AN ANALYTICAL MODEL FOR STEEL SHEAR WALL STRENGTHENED WITH CFRP USING COMPOSITE THEORY

Majid GHOLHAKI
Assistant Professor, Semnan University, Semnan, Iran
mgholhaki@semnan.ac.ir

Younes NOURI
M. Sc Student, Ferdowsi University, Mashhad, Iran
Nouri.Younes@stu.um.ac.ir

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ABSTRACT

In this paper steel plate shear wall strengthen by Carbon Polymer's Fiber was studied. An equation has been proposed for elastic strength using composite theory and maximum work failure model, and another equation has been obtained for elastic displacement related to polymer's fiber using virtual work principle. Considering fibers and shear wall web as a layer and super positioning plate and fiber behavior, composite shear wall model was achieved. Optimum fiber orientation angle for composite shear wall was in diagonal tension field. Finite element values via presented model was compared with and concluded that the offered model can predict composite shear wall in close range.

INTRODUCTION

Steel shear wall can significantly tackle and tolerate lateral loads due to wind and earthquake through diagonal tension field of steel plates confined between boundary elements of system (Astaneh –Asl 2001). The first philosophy of steel shear wall design was based on preventing global buckling in plate, however, it was later seen that most of post shear strength of shea r wall was achieved after buckling of plate (Wagner 1931, Takahashi 1973). These shear walls were initially utilized as a retrofit system, however, after their good performance was approved, they were applied as a structure system. Some advantages of this system are high ductility, energy absorption, stiffness and strength, on contrary the disadvantage of this system is low elastic strength of steel walls. To improve shear performance of steel shear walls, adding vertic al and horizontal stiffeners (Takahashi 1973), low yield point plate materials (Kharrazi 2005), strengthening with concrete (Vian 2004, Rahai 2009, Arabzadeh 2011), perforated web plate (Vian 2004) and covering steel plate with FRP materials (Hatami 2012, Nategh-Alahi 2012, Rahai 2011) have been studied. Due to light weight, high elasticity module and high tension strength, FRP materials have a wide application in civil engineering. Covering plate with FRP increases the shear strength, energy absorption, excessive post buckling field distribution and stiffness of shear wall. So far, configuration of fiber orientation, behavior and seismically parameters of composite steel shear wall have been evaluated by numerical and empirical methods (Nateghi-Alahi 2012) and yet no explicit analytical method has been presented, but experimental and numerical studies absolutely depend on dimension and mechanical properties of steel and FRP. Two major analytical methods have been presented for analysis of steel shear wall that are stripe model (Thorburn 1983) and plate and frame interaction (Roberts 1991). Plate – frame interaction in most cases yields the precise values. In Rahai and Hatami (2012), some specimen strengthened with CFRP layers have been studied and in these experimental tests, fiber orientations, thickness of CFRP and shear wall dimension under cyclic loading were evaluated. Finally, some equations were proposed for nonlinear behavior of CSSW using elastic analysis. In Rahai and Alipour (2011) evaluated the ductility, stiffness, yield shear force factors under push over analysis as well as thickness of FRP layers and conclude that in diagonal tension field,