



# The Behavior of Concrete Frames Retrofitted by Steel Plate Shear Walls in Earthquake

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## Abstract

Steel plate shear walls have been used more frequently in recent years as the lateral load resisting system in the design and retrofit of high-rise buildings. Expected low cost fabrication, speedy erection, and good energy absorbing potential make the steel plate shear wall system an attractive alternative for the seismic upgrading of existing buildings. A new structural steel lateral load building system, called the steel plate shear wall (SPSW) currently under development in Canada, United States, Japan and other countries is gaining interest for its potential application in the seismic upgrading of buildings. While SPSW system can be easily integrated into existing steel frames, its suitability in concrete frames is still in the development stage. This paper concentrates on analytical studies of steel plate shear walls added to concrete frames. First using the fiber-based finite element analysis we propose an analytical model and verify this model by several experimental results (Numerical modeling has been developed in SeismoStruct). This model has been used to compare the behavior of concrete frames with and without steel shear wall. Then we continue our investigations with a parametric study on the behavior of concrete frames retrofitted by steel plate shear wall. We study the influence of changing in parameters such as concrete and steel plate characteristics, width to height ratio of frame and etc on behavior of such frames. Based on analytical results, some design recommendations for the structural system have been proposed.

**Keywords:** Steel plate shear wall, retrofit, fiber-based finite element analysis, parametric study

## 1. INTRODUCTION

A new structural steel lateral load building system, called the steel plate shear wall (SPSW) – currently under development in Canada, United States, Japan, Taiwan and other countries is gaining interest for its potential application in the seismic upgrading of buildings. Extensive analytical studies on steel plate shear walls in the United States, Canada, Taiwan and other countries have already validated the simple analytical model known as strip model to predict the monotonic behavior of this kind of structural system. [7]. A SPSW element is essentially a thin steel in-fill panel bordered by the wide flange members of the column and beam frame. The system's lateral resistance is controlled by the post-buckling strength of the thin steel in-fill panels and the integral moment resisting frame. Extensive analytical and experimental investigations have shown that SPSW system exhibits stable hysteretic characteristics and that SPSW system can be a very effective energy absorbing lateral framing system. While SPSW system can be easily integrated into existing steel frames, its suitability in concrete frames is still in the development stage and a few experimental and analytical results are available.

This paper summarized the analytical work on three separate tests. Some of these specimens have elements such as steel brace or steel plate. Computer models were conducted by SeismoStruct. For more confidence verifying of computer simulations were performed by the three experiments. As a result many situations were experienced in simulations and many failures were considered. Computer simulation is the most cost effective way to predict and study buildings subjected to earthquake loading. In this study, models were developed in SeismoStruct to analyze these experimental models in order to correlate future analytical tools and new design methods and in addition to conduct other computer models to experience them. After verifying models parametric studies were performed on them.

## 2. THE EXPERIMENTS THAT HAVE BEEN USED FOR VALIDATION OF SIMULATIONS

### 2.1. MAHERI AND GHAFFARZADEH EXPERIMENT. [1], [2]