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Ground Response Analysis of Specific Sites in Patiala

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ABSTRACT:Propagation of seismic waves through underlying rock and soil layers above at a particular site is a natural phenomenon. The bedrock motion gets modified during propagation through different soil layer above the bedrock. In the present study, equivalent linear ground response analysis using DEEPSOIL (one of the techniques for ground Response Analysis) has been used for finding the amplification value for a specific sites Patiala. Site was analysed with the help of field data and DEEPSOIL software. For the fulfilment of this purpose geotechnical data have been collected. Sites have been classified depending upon average SPT data's. Peak Ground Acceleration (PGA), amplification factor and Spectral Acceleration have been calculated. Similarly PGA value has been calculated from the same method and estimated from 0.18 to 0.359 using DEEPSOIL.

KEYWORDS:Non- linear Ground Response Analysis, Response Spectrum, Soil characterization, Shear Wave Velocity, Peak Ground Acceleration.

I. INTRODUCTION

Earthquake can be explained as it is the process of rupture at the source which causes movement of seismic waves through underlying rock. Seismic waves go through the layers of soil at specific site of intrigue. Because of the moments of earthquake motion, bedrock motion is significantly modified at the ground surface. This occurs because of the presence of local soil layers over the bedrock underneath the site of interest. The estimation of the amplification and ground reaction because of the important part for any kind of structural designing for smart city Patiala. In this study, the effects of earthquake on local site conditions are observed. Total five sites are analyzed with respect to Loma , Uttarlashi and Uttarkashi earthquake. Results are observed in the terms of amplification, spectral acceleration and peak ground acceleration.

II. METHODOLOGY

Standard penetration test (SPT) data was collected form the site for sub surface ground response analysis. N-value are corrected according to soil strata of that site and ground water table. Measured N value is corrected for Shear wave velocity calculation as N value if influenced by the hemmer efficiency, the rate at which the blows are applied, Bore Hole diameter and rod length as given by Seed and Idriss (1971).

After the completion of SPT the data is used for the calculation of Shear wave velocity and shear wave velocity is calculated using various Vs - N correlations. Ground Response analysis will be done with the help of various method ie . Linear , Non Linear and Equivalent method for frequency domain. And the result will be obtained in the form of response spectrum and PGA values with the help of DEEPSOIL Software. Equivalent method is an approximate method in which the non- linear behavior of soil (i.e. shear modulus and damping is strain dependent) is modeled in the term Equivalent linear property (secant shear modulus and damping which is strain-independent for a range of strain) corresponding to effective shear strain using iterative procedure [3]. For the most part the compelling shear strain is thought to be 65% of the greatest shear strain created in the layer [3]. Sub surface ground response analysis has been done with this methodology and the result will be used for serviceable and safe construction of various building.



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Location of borehole at Patiala city:

Total 5 Bore Hole location were identified for the purpose of seismic ground response analysis Soil sampling of each layer have been done. Bore hole location have been preferred in such a way that it cover the entire area. List of site have been explained in Table 1.

SITE CODE	Location	Latitude	Longitude
PAT 01	Abowal, Patiala	30°21'34.78"	76°21'15.56"
PAT 02	MC Office, Patiala	30°18'48.85"	76°23'36.08"
PAT 03	Devigarh Division, Patiala	30°20'43.36"	76°22'4.52"
PAT 04	Bharpur Garden, Patiala	30°19'7.41"	76°23'17.98"
PAT 05	Tripuri, Patiala	30°21'33.81"	76°23'30.46"

 Table 1 : Location of sites in Patiala

Location of bore hole with respect to depth has been explained using Figure 1 Topographic map of Patiala.



(a): Topographic map of Patiala City

III. ANALYSIS OF GROUND RESPONSE ANALYSIS

No particular record is available for the calculation of Vs. Most of the previous studies have focused on the correlations between Vs and SPT-N values and just few studies have considered other parameters. VS = $A.N^B$ where Vs is shear wave velocity, N is SPT-N value, A and B are constants determined by statistical regression. From various research and calculation the final output have been obtained by using the research and formula. Vs= 82.6 (N)^{0.43} given by Hanumantharao and Ramna (2008)

Table 2: number of blows and shear wave velocity for site PAT 01 , PAT 02, PAT 03 , PAT 04 , PAT 05

S.NO	Depth	PAT01		PAT02		PAT03		PAT04		PAT05	
		Ν	Vs	Ν	Vs	Ν	Vs	N	Vs	Ν	Vs
1	1.5	13	248.87	10	222.32	6	178.48	14	256.93	7	190.71
2	3	23	318.07	14	256.93	7	190.71	14	256.93	14	256.93
3	4.5	26	335.29	20	299.52	9	212.47	17	279.30	18	286.25
4	6	39	399.15	30	356.57	21	305.87	22	312.05	22	312.05
5	7.5	47	432.50	32	366.60	26	335.29	34	376.28	23	318.07

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• SELECTION OF METHOD

The results have been obtained in the form of response spectrum and PGA values using DEEPSOIL Software. Equivalent method is an approximate method in which the non-linear behavior of soil (i.e. shear modulus and damping is strain dependent) is modeled in the term Equivalent linear property (secant shear modulus and damping which is strain-independent for a range of strain) corresponding to effective shear strain using iterative procedure. Ground Response Analysis Of Patiala City.

Ground response analysis have been done for all the three input motion with the varying combination of shear wave velocity. Equivalent linear ground response analysis have been carried out with using DEEPSOIL. DEEPSOIL is a commonly used commercial software for GRA studies.(Hashash et al.) The response spectra for 5% damping at ground level for the sites is considered. Uttarlashi (2005) Input motion response spectra obtained from DEEPSOIL.

Input Motion

Ground motion is the movement of the earth's surface from earthquakes or explosions. Ground motion is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface. Three earthquake Loma (1989), Sikkim (2011) and Uttarkashi (1991) have been used as input motion for the estimation Figure (a) (b), (c).



Time (s)

(b) Accelaration V/S Time Graph of Sikkim Eq

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Figure: Acceleration (g) v/s time graph of Loma Gilory , Sikkim and uttarkashi Earthquake

IV. RESULTS & DISCUSSION

Different set for analysis have been done for all the three input motion with the varying combination of shear wave velocity for equivalent linear ground response analysis the analysis have been carried out with the aid of DEEPSOIL, a commonly used commercial software for GRA studies.(Hashash et al.) Acceleration versus time graph have been explained below for Loma Gilory, Uttarkashi and Sikkim earthquake.



(b)



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Figures : Response Spectram for 5% damping at ground level for site (a) PAT 01 (b) PAT 02 (c) PAT 03 (d) PAT 04 (e) PAT 05 using Loma Sikkim And Uttarkashi earthquake input motion.

The response spectra for 5% damping at ground level for the site is considered for Ground Response Analysis. Loma Gilory (1989), Sikkim (2011) and Uttarkashi (1991) input motion are applied for analysis. Response spectra are obtained from DEEPSOIL are shown in Table 3: The variation of response spectrum along the soil layer is studied for all selected sites with for all the input motion.

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Site code	Location	PSA		
		Loma	Sikkim	Uttarkashi
PAT 01		0.51	0.62	0.83
IAI 01	Abowal, Patiala	0.51	0.02	0.05
PAT 02	MC Office, Patiala	0.69	1.56	1.28
PAT 03	Devigarh Division, Patiala	1.05	1.21	1.50
		0.69	0.41	0.77
PAT 04	Bharpur Garden, Patiala	0.08	0.41	0.77
		1.00	2.52	1.0
PAT 05	Tripuri, Patiala.	1.33	2.52	1.9

Table 3 : PSA result for PAT 01 , PAT 02, PAT 03 , PAT 04 and PAT 05 Sites





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oma Gilory

Sikkim

Uttarkashi



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Figure: Peak Ground Acceleration for site (a) PAT 01 (b) PAT 02 (c) PAT 03 (d) PAT 04 (e) PAT 05 using Loma Sikkim And Uttarkashi earthquake input motion.

Loma Gilory (1989), Sikkim (2011) and Uttarkashi (1991) input motion are applied for Peak Ground Acceleration using DEEPSOIL and results are observed as shown Table 4



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Table 4 : Peak Ground Acceleration of 5 Sites of Patiala City

Site code	Location	PGA		
		Loma	Sikkim	Uttarkashi
PAT 01	Abowal, Patiala	0.129	0.141	0.18
PAT 02	MC Office, Patiala	0.223	0.2577	0.362
PAT 03	Devigarh Division, Patiala	0.254	0.266	0.364
PAT 04	Bharpur Garden, Patiala	0.138	0.139	0.193
PAT 05	Tripuri, Patiala.	0.088	0.46	0.492

V. CONCLUSION

The damage pattern in urban areas during an earthquake depends on the characteristics of the

event and on the interaction between site response and vulnerability of the exposed structures. computer program DEEPSOIL (Hashash, Y.M.A. et al., 2011), for equivalent linear approximation of layered soils has been used to compute the seismic response of horizontally layered soil deposits of the study area. from the results it was concluded that.

- The shear wave velocity for Patiala sites ranges from 149.92 m/s to 595.8 m/s.
- The sub surface ground response spectra ranges from 0.41 to 1.51 g for all 5 sites of Patiala
- Analysis of site, shows higher spectral values, are very well collaborated with the damage scenario. it is also concluded that value of spectral acceleration by Uttarkashi (1991) motion is higher than other two.
- Peak Ground Acceleration for Patiala site was obtained ranges from 0.18g to 0.359 g on surface by all three Loma Gilory (1989), Sikkim (2011) and Uttarkashi (1991) input motion.
- Calculated PGA can be used for estimation of liquefaction of that area.
- Results can be used for safe design of building

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