



Structural Engineering Design: Lessons from Post Earthquake Field Reconnaissance

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Through the Learning from Earthquakes (LFE) Program of the Earthquake Engineering Research Institute (funded by the US National Science Foundation since 1973) multidisciplinary reconnaissance teams are sent out to damaging earthquakes around the world. They bring back observations and lessons that have led to many important advances in engineering, earth sciences, public policy and the social sciences. The following list include some of the lessons that have influenced many aspects of structural design.

- ✓ Designing to code does NOT always safeguard against excessive damage in severe earthquakes.
- ✓ Well-designed, well-detailed, and well-constructed buildings resist earthquake induced forces without excessive damage.
- ✓ Ground failures and large ground movements can cause severe damage and even collapse of otherwise well-built structures.
- ✓ An earthquake will find weak links in a structure and the lateral force resisting system must have a complete load path properly designed for seismic forces.
- ✓ Stiff elements that are not considered in design strongly affect the seismic response of a building.
- ✓ Horizontal diaphragms are essential for the distribution of seismic forces and diaphragms must be properly designed for all required load transfers to and from vertical elements.
- ✓ The intrinsic toughness of wooden buildings can be relied upon only when unsuitable configurations and undesirable combinations with other materials are avoided
- ✓ The stiffness of the lateral-load-resisting system has a major effect on structural and non-structural damage.
- ✓ The performance of cast-in-place reinforced concrete buildings depends on the type of structural system and the quality of the detailing.

- ✓ The stiffness of the lateral-load-resisting system has a major effect on structural and non-structural damage.
- ✓ Irregularities in plan and elevation require special care in design.
- ✓ Soft stories create hazardous conditions.
- ✓ Poor construction practice and lack of quality control can lead to severe damage or collapse.
- ✓ Buildings that experience successive earthquakes may suffer progressive weakening or eventual collapse.
- ✓ Inadequate distance between buildings can, but does not always, result in pounding damage.
- ✓ Elevators and stairways may suffer severe damage that blocks excavation.
- ✓ The weakest links in building systems are often the connections between structural elements.
- ✓ Collapse may result if the strength of non-ductile elements is insufficient
- ✓ Corner columns are vulnerable
- ✓ Exterior panels and parapets need strong anchoring to protect life safety.
- ✓ Unreinforced masonry buildings usually perform very poorly.
- ✓ Reinforced masonry buildings usually perform well.
- ✓ Precast and pre-stressed concrete elements must be well tied together.