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Investigation on Effects of Composite Columns on Seismic Behavior of Steel Plate Shear Walls System

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Abstract

Appropriate effects of composite sections on strength, stiffness and ductility of the structures has led to increasing research on advantages of using composite columns in steel plate shear walls (SPSW) as a lateral load resisting system and its adequate design criteria. The current research was carried out to study the effects of composite columns as vertical boundary elements on seismic behavior of SPSWs by utilizing numerical models based on finite element method. Several models were chosen to include shape and type of column sections, they include : (1) H-shaped steel section , (2) H-shaped steel section with concrete cast between the flanges , (3) Square-shaped steel section and (4) Square-shaped concrete filled steel section. Beam to column joints were assumed as moment connections. The results were compared in parameters such as stiffness, load carrying capacity and energy dissipating capability. It was concluded that using composite vertical boundary elements can considerably improve energy dissipation capacity, stiffness and strength of SPSW systems.

Keywords: Steel plate shear walls, Composite Columns, Non-linear analysis, Seismic behavior, Finite element Method.

1. INTRODUCTION

A typical SPSW consisting of infill panel and boundary elements, exhibits high initial stiffness, behaves in a very ductile manner and dissipates significant amounts of hysteretic energy.

The tension field action of SPSW, would increase the requirements on its boundary elements. The vertical boundary elements (VBE) resist both vertical load and the bulk of overturning moments, and also provide an anchor for tension field action of the infill panel. Therefore SPSW system requires enough stiffness of VBEs. Steel-Concrete composite columns act suitable for resisting both vertical and lateral loads due to their advantages of having two materials, compared to steel-only sections. It is commonly known that steel-concrete composite sections have more stiffness, strength and energy dissipation capacity than ordinary steel or reinforced concrete sections, allowing designers to select slender steel elements.

Furthermore, local buckling of the steel section is delayed due to the restraining effect of the concrete. On the other hand the strength of the concrete is increased by confining by the steel.

Concrete filled tubular (CFT) columns, consist of steel tube filled with concrete, have long been used in buildings and bridges, and research had been reported since 1970's. CFT columns have become popular as structural members in buildings due to their excellent structural performance characteristics, such as high strength, stiffness and high ductility [1].

A new type of steel-concrete composite column composed of H-shaped steel section figures the partially encased composite (PEC) section with concrete cast between the flanges of the steel section has recently been developed by Canam Manac Group [2].

This paper investigates the effect of using CFT and PEC columns, as vertical boundary elements in SPSW system, on seismic behavior of a whole system.