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REVIEW BASED MODELLING OF FRAME-WALL SYSTEM UNDER SEISMIC CONDITION

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Abstract-This study is based on high rise and medium rise RC shear wall-framed structures and squat wall system. The squat wall is design by different aspect ratios. Shear wall-frame system are becoming most popular in large populated cities area in India. It is necessary to analysis of building and study the all parameters of shear wall those are effected the lateral and gravity loads, Wall moment and the stresses on the shear wall. A 3D structure reinforced concrete shear wall-frame dual building systems is designed According to Indian standard codes and analysed. For Proper design steps and analysis of squat shear wall building, different methods used to model and get results which are important to get realistic results. Finite Element analysis study is also done with all models to find and compare best modelling to model and design shear wall structure elements with easiest way. Also, Gravity and Earthquake loading apply to find the behaviour of components for different aspect ratios.

Keywords- Shell elements, frame-wall mixed system*, *Frame elements, seismic performance, Aspect ratios.

1. INTRODUCTION

Shear wall frame mixed system is most required in earthquake prone area. The frame is pull the shear wall back in upper level, and shear wall push the frame in lower level. It causes uniform combined forces are develop in frame-wall mixed building system. Lateral loads are also gives the high stresses. Therefore, it is very important for the structure to have sufficient strength against gravity loads with stiffness to resist lateral forces. India lying in earthquake zone at which there is a need of increase of understanding the behaviour of earthquake, constructing and developing earthquake resistant structures. Reinforced concrete shear walls provide most require in structure because it gives the more strength and stiffness to dual structure in the direction of their orientation, which significantly decrease lateral sway of the structure and they are decrease damage to structure and its contents. Different methodology of modelling available for analysis of structure

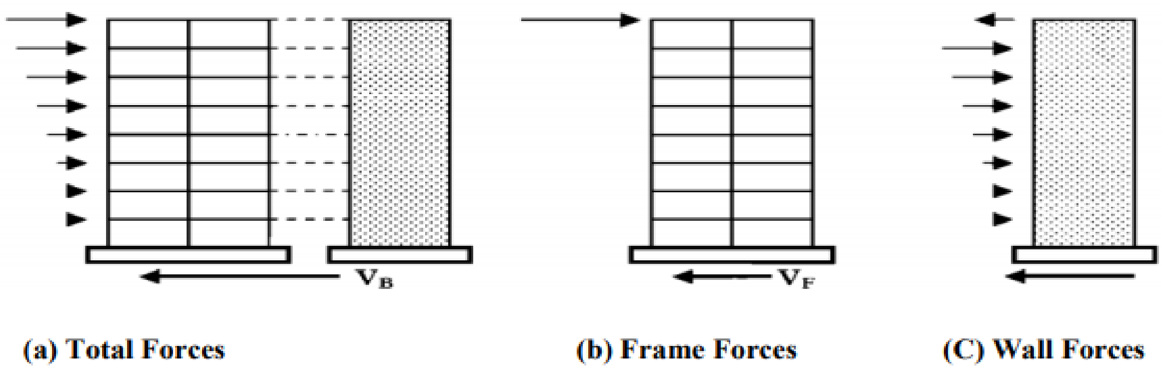

Fig.1 Frame-shear wall structure

2. LITIRATURE REVIEW

Kubin et al. (2008) studied the finite element modelling for shear wall structure for different analysis like static and dynamic analysis of frame and wall structures with different techniques like shell elements and frame elements. There is Shell elements formulations generally include of out-of-plane (plate) and in-plane (membrane) degrees of freedom analysis. In this study, different parameters of modelling the shear walls in structural analysis of buildings were discussed and compared. The effect of different mesh size of shell elements on the bending moment which of attached beams had been be discuss and different practical solution are also be investigated.

Labafzadeh et al. (2008) studied focused on both shear ductility and flexural capacity of the wall system for the height of wall can be efficiently used to provide us with a dual ductility mode shear wall. This study a series of inelastic dynamic analysis on coupled shear wall have been carried out to show the potential of dual ductility behaviour in response of such system under the seismic loads. Due to damage dispersion along the height of the shear wall, the base shear and base moment of these shear wall reduced.

Akis et al. (2009) studied frame element modelling. Two different 3D shear wall models for closed sections and open sections were taken. This models were analysed in computer with frame element modelling and also with other modelling like shell elements. With the help of these new models they are divided in five different groups of shear wall-frame structures with different stories plans and different wall heights which were also analysis. First three natural vibration periods were determined and time history analyses had been performed. The results of these computations were observed to be in good condition with those find out by detailed models containing shell elements.
Shaik and Azam (2013) studied the dual structural system consisting of special moment resisting frame (SMRF) and concrete shear wall has gives the best earthquake performance due to increases lateral strength and lateral strength. A well designed system of shear walls in a structural frame improves the earthquake performance. The results of the study shows that the provision of shear walls symmetrically in the outermost overturning moment resisting frames of the structure and both are interconnected in mutually perpendicular directions forming a core will lead to best seismic performance.
Oni et al. (2013) studied on about three storey and six storey structural models with having a plus shape Shear wall consider. Equivalent static and response spectrum methods were carried out as per IS: 1893 (Part 1)-2002 using finite element analysis software ETABS. Seismic perform was done by pushover analysis as per ATC-40 guidelines for earthquake zone V in India. This paper also presents the effect of the different cases of the building height on the structural response of the shear wall. This paper highlights the accuracy of Push over analysis in comparison with the Response Spectrum Analysis and also done by Equivalent Static Analysis.
Patil et al. (2015) compared the bare frame with models having a RC frame-shear walls, which were modelled by using two different methods. The simplified shear wall which was single element throughout the building and refined model which was multi-layered membrane element. Shear walls are placed in different positions in the building along X and Y direction. The equivalent static and nonlinear static pushover analyses were done by using the software ETABS. For the different load combinations according to IS 1893(part1): 2002 and displacements of different models were compared. The building base shear, fundamental natural period and performance of the models were compared.
Tidke et al. (2016) studied the effect of seismic loading on placement and positioning of shear wall in building at different alternative location. Effect of shear wall has been studied with the help of five different building models. Model one was bare frame structural system and other four models are having for different arrangement of shear wall under the frame. Response spectrum analysis and time history analysis method were also used for analysis in SAP2000 software and structure was assumed to be situated in seismic zone II. From analysis some parameter were determine like building base shear, storey drift and displacement of a structure.
Ugalde et al. (2017) worked on the behaviour of RC shear wall building subjected to large earthquake prone areas. Chile is a most seismically active country in the all over world. Taken Chilean residential building higher than 5 stories mid rise structure is almost completely made up of reinforced concrete shear wall. In 2010. When earthquake was 8.8 scale many residential building are also suffered severe damage, but three buildings was not suffered damage due to 2010 earthquake were evaluated by response history analysis (RHA) considered for the ground motions recorded at the closest station.
Kim et al. (2017) worked on shear wall frame mixed buildings system. These are widely used in seismic force resisting building system. Wall and frame mixed system analysed and design separate by assign a specific portion of the design lateral load wall and frame each one. This new design method is simple and easy to conduct; it does not exactly follow the conventional design process for a wall-frame interaction dual building system, even though it still uses the same seismic force analysis and design parameters. These are suggested design method for the target building denote as M3,it such that the Equivalent lateral force procedure in ASCE7 can still be applied on structure, the wall and frames are analysed and designed simultaneously without any separation of seismic force and gravity load resisting system. The intention of another more conventional design method per (ASCE7) called M2 is the case of wall is resist the 75% and frames is able to resist the least 25% of the design lateral load.

3. 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.

3.1 Shell Elements:

The shell element can be used easily for the analysis of shear wall building structure. In sap2000 software worked on shell element has six degrees of freedom for all nodes and in plan element rotational degree of freedom, which makes it three dimensional finite element models. In shell element type of modelling mesh sizes are defined to get real behaviour. Different mesh sizes can changes the parameters 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.

3.2 Frame Elements:

A frame element is formulated to model a straight bar of cross-section, which can deform not only in the axial direction but also in the directions perpendicular to the axis of the bar. The reinforced bar are having the more capacity to carry both transverse force and axial forces, and also moments. Therefore, a frame element is obtained the properties of both beam element and truss elements. In fact, the frame structure can be found in most of our real world structural problems, for there are not many structures that deform and carrying forces purely in neither axial directions nor purely in transverse directions. Develop the FEM equations for beam and frame structures.

Shell Elements with Rigid Beams along Wall Top:

Shell Elements with Rigid Beams along Wall Top modelling of squat shear wall has rigid beams which are replaced by Beams. Rigid beams defined as only parameters used to defined rigid beams are Torsional constant and Moment of inertias (J, I2, I3). All cross section of rigid beams take for same as other beams. Rigid beams used to decrease the meshing sensitivity. Mesh sizes from coarse to fine gives 5%-10% difference in results.

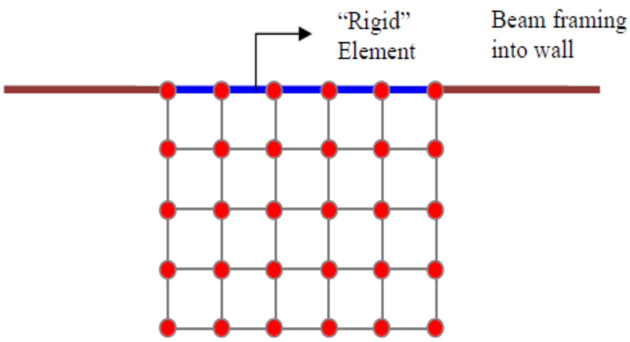

Fig.4-Shell Elements with rigid beams along wall top

Shell Elements with rigid beams penetrating along only single mesh

In third modelling Rigid beams which are penetrating Along wall top are now penetrating in one single mesh size only. Model view shown in the Figure below. Coarse mesh sizes gives good results while finer mesh sizes gives 10%-15% difference in M3 moment.

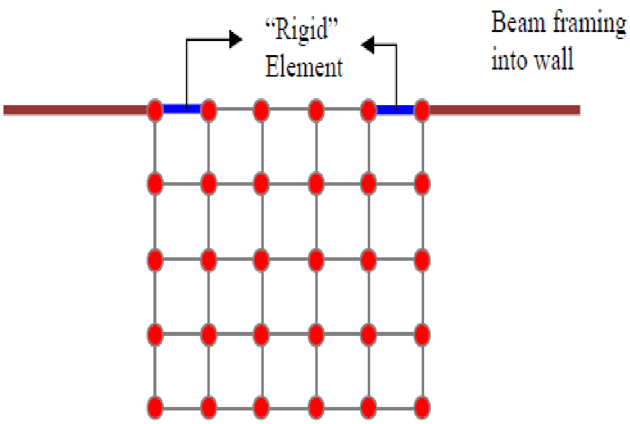

Fig.5-Shell element with rigid beams penetrating along only single mesh

Modelling with Frame Elements:

In this last modelling, Rigid arm section introduced for modelling. Different rigid arm section models are considered with various 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.

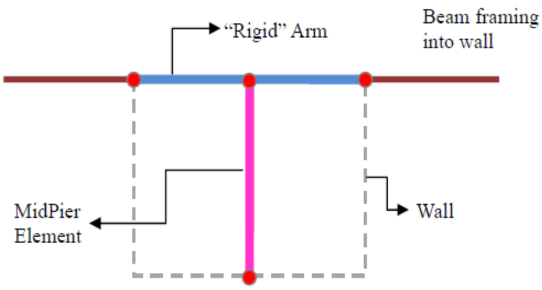

Fig.6-Mid pier model

Table 1: Design methodologies for frame-shear wall

Method	Modelling and analysis approach for design
M1	Wall design for 100% of lateral load frame design for gravity load only.
M2	(I)Frame design for 25% of lateral load and gravity load. (II)Wall design for 100% of lateral load (frame and wall modelled together)
M3	Frame and wall design for 100% of lateral and gravity loads simultaneously.

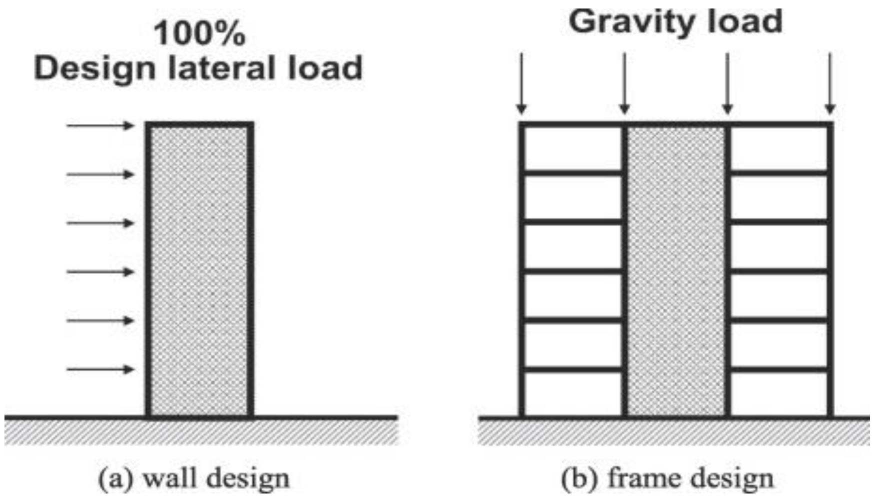

Fig- 3.1 M1 case

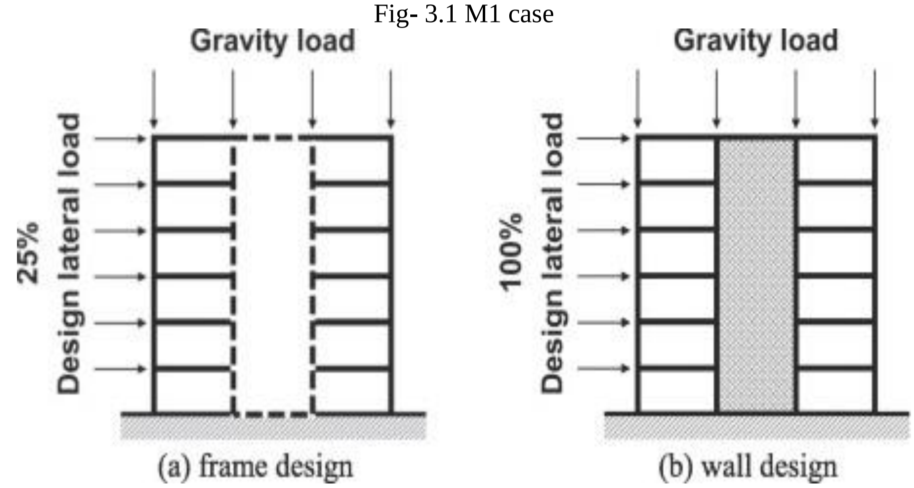

Fig-3.2 M2 case

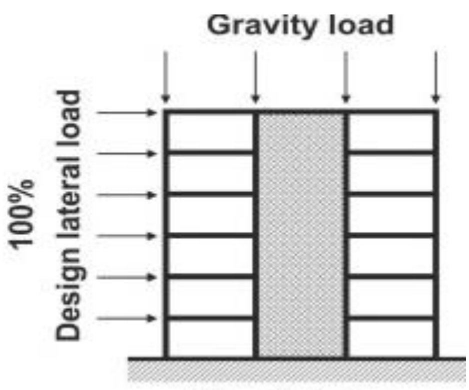

Fig-3.3 M3 case

CONCLUSIONS

Many researchers worked on shear wall positioning and SMRF building, different response spectrum factors and dual ductility mode work on shear wall but according to our study we worked on squat shear wall aspect ratios and mixed building system with different mesh size of shear wall and different design cases of Shear Walls. is very important for analysis. Squat wall modelling with shell element, the bending moment of shear wall are changed massively with mesh sizes. Rigid arm section with different depth of section properties for frame element types gives change in moment of squat shear wall. Mixed building system with have different design and analysis cases so its overturning moment and story shear are different in all cases. Response reduction factor value R is more affect the results, in all models. Stresses are also different in all mixed building system cases.

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