SHEAR WALL ANALYSIS AND DESIGN OPTIMIZATION IN CASE OF HIGH RISE BUILDINGS

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ABSTRACT

India is a developing country with rapid industrialization and urbanization is taking place at an incredibly fast pace. The cities are becoming large urban conglomerates with an urban sprawl ranging up to 1000 km^2. National Capital Territory of India is 842 km^2, and will soon reach a thousand square kilometers. This urban sprawl puts undue burden on land and especially prime arable land is lost to accommodate dwellings and commercial establishments. To tackle this problem, cities should strive to grow upwards rather than sideward. But growing taller has its own advantages and disadvantages. Tall buildings are required due to increasing population density in India, especially in urban areas. Also due to increase in the transportation and safety measure the FSI (Floor Spacing Index) in Indian cities is increasing considerably. Structural engineers in the seismic regions across the world often face the pressure to design high rise buildings with stiffness irregularities, even though they know these buildings are vulnerable under seismic loading. Contemporary tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high rise buildings. Improving the structural systems of tall buildings can control their dynamic response. With more appropriate structural forms such as shear walls and tube structures and improved material properties. The general design concept of the contemporary bearing wall building system depends upon the combined structural action of the floor and roof systems with the walls. The floor system carries vertical loads and, acting as a diaphragm, lateral loads to the walls for transfer to the foundation. Lateral forces of wind and earthquake are usually resisted by shear walls which are parallel to the direction of lateral load. These shear walls, by their shearing resistance and resistance to overturning, transfer the lateral loads to the foundation. In the present study a 36 story high rise building, there is no sudden change in plan because if there is any sudden change it may result in the stiffness/torsional irregularities of building if a small seismic forces or any other less magnitude horizontal force strike the structure. The optimization

techniques which are used in this project are firstly considered the size of shear wall is same throughout the building and then analysis is done from the result the failed shear wall dimensions are increased to resist the whole structure, in this way the optimization was done for number of time till the whole structure comes to stable to resist the forces .In this present project shear wall design and optimization is done by using the software ETABS and the shear walls are arranged in such a way to resist the lateral forces in zone III region throughout the structure according to Indian codes.

INTRODUCTION:

Earthquakes, Tsunamis, Landslides, Floods and Fires are natural calamities causing severe damage and sufferings to persons by collapsing the structures, cutting off transport systems, killing or trapping persons, animals etc. Such natural disasters are challenges to the progress of development. However, civil engineers as designers have a major role to play in minimizing the damages by proper designing the structures or taking other useful decisions. Because of the vastness of the topic, “Disaster management and mitigation”, this module includes understanding the earthquakes, behavior of the materials of construction and structures and the extent to which structural engineers make use of the knowledge in taking proper decisions in designing the structures made of reinforced concrete. The Republic Day earthquake of January 26, 2001 in Gujarat clearly demonstrated the earthquake vulnerability profile of our country. It created a considerable interest amongst the professionals associated with construction activities in any form, as well as the non-professionals regarding the earthquake safety issues. The subject of earthquake engineering has its own sophistication and a lot of new research is being conducted in this subject. The analysis of a structure can be done using any one of the methods namely linear static analysis, nonlinear static analysis, linear dynamic analysis and nonlinear dynamic analysis. Bureau of Indian standards (BIS) has published the IS 1893 – 2000 “Criteria for Earthquake Resistant Design of Structures”. In this code, the equivalent static analysis and response spectrum methods are dealt with. It also says the dynamic analysis can be done using the time history analysis (Bryan Folz1 and Andre Filiatrault). In this work, the analysis is conducted.It is well-established fact that shear walls are quite effective in lateral load resistance of reinforced concrete buildings. The performance of shear walls in high-rise buildings would be different from low-rise buildings. Restriction in the architectural design by the presence of the shear walls may contribute to discourage the engineers from adopting the shear walls. Due to this reasons a new concept of providing storey deep and bay wide discrete staggered shear wall panels have been introduced and nonlinear analysis were conducted on the models. Today many residential and commercial building adopted floating column to provide open space for parking, assembly hall purposes and also provide for good aesthetic view. During earthquake storey shear need to be transferred down to the ground by the shortest path; any discontinuity in the structural member results in change in the load path. Building having vertical setback cause a sudden variation in earthquake forces at the level of discontinuity. The discontinuities in the load path are formed in the buildings with floating columns at an intermediate storey or ground storey and do not continue up to foundation. Shear wall are provide for high rise building to resist lateral loads. These walls generally start from foundation level and they are continuous throughout the floor of the building. They can have minimum thickness of 150- 600mm.Shear wall provide lateral stiffness to structure to resist earthquake and wind loading. For high rise structure contain floating column and transfer girder, we also provide shear wall to reduce lateral movement of structure. Shear wall also reduce the structural responses of transfer girder at different positions.(Arturo , Tena-Colunga, et al,2005) The characteristics (intensity, duration etc) of seismic ground vibrations expected at any location depends upon the magnitude of earthquake, its depth of focus, distance from the epicentre, characteristics of the path through which the seismic waves travel, and the soil strata on which the structure stands. The random earthquake ground motions, which cause the structure to vibrate, can be resolved in any three mutually perpendicular directions. The predominant direction of ground vibration is usually horizontal

LITERATURE REVIEW:

Tabassum G Shrihatti (2015), investigated the effects of conventional analysis and the construction stage analysis RC and steel buildings. Three-dimensional modeling of RCC and steel 30 storey building situated in zone IV and hard soil type is consider and the analysis results are obtained. In both the buildings the frames are consider as rigid frame. Finally, the results like shear force, bending moment and displacements were compared with both the conventional model and construction sequence model of RCC and building respectively using the ETABS-2013 software.

Viji R. Kumar and Binol Varghese (2017) ,studied that a G+29 RCC structure with transfer girder at four locations are analyze for construction sequence and conventional method for zone-II and compared there bending moments, shear forces and displacements for geometric nonlinearity material nonlinearity.

Yousuf Dinar, Munshi Md. Rasel, et al (2014)], studied about the rigid frame structures of both concrete and steel model of different configurations that have been taken for sequential analysis. The analysis result helps us to understand how the structure respond against loads of construction sequential analysis and linear static analysis. The sequential analysis results were compared with conventional analysis results. The effect of sequential construction and its effect on the overall design of the building has been evaluated using finite element modeling. In this work, multi-storey buildings of 5, 10, 15, 20, 25 and 30 storey with a floating column in exterior position is considered. The parameters like column axial load and beam maximum moment is compared with both the analysis using ETABS 9.7.2 software.

Meghna B.S and T.H Sadashiva Murthy (2016), here a RC building structure of G+ 5 storey with floating column in exterior position and RC transfer girder was replaced by composite transfer girder and the analysis of the model is carried out with the help of ETABS software. The analysis involved here are conventional analysis and construction sequence analysis and the parameter such as beam moments and deflection of both the buildings are compared.

VigneshKini K., RajeevaS.V.(2017), studied about the behavior of composite and RCC girder and there comparison for response spectrum analysis and construction sequence analysis for zone-II in the form of bending moments, displacement and shear force of transfer girder, with the help of CSI ETABS 2016.

R.Pranay,I.YaminiSreevalli,Er.Thota.Suneel Kumar (2014), Theytook G+21 storey structure and analyze for conventional method and construction sequence method. Compare bending moment, displacement and shear force of transfer girder which is provide at 1st floor at two location by construction stage analysis and conventional analysis.

SriHarsha B and Vikranth J (2014), investigated about the factor which is affecting limit state of serviceability of structure that is sequential construction and strength of concrete. Here two cases, conventional analysis for building subjected to whole loading construction stage analysis for the building subjected to stage loading are considered and deformation in both the cases are compared with two analysis.

Meghana B.S and T.H. Sadashiva Murthy (2016), reviewed on RC and steel-concrete composite building with floating column in different places in plan. Different buildings such as G+3, G+10 and G+15 storey in earthquake zone II and V were analyzed using conventional analysis using ETABS software. Structural responses such as storey shear, storey drift and storey displacement were compared with the results of normal RC building.

Can Balkaya et al (1993) studied about the shear wall dominant structures. Shear-wall dominant buildings are the prevailing multi-story RC buildings type particularly in the regions prone to high seismic risk. To identify their most essential design parameters, dynamic and inelastic static pushover analyses were conducted on the backbone of performance based design methodology.

Antonio F. Barbosa et al (2000) considering the practical application of nonlinear models in the analysis of reinforced concrete structures. The results of some analyses performed using the reinforced concrete model of the general-purpose finite element code ANSYS are presented and discussed. The differences observed in the response of the same reinforced concrete beam as some variations are made in a material model that is always basically the same are emphasized.

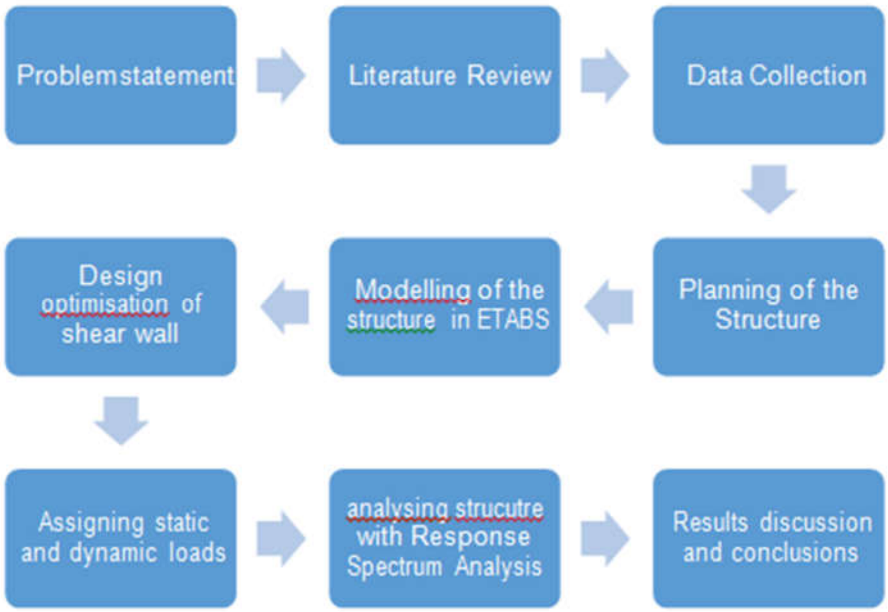
Anthony J. Wolanski, B.S (2004) did study on the flexural behavior of reinforced and prestressed concrete beams using finite element analysis. The two beams that were selected for modeling were simply supported and loaded with two symmetrically placed concentrated transverse loads.

BozdoganK.B.,Deierlein et.al.,2010 discussed in detail the modeling issues, nonlinear behavior and analysis of the frame – shear wall structural system. An approximate method which is based on the continuum approach and one dimensional finite element method to be used for lateral static and dynamic analyses of wall-frame buildings is presented. Shaik Kamal

Shahabodin ,Zaregarizi (2013) presented a study on Comparative investigation on using shear wall and concrete infill to improve seismic performance of existing buildings in areas with high seismic potential. Results shows that concrete fills have considerable strength than brick in fills. whereas the displacement acceptance of brick infills is higher than concrete infills. Masonry infills as lateral resisting elements have considerable strength which can prevent even collapse in moderate earthquakes. Performance of concrete infills is dependent on adjacent elements especially columns, so premature failure in columns due to strong axial forces must be considered.

MisamAbidi,MangulkarMadhuri (2012) presented an assessment to understand the behavior of Reinforced Concrete framed structures by pushover analysis and the Comparative study was done for different models in terms of base shear, displacement, performance point. The inelastic behaviour of the example structures are examined by carrying out displacement controlled pushover analysis.

METHODOLOGY:



MODELLING WITH ETABS

Planning of a structure entails considering the service conditions of the structure. That is, the occupancy, capacity, lifetime and durability. The plan gives the top view of the structure giving the floor plan. The different structural members are drawn and a plan is created. The plan shows the beams, columns and shear walls.

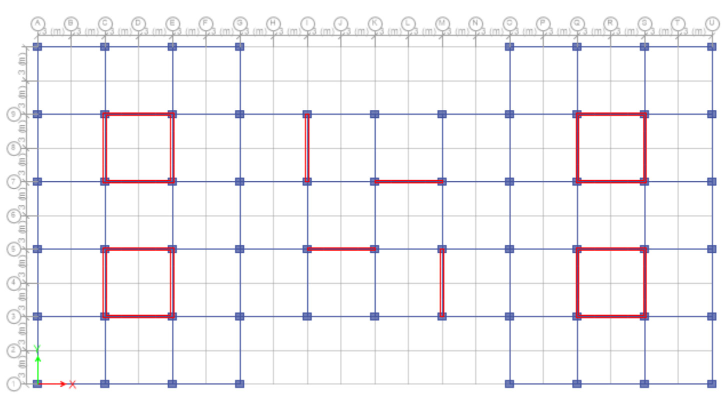


Fig :Top view Plan of the building (from Etabs)

The plan only provides for the floor plan but the structure needs to be analysed in real time conditions hence a full isometric view or 3D view is generated for understanding the structural behavior more holistically.

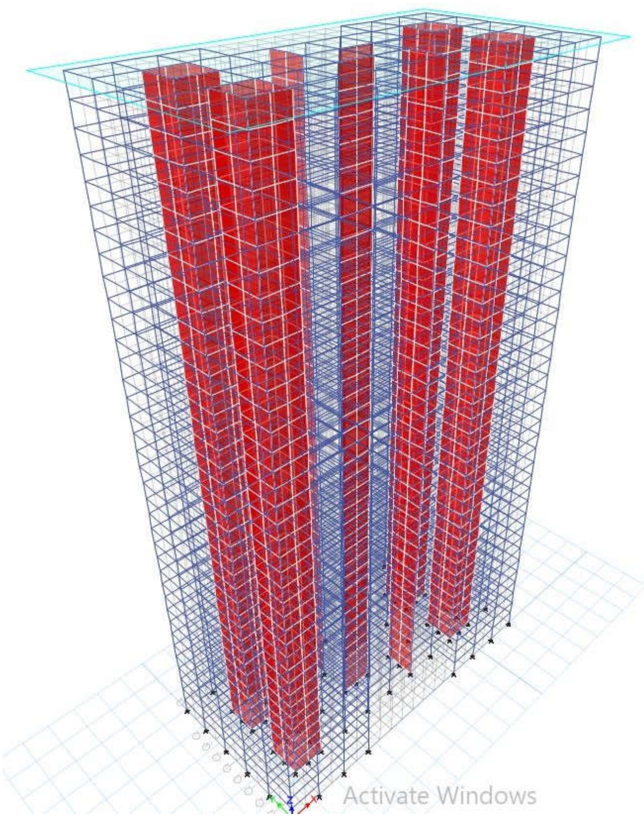


Fig : Isometric view of building (From Etabs)

The fig shows the structural behavior of building that is members,shear walls etc. of whole building.

Story Data

The table1 shows the details of different storys in building that are size of height,elevation etc. and The height of are storys are given constant value.

Table 1 - Story Data

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
Story 37	3000	111000	Yes	None	No

Story 36	3000	108000	No	Story 37	No
Story 35	3000	105000	No	Story 37	No
Story 34	3000	102000	No	Story 37	No
Story 33	3000	99000	No	Story 37	No
Story 32	3000	96000	No	Story 37	No
Story 31	3000	93000	No	Story 37	No
Story 30	3000	90000	No	Story 37	No
Story 29	3000	87000	No	Story 37	No
Story 28	3000	84000	No	Story 37	No
Story 27	3000	81000	No	Story 37	No
Story 26	3000	78000	No	Story 37	No
Story 25	3000	75000	No	Story 37	No
Story 24	3000	72000	No	Story 37	No
Story 23	3000	69000	No	Story 37	No
Story 22	3000	66000	No	Story 37	No
Story 21	3000	63000	No	Story 37	No

CONCLUSIONS

The structure was successfully built using ETABS and the Response spectrum analysis was used to gauge the behaviour of the structure. The structure performed admirably and the results are discussed below.

- The structure not being the same shape all around has changed the displacement of the structure in X and Y direction.
- Displacement is greater in X direction than in Y direction.
- The story drift is also very high when compared to the Y direction.
- The shear walls are symmetrically distributed in X direction and asymmetric in the Y direction.

- Shear wall configuration being symmetric reduces it damping effect than from an asymmetric arrangement.
- The best way to reduce drift and displacement during lateral loading is to incorporate shear wall in an asymmetric configuration in both directions.

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