International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Optimization of Structures using Different Structural System

Shreyans Rathod†*, Israr Khan† and Keshav Sangle†

†Structural Engineering Department, V.J.T.I , Mutunga Mumbai India

Accepted 01 Sept 2016, Available online 02 Sept 2016, **Vol.6, No.5 (Oct 2016)**

Abstract

It is fairly accepted fact that one of the most important human activities is decision making. Like every filed even in construction industry decision making is important especially in high-rise construction. Construction of a high rise structure is a complicated affair with lateral loads playing a dominant role in design of structure it requires need of lateral load resisting system. With evolution in technology various load resisting systems arrived from normal load bearing structures to moment resisting frames to bracing to shear wall to some more modern structures like core out-trigger and tube in tube. Each have their own pros and cons. In the following study a G+50 storey structure has been analyzed using the tube in tube, shear wall and core out-trigger system in ETABS V9.7.4 software and an attempt is made to compare the performance of the three systems on basis of storey shear, storey displacement, time period and storey drift and cost and results are compared to arrive at the most optimum of the three systems for the given particular plan.

Keywords: *Shear wall, Core Out-trigger, tube in tube, ETABs, Optimization.*

1. Introduction

Advancement of technology and the development of economy of world have brought the new era of construction of high rise buildings. High-rise design comes into play when a structure's slender nature makes it dynamically sensitive to lateral loads .The simplified model for the behaviour of a tall building is a vertical cantilever out of the ground. Wind and seismic loading and are normally the governing loading in design of high-rise lateral systems and thus need special mechanism which can't be fulfilled by conventional structures. Thus a design of high rise structure is full of complications and requires new thinking.

The basic requirement of an efficient high rise structural design is that the response of the structure should be acceptable as per various specifications. There can be large number of feasible designs, but it is desirable to choose the best from these several designs. The best design could be in terms of minimum cost, minimum weight or maximum performance or time for construction or a combination of these.

Shear wall system, tube and tube system and core out-trigger system are some of the modern structural systems. Many studies have been conducted to find out the efficiencies of these systems individually but seldom have these systems been compared and this is scope of the project.

Comparison of performance of shear walls based on position and orientation and cost (P. P. Chandurkar, 2013) showed that shear walls placed at the edges combined with MRF and a central core was most efficient as compared to other positions. Lateral forces are reducing when the shear walls are added at the appropriate locations of frames having minimum lateral forces (Ravikanth Chittiprolu,2014). Shear wall provided at corner on each side the structure gives better result than the all position (Vikas Govalkar, 2014).

Analysis of framed tube structures with multiple internal tubes showing more the number of internal tube better is performance (Rakesh Arun, 2015). Importance of shear lag effect in action of axial and lateral loading in tubular structures was studied in the paper by (Uttam Kalwane, 2015).

Out trigger location should be at H/2, H/4, 3H/4 for maxium reduction in shear force (Krunal Z. Mistry, 2015).

Comparison of optimum outrigger locations obtained byresponse spectrum and nonlinear time history analysis by (Abbas Haghollahi, 2015).

To determine the most optimum system of systems under study a G+50 storey structure which 32x32m structure in plan was taken. The plan was symmetrically divided into bays of 4mx4m.The height of each storey was 3.6m.

*Corresponding author: **Shreyans Rathod**

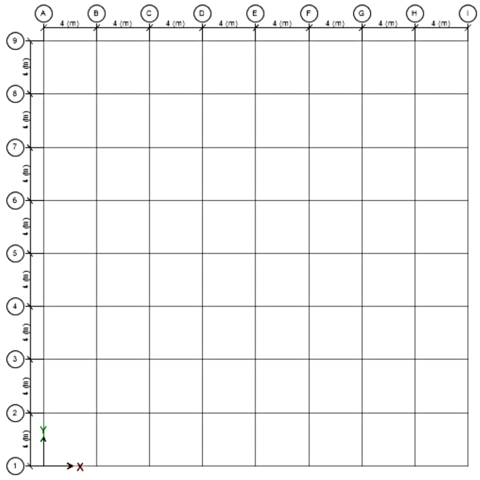

Figure 1: General Plan

2 General Considerations

2.1 Material Properties

Following were the material properties (table no 3.1), considered for modeling and analysis of structures.

Table 1.1 Material Properties

Section	Property
Column	M40
Beam	M35
Shear wall	M40
Slab	M30
Rebar	Hysd415
Binding wire	Fe250

2.2 Loading parameters

The loading parameters were as follows:

1) Dead Load: The weight of structure
2) Live Load: On slab 2 KN/m^2
3) Super Dead: On slab: 1 KN/m^2 On beam: 15KN/M.
4) Wind Load: Vb = 44m/sec Class – IV Category – C
5) Earthquake Load: R = 5, I = 1, Z = 0.36, ZONE = 3

2.3 Design considerations for members

1) Slab was designed as membrane such that load coming on the slab was transferred completely on beams.
2) Shear walls were modeled as thick membrane. For design of shear wall, C & T condition was applied.
3) Joints between beams and columns are assumed as rigid.
4) Mass source considerations for the loads are as mentioned below

Dead load – 1 Live load – 0.25 Super dead load - 1

Design combinations were auto selected from the load combinations in ETAB ULTIMATE 15.0.0

3. Modeling in ETABs

During the course of project the trial and error approach was followed. After detailed literature review a framing was selected and sizes of all elements were kept high and structure was checked. If no elements failed the sizes of the elements were gradually reduced to reach the minimum and no element failed. After a framing reached the elemental sizes at minima another framing of same system was selected. After all possible framing as per previous reviews were checked a new system was taken and the process was repeated. Framed structure was modeled with software ETABS V9.7.4. The following show the schematic diagram of models and their respective structural elemental sizes.

3.1 Shear wall System

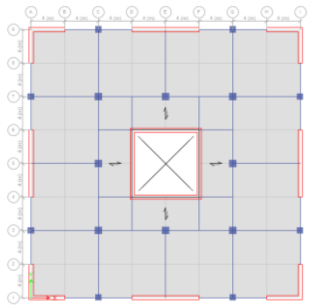

Figure 2 Plan of Shear Wall System

Table 3.1: Section properties of shear wall

Floor	Column	Beam	Shear wall
1-10	1500x1500	300x800(E) 300x800(I) 400x1000(I) 300x600(I)	600
11-20	1200x1200	Same as above	600
21-30	1000x1000	Same as above	600
31-40	700x700	Same as above	600
41-50	600x600	Same as above	600

3.2. Tube in Tube (2 tubes)

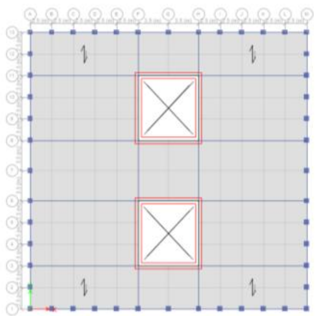

Figure 3 Plan of Tube in Tube with 2 tubes

Table 3.2 Section properties of tube in tube (2 tubes)

Floor	Beam	Column	Shear wall
1-5	450x1000(E) 450x1200(I)	900x900(E*) 1000x1000(I)	900
6-20	SAME AS ABOVE	900x900 (ALL)	750
21-50	SAME AS ABOVE	750x750 (E) 900x900 (I**)	500

*E :External, ** I: internal

3.3 Tube in Tube (single tube)

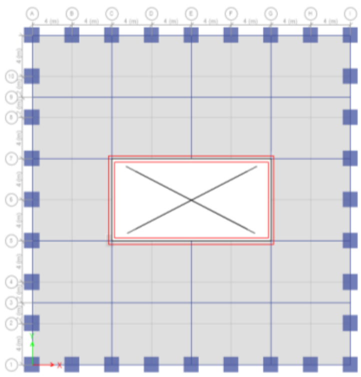

Figure 4 Plan for Tube in Tube single tube

Table 3.3: Sectional Properties tube in tube (single tube)

Floor	Column	Beam	Shear wall
1-15	800x800	300x1000(E) 300x1200(i)	900
16-30	700x700	Same as above	700
31-50	600x600	Same as above	700

3.4. Core Out-trigger System

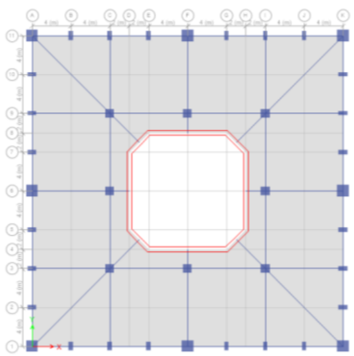

Figure 5 Plan of Core Out-Trigger System

Table 3.4 Sectional Properties core and outrigger

Floor	Column	Beam
1-15	1200x1500 (E) 600x900(E) 900x900(I)	300x900(E) 300x900(I)
16-50	1200x1200(E) 450x900(E) 900x900(I)	Same as above

Table 3.5

Floor	**Girder size**
15th floor	1200x3000
30th floor	1200x3000
45th floor	1000x2500
Floor	**Shear wall**
01-10	1000
11-40	900
41-50	750

4. Results and conclusion

Table 4.1 Comparison of Structures

	Shear wall	Tube in Tube double tube	Tube in tube in single tube	Core out-trigger
Story Displacement (mm)	166.2	116.61	184.9	222.6
Time period (sec)	3.758	4.802	4.372	4.37
story Shear (KN)	18496.97	9724.7	13892.2	16727.36
Story Drift	0.001176	0.000534	0.001213	0.001789
Cost (Rs)	9.6 cr	8.4 cr	8.03 cr	8.73 cr

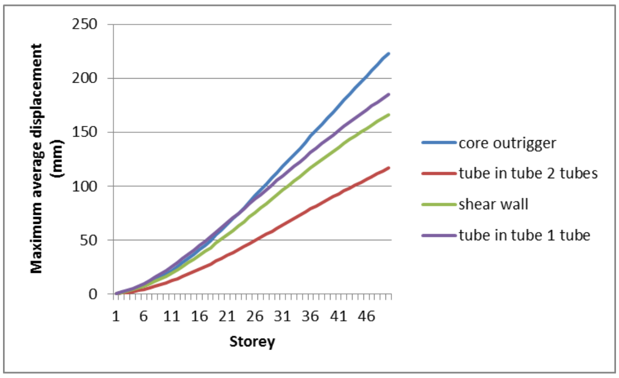

Figure 6: Storey Displacement vs Storey level

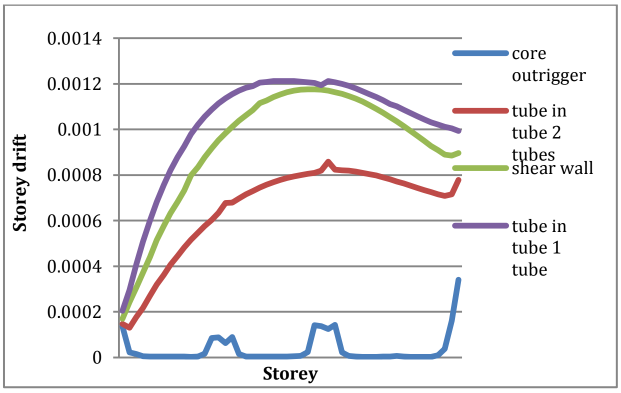

Figure 7 Storey drift vs Storey level

Conclusion

- Story displacement as well as the story drift was minimum for tube in tube system while maximum for core and outrigger system.
- Story shear was minimum for tube in tube system while maximum for shear wall system.
- Time period is minimum for shear wall system while maximum for tube in tube system.
- Economically tube in tube was the cheapest.

References

P. P. Chandurkar,(2013), Seismic Analysis of RCC Building with and Without Shear Wall ,*IJMER.(1805-1810)*

Ravikanth Chittiprolu,(2014), Significance of Shear Wall in Highrise Irregular Buildings, *IJEAR Vol. 4,(35-37*)

Vikas Govalkar, (2014).Analysis of Bare Frame and Infilled Frame with Different Position of Shear Wall

IJRTE ISSN: 2277-3878;

Rakesh Arun, (2015), Analysis of Framed Tube Structures with Multiple Internal Tubes, *Journal of Civil Engineering and Environmental Technology (107-114*).

Uttam Kalwane, (2015)Shear Lag In Tube Structures, *IJISET* ISSN 2348 – 7968.

Krunal Z. Mistry (2015), "Optimum Outrigger Location In Outrigger Structural System For High Rise Building", *IJAERD* 2015, (266-275).

Abbas Haghollahi (2012), Optimization of outrigger locations in steel tall buildings subjected to earthquake loads", *World Conference on Earthquake Engine*ering