RESIDENTIAL TECHNOLOGY Brief

No. 10

Concrete homes stand up to earthquakes

Built according to good practices, concrete homes can be among the safest and most durable types of structures during an earthquake. Homes built with reinforced concrete walls have a record of surviving earthquakes intact, structurally sound and largely unblemished.

In reinforced concrete construction, the combination of concrete and steel provides the three most important properties for earthquake resistance: stiffness, strength, and ductility.

Why buildings survive

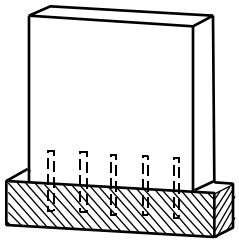
Scientists study damage from earthquakes to determine what types of buildings best withstand seismic forces.

Modern earthquake-resistant design relies on several recent studies:

Year	Earthquake	Magnitude	Studies
1989	Loma Prieta	7.1	University of California, Berkeley
1994	Northridge	6.8	NAHB Research Center National Institute of Standards and Technology
2000	Yountville/Napa	5.2	Stanford University

Studies of earthquake damage consistently show well-anchored shear walls are a key to earthquake resistance in low-rise buildings.

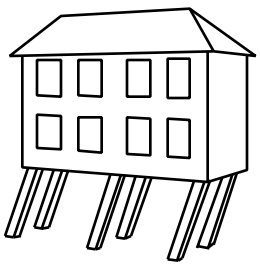
Optimal design conditions include shear walls that extend the entire height and located on all four sides of a building. Long walls are stronger than short walls, and solid walls are better than ones with a lot of openings for windows and doors. These elements are designed to survive severe sideways (in-plane) forces, called racking and shear, without being damaged or bent far out of position. Shear walls also must be well anchored to the foundation structure to work effectively. Properly installed steel reinforcing bars extend across the joint between the walls and the foundation to provide secure anchorage to the foundation.



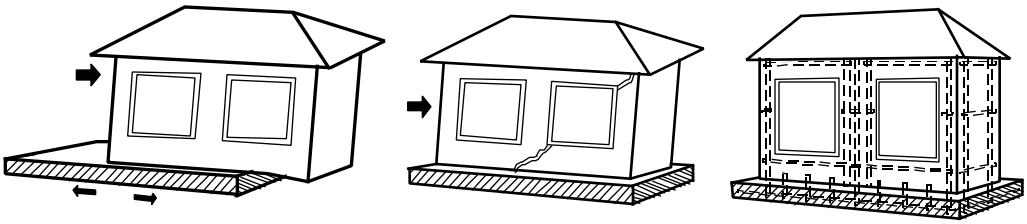
Why buildings fail

Low-rise buildings most vulnerable to earthquakes do not have the necessary stiffness, strength, and ductility to resist the forces of an earthquake or had walls that were not well anchored to a solid foundation, or both. Three types of buildings sustained the most significant damage:

Multi-story buildings with a ground floor consisting only of columns. Most of these buildings were 3 to 4 stories tall with a parking garage or a living area with many large windows on the ground level. The columns may have been strong enough to hold up the structure, but did not provide an adequate amount of racking resistance during a seismic event. When the earthquake shook the building side-to-side, the upper stories sometimes tipped over to one side. Whether built of wood, steel, or concrete—they all suffered damage.

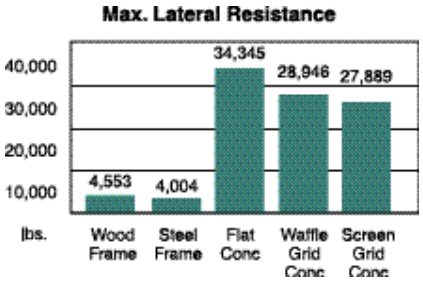


Wood-frame houses with weak connections between the walls and foundation. Wood-framed buildings are inherently ductile (flexible), which is an attribute during an earthquake. However, the shaking sent some of these houses sliding to one side. Frequently, the shear walls were strong enough, but the connection to the foundation was a weak point that gave way.



Un-reinforced masonry or concrete buildings. Masonry or concrete walls not reinforced with steel bars were not ductile enough to be effective shear walls. And if there is no steel connecting them to their foundation, the joint between walls and foundation can be a weak point.

Why reinforced concrete is safe



Reinforced concrete walls are a composite system: Concrete resists compression forces, and reinforcing steel resists tensile forces produced by an earthquake. The concrete is cast around the bars, locking them into place. The exceptional ductility of the steel to resist tensile forces, coupled with the rock-like ability of concrete to resist compression, results in an excellent combination of the three most important earthquake resistance properties: stiffness, strength, and ductility. A study at Construction Technology Laboratories revealed that even a lightly reinforced concrete shear wall has over six times the racking load resistance as framed wall construction.

It's no wonder that modern reinforced concrete buildings were found to survive these recent earthquakes with rarely any significant damage.

What's the bottom line?

Studies have shown that properly designed reinforced concrete walls offer greater earthquake resistance than other types of residential construction. When building a house in areas of high seismic risk, always follow good design practice. Make sure the exterior walls are properly designed and constructed —relatively continuous, unbroken walls of stout construction that includes reinforcing steel. Install strong, durable connections of these walls to the foundation. Adhering to these principles will help to ensure your house is a "Beautiful Home—Built to Last".

More Information?

Concrete Homes:
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