9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology, Isfahan, Iran

Ultimate Strength of the RC walls under interactive performance of in-plane and out-of-plane loadings

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Abstract

Reinforced concrete walls are such structural components which can be exposed to in-plane and out-of-plane loads in especial loading conditions. Design of these walls usually is done without considering the reducing effect of each type load on each other. In present paper, for reasonable dimensions of a RC wall at first, the nonlinear load bearing behavior was examined. For this purpose, finite element modeling was employed and in order to verify the procedure, a popular experimental test was modeled. In the following, using the material properties of the verified model, the subject of paper was followed. In this order, the interactive influence of loads was investigated with evaluation of the load bearing capacity for each type load when the other one was constant. The results indicate major influence of studied loads on each other that indicate importance of the study for interactive influences of loads for structures in such conditions.

Keywords: Ultimate strength, RC wall, in plane load, out of plane load, interactive load.

1. Introduction

Reinforced concrete walls and slabs are such structural members which can be exposed to explosive loads in direct or indirect manners especially in the especial buildings such as sanctuaries and shelters. These conditions can provide for the member in-plane and out-of-plane loads or a combination from mentioned loads that must be considered for evaluation of the strength in these conditions. In this way, the simultaneous examination of the interactive influence of in-plane and out-of-plane loadings on the RC walls seems to be a necessary task in especial loading conditions such as explosive loading on the construction of the shelters and strategic sanctuaries regarding the specific nature of explosion load which affects their perimeter by shock waves in all directions. In the design of these structures components, the provisions of codes usually assume a ratio between two type loads that this ratio can vary regarding the various parameters such as distance between the explosion center, the position of the wall, the explosion type and power and also location of a RC wall in the shelter structure in relation to other load bearing elements [1]. However, design of structure walls usually is done without considering the interactive influence of loads in the case of simultaneous action on the structure. Present research reveals the reducer influence of two type loads on each other. In Figure 1-a schematic of the constructions subjected to explosion load is seen. The side wall in this figure is subjected to two type loads: firstly in-plane load made by adjacent components that in this condition the wall acts as a shear wall and secondly out-of-plane load made by shock waves in its environment that here the interactive load bearing capacity is the concern of present work. To study the objective of paper reasonable dimensions for a typical wall were assigned (Figure1-b) however the influence of dimensions can be investigated in supplementary studies. In this regard, in present paper for the ratio of out-of-plane loading (here nominated pressure) to in-plane loading (here nominated traction) five values were assigned which were rational regarding the dimensions of wall and the behavior of the walls were examined for these values.
FE Modeling was chosen for investigation of the subject and material nonlinearity was included in the models both for steel reinforcement and concrete. For verification of the modeling procedure, a simulation from an experimental model [2] was carried out and the results were compared to gain validation. Then, for predefined dimensions of a RC wall the objective of paper was studied. Concrete damage and plasticity were modeled using smeared crack method. At first, the influence of each type load (pressure and traction) was examined on the RC wall separately and then the interactive function of loads was identified.