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Mean Response Spectra for Earthquake Recorded In Seismic Zone-5

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Abstract - *In the History of earthquakes, it is found that data of 11 earthquakes is available to me. Out of them, attempt has been made in this paper to be present the mean acceleration response spectra of strong earthquakes with three ground motions occurred in zone 5 at 11 different places in Indian region. Response spectra for each strong ground excitation is developed. A mean response spectra is developed for selected strong ground motion using statistical analysis.*

Key Words: Response spectra; State space method; MATLAB program;

1. INTRODUCTION

Study of response spectrum is required because the powerful earthquake that struck in India has been the most damaging earthquakes and caused a large loss of property and life. So it is required to use accurate design provisions to carry out the accurate design to resist the seismic forces based on available response of previous earthquake ground excitation.

Concept of response spectra was first introduced by Housner (1941) and Biot (1942), since then it is useful and informative in solving problems of design and analysis of structures subjected to strong earthquake motions. Structures constructed on the soil that undergoing in the deformation during ground motion that deformation or change in behavior described by the response of the structure in the form of Deformation, Velocity and Acceleration.

2. RESPONSE SPECTRUM CONCEPT

2.1 Response spectra

In engineering purpose response spectra is the time variation of ground acceleration which is the most useful way of defining the shaking of ground during an earthquake. It is expressed by Time history graph. Response spectra is behavior of single degree of freedom (SDOF) system against the ground motion which differs for the different types of building according to natural period of the system.

Response spectrum is a graphical relationship of maximum values of acceleration response, velocity response and deformation response of an infinite series of linear elastic SDOF systems subjected to time dependent dynamic excitation. Here response spectrum is discussed in the form of Acceleration response spectrum.

2.2 Construction of response spectra

The Time history graph are shows the numerical values of ground acceleration with 26706 data recorded by Ahmedabad station at interval of 0.005 second and total recording time 133.53 second for Bhuj earthquake. For each component, the peak value of acceleration is determined from the time history having maximum Peak ground acceleration (PGA) -1.0382 m/sec2 of N 78 E component is considered for strong ground motion component.

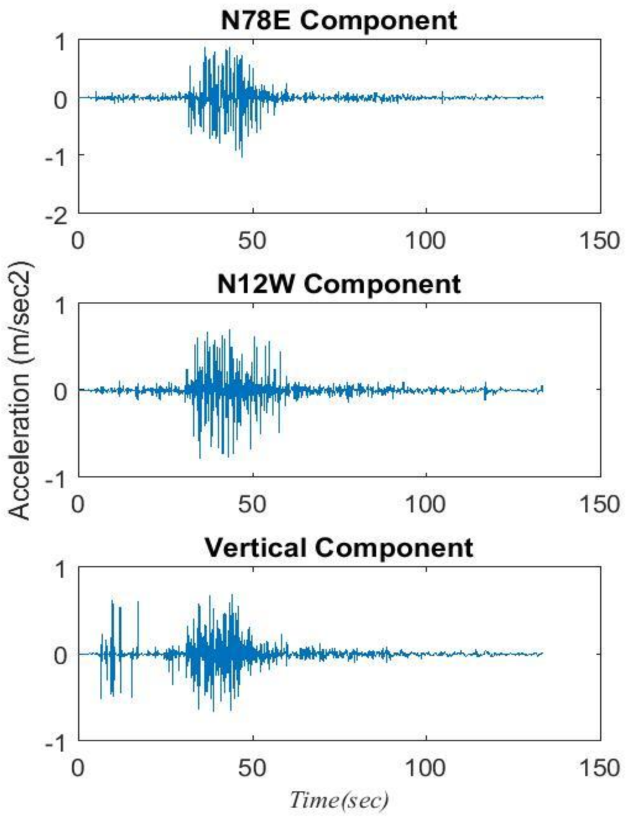

Figure 1: Ground acceleration for Bhuj (2001) earthquake recorded at Ahmedabad station

The system considered is an idealized one-storey building which consists of a rigid floor supported on columns as linear elastic system and the structure is excited by uni-directional horizontal component of earthquake ground excitation.

Response of structures developed in the form of deformation, velocity and acceleration quantities by State space method for 600 Linear SDOF system having different values of natural time period from 0 to 6 sec. with instants time variation of 0.01 sec. to the peak deformation and velocity respectively that graphs shows the deformation response spectra and velocity response spectra.

The state space method analyses the response of the system using the displacement and velocity as independent variables, these two independent variable are expressed as,

$$z(k+1) = F_s \cdot z(k) + H_{sd} \cdot F_k$$

$$\dot{z}(k+1) = F_s \cdot z(k) + F_k$$

Where z = $\{u\ \dot{u}\}^T$ and $\dot{z} = \{\dot{u}\ \ddot{u}\}^T$ is a state vector; F_s is the system matrix; H_{sd} is the distribution matrix of control forces; and F_k is forcing function.

The peak deformations u = 0.0153 m. and velocity $\dot{u}$ = 0.1598 m/sec. for a system with natural period T_n = 0.5 sec. u = 0.0469 m. and velocity $\dot{u}$ = 0.2802 m/sec. for a system with T_n = l sec. and u = 0.0620 m. and velocity $\dot{u}$ = 0.2646 m/sec. for a system with T_n = 2sec. and damping ratio ζ = 5% are calculate as in (1) and (2); the u, $\dot{u}$ and $\ddot{u}$ value so determined for each system provides one point on the response spectra. Repeating such computations for a range of values of T_n up to 6 sec. at while keeping ζ constant at 5% provides the deformation response spectra as in Fig.2, velocity response spectra as in Fig.3 and acceleration response spectra as in Fig.4

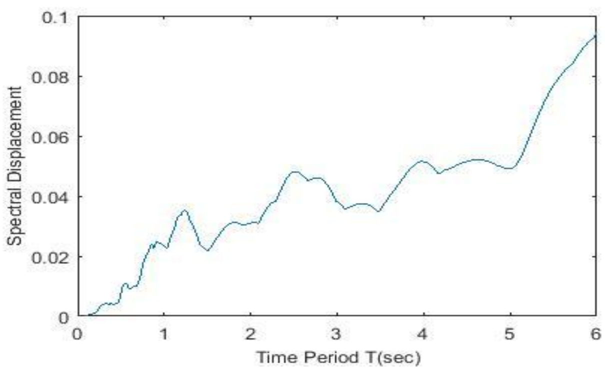

Figure 2: Displacement response spectra for Bhuj Earthquake

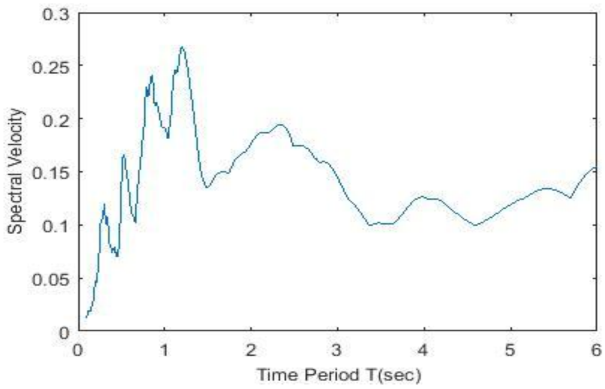

Figure 3: Velocity response spectra for Bhuj Earthquake

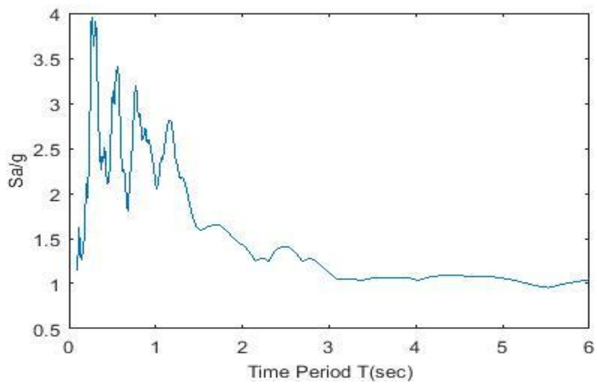

Figure 4: Acceleration response spectra for Bhuj Earthquake

3. RESULTS & DISCUSSION

Total 33 strong motion records from 11 sites were analysed for determining the acceleration response spectra for each earthquake. 11 earthquakes recorded by Centre for engineering strong motion data (CESMD) and Indian meteorological department (IMD) Ministry of Earth Science networks have been used in the present study. The peak ground acceleration (PGA), ranging from 0.064g to 0.359g, locations of these earthquakes and their magnitude range used in the present work for each station are as shown in Table 1.

Earthquake	Recording station	PGA (g)	Duration (sec.)	Magnitude	Location
Bhuj (2001)	Ahmedabad	0.106	133.525	7.6	23.40N, 70.28E
Chamba (1995)	Chamba	0.146	18.24	4.9	32.55N, 75.98E
Chamoli (1999)	Gopeshwar	0.359	24.34	6.4	30.41N, 79.42E
India Bangladesh (1988)	Dauki	0.112	45.28	5.8	24.65N, 91.52E
India Burma (1987)	Laisong	0.061	16.78	5.7	25.27N, 94.20E
India Burma (1988)	Bokajan	0.224	57.82	6.8	25.15N, 95.13E
India Burma (1990)	Laisong	0.064	9.04	6.1	24.75N, 95.24E
India Burma (1995)	Diphu	0.102	28.58	6.4	25.01N, 95.34E
India Burma (1997)	Jellalpur	0.289	88.00	6	25.00N 92.28E
NE India (1986)	Ummulong	0.113	16.94	5.2	25.43N, 92.08E
Xizang India (1996)	Ukhimath	0.078	15.20	4.8	30.65N, 79.10E

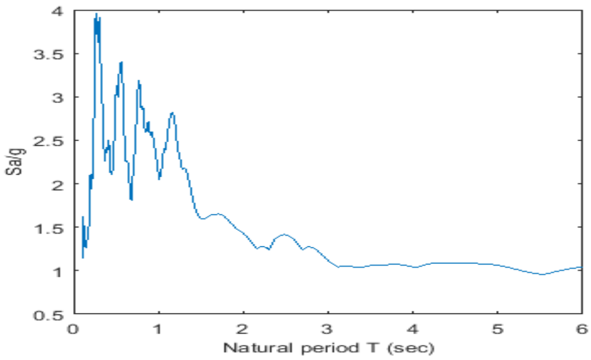

Figure 5: Bhuj (2001) Acceleration Response Spectra at Ahmedabad Station

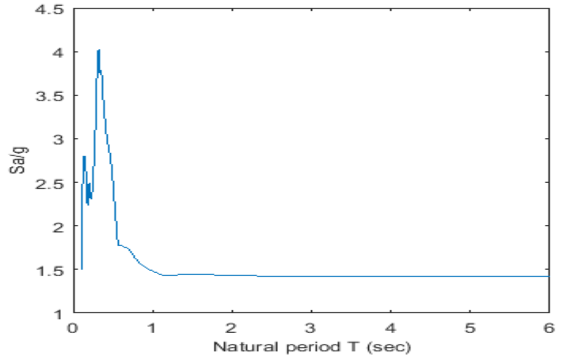

Figure 6: Chamba (1995) Acceleration Response Spectra at Chamba Station

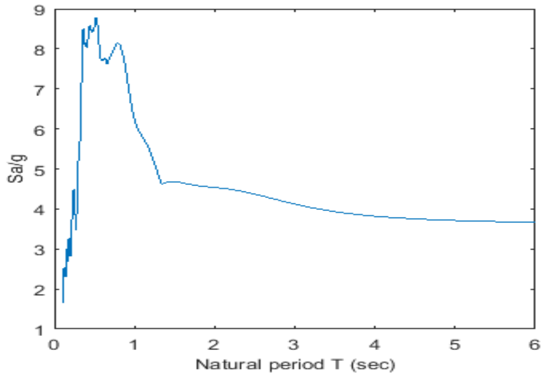

Figure 7: Chamoli (1999) Acceleration Response Spectra at Gopeshwar Station

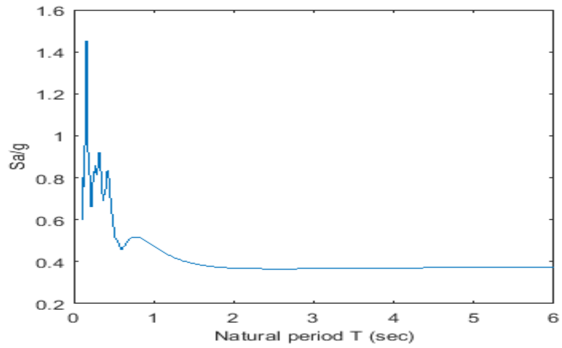

Figure 8: India Bangladesh (1988) Acceleration Response Spectra at Dauki Station

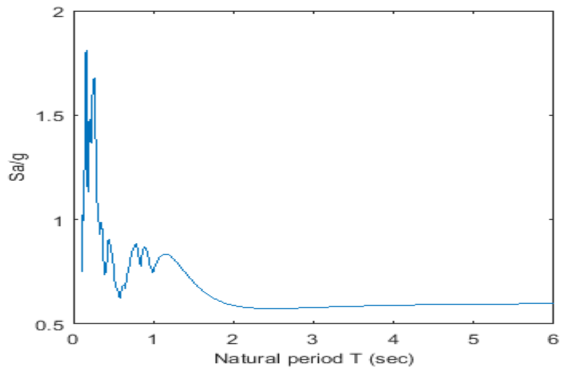

Figure 9: India-Burma (1987) Acceleration Response Spectra at Laisong Station

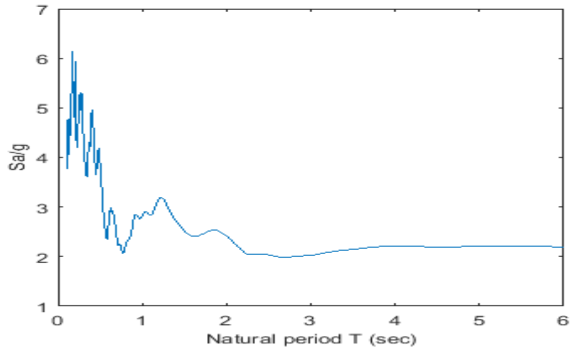

Figure 10: India-Burma (1988) Acceleration Response Spectra at Bokajan Station

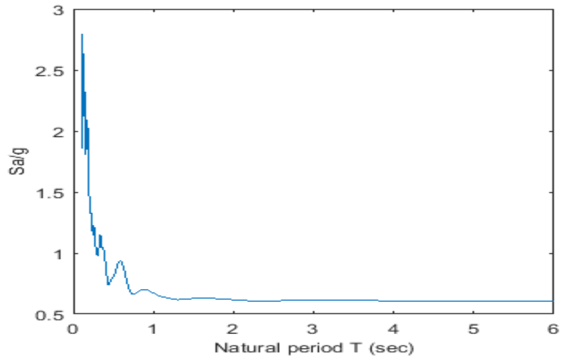

Figure 11: India-Burma (1990) Acceleration Response Spectra at Laisong Station

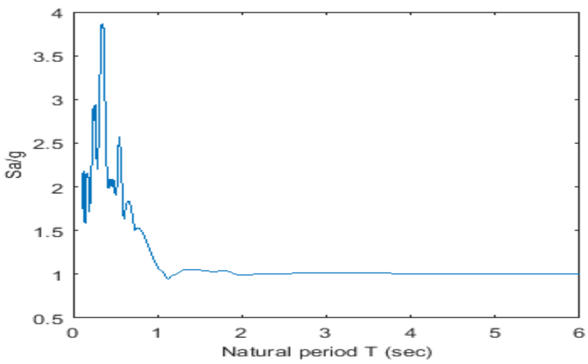

Figure 12: India-Burma (1995) Acceleration Response Spectra at Diphu Station

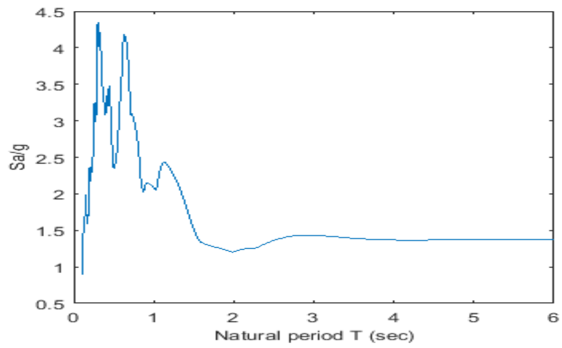

Figure 13: India-Burma (1997) Acceleration Response Spectra at Jellalpur Station

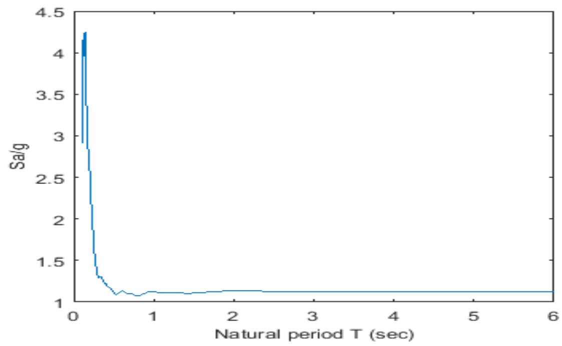

Figure 14: NE-India (1986) Acceleration Response Spectra at Ummulong Station

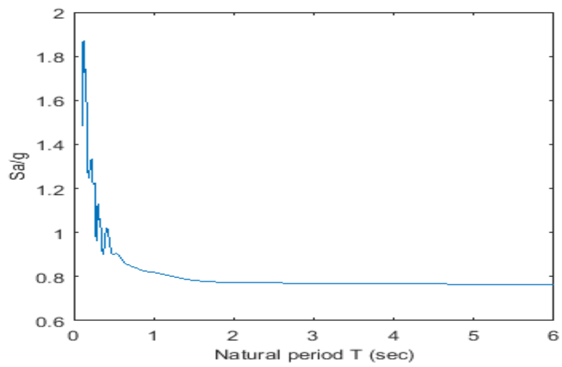

Figure 15: Xizang India (1996) Acceleration Response Spectra at Ukhimath Station

Fig. 5 to Fig. 15 shows the acceleration response spectra for earthquakes listed as in Table 1.

Fig. 16 gives clear differences between the maximum acceleration of the structural system that is located in zone 5 in India.

Acceleration response is not much higher for the systems for natural vibration period 0.12 to 0.23 sec. Acceleration response, Sa/g value is much higher in the range up to 3.5774 and gives greater response for the structural systems having the natural vibration period is more than 0.23 sec

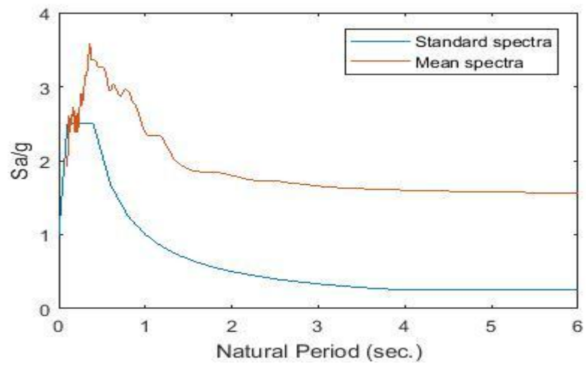

Figure 16: Comparison of Mean spectra and standard spectra

4. CONCLUSIONS

From overall observation it may be observed that the structural systems in seismic zone 5 designed before 2001 may not be able to resist the external lateral force acted upon due to earthquake.

Response from mean response spectrum derived is larger than code based design spectrum for SDOF systems having natural period values more than 0.12 sec., hence it is necessary to revise the codal provisions.

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