COMPARATIVE STUDY ON SEISMIC BEHAVIOUR OF METRO RAILWAY STATION UNDER VARIOUS SEISMIC ZONES

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Abstract- *India is a developing country which has given more importance for improving the infrastructure which creates more revenue for the nation. Due to this cities are growing and leading to urbanisation, the urbanization is divided into three patterns which are namely cluster wise expansion, satellite cities and sub urbanisation. To meet the transportation facility and to ease of traffic in densely populated cities adoption of metro services has become common. In this project, comparative studies of metro railway station under different loading condition for different seismic zone are done. The station comprises of nine stores such as stilt parking level, first floor level, second floor which is link bridge level, third floor which is platform level, fourth, fifth, sixth floor for commercial activity and a terrace. The analysis of this buildingis done using ETABS version-15.0 for different load cases such as time history case and response spectrum case. Finally responses of the building such as maximum displacement, natural period and base shear etc. are obtained and used for the study*

***K*ey Words:ETABS Version-15.0, Response spectrum method and Linear time history method.**

1. INTRODUCTION

Earthquakes are one of the most demoralizing natural hazards that effect great loss of life and livelihood. Prediction of time of occurrence, location and intensity of future earthquakes are unfortunately not yet possible. Recent earthquakes have shown that effective prevention has to be based mainly on adequate design, construction and maintenance of new civil engineering structures and retrofitting of existing structures and monuments lacking appropriate seismic resistance characteristics.

Damages caused by recent earthquake have pointed out that the seismic behaviour of a structure is highly influenced by the response of super structure if the structures are not properly designed and constructed with required quality may cause great destruction of structures. This fact has resulted in to ensure safety against earthquake forces of all tall structures. Hence, there is need to determine seismic responses of such building for designing earthquake resistant structures by carrying seismic analysis of the structure.

1.1 Overview of Metro Rail Projects in India

India is a developing country which has given more importance for improving the infrastructure in the entire Nation. As a result the cities are becoming Metro cities with infrastructural facilities such as improvement in transportation facilities, Metro Railway Services, Industrialization etc.

India is looking to create a world class superstructure with its surviving metros such as Kolkata and Delhi metros with addition of Mumbai, Bengaluru, Hyderabad, Chennai, Jaipur and Kochi metros in next few years while proposal for MRSTS for Pune, Chandigarh, and Ahmedabad are being chalked out.

The metro rails are rail-based, mass rapid transport system that can operate on an exclusive right of way, which is separated from all modes of transport in an urban area. Most often, the right of way is either underground or elevated above street level. These systems generally operate at an average speed of 20-35km/h, and are characterized by their high capacity it carries 50,000-75,000 passengers per hour, per direction and high frequency of operation. The capital cost of construction is between 20-30 times that of the bus rapid transit system, it's depending on whether the metro systems are underground or elevated.

2. LITRETURE STUDY

Arvindreddy, R. J Fernandes [1] studied seismic analysis of RC regular and irregular frame structures. Here, an analytical study is carried out to find response of different regular and irregular structures located in sever zone v. analysis has been made by considering the fifteen storey building for both regular and irregular plan by static and dynamic methods using ETABS 2013 and IS code 1893-2002 Different method of analysis such as equivalent static method and response spectrum method are adopted in order to study the storey displacement, base shear, storey drift and also time history analysis will be carried out by taking bhuj

earthquake data. Finally they concluded that the structure built non conservative side with irregularity in stiffness and as seen from time history analysis as storeyincreases behaviour of stiffness irregularity and diaphragm irregularity becomes reverse.

Mayuri D. Bhagwat, Dr. P S Patil [2]In this work dynamic analysis of G+12 multistoried RCC building considering for koyna and bhuj earthquake is carried out by time history analysis and response spectrum analysis and seismic responses of such building are comparatively studied and modelled with the help of ETABS software. Two time histories such as koyna and bhuj have been used to develop different acceptable criteria such as base shear, storey displacement and storey drift. They concluded that, a structure having different irregularity, it is necessary to analyse the structure in various earthquake zones and it is clears that the effect of earthquake on structure can be minimize by proving shear wall, base isolation .

Md. Armanchowdhuray, Wahid Hassan [3] In this study RC building with regular and irregular plan is considered for the analysis, here response spectrum and time history analysis will be carried out by considering the bhuj earthquake data to obtain the different structural responses like natural period, base shear, acceleration, deflection and they are concluded that, analysis ofmultistoried RCC building using time history method becomes necessary to ensure safety against the earthquake force.

3. PRESENT WORK

3.1 Methodology

The methodology includes

- Collection of detailed description of metro railway station.
- Collection of detailed information about an earthquake ground motion and parameters of time history analysis.
- Finite element based software ETABS version-15 is used to model the metro railway station.
- The equivalent lateral force method, time history analysis and response spectrum analysis are carried out to obtain results such as Displacement, Storey drift and Base shear etc.
- Results of equivalent lateral force method, response spectrum analysis and time history analysis are tabulated and discussed.

3.2 Objectives

Following are the objectives of the present study

- To analyse a metro railway station for seismic forces.
- To study the various responses such as base shear, lateral displacement and storey drift etc. of metro railway station for Bhuj earthquake.
- Analysis of metro station with different zones by response spectrum and time history methods.
- To compare effect of equivalent lateral force and response spectrum analysis on performance of a metro railway station.

4. MODELLING AND ANALYSIS

The Metro Station comprises of 9 different levels such as Stilt Parking Level, Plinth Level, First Floor Level, Link Bridge Level, Platform Level, Fourth, Fifth, Sixth Floor Levels and Terrace. The Structure details consist of 80.55m (length) x 26.9m (width) x 41.13m (height).

4.1 Dimensions of structural system

- Number of storeys=8
- Number of bays in X-direction = 11 bay
- Number of bays in Y-direction = 3 bay
- Height of Stilt Parking Level=1.5m
- Height of Plinth Level=6.610m
- Height of First Floor Level=6.610m
- Height of Link Bridge Level=5.010m
- Height of Platform Level=4.650m
- Height of Fourth, Fifth, Sixth Floor Levels and Terrace=4.2m
- Total height of the structure=41.13m

4.2 Dimensions of structural elements

Beam sizes	B1: (0.3x0.85m)
	B2: (0.7x0.7m)
	B3: (0.4x0.8m)
	B4: (0.25x0.7m)
	B5: (0.25x0.35m)
	B6: (0.25x0.6m)
	B7: (0.35x0.9m)
	B8: (0.35x0.7m)
	B9: (0.23x0.7m)
Column sizes	C1: 0.9x1.10m
	C2: 0.4x0.6m
Slab thickness	0.175m

4.3 Material properties

- Grade of Concrete : M40
- Grade of steel : Fe 500
- Poissons ratio of concrete = 0.2
- Poissons ratio of steel = 0.3
- Elastic modulus of concrete =$(3.16x10^7)$ kN/m^2
- Elastic modulus of steel = $(2x10^8)$ kN/m^2

4.4Structural Model Considered for Analysis

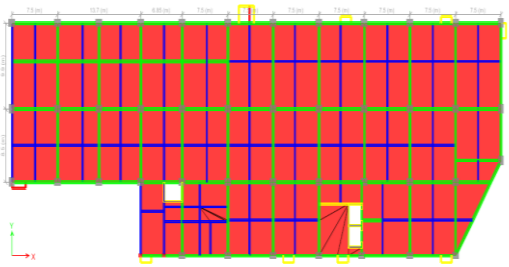

Figure 1: Building Plan

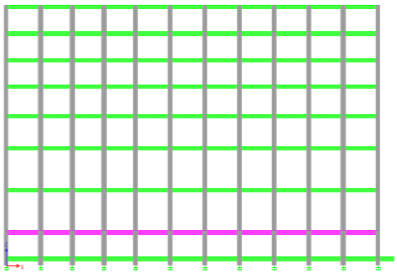

Figure 2: Building elevation in X- Direction

Figure 3: Building elevation in Y- Direction

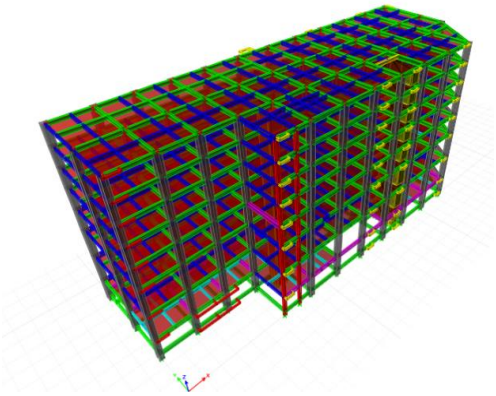

Figure 4: 3D View of Building

5. RESULTS AND DISCUSSION

5.1 Displacement

The displacement of the building is more in zone V compare to zone II and zone III. It indicates that zone V is more seismic prone area compared to zone III and zone II.The variation of displacement are tabulated in table 1, 2 and plotted in figure 1, 2.

Table 1: Pecentage variation in displacement along X-direction

Building type	Zone type	Maximum displacement(mm)			% variation in maximum displacement
Metro station	Zone II	17	-	-	-
	ZoneIII	-	27.2	-	60.16
	Zone V	-	-	75.2	342.35

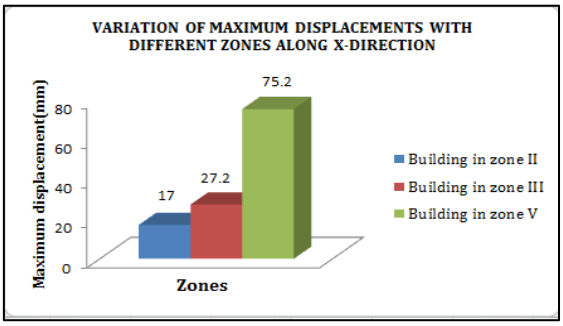

Figure 1: Variation of maximum displacements under different zones along X-direction

Table 2: Pecentage variation in displacement along Y-direction

Building type	Zone type	Maximum displacement(mm)			% variation in maximum displacement
Metro station	Zone II	24.2	-	-	-
	ZoneIII	-	38.6	-	59.68
	Zone V	-	-	106.8	341.32

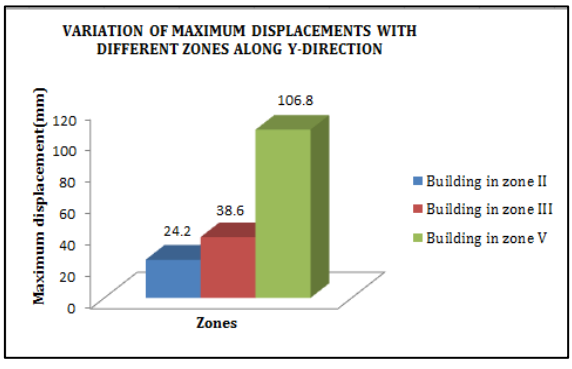

Figure 2: Variation of maximum displacements in Y direction

5.2 Base Shear

The base shear of the building is more in zone V compare to zone II and zone III. It indicates that zone V is more seismic prone area compared to zone III and zone II. The variation of base shear are tabulated in table 3, 4 and plotted in figure 3, 4.

Table 3: Pecentage variation in base shear along X-direction

Building type	Zone type	Maximum base shear (kN)			% variation in maximum base shear
Metro station	Zone II	3318	-	-	-
	ZoneIII	-	5310	-	60.0
	Zone V	-	-	14670.5	342.06

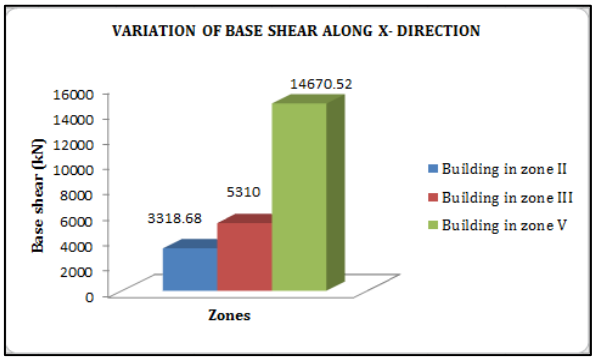

Figure 3: Variation of maximum base shear under different zones along X-direction

Table 4: Pecentage variation in base shear along Y-direction

Building type	Zone type	Maximum displacement(mm)			% variation in base shear
Metro station	Zone II	3417.8	-	-	-
	ZoneIII	-	5469	-	60.0
	Zone V	-	-	15109	342.05

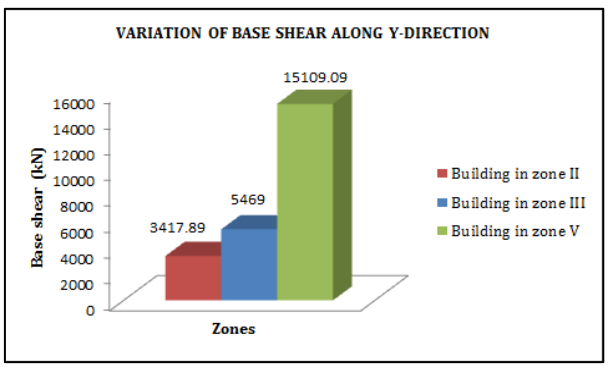

Figure 4: Variation of maximum base shear under different zones along Y-direction

5.3 Stiffness

The building in zone II is more stiff than compared to building in zone III and zone V because zone III and zone V are highly seismic prone area compared to zone II.The variation of base shear are tabulated in table 5 and plotted in figure 5.

Table 5: Pecentage variation in stiffnessunder different zones

Building type	Zone type	Stiffness (kN/mm)			% variation in maximum displacement
Metro station	Zone II	92.37	-	-	-
	ZoneIII	-	93.17	-	0.86
	Zone V	-	-	106.8	1.65

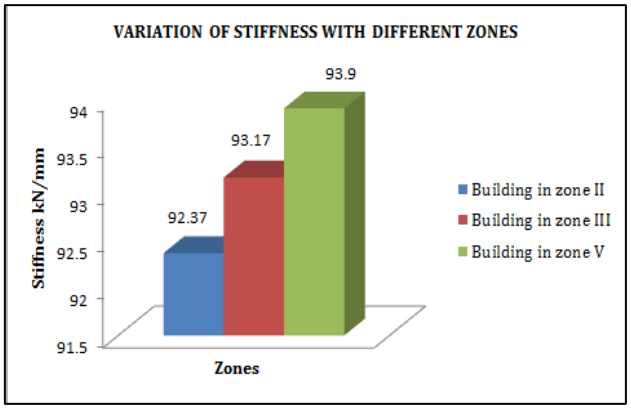

Figure 5: Variation of stiffness under different zones

6. CONCLUSION

Following are the conclusion are observed from above figures

1. From figure 1 and 2 we observed that, the displacement in zone II is less when compared to zone III and zone V. The displacement is comparatively less in present are of metro than compared to proposed area of metro because zone III and zone V are highly prone to earthquake compared to zone II.
2. From figure 3 and 4 we observed that, the base shear in zone II is less when compare to zone III and zone V because zone III and zone V are highly prone to earthquake than compared to zone II.
3. From figure 5 we observed that, The building in zone II is more stiff than compared to building in zone III and zone V because zone III and zone V are highly seismic prone area compared to zone II.

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