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Earthquake Response Analysis of Sites In Warangal Using DEEPSOIL Software

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Abstract— Earthquake response analysis has been carried out for various locations in the warangal (India) adopting the linear approach. Based on the provisions of National Earthquake Hazards Reduction Program (NEHRP), all the sites have been classified using average shear wave velocity (Vs30) for the soil profile. Time histories from have been used as an input and soil amplification has been estimated at the surface using DEEPSOIL software. The results of the study have been formulated in terms of response spectra, PGA at surface time histories and strain(%) time histories. These results can be used for dynamic analyses and design of structures, planning of advanced dynamic lab test etc. Moreover, it has been observed that sites in warangal can significantly amplify ground motions and hence a site-specific design approach must be adopted for important structures.

Index Terms-Ground Response Analysis; Dynamic Analysis; Earthquake Hazard; PGA; Amplification; Warangal

1. INTRODUCTION

Seismic waves generally travel several kilometers in rock but a few meters in soil, yet the soil plays a very important role in determining the characteristics of ground motion and its analysis. The local soil conditions have a profound influence on the ground response during an earthquake. Also, the topography, nature of bed rock and the nature and the geometry of the deposits are the primary factors that influence the local modification of the wave motion between the bed rock and soil outcrop. Hence local site effects play a key role in earthquake-resistant design and must be accounted for on a case-by-case basis.The response at the surface of soil deposits is dependent mainly on the frequency content,amplitude of ground motion at bedrock, and the geometry and material properties of the soil layers above the bedrock. Seismic site characterization was obtained based on average shear wave velocity (Vs30) of top 30m depth as per National Earthquake Hazard Reduction Program (NEHRP) or International Building Code (IBC) 2000 methods. This paper presents the 5% damped linear response spectra, PGA, PGV, PGD for periods ranging from 0.01 to 40 sec using linear approach in DEEP SOIL software.

In many soil problems, only a small improvement in soil properties is necessary; however a low costtreatment is essential. In this research recycled bassanite is used as a stabilizer agent for improvement of clay soil. Additionally, this study will evaluate the use of furnace slag cement as solidification agent to improve the environmental properties of clay soil treated with recycled bassanite.

2. STUDY AREA AND DATA COLLECTION

Warangal is the largest city in Telangana state after the capital city Hyderabad, with many ancient monuments like Thousand Pillar Temple, Warangal Fort, Kush Mahal and Bhadrakali Temple that features it as a historical city. Warangal district is situated to the northeast of Hyderabad and bordered by districts of Khammam in the east. Karimnagar to the north, Medak to its west and Nalgonda to the southwest and lies between latitudes 17º 20' and 18º 35' and longitudes 78º 50' and 80º 40'. Warangal is selected in the Smart City Mission program by Government of India to make

a citizen-friendly and sustainable city. It has also been chosen for the National Heritage City Development and Augmentation Yojana (HRIDAY) scheme by the Government of India with the aim of bringing together the heritage conservation, the urban planning and the economic growth The peninsular India was considered to be aseismic in nature but the unexpected earthquakes at Koyna (10th December 1967), Jabalpur (21st May 1997) and Latur (29th September 1993) emphasized that the intra-plate region is also prone to deadly earthquakes. According to seismic zonation map of India , Warangal comes under zone III with the zone factor as 0.08g.For this Geotechnical data was obtained by MASW test conducted at 41 locations in order to cover the study area upto a depth of 30m.Linear response analysis was done using shear wave velocities obtained in MASW testing.

3. METHODOLGY

The procedure in the simplest form consist of the following steps [9]: (1) to collect data, (2) to model them for computer programs, (3) to execute computer program, and (4) to interpret the results. Several input data are required in the ground response analysis. They are classified into four categories:

Site Characterization: It includes site classification, geological or topological configuration such as development of soil profiles and cross-sectional shape.

Dynamic Characterization: It includes the assessment of dynamic soil properties either by laboratory experimentations or by using standard curves and correlations.

Input earthquake motion: Suitable time histories are selected in line with the expected earthquake hazard in area.

Analysis Type: The parameters to control the flow of the computer program are selected such as linear, nonlinear or equivalent linear. These analyses types can further be 1D, 2D or 3D as per the requirement or degree of accuracy required.

3.1 Site Classification

Site effects that represent seismic ground response characteristics are usually incorporated as amplification factors in seismic codal provisions (e.g. NEHRP 2001, UBC 97, IBC 2000 and EC8 2003). So, that site effects can be accounted for while designing. These factors are based on average shear wave velocity of top 30m of the soil profile (Vs30). These values were obtained from MASW testing.

Table1. Seismic site classification based on NEHRP or IBC 2000

NEHRP Site class	**Description**	**Average Shear Wave Velocity (Vs30) m/sec**
A	Hard rock	> 1500
B	Firm and hard rock	760 – 1500
C	Dense soil, Soft rock	360 – 760
D	Stiff soil	180 – 360
E	Soft clays	< 180
F	Special sand soils e.g., liquefiable soils, sensitive clays, organic soils, soft clays	>36 m thick

The thickness of the layers are so adjusted that a maximum frequency can a layer propogate is always 50Hz

3.2 Input motions

The final step in ground response analysis involves in getting or generating a acceleration time history, which is compatible with maximum dynamic load expected at site of interest. PGA values at rock site are carried out to be 0.08g. Several recorded time histories have been used and finally selected is northridge2 for carrying out ground response analysis

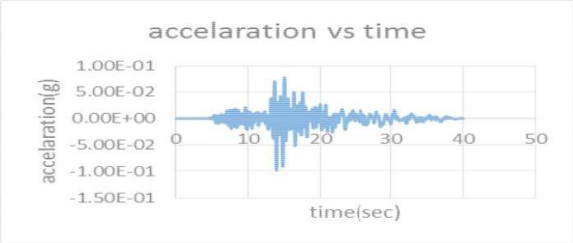

Figure 1. Northridge2 input motion

4. RESULTS

Earthquake response analysis was carried out at different locations in Warangal .At NIT Warangal PGA at bed rock is 0.08g and it was amplified to 0.144g which shows that soil in Warangal are capable of amplifying ground motion.This behavior must be accounted for earthquake resistant design structures in Warangal city.The amplified acceleration time history at Nit Warangal is shown in figure2.Shear strain(%) with time Nit Warangal is shown in figure 3.The comparision between PGA at bedrock and surface is shown in Figure4. Table 2 shows PGA values at surface of various sites in Warangal city.

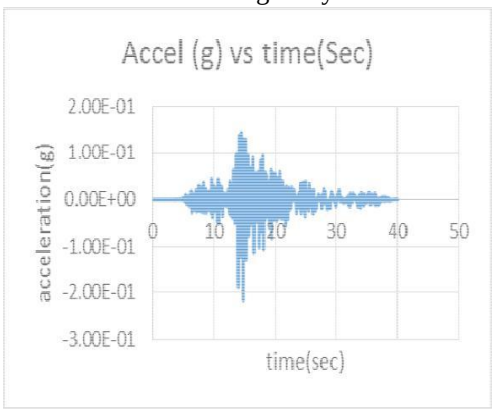

Figure 2. Acceleration time history at Surface level at NITW

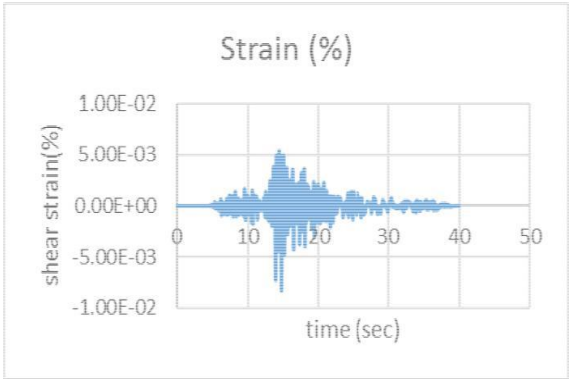

Figure 3. shear strain(%) vs time at NIT Warangal

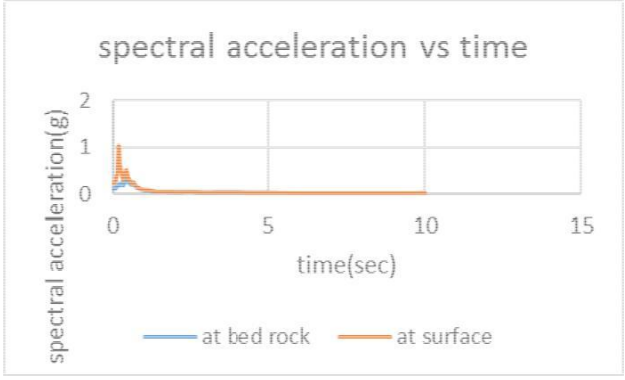

Figure 4. Comparision of spectral acceleration at bed rock and surface level of NITW

Table2: Site Response Analysis At Different Sites At Warangal

Site	**Site characteisation (class)**	**PGA (g)at surface**
NITW	C	0.144
WARANGAL AIRPORT	C	0.244
KTPP	C	0.137
ETURANAGARAM	D	0.28
TADAVI	C	0.249
RAMALINGESWARA TEMPLE	C	0.257
JANGOAN	C	0.146

5. CONCLUSIONS

Effect of local site conditions on earthquake ground motion has been estimated at NIT warangal by carrying out linear ground response analysis by DEEPSOIL software .The acceleration time history of Northridge2 has been taken as input motion .Based on analysis of results following conclusions can be drawn.

1. The minimum and maximum PGA is ranging from 0.137g and 0.249g at KTPP (Kakatiya Thermal Power Plant) and Tadavi respectively. However, higher pga ranges for short time but catastrophic to weak and old structures. The pga values developed in the study can used in costructing Earthquake resistant buildings.
2. Higher strain amplitude at certain depths indicates settlement of important structures.
3. The response spectra developed for these sites can be used for dynamic analyses of important structures in site.

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