International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 6, pp: 300-310 www.ijaem.net ISSN: 2395-5252

Seismic Analysis of Tall Building with Central Core as Tube Structure

Mrunal P. Kawade[1], Vivek S. Bangde[2], G.H. SAWAI[3]
[1,2]*Student, Department of Civil Engineering, RashtrasantTukdojiMaharaj Nagpur University, Nagpur, India.*
[3]*Head of Department, Department of Civil Engineering, VM Institute of Engineering & Technology, Nagpur, India VM Institute of Engineering & Technology, Nagpur, Maharashtra, India.*
Corresponding Author: Mrunal P. Kawade

Date of Submission: 02-09-2020 Date of Acceptance: 20-09-2020

ABSTRACT:-A High Rise building with 25 floors having a centralized shear core is analyzed for earthquake loads with respect to a RC Frame Structure having same number of storeys. Comparison is made among the 8 configurations of the same building plan which are: Rigid Frame, Rigid Frame with central shear wall, Tube in Tube Structure, Tube Mega Frame Structure, Suspended Structure, Trussed Tube, Tube in Tube with Outriggers & Frame with central core and outriggers & belt truss. The usefulness of shear walls in the structural planning of multi-storey buildings has long been recognized. Incorporation of shear wall has become inevitable in multi-storey building to resist lateral forces. The buildings have been modeled using ETABS software for earthquake zone V in India. This paper aims to determine the effect of seismic loads, To study the lateral storey displacement, story drift and base shear, Story shear and time period for rigid frame, frame shear wall, braced frame, suspended structure, tube-in-tube and tubed mega framed structure. Dynamic responses under zone V earthquake as per IS 1893 (part 1): 2016 have been carried out. In dynamic analysis, Response Spectrum method isused

Key Words: Shear Core, Response Spectrum, High Rise, ETABS, Seismic, drift, shear, time period.

I. INTRODUCTION

1.1 Background

A high rise building provides effective way for the residential and commercial use. Apart from these advantages, a high rise building becomes landmarks of a city to signify the whole world. Different types of structural systems are to be used to resist the effect of lateral loads on the buildings. They are rigid frame structures, braced frame structures, shear wall frame structures, outrigger systems, and tubular structures. Out of these the tubular systems are extensively used and which is considered as a better lateral structural systems for high rise buildings. The tubular structures are further classified as frame tube, braced tube, bundled tube, tube in tube, and tube mega frame structures. The tube in tube structures and tube mega frame structures are the innovative and fresh concept in the tubular structures. The tube in tube structures are to be widely used in tall buildings. And the tubed mega frame structures are the new concept in the field of tubular structures for tall buildings. Generally Tube in tube structures are formed by connecting peripheral frame tube and inner core tube. These tubes are interconnected by system of floor slabs and grid beams.as the columns of outer and inner core tubes are placed so closely, it is not seen as a solid system but it act like a solid surface. In the tube in tube structure the high strength concrete central tube carries the major load. The total loads acting on the structures to be collectively shared between the inner and outer tubes. The tubed mega frames are new concept for tall building. It is formed by avoiding central core tube and peripheral tubes connected by perimeter wall instead of one central core. The main function of perimeter wall is to transfer load between the long vertical tubes. In tubed mega frames instead of one central tube several vertical tubes are carrying the lateral loads. And the space utilization is maximum in tubed mega frames compare to tube in tube structure.

1.2 Lateral load resistingsystems

Lateral load resisting systems are structural elements which resist seismic, wind and eccentric gravity loads. There are a lot of different systems but they can be broken down to three fundamental ones which all other systems are a combination of. They are:

- Shearwalls
- Moment resistingframes
- Braced frames

1.3 Structural System in High RiseBuilding

The two primary types of vertical load resisting elements of tall buildings are columns and walls, the later acting either independently as a shear walls or in assemblies as shear wall cores. The building function will lead naturally to the provision of all to divide and enclose space, and cores to contain and convey services such as elevators. Column will beprovided,inotherwiseunsupportedregions,totransmit gravity loads and, in some types of structures horizontal loads.

1.4 Shear wall – framebuildings

A Shear Wall is a structural system composed of braced panels (also known as shear panels) to counter the effects of lateral load acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. Depending on the size of the building some interior walls must be braced as well. The main function of shear wall for the type of structure being considered here is to increase the rigidity for lateral load resistance. Shear walls also resist vertical load, and the difference between a column and a shear wall may not always be obvious. The distinguishing features are the much higher moment of inertia of the shear wall than a column and the width of the shear wall, which is not negligible in comparison with the span of adjacentbeams

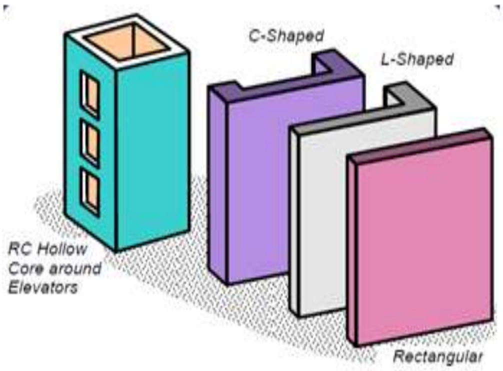

Figure 1.1 Various Types of Shear Walls

1.5 Braced rigidframe

If the braced frame, or shear walls, and a rigid frame are combined, it produces a greater amount of lateral stiffness. This is because of the way the two systems react to the horizontal loads. With the moment frames shear deformation and the bracing's bending deformation the combined deformation is more efficient, as shown inFigure 1.3. Instead of continuing to bend at the top the rigid frame keeps the shear wall or braced frame in place, while at the bottom the bracing, or wall, is restraining the shear deformation of the moment frame. This results in a deflection with an "S" shape

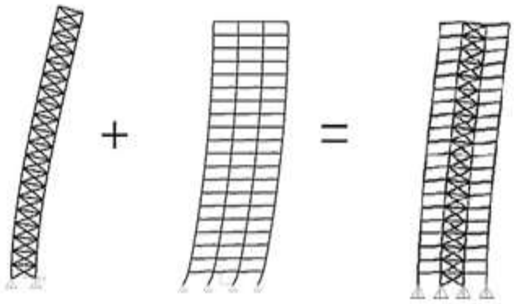

Figure 1.2 A braced frame combined with a rigid frame will decrease a buildings deflection

1.6 Tubulardesign

In the 1960's Fazlur Khan discovered that the steel frame systems was not the only way to stabilize high-rise buildings. By looking at a building as a vertically standing hollow box, cantilevering out of the ground, he discovered the tube design. As a theoretical idea he pictured the walls around the building being solid, later adding openings for windows for a workable application. This analysis showed that even with openings this structural form would provide a lot in terms of lateral resistance. This is because when the walls are connected as a box it will fully utilize the outer perimeter walls in every direction; see Figure 1.4 and following page. Elementary beam theory indicates that the elements farthest away from the central axis will be the most utilized in supporting the structures bending loads and obtaining greater stiffness. Along with providing lateral stiffness the perimeter is often designed to take a larger part of the vertical load than before. With more vertical load in the perimeter the buildings ability to resist overturning increases. Khan's discovery of the tube offered a few new variations such as the framed tube, trussed tube and the bundled tube. (Khan, 2004)

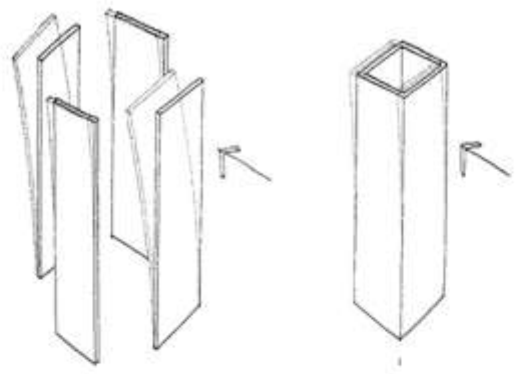

Figure 1.3 When subjected to wind loads, unconnected walls will bend around their weak axis offering little resistance. If connected to a tube, the walls will participate together in resisting the load. The effectiveness will increase significantly (Khan,2004)

II. METHODOLOGY

2.1 Essentials of Structural Systems for Seismic Resistance

The primary purpose of all structural members used in buildings is to support gravity loads. However, buildings may also be subjected to lateral forces due to wind and earthquakes. The effects of lateral forces in buildings will be more significant as the building height increases. All structural systems will not behave equally under seismic excitation. Aspects of structural configuration, symmetry, mass distribution and vertical regularity must be considered.In addition to that, the importance of strength, stiffness and ductility in relation to acceptable response must be evaluated in structural system (Paulay and Priestley, 1992). The first task of the structural designer is to select the appropriate structural system for the satisfactory seismic performance of the building within the constraints dictated by architectural requirements. It is better where possible to discuss architect and structural engineer for alternative structural configuration at the earliest stage of concept development. Thus, undesirable geometry is not locked into the system before structural design is started. Irregularities in buildings contribute to complexity of structural behavior. When not recognized, they may result in unexpected damage and even collapse of the structures. There are many possible sources of structural irregularities. Drastic changes in geometry, interruptions in load path, discontinuities in both strength and stiffness, disruption in critical region by openings and unusual proportion of members are few of the possibilities. The recognition of many of these irregularities and of conceptions for remedial measures for the mitigation of their undesired effects relies on sound understanding of structuralbehavior.

2.2 Response SpectrumMethod

In order to perform the seismic analysis and design of a structure to be built at a particular location, the actual time history record is required. However, it is not possible to have such records at each and every location. Further, the seismic analysis of structures cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. This deals with response spectrum method and its application to various types of the structures. The codal provisions as per IS 1893 (Part 1): 2016 code for response spectrum analysis of multi-story building is alsosummarized.

2.3 Details of theBuilding

A symmetrical building of plan 32m X 32m located with location in zone V, India is considered. Eight bays of length 4m along X - direction Y - direction are provided. Shear Wall is provided at the center core.

Table 2.1.Details of the building

Building Parameters	**Details**
Type of frame	Special RC moment resisting frame fixedat the base
Building plan	32m X 32m
Number of storeys	25
Length of span in X direction	4m
Length of span in Y direction	4m
Floor height	3.0 m
Depth of Slab	150 mm
Size of beam	(300 × 800)

	mm
Size of column	(exterior) (800 × 800) mm
Size of column	(interior) (800 × 800) mm
Live load on floor	2 KN/m2
Floor finish	1.0 KN/m2
Wall load (230mm brick wall)	13.8 KN/m
Grade of Concrete	M 40 concrete
Grade of Steel	Fe500
Thickness of shear wall	400mm
Bracing section	ISMC 300
Density of concrete	25 KN/m3
Damping of structure	5 percent

Table 2.2.Details of seismic parameters

Seismic Parameters	**Details**
Seismic zone	V
Importance factor	1.2
Response reduction factor	5
Type of soil	Medium
Response spectra	As per IS 1893(Part-1):2016
Damping of structure	5 percent

III. MODELING OFBUILDING

3.1 ModelDesign

One of the objectives of this model generation is to ensure that the models represent the characteristics of residential buildings. High-rise buildings are different in shape, height and functions. This makes each building characteristics different from each other. There are some standards for each kind of high-rise buildings, such as residential, office and commercials. However, for model generation, main factors such as column layout, grid spacing, floor shape, floor height, mass and stiffness irregularity, and column orientation were considered. Mostly in Residential buildings, floor plan will be same for all floors. So the buildings were considered with same floor plan in allfloors. Shear walls of same section were used for same height of buildings throughout the height. In this study a high rise multi-storey building is studied for building with shear walls provided at the centre core. The buildings are modeled using software ETABS. Dynamic analysis is carried out for thiscase.

3.2 Structural Modeling ofBuilding

To study the effects of central core on seismic responses of buildings, three dimensional (3D) geometric models of the buildings were developed in ETABS. Beams and columns were modeled as frame elements. Shear walls were modeled as plate elements. Floor slabs were modeled as rigid horizontal plane. Due to time limitations, it was impossible to account accurately for all aspects of behavior of all the components and materials even if their sizes and properties were known. Thus, for simplicity, following assumptions were made for the structural modeling:

1. The materials of the structure were assumed as homogeneous, isotropic and linearlyelastic.
2. The effects of secondary structural components and nonstructural components such as staircase, masonry infill walls were assumed to benegligible.
3. Floors slabs were assumed rigid inplane.
4. Foundation for analysis was considered asrigid.

3.3 Layout of theBuildings

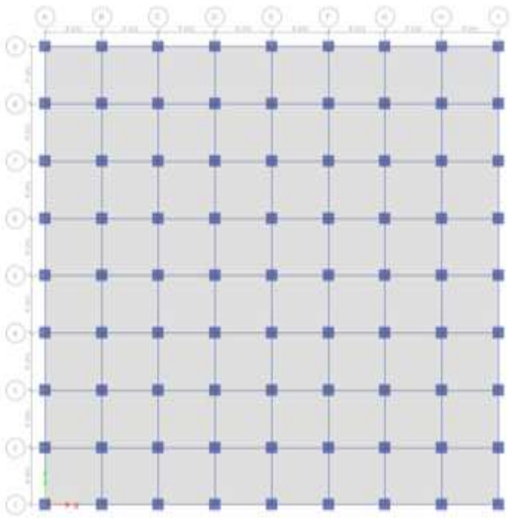

Fig.3.1 Plan of Rigid Frame

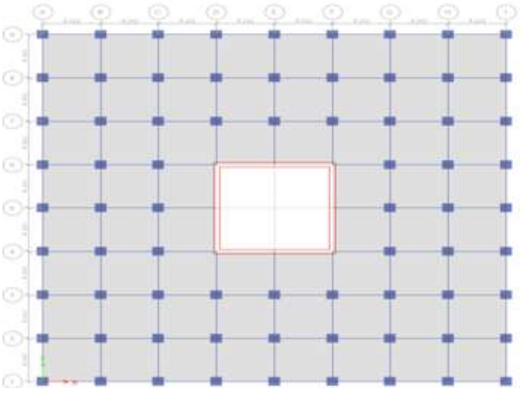

Fig.3.2 Plan of Frame with central shear wall core

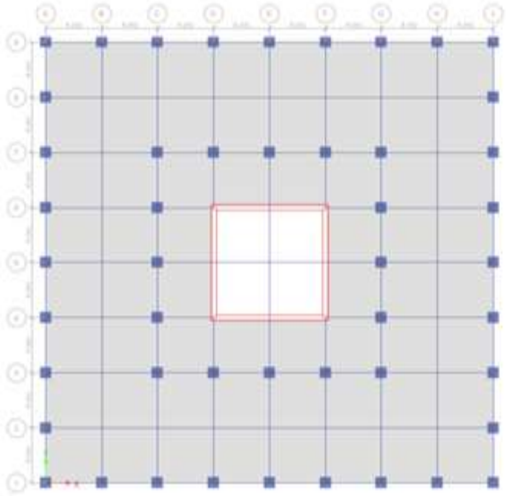

Fig.3.3 Plan of Tube in tube frame

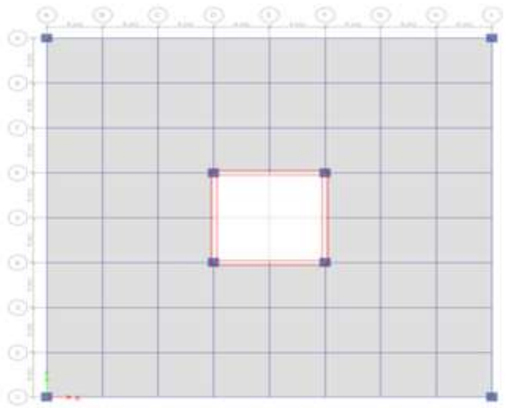

Fig.3.4 Plan of Tubed mega frame structure

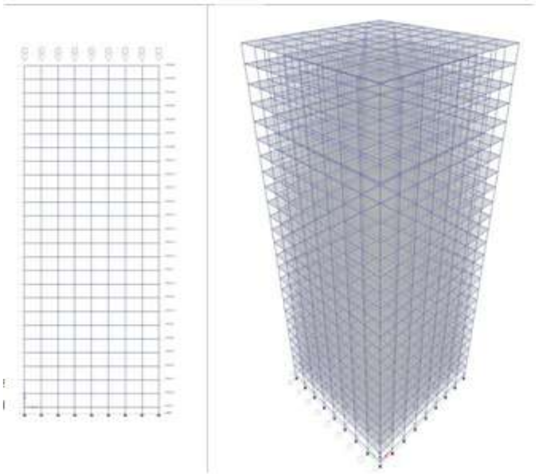

Figure 3.5 Rigid Frame

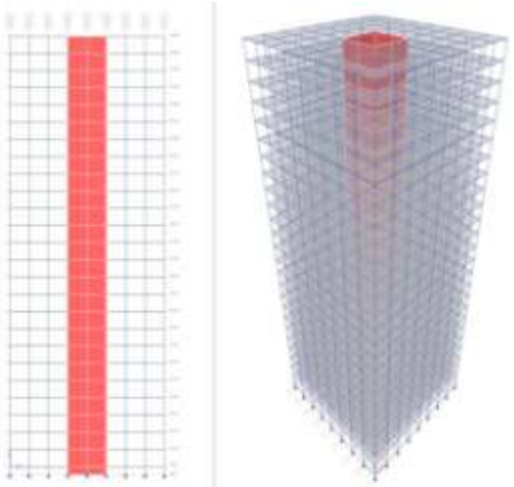

Figure 3.6 Rigid Frame with central shear wall

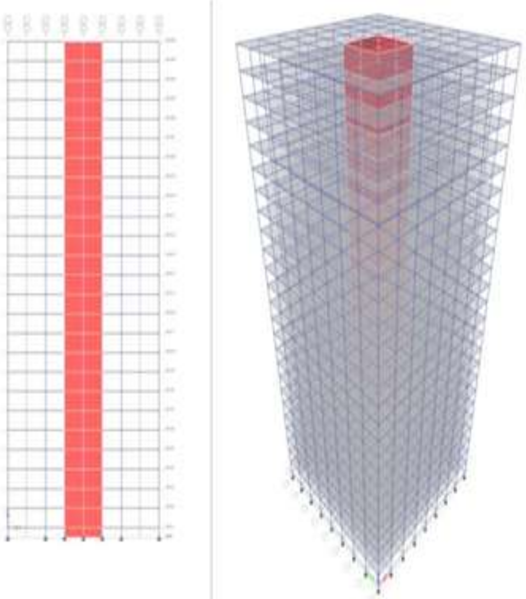

Figure 3.7 Tube in tube structure

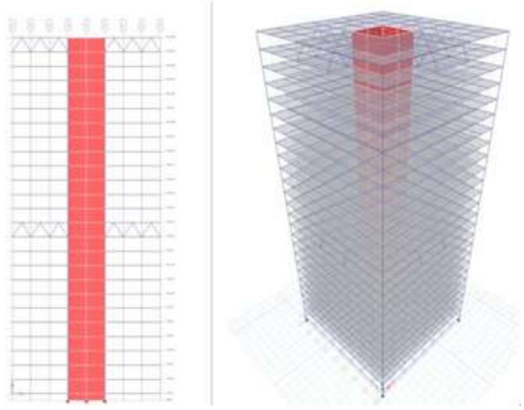

Figure 3.8 Tubed mega frame structure

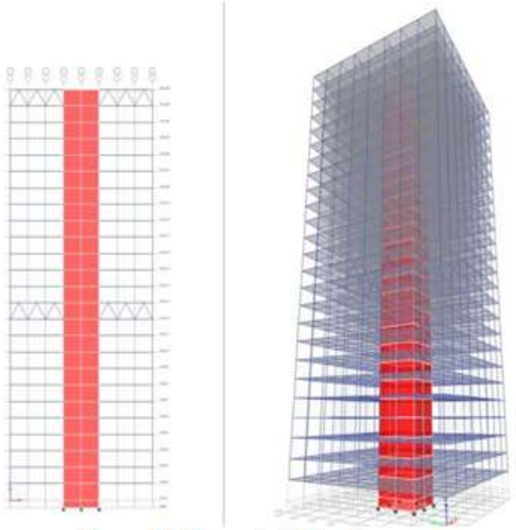

Figure 3.9 Suspended Tube Structure

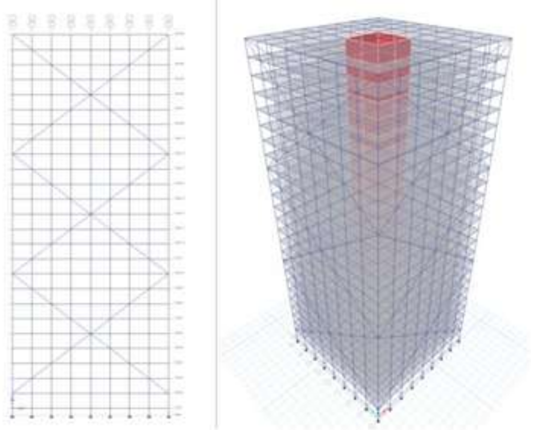

Figure 3.10 Trussed Tube

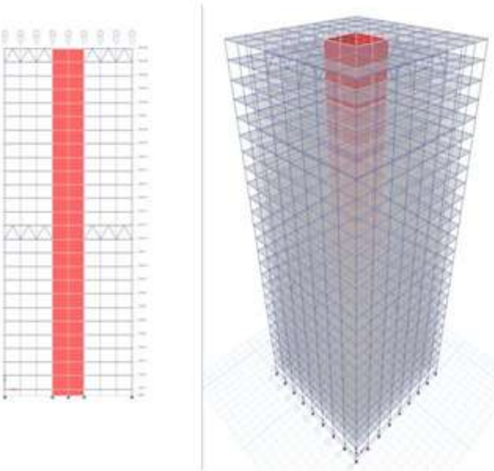

Figure 3.11 Tube in tube with outriggers

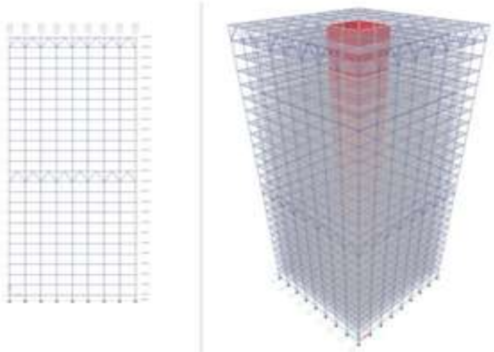

Figure 3.12 Frame with central core and outriggers & belt truss

3.4 Building DesignRequirements

The proposed reinforced concrete shear wall buildings are located in zone V, India. Code requirements from IS 456 : 2000, and IS 1893 (part 1) : 2016 were used for structural design.

In the ETABS design model, modeling was done in order to verify sufficient strength and stiffness. Rigid diaphragms, along with lumped masses, were assigned at each level.

3.5 LoadCombinations

As per IS 1893 (Part 1): 2016 Clause no. 6.3. the following load cases have to be considered for analysis:

1.5 (DL + IL)
1.2 (DL + IL ± EL)
1.5 (DL ± EL)
0.9 DL ± 1.5 EL

Earthquake load must be considered for +X, -X, +Y and –Y directions.

3.6 Structural Analysis

Initial dimensions of the structural elements for the buildings were assumed on the basis of gravity loads and imposed loads. Since, the buildings were assumed as apartment buildings, imposed load of 2 kN/m2 and load due to floor finish were taken as 1.0 kN/m2 as per Indian Standard, IS 875 (part2) : 1987. Lateral loads due to earthquake (EL) were calculated considering full dead load (DL) plus 25% of imposed load (IL), using seismic coefficient method given in IS 1893 (Part 1) : 2016.

Since the buildings were assumed as apartment buildings with dual system (shear wall and special moment resisting frame) situated in seismic zone V,

Importance factor (I) = 1.2,
Zone factor (Z) = 0.36 and
Response reduction factor (R) = 5 as given

in IS code -1893 were used for lateral load calculations. Assuming medium type of soil on which the foundations rest and the damping ratio of 5% for concrete structure, average response acceleration coefficient (Sa/g) was obtained from depending on the approximate fundamental natural time period of the structure estimated

$$\text{By: } Ta = \frac{0.09h}{\sqrt{d}}$$

In which,

h = height of building in meter
d = base dimension of the building at plinth level, in meter, along the considered direction of lateral force

$$Qi = VB\left\{\frac{Wihi^2}{\sum_{j=1}^{n} Wihi^2}\right\}$$

Qi = design lateral force at floor i
Wi = seismic weight of floor i
hi = height of floor i measured from base, and
n = number of stories in the building, is the number of levels at which masses are located assuming the floor is capable of providing rigid diaphragm action (floor to be infinitely rigid in the horizontal plane), total shear in any horizontal plane is distributed to the various vertical elements according to their relativestiffness.

After several analyses in ETABS using equivalent static lateral force analysis for various load combinations given in IS 1893 (Part 1): 2016, final dimensions of the structural elements for further analyses of the buildings were obtained. The maximum percentage of reinforcements for structural elements was limited to 4% of concrete gross area as per IS 456 : 2000.

Concrete grade of M40 i.e. characteristic compressive strength (fck) of 40 N/mm² was assumed for all structural elements. Material properties were assumed same for all structural elements used in both allthe buildings. The material properties assumed for final structural analysis are asfollows:

Modulus of elasticity (E) = 31.62×10^6kN/m2
Poisson's ratio (ν) = 0.15
Unit weight of concrete (γ) = 25 kN/m3

IV. RESULT AND DISCUSSIONS

The behavior of each model is studied and the results are tabulated. The variation of systematic parameters like base shear, lateral displacement, story drift, natural time period, axial force, shear force and moments in column and shear force, torsion and moment in beam has been studied for response spectrum analysis method.

Model 1	Rigid Frame
Model 2	Frame with central shear wall
Model 3	Tube in tube structure
Model 4	Tubed mega frame structure
Model 5	Suspended structure
Model 6	Trussed Tube
Model 7	Tube in tube with outriggers
Model 8	Frame with outriggers & belt truss

4.1 Results of Base shear for allmodels

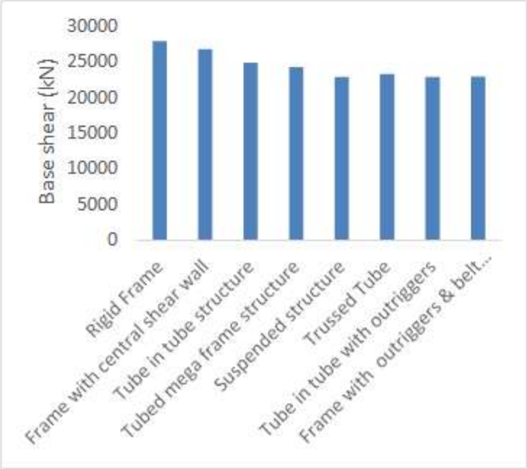

Figure 4.1 Comparison of Base shear

Figure 4.1 shows comparison of base shear for all eight models. It shows that base shear is maximum in rigid frame without central shear wall core and minimum in suspended structure with central shear wall core. By adding central shear wall core base shear is reduced in all models other than rigid frame up to 10% to 25%.

4.2 Results of maximum lateral displacement for all models

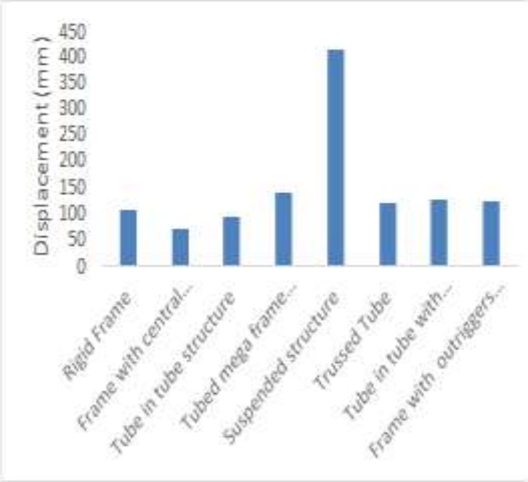

Figure 4.2 Comparison of maximum lateral displacement

Figure 4.2 shows comparison of maximum lateral displacement for all eight models. It shows that lateral displacement is maximum in suspended structure with central shear wall core and minimum in frame with central shear wall core. By adding central shear wall core lateral displacement is reduced in rigid frame and tube in tube structure. But in tubed mega frame and suspended structure displacement is increased drastically which is about 80%. By providing truss in outer frame, displacement is controlled but still high is increased upto 30% as compared to frame with central core. It is because of columns are provided in outer perimeter only in tubed structure.

4.3 Results of natural time period for allmodels

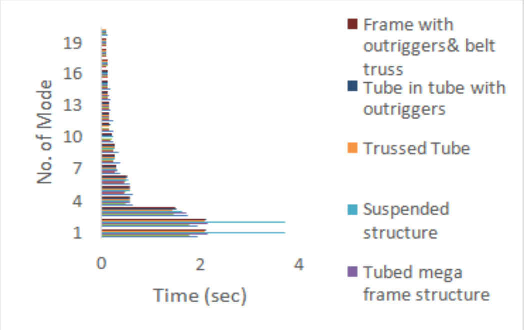

Figure 4.3 Comparison of natural time period

Figure 4.3 shows comparison of natural time period for all eight models. It shows that time period is maximum in suspended structure with central shear wall core and minimum in rigid frame with central core. This is due to central shear wall core in rigid frame added extra stiffness in structure which reduced lateral displacement thus reducing oscillation period of structure. Though other tubed frame having central core, but columns only in outer perimeter reduces stability of structure increasing oscillation period ofstructure.

4.4 Results of storey drift for allmodels

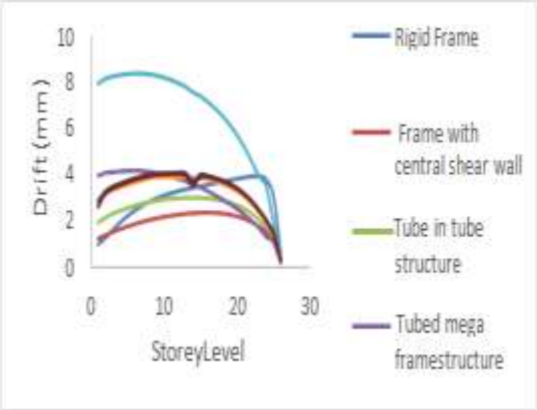

Figure 4.4 Comparison of storeydrift

Figure 4.4 shows comparison of storey drift for all eight models. It shows that strorey drift is maximum in suspended structure with central shear wall core and minimum in rigid frame with central core. This is due to centrals hear wall coreinrigid frame added extra stiffness in structure which reduced lateral displacement thus reducing storey drift ratio of structure. Though other tubed frame having central core, but columns only in outer perimeter reduces stability of structure increasing storey drift ratio of structure.

4.5 Results of axial force in column for allmodels

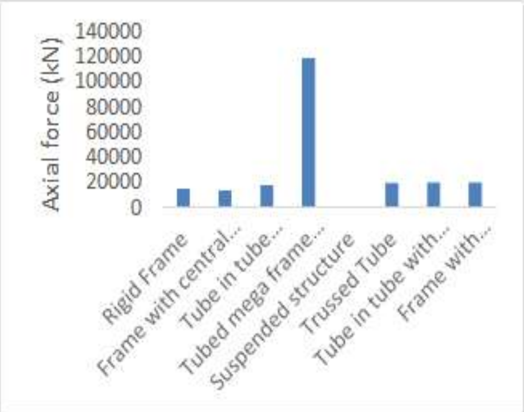

Figure 4.5 Comparison of axial force in column

Figure 4.5 shows comparison of axial force in column for all eight models. It shows that axial force is maximum in tubed mega frame with central shear wall core and minimum in suspended structure with central core. This is due to tubed mega frame having only four columns at corner of 3 times increased size of design section carrying highest axial force in column. While in suspended structure all weight of structure is concentrated on central core and less force is passing through column. Axial force in column of tubed mega frame is increased upto 90% than in frame with centralcore.

4.6 Results of shear force in beams for allmodels

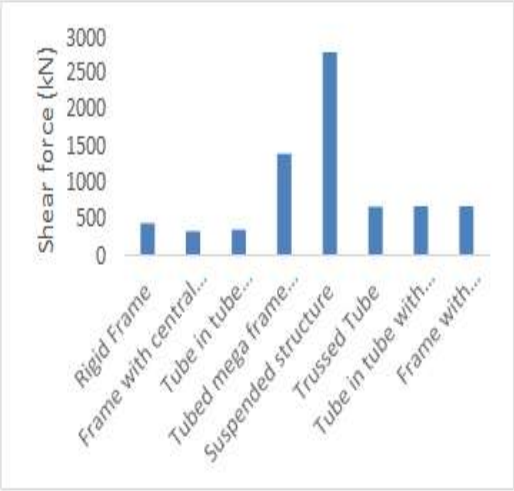

Figure 4.6 Comparison of shear force in beam

Figure 4.6 shows comparison of shear force in beam for all eight models. It shows that shear force is maximum in tubed mega frame and suspended structure with central shear wall core. It is minimum in frame with central core. Shear force in tubed mega frame is increased upto 50% and in suspended structure is increased upto 85% than other models.

V. CONCLUSION AND FUTURESTUDY

It is not a simple task to determine which of the stabilization system that is most effective because there appears to be no universal solution to meet all possible requirements that may arise. Some systems are best suited taking into account certain factors, but has disadvantages over others. Based on the analysis as discussed in chapter5 following conclusions can bedrawn.

- From the previous study we can observed that rigid frame have maximum base shear against lateral seismic loading and other models with central core wall i.e. tube in tube, tubed mega frame, suspended structure, frame with outriggers and truss shows gradually decreasing baseshear.
- From the previous study we can observed that rigid frame with central core wall will get maximum reduction in displacement and drift. Whereas suspended structure with core wall shows drastically increasing displacement and drift as whole weight of structure stabilized on central corewall.
- Natural time period for tubed mega frame and suspended structure are more than othermodels.
- Axial force, shear force and moments in column are very high in both tubed mega frame structure and suspended structure. Also shear force and moments in beam are maximum in bothstructure.
- Hence, practically tubed mega frame and suspended structure are not economic structure. Also these structure cannot be efficiently designed against lateral seismic loading.
- On other hand, by adding central core wall in rigid frame and tube in tube structure behaves efficiently against lateral loading because of increased stiffness.
- From the results depicts that Outrigger and belt truss one of the efficient resisting system against lateral load used in the multistory buildings. But abrupt changes in the number of column in geometry reduces the stiffness of thebuilding.

FUTURE STUDY

- The study can be extended for steel and composite multistoried building.
- Different plan geometry can be considered for further study.
- Here analysis is done with response spectrum method. Further analysis can be do with time history method and comparative results can be plot.
- Quantity of concrete and steel can be find out and do cost estimation ofmaterial.

REFRENCES

[1]. Mohan K, “Analysis Of Different Forms Of Tube In Tube Structures Subjected To Lateral Loads”(IJIRT) ISSN : 2349-6002, Volume 4 ,Issue 2, July 2017

[2]. Archana J, Reshmi P R, “Comparative Study On Tube-In-Tube Structures And Tubed Mega Frames”, Vol. 5, Issue 8, August2016.

[3]. Basavanag ouda A Patil And Kavitha.S, “Dynamic Analysis of Tall Tubular Steel Structures For Different Geometric Configurations,” International Journal Of

Engineering Research, ISSN: 2321-7758, Vol.4. Issue.4. 2016 (July-August).

[4]. Hamid MirzaHosseini, “Optimal Design Of Tube In Tube Systems”, Indian Journal Of Fundamental And Applied Life Sciences ISSN: 2231– 6345 2015 Vol. 5 (S3), Pp. 119-138/ Mirza Hosseini.

[5]. Nimmy Dileep, Renjith R, “Analytical Investigation On The Performance Of Tube-In-Tube Structures Subjected To Lateral Loads”, International Journal Of Technical Research And Applications E-ISSN: 2320-8163, Vol. 3, Issue4 (July-August 2015), PP. 284-288.

[6]. Dhana palagoud Patil And Naveena M P, “Dynamic Analysis Of Steel Tube Structure With Bracing Systems”, International Journal Of Research In Engineering And Technology Eissn: 2319-1163, Pissn: 2321-7308, Vol.04. Issue: 08August-2015.

[7]. Jignesha Patel, Roshni J John, “Seismic Analysis Of Frame Tube Structure”, International Journal Of Scientific & Engineering Research, Vol.6, Issue 12, December-2015.

[8]. Er. Nishant Rana And Siddhant Rana, “Structural Forms Systems For Tall Building Structures”, SSRG International Journal Of Civil Engineering (SSRG- IJCE) – Vol.1issue4 September2014.

[9]. Myoungsu Shin, Thomas H.-K. Kang And Benjamin Pimentel, “Towards Optimal Design Of High-Rise Building Tube Systems”, Thomas H.-K. Kang, School Of Civil Engineering And Environmental Science, University Of Oklahoma, 202 W. Boyd Street, Room 334, Norman, Ok 73019, USA Struct. Design Tall Spec. Build. 21, 447–464(2012)

[10]. Abdul KadirMarsono And Lee Siong Wee, “Nonlinear Finite Element Analysis Of Reinforced

[11]. Concrete Tube In Tube Of Tall Buildings”, Proceedings Of The 6th Asia-Pacific Structural Engineering And Construction Conference (APSEC 2006), 5– 6 September 2006, Kuala Lumpur, Malaysia.

[12]. Richard A. Ellis And David Pillington, “Seismic Analysis Of Frame Tube Structure”, International Journal Of Scientific & Engineering Research, Vol.4, Issue 6, December-2003.

[13]. Abhishek, Smitha B K, “Comparative Study Of Tube In Tube Structures And Tubed Mega Frames”, international Journal Of Recent Trends In Engineering & Research (Ijrter) Volume 04, Issue 06; June - 2018 [Issn:2455-1457]

[14]. Gangisetty Sri Harsha *, Dr. H. SudarsanaRao, “Shear Wall Analysis & Design Optimization In High Rise Buildings”, International Journal Of Engineering Sciences & Research Technology August, 2015, Issn: 2277-9655 (I2or), Publication Impact Factor:3.785

[15]. Mahdi Hosseini, Mohammed Farookh, Dr. HadiHosseini, ”earthquake Analysis Of Multi-Storey Building With Effect Of Shear Walls (Shear Walls At The Centre Core And Corners)”, International Journal Of Innovative Research In Science, Engineering And Technology ,Website: Www. Ijirset. Com Vol. 6, Issue 6, June2017

[16]. Mahdi Hosseini, N. V. RamanaRao, “earthquakes Analysis Of High Rise Buildings With Shear Walls At The Center Core And Center Of Each Side Of The External Perimeter With Opening”, international Journal Of Science And Research (Ijsr) Issn (Online): 2319-7064 Index Copernicus Value (2015): 78.96 | Impact Factor (2015):6.

[17]. Zahid Manzoor, Gurpreet Singh, “Analytical Study On Outrigger And Hexagrid System In High-Rise Buildings”, international Journal Of Innovative Technology And Exploring Engineering (Ijitee) Issn: 2278-3075, Volume-8 Issue-7 May, 2019

[18]. Prof. N. G. Gore, Miss PurvaMhatre, “Outrigger Structural System – A Review And Comparison Of The Structural System”, international Journal Of Engineering Trends And Technology (Ijett) – Volume 64 Number 1 – October2018.

[19]. Alok Rathore, Dr. SavitaMaru, “The Behavior Of Outrigger Structural System In High-Rise Building: Reviews”, international Journal Of Science, Engineering And Technology Research (Ijsetr) Volume 6, Issue 11, November 2017, Issn: 2278-7798

[20]. Is 1893 [Part-I]- 2016, “Criteria Of Earthquake Resistance Design Of Structures Bureau Of Indian Standards”, New Delhi.

[21]. Is 875 [Part-I]-1987, “Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures. Dead Loads Unit Weights Of Building Materials And Stored Materials, Bureau Of Indian Standard, NewDelhi.

[22]. Bureau Of Indian Standard, Is-456(2000),”Plain And Reinforced Concrete Code Of Practice”. Is 875[Part-Ii]-

1987.Code Of Practice For Design Loads (Other Than Earthquake) For Building Structures, Imposed Loads Bureau Of Indian Standard, New Delhi.

[23]. Ravikanth Chittiprolu, Ramacharla Pradeep Kumar "Significance Of Shear Wall In High-Rise Irregular Buildings". Etabs Nonlinear Ver.9, Extended Three Dimensional Analysis Of Building Systems, Computers And Structures Inc. Berkeley, Causa, 2006. [1] Duggal, S.K., "Earthquake Resistant Design Of Structures" Oxford University Press, New Delhi 2010

[24]. Chopra, A.K., "Dynamics Of Structures: Theory And Application To Earthquake Engineering", Pearson Education, 4th Edition,2012.