Comparative study of shear wall system and framed tube system in high rise buildings

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ABSTRACT

In view of land cost and limited land, rapid increases of urbanization to accommodate the population trends to build high rise building with safety and, with stand for high wind velocity as well as earthquake (lateral loads) resistance is primary focus in this present study.

Performance based analysis of high rise building with shear wall system and framed tube system has been carried out and its is that results observed that lateral roof displacement for (20) story structure framed shear wall system and framed system are very close whereas framed tube system is very effective in higher story (40)

INTRODUCTION

High rise buildings have always fascinated the minds of people since the start of its construction in the ancient times. The construction of such buildings began in the ancient times for defensive purposes or religious purposes (roman temples, paranoiac, churches....). But in the modern era construction of such project began in the eighties of the nineteenth century for the purpose of either residential or administrative, than it become to meet the requirements of hotels & and other touristic needs as well.

There are many reasons to establish a high rise building investment project. And they are as follows:

- Rapid growth of population in urban communities, and therefore the constant pressure of the limited land area affected the evolution of building.
- Expensive land prices.
- Restriction of random expansion in major cities adjacent to agricultural land.
- The high cost of setting up infrastructure for new cities.
- Expression of progress and civilization.

And there are many other factors, for example the city of Rio de Janeiro & Hong Kong, they had other specific reasons such as terrain's conditions or the lack of land area like the United Arab Emirates and others.

There are many elements that encourages constructing of high rise building are availability of constructing materials and structural technology to implement the construction and mechanical system (elevators HVAC etc) economic facilitate studies are considerably on of the most important success elements in investment projects. Through the value analysis that can be applied all services operations cost and increase the quality in the same time, without compromising the building efficiency.

Shear wall framed system are utilized in both reinforced concrete and complete construction shear wall resisting all the lateral loads , the primary characteristic of a framed tube system is the employment of closely spaced perimeters column interconnected by deep ,so that whole building works as a huge vertical cantilever to exist overturning moments

METHODOLOGY

In this study reinforced concrete buildings with 20 and 40 story residential building are consider

Different structural system such as framed structure with shear wall and tube system has been to building with different height (20-65M)(40-129M) story and various internal forces (reaction, bending moment, shear force, axial force) of the members joint displacement, and storey and has been studied and compared.

Analysis is carried out on structure software ETABS VS 9.7.4.2009 software with parameters are assigned below slabs are as members are shear wall is considered as shell

DETAILS OF STRUCTURE

Plan Dimension : 42m x 30m

X-Dir. 7-bay X 6m =42m

Y-Dir. 5-bay X 6m =30m

Ground Floor height : 4.2m

Height for Stories above Ground Level : 3.2m

Height of Structures Considered for the Study

20 – Story Structure _ 65m

40 – Story Structure _ 129m

LOADS

1- Dead Load

-Self Weight of the Slab + Self Weight of beams and columns + Floor finish + Wall Load

Floor finish = .07 x 20 =1.4Kn/m² (ceramic floor finishing with cement morter).

Wall load – 0.12x2.6x9=2.8Kn/m (Thirmoston light weight Blocks with width of 120mm are considered).

2- Live Load

Live Load -2 Kn/m² (Considered as a residential building as per IS: 875 (part 2) - 1987

3- Wind Load

Wind Load considered for the Hyderabad region for the terrain category 3 and class C 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 – 5, Importance factor – 1.5, Soil Type –medium values taken from IS : 1893 - 2002

3 Lateral Load Resisting Structural Systems Considered are:-

i) Framed Shear Wall System.

ii) Framed Tube System.

Framed Shear Wall System

The shear wall system is considered here to resist lateral resisting system.

Framed Tube System

Column in the Tube System in the outer periphery are 2m centre to center.

According to IS: 465 – 2000 – Code of Practice for Plain and Reinforced Concrete the thickness of all slabs and for all models =170mm

Column Dimensions

i) 20-Story Structure

- 650mmx650mm concrete column from 0m to 33m height.
- 600mmx600mm concrete column from 33m to 65m height.

ii) 40-Story Structure

- 750mmx750mm concrete column from 0m to 33m height.
- 700mmx700mm concrete column from 33m to 65m height.
- 650mmx650mm concrete column from 65m to 97m height.
- 600mmx600mm concrete column from 97m to 129m height.

Shear Wall Thickness

i) 20-Story Structure

- 250mm thick concrete wall from 0m to 65m height.

ii) 40-Story Structure

- 300mm thick concrete wall from 0m to 65m height.
- 250mm thick concrete wall from 65m to 129m height.

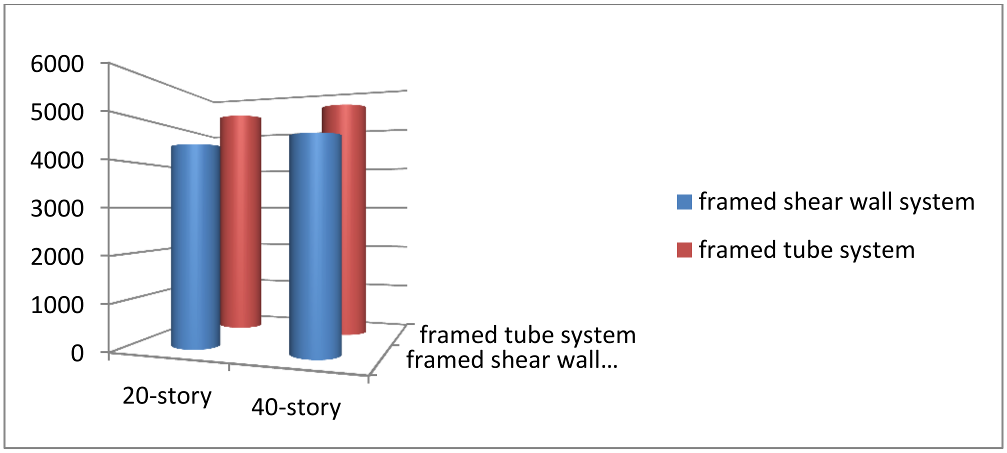
Properties of Materials used in the Structures

- *Grade of concrete for foundations , columns & shear walls = M70*
- *Grade of concrete for beams & slabs = M40*
- *Grade of steel =415N/mm2*
- *modulus of elasticity of concrete E=5000√fck*
- *modulus of elasticity of steel E=2.5e+008* Kn/m²
- *Poison's ratio μ=0.2*
- *Density of concrete = 25* Kn/m³
- *Density of steel – 78.5* Kn/m³

RESULTS

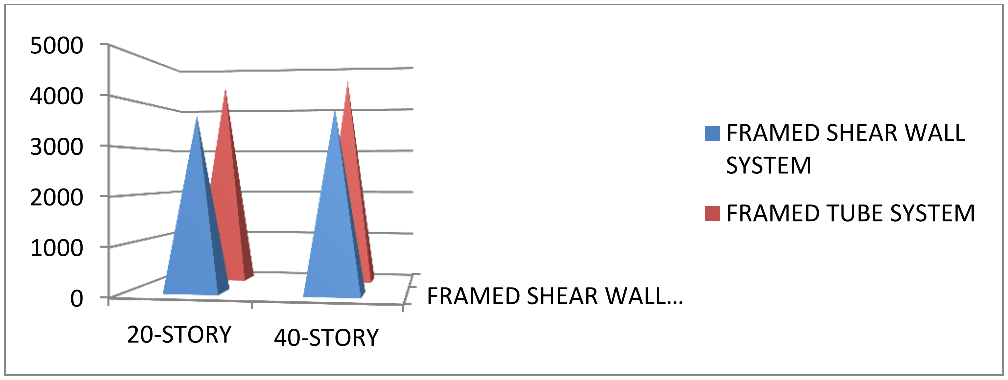
Structures with different structural systems such as framed shear wall structural system and framed tube structural system are considered for 20 and 40 story analysis carried out for displacements, base shear and support reactions.

Results obtained for base shear due to lateral load for 20 and 40 storeys structure in X-direction



Base shear in kn	20-story	40-story
Framed shear wall system	4340.91	4478.94
Framed tube system	5301.83	5432.98

Results obtained for base shear due to lateral load for 20 and 40 story structures in Y-direction

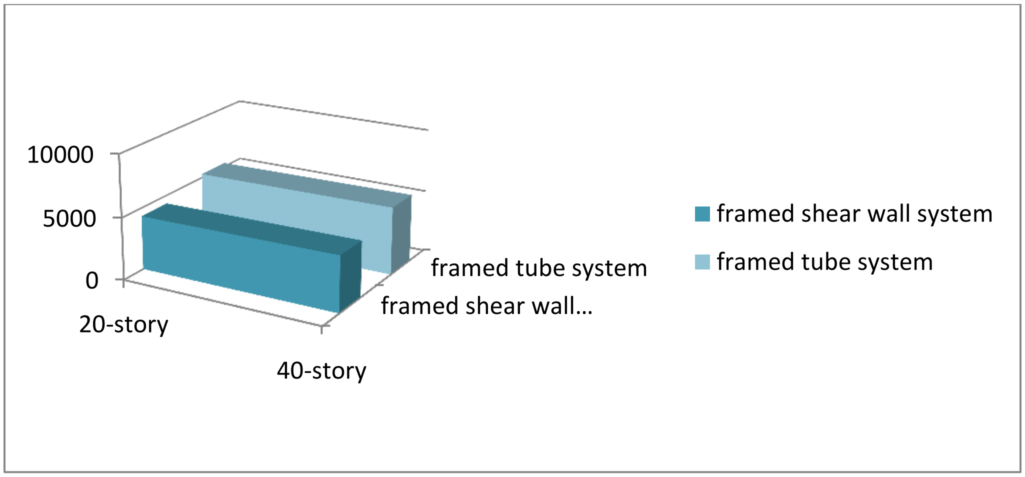


Base shear in kn	20-story	40-story
Framed shear wall system	3670.17	3783.47

Framed tube system	4482.61	4589.85

Base reaction at service combinations

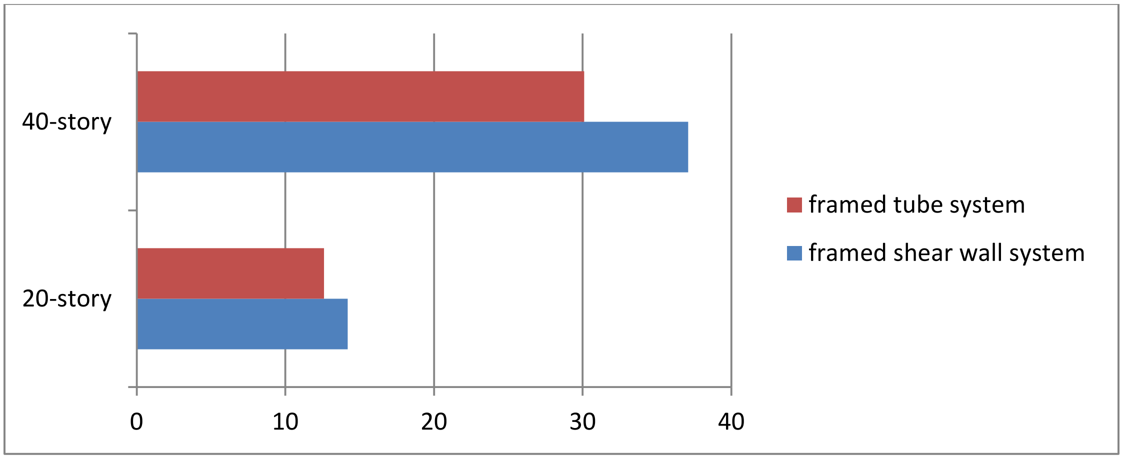
Base reaction in kn at service combinations loads is calculates for 20 & 40 story with different structural system



Base reaction due to service combination in kn	20-story	40-story
Framed shear wall system	4340.91	4478.94
Framed tube system	5301.83	5432.98

ROOF DISPLACEMENT AT SERIVEC COMBINATIONS

The roof displacement in mm at service combination load in calculated for 20&40 story with different structural system

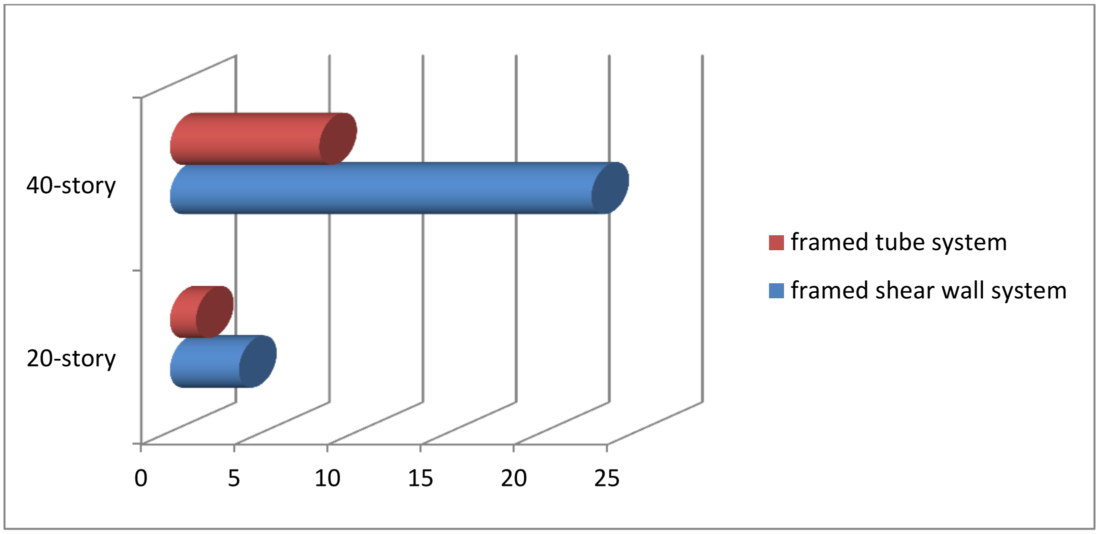


Roof displacement at service	20-story	40-story

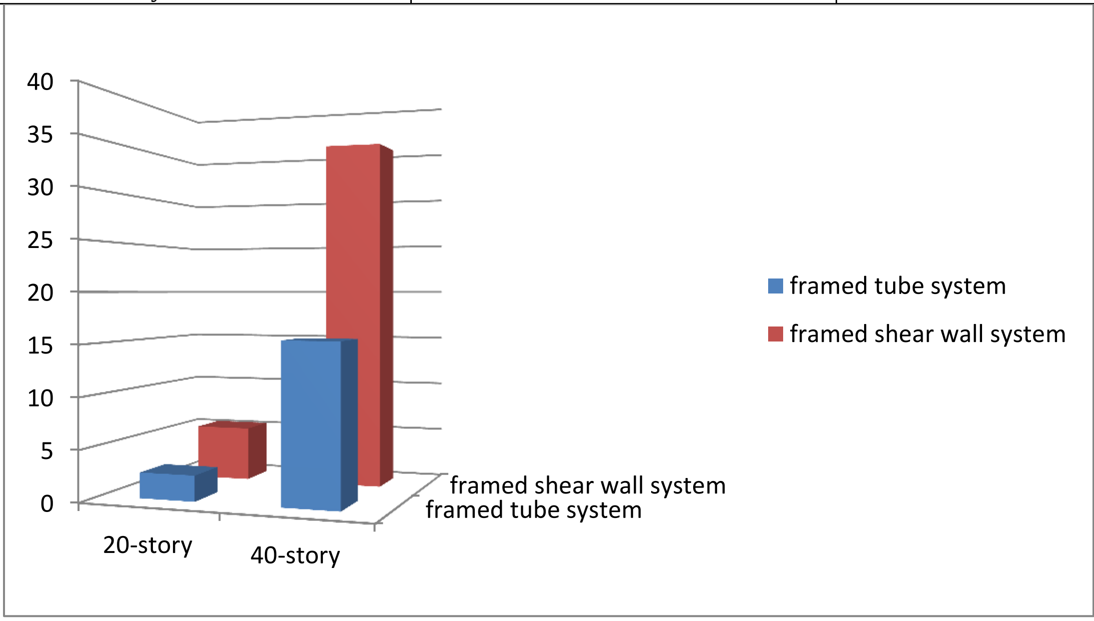
combinations in (mm)		
Framed shear wall system	14.2	37.1
Framed tube system	12.6	30.1

Lateral roof displacement due to wind load combinations in X&Y- direction

The lateral roof displacement in mm due to wind loads is calculated for 20&40-story with framed shear wall system and framed tube system in X&Y-direction



Lateral roof displacement due wind load in X-direction in (mm)	20-story	40-story
Framed shear wall system	3.7	22.6
Framed tube system	1.4	8



Lateral roof displacement due wind load in Y-direction in (mm)	20-story	40-story
Framed shear wall system	5.4	15.5
Framed tube system	2.5	35.2

Conclusions

In the present work, framed shear wall system & framed tube system considered for 20&40-story structures.

Observed results indicates the lateral base shear (earthquake), base shear at service combinations are near 4% to 9% varies not larger variation

Observed results indicates the roof displacement due to service combinations are 12% to 18% varies and lateral roof displacement due to wind load are to high 40% to 70% varies is to large variation

Further study

For further study, other structure systems such as tube in tube system and bundled tube system for high wind pressure and for high tall and high width structure are considered for work.

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