Ground Response Analysis for Two Selected Sites in Al-Hilla City in the Middle of Iraq

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Abstract

Ground response analysis also termed as soil amplification study comprises the calculation of site natural periods, ground motion amplification, evaluation of liquefaction potential, and stability analysis. The important features that are considered for analysis are characteristics of soil overlying bedrock, bedrock location and inclination, topography of bedrock and soil deposits, faults in the soil deposits.

In this paper, two sites within Al-Hilla city were selected to investigate the ground response analysis. Laboratory tests included moisture content, Aterbberg limits , and the grain size distribution curves have been developed to understand the particle size distribution of the alluvium present, while field work included: shear wave velocity measurements and N-value calculation.

From geotechnical characterization, it has been observed that the soil profile in the two sites is dominated by silty sand and silty clay. The site response analysis of ground motion was carried out using Proshake software. The results of the equivalent linear analysis show that the peak surface ground acceleration ranges between 0.0523g to 0.0639g. The amplification factor for acceleration is in the range between 1.048 to 1.27.

Keywords: Ground response analysis, Proshake, Hilla city, Amplification factor.

Introduction

During earthquake seismic waves, propagation alters the amplitude, frequency and time duration of ground movement by time it reaches the surface. The ground movement effect propagates in the form of waves moves from one medium to another. Prediction of ground motion characteristics is considered a physical problem because of wave propagation in continuous medium is a mathematical problem. Ground response analysis term refers to the evaluation of response of the site to dynamic loading. The upward transmission of the stress waves from rock to the softer soil layers generating an earthquake, which causes ground vibration [**1**].

A sudden movement takes place in the rocks along a weak region in the earth's crust when they reach their strength, if opposite sides of the fault slipped, it will release large elastic strain energy stored in the interface [**2**].

For many years, the influence of local site conditions on the nature of the ground motions and the damage they may cause have been observed and studied. The early work of seismologists studied site amplification showed that they used to assume linear soil behavior and they rarely considered the soil non-linearity in their assessments of site conditions Finn, [**3**] [**4**]. Soil non-linearity is first considered in the work of [**5**].

Some previous studies that are related to study of ground motion are summarized below:

Idriss, [**6**] developed an empirical correlation between the peak acceleration at a rock outcrop and soft soil. The relation is based on recordings from Mexico City in 1985 and Loma Prieta in 1989.

Kramer, [**7**] developed a nonlinear approach by which a nonlinear inelastic stress-strain relationship is followed by a set of small incrementally linear steps.

Alridha, [**8**] studied the dynamic response of soil deposits for two locations in Iraq, using Kanai algorithm for transient motion through the Fast Fourier Transform (FFT). The results of the analysis were represented by soil response plots.

Alridha, [**9**] computed the fundamental period of stratified layers in Baghdad city. The results were presented in the form of amplification function, and from which the values of fundamental periods were estimated.

Location of Study Area

The study area lies nearly at 100 km south of Baghdad governorate, which is located at the middle of Iraq in Babylon governorate. The elevation of Hilla city is about 35 m above the sea level. It is accurately determined by the (Longitude. 44°22′30″ E - 44°27′ 30″ E and Lattiude. 32°24′30″ N - 32°31′30″ N) as shown in Figure 1.

Aims of the Study

The study consists of field and laboratory work in addition to analytical analysis to determine the important seismic parameters and relationships between them, such as acceleration, shear stress - time history relationships, peak ground acceleration - depth relationships and response spectrum relationships for potential earthquake using the ProShake computer program adopting the earthquake site response analysis for the study area**.**

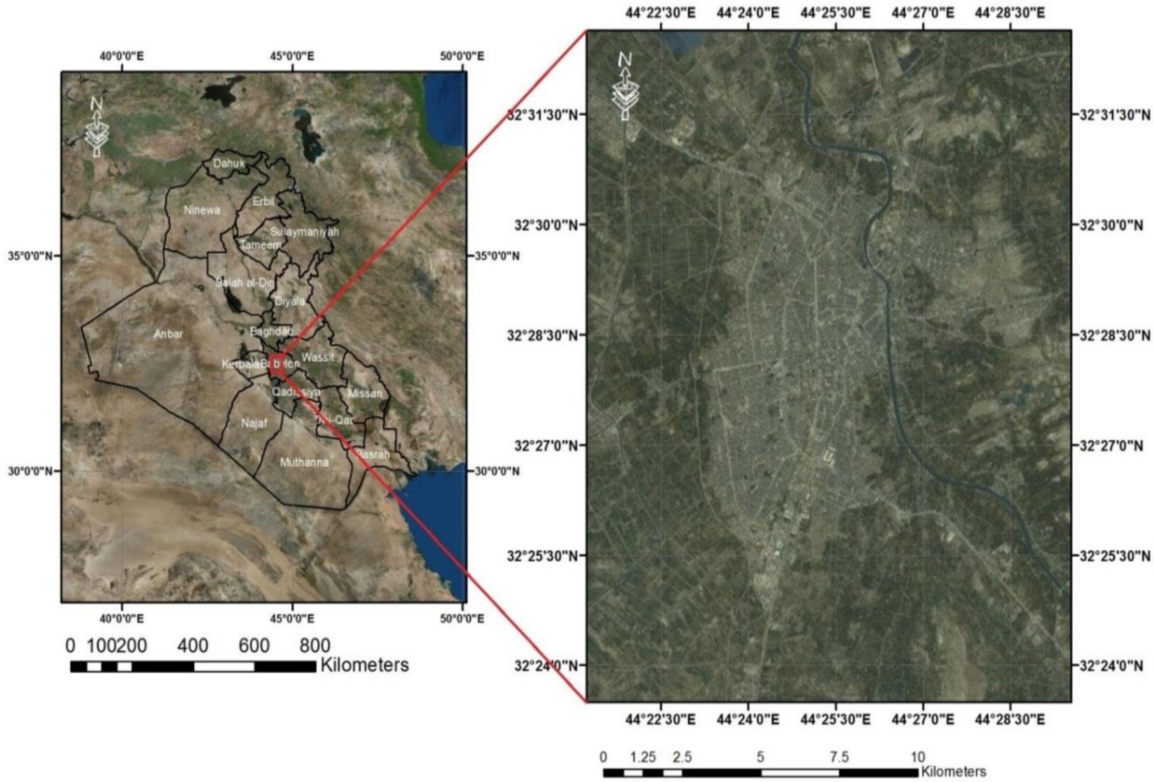

Figure 1: Location of the study area.

Geological Setting of the Study Area

It is located down the Physiological parts in the (Mesopotamian Plain) Buady, [**10**]. Appear in the study area deposits of Quaternary period and the area is characterized by flood plain deposits for Euphrates River, and there are (depression fill deposits) and wind deposits, these sediments accumulate as a result of floods and consists generally of thin layers of fine sand, clay and silty clay Parsons, [**11**]. The dry marsh soils are flats salt that occupies multiple areas of the lower part of the alluvial plain, all of which belong to Holocene Al-Abdullah, [**12**]. Figure 2 shows a geological map of the study area.

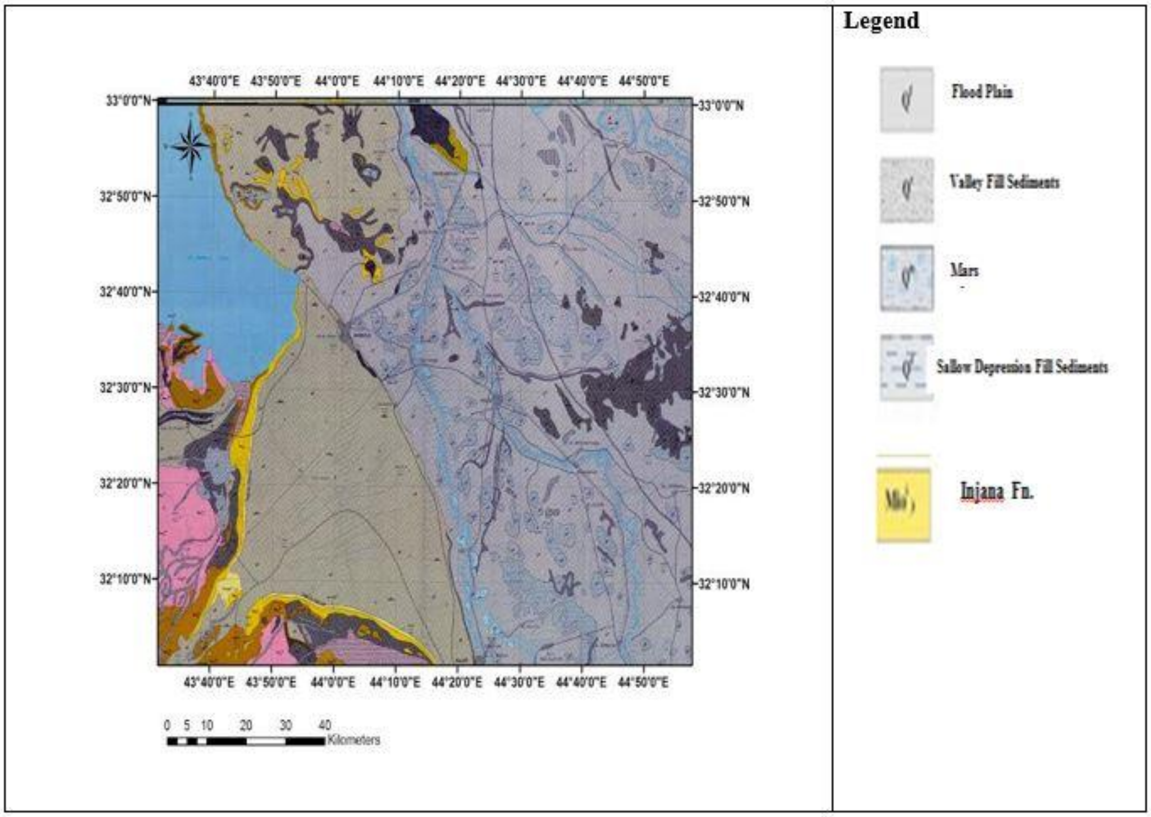

Figure 2: Geological map of the study area (Bar wary and Slewa, [13]).

Research Methodology

The research methodology includes four stages of work:

I. Data collection stage

All of the available publications about the study area (journals, papers, theses, and reports) about soil investigation reports were collected from various public and private organizations**,** maps, including seismic, geologic maps and satellite images and studied in order to make a better idea about the study area.

II. **Field work stage**

Fieldwork was conducted in steps, due to the size and variety of the work. In this stage. Two field works were conducted.

A. Drilling and sampling:

Two projects were selected; the first project is in Hilla city where soil investigation was carried out in April / 2016. The borehole is located inside a building for the Babylon

Provincial Council "Hilla- city "(HP) and the second project is in the Communication Tower for Hilla Railway Station Site (H8).

The standard test methods [**14**] [**15**] were followed with boring depth reached 10 meters from the natural ground surface in a building for the Babylon Provincial Council "Hilla- city and 15 m in the second site.

B. Measurement of shear wave velocity Vs

The shear wave velocity Vs was determined by seismic refraction survey method. The purpose of the seismic refraction survey is to evaluate the velocities of seismic waves (V_p and V_s) for subsoil layers. This was done using ABEM Terraloc Mark 6, [**16**] device. This device represents a high analytical capacity of seismic recorders in shallow depth and consists of separately two units.

III. **Laboratory tests**

Laboratory tests were conducted by the National Center for Construction Laboratories (NCCL) in Hilla city, and the performed laboratory tests in this stage are listed in Table 1.

Table 1: Laboratory tests carried out on soil samples.

Test Types	**Number Samples Tested**	**Specifications**
Moisture content	10	ASTM- D 2216, [**17**]
Atterberg limits	8	ASTM-D4318, [**18**]
Specific gravity	15	ASTM - D854, [**19**]
Grain size analysis	14	ASTM - D422, [**20**]
Classification of soils	13	ASTM -D2487, [**21**]

IV. Earthquake analysis:

The office work is one of the most important stages in this study, where after the completion of the previous three stages, the required data were analyzed by using the ProShake program for the ground response analysis.

Then the data and the extracted relationships and parameters were drawn. All laboratory test results of soil and field measurements were used to complete interpretation and analysis of results.

Computer Program

The program was originally called SHAKE. It was then developed to SHAKE90 and then ProShake [**22**]. In this study, ProShake program version 1.1 was used for ground response analysis.

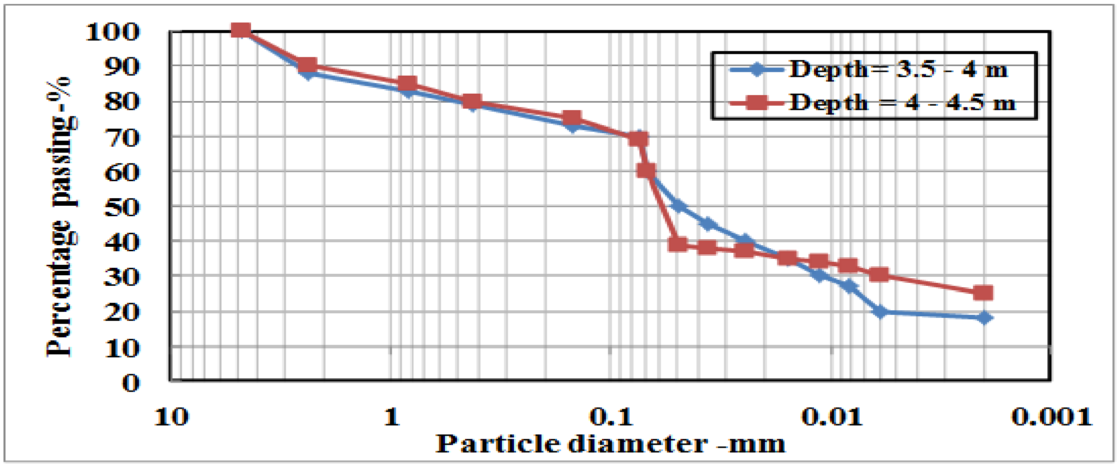

Figure 3: Grain size distribution curves for site (H8)) in Al- Hilla city.

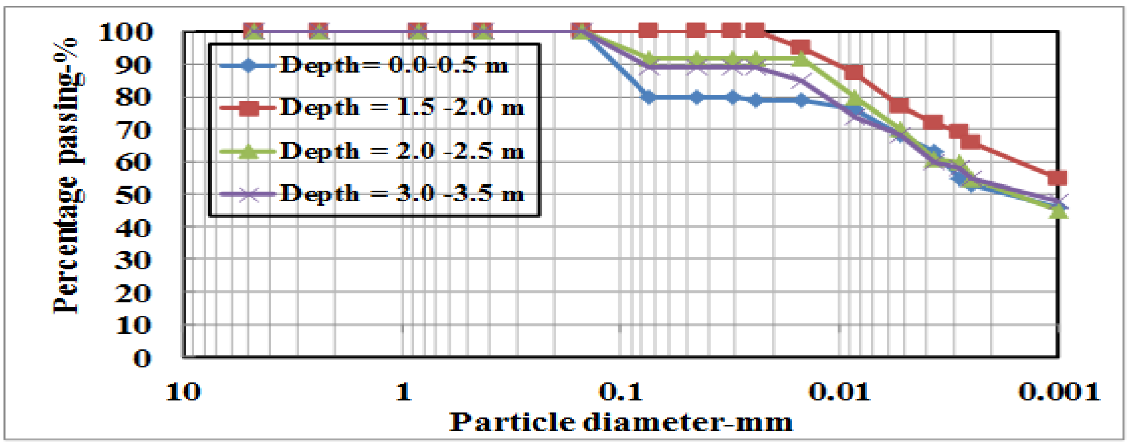

Figure 4: Grain size distribution curves to site (HP) in Al- Hilla city.

Results of Field and Laboratory Tests

The grain size distribution analysis to some depths of soil profile samples which are shown in Figures 3 and 4. Results of some important geotechnical and dynamic properties for two sites: H8 and HP are shown in Tables 2 and 3, respectively, while Borehole log in (H8) site is shown in Figure 5 and the borehole log (HP) is shown in Figure 6.

Table 2: Geotechnical and dynamic properties to the Communication Tower for Hilla Railway Station Site, H8.

Depth of sample (m)		Index properties			Particle size distribution sieve analysis & Hydrometer analysis				Specific gravity	S.P.T. "N" value	Symbol Uni. Class USCS	γ_{wet} kN/m³	γ_{dry} kN/m³	V_s m/sec
From	To	M. C. %	L. L. %	P.I. %	200 Clay %	40 Silt %	10 Sand %	4 Gravel %						
0.0	0.5	-	-	-						-				
0.5	1.0									>50				
1.5	2.0	18	42	28							CL			
2.0	2.5		32	31						14	CL	18	14.6	110
3.5	4.0	23	-	-	20	50	30	0	2.67					
4.0	4.5				30	39	31	0	2.71	15				
6.0	6.5	24	46	19							CL	19	15.3	130
6.5	7.0				30	46	24	0	2.71	20				
8.0	8.5				32	33	35	0	2.69					
9.5	10				20	49	31	0	2.68	16				

The water table was encountered at a depth of (0.5) m below the ground surface after 24 h at 25/9/2006.

Table 3: Geotechnical and dynamic properties for Babylon Provincial Council Building (HP) in Hilla City.

Depth of sample (m)		Index properties			Particle size distribution sieve analysis & Hydrometer analysis				Specific gravity	S.P.T. "N" value	Symbol Uni. Class USCS	γ_{wet} kN/m³	γ_{dry} kN/m³	V_s m/sec
From	To	M.C. %	L.L %	P. I. %	200 Clay %	40 Silt %	10 Sand %	4 Gravel %						
0.0	0.5				67	13	19	1	2.75		CL			
0.5	1.0									10				
1.5	2.0	21,22	45	21	78	21	1	0	2.75		CL	20.06	16.59	200
2.0	2.5	19	51	26	69	24	7	0	2.75	9	CH			
3.0	3.5	20	42	21	66	22	12	0	2.75		CL	19.58	16.31	
3.5	4.0				12	32	56	0	2.65	10	SM			250
5.0	5.5	20			24	70	6	0	2.7	8	ML			
6.0	6.5	21	44	18	73	23	4	0	2.75	13	CL			280
7.5	8.0	22.21			27	45	28	0	2.71	16	ML	18.63	15.35	
8.0	8.5				9	27	64	0	2.65		SM			310
9.5	10	23	61	36	96	1	3	0	2.75	15	CH			

The water table was encountered at a depth of (1.0) m below the ground surface after 24 h at 16/5/2016

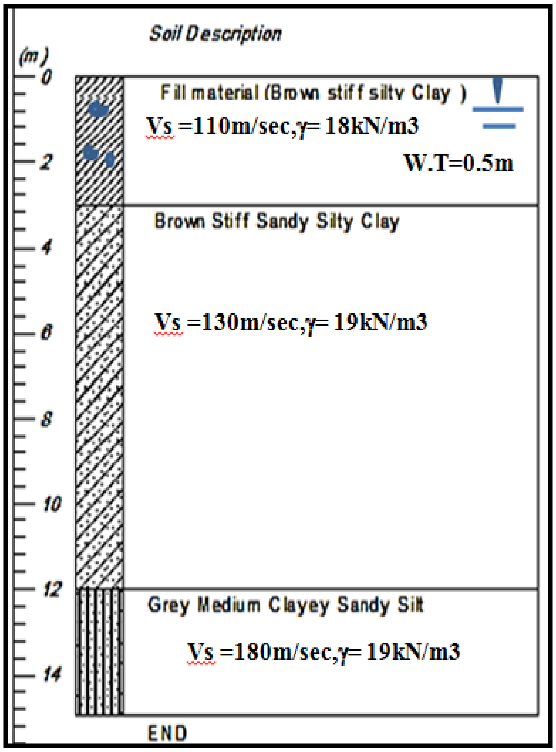

Figure 5: Borehole log for the site (H8) in Al-Hilla city.

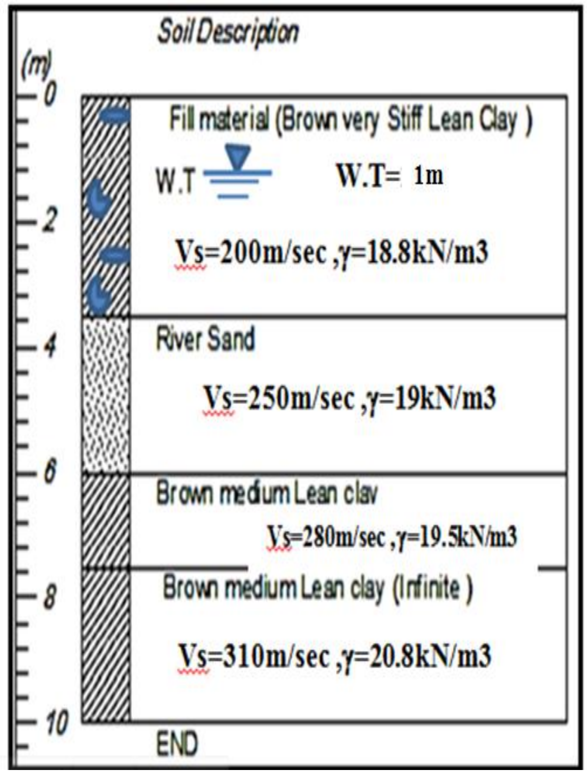

Figure 6: Borehole log for the site (HP) in Al-Hilla city.

Selection of Earthquake Design

Iraqi earthquake was selected with a value of peak ground acceleration of 0.05g and used for the selected sites response analysis in the study area. The selected Iraqi earthquake occurred at origin time: 15:04:54 universal, UTC on date 25 June 2009. It was recorded at station in (Badra area) in the middle of Iraq near the Iranian border (lattitude: 33º.102´) and longitude: 46º.341´). It had a magnitude of 4.4 on Richter scale, focal depth about 8 km, the epicentric distance from Badra station is about 33 km (ISN, [**23**]).

Figure 7 shows the time history of acceleration for the Iraqi earthquake with a peak acceleration of 0.05g.

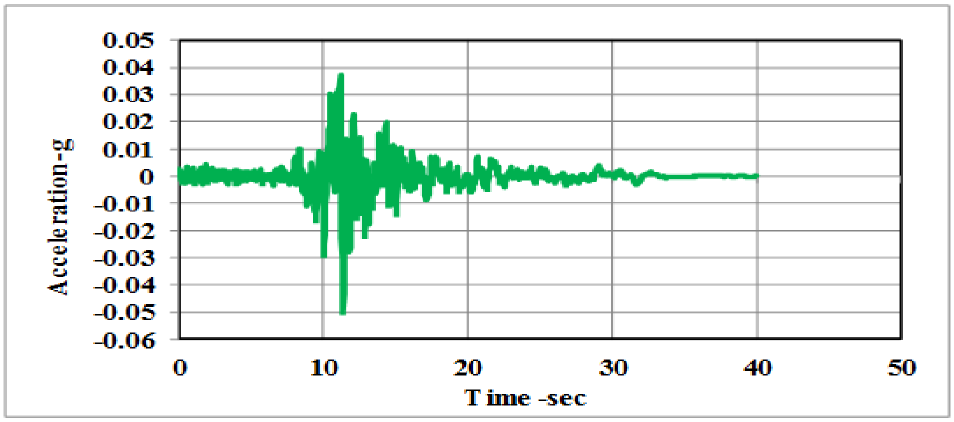

Figure 7: Acceleration – time history for Iraqi earthquake with a peak acceleration of 0.05g.

Results of Analysis

1. Babylon Provincial Council Building site, HP

Figure 8 and Table 4 show that the peak acceleration to layers 1, 2, 3, and 4 are 0.0523, 0.0499, 0.0469 and 0.0434g, respectively which happens at a time lying between 11.36 to 11.4 sec. The acceleration values are diminished completely at time of 33 sec. This is probably due to nonlinear soil behavior due to large strains.

Figure 9 and Table 4 show that the maximum velocity in layers 1, 2, 3, and 4 is 11.36, 11.19, 11.00 and 10.89 cm/sec respectively in time 11.28 sec while the velocity values are diminished at time of 33.5 sec.

The variation of the peak ground acceleration and velocity with time returns to the strong influence of the soils deposited in the ground at each site as shown in Figure 6.

Figure 10 and Table 5 show that the peak shear stress increases gradually in layers 2, 3 and 4 are 3.69, 5.30 and 6.853 kN/m^2, a time lying between 10.1 Secs to 11.4 Sec, respectively, while the shear stress values are diminished at a time of about 32.5 Sec.

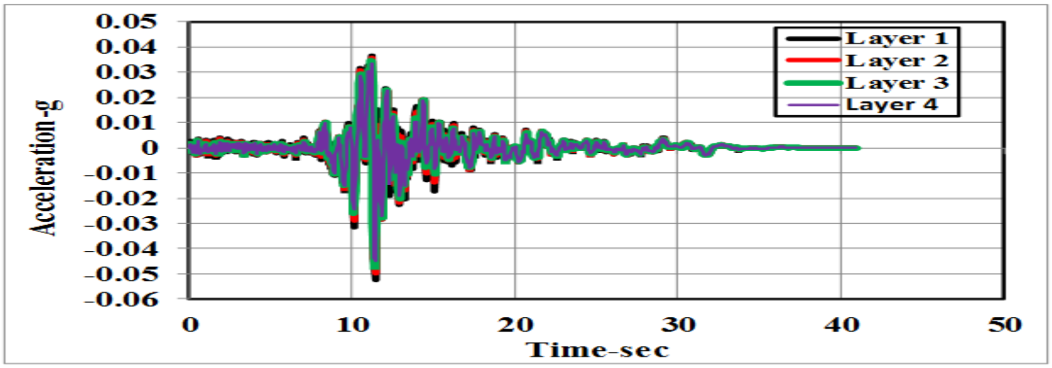

Figure 8: Acceleration – time history for site HP under Iraqi earthquake of amplitude 0.05g.

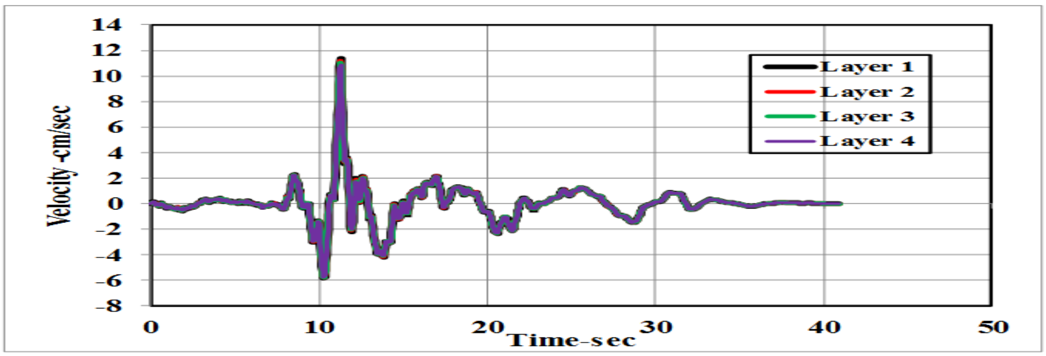

Figure 9: Velocity – time history for site HP under Iraqi earthquake of amplitude 0.05g.

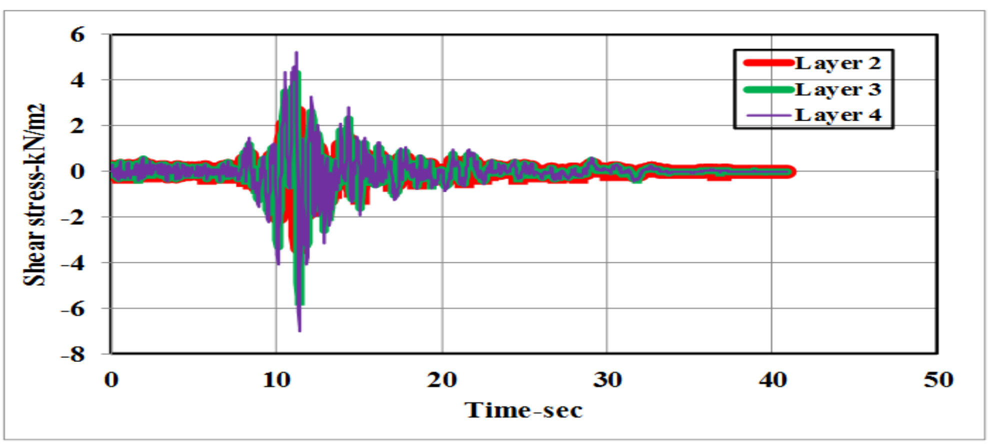

Figure 10: Shear stress – time history for site HP under Iraqi earthquake of amplitude 0.05g.

Figure 11 and Table 6 depict that the obtained predominant period, which corresponds to maximum spectral acceleration under acceleration amplitude 0.05g and 5% damping ratio for site HP, is 0.65 seconds, that can be related to soil deposits.

Figure 12 and Table 6 depict that the obtained predominant period, which corresponds to the maximum spectral velocity under acceleration amplitude 0.05g and 5% damping ratio for site HP is 0.65 Sec for layers 1, 2, 3 and 4.

The frequency content of an earthquake motion will strongly influence the effects of that motion and hence only the peak acceleration PGA value cannot characterize the ground surface motion. A response spectrum is used extensively in earthquake engineering practice to indicate the frequency content of an earthquake motion. A response spectrum describes the maximum response of a single degree of freedom (SDOF) system to a practical input motion as a function of the natural frequency /period and damping ratio of the SDOF system. It is represented in a single graph the combined influences of terrain acceleration amplitudes and frequency components of the movement. Since the time history of the seismic excitement in a certain site is characterized by the corresponding response spectrum, the differences among the time histories of the movement in different places can be analyzed by the comparison of their spectra.

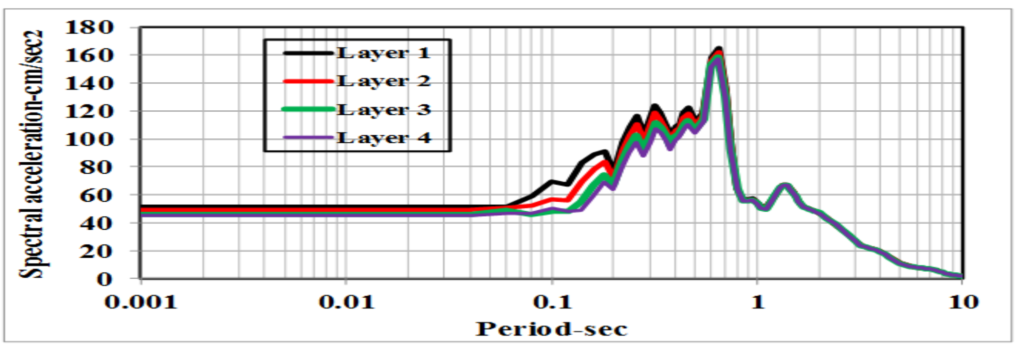

Figure 11: Spectral acceleration– period to response spectra with (5% damping) for site HP under Iraqi earthquake of amplitude 0.05g.

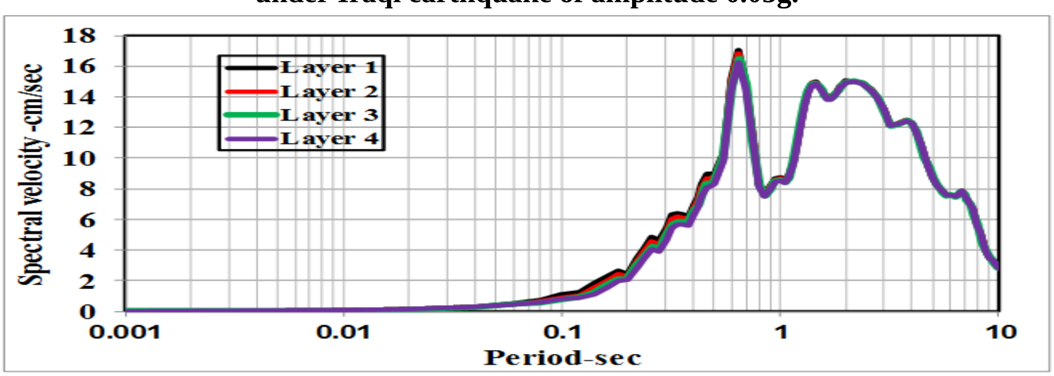

Figure 12: Spectral velocity– period to response spectra with (5% damping) for site HP under Iraqi earthquake of amplitude 0.05g.

Figure 13 presents that the acceleration values increase from depth 7.5 m, which is about 0.0457 to 0.0524 g at the ground surface. The ratio between the peak ground acceleration at the ground surface to the peak ground acceleration amplitude for earthquake: 0.05g for the soft soil sites gives the amplification factor (A.F) which is calculated by the following equation:

$$\boldsymbol{A.F} = \frac{a_{ground(max)}}{a_{earthquake\ (max)}} \qquad (1)$$

Where:

A.F: Amplification factor for acceleration,

$a_{\mathbf{ground(max)}}$ **:** Peak ground acceleration at the ground surface, and

$a_{\mathbf{earthquake(max)}}$**:** Peak ground acceleration amplitude for earthquake**.**

But the amplification factor for acceleration of soil layers equals 1.048, in accordance with equation (1), under acceleration amplitude 0.05g, as shown in Table 7. Shallow water table depths and low SPT values results in lower average shear wave velocities. Thus, amplification of seismic waves depends not only on overburden thickness, but also on various other factors like the frequency of the input motion, average shear wave velocity of the soil profile and water table depth.

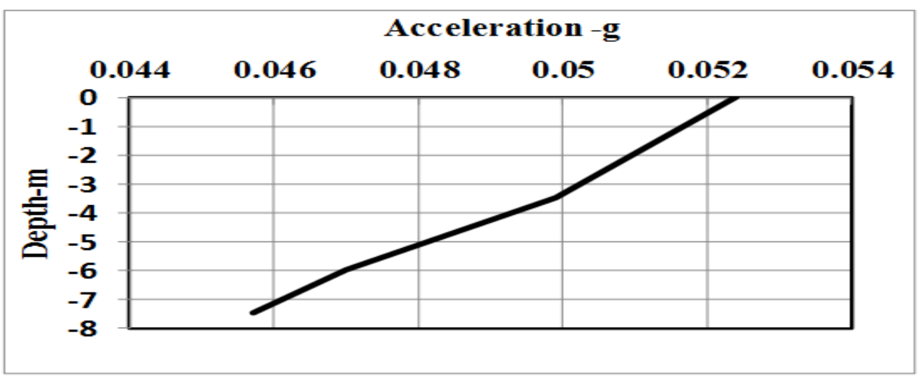

Figure 13: Variation of acceleration with depth for site HP under Iraqi earthquake of amplitude 0.05g.

Amplification of ground motion is highly dependent on the local geology, topography and Geotechnical conditions. It is observed that large concentration of damage in specific areas during an earthquake is due to site dependent factors related to surface geological conditions and local soil altering seismic motion.

Figure 14 shows that the displacement is equal 29.535 mm at depth 7.5 m and about 29.687 mm at the ground surface, but the displacement is reduced at depth 6 m and becomes 29.474 mm.

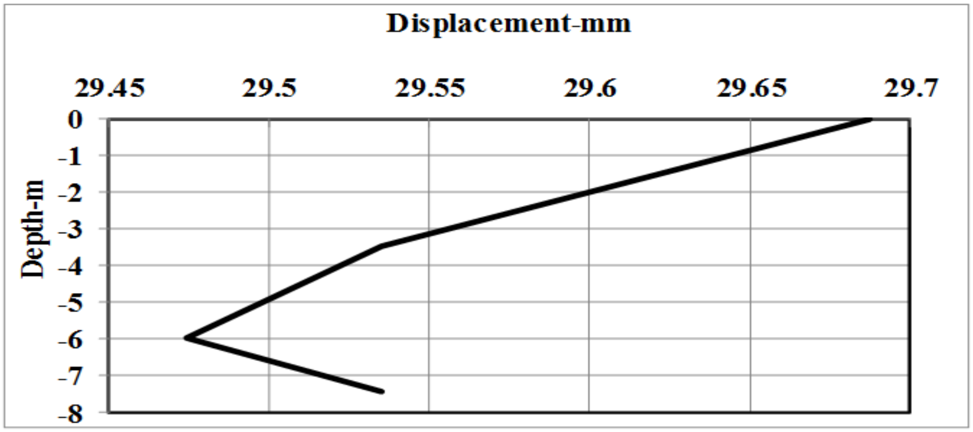

Figure 14: Variation of displacement with depth for site HP under Iraqi earthquake of amplitude 0.05g.

Figure 15 depicts that the shear stress increases gradually with depth, where it is equal 1.704 kN/m^2 at depth 1.75 m half space to layer 1, and 7.005 kN/m^2 at depth 7.5 m. Figure 16 reveals that the effective shear strains equal 0.00147% at depth 1.75 m half space to layer 1, and 0.00250 % at depth 4.75 m half space to layer 2, and 0.00274 % at depth 6.75 m to surface layer 3 , and 0.00240% at depth 7.5 m for the surface layer 4.

Figure 15: Distribution of shear stress with depth for site HP under Iraqi earthquake of amplitude 0.05g.

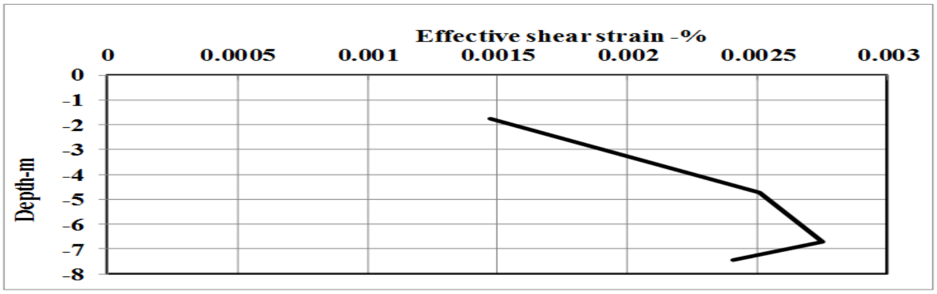

Figure 16: Distribution of effective shear strain with depth for site HP under Iraqi earthquake of amplitude 0.05g.

Figure 17 and Table 8 show that the shear modulus increases gradually with depth, where it is equal to 75095 kN/m² at depth 1.75 m half space to layer 1, and 117448 kN/m² at depth 4.75 m, half space to layer 2, and 150029 kN/m² at depth 6.75 m half space to layer 3 and 189328 kN/m² at depth 7.5 m for surface layer 4.

Figure 18 depicts that the damping ratio equals 1.01% at depth 1.75 m half space to layer 1, and 1.3 % at depth 4.75 m half space to layer 2, and 1.35 % at depth 6.75 m half space to layer 3 and 1.28% at depth 7.5 m in the surface layer 4. Damping factors of the soil are difficult to be assessed. Important steps in site specific ground response analysis are dynamic characterization of the site and selection of rock motions.

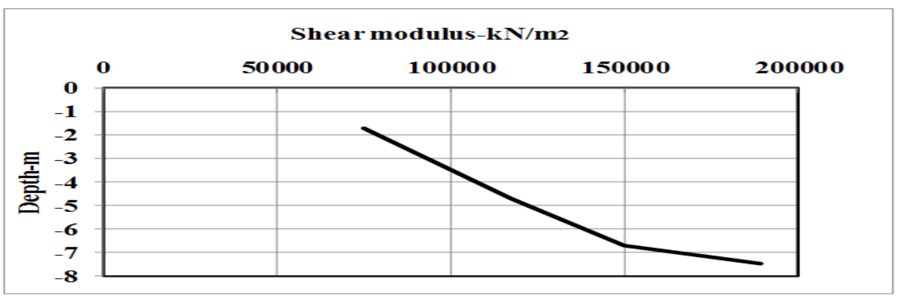

Figure 17: Variation of shear modulus with depth for site HP under Iraqi earthquake of amplitude 0.05g.

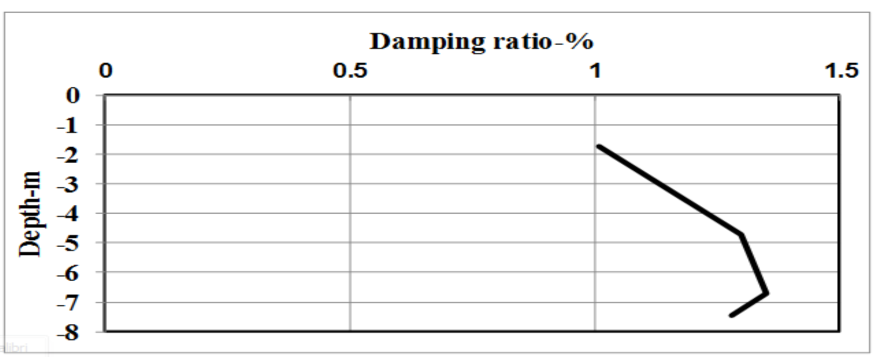

Figure 18: Variation of damping ratio with depth for site HP under Iraqi earthquake of amplitude 0.05g

2. The Communication Tower for Hilla Railway Station Site, H8

Figure 19 and Table 4 show that the peak accelerations to layers 1, 2 and 3 are 0.0639, 0.0558 and 0.0329g in time history from 11.16 to 11.44 sec, respectively. While the accelerations values are diminished at a time history of 33.08 sec.

Figure 20 and Table 4 show that the maximum displacements to layers 1, 2 and 3 are 29.95, 29.24and 28.77 mm in time history from 10.56 to 10.6 sec , respectively. While the displacements values are diminished at a time history 40 sec, in site H8. The variation of the peak ground acceleration and displacement with time history return to the strong influence of the soils deposited on the ground at each site.

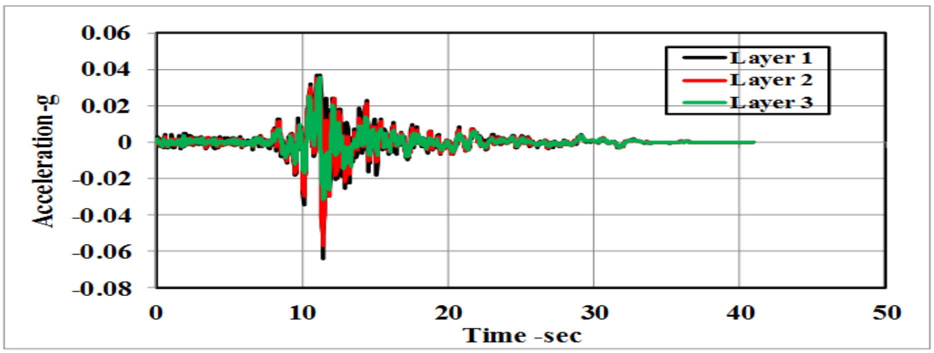

Figure 19: Acceleration – time history for site H8, under Iraqi earthquake of amplitude 0.05g.

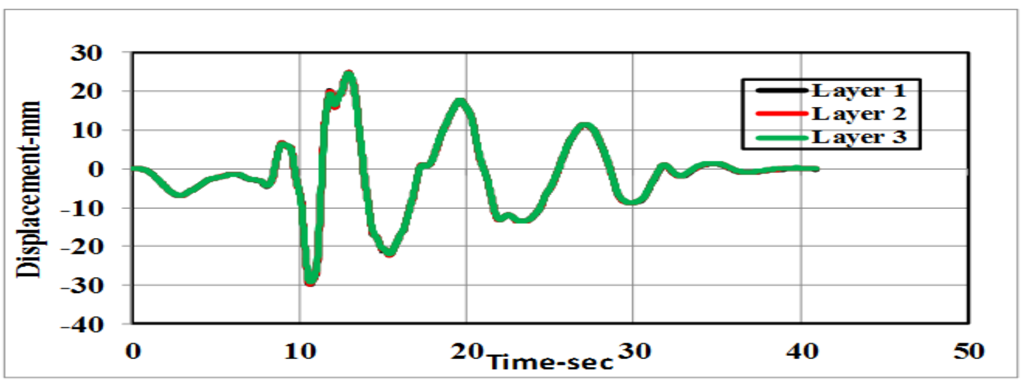

Figure 20: Displacement – time history for site H8, under Iraqi earthquake of amplitude 0.05g.

Figure 21 and Table 5 show that the peak shear strain to layers 2, 3 are 0.0134 and 0.0149%, in time history 11.4 sec, respectively. The shear strain values are diminished at a time history nearly 32.74 sec.

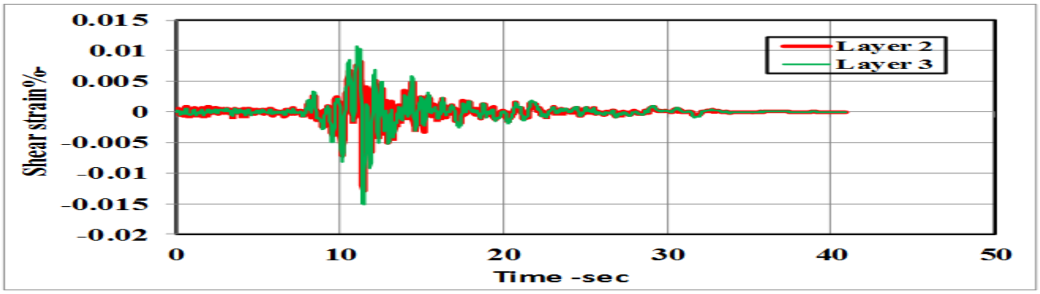

Figure 21: Shear strain - time history for site H8, under Iraqi earthquake of amplitude 0.05g.

Figure 22 and Table 6 display that the obtained predominant periods which correspond to maximum spectral acceleration under acceleration amplitude 0.05g and 5% damping ratio to the layers 1, 2 and 3 for site H8 , 0.65 seconds, that can be related to soil deposits .

Figure 23 and Table 6 display that the maximum spectral displacements are 8.5, 8.4, 8.3 cm at predominant periods value from 6.8to 7 sec to layers 1, 2 and 3, respectively.

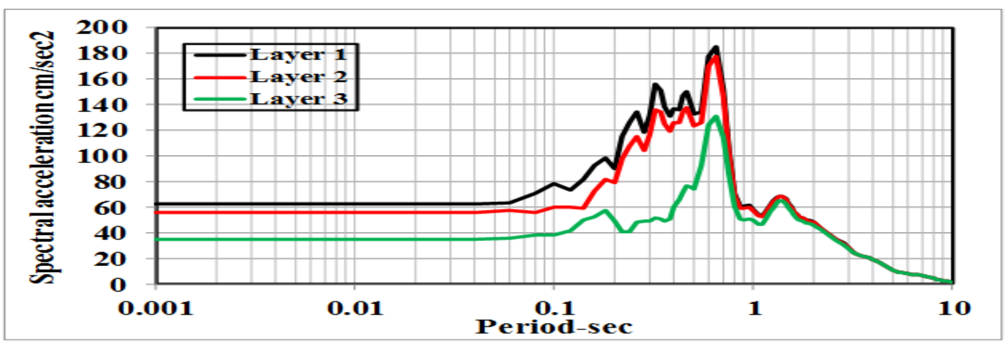

Figure 22: Spectral acceleration– period to response spectra with (5% damping) for site H8, under Iraqi earthquake of amplitude 0.05g.

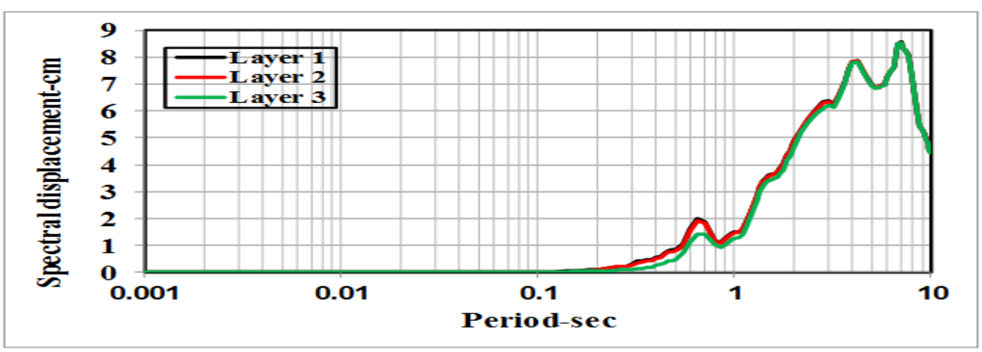

Figure 23: Spectral displacement – period to response spectra with (5% damping) for site H8, under Iraqi earthquake of amplitude 0.05g.

Figure 24 and Table 7 present that the accelerations are increased from depth 9 m about 0.035 to 0.0639g at ground surface, so that the amplification factor of soil layers equal 1.27 in site of H8, under acceleration amplitude 0.05g. Depth plots are useful to examine the variation of ground motion amplitudes in depth. Figure 25 presents that the velocities at depth 9 m nearly 9.832 cm/Sec, then increased to up 11.789 cm/Sec at the ground surface.

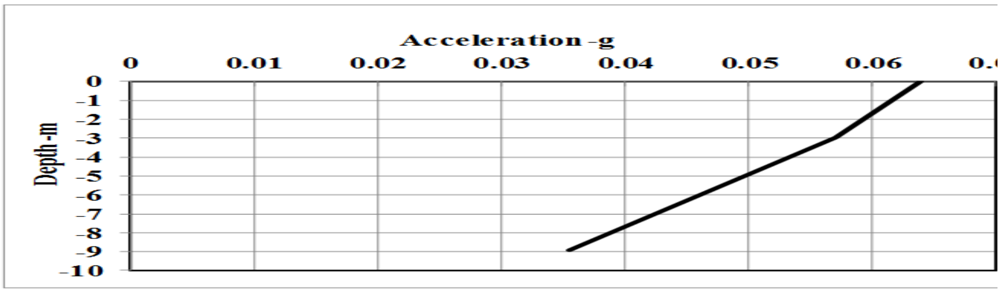

Figure 24: Variation of acceleration with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

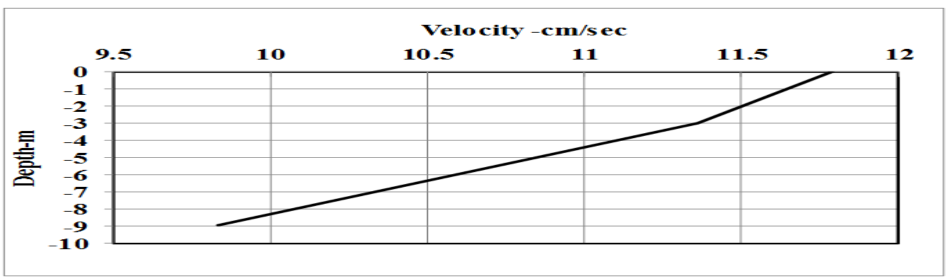

Figure 25: Variation of velocity with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

Figure 26 shows that the shear strains equal 0.00839% at depth 1.5 m half space to layer 1 , and 0.0238 % at depth 6 m half space to layer 2, and 0.0151% at a depth 9 m to the surface layer 3.

Figure 27 depicts that the effective shear strains equal 0.0054% at a depth 1.5 m half space to layer 1, and 0.0155 % at a depth 6 m half space to layer 2, and 0.0098 % at depth 9m to surface layer 3.

Figure 28 and Table 8 show that the shear modulus increases gradually with depth , where it is equal to 20109 kN/m² at depth 1.5 m half space to layer 1, and 25075 kN/m² at depth 6m half space to layer 2, and 53439 kN/m² at depth 9 m to surface layer 3.

Figure 29 shows that the cyclic stress ratio equal to 0.063% of depth 1.5 m half space to layer 1, and 0.068% at depth 6 m half space to layer 2, and 0.062% at depth 9 m to surface layer 3. The cyclic stress ratio is defined as the ratio of the peak shear stress to the vertical effective stress.

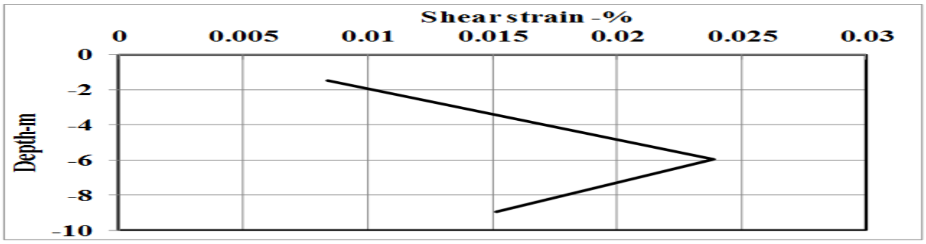

Figure 26: Distribution of shear strain with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

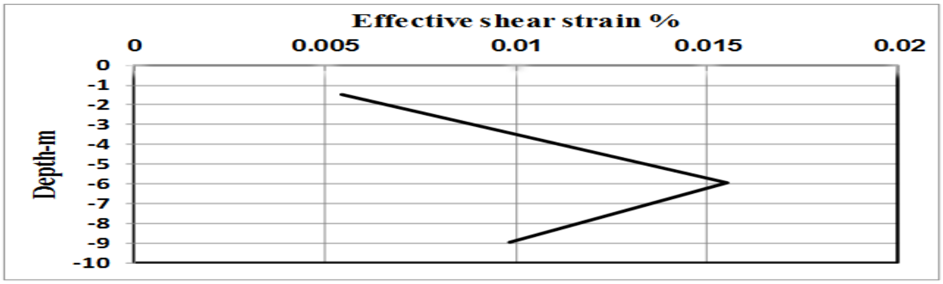

Figure 27: Distribution effective shear strain with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

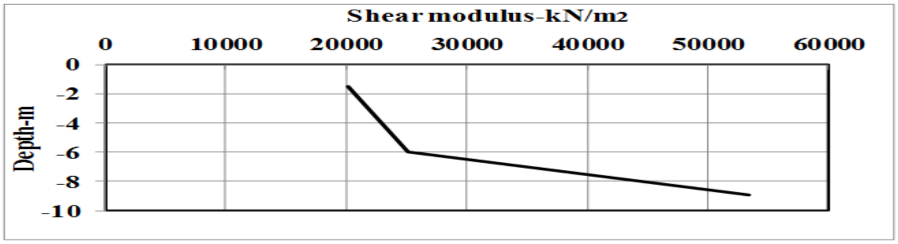

Figure 28: Variation of shear modulus with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

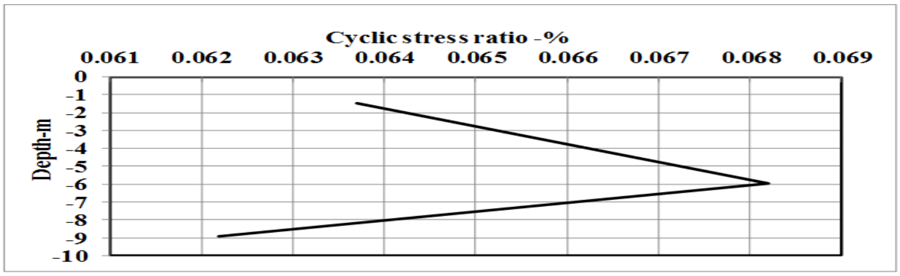

Figure 29: Variation of cyclic stress ratio with depth for site H8, under Iraqi earthquake of amplitude 0.05g.

Table 4: Peak acceleration, velocity and displacement with time history values for amplitudes (0.05g) to sites H8 and HP.

Layers for site H8	Peak Acceleration (g)	Time of peak acc. for each layer (sec)	Time of dying out of acc. (sec)	Peak velocity (cm/sec)	Time of peak vel. for each layer (sec)	Time of dying out of velocity (sec)
1	0.0639	11.44	33.08	11.79	11.32	36.14
2	0.0558	11.42		11.36	11.3	
3	0.0329	11.16		9.82	11.26	
Layers for site HP	**Peak accel. (g)**	**Time of peak acc. for each layer(sec)**	**Time of dying out of acc. sec**	**Peak dis. (mm)**	**Time of peak dis. for each layer (sec)**	**Time of dying out of dis. (Sec)**
1	0.0523	11.4	33.4	29.33	10.56	40
2	0.0499			29.03	10.56	
3	0.0469			28.50	10.48	
4	0.0434	11.36		27.73	10.48	

Table 5: Peak shear strain and shear stress with time history values for amplitudes (0.05g) to sites, H8 and HP.

Layers for site H8	Peak Shear strain %	Time of peak shear strain. for each layer (sec)	Time of dying out of shear strain (sec)
2	0.0134	11.4	32.74
3	0.0149		
Layers for site HP	**Peak shear stress (kN/m^2)**	**Time of peak shear stress for each layer (sec)**	**Time of dying out of shear stress (sec.)**
2	3.69	10.06	32.52
3	5.30	11.34	
4	6.85	11.38	

Table 6: Spectral acceleration, velocity, displacement – period values to response spectra with (5% damping) for sites H8 and HP under amplitudes 0.05g.

Layers for site H8	Spectral Acceleration (cm/sec^2)	Period to each layer/ sec	Spectral displaceme nt (cm)	Period to each layer/ (sec)
1	185	0.65	8.5	7
2	177		8.4	6.8
3	131		8.3	6.8
Layers for site HP	**Spectral Acceleration (cm/sec2)**	**Period to each layer (sec)**	**Spectral velocity (cm/sec)**	**Period to each layer (sec)**
1	165	0.65	17.1	0.65
2	162		16.8	
3	159		16.5	
4	157		16.3	

Table 7: Amplification factor for acceleration values in two locations under Iraqi earthquake of amplitudes 0.05g.

No.	Location No.	PGA at earthquake (g)	PGA at ground surface (g)	A.F at acceleration amplitude 0.05g
1	HP	0.05	0.0524	1.048
2	H8	0.05	0.0639	1.27

Table 8: Results of ground shear modulus for two sites.

Peak earthquake acceleration (g)	Ground shear modulus for Al-Hilla city in two sites (kN/m^2)						
	H8			HP			
	Layer No.			Layer No.			
	1	2	3	1	2	3	4
0.05g	20109	25075	53439	75095	117448	150029	189328

Conclusions:

1. The amplification factor for acceleration which is a measure of amplification potential of the soil column was computed using this peak acceleration and the peak acceleration at earthquake level. The range of amplification factor was 1.048 to 1.27. The high amplification factor at H8 location is due to the presence of fill soils.
2. The ground shear modulus values of HP site are higher than H8 site values, in Al-Hilla city. The reason for these are returned to the differences in density and shear wave velocity of the soil layers between the two regions.

3. The obtained predominant period which correspond to maximum spectral acceleration under acceleration amplitudes 0.05 g and 5% damping are 185, 177 and 131 cm/sec^2 to layer 1,2 and 3for site H8 and are 165, 162,159 and 157 cm/sec^{2}to layer 1,2,3 and 4 for site HP respectively.
4. The maximum spectral displacement values to the layers 1, 2 and 3 for the H8 site in the study area are 8.5, 8.4 and 8.3 cm under the peak ground acceleration amplitudes 0.05 g, respectively ,and 5% damping ratio correspond to predominant period value between 6.8 to 7 sec, while the obtained predominant period which correspond to maximum spectral velocity under acceleration amplitudes 0.05g and 5% damping ratio to the layers 1, 2, 3 and 4 for site HP at Al-Hilla city are 17, 16.8, 16.5 and 16.3 cm/sec., respectively, which occur at period value is 0.65 seconds. The variation of the spectral displacement with period returns to the strong influence of the soils deposited in the ground at each site.

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تحليل الاستجابة الأرضية لموقعين مختارين في مدينة الحلة في وسط العراق

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الخلاصة

يصف تحليل الاستجابة الأرضية أيضا دراسة تضخيم التربة ويتضمن حساب الفترات الطبيعية للموقع، وتضخيم الحركة الأرضية، وتقييم قابلية تمييع التربة، وتحليل الاستقرارية. الميزات المهمة التي يتم أخذها في الاعتبار للتحليل هي خصائص صخور الاساس التحتية، موقع وميل حجر الأساس، تضاريس حجر الاساس ورواسب التربة، والفوالق في رواسب التربة.

في هذا البحث، تم اختيار موقعين في مدينة الحلة للبحث في تحليل الاستجابة الأرضية. وتضمنت الفحوصات المختبرية محتوى الرطوبة، وحدود اتيربيرغ، وبمعرفة توزيع حجم الحبيبات تم رسم منحنيات توزيع الحجم الحبيبي للرواسب النهرية المتواجدة، في حين شمل العمل الميداني: قياسات سرعة موجة القص v_s وحساب قيمة - N من فحص الاختراق القياسي (قيم ال SPT) لكل موقع. التوصيف الجيوتقني، اوضح أن التربة في الموقعين تسود عليها الرمال الغرينية والطين الغريني. تحليل استجابة الموقع لحركة الأرض طبق باستخدام برنامج Proshake. نتائج التحليل الخطي المكافئ بينت أن قمة تسارع سطح الأرض تتراوح بين g٠,٠٥٢٣ إلى g٠,٠٦٣٩. عامل التضخيم للتسارع في مدى ما بين ١,٠٤٨ إلى ١,٢٧.

الكلمات المفتاحية: تحليل الاستجابة الأرضية، بروشيك، مدينة الحلة، عامل التضخيم.