Effect of Stiffening in Behavior of Steel Plate Shear Walls

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One of the most effective ways to improve the behavior of unstiffened steel plate shear walls (SPSW) is stiffening of steel plates. Utilizing stiffeners will result in increased strength, stiffness and most significant of all, increase in the energy dissipation in SPSWs. In this numerical study, the behavior of SPSWs with various layouts of stiffeners has been investigated. Loading patterns include monotonic loads and cyclic loads. Increase in ultimate strength of the panel was obtained at about 23% and ultimate strength of the plate at about 12% in optimal stiffening of panels, implying the elimination of pinching in the hysteresis loops.
Keywords: Steel Plate Shear Wall, Stiffener, Pinching, Hysteresis Loop

1. Introduction

Utilizing a SPSW system as a lateral load resisting system in buildings has had great significance for researchers and designers during the past three decades. This new phenomenon, which is rapidly developing throughout the world, is being used for the construction of modern buildings and perhaps rehabilitation of existing buildings especially in countries with high seismicity rate such as the United States of America and Japan [1]. With regard to the high strength of steel plates, in order to make use of its post buckling strength, even in high SPSWs, and for large shear loads, the required plate is very thin. Hysteresis loops of steel plate shear walls without stiffeners are S shaped. In order to improve these types of curves and increase the amount of energy dissipation (increase the surface under these loops) in SPSWs, it is possible to operate in two ways; by increasing thickness or stiffening the steel plates with longitudinal and transverse stiffeners [2]. In the initial method, which is completely uneconomical, in order to improve the hysteresis loops, the steel plate thickness is increased so the plate will not buckle prior yielding. This increase in thickness is very considerable and therefore not economical. The appropriate method for improving hysteresis loops and eliminating pinching is stiffening SPSWs with longitudinal and transverse stiffeners. By optimal stiffening of shear panels, it is possible to change the hysteresis loops from S shapes to spindle shapes. Thus, by increasing the surface below these curves, the amount of energy dissipation will increase and result in improvement of panel behavior. Also in this condition, it will prevent buckling below the plates prior yielding.

Study carried out at the beginning of the 70's by Takahashi et al. [3] is the only reliable research in stiffening of SPSWs; however it did not show process of using stiffeners in behavior of SPSWs properly. Therefore, the aim of this research is to study the process of the steel plate shear walls hysteresis loop as a one storey panel during different layouts of stiffeners; and also increasing strength in optimal stiffening in which pinching in the hysteresis loops is completely eliminated. The present research is carried out numerically and by the finite element method. Panel design carried out in the latter half of the 80's using the Plate-Frame Interaction (PFI) method was presented by Sabouri and Roberts [4,5] and Sabouri [2,6]. Designing the panels with the PFI method is such that during the loading process, foremost the steel plate and then the frame are failed. Moreover, As a result of the frame failure, plastic hinges are also formed at the outset and end of the columns.