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NUMERICAL STUDY AND NONLINEAR MODEL OF THE EFFECT OF GUSSET-REINFORCED STIFFENER ON THE STEEL PLATE SHEAR WALLS WITH OPENING

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The shear-plate steel wall (SPSW) is being nowadays used in the seismic design and retrofitting due to its advantages as a robust lateral load-bearing system. The high amount of absorbed energy, large load-bearing capacity, and post-buckling behavior of SPSW are central in the nonlinear behavior of a system. Significantly high strength and stiffness of the system lead to controlling over the lateral displacement of the structure, assuring the proper performance under medium lateral loads. Ductility of steel plate in SPSW results in the appropriate performance once the structure is subjected to severe seismic loads. The main benefits of using SPSW include a reduction by 50% in the steel consumption compared to bending steel frame and the possibility of installing openings at any point in SPSW. Regulations have been presented in previous studies and different standards, including Canadian steel structure design standard and FEMA450, for the design of SPSW. In recent years, the regulations on the special design of SPSW have been added to the standards of steel structure seismic design AISC341 and ASCE7. Among the recent studies, one can refer to the research on SPSW with Combination of Angular and circular openings conducted by (Jalali, 2016) and the numerical study on stiffened steel plate shear walls with central perforation conducted by (Nezamisavojbalaghi and Gharani, 2017). The present study numerically investigates the seismic behavior of SPSW with circular opening equipped with gusset-reinforced stiffeners, which have been rarely addressed in previous studies. Nonlinear stiffness is considered in numerical modeling. To validate the proposed numerical modeling, the experimental study conducted by (Alavi and Nateghi, 2013) on SPSW in the International Institute of Earthquake Engineering and Seismology, Iran, is used. Moreover, numerical models in the present study are analyzed after the validation process. Models include four specimens of single-story SPSW with the same opening in four different modes of gusset-reinforced stiffener arrangements for two different states where the gusset-reinforced stiffener is either mounted on one side or both sides of SPSW. Two models are shown in Figures 1 and 2. Numerical models with nonlinear stiffness are subjected to reciprocation loading. Subsequently, by examining pushover curves and hysteresis loops obtained for each model, seismic parameters such as strength and stiffness, ductility, and also energy absorption of panels are obtained and compared.

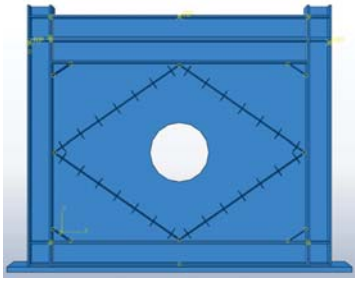

Figure 1. SPSW with rhombus-shaped gusset at a distance .1 cm from boundary components of

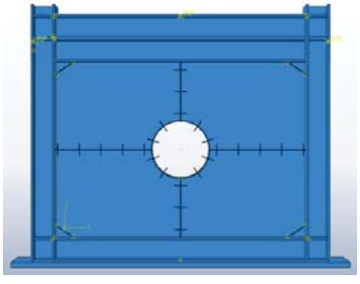

Figure 2. SPSW with vertical and horizontal stiffeners around the opening.

Figures 3 and 4 show the contours of Von Mises stresses. Besides, Figure 5 depicts the capacity curves of two SPSW models with gusset and weld (Figures 1 and 2) and the SPSW model without stiffener and opening.

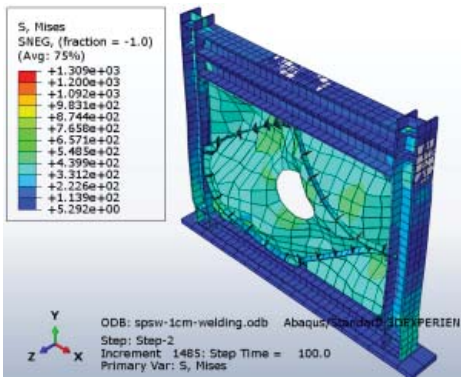

Figure 3. Contour of Von Mises stress for SPSW with rhombus stiffeners at a distance of 1 cm from boundary components.

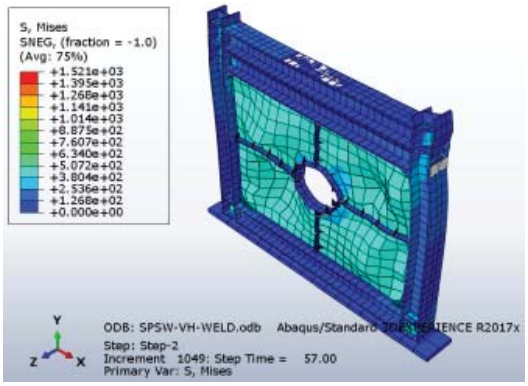

Figure 4. Contour of Von Mises stress for SPSW with vertical and horizontal stiffeners.

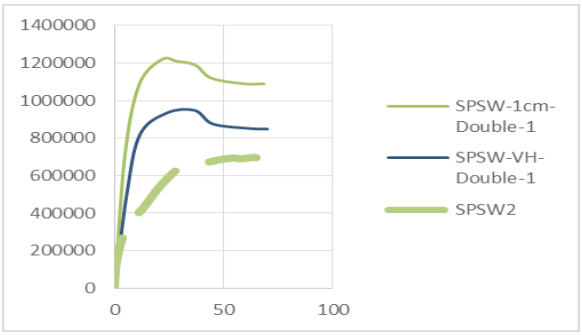

Figure 5. Capacity curves of two SPSW models with gusset and weld (Figures 1 and 2) and the SPSW model without stiffener and opening.

The analytical results of numerical models reveal that the specimen with rhombus-shaped gusset being placed at the apex of rhombus at the distance of 1 cm away from the vertical and horizontal components shows a better behavior once the stiffeners are welded back-to-back on both sides of SPSW. Furthermore, the former specimen shows a superior behavior compared to the SPSW with gusset-reinforced stiffener welded only on one side of SPSW. Due to the convenience of executing SPSW with gusset-reinforced stiffener on one side of SPSW, this model can be used to implement projects.

REFERENCES

Jalali, S. (2016). *Seismic Response of Steel Shear Walls with Combination of Angular and Circular Openings*. M.Sc. Thesis, Islamic Azad University, Mahabad Branch, Iran.

Nezamisavojbolaghi, K. and Gharani, A. (2017). Numerical study on stiffened steel plate shear walls with central perforation. *ECCOMAS*, 1419-1431.

Alavi, E. and Nateghi, F. (2013). Experimental Study on diagonally stiffened steel plate shear walls with central Perforation. *Journal of Constructional Steel Research, 89*, 9-20.