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"COMPARISION OF PRACTICAL METHODS FOR MODELLING SQUAT SHEAR WALLS FOR ANALYSES OF BUILDINGS"

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Abstract--- For Proper Analysis of squat shear wall building, different methods used to modelled and get results which is important to get realistic results. In the present work total 4 types of modelling are used to analysis G+1 squat shear wall building for aspect ratio 1.0 and seismic zone V with all soil types. Linear static analysis done with all models to find and compare best modelling to model and design shear wall structure elements with easiest way. Earthquake loading apply to find the behaviour of components.

Keywords— Shell elements, Frame elements, Aspect ratios, Squat shear wall, Finite element analysis

1. INTRODUCTION

In Multi-storeyed Building Lateral loads gives big moments and much more stresses and also gives vibration to buildings. For this it is necessary to build a high strength against lateral loads to resist loads. India needs these types of changes in buildings due to earthquake zones. For constructing buildings, it is necessary to understand the cause of earthquake and types of earthquakes. Reinforced concrete shear wall gives high power and reduces moments of buildings and therefore it will reduce the damage of structure from earthquake. Different methodology of modelling available for analysis of structure. Finite elements methods are very useful for static and dynamic analysis. In this study, different modelling techniques either shell elements or frame elements modelling done to modelled squat shear wall with different aspect ratios and applied gravity and earthquake loading on G+1 building using of sap2000 software for comparison of both modellings. Also effects of meshing and Frame rigidity check for both modellings.

2. MODELLING OF SQUAT SHEAR WALL

For Finite element analysis of G+1 squat shear wall building requires proper methodology. Mainly two modelling methods explain below.

2.1 Shell Elements:

The shell element Method generally used to analyse different RC shear wall buildings. In sap2000 software shell element has six direction rights for all points and In plan round direction rights, which helps to make it three dimensional FEM model. In shell element type of modelling mesh sizes are defined to get real behaviour. Different mesh sizes can changes the form of shear wall building structure. Generally, in modelling with shell elements the beam connecting to shear wall modelled to some extra inside the shear wall.

2.2 Frame Elements:

Frame Element modelled is a long single bar, which can demonized in both axial and Side of the direction of bar. This frame bar can easily take all forces like Axial and transverse and also can handled moments of structure. Frame Element has both properties of truss and beam. All types of structure regarding taking loads can found to be frame elements and it can solve most of the structure problems. Therefore, most structure demonized are found breaking in axial directions. In Fem analysis, Frame Element plays important role to handle a structure within their limits.

3. Numerical Study

Squat shear wall of 250x4500 cross section are modelled for different types of modelling. Material Properties taken as M25 for concrete and FE415 for steel. The live load taken as 2 KN/M^2 according to Indian standard code. Squat walls considered by taking aspect ratio 1.0. Structure analysis software sap2000 used for the analysis of building. The squat shear wall G+1 building analysed for seismic zone V with Soil Profile I,II,III. Importance factor and Response Reduction

Factor taken as 1 and 5 respectively.The height of one storey taken as 4.5 m. Members dimensions of the building shown in Table 1.

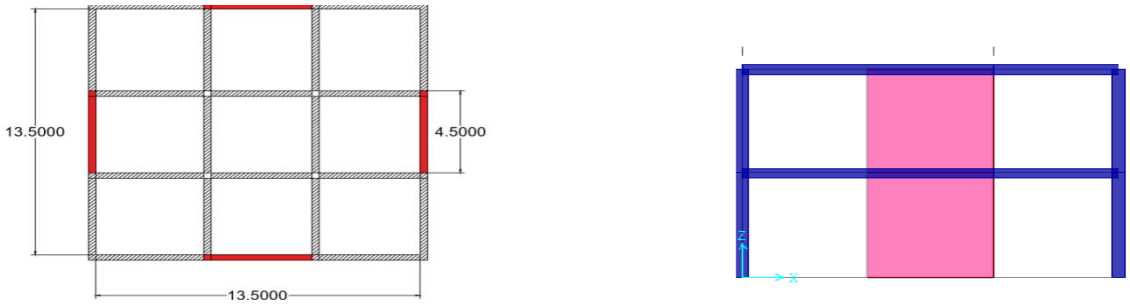

Figure 1: Plan Of G+1 squat building and Three Dimensional model of G+1 Squat wall Building

Table 1 Dimensions of Building

Column (mm)	450x450
Beams (mm)	250x500
Slab Thickness (mm)	150
Squat Walls (mm)	4500x250

3.1 Analysis of the Building:

Four Analysis Set up done for the G+1 squat wall building with modelling techniques. 1) Shell element Modelling only. 2) Shell elements with rigid beam along wall top. 3) Shell elements with rigid beams along one mesh size only. 4) Frame elements Modelling. For aspect ratio 1.0 models, earthquake loading with help of IS 1893:2016 part-1 applied to models.

3.2 Modelling with Shell elements:

3.2.1 Shell elements only

In this first type of modelling, squat shear wall with 4.5 m long with mesh sizes of 16x16 m to 2x2 m modeled. Results given below in tables shown that mesh sizes gives 10 times difference in Moment (M3) for all aspect ratios.

Table 2 Squat shear wall Internal Forces (KN,m) for "Shell Elements Only" Model for (EQX) loading

Meshing	W	V2	V3	M2	M3
Shell 16x16	4.89E-10	135.21	0	0	928.19
Shell 8x8	1.52E-11	136.58	0	0	951.35
Shell 4x4	2.22E-12	137.59	0	0	973.32
Shell 2x2	1.19E-12	137.16	0	0	990.62

3.2.2 Shell Elements with Rigid Arm Beams on Wall Top of the End

In modelling with Shell elements with rigid arm on wall top of the end, the actual beams replaced by rigid arm beams. Torsional Constant and Moment of inertia (J,I2,I3) are used to define rigid arm beam properties. The cross section of rigid arm and actual beam section is same for entire analyses. Rigid arm beams decrease mesh sensitivity. 16x16 meshing to 2x2 meshing gives 5-10% Differents in moments.

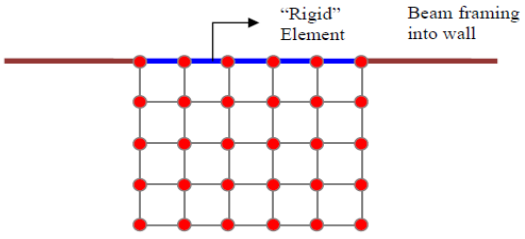

Figure 2: Shell element with rigid Arms model

Table 3: Squat shear wall Internal Forces (KN,m) for Shell Elements With Rigid Beams Along Wall Top Chord for (EQX) loading

Meshing	W	V2	V3	M2	M3
Shell 16x16	5.80E-11	131.45	0	0	900.78
Shell 8x8	7.60E-11	132.78	0	0	923.58
Shell 4x4	3.38E-12	133.78	0	0	945.15
Shell 2x2	1.08E-12	133.36	0	0	962.07

3.2.3 Shell Elements with rigid beams Penetrating Along one mesh

In this modelling Rigid arm beams are involved in single mesh only. The side corner of wall mesh is only part in which rigid arm involved. And other meshing remains without any rigid arm. Model view shown in the Figure below. 16x16 meshing gives good results while 2x2 mesh sizes gives 10%-15% difference in moment.

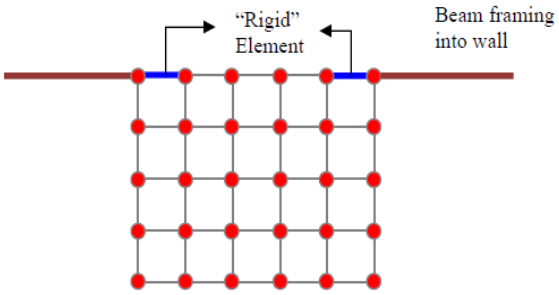

Figure 3: Shell element with rigid arm beams within One mesh model

Table 4: Squat shear wall Internal Forces (kN, m) for Shell Elements for Rigid Beams with Penetrating Along One Mesh for (EQX) loading

Meshing	W	V2	V3	M2	M3
Shell 16x16	1.74E-09	131.45	0	0	901.93
Shell 8x8	1.19E-11	132.78	0	0	924.20
Shell 4x4	3.95E-12	133.78	0	0	945.34
Shell 2x2	0.027	133.36	0	0	962.83

3.3 Modelling with Frame (Mid-pier) Elements:

In this modelling, Rigid arm section used for modelling. Different rigid arm section models are taken with different depth. Depth of rigid arm section taken as Half a storey height, one storey height, one and half storey height and two storey height. Results given below in table and shows change in Moment M3.

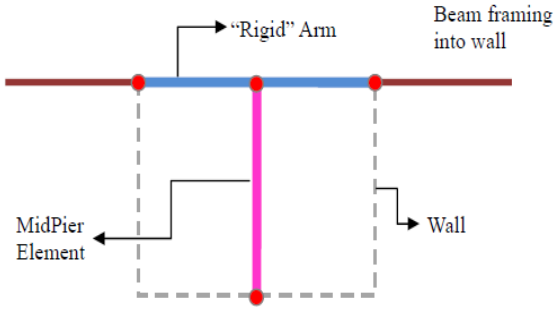

Figure 4: Mid pier element Model

Table 5: Squat shear wall Internal Forces (kN, m) for Modelling of Shearwalls Using Frame Elements for (EQX) loading

Model	W	V2	V3	M2	M3
MidPier_Half	1.78E-13	123.61	0	0	905.37
MidPier_1st	3.50E-14	123.39	0	0	900.10
MidPier_1.5th	1.11E-11	123.31	0	0	898.26
MidPier_2nd	1.07E-11	123.25	0	0	897.28

4. Discussion and Conclusion

Shear wall are important structure element for resisting lateral loads. Using Sap2000 software for a linear static analysis for different modelling, following Result compare with graph which is shown below and further conclusion can be made.

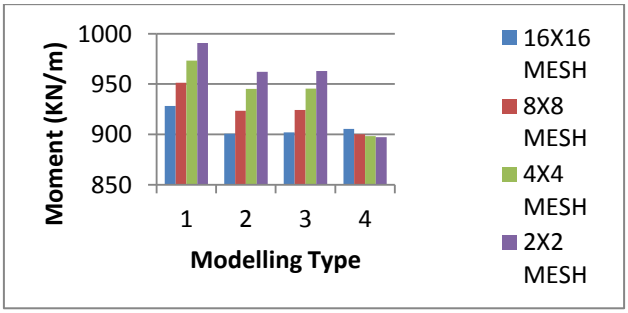

Figure 5: Compared results for different Modellings

- Meshing of Shear Walls is very important for Obtaining good results. In modelling with shell element, the bending moment of squat shear wall are changed massively with mesh sizes. From 16x16 to 2x2 of meshing, the results Showing ten times of difference in results.
- In shell element modelling, using of rigid arm beams gives good results for 16x16 meshing. For 2x2 meshes 10-15% difference are face in squat shear wall moment.
- In shell modelling, size of mesh also changes the moment. Coarse mesh size gives 5-10% difference in moment from finer meshes.
- Modelling of shear wall with columns can increase the strength of the structural building. In modelling shear wall with Mid pier element, different depth of rigid arm section gives 5-15% differences in the inside forces of squat shear wall.
- Rigid arm section with different depth of section properties for frame element types gives change in moment of squat shear wall.
- For one storey height rigid arm section gives good results for comparing to shell elements.

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