STIFFENER REQUIREMENTS IN STIFFENED STEEL PLATE SHEAR WALLS

Ahmad RAHMZADEH
Earthquake Engineering Graduate Student, School of Civil Engineering, College of Engineering, University of Tehran, Tehran, Iran
a.rahmzadeh@ut.ac.ir

Mehdi GHASSEMIEH
Associate Professor, School of Civil Engineering, College of Engineering, University of Tehran, Tehran, Iran
mghassem@ut.ac.ir

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The 35-story Kobe City Hall tower that showed a good performance during the 1995 Kobe earthquake can be mentioned as a practical application of stiffened steel plate shear walls as a lateral load resistant structural system. During the 1970's, as first practices, steel plate shear walls (SPSWs) were used along with stiffeners, since out-of-plane buckling of infill panel used to be considered as the design limit state for them. Laboratory tests conducted by Takahashi et al. (1973), on plates with various thicknesses and different stiffener dimensions, indicated that by effectively reinforcing the shear panel, hysteresis loops of an SPSW can be transformed from s-shaped to spindle-shaped (Figure 1). This transformation increases the area under the hysteresis loops which increases the energy dissipation of the wall and simultaneously improves its performance.

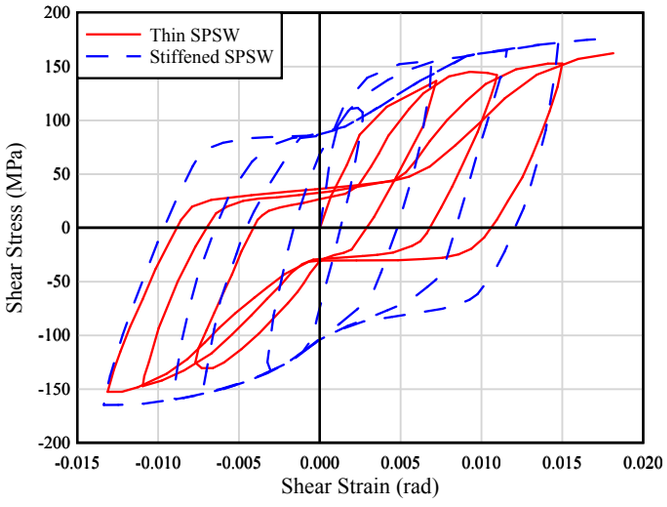

Figure 1. Thin SPSW and Stiffened SPSW specimen hysteresis curves (Takahashi et al., 1973)

Key researches in the 1980's showed that the post-buckling strength and ductility of thin SPSWs, which is provided by the formation of a diagonal tension field, can be substantial (Thorburn et al., 1983; Timler and Kulak, 1983; Tromposch and Kulak, 1987). These findings lead the researchers and designers, especially in the United States and Canada, to turn their attention to thin SPSWs on the account of their being more economical in comparison with stiffened SPSWs.

Yet general belief is that in order to improve buckling stability of infill steel plate, it is required to use heavy stiffeners, which leads to uneconomical design. This paper investigates the influence of stiffener rigidity on structural behavior of SPSW. It will be demonstrated that in some cases, Plate girder equations and orthotropic plate solution used to determine

the minimum required moment of inertia of stiffeners are not applicable to stiffeners in SPSW. Thereafter by means of finite element analyses (FEA), new graphs for designing stiffeners in various practical configurations are proposed and the requirements presented in American Institute of Steel Construction (AISC) Steel Design Guide 20 (Sabelli and Bruneau, 2007) are amended as well. In the end the results of this study will be compared to the laboratory test results obtained in prior studies.

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