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Updating Earthquake Engineering Standards

By John Burrows and Jim Gallagher

This is the fourth in a series of articles intended to inform readers of On Site about important changes to the national model building codes, which will be released later this year.

New earthquake engineering requirements will be introduced in the 2005 version of the National Building Code of Canada (NBC) to refine the way seismic design is done. The changes address the differing seismic behaviour on the eastern and western sides of the continent, incorporate new findings about the role the soil plays in a building's response to an earthquake, and for some cases, mandates a more precise design approach known as dynamic analysis where previously its use had only been recommended. Earthquake-resistant design attempts to provide a structure, its foundation, and its contents with the strength and deformation characteristics necessary to enable it to survive the design earthquake. Although it is theoretically possible to design a structure to be "earthquake proof," implying no damage or malfunction under the maximum predictable ground motions, this would be prohibitively expensive. Instead, the design philosophy for ordinary buildings is to guard against total collapse and consequent loss of life but accept the possibility of some damage.

Exposure to earthquakes varies across Canada. The seismic risk map of Canada guides those concerned with the design and construction of buildings by establishing seismic risk zones in terms of probable severity of ground motion that may occur in future earthquakes. As the Prairie Provinces have a record of limited seismic activity and thus the probability of damage in a future earthquake is very low (Zone 0), the changes to seismic design will mostly affect the other regions of Canada. It is estimated that seismic requirements in Vancouver and Victoria are four to five times what would be dictated in Ontario, while seismic requirements would be negligible in much of Alberta, Saskatchewan and Manitoba.

Past versions of the NBC have permitted seismic design for buildings based primarily on static analysis, which uses an approximation based on studies of typical buildings to calculate the forces acting upon a structure. The committee developing proposed technical changes for the 2005 NBC recommended a more detailed and complex method as the default method for evaluating earthquake loads, called the dynamic analysis procedure. This method has been adopted internationally and provides a more accurate analysis of high or complex buildings than the previous static analysis. However, the 2005 Code provisions make allowance for the use of static analysis for most buildings in areas of low seismicity, and for buildings meeting certain configuration and design restrictions in higher seismic areas.

Static analysis is a calculation-based design procedure that makes assumptions about how a building will react to earthquake forces. Dynamic analysis makes use of computer software to more accurately predict the oscillations the elastic properties of a building

will cause as a result of earthquake loads. For those engineers and building officials not familiar with dynamic analysis, some training may be required when the new seismic design requirements come into effect.

Since designers of tall buildings in British Columbia already are familiar with dynamic analysis, the new requirements regarding its use are more likely to affect engineering practices in urban centres located in the most active seismic zones in eastern Canada.

The new provisions will have a more significant impact on post-disaster buildings (hospitals, power stations, etc.) than on residential, commercial and other buildings, and may result in direct and indirect costs to municipal building officials, structural engineers and geotechnical engineers.

As builders know, changes to the building code generally have greater repercussions for renovation projects than for new construction. Costs mount when new elements like upgrades for fire exits, sprinklers, universal access requirements, and seismic strengthening have to be retrofitted into a structure that was not built to accommodate them. An earlier article in On Site (March/April) described the introduction of an objective-based format in the 2005 NBC. Builders can follow the methodology set out in the code, or they can propose an alternative approach that will result in an equivalent level of performance.

The 2005 NBC changes to the way buildings are designed to resist earthquakes will have the greatest effect for certain types of buildings in eastern Canada. The use of dynamic analysis as the default design method will result in a more accurate analysis of complex buildings than the older static analysis and will bring Canadian seismic design methods in line with international technological advances.

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