6th International Conference on Advances in Experimental Structural Engineering
11th International Workshop on Advanced Smart Materials and Smart Structures Technology
August 1-2, 2015, University of Illinois, Urbana-Champaign, United States

Seismic Response and Design of Steel Building Structures with X-braced Frames of the Conventional Construction Category

Robert Tremblay*

* *Presenting Author*

Corresponding Author: Robert Tremblay
Contact Email: robert.tremblay@polymtl.ca

ABSTRACT

The National Building Code of Canada includes seismic design provisions for a number of seismic force resistance systems for steel buildings. Most systems must be specially designed an detailed such that they can withstand the seismic demand through ductile response. Conversely, the Conventional Construction (Type CC) category essentially relies on the inherent ductility of steel and friction anticipated in typical steel framing construction to dissipate the seismic input energy and achieve proper response. Capacity design is not required for this category but the ductility-related force modification factor is limited to 1.5. In moderate and high seismic zones, higher design loads are specified for the connections if the governing failure mode is not a ductile one. This category is preferred by design engineers for low-rise moment frames and concentrically braced steel frames as it represents a much simpler and less expensive solution, in spite of the higher seismic loads, compared to the more ductile systems.

The article summarizes recent experimental and numerical studies that have been performed to assess the seismic performance of Type CC X-braced frames for low-rise buildings. Connection test data are used to evaluate and compare the ductility capacity of typical connections used for bracing members. Results from cyclic quasi-static tests carried out on individual bracing members and complete X-bracing assemblies are presented to describe overall response and expected possible failure modes. The development of detailed numerical modelling of braced steel frames is also presented with focus on brace inelastic axial response and connection failure modes including low-cycle fatigue failure. The use of the numerical model for the hybrid simulations of the collapse response of multi-storey braced frames is described. Results from nonlinear response history analysis of low-rise buildings with Type CC X-bracing are examined, and modifications to current design procedures are proposed to improve the system seismic performance regarding brace connection failure. In this part of the article, differences in the seismic demand anticipated in eastern and western regions of North America are also discussed. In the last section of the article, the buckling response of braced frame columns under seismic induced axial force demand is examined with reference to full-scale testing of I-shaped columns subjected to cyclic axial loading.

KEYWORDS: *bolted lap splice connections, earthquakes, low-cycle fatigue, numerical modelling, X-bracing*