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Understanding earthquake retrofit strategies

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When you listen to local talk radio, read the newspaper or surf the internet, have you noticed the surge in ads from contractors offering to “earthquake retrofit” your home or place of business? Earthquake preparedness is “in” these days, with a growing number of opportunities to buy emergency supplies and to improve the seismic resilience of buildings. Some contractors have seized upon this renewed interest in earthquake preparedness and now make themselves available to implement seismic upgrades to existing buildings. However, before you undertake a seismic upgrade project, understand what you are, and are not, getting for your building investment.

Two types of seismic upgrade methodologies

A seismic upgrade of an existing building can be approached from one of two methodologies: 1) a prescriptive, or “rule of thumb,” approach, or 2) an engineered approach. Understanding the differences between these approaches is essential to making an informed decision when contemplating a seismic upgrade of your home or place of business.

Prescriptive seismic upgrades

The prescriptive, or “rule of thumb,” seismic upgrade methodology is typically completed by a contractor without the involvement of a structural engineer. This approach is typically characterized by actions taken by the contractor intended to mitigate building deficiencies that have been routinely manifested in past earthquakes. The most common work undertaken is the installation of anchors between the building’s walls and the building’s foundation. Other common actions include strengthening the connections between readily accessible posts, beams and similar structural framing. Often this work is limited to a basement or crawlspace, with little or no work occurring above the foundation. The contractor’s efforts are often guided by standard procedures, or a “checklist” of routine actions. A prescriptive seismic upgrade usually offers minor customization for a specific building, with the same types of work occurring from building to building; a “one size fits all” approach. The contractor assumes responsibility for the identification of seismic deficiencies and the implementation of the appropriate upgrades, though a prescriptive upgrade often requires relatively little judgment to be exercised. At the completion of the project the building structure is deemed more earthquake resilient. However, the building structure cannot necessarily be represented as compliant with specific code standards, nor can the improvement in seismic resilience be readily quantified. The nature and extent to which additional seismic deficiencies, if any, are present elsewhere in the building remains undefined.

Engineered seismic upgrades

The engineered seismic upgrade methodology requires the involvement of a structural engineer to analyze the building (both visually and computationally), identify building-specific seismic deficiencies and develop corresponding seismic rehabilitation measures. The entire structure “load path” – from the foundation to the roof – is analyzed and critiqued. Breaks, or weaknesses, in the seismic load path become targets for tailored seismic strengthening. Because each building is structurally unique, the resulting scope of seismic upgrades is customized to that building. An engineered seismic upgrade also considers the known seismicity of the area in which the building is located,

can account for the stability of the soils below the foundation, and contemplates the geometry, configuration and detailed characteristics of the construction of the building. The identification of seismic deficiencies is guided by engineering codes and standards for seismic upgrades and a structural engineer's experience and judgment. Corresponding seismic upgrades, the result of engineering analyses, are developed to render the structure compliant with national standards for seismic upgrades. Following an engineered seismic upgrade, the building is deemed capable of providing a defined level of seismic safety. A set of formal construction plans, specifications and engineering calculations are prepared by a structural engineer for procuring building permits, soliciting contractor bids and directing construction activities. Unforeseen conditions encountered during the construction phase, a common occurrence in most renovation and seismic upgrade projects, are addressed by the structural engineer via supplemental guidance provided to the contractor.

Pros and cons of the prescriptive upgrade method

Prescriptive seismic upgrades offer an economical and efficient means of incrementally improving the seismic resilience of a building. The lower cost of a prescriptive seismic upgrade allows a larger number of building owners to initiate a seismic upgrade project. The scope of the seismic upgrade work is usually limited to readily accessible areas of the building, allowing occupancy of the building to continue while construction work is underway. The limited scope of a prescriptive seismic upgrade also allows the project schedule to be shortened. A prescriptive seismic upgrade often is sufficient for some insurers to make earthquake insurance, or reductions in other insurance product premiums, available to the building owner.

The prescriptive approach typically only addresses building deficiencies, as perceived by the contractor, at or below the foundation level. The balance of the structure, where additional seismic deficiencies are likely present, is not addressed. Depending upon the structural characteristics of the building, the portions of the building above the foundation remain prone to earthquake damage. The prescriptive "rule of thumb" approach does not consider a building's unique structural characteristics, local seismicity or soil conditions. Though the project is perceived to have benefited the building, the future seismic performance of the building cannot be quantified or predicted. Without the involvement of a structural engineer, the contractor is tasked with tasks that typically involve a structural engineer, such as the identification of deficiencies and the development of the corresponding upgrades. While some contractors may engage a structural engineer on a limited basis, this is not a typical practice.

Pros and cons of the engineered upgrade method

An engineered seismic upgrade represents a comprehensive, customized and quantifiable methodology. The unique structural characteristics of the building, the surrounding soils and the local seismicity are considered and incorporated into the design of the upgrades. An engineered seismic upgrade can even allow the building owner to customize the level of seismic protection that is appropriate for their building and its use; that level of protection can even be varied for different earthquake sizes. For example, the owner of an ordinary office building may choose a level of seismic upgrade characterized as “life safe” for smaller, more frequent earthquakes, and “collapse prevention” for larger, less frequent earthquakes. However, the owner of a building that houses a business that cannot easily tolerate post-earthquake downtime may choose an enhanced seismic upgrade objective of “immediate occupancy” for smaller, more frequent earthquakes, and “life safety” for larger, less frequent earthquakes. The ability to consider and quantify these issues is unique to the engineered upgrade methodology.

The benefits of an engineered seismic upgrade come with a cost. The professional fees associated with an engineered seismic evaluation and upgrade of a building typically exceeds the total project costs of a prescriptive upgrade. The construction costs to implement the engineered upgrades will often far exceed the prescriptive upgrade construction costs. Many, if not all, portions of the building may be affected, and the construction duration will be extended. While some of the construction work can be completed in phases, there may be disruption to the occupancy of the building during the implementation of the engineered upgrades.

Choose carefully

Seismic risk in the Pacific Northwest is real and affects all building and home owners. For many building owners, a seismic upgrade represents a prudent investment. When considering a seismic upgrade project, identify your long-term objectives and budget, then choose the seismic methodology that best suits your circumstance.

Brandon Erickson, PE, SE is principal of Erickson Structural Consulting Engineers PC. His practice focuses on structural assessment, rehabilitation and renovation of existing buildings. He can be reached at brandon@ericksonstructural.com or 360.571.5577.