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Analytical study on the effects of orientation and thickness of FRP in the semi-supported steel shear walls reinforced by FRP

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Abstract

Semi-supported steel shear walls (SSSW) are lateral load resisting systems. In this new type of steel shear walls, the shear wall was not connected directly to the main columns; instead it was connected to the secondary columns that is not under gravity loads and which are used for tension field in plate. For reinforcement and improvement of behavior of semi-supported steel shear wall, fiber reinforced polymers (FRP) can be used. In this research, nonlinear behavior of composite semi supported steel shear walls (CSSSW) were resisted by the fiber reinforced polymers (FRP) were studied. The seismic performance factors in the proposed system, were evaluated the effects of FRP's orientation and FRP's thickness. The results showed that, installation of FRP increase energy dissipation capacity and ultimate strength. In addition, thicken FRP layers up to optimal amount improved composite semi supported steel shear walls (CSSSW) behavior.

Keywords: Semi-supported, Steel Shear Wall, Composite, Energy Dissipation

1. INTRODUCTION

The use of steel plate shear (SPSW) walls as a lateral load resisting system with high seismic performance have attracted great interests in all over the world [1]. A SPSW is similar to a plate girder that is placed vertically and is expanded in the total height of the building. High elastic stiffness, high ductility and stable hysteresis loops are some of the desirable characteristics of SPSW system. In the traditional type of SPSW, the post-buckling behavior of the plate induces severe stresses on the columns. Accordingly, to prevent columns from plastic deformation and collapse of the structure, large strong columns should be used. This may lead to abnormal and non-economical columns [2]. Generally the system has been proposed that named semi-supported steel shear wall (SSSSW) in order to protect the primary columns under extreme demands and to improve the overall seismic performance. The system can be used for rehabilitation of steel structures as well as for excellent lateral load resisting systems [3]. Recent studies show that fiber reinforced polymer (FRP) laminates are effective to enhance load-carrying capacity of damaged or sub-standard steel structures by increasing strength, stiffness and even ductility of steel structural elements. FRP layers have a linear behavior until failure, so it can increase initial stiffness and ultimate strength of system [4].

This report attempts to provide information on the seismic characteristics of composite semi-supported steel shear wall (CSSSSW). The results shows that FRP laminates increase shear force capacity of SSSSW; also improve the system behavior and enhancement the ductility.

During the last two decades, extensive investigations have been carried out on the modeling and seismic behavior of CSSW in North America and Japan. Timler and Kulak [5] and Driver et al [2] performed tests on SPSW under monotonic and cyclic loadings. Their results showed good ductility and high lateral strength of this system. Studies by Astaneh-Asl [6] on the ordinary steel and composite shear wall of two samples of three-story, at a scale of 1-3, under cyclic loads, have shown that the concrete layer produces a better distribution of stress in the steel plate, developing tension field lines in a wider region. Nateghi and Khazaei[4] investigated nonlinear behavior of strengthened steel plate shear wall by FRP laminate. Xue and Lu [7] studied the behavior of some finite element models of SSWs when some of them do not connect to the