Investigation of Nonlinear Static Behavior and Macro-Model for Nonlinear Analysis of ۳D RC Shear Walls

Abstract

Shear walls are important systems used to resist vertical loads and earthquakes. Evaluation of building during earthquakes shows successful performance of these walls to minimize damage. The behavior of shear walls depends on the aspect ratio. Shear walls with high aspect ratio (more than two) are called flexural or slender walls. Walls with low aspect ratio (less than one) are called short or squat and if aspect ratio of walls is between one and two, walls are called shear-flexural. In shear flexural wallboth flexural and shear behavior can occur. The height to the length ratio of shear walls in tall building is ۱۰ to ۱۲. Hence, these walls are flexural or slender and shear deformations are negligible. Efficient analytical models that predict actual behavior of structures must be applied to analyse seismic behavior of flexural walls for design purposes.The analytical models should be able to contribute to the effective factors and main characteristic of the response of shear wall. Moreover, these models must have ability to simulate non-linear behaviors of walls. Three common methods of modeling aremicro or small scale, meso or medium scale and macro or large scale. Majority of research have focused on walls with rectangular sections but walls with non-rectangular and flanged sections have not yet been well studied. Present regulations and guidelines do not have specific clauses for walls with non-rectangular sections. However, flanged walls has better performance than walls with rectangular section due to participation of the Thus, the present study focuses on analyzing and modeling behavior of slender shear walls with non-rectangular cross-section, including L-shaped, T-shaped, and H-shaped sections. However, we have also tried to propose a macro model based on the lumped plasticity to analyze and predict behavior of three dimensional shear walls. In our proposed model linear behavior of the wall before cracking is considered. For this purpose, we initially used finite element method (micro) in software Abaqus ۶,۱۲ and fiber method (meso) in software Opensees ۲,۴,۰ for nonlinear static analysis of shear walls. In order to evaluate the accuracy of obtained results from two modeling methods, three experimental RC shear walls samples were selected and results of the modeling were compared. The results show that analysis of slender RC shear walls with fiber modeling method is much more fasterand more accurate than the finite element method. Although, the finite element method and fiber method yield accurate information on the local behavior of walls, they are complex and time consuming. Also, in some cases detailed local information is not required and overall predictionof walls behavior are considered. Due to these reasons, researchers have considered macro modeling method. In this study we tried to simulate and predict non-linear behavior of shear wall using macro modeling. In present study shear wall model with two members, rotation spring at the base of wall for modeling nonlinear behavior of wall and elastic part that is equal length of wall. The proposed macro model parameters are dependent on the characteristics of wall geometry and mechanical properties of materials. After determining model parameters effective factors are identified and a direct formula is presented to express model parameters. A compressive axial load on the wall, shape of cross section of wall, a percontage of longitudinal reinforcement and aspect ratio of shear wall were identified as the effective factors. By evaluation these factors in ۴۶۰ samples of wall, we presented the formula to determine model parameters. The advantage of the proposed modelisefficiency and applicability for the walls with both rectangular and non-rectangular sections. The accuracy of the proposed model using experimental results was confirmed. Also, comparison of obtained results to those of Code ۳۶۰ demonstrates the efficiency and accuracy of the proposed model.

Key Words:۳D slender shear walls, shear walls with flanged section, a large scale (macro) modeling, hinge plastic.