International Journal of Engineering & Technology, 7 (4.20) (2018) 45-50

SPC

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper



Nonlinear Analysis of Local Site Effects on Seismic Ground Response in New Damietta City, Egypt

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Abstract

New Damietta City is situated in a locale of moderate notable seismicity about M6.25 have happened. These dangerous tremors started from the Mediterranean subduction zone among African and Eurasian plates and is underlain by soaked late Holocene stores. In this examination, the city of New Damietta was assessed regarding site intensification and site period. Geographical and geotechnical examination including information base of 543 boreholes were gathered from past geotechnical reports and corroborative exhausting logs were executed by the Lodging and Building national Exploration focus. These information were incorporated to decide the variety of the dirt profile and in addition the qualities of the dirt layers inside the investigation site. One dimensional ground response close examination using corresponding straight system and nonlinear procedure have been done. Nonlinear examinations' results were differentiated and those of the indistinguishable direct method, and both of the similarities and differences are discussed. It is assumed that because of nonlinearity of soil under strong ground developments, 1-D parallel direct showing overestimates the strengthening structures the extent that add up to upgrade level, and can't viably speak to full frequencies and hysteric soil lead. Along these lines, more reasonable and suitable numerical strategies for ground reaction examination ought to be reviewed

Keywords: *Equivalent Linear Method; Ground Response Study; Nonlinear Method; New Damietta City.*

1. Introduction

The effect of close-by geologic and soil conditions on the intensity of ground shaking and seismic tremor hurt has been seen for quite a while. Adjacent site conditions can altogether affect most of the basic qualities of strong ground development: abundancy; repeat substance; and term. The level of their effect depends upon the geometry and material properties of the subsurface materials, on area geology, and on the characteristics of the information development. Past shakes, for instance, Kobe (1995), Northridge (1994), and Loma Prieta (1989) have portrayed the job of nearby site condition in adjusting the qualities of solid movements [1].

It is understood that, site impacts accept a vital job in depicting seismic ground developments since they may solidly heighten seismic developments inside the most astounding layer of the ground. Site effects can be surveyed by techniques for numerical reenactments, exploratory and correct systems. In light of the anomalous condition of increase caused by the site impacts, which can be practically two solicitations of degrees, it couldn't be rejected in building practice. It is illustrated that, the ground development upgrade prompts unusual condition of damages over sensitive soil and unconsolidated stores than blended and hard buildup. The brisk extending in urbanization and land use masterminding Egypt inspired the importance of such kind of current examination for restricting the unsafe threats from the seismic tremors later on. New Damietta City is one of the new urban settlements along the Mediterranean Ocean bank of Nile Delta and situated at scopes 31° 24′ 36"N and longitudes 31° 37′ 54"E. The city lies in the salty beach front surge plain and the region has a delicate slant towards the Mediterranean Ocean with normal dimension approaches the ocean level as appeared in Figure 1.0.

The regular strategy in tremor designing for displaying wave transmission in layered locales and dynamic soil-structure cooperation is "proportional direct" technique. The proportional direct strategy utilizes straight properties for every component that stay consistent since the commencement of shaking. Since the seismic ground reaction is essentially influenced by the nonlinear conduct of the dirt profile. Hence, it is most essential to legitimately demonstrate the dirt nonlinearity in the dynamic investigation of nearby webpage impacts amid seismic tremor excitations [1]

In this examination, the New Damietta City was dissected to analyze the diverse site reaction strategies. Ten delegate exhausting logs over the city were chosen to explore a scope of key site frequencies and territorial attributes. The land and geotechnical qualities of these locales and their portrayal for site reaction examination are researched. Additionally, an endeavor was made to play out a genuine nonlinear examination of the seismic ground reaction on New Damietta City utilizing the 1992 Dahshour Quake and think about the determined free-field ground movement from this investigation with those acquired from the identical direct strategy. The investigation talks about the impact of nearby website conditions on tremor ground movement utilizing both identical straight and nonlinear seismic webpage reaction examination in SHAKE2000 and DEEPSOIL 5.1 projects. Nonlinear webpage reaction examination, and in addition proportionate direct methodology utilizing SHAKE2000 program and DEEPSOIL 5.1 , was utilized to gauge the website reaction and concentrate the dirt conduct amid the seismic tremor wave

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proliferation. The nonlinear webpage reaction was evaluated by elasto-plastic constitutive model.

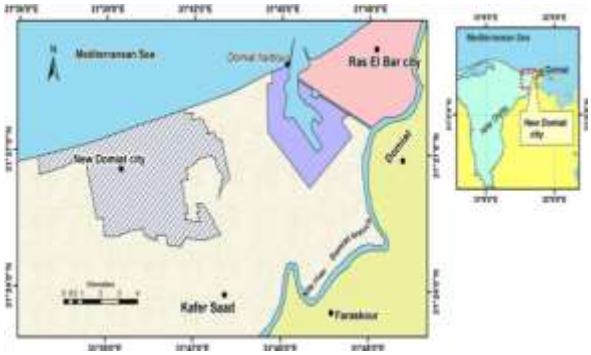


Fig.1: Location map of New Damietta City

2. Geological aspects of the City

Geographical setting of Nile delta was examined by a few creators [2,3,4,5]. Subsurface examinations uncover a succession of sedimentary rocks running in age from Neogene to Quaternary [6]. It is subdivided into eight arrangements, to be specific from base to top: Sidi Salem, Qawasim, Rosetta, Abu Madi, Kafr El-Sheik, El-Wastani, Mit Ghamr and Bilqas Developments. The Miocene, thus is made out of Sidi Salem, Qawasim and Rosetta Developments; While the Pliocene is established from Abu Madi; Kafr El-Sheik, El-Wastani and Lower Mit Ghamr Arrangements as appeared in Figure 2.0 and Figure 3.0.

Ongoing Quaternary, (Q) stores make the territory from progress surface and stretch out beneath to around one kilometer profundity. Such ongoing stores comprise of the three after arrangements: Bilqas, Mit Ghamr and El Wastani [2,3,6] Bilqas development is of the Holocene age (Late Pleistocene, Q3). It frames the highest stores stretching out in the subsurface of north Delta district, most likely shaping in marsh or waterfront condition. The development is comprised of rotating fine to medium grained sand, including ongoing Mediterranean mollusks of the Holocene and mud interbeds. The mud beds contain vegetable issue and peat beds. The recorded thickness of Bilqas development in the oil wells bored in the Delta ranges from zero to 60 m. At El Wastani oil well (31° 35' 46" E, 31° 24' 08" N and + 0.4 m above ocean level) the recorded profundity of Bilqas development in the well is around 10 m. This well is so near mirror the development in the examined zone. Mit Ghamr development (Center Pleistocene, Q2) is comprised of sand and stone beds with couple of minor mud interbeds in the lower part. The earth beds incorporate couple of peat skylines. Here, this development underlies Bilqas arrangement and conveys marine faunas. Its thickness at El Wastani well is around 920 m. Mit Ghamr development is recorded in all wells bored in the Delta. El Wastani development (early and center Pleistocene, Q1/Q2) is comprised of thick beds of coarse to medium grained sand rotating with thin sandy earth beds. This arrangement underlies the seaside sands of Mit Ghamr development. Its thickness at El Wastani Well reaches around 80 m.

3. Geotechnical aspects of the City

Data for this study were acquired from a geotechnical data base of the New Damietta city established by Housing and Building National Research Center [7] and it consists of 543 borings log were collected from previous geotechnical reports and confirmatory boring logs were executed by the Housing and Building national Research center. The database incorporates both general and geologic data accumulated from subsurface investigations, for example, task and boring data, date and profundity of exhausting, ground surface height, profundity to groundwater, profundities and depictions of stratigraphic units and tests, standard entrance test (SPT) N-qualities, and x-y organize values. The dirt examples were described by soil type (i.e., sand, residue, silty sand, earth, and so forth.) and a nitty gritty example portrayal. At the point when accessible on the first exhausting log, stratigraphic unit was additionally connected with individual soil tests. The stratigraphy was described by geologic unit and profundity to best and base of every unit. Figure 4.0 and Figure 5.0 show soil distribution map across the city and the distribution of representative and confirmation borings in the study area.

The soil formations in the city consist mainly of layers of fine to medium sand / or silty sand , the sand layer in many boring profiles reaches up to 15m and the thickness and extensions of these layers are different from one location to the other. Layers of silty clay and sometimes clayey silt appear mostly at lower depths ,lenses of peat and organic matter are found at shallow depths in few borings. Recorded water levels range from 0.3 to 0.6 m below ground surface and 1.5 m near the southern part of the studied area. Figure 6.0 and Figure 7.0 show geotechnical section across the city.

4. Seismic activity around new Damietta city

The territory is learned about a bit of the harming seismic tremors began from the Mediterranean subduction zone among African and Eurasian plates. Later seismic development from 1900 to December 2008 inside a float with 150-km go around New Damietta city have been assembled from the national, general shudder server ranches and Egyptian National Seismic System discharges as showed up in Figure 8.0.

Suitably, there are three particular seismogenic sources that could impact the region as showed up in Figure 8.0 as seeks after: (1) Egyptian– Mediterranean Ocean detachment zone, where the seismic activity of this zone is related to the rack and terrain incline connecting from the rack separate to the Nile cone. It is balanced and running practically parallel to the Egyptian shore line [8] (2) Northeastern desert source, where a wide zone of seismic activities is arranged toward the east of the Nile Delta. Some of felt tremors have been represented in this source (M>4). The seismic activity of this zone is related to the NW– SE inclining defects that running parallel to the Red Sea– Bay of Suez slant. (3) Southwest Cairo (Dahshour zone) source is the place the development is packed and where New Damietta city is impacted by 12 October 1992 Dahshour seismic tremor (Mw=5.8). Fundamentally, the defects in Dahshour zone are inclining east– west, parallel to the Mediterranean example, or northwest– southeast parallel to the Bay of Suez slant [9].

The most dangerous seismic tremors influencing the City in twenty Century is the 1954 quake which its epicenter was in the Mediterranean Ocean with greatness 6.25 Richter and amax = 0.25g. Figure 9.0 demonstrates the increasing speed time history of 1954 tremor at bedrock level.

5. Seismic response analysis

With the end goal to contemplate the impacts of neighborhood topography on the seismic ground reaction at New Dameitta City , 1-D numerical model of the ground profile with 30 m profundity was set up. Figure 10 demonstrates the thirtenn delegate exhausting logs that was utilized for ground reaction examination. Subusrface profile data including unit weight , shear wave speed at various borehole areas were utilized for the ground reaction proportional straight investigation utilizing SHAKE2000 [10] and nonlinear examination utilizing DEEPSOIL 5.1 [11].

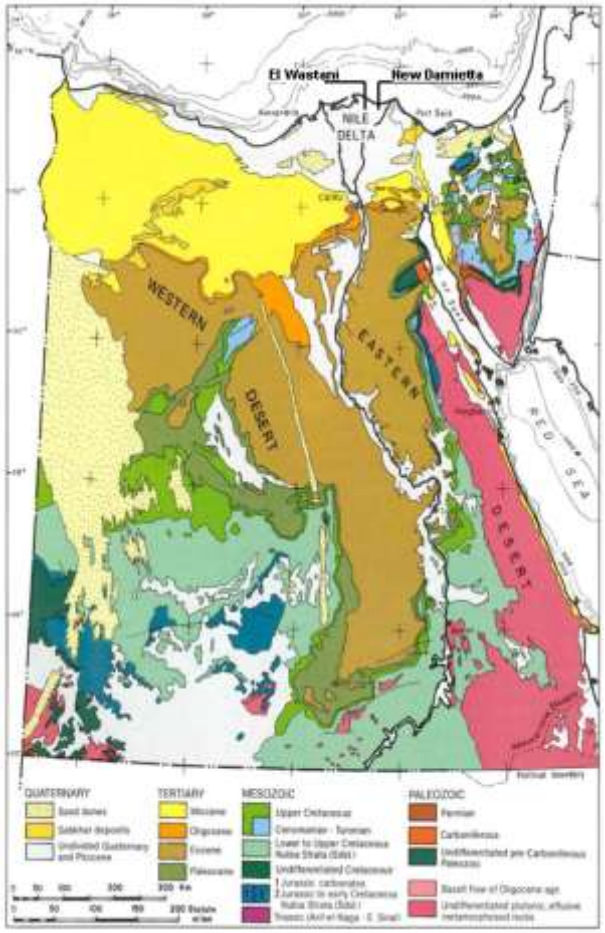


Fig. 2: Geological map of Egypt [4]

AGE	FORMATION	AVE THICKNESS (m)	LITHOLOGY	REMARKS
Q3	Bilgas	50		NEONILE
Q2	Mit Ghamr	700		PRENILE
Q1	El Wastani	300		PROTONILE
Tpl	Kafr El Sheikh	1500		PALEONILE MARINE GULF PHASE
	Abu Madi	300		EONILE
	Rosetta	50		MESSINIAN EVAPORITES
Tmu	Qawasim	700		EONILE
Tmm	Sidi Salem	>700		NORTH DELTA EMBAYMENT OPEN MARINE SHALE FACIES

Fig.3: Stratigraphy and average thickness of geological formations of the North Nile Delta area [6]

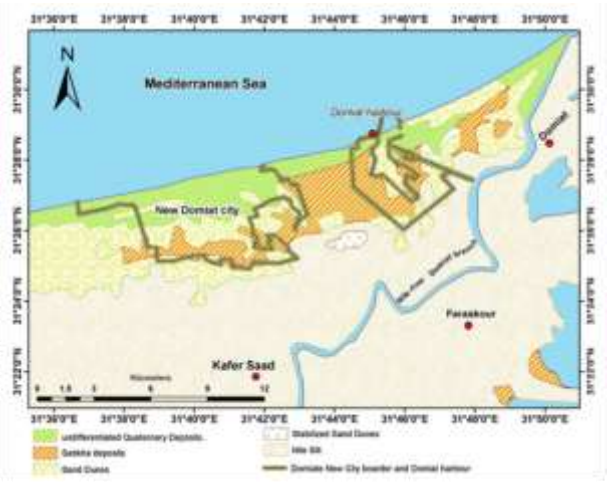


Fig.4: Soil distribution map for New Damietta City [9]



Fig.5.: The distribution of Representative and confirmation borings in the study area [7]

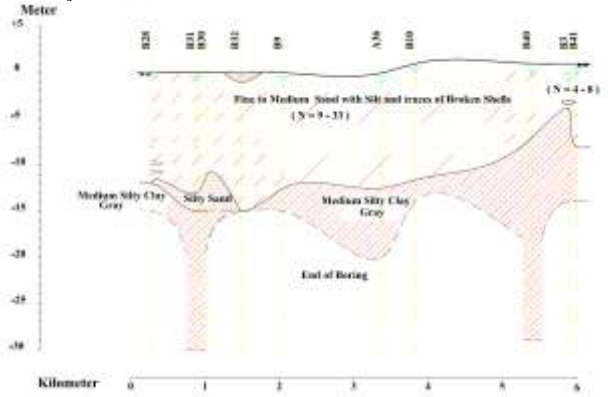


Fig.6: Diagonal geotechnical section across the city from the north east to the south west [7]

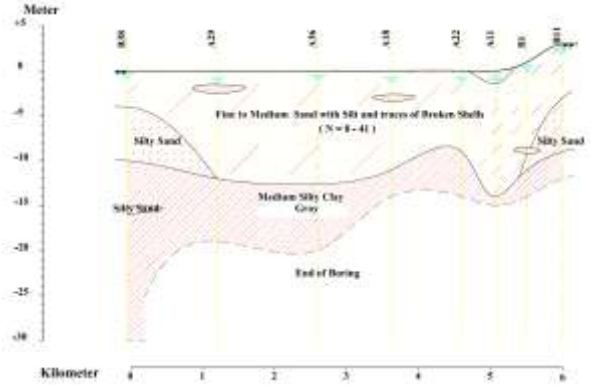


Fig.7: Diagonal geotechnical section across the city from the south east to the north west [7]

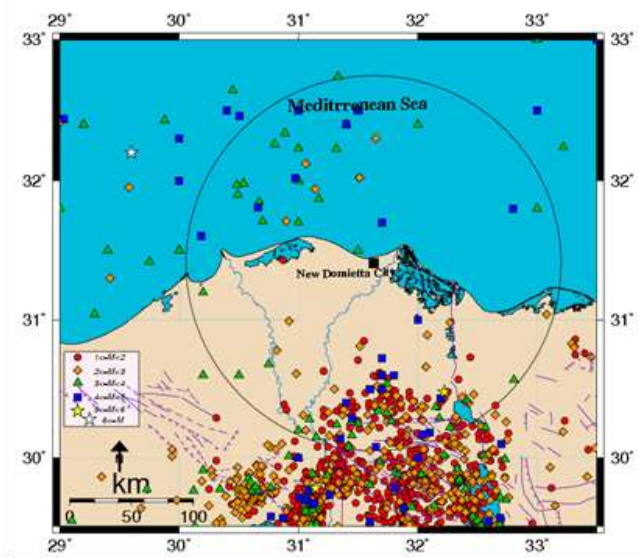


Fig.8: Seismicity map (150- km radius) around New Damietta city (1900-2008) [9]

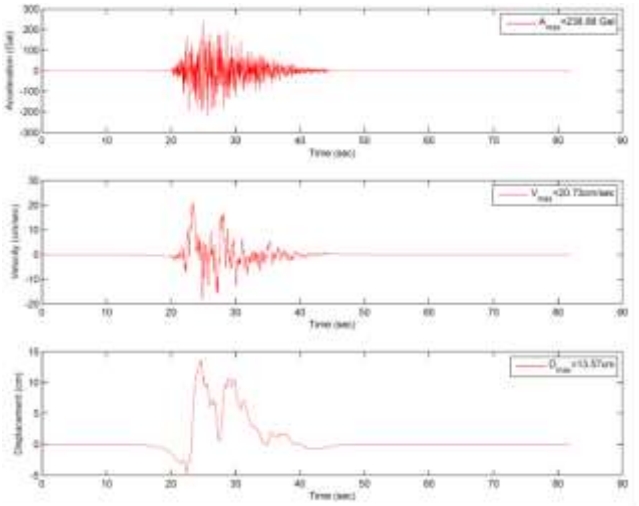


Fig.9: Time histories of the 1954 Earthquake at bedrock level with amax=0.25g

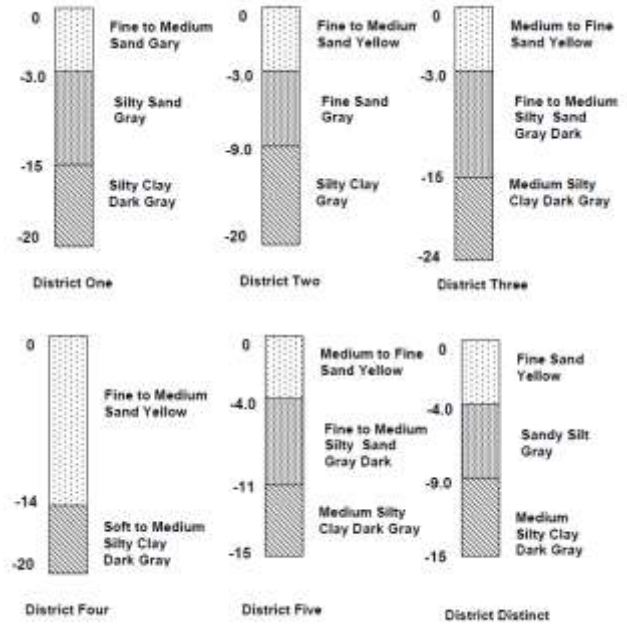


Fig.10: Thirteen representative boring logs for the thirteen districts at New Damietta City

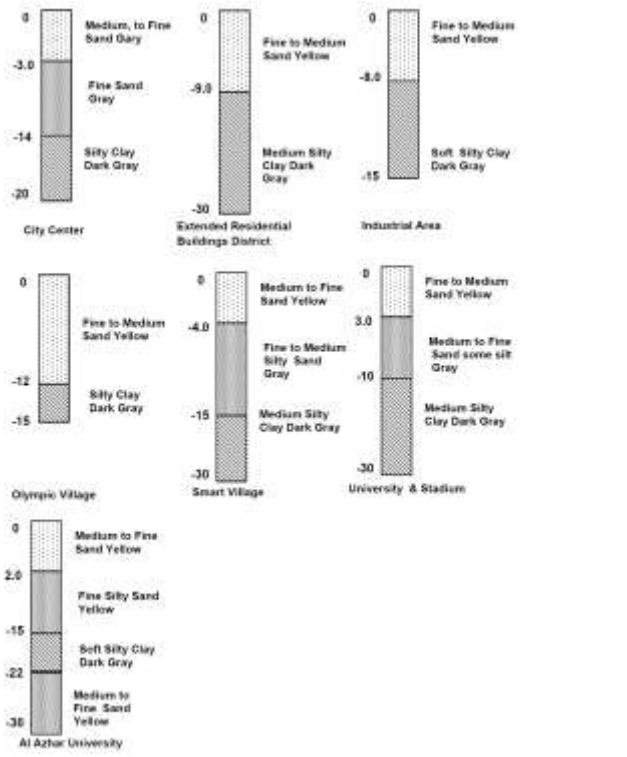


Fig.10: Thirteen representative boring logs for the thirteen districts at New Damietta City Contd.

5.1 Equivalent Linear Site Response

Equivalent linear analysis was done by SHAKE2000 [10] for the thirten delegate boreholes as appeared in Figure 10 by applying the flat speeding up of the 1954 Earthquake at bedrock level and at profundity 30 m underneath the surface . The shear modulus and the damping proportion by Darendeli [12] were utilized for sand and mud layers and for shake layers the shear modulus and damping proportion by Schandel [13]were utilized. The surface speeding up time history, the variety of pinnacle increasing speed with profundity, the reaction range at various damping proportion at

surface lastly the intensification range between the surface layer and bedrock layer are introduced for the thirteen delegate exhausting logs as appeared in Table 1.

5.2. Nonlinear Site Response

Nonlinear analysis was finished by DEEPSOIL 5.1 [11] for the thirten agent boreholes as appeared in Figure 10 by applying the flat speeding up of the 1954 Earthquake at bedrock level and at profundity 30 m beneath the surface. DEEPSOIL5.1 fuses the MKZ spine display, and thick damping is consolidated by means of the Rayleigh damping detailing. The MKZ display parameters were chosen to best fit both the predefined modulus decrease and damping bends for each layer. The predefined modulus decrease and damping bends utilized in this examination were Darendeli [12] for sand and earth layers and Schandel [13] for shake layers. The surface speeding up time history, the variety of pinnacle quickening with profundity and the reaction range at 5% damping proportion at surface are exhibited for the thriteen agent exhausting logs as appeared in Table 1.

6. Comments on the comparison of response analyses

Both nonlinear and equivalent linear analysis are utilized to perform ground reaction investigations, with very unique detailing and fundamental presumptions. Subsequently, it is sensible to hope to discover a few contrasts in their outcomes. The nonlinear technique requires a dependable stress– strain or constitutive model. Field/research facility tests are required to assess the nonlinear model conduct. Equal direct technique does not have the ability of fusing pressure history impacts on the dynamic conduct.

The correlation of results demonstrated comparable pinnacle reaction spectra regarding top recurrence for both identical and nonlinear examination, as appeared in Table 1. Because of the nonappearance of pore water weight in the dirt profile considered in the investigation, the ground reaction results are comparative for both nonlinear and proportionate direct techniques. In any case, the intensification levels of nonlinear examination are not exactly the comparable direct technique particularly in significant lots. Table 1 demonstrates the intensification factor utilizing the equal straight and nonlinear strategies Therefore, in light of discoveries of this examination, the identical direct strategy indicates higher enhancement and higher reaction spectra contrast with the genuine nonlinear investigation.

Table 1: Amplification factors in both equivalent linear and nonlinear analyses

Districts	Methiod	Peack Surfac Acc. (g)	Frequency at Peak (Hz)	RRS at Peak	Amplification Factor
District One	Equivalent Linear	0.27	4.0	1.6	3.4
	Non Linear	0.30	3.7	1.6	3.7
District Two	Equivalent Linear	0.27	4.2	1.6	3.2
	Non Linear	0.30	3.8	1.4	3.4
District Three	Equivalent Linear	0.26	4.5	1.6	3.3
	Non Linear	0.29	4.0	1.5	3.0
District Four	Equivalent Linear	0.26	4.5	1.6	3.5
	Non Linear	0.28	4.0	1.4	3.6
District Five	Equivalent Linear	0.26	3.9	2.0	3.0
	Non Linear	0.28	3.7	1.8	3.3
Distinict District	Equivalent Linear	0.27	4.5	1.6	3.4
	Non Linear	0.30	4.0	1.6	3.7
City Center	Equivalent Linear	0.25	3.8	1.4	3.2
	Non Linear	0.27	3.6	1.8	3.5
Extended Residential	Equivalent Linear	0.26	4.4	1.6	3.1
Building District	Non Linear	0.30	3.9	1.6	3.4
Industrial Area	Equivalent Linear	0.27	4.3	1.6	3.4
	Non Linear	0.29	4.0	1.6	3.7
Olympic Village	Equivalent Linear	0.26	3.8	2.0	3.4
	Non Linear	0.27	3.6	1.8	3.6
Smart Village	Equivalent Linear	0.26	4.2	1.6	3.2
	Non Linear	0.28	3.8	1.4	3.4
University & Staduim	Equivalent Linear	0.26	4.5	1.6	3.4
	Non Linear	0.30	4.0	1.4	3.3
Al Azhar University	Equivalent Linear	0.27	4.3	1.6	3.3
	Non Linear	0.30	4.0	1.4	3.0

7. Conclusion

The impacts of neighborhood site condition in New Damietta City was examined by building up a 1-D ground profile. The seismic reaction of the ground surface was investigated utilizing both nonlinear and proportional straight techniques. With the end goal to assess the impact of nonlinear investigation on the ground reaction, a progression of nonlinear webpage reaction examination has been directed utilizing DEEPSOIL 5.1 and contrasted and the identical straight methodology utilizing SHAKE2000.

The reaction spectra, in both nonlinear and equal straight methodologies, indicated crest surface speeding up from 0.26– 0.30 (g) . Be that as it may, the recurrence at crest for proportional straight from 38 – 4.5 and for non direct from 3.7 – 4.0 (Hz), the intensification dimensions of nonlinear examination were not exactly the identical direct technique particularly in extensive stretches. The intensification factor utilizing the proportional straight strategy was from 3.2 to 3.3, while this factor in full nonlinear technique was from 3.5 to 3.7.

Acknowledgment

The authors are deeply indebted to Prof. Amira Abdel Rahman, Housing and Building National Research Center (HBRC) for giving her the opportunity of using the geotechnical data base that was established in 2007 under her supervision by Housing and Building research Center (HBRC) and for her valuable advices during collecting data and references for this study.

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