Seismic Performance of Perforated Steel Plate Shear Walls Designed According to Canadian Seismic Provisions

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Abstract

Perforated Steel Plate Shear Wall (P-SPSW) is a relatively new lateral load resisting system. Research on P-SPSW is in the initial stage, and to the best of these researchers' knowledge, no seismic performance of code designed P-SPSWs has been studied yet. The main objective of this study is to evaluate the seismic performance of code designed P-SPSWs. Three multi-storeys (4-, 8-, and 12-storey) P-SPSWs were designed according to the seismic provisions of NBCC 2010 and CAN/CSA S16-14. Nonlinear time history (NTH) analysis was conducted using detailed finite element (FE) modeling techniques for a series of ground motion records which were compatible with Vancouver response spectrum. All the perforated shear walls exhibited excellent seismic behavior including high stiffness, stable ductility, good energy dissipation capability and also current code equation provides a good estimation of the shear strength of the perforated plate when the infill plate is fully yielded. The applicability of the modified strip model (MSM) was also evaluated in this research for unstiffened P-SPSW. It was observed that the modified strip model captures the inelastic behavior of multi-storey unstiffened P-SPSWs with adequate accuracy. The ultimate strength was predicted well, and the initial stiffness was slightly underestimated.

Keywords: Lateral load resisting system, Nonlinear time history analysis, Response spectrum, modified strip model.

1 Introduction

Over the last two decades, unstiffened steel plate shear walls (SPSW) has become a popular and efficient lateral load resisting system in North America and Japan. High initial stiffness, excellent ductility, and energy dissipation capacity and tremendous post-buckling strength make this system unique.

Taking into account the post-buckling strength in the infill plate, Thorburn et al. (1983) proposed strip model for the thin unstiffened SPSW. When designing unstiffened SPSW, it is considered that column overturning moment will be resisted by axial coupling loads and storey shear will be resisted by the diagonal tension field in the infill plate. Often, from practical availability and to meet welding and handling requirement, minimum infill plate thickness being used is thicker than the required plate thickness. The larger infill plate results in large demand in the boundary members which consequently increases member sizes and cost of the project.

Recently few recommendations have been made by researchers to alleviate this problem. These are: use of light gauge cold-formed steel plate instead of hot rolled (Berman and Bruneau 2005), connect the infill plate only with floor beams, use of circular perforations (Vian 2005; Purba 2006). Among these alternatives, perforated SPSW has drawn more attentions from the engineering community because the perforated system can accommodate passing of utilities like electric lines, water pipes, etc. through the infill plate. Also,

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