

Presentation Title

Evolution of Lateral Design in the United States

Speakers

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Abstract

This presentation will explore the design profession's evolving understanding of lateral design. It will show how the US building codes' handling of seismic and wind forces has changed over time, often in response to extreme events. The talk will also discuss how historic buildings are treated with the latest standards and codes.

Prior to the 20th Century most buildings in the US were designed without an explicitly defined lateral force resisting system. Regardless of the original designer's intent the gravity systems, such as load bearing masonry walls, often served to resist wind and seismic forces.

In the late 1800s research into wind loading began in Europe, in part in response to the 1879 Tay Bridge failure. Early research on wind was focused on bridges, but in the early 1900s this research was applied to buildings as well. During the early 20th century little consensus existed in the design profession regarding the lateral forces that needed to be resisted and the most efficient details of construction. Some of the high-rise buildings from the time incorporated significant 'wind' frames, while others ignored lateral forces altogether. Lateral provisions were typically only considered for buildings over 100 feet, which meant lateral bracing was rarely considered outside of large cities. Starting in the 1910s provisions to account for wind pressures were included in building codes of cities like New York, Philadelphia, Chicago and Baltimore. In recent decades extreme wind events such as Hurricane Andrew in 1992 have had a profound impact on wind loadings and analysis in the US.

Surprisingly, the 1886 Charleston Earthquake and the 1906 San Francisco Earthquake produced little in the way of code requirements to address seismic forces. Outside the US, engineers in Italy and Japan were just starting to consider earthquakes. It wasn't until the 1920s that seismic requirements started to appear in building codes in California. It would take until the early 1990s for model building codes across the United States to include seismic design requirements. The 1989 Loma Prieta and 1994 Northridge Earthquakes continued to provide engineering lessons and further refine seismic requirements. In recent years seismic standards in the US have started to move away from prescriptive requirements and towards performance-based design.

The presentation will draw upon lateral assessments and retrofits performed for a wide variety of existing buildings to discuss how to best improve building resiliency for such buildings today. Case studies will be used to show how best address wind and seismic requirements; the non-confirming rights of historic buildings, the thresholds in various international building codes that trigger a lateral evaluation, and the benefits of a performance-based approach when dealing with existing structures. Specific case histories will be drawn from pre-eminent existing buildings in the United States—including National Historic Landmark structures. Specific examples of lateral analysis and retrofit of such buildings will illustrate the need to carefully balance between preserving historic fabric and protecting building occupants in the event of extreme lateral load events.