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Experimental and Numerical Research on Steel Plate Shear Wall with Infill Plate Connected to Beam Only

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Abstract

Steel plate shear walls consist of thin infill steel plates attached to beams, called (horizontal boundary elements, HBEs), and columns (vertical boundary elements, VBEs) in structural steel frames. The thin unstiffened web plates are expected to buckle in shear at low load levels and develop tension field action, providing ductility and energy dissipation through tension yielding of the web plate. HBEs are designed for stiffness and strength requirements and are expected to anchor the tension field formation in the web plates. VBEs are designed for yielding of web plates and plastic hinge formation at the ends of the HBEs. This design approach may result in very large demand on boundary frame members, especially VBEs in most cases. Several methods such as using LYP, perforating the infill plate and omitting connection of infill plate to columns have been proposed to reduce the moment and axial force demands on the VBEs. Study the behavior of steel plate shear walls omitting the connection of infill plate and columns is the main purpose of this research. A classic analysis base on PFI method along with quasi static cyclic experimental study has been performed in order to investigate the behavior of such a system. The results of the experimental study are used to verify numerical models. Behaviors of proposed system (overall capacity and initial stiffness) were compared with those of the conventional SPSWs. Results show that both parameters are reduced in comparison to the conventional SPSWs.

Keywords: SPSW; Hystertic Behavior; Ultimate Capacity; Initial Stiffness.

1. Introduction

Steel plate shear walls (SPSW) are lateral load resisting systems which are used in regions of high seismicity. A typical SPSW consists of infill steel plates connected to the beams, known as the horizontal boundary elements (HBEs); and to the columns, as the vertical boundary elements (VBEs). The infill plate connected to the surrounding beams and columns, buckles in shear at low lateral loads and develop a diagonal tension field that induces sever stresses on the surrounding frame members. From the numerous investigations conducted worldwide, it has been shown that SPSWs have many advantages such as high initial stiffness and ultimate shear strength, substantial ductility, fast construction, reduction of seismic mass and increased useable floor plan. The overall building cost of SPSW structures is also shown to be reduced in comparison with other lateral load resisting systems [1-8].

Many previous experimental and analytical studies have shown that using of web plates with minimum available thickness larger than required for resisting specified lateral loads may also result in excessive design forces to the HBEs and VBEs, thus increasing their size. Column flexural demands result from the development of the tension field in the infill plate (pull-in forces) and from the frame action of the boundary moment frame. Column axial demands result primarily from resisting the overturning moment that can be large for multi-story SPSWs, Column axial demands is also the result of infill plate pull in forces vertical component. As a result, there exists concern about VBEs high demand that

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