Steel Framing Alliance™
Steel. The Better Builder.
VOL. 1 ISSUE 2

PERFORMANCE OF STEEL FRAMED HOUSES DURING AN EARTHQUAKE

Earthquakes are one of the most destructive forces in nature. In recorded history, single seismic events have altered the course of major rivers, erased land masses from the map, and devastated man-made structures within a considerable distance of the earthquake epicenter. Frequently, earthquakes also produce additional hazards such as tidal waves (tsunami) and fire caused by damage to the infrastructure of a populated area. The inevitable consequence of any major seismic event is the loss of life.

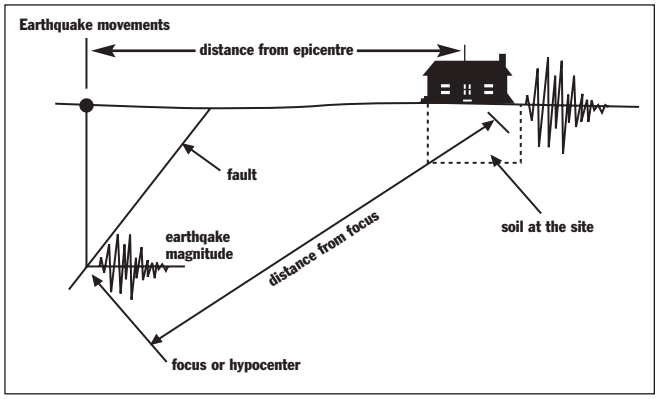
Improvements to design and construction methods in the United States over the past 50 years have helped make the modern home a safer habitat during an earthquake. One of them, the use of light gauge steel framing, offers very real advantages over traditional wood framing should an earthquake strike.

What Happens to a House During an Earthquake?

The earthquake (seismic) forces that can destroy a house are produced by strong and erratic side-to-side and up-and-down movements in the ground (see Earthquake movements). Structural damage is typically caused by "inertia", or the reluctance of the upper portions of a structure to begin moving once the ground has shifted, and then conversely, to stop moving once the structure has begun moving.

When the earth shifts sideways, the effect of inertia on a house is similar to that experienced by players in the game "crack the whip." If the movement is vertical, inertia causes the structure to be compressed as the earth rises and "telescoped" as the ground stops moving.

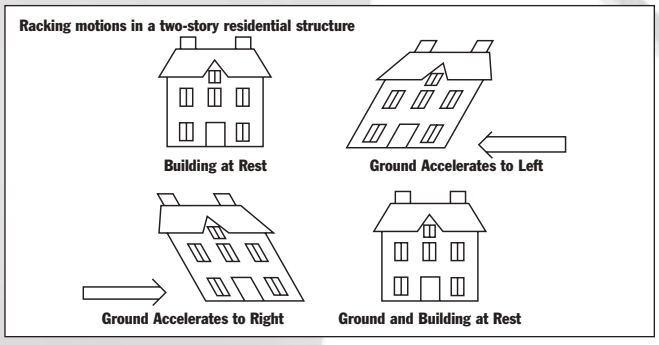
Homes are designed to resist the stresses of inertia by absorbing the energy that is produced by earthquakes. This is commonly accomplished by allowing the structure to "flex" with the ground movement in varying degrees, depending upon the material used to build the house, design of the structure, quality of construction, level of engineering, and the applicable building code.



Engineering a House for Earthquakes

Houses framed with either wood or steel rely on the same basic design concept. Induced lateral forces, such as those produced during an earthquake, subject the structure to sliding and "racking" (see Racking Motions in a two-story residential structure). To control this motion, the roof and floors must be tied to the walls all the way down to the foundation. In addition, "racking" must be limited to tolerable levels. The roof and floor between stiff walls (those designed to limit racking) must be designed to limit motion and transfer loads to the walls and, ultimately, the foundation.

Since the lateral forces are primarily generated at the floor and roof levels, walls will tend to "uplift" and "overturn". This is controlled by tying the walls together to reduce uplift forces and ultimately fastening the walls to the foundation.



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Light Gauge Steel Construction

Most regard light gauge steel framing as a modern concept, although it has been used in both residential and commercial construction for many decades. So, while steel framing has recently become a viable contender in the home building industry, it has a reliable track record over an extended period for consistent performance as a structural material. There is no difference between the appearance of a home framed with light gauge steel and one framed with wood. Rather, the most significant difference between a steel framed house and another framed with wood is determined by how well the framing material can provide long-term, consistent performance; for example, sagging roof lines typically found in an older wood framed home are not evidenced in steel framed homes.

Advantages of Light Gauge Steel in an Earthquake

Earthquakes are unpredictable in terms of magnitude, frequency, duration, and location. Consequently, the ideal structure to withstand earthquake forces will behave in a consistent and predictable manner. Unlike wood, light gauge steel is capable of meeting this standard due to the strict process used to manufacture steel studs, the inherent properties of steel, and typical construction methods used in steel framing.

Specific advantages offered by the use of steel framing in a seismic event include the following considerations:

1. Steel is a stable material with consistent chemical attributes. Once the steel stud has been formed, it will remain straight with virtually no change to the thickness, width or other dimensional properties. Once a tree is harvested, on the other hand, the wood immediately begins to dry and shrink. This continues to a lesser degree after the stud is processed, but can be seen as the lumber warps, twists, or bows. Inconsistency in the quality of wood in an individual stud also can result in cracks or weak spots in a stud.

2. Because the material and geometric properties of a steel framing member are stable, the overall strength of the structure will depend upon the quality of connections between the studs. Steel framing typically uses screws that provide a mechanical locking connection. Wood framing connections are made with nails that rely on friction and bending. As the wood dries and shrink over time, the amount of friction holding the nail into the wood declines.

3. Steel has a significantly higher strength-to-weight ratio than wood. A steel frame is typically one-third the weight of a wood frame. Consequently, damage through "inertia" will be significantly reduced since there is less weight to move during an earthquake, and less weight that must stop.

4. The building codes used in the design of steel framed walls are based on more rigorous testing procedures put into place after the recent California earthquakes of the last decade.

5. Steel framing is more likely than wood to maintain its structural integrity over the long-term because it is impervious to rot, termites and other pests that can slowly degrade the structural integrity of framing members, lessening the ability of a house to withstand seismic forces.

6. Steel is non-combustible and does not contribute fuel to the spread of a fire. This can be an important factor should an earthquake's devastation produce fires, similar to that experienced in both the 1906 San Andreas and 1989 Loma Prieta events in California.

SUMMARY

The purchase of a home is the single largest investment that most people will ever make. As a result, structural and non-structural problems during the life of a house can be both financially and emotionally draining. In California, where earthquakes are more frequent and violent than anywhere else in the United States, the prudent homeowner will take necessary precautions to protect against loss. Building with steel should be considered at the top of the list.

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