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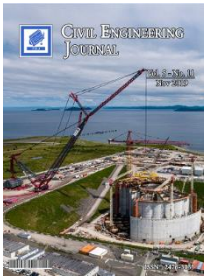

Experimental and Numerical Investigations of Composite Concrete–Steel Plate Shear Walls Subjected to Axial Load

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Abstract

This research is presented experimental and numerical investigations of composite concrete-steel plate shear walls under axial loads to predicate the effect of both concrete compressive strength and aspect ratio of the wall on the axial capacity, lateral displacement and axial shortening of the walls. The experimental program includes casting and testing two groups of walls with various aspect ratios. The first group with aspect ratio H/L=1.667 and the second group with aspect ratio H/L=2. Each group consists of three composite concrete -steel plate wall with three targets of cube compressive strength of values 39, 54.75 and 63.3 MPa. The tests result obtained that the increase in concrete compressive strength results in increasing the ultimate axial load capacity of the wall. Thus, the failure load, the corresponding lateral displacement and the axial shortening increased by increasing the compressive strength and the rate of increase in failure load of the tested walls was about (34.5% , 23.1%) as compressive strength increased from 39 to 63.3 MPa for case of composite wall with aspect ratio H/L=1.667 and H/L=2, respectively. The effect of increasing aspect ratio on the axial load capacity, lateral displacement and axial shortening of the walls was also studied in this study. Compared the main performance characteristic of the testing walls, it can be indicated that the walls with aspect ratio equal to (2) failed under lower axial loads as compared with walls with aspect ratio equal to 1.667 ratios by about (5.8, 12, 15.6 %) at compressive strength (39, 54.75, 63.3 MPa), respectively and experienced large flexural deformations. The mode of failure of all walls was characterized by buckling of steel plates as well as cracking and crushing of concrete in the most compressive zone. Nonlinear three-dimensional finite element analysis is also used to evaluate the performance of the composite wall, by using ABAQUS computer Program (version 6.13). Finite element results were compared with experimental results. The comparison shows good accuracy.

Keywords: Composite Concrete-Steel Plate Shear Walls; Axial Load; Compressive Strength; Aspect Ratio; Lateral Displacement; Shortening; Failure Mode.

1. Introduction

Concrete filled steel tubes have been widely used in bridges and high- rise buildings for its advantages of high-load bearing capacity, good seismic behavior and fast construction [1, 2]. Recently, a new kind of composite wall structure with a steel plate in addition to concrete, chiefly employed in super -high rise building, missile as well as plate resistance walls for the great bearing capacity that it has and reducing in its thickness. The axial compression loading is considered as a critical case because of the relative motion happens between the faceplate and infill concrete. On the other hand,

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