www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 4 April 2015, Page No. 11687-11697

Comparative Seismic Analysis Of An Irregular Building With A Shear Wall And Frame Tube System Of Various Sizes

B.N.Sarath, D.Claudiajeyapushpa

School of Mechanical and Building Sciences,
VIT University– Chennai- 600127,
Tamil Nadu.
naga.sarath2013@vit.ac.in
Assoc. Professor, (SMBS)
VIT University– Chennai- 600127
Tamil Nadu.
claudia.jeyapushpa@vit.ac.in

Abstract : **Lateral load effects on high rise buildings are quite significant and increase rapidly with increase in height. In high rise structures, the behavior of the structure is greatly influenced by the type of lateral system provided and the selection of appropriate. The selection is dependent on many aspects such as structural behavior of the system economic feasibility and availability of materials. Few of the lateral structural systems are Shear wall system, Braced frame system, Framed tube system, Tube in tube system, Bundled tube system. The lateral structural systems give the structure the stiffness, which would considerably decrease the lateral displacements. In the present work a Plain frame system, a Shear wall system and Framed tube system are considered for 30, 40, 50 and 60 story structures. The analysis has been carried out using software Etabs The roof displacements, internal forces (Support Reactions, Bending Moments and Shear Forced) of members and joint displacements are studied and compared. It is seen that the Shear wall system is very much effective in resisting lateral loads for the structures up to 30 stories and for structures beyond 30 stories the Framed tube system is very much effective than Shear wall system in resisting lateral loads.**

Keywords:*Etabs, Shear wall system, Frame tube system*

I. INTRODUCTION

In the ancient tall structures, which can be considered as prototypes of resent day high-rise buildings, were protective or symbolic in nature and were infrequently used Tall buildings were primarily solid, serving more as monuments than as space enclosures. Throughout history, people had to make use of the available building materials. The Pyramid of Cheops, for example, was built by piling huge masonry and timber, used in construction through the early centuries had their limitation. The spans which timber and stone could bridge, either as beams, lintels or arches, were limited. Wood was nor strong enough for large structures nor did it possess fire resisting characteristics. Brick and stone masonry, in spite of their excellent strength and fire resistance, suffered from the drawback of weight. The mass of masonry required to carry the weight of a structure elements, i.e., columns, walls, and braces, was inordinately large when compared to gross floor area. This percentage was at a maximum value for the pyramids.

II. LITERATURE REVIEW

X.G.H.E sudied the behavior of concrete frame core wall structure with non continuous exterior frame beams by considering a concrete frame wall tall building with inner balconies with 3 story height at the two opposite corners on some floors the corresponded edge beams cannot be connected to the two corner columns which are in a diagonal line. The layout affects the lateral stiffness of the structure. The behavior of the structure is compared with the ordinary frame core wall structure which has continuous exterior frame beams, and another way, comparison of behaviors of similar structures, in which inner balconies are with different story behaviors of similar structures, in which inner balcony are with different story heights, is carried out. It is concluded that the lacking of some corner beams of the introduced structure has little influence on its overall behavior. The influence is only about 3-4% and the seismic behavior of the structure is quite well.

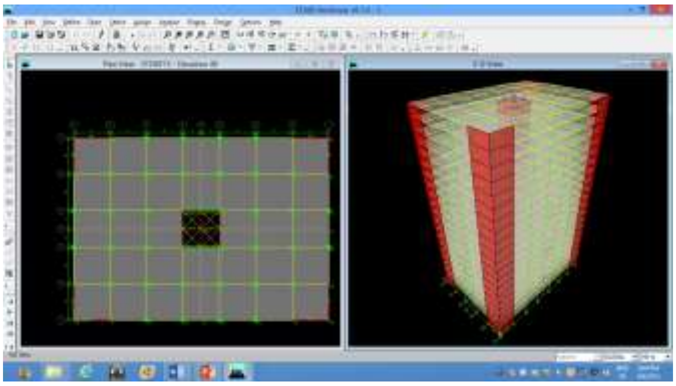
Khanetal discussed the analysis and design of framed tube structures for tall concrete buildings. The behavior of framed tube structures is discussed from an overall structural system point of view. The influence of various structural parameters is emphasized for achieving better tubular behaviors. The concept of the equivalent reduced plane frame modeling technique is used for developing a series of influence curves for the preliminary analysis and design.

A.M. Chandler et al suggested the application of strut-and-tie method on outrigger braced core wall buildings. This is to enhance practicing engineers to understand the general structural behavior of outrigger braced core wall system. Strut-and-tie method is applied to analyze the whole lateral structural system. The complete load transfer mechanism between the outrigger brace and the core wall is displayed. Many practical concerns in design including the structural behaviors of different configuration of our triggers, the effect of openings through the core wall adjacent to the outrigger brace, the arrangement of shear studs on outrigger brace and the shear link arrangement in core wall are briefly discussed.

Aysin Sev conducted a feasible study on tubular systems for tall office buildings with special cases.The building skeleton was considered with closely T aced perimeter columns that provide much greater lateral resistance than is obtained with conventional systems because of the three dimensional response of the building to lateral loads. This paper gives a brief explanation of tubular systems with a number of case studies from Turkey and abroad. In this context, the historical development of tubular systems is given firstly. Then, the tube concept is identified from the structural point of view as well as architectural point of view, and types of tubular systems - such as framed tubes, trussed tubes, and bundled tubes - are considered.

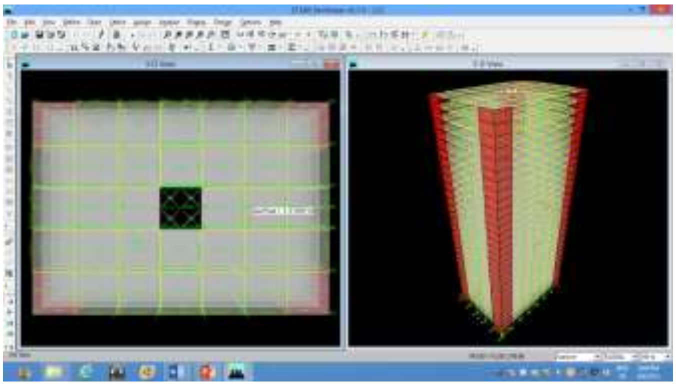
Jiemin Ding et al1 introduced the design and research for a tall building of concrete filled square steel tube. The braced - frame system was adopted to reduce the torsion effect brought by architectural irregularities of plan and elevation. The modal analysis, response spectrum analysis and time history analysis was carried out by several software. The period, displacement and story shearing force etc. were obtained and compared with each other.

III.MODELLING

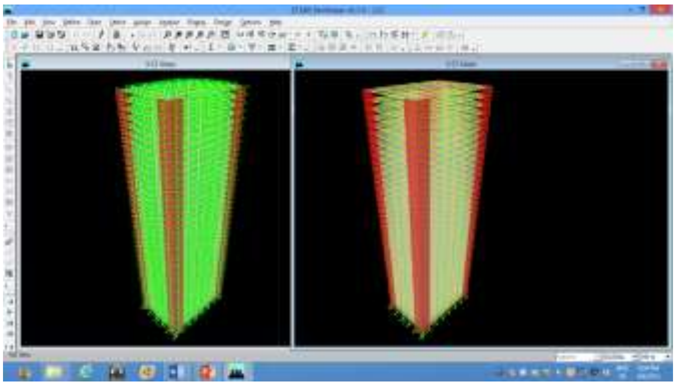


30 story building

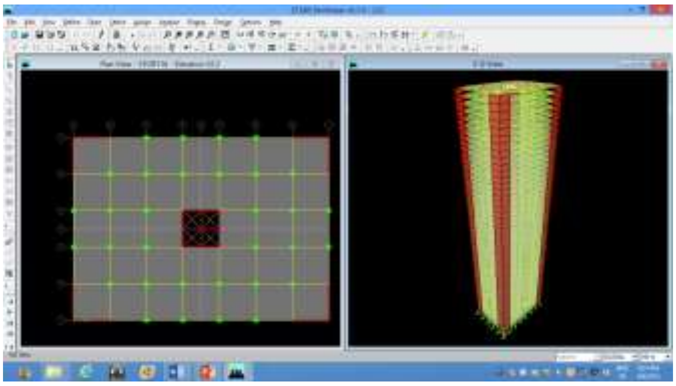
40 story building



50 story building



60 story building



IV DETAILS OF STRUCTURE

Floor Dimensions : 48m x 36m

Floor to Floor height : 3m

Heights of Structure Considered for the Study

30 - Story Structure - 91.5m

40 - Story Structure - 121.5m

50 - Story Structure - 151.5m

Loads

1. Dead Lead

Self Weight of the Slab + Self Weight of beams and columns

- Floor finish + Wall Load

Wall load - 6kN/m (Aerocon light weight Blocks are considered)

2. Live Load

Live Load + 4kN/m2 - Considered as a Mercantile Building as per IS 875 (Part 2) - 1987. Live load reduction is considered as per clause 3.2.1 of the code IS 875 (Part 2) - 1987

3. Wind Load

Wind Load considered for the Hyderabad region for the terrain category 3 and class B from IS : 875 (Part 3) - 1987

4. Earthquake Load

Earthquake load is considered in the form of Spectrum load for Zone - 2, Response reduction factor - 4. Importance factor - 1.5. Soil Type - medium values taken from IS : 1893 - 2002

-

V RESULTS

1.Results of 30 story structure

	Beam - Column Frame	Shear wall Frame	External Tube
Maximum Support Reactions in kN	9.59E + 04	8.94E + 04	7.33E + 04
maximum support Reactions in kN (outer periphery)	5.26E + 04	40625	10916

Table 5.1b Lateral displacements due to wind load different storey heights

Story number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	5	3	2
10	9	6	4
15	13	9	6
20	26	13	14
25	35	16	19
30	40	19	22

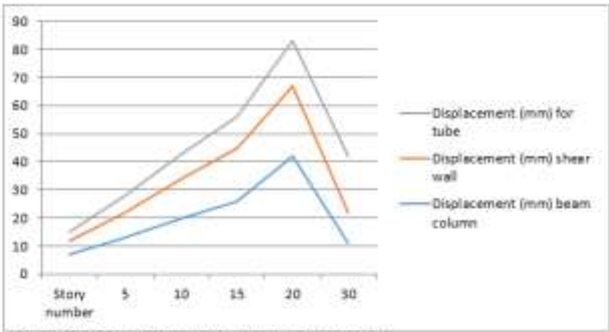
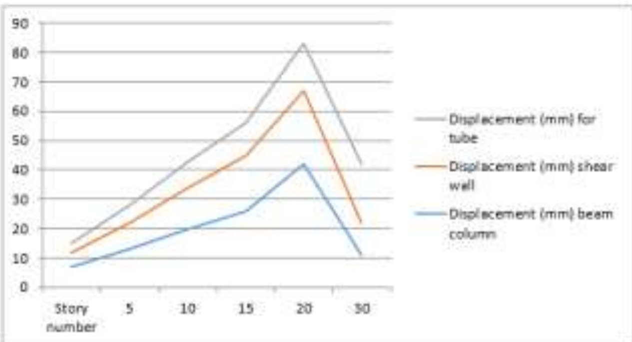


Figure 5.1a Graph Lateral displacement due to wind load Vs Number of storey

Table 5.1c Lateral displacements due to Earthquake load at different storey heights

Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) For for External Tube Frame
5	4	3	2
10	6	6	4
15	9	9	6
20	18	14	14
25	25	18	20
30	30	21	24



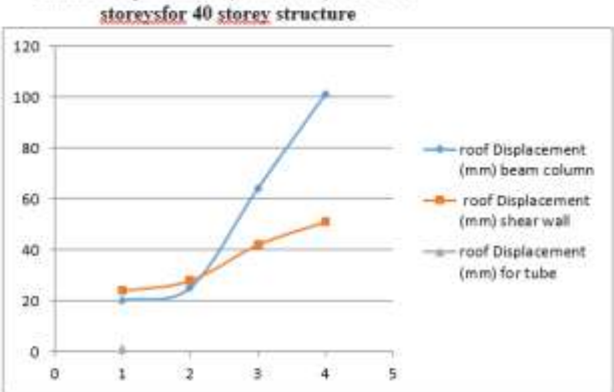
2.Results of 40 story building

	Beam Column Frame	Shear wall Frame	External Tube Frame
Maximum Support Reactions in kN	1.28E + 05	1.23E + 05	1.24E + 05
Maximum support Reactions in kN (outer periphery)	6.99E + 04	54156	16183

Table 3.2b Lateral displacements due to wind load at different storey heights

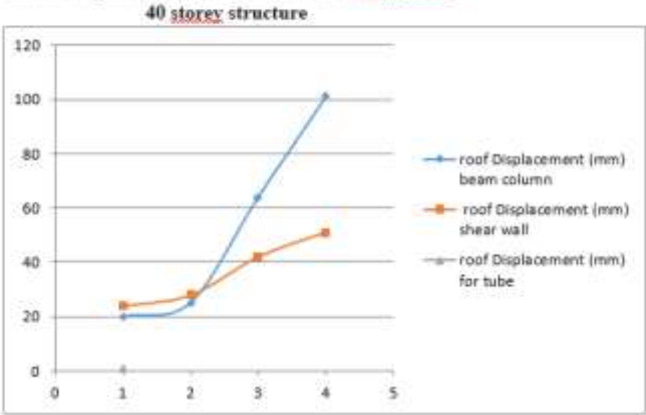
Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	7	5	3
10	13	9	6
15	20	14	9
20	28	19	11
25	42	25	16
30	53	31	19
35	65	36	22
40	72	41	25

Literal Displacement (Wind load) Vs No. of storeysfor 40 storey structure



Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	4	3	3
10	7	7	6
15	10	10	9
20	13	13	12
25	21	18	17
30	29	22	21
35	35	27	24
40	39	30	28

Literal Displacement (EQ load) Vs No. of storeysfor 40 storey structure

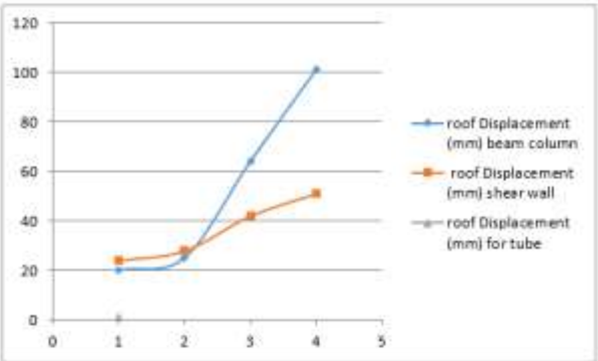


3.Results of 50 story building

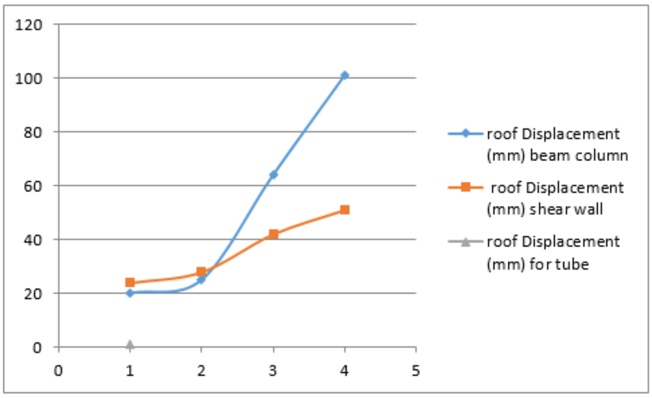
	Beam Column Frame	Shear wall Frame	External Tube Frame
Maximum Support Reactions in kN	1.63E + 05	1.59E + 05	1.43E + 05
Maximum support Reactions in kN (outer periphery)	8.68E + 04	68260	18230

Lateral displacements due to wind load at different storey heights

Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	8	7	5
10	16	14	9
15	24	21	13
20	32	28	18
25	49	37	24
30	81	56	37
35	81	56	37
40	100	65	48
45	115	74	58
50	126	82	64



Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	3	4	3
10	6	7	5
15	9	10	8
20	12	14	10
25	19	18	14
30	25	23	18
35	31	28	22
40	39	33	30
45	47	38	37
50	52	42	41



Literal Displacement (EQ load) Vs No. of storeysfor 50 storey structure

4.Results of 60 story building

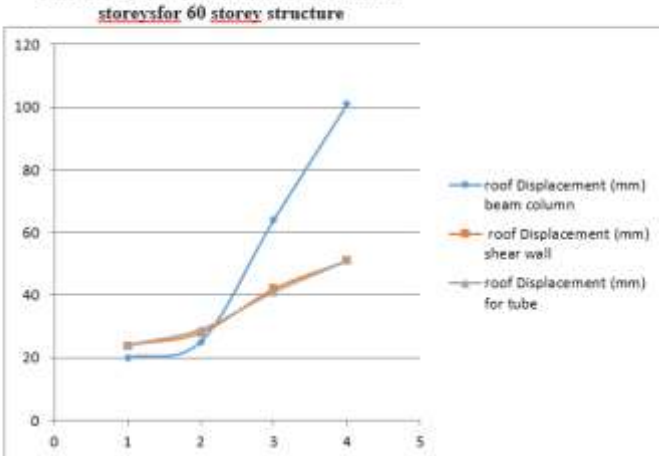
Results obtained for support reactions for the 60 storey structures

	Beam Column Frame	Shear wall Frame	External Tube Frame
Maximum Support Reactions in kN	1.94E + 05	1.90E + 05	1.76E + 05
Maximum support Reactions in kN (outer periphery)	1.02E + 05	81148	21830

Lateral displacements due to wind load at different storey heights

Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	10	9	7
10	19	18	13
15	29	28	19
20	40	37	25
25	53	50	33
30	66	64	41
35	88	78	50
40	109	92	59

Literal Displacement (Wind load) Vs No. of storeysfor 60 storey structure



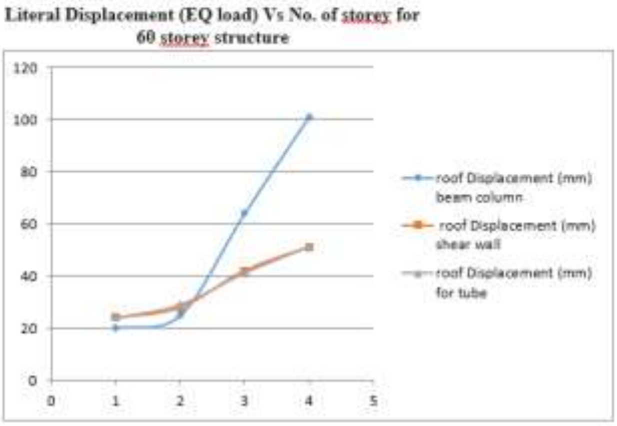


Figure 5.4a Graph Lateral displacement due to wind load Vs Number of storey Table 5.4c Lateral displacements due to earthquake load at different storey heights

Storey number	Displacement (mm) for Beam - Column Frame	Displacement (mm) for Shear wall Frame	Displacement (mm) for for External Tube Frame
5	3	3	3
10	6	7	6
15	9	10	9
20	13	13	12
25	16	18	16
30	21	23	20
35	28	28	24
40	34	33	28
45	43	39	35
50	50	45	41
55	57	51	46
60	62	56	51

V1 CONCLUSIONS

In the present work there lateral structural systems i.e. Plain Frame System, Shear wall system and Framed tube system are considered for 30, 40, 50 and 60 story structures. Based on the results obtained from he work, the following conclusions are drawn.

The lateral roof displacements in the 30-storey structures with Shear wall system and Framed tube system are very close (difference of nearly 2%) At the Shear wall system is economical compared to the Framed tube system, Shear wall system is preferred. The shear wall acts as a vertical cantilever for the building, the wall is stiff for shore lengths but as the length goes on increasing the stiffness of the wall decreases, hence it gets ineffective for much higher heights. Roof displacement in Shear wall system is reduced by 52.5% where as in Framed tube system it is reduced by 50% compared to the Plain frame system. For the 40, 50 and 60 story structures the Framed tube is very much effective in resisting lateral loads (both Wind and Earthquake loads) compared to the Shear wall structures. Framed Tube system is able to resist higher percentages of wind loads compared to the earthquake loads. The decrease in the lateral displacements in the 60 story Tube structure due to wind load combination is 45.4% where as due to earthquake load combination is 17.8% compared to the Plain Frame structure.

For the structure with Framed tube, the maximum support reactions for outer periphery supports are much less compared to that of the Shear wall structure as the columns are very close to each other. Maximum Base shear for the 30 story structure is observed for structure with Shear wall system. Maximum Base Shear for 40, 50 and 60 story structure is observed for structure with Framed tube system.

V11 REFERENCES

1. Ali, M.M., The Art of Skyscraper, Genius of Fazlur Khan, Rizzoli International Publications,

   Inc., New York (Forthcoming) 2001.

2. A.M. Chandler R.K. Su, and P.C.W. Wong (2005). "Application of Strut and Tie Method on Outrigger Braced Core Wall Buildings". proc. of "Tall Buildings - From Engineering to Sustainability, Hong Kong (www. eproceedings.worldsci.net)

3. Aysin Sev (2005), "Tubular Systems for Tall Office Buildings with Special cases from Turkey," proc. of "Tall Buildings - From Engineering to Sustainability cases from Turkey." Proc. of "Tall Buildings - From Engineering to Sustainability, Hong Kong

4. Bo Li, Kejia Yang, Mingke Deng, Xingwan Liang (2005), "Displacement - Based Seismic Design of Shear Wall Structure in Tall Buildings", proc. of "Tall Buildings from Engineering to Sustainability, Hong Kong

5. Bungule S Taranath, "Structural Analysis and Design of Tall Buildings", McGraw Hill Book

   Company, Singapore, p l 30 311 - 340 1988.

6. Colaco, J.P., (1971) "Preliminary Design of Shear walls for Tall Buildings", ACI journal, 3rdJanuary.

7. CTBUH, Architecture of Tall Buildings, Council of Tall Buildings and Urban Habitat, Monograph 30 M Ali P J. Armstrong, eds., McGraw - Hill, Inc., New York, 199