



The usage of Limit States Method in Unstiffened Steel Plate Shear Wall analysis and design with Special Ductility with concentration on horizontal and vertical boundary elements

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Abstract

Steel plate shear wall (SPSW) is a lateral force resisting system that is not only applicable in the construction of buildings which are designed from the outset, but also they are efficient systems in seismic retrofit of the existing structures. This lateral resisting system with individual specifications and performance is used in order to increase lateral resistance and stiffness against lateral forces especially earthquake. The main role of SPSW similar to the other lateral resisting systems is to supply the strength and stability against shear forces that are produced in stories because of the earthquake and they resist against overturning moment that is produced from the mentioned force. Canada steel structures design codes (CAN/CSA S16-01/2001 and FEMA450) offered criteria in design of the structures in 2004. The provisions related to the design of these shear walls were added particularly to steel structures seismic design codes as AISC341-2005 in 2005. In this paper we target to analyze, calculate, design and evaluate a 9 stories steel structure that has special steel plate shear walls, i.e. SPSW with special ductility and we use limit states specifications (LRFD method) while the design of horizontal and vertical boundary elements is specially considered. The emphasis of this paper is to design and control one of the main elements of this system including on beam in one of the stories as a sample by using from limit states method (LSD) named LRFD provisions. This paper consists of: the calculation of bending moment due to uniform load and two centralized axial forces, strength, reduced bending strength, compact control, shear control and bending moment, and axial force interaction control for HBE.

Keywords: unstiffened special steel plate shear walls, special ductility, limit state provisions, web plate thickness, diagonal tension field action, vertical and horizontal boundary elements, inelastic deformations.

1. INTRODUCTION

1-1. STEEL PLATE SHEAR WALL PRESENTATION

Steel plate shear wall is a system consisting of steel plates (stiffened or unstiffened), steel boundary columns and steel boundary beams which is constructed in the level of each story. The lateral load resisting system SPSW could be considered similar to plate- girders in which its frame columns behave like plate girders flanges, its beams similar to plate girders intermediate stiffener and its steel plate is equivalent to plate girders web. The main components of SPSW system consists of steel plate called serve as web plate, columns serve as vertical boundary member or VBE and beams serve as horizontal boundary members or HBE (Fig. 1) [1], [3].

One of the simple analytical models that was in accordance with the high stiffness of vertical boundary components (VBE), proposed by Torber et al. in 1983, in which the produced tension field behavior in the web plate was modeled by a large number of truss members with identical slope angle. In the above model tension yield strength steel shear wall web plate is considered serve as limit stress in truss members shown in Fig. 2. Canada shear walls design code (CAS2001) has recommended the strip model as suitable method in analysis. Steel shear walls can be utilized to different types. As regards the buckling limit strength in plates is much less than their post buckling strength, the use of post buckling capacity in steel plates has been taken into consideration. It should be noted that plate buckling is not meant to result the destruction and failure of a structure and if the plate has enough lateral support, its post buckling forces could be up to several times the theoretical buckling limit forces. Thin steel shear wall buckles at low loads and after which strength - load