Representation & Comparison of the Nonlinear 3D Modeling Methods of RC Shear Walls

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Abstract

One of the most common lateral load resistant systems in buildings is concrete shear walls. Correct estimation of seismic behavior, correct analysis and correct design of such a system needs an accurate modeling method that shows the real behavior. Analytical model must be capable to predict characteristics of seismic behavior of RC shear walls like initial stiffness, first yielding, stiffness degradation, resistant degradation, hysteretic behavior and energy dissipation. Initial investigations shows that most of the past researches concentrated on planer shear walls and there is no comprehensive investigation on modeling 3D shear walls. Shear wall's seismic behavior depends on the ratio of height of the wall to wall's width. An aspect ratio less than one leads to shear behavior, between one and two leads to flexural-shear behavior and greater than two leads to flexural behavior. The main purpose of this study is development and comparison of capabilities of modeling methods for 3D shear walls at the scale of micro, meso, and macro modeling. 3D solid elements are used in FEM modeling method that is performed in Abaqus software and fiber elements are used as meso modeling method performed in Opensees software. In this study based on FEM and fiber modeling and analysis, a new macro modeling method is presented. Depending on software capabilities, past investigations have mostly embarked on planer shear walls. On the other hand, the focus of this study is on 3D shear walls using 3D FEM and fiber elements modeling. As an accuracy test, the results of the represented modeling methods were compared with the experimental results of four specimens consisting of two planer shear wall, an H shaped and a T shaped shear wall, showing a good resemblance. In this study to compare the FEM and fiber modeling methods capabilities, three H shaped walls 15, 21 and 30 m high, three T shaped walls 15, 21 and 30 m high, and three L shaped wall 15, 21 and 30 m high were modeled with the both modeling methods. The results showed that the fiber modeling method compares well with the FEM presenting an accurate estimation of both the total and local behavior. The comparison also showed that analysis of the fiber elements model took a few minutes while analysis of the FEM model lasted 6 to 8 hours to complete. Initial shear wall specimens contained 0.6% reinforcement in their sections. For representing the macro modeling method, besides 9 initial specimens, 9 specimens with 1.5% reinforcement in their sections and 9 specimens with 2% reinforcement were taken into account to assess the reinforcement percentage effect. For comparison with the results of the macro modeling, the extra specimens were also modeled with the fiber modeling method. The comparison between the results of macro and fiber elements modeling methods showed the capability of the macro modeling in prediction of lateral behavior of the shear walls. The comparison also showed that analysis of the presented macro model took about 2 to 3 minutes while analysis of the fibers model continued to about 15 minutes.

Key Words
Opensees, Abaqus, Macro Modeling, Meso Modeling, Micro Modeling.