

SEISMIC ANALYSIS OF REINFORCED CONCRETE BUILDING FOR DYNAMIC CHARACTERISTICS OF GROUND MOTION

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Abstract: Current work deals with studying the frequency content of ground speed on reinforced concrete (RC) buildings. Linear time history analysis is done in the structural analysis and design (STAAD Pro) software. The proposed method is to study the reaction of low, middle, and high-rise reinforced concrete buildings under low, intermediate and high-frequency content of ground motions. Regularly three-dimensional two, six and twenty-storey RC buildings have low, intermediate and high frequency content with six ground speeds, in which the same period and peak ground acceleration (PGA) are studied.

In response to storey displacement, storey velocity, storey acceleration and ground shear in the base shear, the response of the buildings has been received. For each type of building, the responses of each ground motion are studied and compared. The results show that low frequency material ground motions have significant impact on regular RC buildings. However, the responses to regular RC buildings have little effect on high frequency content of ground motions.

IndexTerms - Reinforced concrete building, ground motion, peak ground acceleration, frequency content, column beam joint ratio, time history analysis.

I. INTRODUCTION

The purpose of seismic design is to constraint the damage to a suitable percent in a structure. The structure prepared in this manner should have the ability to resist the slightest level of earthquake without damage, which has to face the middle level, earthquake without structural damage, however, the possibility of some non-structural damage, and without collapse, has to face important levels of ground speed, yet with some structural and addition non-structural damage. In the upcoming work, two, six and twenty-storey regular RC buildings are subjected to six landed aspects of low, intermediate and high frequency content. Buildings will be prepared in three dimensions and the linear time history analysis has to done using structural analysis and design (STAAD Pro) software.

II. LITERATURE REVIEW

In the review of literature, the features of the motion of the ground, which play important roles in seismic analysis of the structures, were explained. Then the behavior of RC buildings under seismic load is represented. There are some research related to seismic behavior of structures under frequency material.No research work is done on seismic behaviour of RC buildings under low, intermediate, and high-frequency content ground motions considering column beam joint ratio.

Sarno (2013) studied the effects of many earthquakes on inelastic structural response. Five stations are selected to point to a set of sites that come in contact with the different earthquakes of different dimensions and source-to-site distance. Three of the tenths of the records taken at these five places are selected for each venue, which reflects the leading and lagging states of powerful land movement. RC frame analysis is subject to the same set of ground motion used for the response of RC frame, not only verify that many earthquakes are comprehensive and need urgent studies, but rather the lack of conservatism in the protection of structures traditionally when subject to various earthquakes.

Cakir (2013) Studies the evaluation of the effect of earthquake frequency content on the seismic behaviour of cantilever retaining wall associated with soil-structure interaction. They carried out a 3D backfill-structure-soil / foundation conversation event through the finite element method to analyze the dynamic behaviour of the cantilever that maintain the wall under various ground motions. They evaluated soil structure using the effects of earthquake frequency content as well as five separate ground motion and six different types of soil. He also did analytical formulation using the modal analysis technique to examine the finite element model verification, and he made a very good agreement between numerical and analytical results. In the end, they made the method comprehensive to examine the effects of parametric effects not only the frequency of earthquake, but also the interaction of soil / foundations and nonlinear time history analysis. Their results indicate that with the change in properties of soil, some displacements are made on tension reactions under lateral displacement and various ground speeds. He briefly said that the dynamic response of the Cantilever wall is susceptible to the frequency characteristics of earthquake records and the interaction of the soil structure.

Stefano & Pintucchi (2008) Research on seismic behaviour of irregular buildings. He reviewed three areas of research. First, the impact of planning-irregularity using a single-story and multi-story building model Using base isolation and other types of equipment, there is an inactive control as an approach to reduce secondary effects. Third, concerns a vertical irregular structure and

setback buildings. However, fewer papers are published in the last one, it reports on progress and progress in seismic behaviour of irregular buildings at high altitude to show a growing interest within the experts in the state-of-the-art research field.

Nayak and Biswal (2013) studied the seismic behavior of partially filled rigid rectangular tanks, which had lower downstream blocks. They used six different ground speeds of low, intermediate and high frequency materials to check the dynamic behavior of the tank liquid-submerged block system. They established a Velocity capability-based Galerkin finite element model for analysis and the effect of submerged blocks on the impulsive and sensory response components of hydrodynamic behavior in the context of the base transverse moment, the base shear and the pressure distribution enumerated with both the tank and the block wall shown. The magnitude of related physical reactions are less than the peak impulsive response components of dynamic physical parameters, in all the grounded studies studied for exploration, regardless of their frequency content.

III. OBJECTIVE AND SCOPE

To study the response of low, mid, and high-rise regular three-dimensional RC buildings with a beam column joint ratio under low, intermediate, and high-frequency content ground motions in terms of story displacement, story velocity, story acceleration and base shear performing linear time-history analysis using STAAD Pro software. From the three dynamic characteristics of ground motion, which are PGA, duration, and frequency content, keeping PGA and duration constant and changing only the frequency content to see how low, mid, and high-rise reinforced concrete buildings behave under low, intermediate, and high-frequency content ground motions. .

IV. METHODOLOGY

The following six ground motion records, which have low, intermediate, and high-frequency content, have been considered for the analysis:

1. 1979 Imperial Valley-06 (Holtville Post Office) H-HVP225 component [GM1]
2. IS 1893 (Part1) : 2002 (Artificial ground motion) [GM2]
3. 1957 San Francisco (Golden Gate Park) GGP010 component [GM3]
4. 1940 Imperial Valley (El Centro) elcentro_EW component [GM4]
5. 1992 Landers (Fort Irwin) FTI000 component [GM5]
6. 1983 Coalinga-06 (CDMG46617) E-CHP000 component [GM6]

The procedure to be conducted briefly is described below:

1. Ground Motion record is collected and then normalized.
2. Linear time history analysis is done in STAAD Pro.
3. Reasons for story displacement, story velocity, story acceleration, and shear shear due to building will study.
4. The results of three regular and irregular RC buildings are compared to six ground speeds.

V. STRUCTURAL MODELLING

Two, six, and twenty-story regular reinforced concrete buildings, which are low, mid, and high-rise, are considered. The beam length in (x) transverse direction is 4m and in (z) longitudinal direction 5m, with three bays in X direction and five bays in Z direction.

Table 1: Beam and column length and cross section dimension

Structural Element	Cross section (mm x mm)	Length (m)
Beam in (x) transverse direction	350 x 400	4
Beam in (z) longitudinal direction	350 x 400	5
Column	350 x 400	3.5

VI. GROUND MOTIONS AND LINEAR TIME HISTORY ANALYSIS

6.1. Classification of ground motions

- High-frequency content $PGA/PGV > 1.2$
- Intermediate-frequency content $0.8 < PGA/PGV < 1.2$
- Low-frequency content $PGA/PGV < 0.8$

The ratio of peak ground acceleration in terms of acceleration of gravity (g) to peak ground velocity in unit of (m/s) is defined as the ground motion frequency content.

6.2. Linear time history analysis

The timing history analysis is the dynamic reaction of the structure, at all times, when its base is in contact with the motion of a particular land. Static techniques apply when high mode effects are not important. This is for the most part valid for small, regular structures. Thus, for long structures, torsioned asymmetrical structures, or no conservative structures, a dynamic method is required.

Time-history analysis is used to determine the dynamic response of a structure to arbitrarily load. The equation of motion can be represented in this form

$$m\ddot{x}(t) + c\dot{x}(t) + kx(t) = p(t)$$

Where,

k = stiffness matrix

C = the damping matrix

m = the diagonal mass matrix

\ddot{x} , \dot{x} , and x are the displacements, velocities and accelerations of the structure and $p(t)$ is applied load.

Table 2: Ground motion characteristics and classification of its frequency-content for 35 s duration

Records (Station)	Component	Magnitude	Epicentral Distance (km)	Duration (s)	Time step for response computation (s)	PGA (g)	PGV (m/s)	PGA/PGV	Frequency Content Classification
1979 Imperial Valley-06 (Holtville Post Office) [GM1]	H-HVP225	6.53	19.81	35	0.005	0.2526	0.4875	0.5182	Low
IS 1893 (Part1) : 2002 [GM2]	-	-	-	35	0.01	1	1.0407	0.9609	Intermediate
1957 San Francisco (Golden Gate Park) [GM3]	GGP010	5.28	11.13	35	0.005	0.0953	0.0391	2.4405	High
1940 Imperial Valley (El Centro) [GM4]	elcentro_EW	7.1	-	35	0.02	0.2141	0.4879	0.4389	Low
1992 Landers (Fort Irwin) [GM5]	FTI000	7.28	120.99	35	0.02	0.1136	0.0957	1.1868	Intermediate
1983 Coalinga-06 (CDMG46617) [GM6]	E-CHP000	4.89	9.27	35	0.005	0.1479	0.0573	2.5810	High

VII. RESULTS AND DISCUSSION

7.1. Two-Story Regular RC Building

Figure 1-8 shows story displacement, velocity, acceleration and base shear of two-story regular RC building due to ground motion GM1, GM2, GM3, GM4, GM5, and GM6 in X and Z direction.

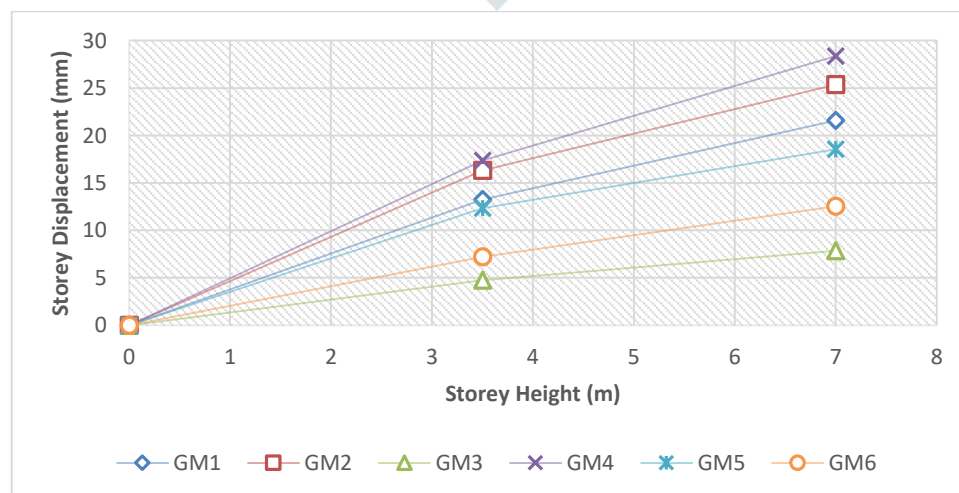


Fig.1 Storey Displacement Vs Storey height in X Direction

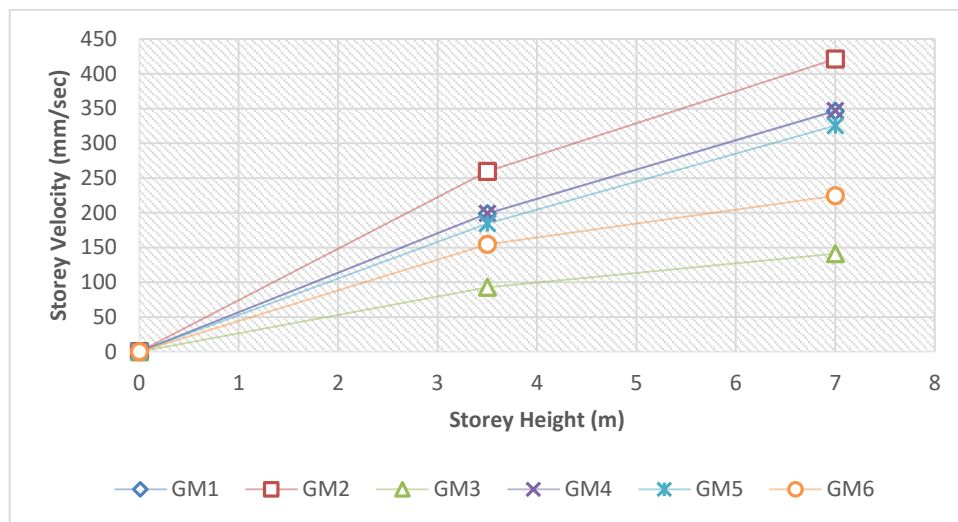


Fig 2.Storey height vs Storey velocity in X Direction

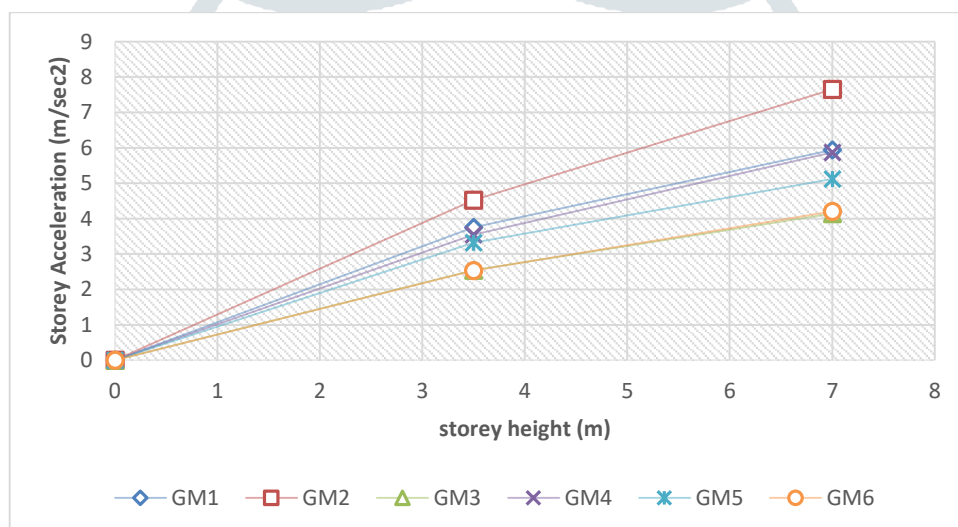


Fig. 3 Storey height vs Storey acceleration in X Direction

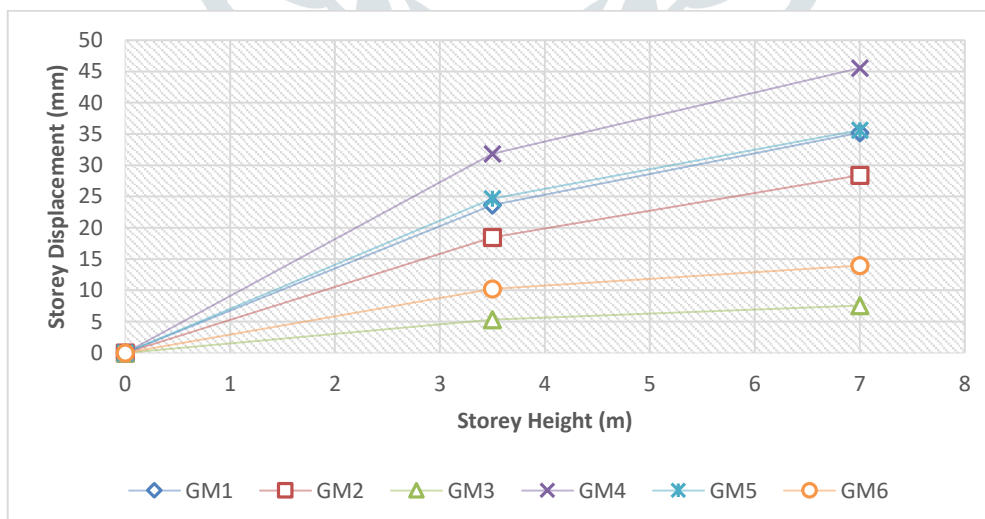


Fig.4 Storey height Vs Storey Displacement in Z direction

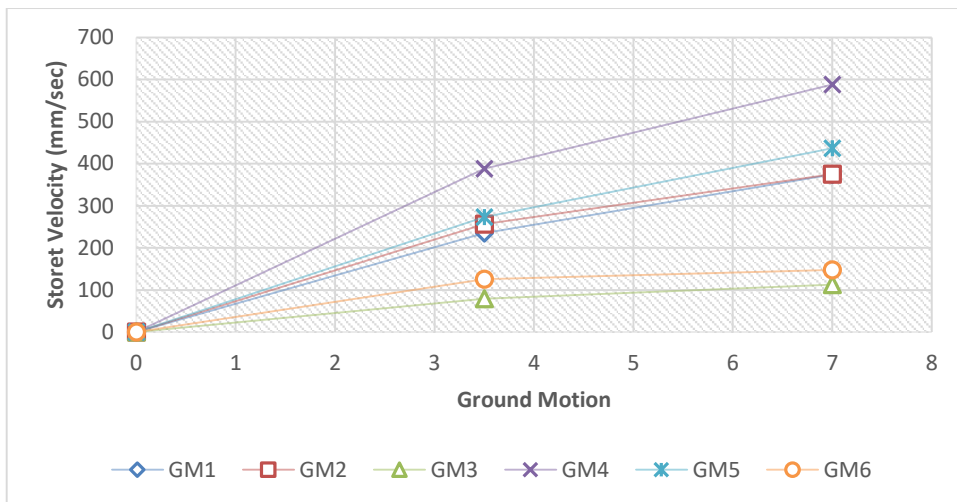


Fig.5 Storey Height Vs Velocity in Z Direction

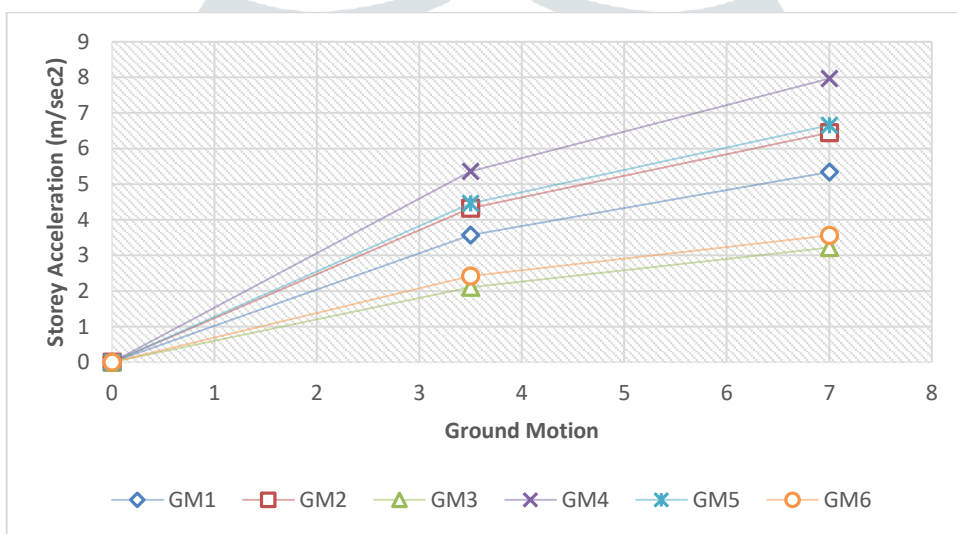


Fig.6 Storey Height vs Acceleration in Z direction

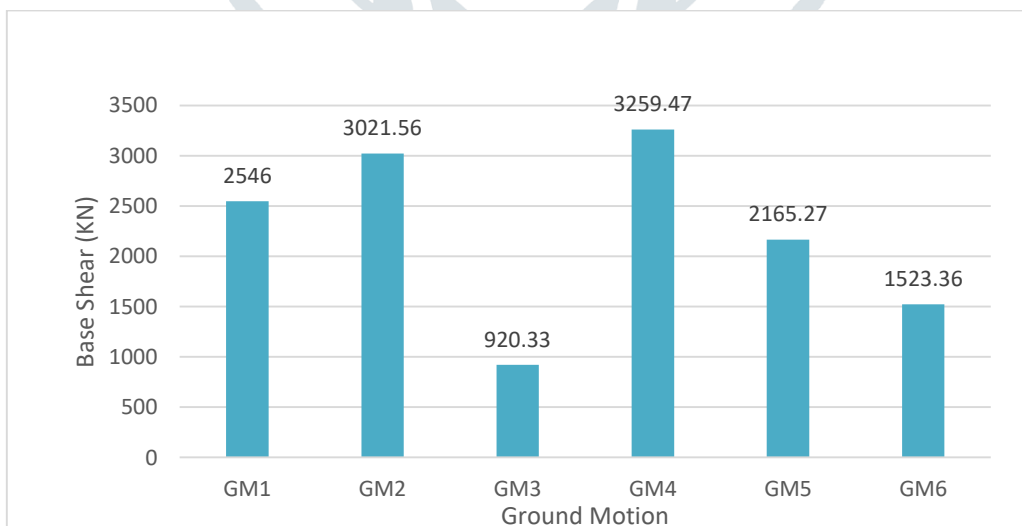


Fig.7 Base Shear of Two Storey Building in X Direction

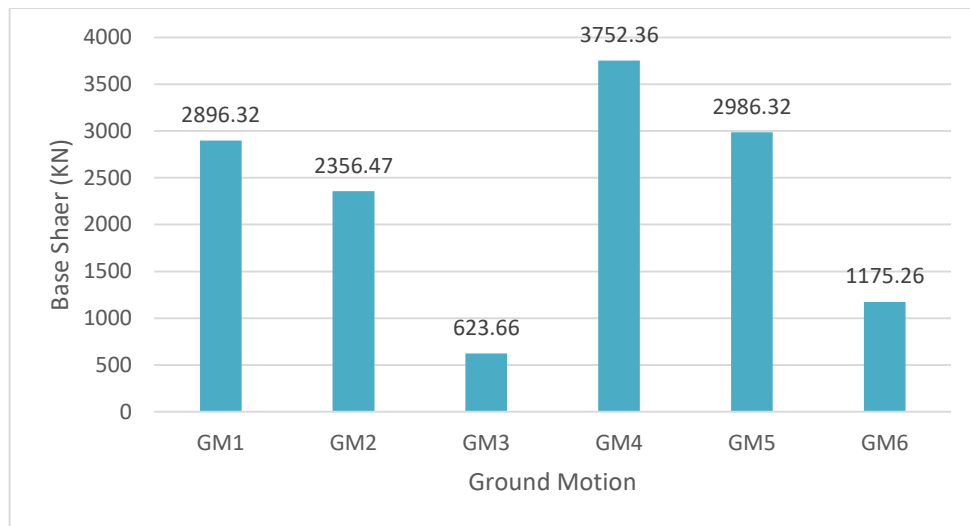


Fig.8 Base Shear of Two Storey Building in Z Direction

7.2. Six-Story Regular RC Building

Figure 9-16 shows story displacement, velocity, acceleration and base shear of six-story regular RC building due to ground motion GM1, GM2, GM3, GM4, GM5, and GM6 in X and Z direction.

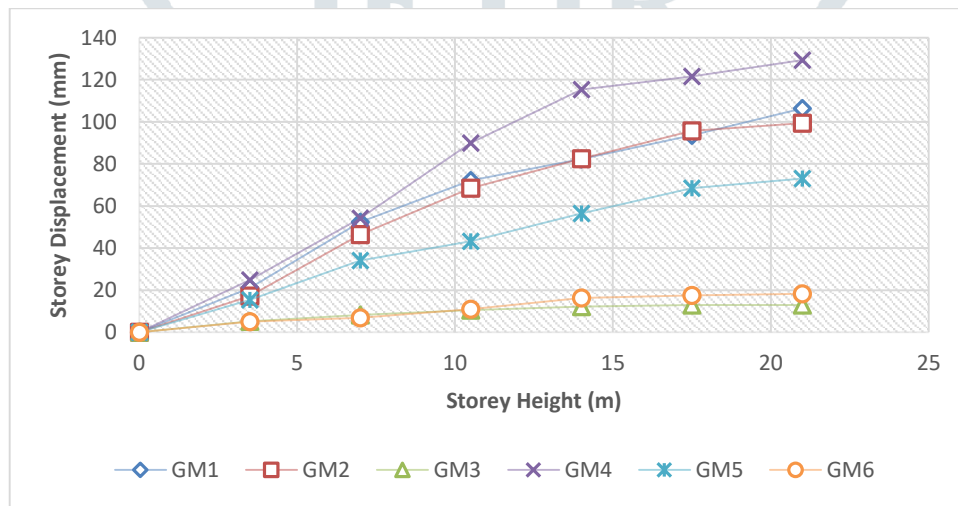


Fig.9 Storey Height vs Storey Displacement in X Direction

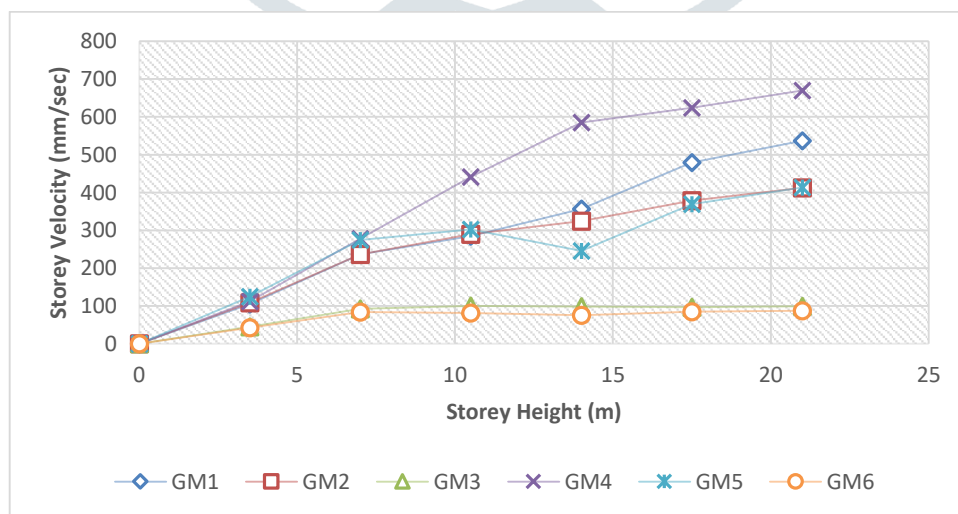


Fig. 10 Storey Height Vs Storey Velocity in X direction

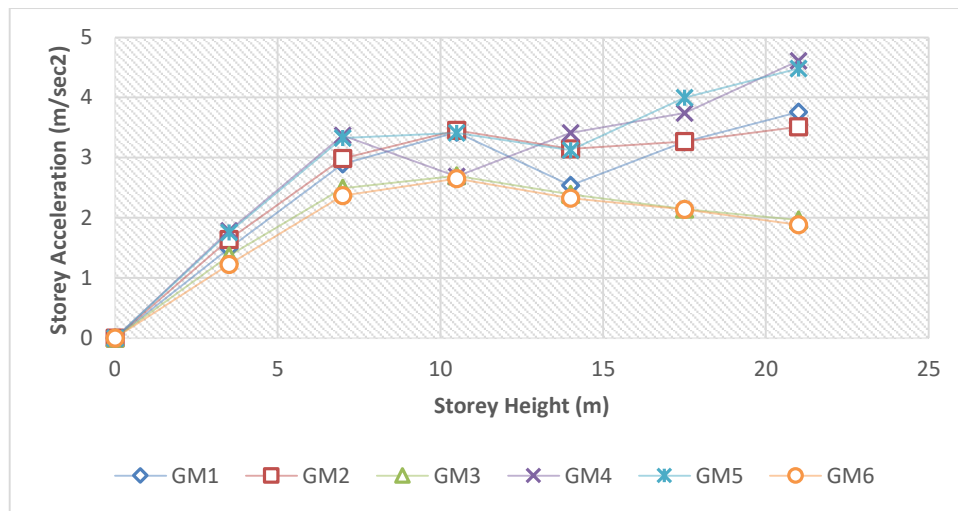


Fig.11 Storey Height Vs Storey Acceleration in X direction

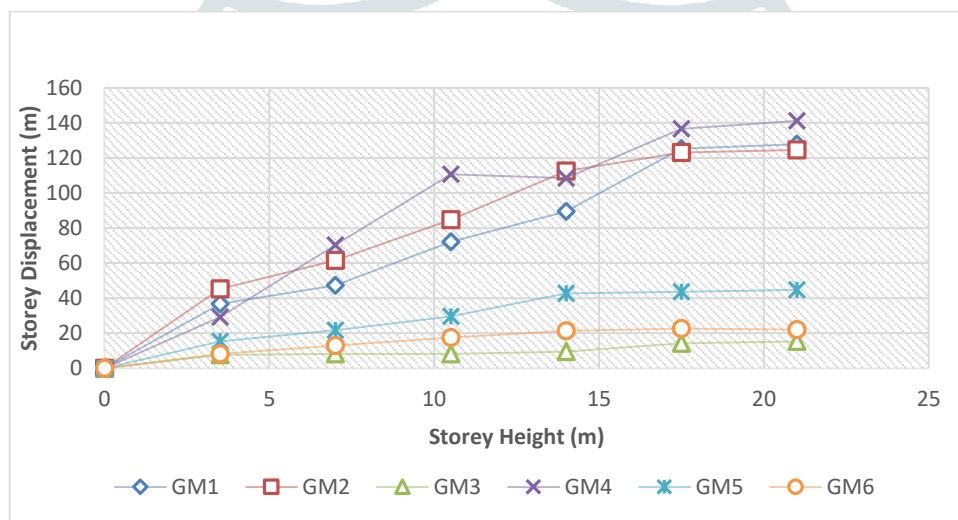


Fig.12 Storey Height Vs Storey Displacement In Z direction

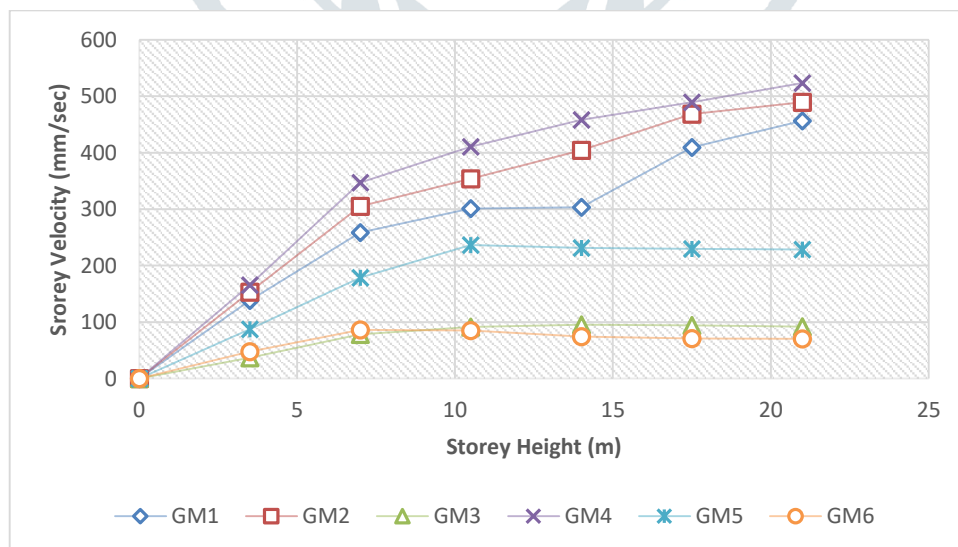


Fig.13 Storey Height Vs Storey Velocity in Z direction

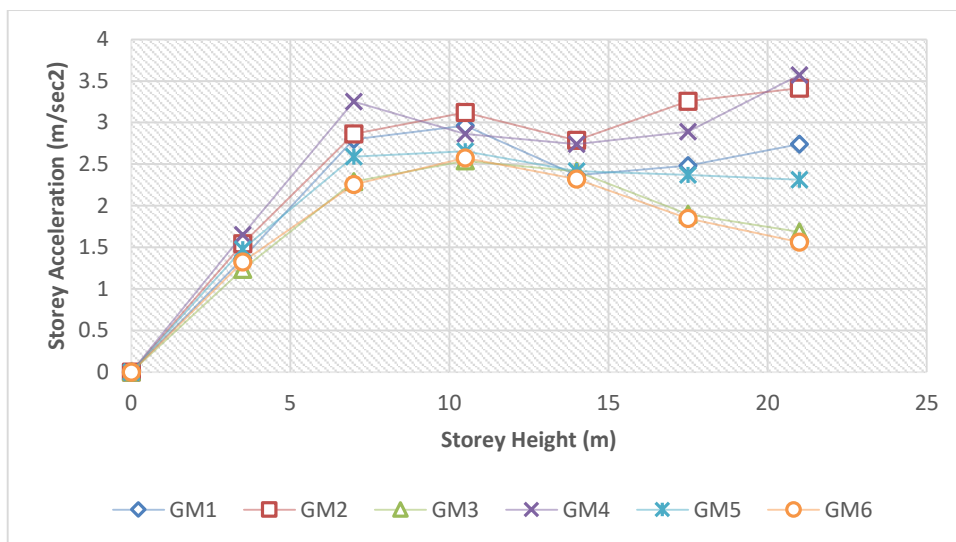


Fig.14 Storey Height Vs Storey Acceleration in Z direction

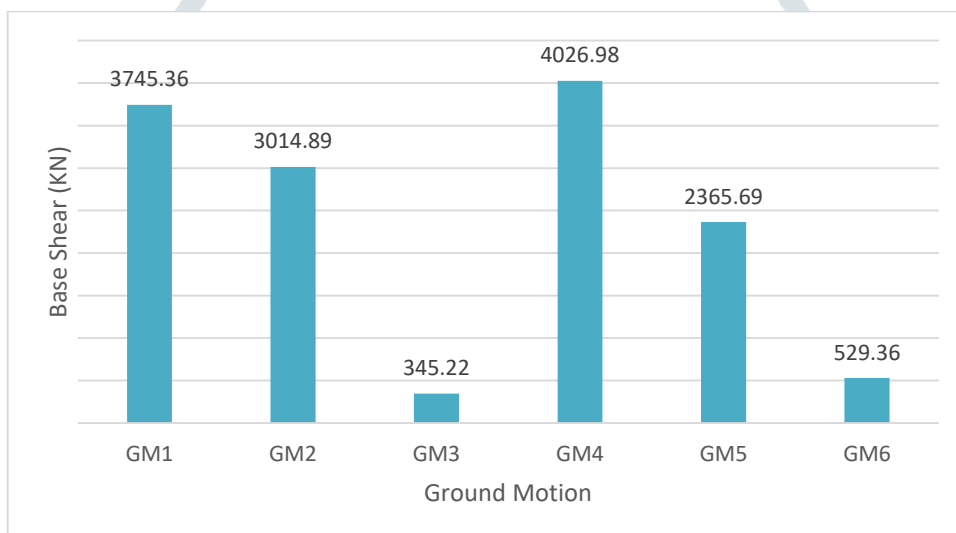


Fig.15 Base Shear of Six Storey Building in X Direction

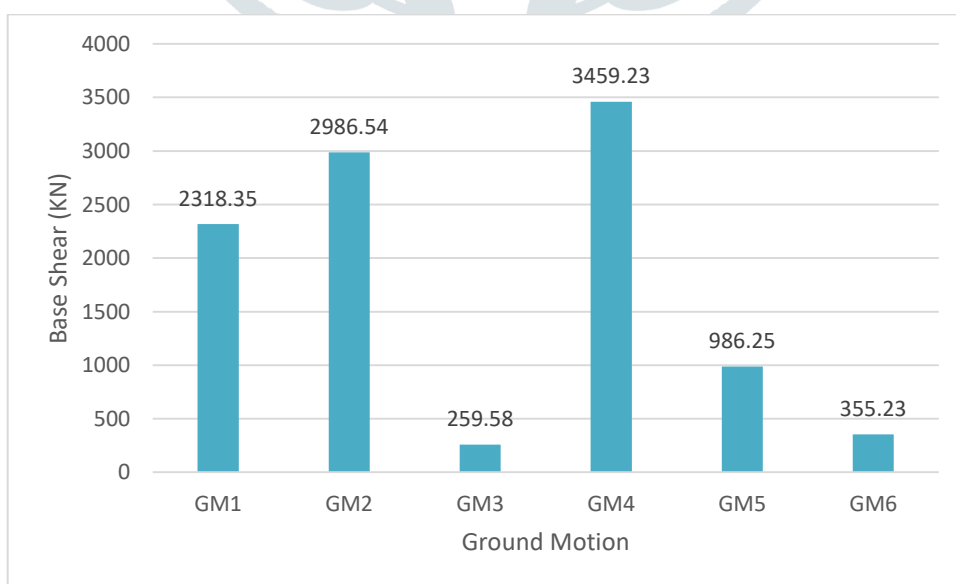


Fig. 16 Base Shear of Six Storey Building in Z Direction

7.3. Twenty-Story Regular RC Building

Figure 17-224 shows story displacement, velocity, acceleration and base shear of twenty-story regular RC building due to ground motion GM1, GM2, GM3, GM4, GM5, and GM6 in X and Z direction.

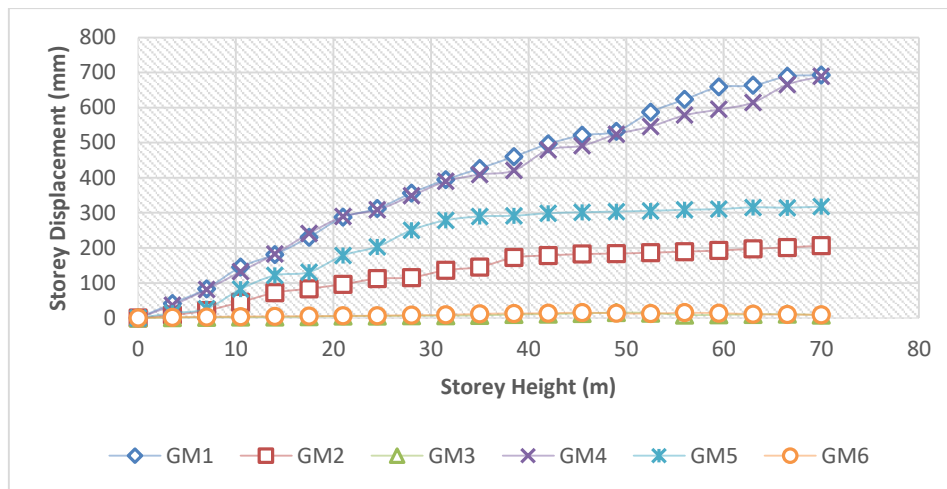


Fig.17 Storey Height Vs Storey Displacement in X Direction

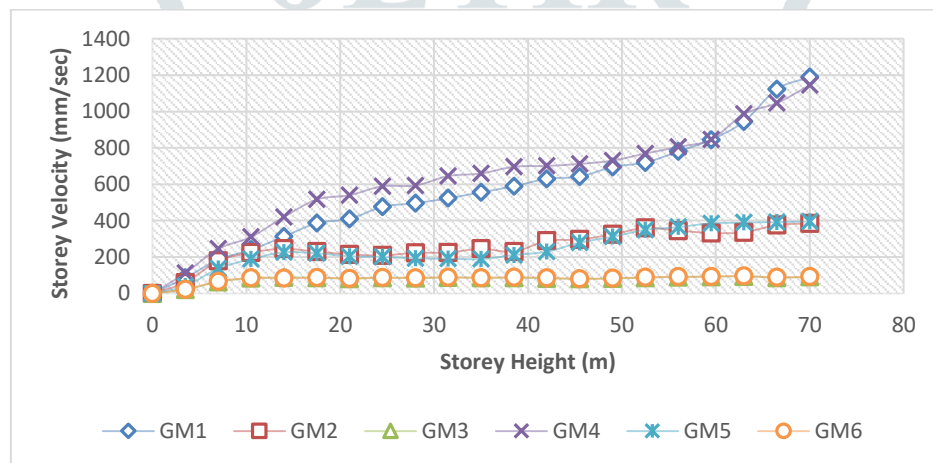


Fig.18 Storey Height Vs Storey Velocity In X Direction

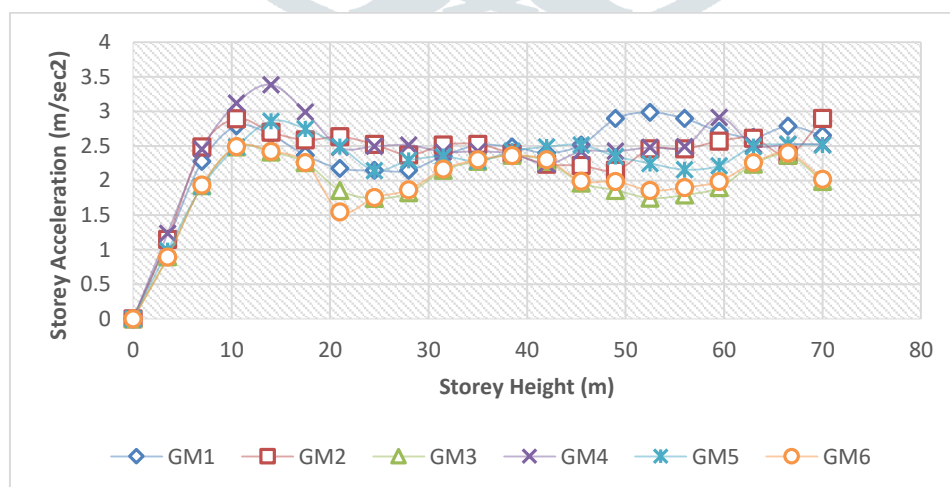


Fig.19 Storey height vs Storey Acceleration in X Direction

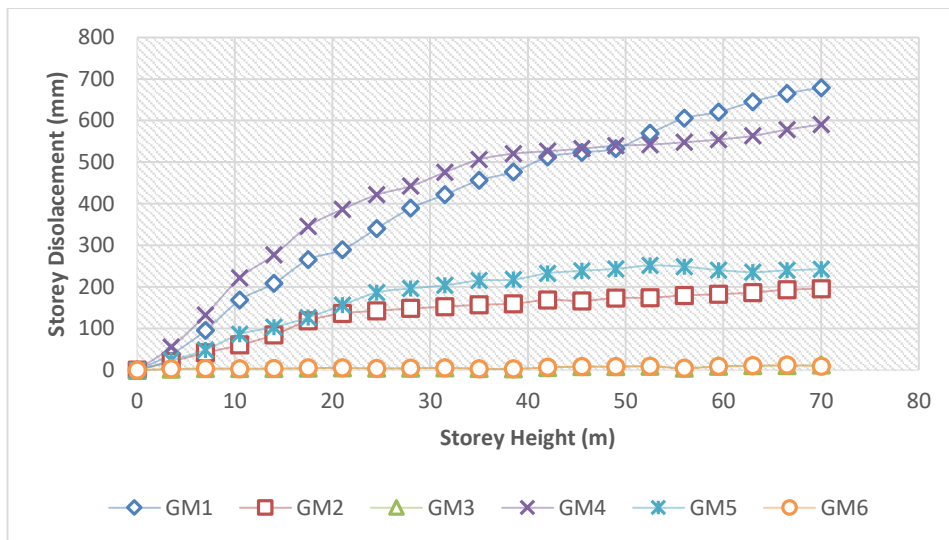


Fig.20 Storey Height Vs Storey Displacement in z direction

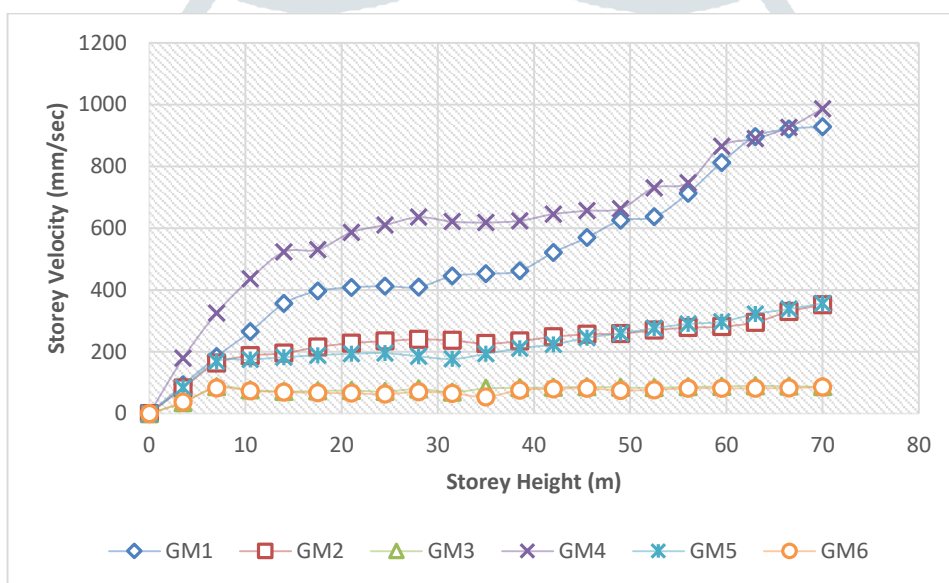


Fig.21 Storey Height Vs Storey Velocity in Z Direction

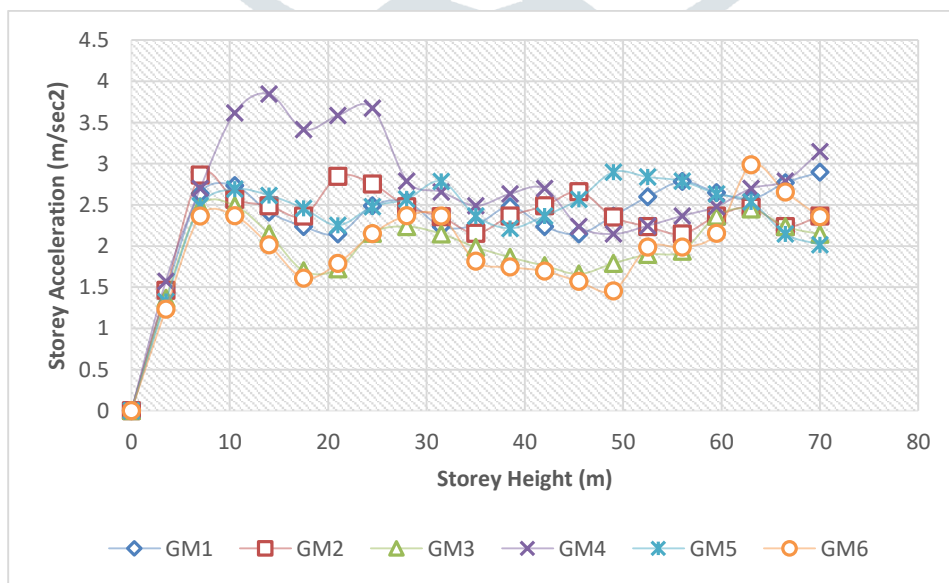


Fig.22 Storey Height Vs Storey Acceleration in Z Direction

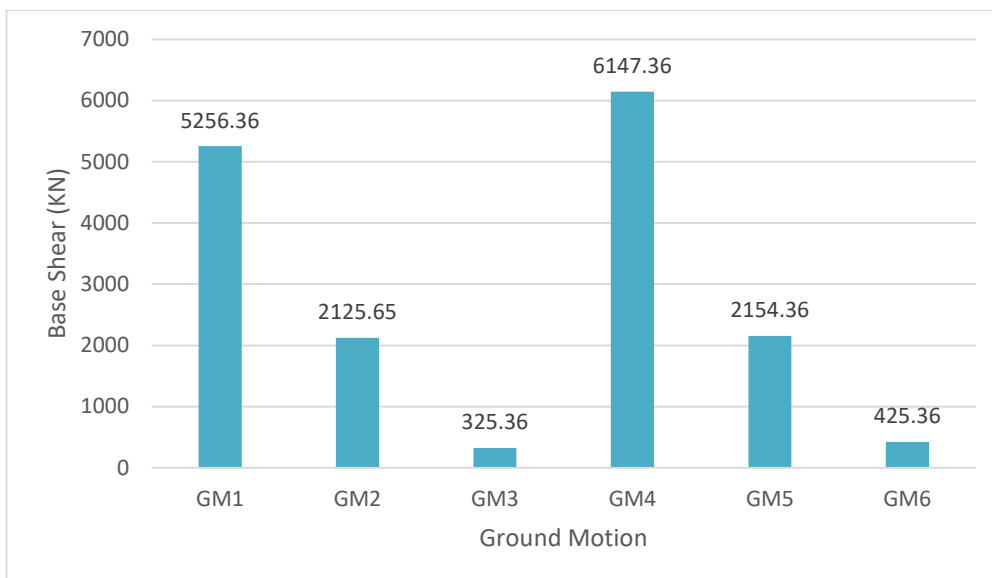


Fig.24 Base Shear of Twenty Storey Building in X Direction

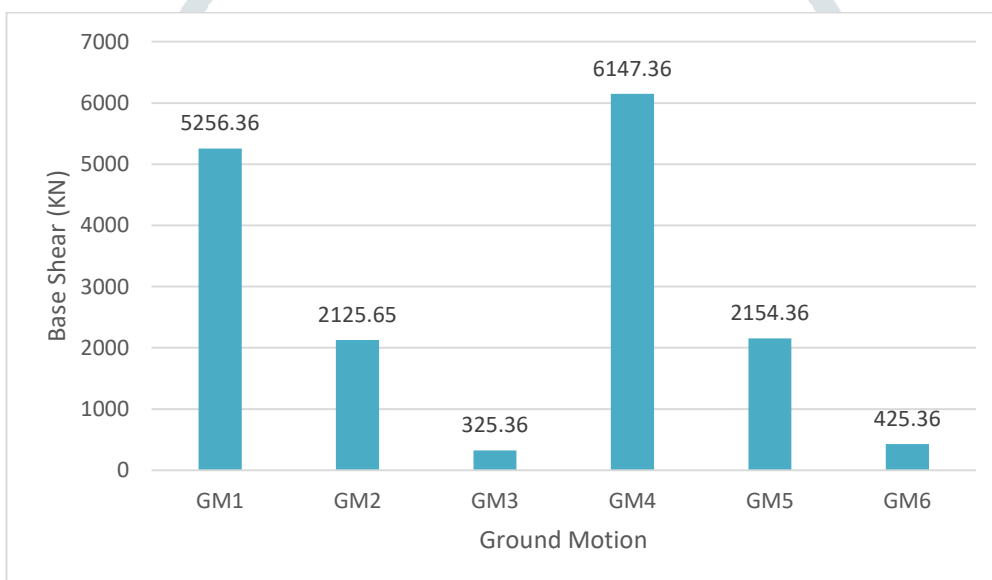


Fig.24 Base Shear of Twenty Storey Building in X Direction

VIII.CONCLUSION

The maximum and minimum values of story displacement, story velocity, story acceleration, and base shear of two, six, and twenty-story regular RC building due to GM1-GM6 in x and z-direction are summarized in Table 3.

Table 3: Two, six, and twenty-story regular RC building responses due to GM1-GM6 in x and z-direction

RC Building	Two-Story				Six-Story				Twenty-Story			
	GM (x)*		GM (z)**		GM (x)		GM (z)		GM (x)		GM (z)	
Maximum/ Minimum	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Story displacement	4	3	4	3	4	3	4	3	1	3, 6	1	3, 6
Story Velocity	2	3	4	3	4	3, 6	4	6	1	3, 6	4	3, 6
Story Acceleration	2	3, 6	4	3	5	6	4	6	4	3, 6	4	3, 6
Base Shear	4	3	4	3	4	3	4	3	4	3	4	3

The results show that low- frequency content ground motions have significant effect on both regular as well as irregular RC buildings. However, high-frequency content ground motions have very less effect on responses of the regular RC buildings.

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