STUDY ON THE BEHAVIOUR RCC TALL BUILDING FOR RIGID FRAME SYSTEM, SHEAR WALL SYSTEM AND BRACED FRAME SYSTEM HAVING VARIOUS FLOOR LEVELS

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ABSTRACT:
The vertical cities are becoming a popular day by day. With an advent to modern construction technology and computers, the basic aim has been to construct safer buildings, keeping in view of overall economics of the building. Therefore, studying the structural systems and associated behaviour of these types of structures would be very interesting. Here in this paper; we will study the structural aspects of the tall RC buildings, located in the high seismic zone having various floor levels. In this structure, Shear Wall system, Rigid Frame system and Braced Frame system are utilized under both lateral and gravity loads, and may result some especial issues in the behaviour of structural elements such as shear walls, bracings etc. In this paper; the behaviour of structure for various height will be discussed. Finally, after an analysis, design and estimation (only for concrete and steel quantity) of various heights and structures; we will conclude the optimality and conceptuality of the high rise building design. Finally, having some technical information about the structural behaviour of the case would be very fascinating and useful for designers.

KEYWORDS:
Tall Building, Reinforced Concrete, Shear Wall system, Braced Frame system, Rigid Frame system.

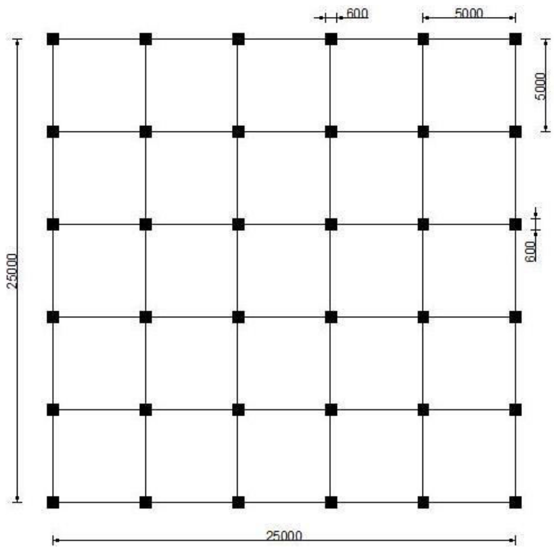
1. INTRODUCTION

Tall buildings throughout the world are becoming popular day by day. With the advent of modern day construction technology and computers, the basic aim has been to construct safer buildings keeping in view of overall economics of the project. A high-rise building, apartment tower, office tower, apartment block, or block of flats, is a tall structure used as a residential or office use. In some areas they may be referred to as "multi dwelling unit" or “vertical cities”. They have the potential to decongest the urban sprawl on the ground level, and increase the urban density, housing higher number of families in lesser space. Benefits include they act as landmarks create unique skyline and efficient land use.

The international conference on fire safety in high-rise buildings defined a high-rise as "any structure where the height can have a serious impact on evacuation" high-rise as being higher than 70 feet (21 m).

There are various types of structures used to build a high rise building. From these, the choice of structure to be constructed is based on the height, utilities and economy of the proposed building.

2. PLANNING:



All dimensions are in mm

Fig 1. Plan

There are 5 bays in x direction and y direction, each bay spanning 5m interval respectively. The height of the structure is varied as 20,25,30,35 and 40 floors for bending moment, shear force for columns, storey shear and displacement calculation. The height of the single storey is 3.2 m. the grade of concrete is M30 and the grade of the steel used is Fe 500.

1.1 Properties of Concrete

Weight per unit volume of the concrete	=25 N/mm^2
Modulus of elasticity 5000√fck	=27386.1279
Poison's ratio	=0.2
Coefficient of thermal expansion	=9.9 X 10^{-6}
Shear modulus	=11410886.6

The beam and column size of the building are varied throughout the structure in order to avoid failure and also for the development of economic structure

The various cross section of the beam are as follows

- 230 x 400
- 300 x 450
- 300 x 500
- 300 x 600
- 400 x 600

The clear cover of the beam is provided as 25mm. Due to longer span and loading condition, the area of reinforcement of the beam is more. Hence, we can provide the tension reinforcement and compression reinforcement as two layers at top and bottom of the mid span respectively and at the corners vice-versa. By providing the reinforcement in two layers the moment of inertia varies. The inner reinforcement can take only minimum load; thus we increase the breadth of the beam.

The various cross section of the column are as follows

- 300 X 300
- 450 X 450
- 600 X 600
- 750 X 750
- 800 X 800
- 850 X 850
- 900 X 900

The clear cover of the column as 50mm and the thickness of the slab is assumed as 150mm

1.2 Loading Condition

There are different types of loads acting on the structure. Namely,

- Dead Load
- Live Load
- Super Dead Load (Floor Finishes)
- Wind Load (In X Direction and Y Direction)
- Seismic Load (In X Direction and Y Direction)

For Wind Load Is 875-1987

Windward Coefficient	=	0.8
Leeward Coefficient	=	0.5
Wind Speed	=	39 M/S
Terrain Category	=	2
Structure Class	=	B
Risk Coefficient	=	1
Topography Factor	=	1

For Seismic Load Is 1893-2002,

Eccentric Ratio	=	0.05
Soil Type	=	2
Importance Factor	=	1
Response Factor	=	5

1.3 Load Combination

C1 = 1.4D

C2 = 1.2D + 1.6L

C3 = 1.2D + 1.6L + 0.8Wx

C4 = 1.2D + 1.6L + 0.8Wy

C5 = 1.2D + 1.6Wx + 1L

C6 = 1.2D + 1.6Wy + 1L

C7 = 1.2D + 1.0Ex + 1.0L

C8 = 1.2D + 1.0Ey + 1.0L

C9 = 0.9D + 1.6Wx

C10= 0.9D + 1.6Wy

C11= 0.9D + 1.0Ex

C12= 0.9D + 1.0Ey

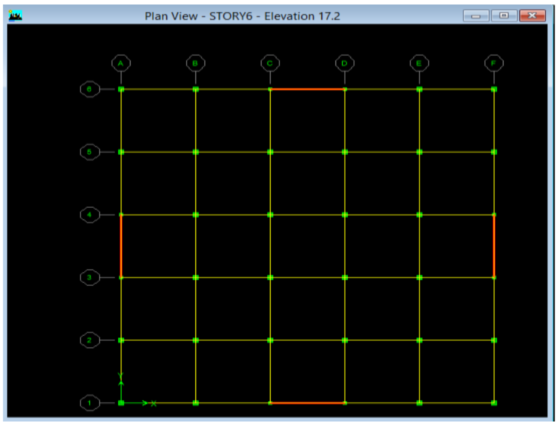


Fig. 2 Position of Shear Wall

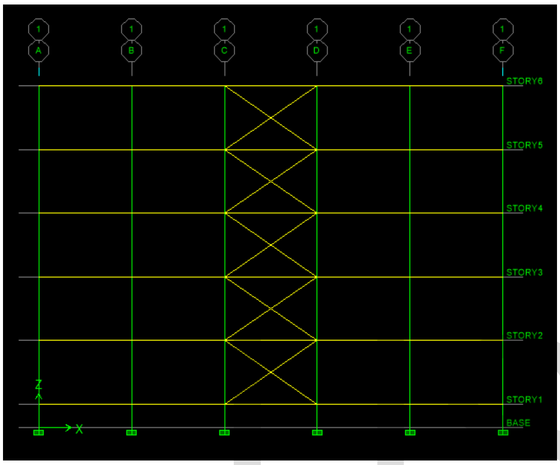
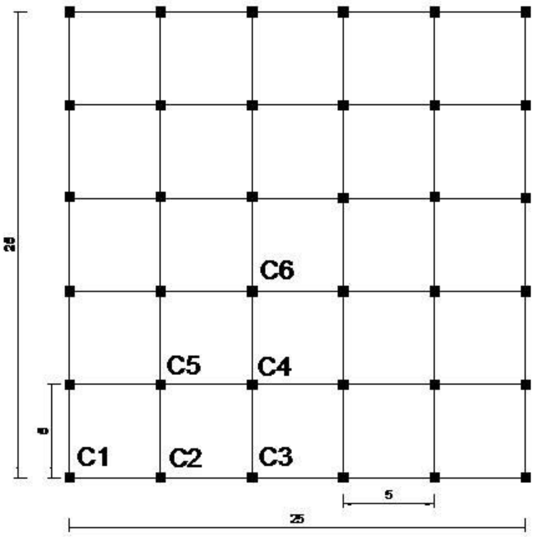


Fig 3 Position of Braced Frame Structure

3. RESULTS AND DISCUSSION



All the dimensions are in mm

Fig 4. Selection of columns for comparison

3.1 Comparison of bending moment and shear force

We can compare the Bending Moment, Shear Force for columns selected as C1, C2, C3, C4, C5, and C6 as shown in the figure 4 between Rigid Frame Structures, Shear Wall Structure and Braced Frame Structure.

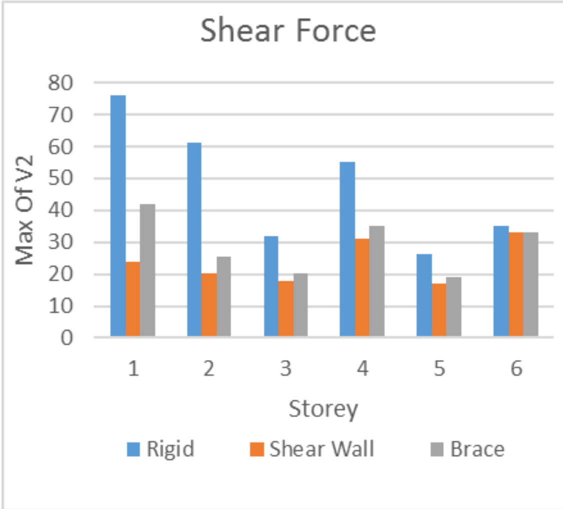


Fig.5 Comparison of Shear Force (G+5, COLUMN 1)

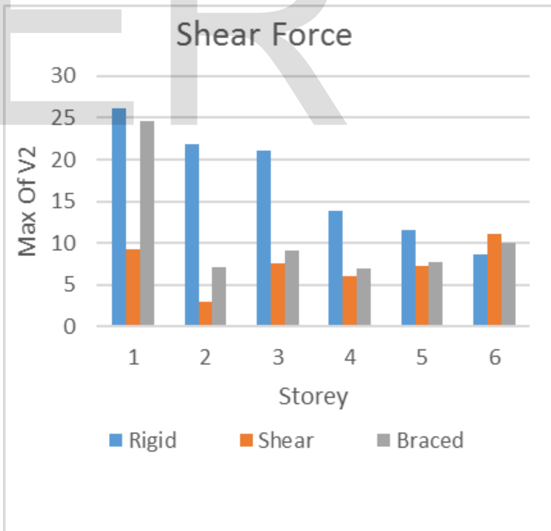


Fig.6 comparison of Shear Force (G+10, COLUMN 1)

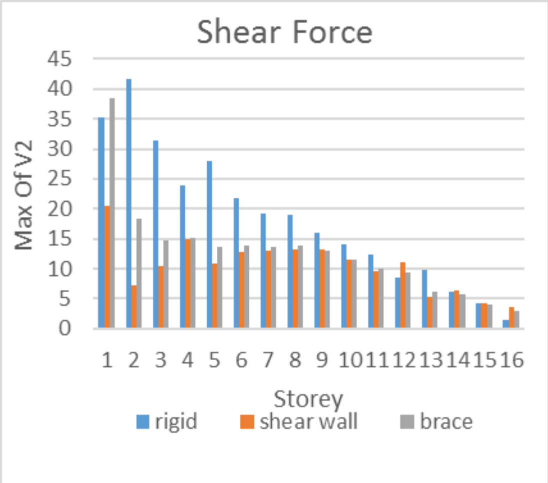


Fig.7 Comparison of Shear Force (G+15, COLUMN 1)

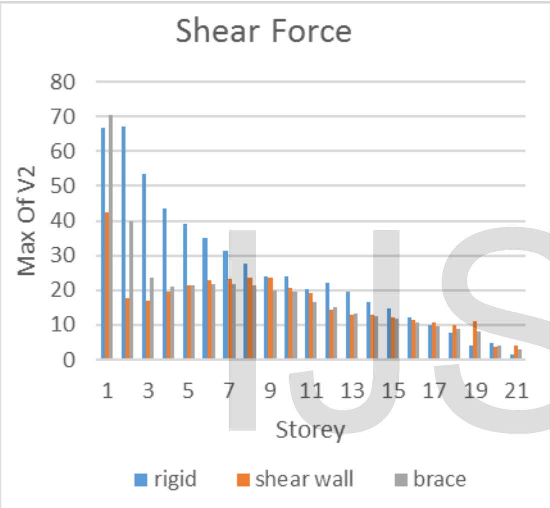


Fig.8 Comparison of Shear Force (G+20, COLUMN 1)

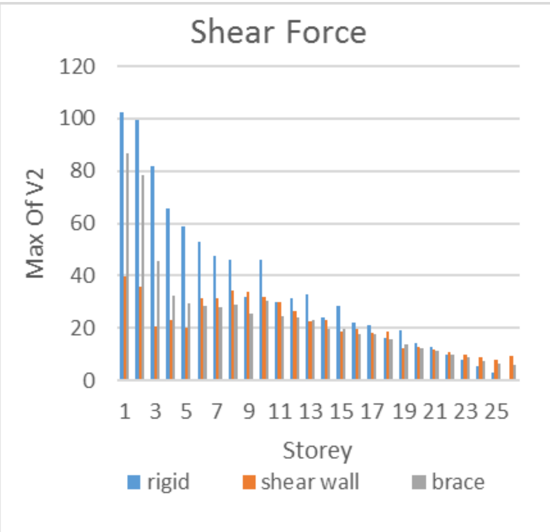


Fig.9 Comparison Shear Force (G+25, COLUMN 1)

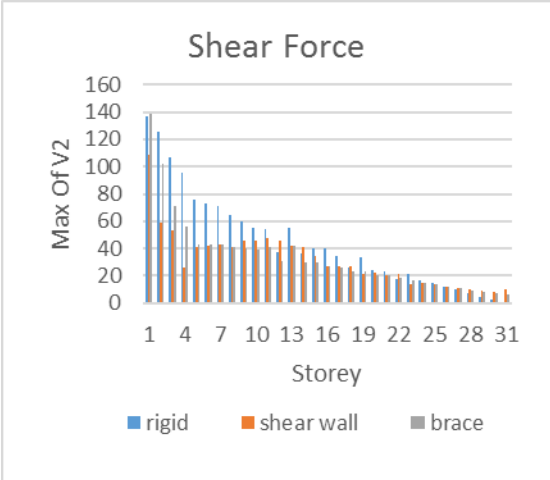


Fig.10. Comparison Shear Force (G+30, COLUMN 1)

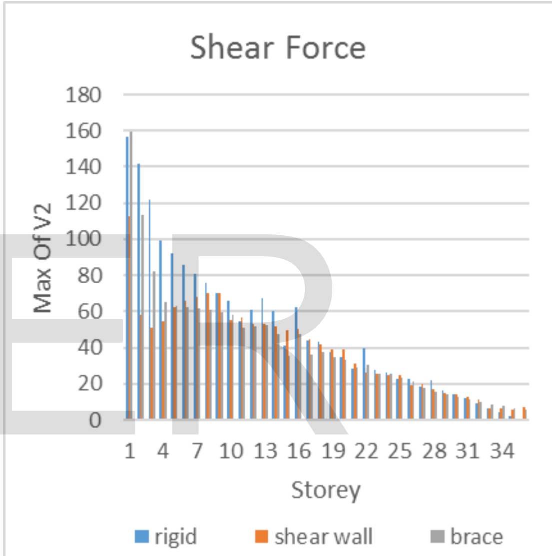


Fig.11 Comparison Shear Force (G+35, COLUMN 1)

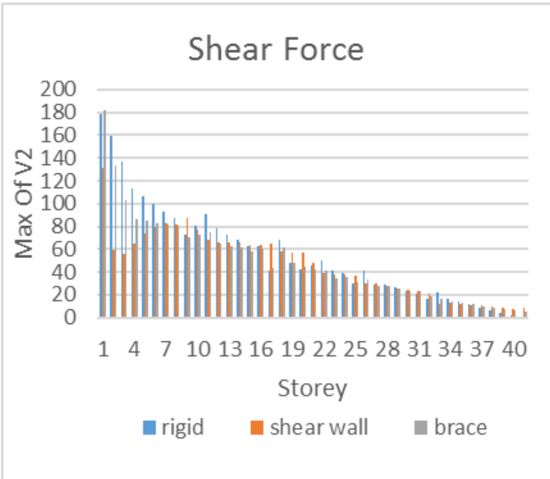


Fig.12 Comparison Shear Force (G+40, COLUMN 1)

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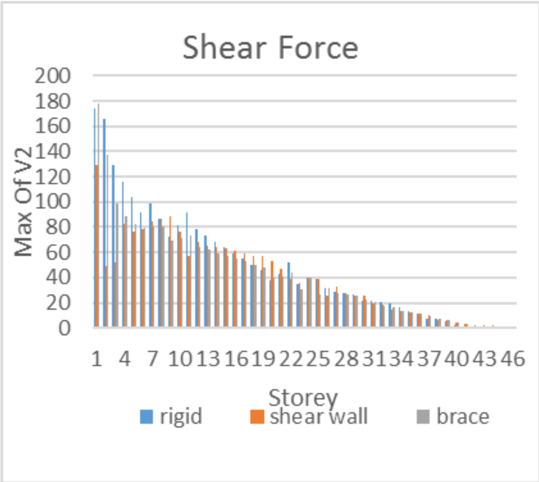

Fig.13 Comparison Shear Force (G+45, COLUMN 1)

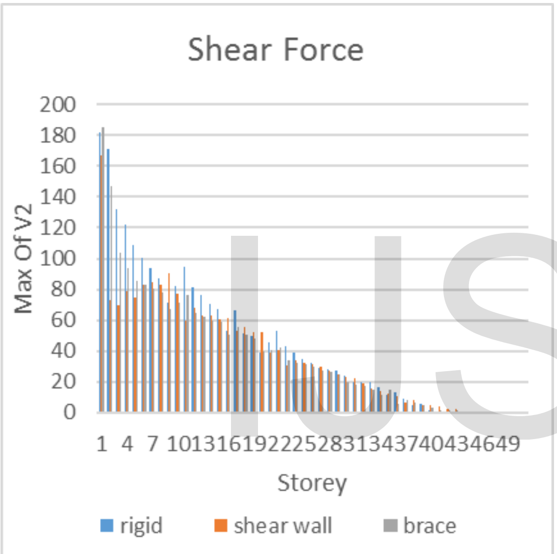

Fig.14 Comparison Shear Force (G+50, COLUMN 1)

For column-1

- Rigid frame has maximum shear force
- Shear force is minimum by using shear wall structure

Similarly,
For column-2

- Rigid frame has maximum shear force
- For height up to 10 floors, shear force is minimum when shear wall is used
- For height more than 10 floors, shear force is minimum when bracings are used

For column-3

- Shear wall structure has maximum shear force
- Shear force is minimum when braced frames are used

For column-4

- Rigid frame has maximum shear force
- For height up to 15 floors, shear force is minimum by using shear wall
- For height more than 15 floors, shear force is minimum by using bracings

For column-5

- Rigid frame has maximum shear force
- For height up to 15 floors, shear force is minimum when shear wall is used
- For height more than 15 floors, shear force is minimum when bracings are used

For column-6

- Rigid frame has maximum shear force
- For height up to 15 floors, shear force is minimum when shear wall is used
- For height more than 15 floors, shear force is minimum when bracings are used

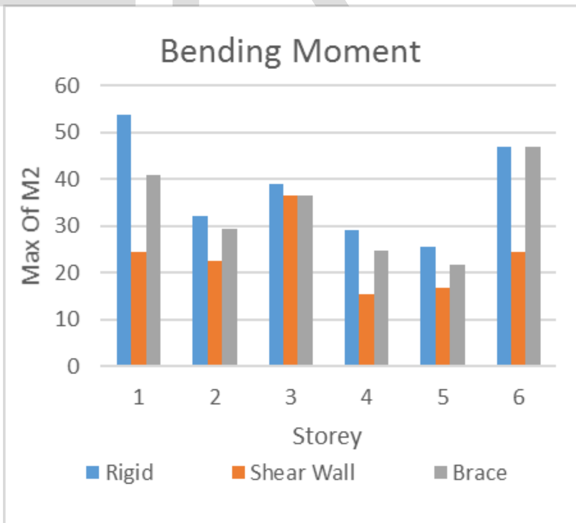

Fig.15 Comparison Bending Moment (G+5, COLUMN 1)

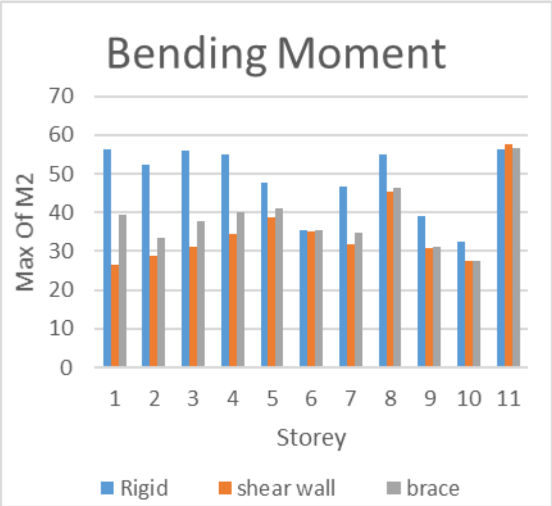

Fig.16 Comparison Bending Moment (G+15, COLUMN 1)

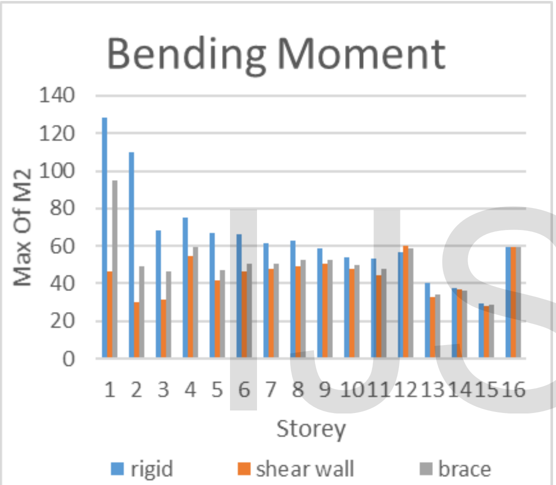

Fig.17 Comparison Bending Moment (G+15, COLUMN 1)

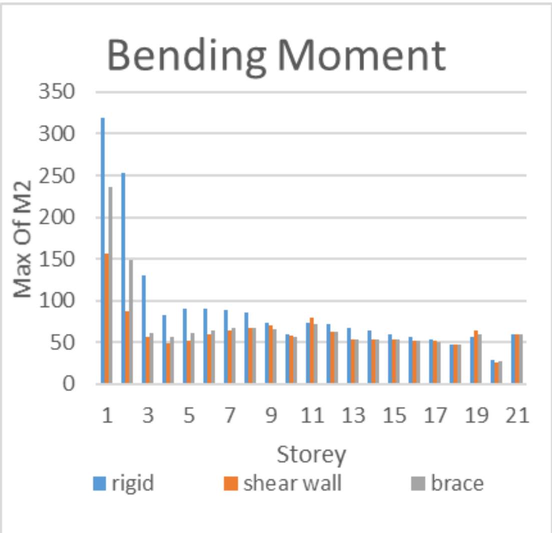

Fig.18 Comparison Bending Moment (G+20, COLUMN 1)

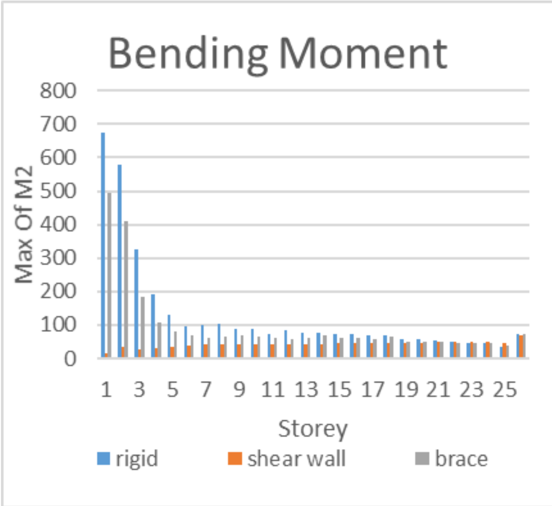

Fig.19 Comparison Bending Moment (G+25, COLUMN 1)

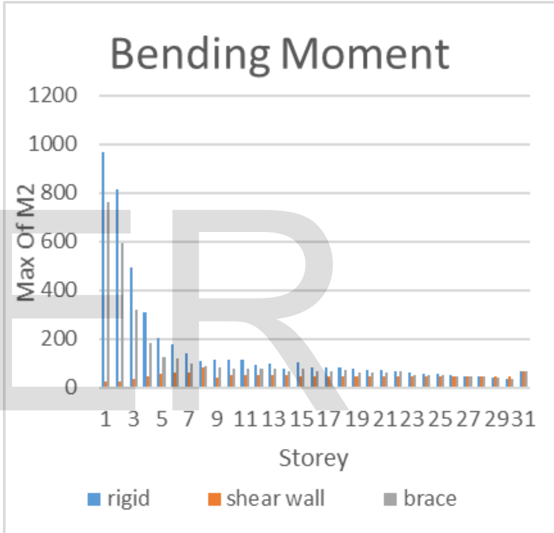

Fig 20 Comparison Bending Moment (G+30, COLUMN 1)

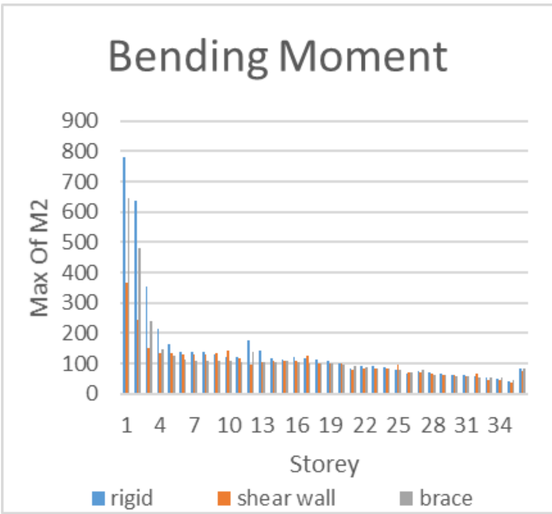

Fig.21 Comparison Bending Moment (G+35, COLUMN 1)

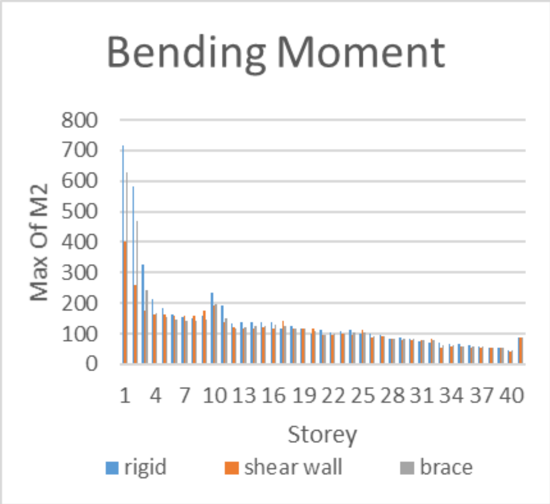

Fig.22 Comparison Bending Moment (G+40, COLUMN 1)

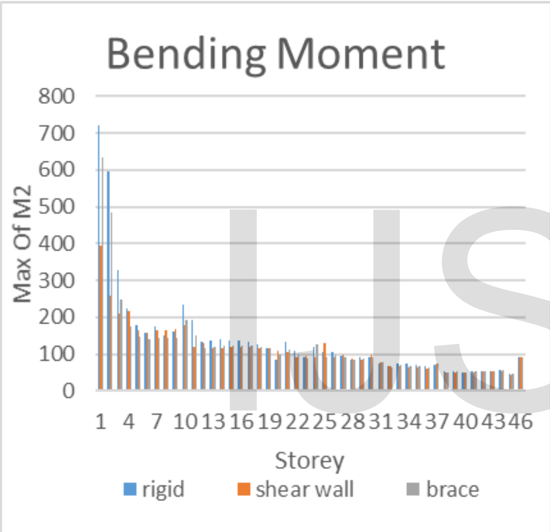

Fig.23 Comparison Bending Moment (G+45, COLUMN 1)

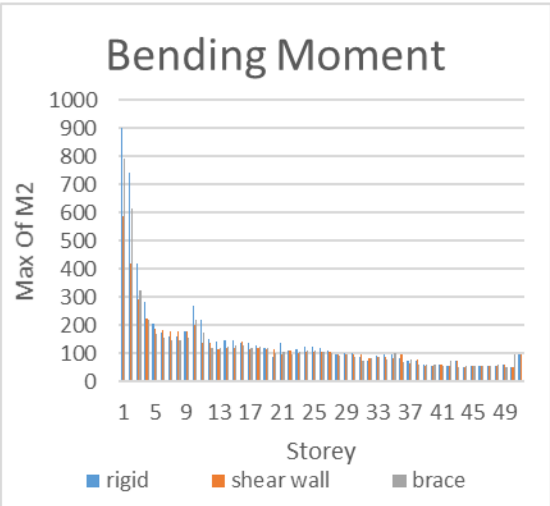

Fig.24 Comparison Bending Moment (G+50, COLUMN 1)

For column-1

- Rigid frame structure has maximum Bending Moment
- Bending Moment is Minimum when shear wall is used

For column-2

- Rigid Frame Structure has maximum bending moment
- Bending moment is minimum when Bracings are used

For column-3

- Rigid frame structure has maximum Bending Moment
- Bending Moment is Minimum when shear wall is used

For column-4

- Rigid frame has maximum Bending Moment
- For height up to 30 floors, Bending Moment is Minimum when shear wall is used
- For height more than 30 floors, Bending Moment is Minimum when Bracings are used

For column-5

- Rigid frame has maximum Bending Moment
- For height up to 20 floors, Bending Moment is minimum when shear wall is used
- For height more than 20 floors, Bending Moment is minimum when Bracings are used

For column-6

- Rigid frame has maximum Bending Moment
- For height up to 15 floors, Bending Moment is minimum when shear wall is used
- For height more than 15 floors, Bending Moment is minimum when Bracings are used.

3.2 Cost Comparison

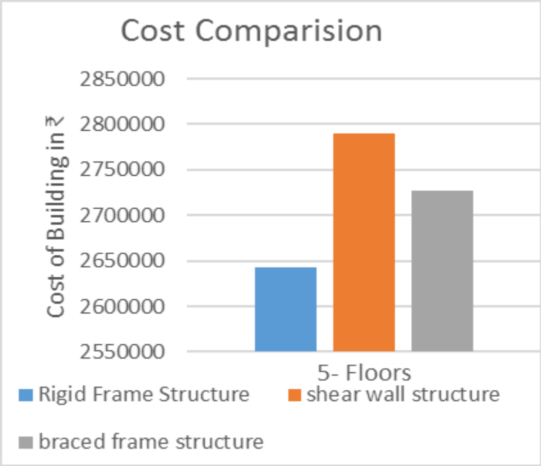

Fig 25 Cost Comparison (G+5)

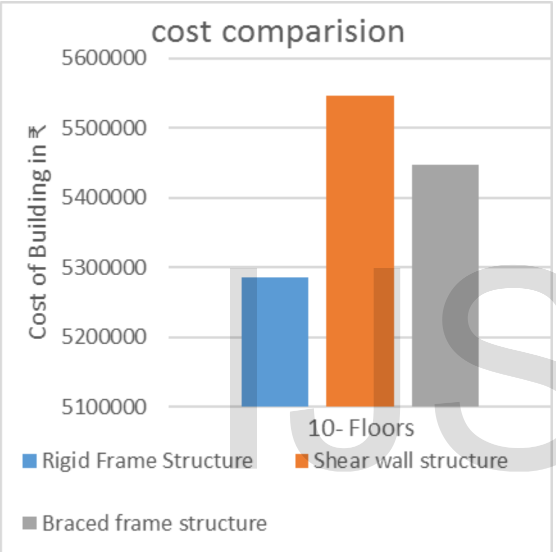

Fig 26 Cost Comparison (G+10)

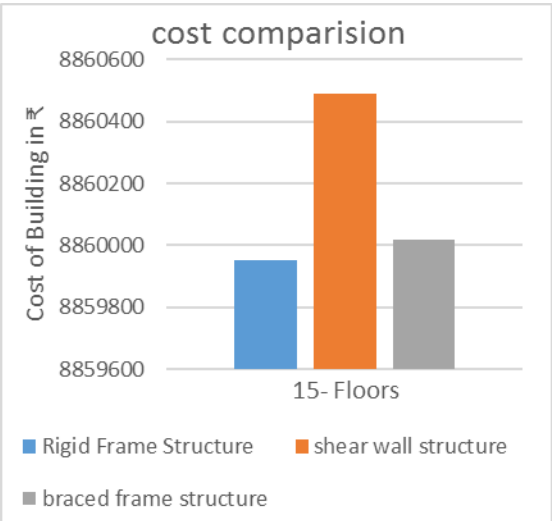

Fig 27 Cost Comparison (G+15)

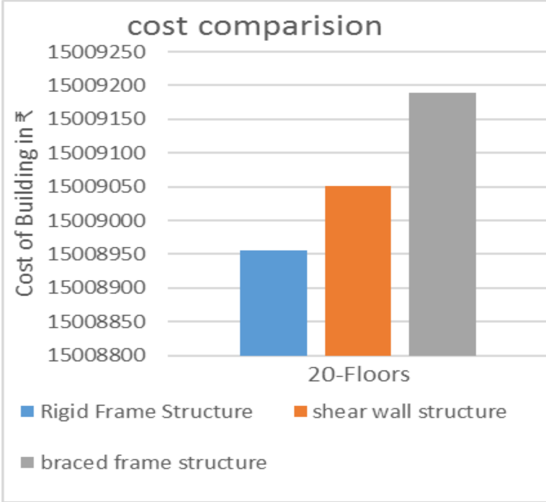

Fig 28 Cost Comparison (G+20)

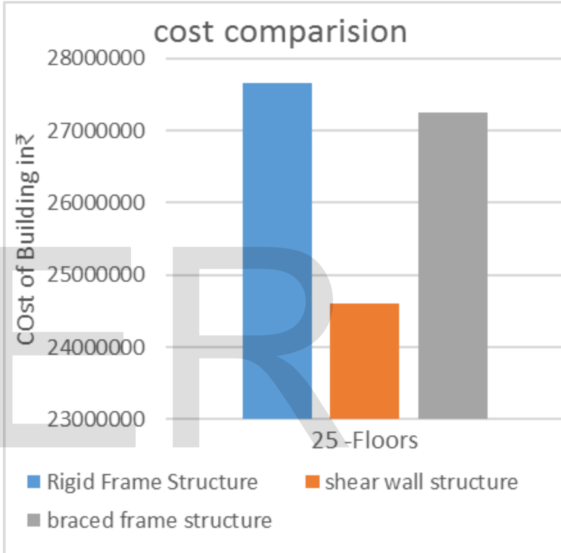

Fig 29 Cost Comparison (G+25)

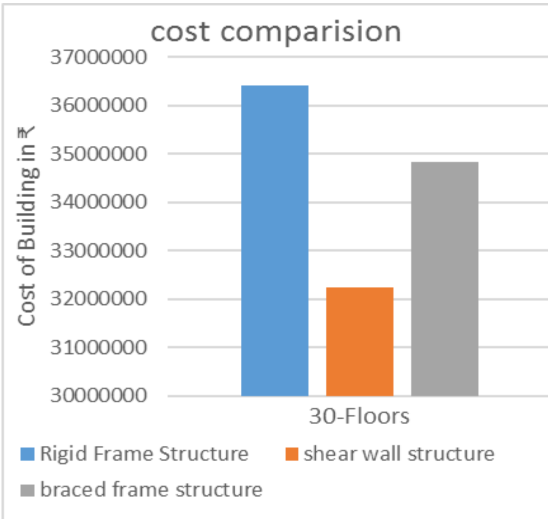

Fig 30 Cost Comparison (G+30)

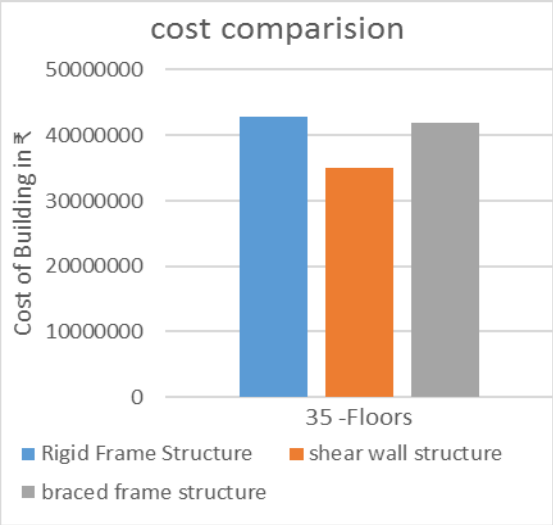

Fig 31 Cost Comparison (G+35)

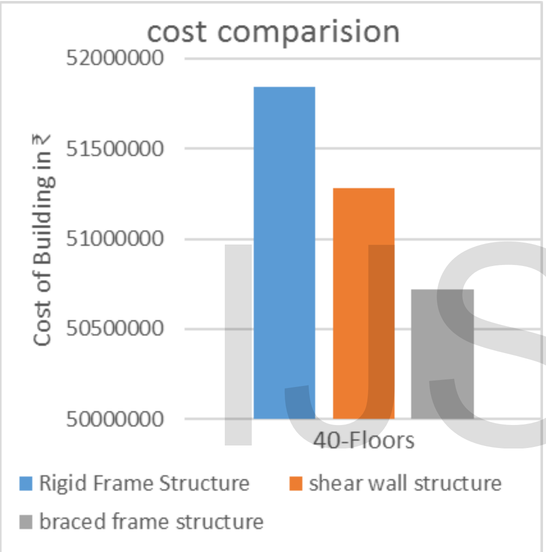

Fig 32 Cost Comparison (G+40)

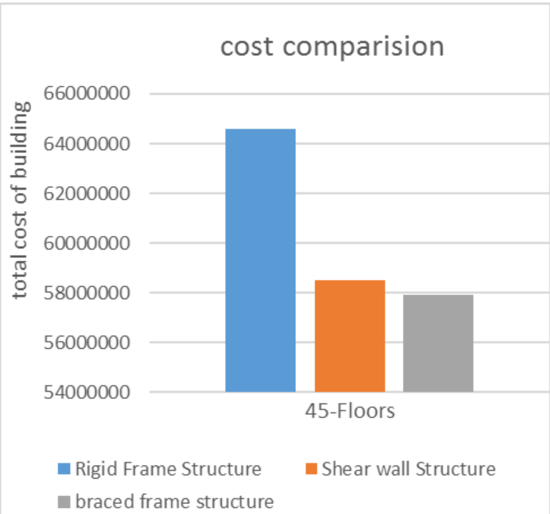

Fig 33 Cost Comparison (G+45)

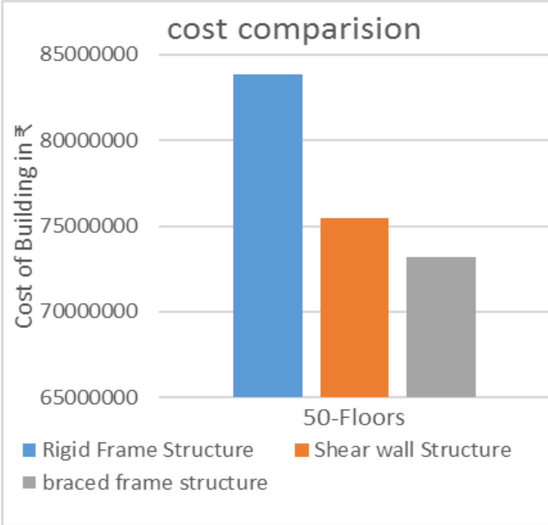

fig 34 Cost Comparison G+50)

4.CONCLUSION

In this investigation, the Rigid frame structure, Shear Wall Structure and Braced Frame Structure having 5-bays in both the longitudinal and transverse direction and the number of storeys as 5, 10, 15, 20,25,30,35,40, 45, 50 for the same loading condition is analysed using ETABS

From the result it is concluded that,

- Up to the height of 20 floors, the use of Rigid Frame Structure gives the economical solution
- From the height of above 20 floors to 35 floor, the use of Shear Wall Structure gives the economical solution
- From the height of above 35 floors, the use of Braced Frame Structure gives the economical solution

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