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Comparison of Response Spectrum for Different Zone in India

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Abstract - ***The paper presents the results of an analysis for the acceleration response spectrum of 197 ground motion records obtained from 23 earthquakes which struck the 15 places in India, mostly in the eastern part of India. The analysis shows clear differences in the acceleration response spectrum for different zones, guiding the needs for consideration of these effects in selecting earthquake resistance criteria.***

Key Words: *Spectral acceleration, Response spectrum, Newmark's beta method, MATLAB-code.*

1. INTRODUCTION

Importance of the response spectrum gives the information of the ground motion produced during earthquakes and their effects on the structural system. Since the concept of response spectrum was first introduced by Housner (1941) and Biot (1942), spectra have been widely used for the purpose of differentiating between the different ground motion records and gives simple way to find the response of the all possible structural systems. In the past few years, several studies (H. Bolton Seed 1976, Ref.[3]) have been carried out with the objective of the different shapes of the spectra according to the different soil and geological site conditions and their use for selecting the appropriate earthquake resisting structural design. (Bijan Mohraj 1976 Ref. [2]) research contributes the study of earthquake response spectrum for different geological conditions.
Recently, our work deals with generalization of the response spectrum (Ref. [1]) and development of response spectrum by Newmarks Average acceleration method. The ground motion data is collected from IMD (Indian metrological Department).The responses of 3000 elastic single degree of freedom system having different values of natural period (Tn) is calculated for the all collected ground motion data. The arrangement of spectral shapes according to the different zone in India gives the appropriate comparisons between responses of the system and their earthquake resistant design criteria.

2. CONCEPT OF RESPONSE SPECTRUM

In engineering purpose the time variation of ground acceleration (motion) which is the most useful way of defining the shaking of ground during an earthquake. It is expressed by Time history graph. Response is the behavior of SDOF system against the existing ground motion which differs for the different building according to natural period of the system. Response is very useful tools for the designing of the structure according to the safety during an earthquake. Response spectrum is a graphical relationship of maximum values of acceleration, velocity and deformation response of an infinite series of elastic single degree of freedom (SDOF) systems subjected to time dependent dynamic excitation. Now days it is a central concept in earthquake engineering, the response spectrum gives a convenient means to understand the peak response of all possible linear SDOF systems to a particular component of ground motion. Response spectrum is characterized in Deformation response spectrum, Pseudo-Velocity response spectrum and Pseudo- Acceleration response spectrum.

3. CONSTRUCTION OF RESPONSE SPECTRUM

For development of response spectrum the properties of SDOF system is used in the Newmark's method. Required values of mass, stiffness and frequency ω_n of the system are taken. Response of 3000 SDOF systems having time period values from 0s to 3s with an interval of 0.001s is calculated using MATLAB code. Here, the SDOF system having M20 grade of concrete, Fe415 steel is used.
In order to study the response, the appropriate size of the structural members of a building is selected. Consider the Single degree of freedom system having column size, beam size, slab thickness, with dimensions as shown below. Stiffness and mass is calculated for this particular building. Here, Beam and column connections of the SDOF system are to be fixed.
Damping ratio for concrete structures = 5% and for steel structures = 2%. Here, consider all buildings made using concrete material so damping ratio ζ = 5%.
Damping coefficient describes as absorption of the energy during the external loading.

- Beam size = 230mm x 350mm
- Slab thickness =120mm

- Column size = 300mm x 300mm
- Height =3.2 m

3.1 Characteristics of the system

- Moment of Inertia, I = 6.75×10^8 mm^4
- Modulus of elasticity, E=5000$\sqrt{f_{ck}}$ = 22360.68 N/mm^2
- Stiffness k =$\frac{12EI}{l^3}$= 5.5274×10^6 N/m
- Total stiffness=22.11×10^6 N/m
- Total weight of SDOF system = 138.805 KN
- Mass of the SDOF system, m = 14149.337 Kg
- Natural frequency, ω_n =19.765 rad/sec
- T_n=0.4547 sec
- Critical damping , C_c =2mω_n=559323.3 Ns/m
- Damping coefficient, C = $C_c\zeta$= 27966.165 Ns/m

Response of structures developed characterized by deformation, velocity and acceleration quantities by Newmark's average acceleration method for Linear SDOF system (Ref.[1]-A. K. Chopra, Dynamics of structures, Second Edition, pg.177).

The parameters β and Ɣ define the variation of acceleration over a time steps and determine the stability and accuracy of the method.

Typical section for Ɣ is (1/2) and 1/6 ≤ β ≤ 1/4 is right for the point of view with the accuracy.

Here from below equations we take incremental for the getting value ofu_{i+1} for time i+1 from the known $u_i$for time i.

For Average acceleration method Ɣ=1/2, β=1/4.

4. STUDY AREA

In the present study total 197 different ground motion data considering of 22 earthquakes and 15 recording stations were studied. All station records the ground motion data during earthquake using accelerometer.

All details about the name of earthquake and their recording stations in the different zone of India listed below.

Table -1: Earthquake recorded events for Indian context (1986 to 2012)

ZONE	TOTAL STATIONS
EAST	140
NORTH	53
WEST	3
SOUTH	1
TOTAL RECORDS IN INDIA	**197**

Table -2: Earthquake recorded events for East Zone.

EAST ZONE	RECORDING STATIONS
North-East India	12
India-Burma 1987	14
India-Bangladesh 1988	18
India-Burma 1988	33
India-Burma 1990	14
India-Burma 1995	9
India-Bangladesh 1997	11
Nagaland 2008	1
Manipur-Meghalaya border 2009	5
Bhutan2009	14
Assam 2012	3
Nagaland2012(1/7&14/7)	6
	140

Table -3: Earthquake recorded events for West Zone.

WEST ZONE	RECORDING STATIONS
Kutch 2001	3

Table -4: Earthquake recorded events for North Zone.

NORTH ZONE	RECORDING STATIONS
Dharmsala 1986	9
Uttarkashi 1991	13
Chamba 1995	2
Xizang-India border 1997	1
Chamoli 1999	11
Chamoli 2005	8
Uttarkashi 2007	2
(Uttarakhand) Tibet border 2008	7
	53

Table -5: Earthquake recorded events for South Zone.

SOUTH ZONE	RECORDING STATIONS
Nicobar Island 2010	1

5. ACCELERATION RESPONSE SPECTRUM FOR DIFFERENT ZONE IN INDIA

As per the study different site or area gives different response spectrum and it is characterized by Deformation, velocity and Acceleration. All response spectrums indicate the different effects and their needs and consideration of selecting the appropriate resisting design. Here India is divided in 4 zones (East zone, North zone, West zone and South zone). These graphs are indicating the acceleration response spectrum of the structural systems located in different zones in India. Here, all combine spectral acceleration graphs shows the maximum response of the 3000 structural systems having different values of Tn with instants time variation of 0.001sec.

5.1. Zone in eastern part of India (East zone)

Figure shows acceleration response spectrum for all recorded 140 ground motion data in eastern side of India. All colored line gives the shape of maximum acceleration responses of the 3000 structural systems of specified earthquake. Here, consider 12 earthquakes and their data since 1986 to 2012.

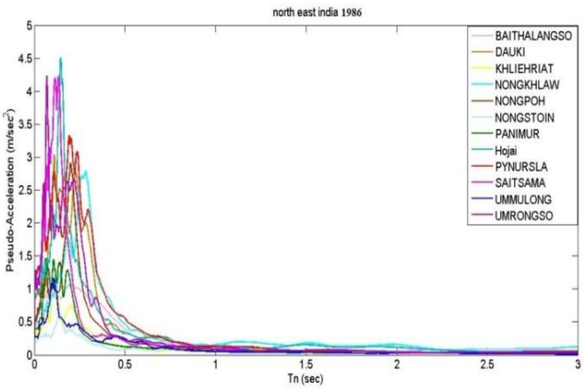

Fig -1: Pseudo-Acceleration Response Spectum for North-East India 1986 for 12 station.

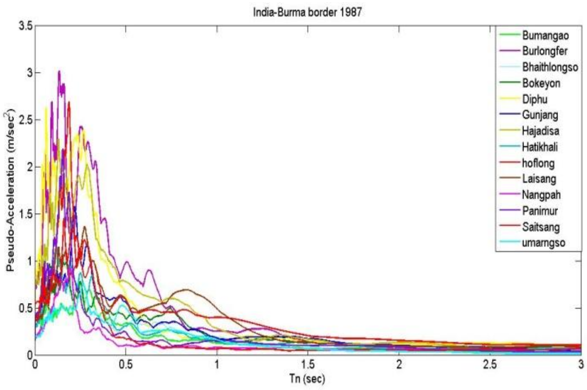

Fig -2: Pseudo-Acceleration Response Spectum for India-Burma Borber 1987 for 14 station.

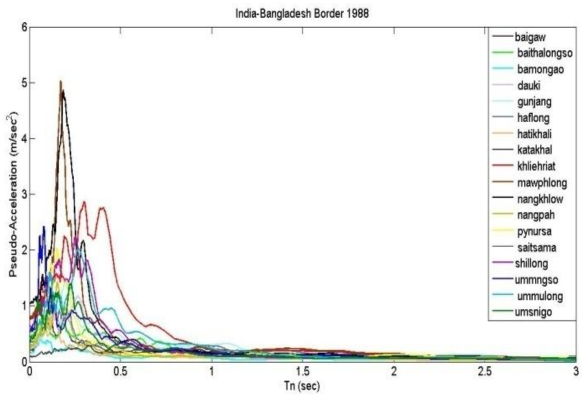

Fig -3: Pseudo-Acceleration Response Spectum for India-Bangladesh Borber 1988 for 18 station.

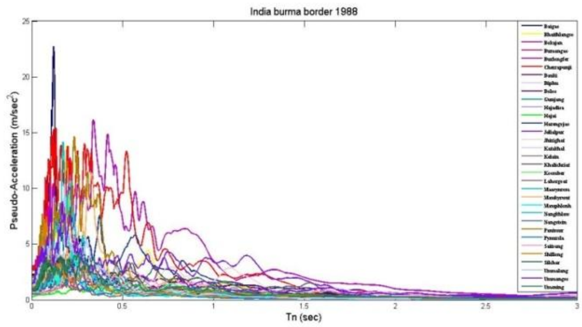

Fig -4: Pseudo-Acceleration Response Spectum for India-Burma Borber 1988 for 33 station.

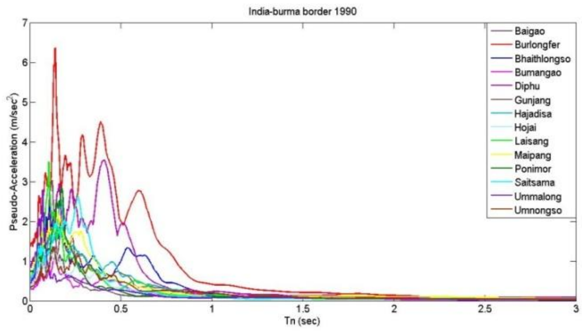

Fig -5: Pseudo-Acceleration Response Spectum for India-Burma Borber 1990 for 14 station.

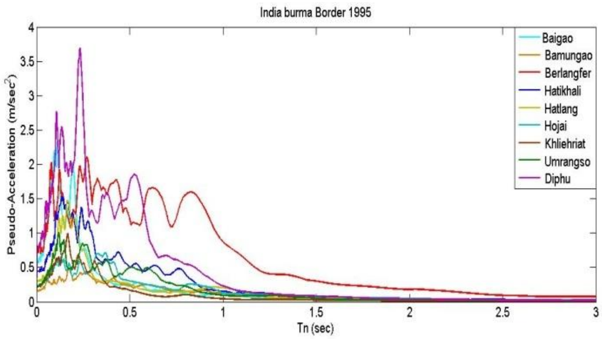

Fig -6: Pseudo-Acceleration Response Spectum for India-Burma Borber 1995 for 9 station.

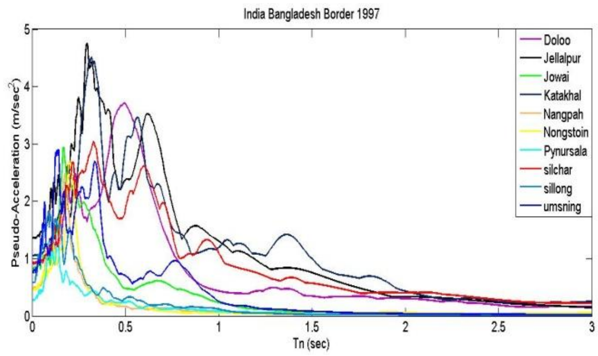

Fig -7: Pseudo-Acceleration Response Spectum for India-Bhagladesh Borber 1997 for 11 station.

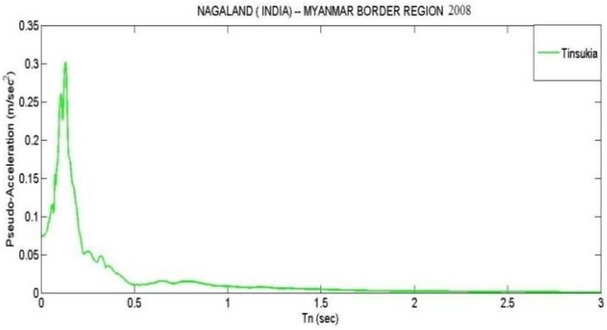

Fig -8: Pseudo-Acceleration Response Spectum for Nagaland (India)-Myanmar Border 2008 for 1station.

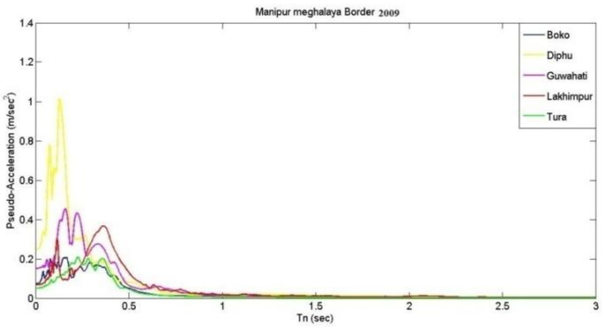

Fig -9: Pseudo-Acceleration Response Spectum for Manimar-Mayanmar Border 2009 for 5 station.

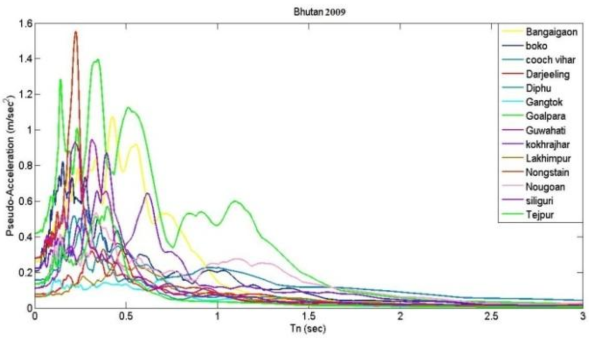

Fig -10: Pseudo-Acceleration ResponseSpectum for Bhutan 2009 for 14 station.

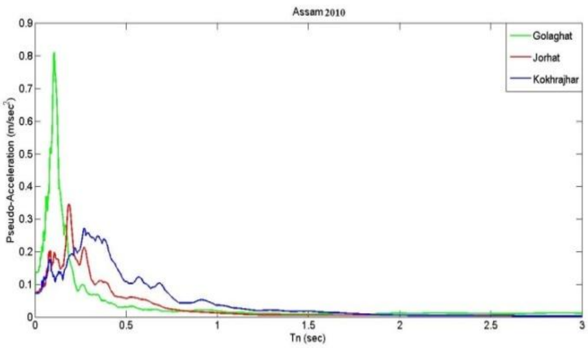

Fig -11: Pseudo-Acceleration Response Spectum for Assam 2010 for 3 station.

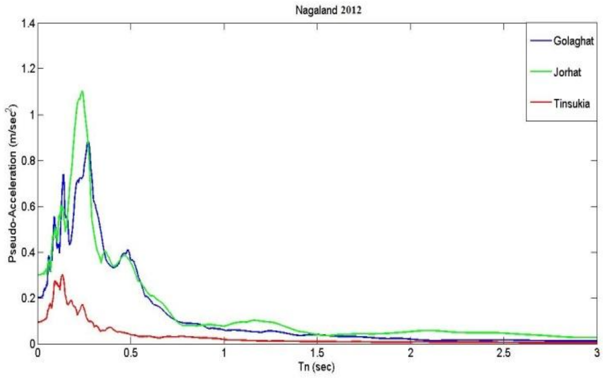

Fig -12: Pseudo-Acceleration Response Spectum for Nagaland 2012(1/7/2012) for 3 station.

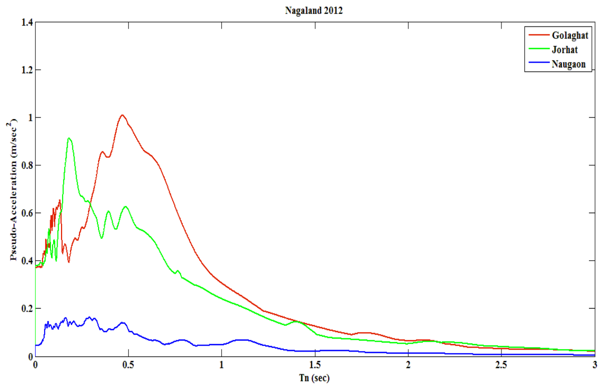

Fig -13: Pseudo-Acceleration Response Spectum for Nagaland 2012(14/7/2012) for 3 station.

5.2. Zone in northern part of India (North zone)

Figure shows the spectral acceleration shapes of the all recorded 53 ground motion data in Northern side of India. All colored line gives the shape of maximum acceleration responses of the 3000 structural systems of specified earthquake. Here, consider 8 earthquakes and their data since 1986 to 2012.

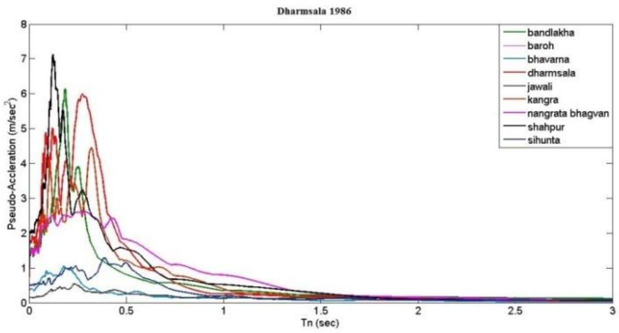

Fig -14: Pseudo-Acceleration Response Spectum for Dharmsala 1986 for 9 station.

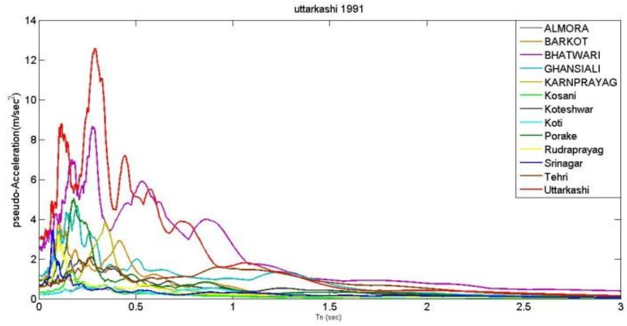

Fig -15: Pseudo-Acceleration Response Spectum for Uttarkashi 1991 for 13 station.

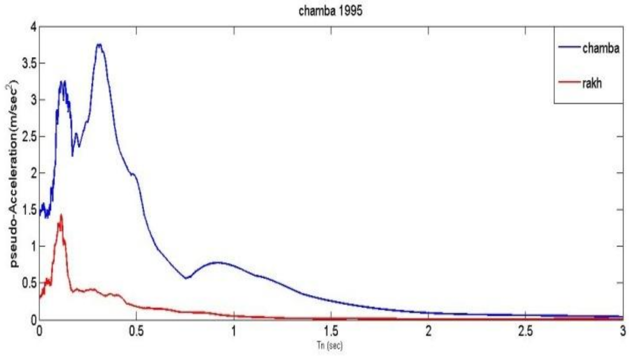

Fig -16: Pseudo-Acceleration Response Spectum for Chamba 1995 for 2 station.

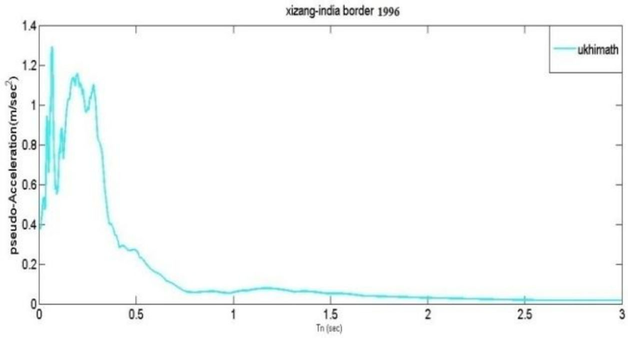

Fig -17: Pseudo-Acceleration Response Spectum for Xizang-India border 1996 for 1 station.

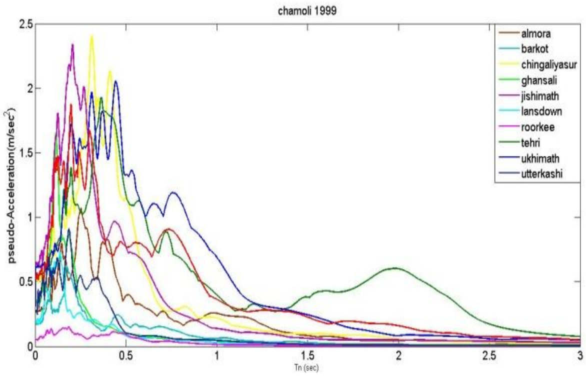

Fig -18: Pseudo-Acceleration Response Spectum for Chamoli 1999 for 11 station.

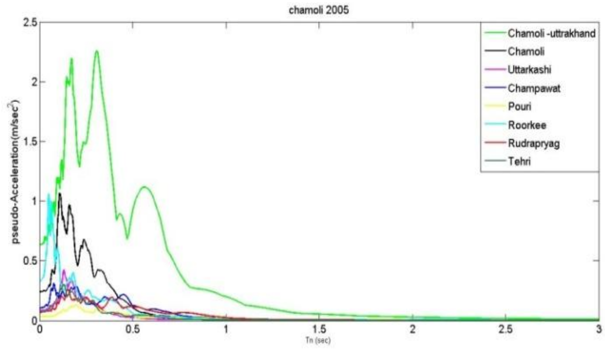

Fig -19: Pseudo-Acceleration Response Spectum for Chamoli 2005 for 8 station.

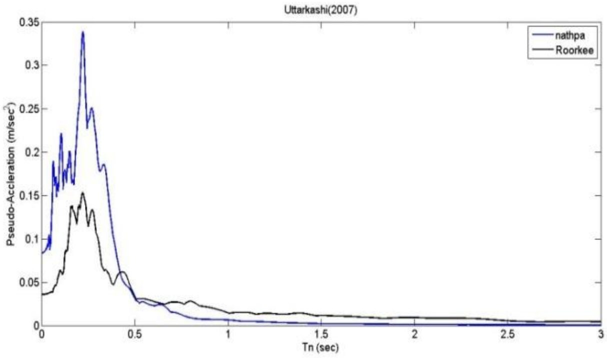

Fig -20: Pseudo-Acceleration Response Spectum for Uttarkashi 2007 for 2 station.

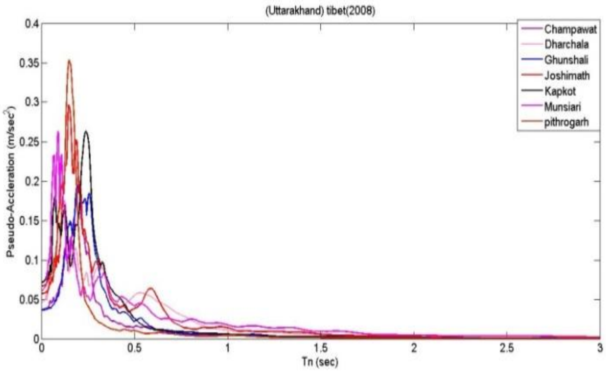

Fig -21: Pseudo-Acceleration Response Spectum for (Uttarakhand)-Tibet 2008 for 7 station.

5.3. Zone in western part of India (West zone)

Figure shows the spectral acceleration shapes of the all recorded 1 ground motion data in western side of India. All colored line gives the shape of maximum acceleration responses of the 3000 structural systems of specified earthquake. Here, consider 1 earthquake and their data since 1986 to 2012. Here, acceleration response spectrum for Bhuj is developed for aftershock ground motion. Hence not consider.

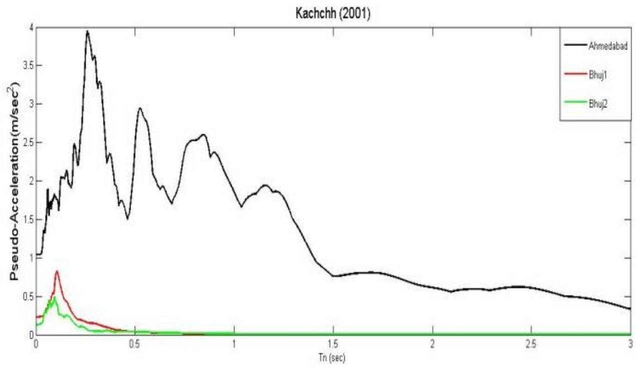

Fig -22: Pseudo-Acceleration Response Spectum for Kachchh 2001 for 3 station.

5.4. Zone in southern part of India (South zone)

Figure shows the spectral acceleration shapes of the all recorded 1 ground motion data in southern side of India. All colored line gives the shape of maximum acceleration responses of the 3000 structural systems of specified earthquake. Here, consider 1 earthquake and their data since 1986 to 2012.

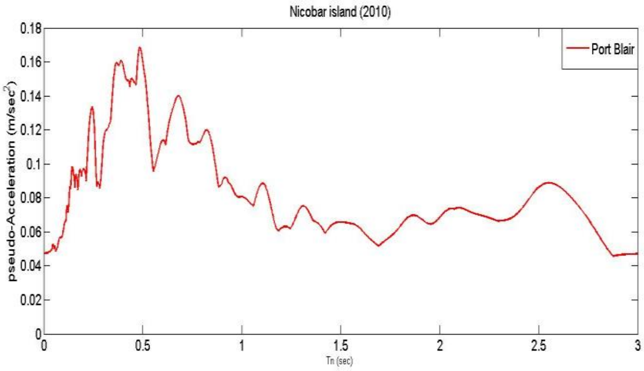

Fig -23: Pseudo-Acceleration Response Spectum for Nicobar 2010 for 1 station.

6. COMPARISON BETWEEN DIFFERENT ZONES IN INDIA

Fig. 24, 25, 26 and 27 gives clear differences between the maximum acceleration values of the structural system which is located in different zone in India.

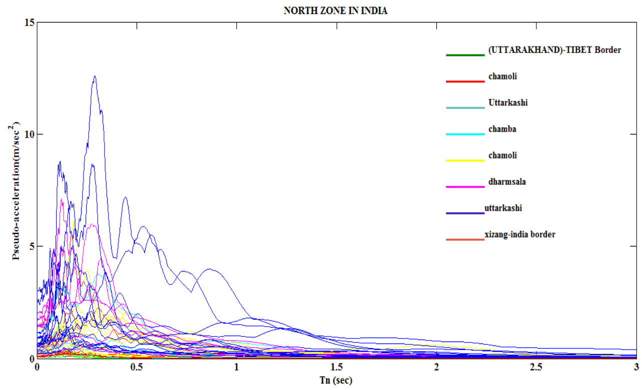

Fig -24: Pseudo-Acceleration Response Spectum for North zone.

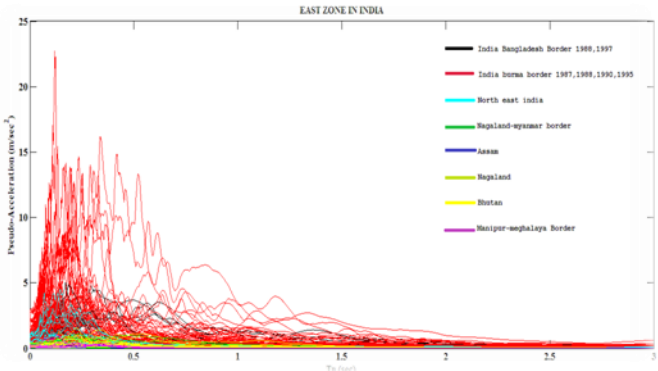

Fig -25: Pseudo-Acceleration Response Spectum for East zone.

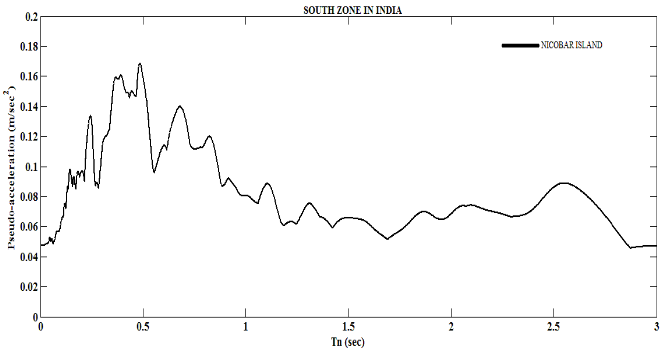

Fig -26: Pseudo-Acceleration Response Spectum for South zone.

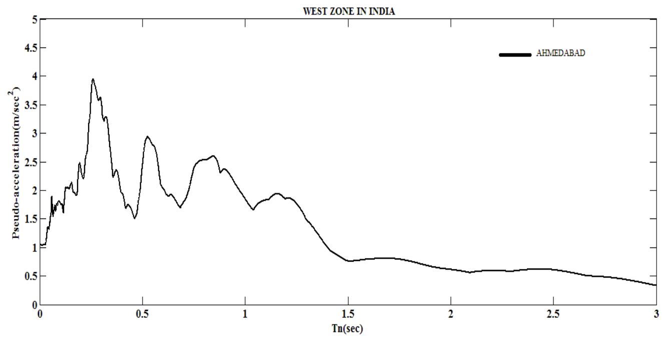

Fig -27: Pseudo-Acceleration Response Spectum for West zone.

7. CONCLUSION

- In East Zone acceleration response is very higher in the range up to 25 (m/sec^2) and gives greater response for the structural systems having the natural vibration period in range of 0.1 to 0.6 sec.
- In North Zone acceleration response is higher in the range up to 15(m/sec^2) and gives more response for the structural systems for natural vibration period 0.1 to 1.0 sec.
- In West Zone acceleration response is lower in the range up to 4 (m/sec^2) and gives lower response of the systems for natural vibration period 0.1 to 1.5 sec.
- The Acceleration Response in the South Zone is very lower in the range of up to 0.20 (m/sec^2). It gives nearly same response of the system say neglected.
- The current spectral shape gives the appropriate comparisons between all the zones in India. From the observation say that in the East zone and North zone have greater need of concentration on the earthquake resistant design and their criteria compare with response developed for the West and South zone.

REFERENCES

[1] Anil k. chopra - Dynamic Of Strucures 'Theory And Application To Earthquake Engineering' (Second Adition, pg.177, pg.197-217)

[2] BijanMohraj - A study of Earthquake response spectra for different geological condition, Journal: bulletin of the seismological society of America, vol. 66, No. 3, pp, 915-935. June 1976

[3] H. Bolton Seed, CelsoUgas, And John Lysmer - Site-Dependent Spectra for Earthquake-Resistant Design, journal: Bulletin of the Seismological Society of America. Vol. 66, No. 1, pp. 221-243. February 1976

[4] IS 1893 (Part 1): 2002 - Criteria for earthquake resistant design of structure, Bureau of Indian Standards (BIS), New Delhi, pp.14.

[5] Kishankumar Patel, Surendrasingh Sindal, Sangril Patel and Tejan Patel-Response Spectrum Analysis for Bhuj Earthquake Recorded at Ahmedabad Station, IJCMS ISSN 2347 – 8527 Volume 5, Issue 1, January 2016.

[6] Robert M. Ebeling - Introduction to the computation of response spectrum for Earthquake loading, Technical Report ITL-92-4. June 1992

[7] S. Satish - Study of Earthquake Response Spectra, Birla Institute of technology & Science, India. May 2003

[8] Sigmund A. Freeman – Response spectra as a useful design and analysis tool for practicing structural engineers, ISET journal of Earthquake Technology, Paper No. 457,Vol. 44, No.1, March 2007,pp.25-37.

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