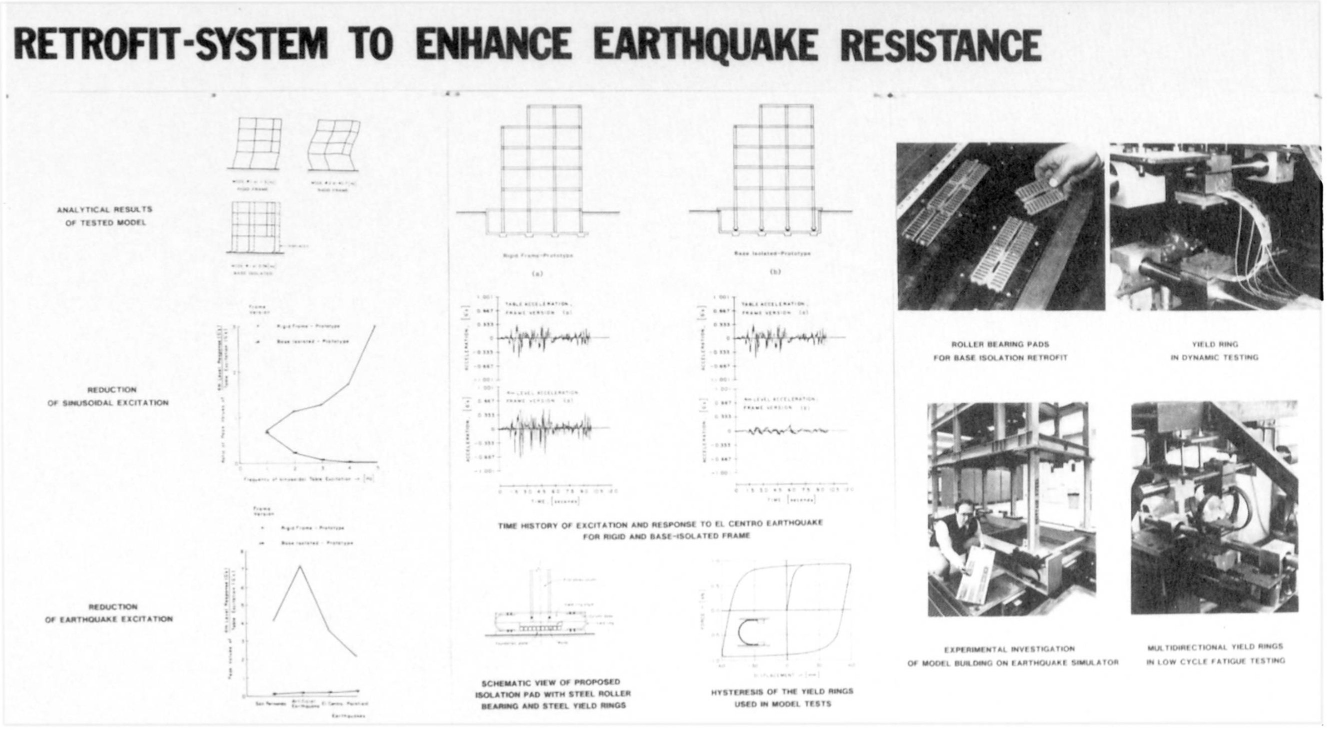
The key idea of the system is to separate the building from the existing ground motion by roller bearings or sliding pads and restricting it from excessive displacements by solid state steel energy absorbers. Extensive experimental tests have been conducted to prove the principles, to correlate analytical programmes, and to devise an engineering approach to the design of the system as a whole and the energy absorbers in particular. A transparent design procedure is now available, which enables the engineer to design this retrofit-system for different earthquake regions and for different structures.

One of the focal points of the research project was to show, how a retrofit base-isolation system could be implemented in steel buildings without additional blind-storeys or double foundations as used in recent proposals by others. This results in considerable cost savings, which make the new approach very attractive for a broad spectrum of buildings for which until now an update in respect to earthquake resistance was believed to be too expensive.

High importance was placed on the investigations and development of reliable, inexpensive, and replaceable energy absorbers. They have to restrain the building against wind loads and, in case being subjected to major earthquake loadings, have to prevent the building from excessive displacements. These devices are designed to deform elastically under minor loads (such as wind) or displacements (such as thermal expansion) and to deform plastically when severe loads (such as earthquakes) are imposed on the building or bridge. The energy absorbers allow displacements in all directions, however work most efficiently for displacements in the horizontal plane. They consist of curved plates of hot-rolled mild steel plates. An engineering method was introduced by the author for the practical design of the steel energy absorbers and for predetermining the number of cycles to failure.

In the experimental studies steel roller bearings were used because they had a very low friction coefficient without becoming unstable for large displacements. However, the design approach is valid for other low friction sliding devices, too, e.g. for neoprene bearings often used in bridge applications.

A wide range of applications can be foreseen for the solid state steel energy absorbers, particularly in the area where currently viscous or friction dampers are used (bridges, nuclear power plants), which can add considerable costs, constant maintenance, and can cause problems of implementation because of bulkiness.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