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**A STUDY OF THE BEHAVIOUR OF PARAMETRIC AND COST ANALYSIS OF HIGH
RISE BUILDINGS IN DIFFERENT SESMIC ZONES OF INDIA BY USING SHEAR
WALLS**

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ABSTRACT

India has a very high frequency of great earthquakes (magnitude greater than 7.0) for instance, during 1897(Assam Earthquake) to 2005(Jammu & Kashmir Earthquake), the country was hit by number of great earthquakes. To minimize loss after earthquakes, the experimental and analytical studies on seismic design Incorporation of shear wall has become inevitable in high rise building to resist lateral forces. There are lots of literatures available to design and analyze the shear walls. However the decision about the effect of shear wall to floor area ratios in multi-storey building is not much discussed in any literatures. One of the major parameters influencing the seismic behavior of wall-frame buildings is the shear wall ratios. Therefore, it is important to evaluate the capacity of buildings with different shear wall ratios against seismic force demand. In order to address this problem, the present work aims to carry out a seismic evaluation of the RC building using static linear method or static response method.

In present study we have taken models of high rise structures which are subjected to seismic forces are analyzed for parameters like storey shear, displacement and time period.

The different storey's of 10, 20, 30 floors are taken in zones I, II, II which are subjected to earth quake loads in x-direction and y-direction. In this analysis we are comparing the change in percentages of storey shear, storey displacement and time period with respect to zones. Hence the main aim of the analysis is to resist the maximum seismic forces of the high rise structures to prevent loss of life and damage of property

KEYWORDS:

INTRODUCTION

The need for high-rise buildings is inevitable while the land in the rapidly developing cities and towns are becoming scarce due to increasing number of population. The buildings, which appeared to be strong enough, may crumble like houses of cards approaches encourage use of shear walls for earthquake- resistant design. Reinforced concrete (RC) wall –frame buildings are widely recommended for urban construction in areas with high seismic hazard. Presence of shear wall systems are one of the most commonly used lateral-load resisting systems in high rise buildings. during earthquake and deficiencies may be exposed. Experience gained from the bhuj earthquake of 2001 demonstrates that the most of buildings collapsed were found deficient to meet out the requirements of the present day codes. Shear wall are one of the excellent means of providing earthquake resistance to multi-storied reinforced concrete building. The structure is still damaged due to some or the other reason during earthquakes. Behavior of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and vertical planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. Structural design of buildings for seismic loading is primarily concerned with structural safety during major earthquakes, in tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load. The major criteria now-a-days in designing RC structures in seismic zones is control of lateral displacement resulting from lateral forces. In this thesis effort has been made to investigate the effect of shear wall area to floor area ratio on seismic performance in terms of lateral displacement, drifts and base shear in RC framed building. For this purpose, 20, 30 and 40 storied building is considered in which shear wall are provided with three seismic zones.Linear static analysis is also known as time seismic coefficient method. It is an important and accurate

technique for structural seismic analysis especially when the evaluated structural response is linear. Linear static analysis was carried out with three seismic zones (II, III and IV) for 20,30 and 40 storied building with shear wall.

SHEAR WALLS

GENERAL

Two main types of structural systems, which are concrete frame systems and concrete frame-wall systems, are used by civil engineers to resist external vertical and horizontal loads for concrete structures. ATC 40 (1996) states that both vertical and horizontal loads are carried by frames in concrete frame systems; but in concrete frame-wall systems, shear walls are generating the lateral resistance of the building and also these members can carry some local vertical loads. Experimental and analytical research demonstrated that concrete frame-wall buildings have displayed better seismic performance and resistance compared to concrete frame systems [2]. Seismic performance of the building, which is the performance of the building when subjected to earthquake loading, is based on strength, stiffness and deformation capacity of the building.

REINFORCED CONCRETE SHEAR WALLS

Shear walls are vertical elements in the lateral force resisting system. They transmit lateral forces from the diaphragm above to the diaphragm below or to the foundation. Shear walls might be considered as analogous to a cantilever plate girder standing on end in a vertical plane where the wall performs the function of a plate girder web, the floor diaphragms function as web stiffeners, and the integral reinforcement of the vertical boundaries functions as flanges. The distribution of shear forces is proportional to the moment of inertia of the cross sections of the walls. The displacements in each floor or level are the result of the flexural deformations in the walls. Shear walls may be subjected to both vertical (gravity) and horizontal (wind or earthquake) forces. The horizontal forces are both in plane and out of plane. The walls will be designed to withstand all vertical loads and horizontal forces, both parallel to and normal to the flat surface, with due allowance for the effect of any eccentric loading or overturning forces generated.

MODELLING PARAMETERS

Building Description

Reinforced Concrete Frames of 20 storey, 30 storey and 40 storey with plan size 27mx22m, with heights of 61.5m, 91.5m and 121.5m respectively are modeled.

S.No	Description	Information
1	Number of Storey's above the ground level	20 30 40
2	Type of Structure	R C Frame
3	Soil considered • Type of Soil	Medium soil
4	Dead Loads • Brick Masonry • Plain Cement Concrete • Floor Finish	IS: 875 Part 1 20KN/m3 25KN/m3 and 35 KN/m3 1.00 KN/m2
5	Imposed Loads • Floor Loads, Roof Loads	IS: 875 Part 1 3 KN/m2
6	Seismic Zone	II, III, IV
7	Important Factor- I	1.0
8	Seismic Zone Factor-Z	0.10, 0.16, 0.24
9	Response reduction factor-R	5.0

Table 5.1 Data of RC Frames considered study

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Plan of the RC building considered

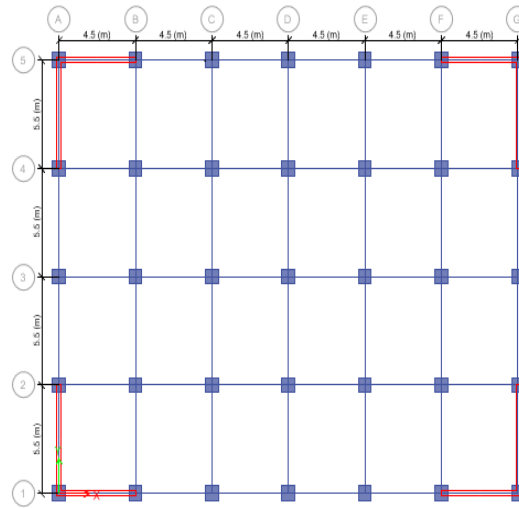


Fig. 5.1 Building plan

3D Views of RC building considered

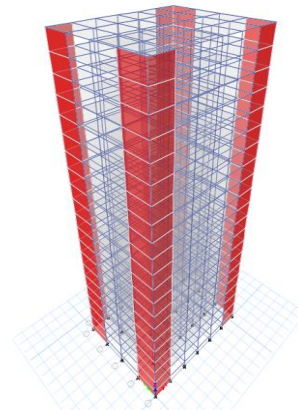


Fig. 5.2 3D view of 20 storied building

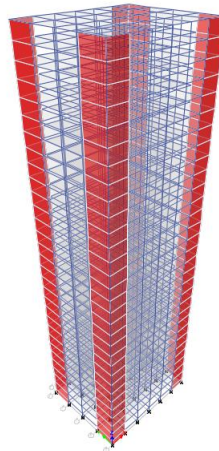


Fig. 5.3 3D view of 30 storied building

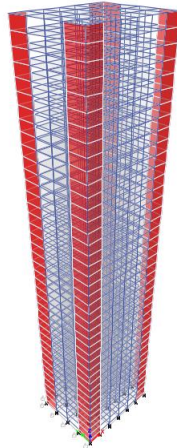


Fig. 5.4 3D view of 40 storied building

5.2.4 Sections Considered:

	20Storey	30 storey	40 storey
BEAM	25B300X450	25B300X450	25B300X450
COLUMN	35C750X750	40C900X900	40C1200X1200

Material properties

M40 grade concrete structure

- Weight/unit volume = 25kN/m³
- Mass per unit volume as 2.55kN/m³
- Modulus of Elasticity = 5000√fck = 31622776.6 kN/m²
- Poisson's Ratio = 0.2
- Coefficient of thermal expansion = 9.9E-06
- Specified compressive concrete strength f_{ck}= 40000 kN/m²
- Yield stress of steel considered f_y= 500000kN/m²

M35 grade concrete structure

- Weight/unit volume = 30kN/m³
- Mass per unit volume as 2.55kN/m³
- Modulus of Elasticity = 5000√fck =29580398.92kN/m²
- Poisson's Ratio = 0.2
- Coefficient of Thermal Expansion = 9.9E-06
- Specified compressive concrete strength f_{ck} =35000kN/m²
- Yield stress of steel considered f_y=500000kN/m²

5.2.6 Other details:

- Thickness of slab: M25 slab of 150 mm thickness.
- Thickness of shear walls: 230mm.
- Reinforcement considered for design: Fe500

5.2.7 Loads Considered: (as per IS 875 Part I)

- Dead load = Self weight of structure
- LL = 3kN/m²

- Floor Finish = 1kN/m^2
- Wall load = $h \times t \times \text{unit weight} = (3-0.45) \times 0.23 \times 20 = 11.73\text{kN/m}$
- Seismic weight consideration as per clause 7.3.1, Table 8 of IS 1893 part 1:2002 for 5% damping is $DL+FF+0.25LL$
- Maximum storey drift should not be more than 0.004 times the storey height as per IS 1893 Part 1:2002.

MODELING ASSUMPTIONS

- The following assumptions were made in creating models of building for seismic evaluation in this study.
- Diaphragm was assumed to be rigid. That is, the floor was assumed to be rigid in the plan of diaphragm but flexible in bending.
- Lateral load is assumed to be acted only at floor level.
- Joints are assumed to be rigid.
- Footings are assumed to be fixed.

RESULTS AND DISCUSSIONS

GENERAL

The software ETABS is used to analyze the buildings considered in the present work by using Linear static analysis. Three seismic zones (II, III, IV) are utilized to evaluate the seismic behavior of the structure. The shear wall thickness in the 20, 30, 40 storied building are considered as 230mm. The performance of building in terms of storey displacements, and base shear are studied.

TWENTY STORIED BUILDING

Storey Displacement

Storey displacement Vs Storey number graphs of the designed building in both directions with three seismic zones are shown in Figures 6.1 to 6.2, respectively. These results are obtained by increasing seismic zones and the trend lines are also shown in below figures.

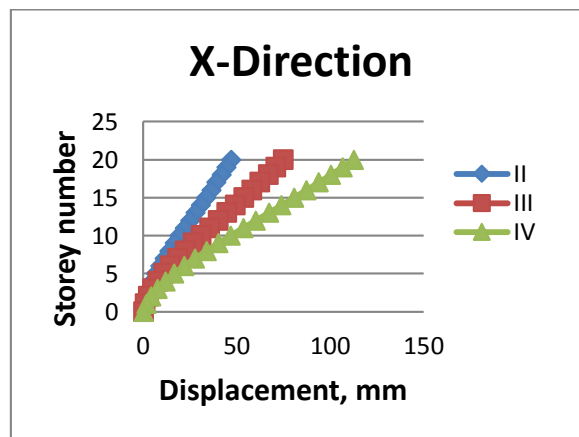


Fig 6.1 Storey Displacement Vs Storey number with three seismic zones in X-direction

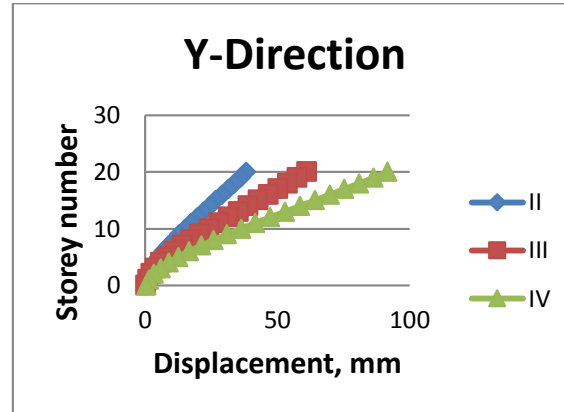


Fig 6.2 Storey Displacement Vs Storey number with three seismic zones in Y-direction

The storey displacement of the building increases with increasing seismic zones as shown in Fig.6.1 to 6.2. A significant increase in displacement was observed for seismic zones between III & IV in both X & Y directions. It is observed that displacements increase as seismic zones increase. The percentage variation of displacement between seismic zones II, III and IV is variable to 38.00, 33.40, respectively in X-direction. In Y-direction the percentage variation of displacement between zones II, III and IV is variable to 44.00, 25.70, respectively. The lateral displacements are within the limits due to placement of shear wall symmetrically in both directions.

Base Shear

Figure 6.3 to 6.4 shows the variation of the base shear with increasing seismic zones for 20 storied building in both directions.

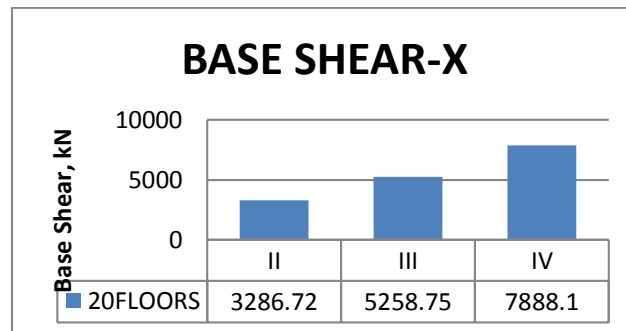


Fig 6.3 Base shear Vs seismic zones in X-direction

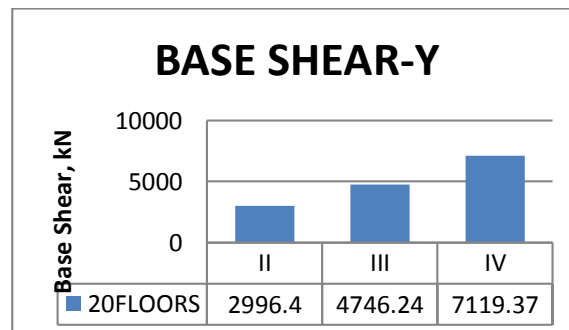


Fig 6.4 Base shear Vs seismic zones in Y-direction

It can be easily observed from these figures 6.3 to 6.4 that the base shear increases with increasing seismic zones in 20 storied building. The percentage variation of increase in base shear for seismic zones are 37.60, 33.40,

respectively in X-direction. In Y-direction it was observed as 36.90, 33.40, respectively. This indicates as the seismic zone increases the base shear increases.

THIRTY STORIED BUILDING

Storey Displacement

Storey displacement Vs Storey number graphs of the designed building in both directions with three seismic zones are shown in Figures 6.5 to 6.6, respectively. These results are obtained by increasing seismic zones and the trend lines are also shown in below figures.

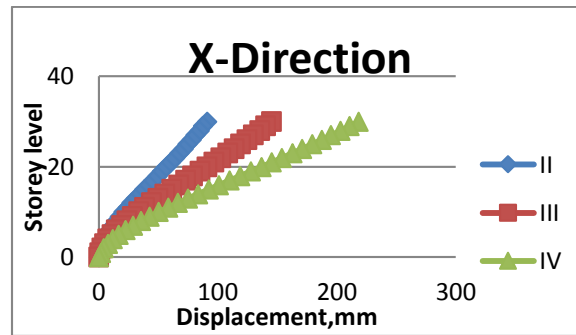


Fig 6.5 Storey Displacement Vs Storey number with three seismic zones in X-direction

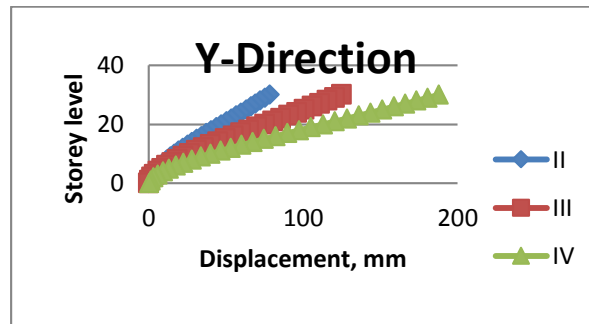


Fig 6.6 Storey Displacement Vs Storey number with three seismic zones in Y-direction

The storey displacement of the building increases with increasing seismic zones as shown in Fig.6.5 to 6.6. A significant increase in displacement was observed for seismic zones between III & IV in both X & Y directions .

It is observed that displacements increases as seismic zones increase. the percentage variation of displacement between seismic zones II, III and IV is variable to 37.50, 33.40, respectively in X-direction. In Y-direction the percentage variation of displacement between zones II, III and IV is variable to 70.00, 34.00, respectively. The lateral displacements are within the limits due to placement of shear wall symmetrically in both directions.

Base Shear

Figure 6.7 to 6.8 shows the variation of the base shear with increasing seismic zones for 30 storied building in both directions.

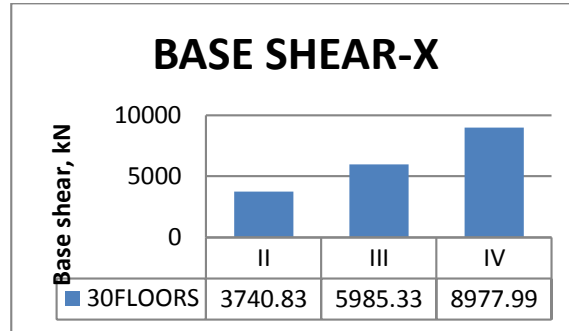


Fig 6.7 Base shear Vs seismic zones in X-direction

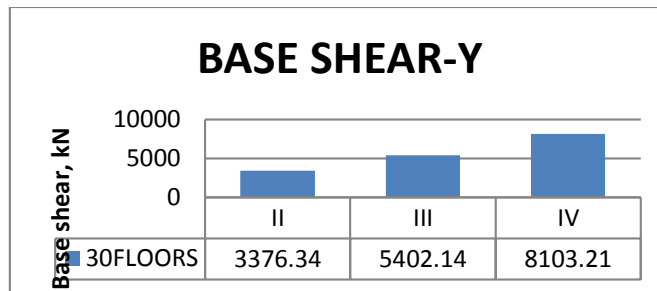


Fig 6.8 Base shear Vs seismic zones in Y-direction

It can be easily observed from these figures 6.60 to 6.60 that the base shear increase with increasing seismic zones in 30 storied building. The percentage variation of increase in base shear for seismic zones are 37.60, 33.40, respectively in X-direction. In Y-direction it was observed as 37.50, 33.40, respectively. This indicates as the seismic zone increases the base shear increases.

FOURTY STORIED BUILDING

Storey Displacement

Storey displacement Vs Storey number graphs of the designed building in both directions with three seismic zones are shown in Figures 6.9 to 6.10, respectively. These results are obtained by increasing seismic zones and the trend lines are also shown in below figures.

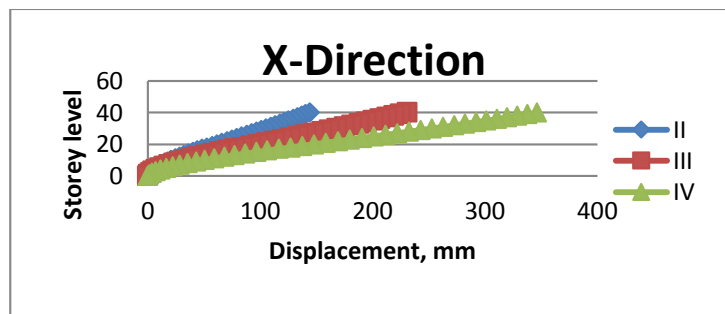


Fig 6.9 Storey Displacement Vs Storey number with three seismic zones in X-direction

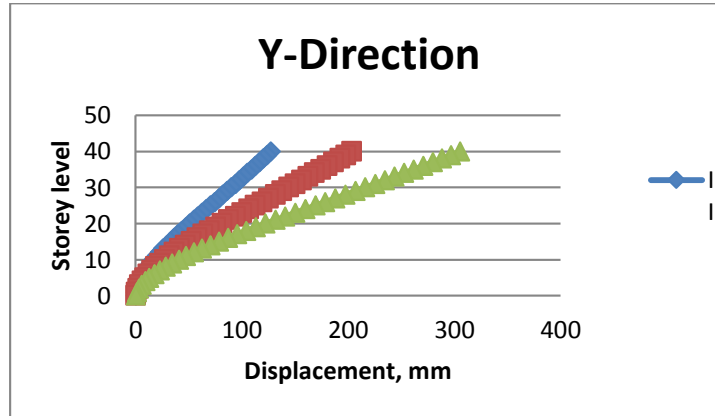


Fig 6.10 Storey Displacement Vs Storey number with three seismic zones in Y-direction

The storey displacement of the building increases with increasing seismic zones as shown in Fig.6.9 to 6.10. A significant increase in displacement was observed for seismic zones between III & IV in both X & Y directions.

It is observed that displacements increases as seismic zones increase. the percentage variation of displacement between seismic zones II, III and IV is variable to 37.50, 33.40, respectively in X-direction. In Y-direction the percentage variation of displacement between zones II, III and IV is variable to 37.50, 33.40, respectively. The lateral displacements are within the limits due to placement of shear wall symmetrically in both directions.

Base Shear

Figure 6.11 to 6.12 shows the variation of the base shear with increasing seismic zones for 20 storied building in both directions.

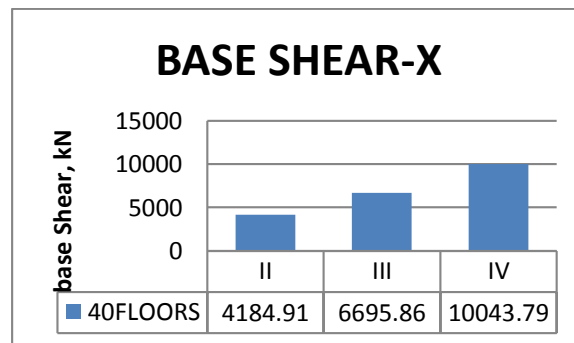


Fig 6.11 Base shear Vs seismic zones in X-direction

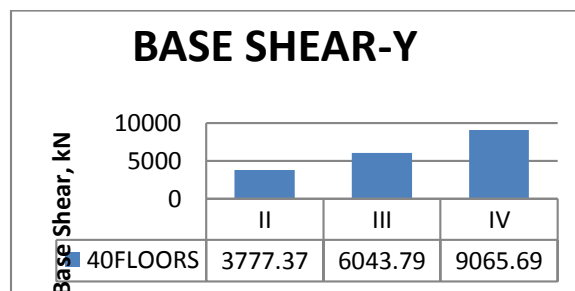


Fig 6.12 Base shear Vs seismic zones in Y-direction

It can be easily observed from these figures 6.60 to 6.60 that the base shear increase with increasing seismic zones in 40 storied building. The percentage variation of increase in base shear for seismic zones are 37.60, 33.40, respectively in X-direction. In Y-direction it was observed as 37.50, 33.40, respectively. This indicates as the seismic zone increases the base shear increases.

CONCLUSIONS

For 20 storey's structures in zone II, III, IV the percentage variation of increase in base shear for seismic zones are 37.60, 33.40, respectively in X-direction. In Y-direction it was observed as 36.90, 33.40, respectively. This indicates as the seismic zone increases the base shear increases.

For 30 storey's structures in zone II, III, IV the percentage variation of increase in base shear for seismic zones are 37.60, 33.40, respectively in X-direction. In Y-direction it was observed as 37.50, 33.40, respectively. This indicates as the seismic zone increases the base shear increases.

For 40 storey's structures in zone II, III, IV the percentage variation of increase in base shear for seismic zones are 37.60, 33.40, respectively in X-direction. In Y-direction it was observed as 37.50, 33.40, respectively. This indicates as the seismic zone increases the base shear increases