

Utilizing Shear Wave Velocity Techniques for Identifying Engineering Challenges in 6th October City, Egypt

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Abstract

In Egypt, geophysical surveys are now more critical, especially following the significant impact of the October 1992 earthquake on structures in Greater Cairo. Engineering site investigations aim to determine the depth and lithological composition of the bedrock, groundwater depth, and lateral lithological variations, and to identify faults or fissures. To meet these objectives, shallow seismic refraction surveys were conducted in a selected area within 6th October City, Egypt, to assess subsurface characteristics before commencing construction activities. The first step was taken to identify the underlying geological structure by acquiring fifteen seismic refraction profiles over the research region. The primary wave velocity distribution analysis identified the existence of three separate geoseismic strata characterized by velocity ranges of (685 to 835 m/s), (680 to 1030 m/s), and (1340 to 1525 m/s). The sediment layers exhibit shear wave velocities ranging from 356 to 440 m/s, 360 to 536 m/s, and 690 to 790 m/s, respectively. These findings indicate that the first layer has low velocity values, which reflect a sediment composition consisting of sandy gravel. On the other hand, the second layer consists of coarse gravelly sand, while the third layer consists of clayey limestone. The sediment layers were analyzed using a basic equation to derive geophysical characteristics, which include the velocity of the shear wave, the density of the rock, and material indices (including material index, Poisson's ratio, N-value, and stress ratio). According to these data, the sediment layers beneath the surface in this area have a moderate to high level of competence.

Keywords:

Geotechnical, Poisson's ratio, Shear wave.

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1. Introduction

Shallow geophysical techniques such as seismic refraction methods are highly sought after for detecting subsurface structures and lithologic layers at shallow depths (less than 100 ft). Utilizing shallow geophysical methods offers precise and affordable solutions for engineering, environmental, and archaeological surveys. They enhance the interpretive abilities of geophysicists and augment the capabilities of engineers and geologists by leveraging basic geophysical principles. Seismic refraction techniques have significantly contributed to numerous engineering endeavors, including constructing hydroelectric power plants, subways, roads, and tunnels over the past three decades.

Seismic methods have become essential for calculating elastic moduli, which help estimate elastic deformation in civil engineering projects (Harden and Drnevich, 1972; David and Taylor Smith, 1979; Stumpel et al., 1984; Ghanem et al., 2021; Mohsain and Al-Khalidy, 2022).

The interpretation of the moduli called dynamic elastic obtained from foundation rock's velocity measurements during earthquakes and machine cyclic loading indicates extra stresses that may surpass the rock materials' ultimate bearing capability (Bowles, 1984). Relying exclusively on soil competence ratings is insufficient for determining foundation placements, particularly in earthquake-prone areas.

For engineers, soil is the material that covers bedrock after it has weathered and is often used as the foundation for construction projects. Soil

geotechnical properties depend on the elasticity of the underlying source rocks, which can be measured using traditional geophysical methods (Dutta, 1984; Abed Elrahman et al., 1991 and 1992; Al-Juraisy and Al-Saigh, 2010; Al-Nuaiemy et al., 2018).

Understanding soil stiffness, usually measured by shear wave velocity (V_s), is crucial for predicting soil behavior during earthquakes. Additionally, evaluating site amplification depends on soil stiffness (Borcherdt, 1994). Determining shear wave velocity in each subsurface layer allows us to estimate ground shaking at a given location (Hunter et al., 2002). This study will use this technique for accurate predictions. Located 32 km south of Cairo and within 20 km of the Great Pyramids of Giza (Fig. 1), 6th October City has been the subject of intensive investigation by numerous scientists for engineering and environmental purposes (e.g., Abd Elrahman et al., 1991 and others).

The study area's surface geology (Fig. 2) reveals that the Gebel Qatrany Formation, consisting of strata of reddish claystone, burrowed siltstone, and continental and coastal marine deposits, is present throughout. In the region, the sediment composition generally comprises lithic pieces, gravel, sand, silt, and clay, with the exception of some regions where the topsoil has a distinct composition.

This study aims to ascertain the shear wave velocity in each soil horizon for engineering and geotechnical purposes. In order to examine the challenges faced on the engineering site and provide an accurate representation of the underground layers and velocities in the study area, we conducted a shallow seismic refraction investigation. This study utilizes geotechnical data collected from subsurface investigations to evaluate the response of the site. The dataset obtained by Mohamed in 1991, 2003, and 2009 consists of measurements of various parameters such as thickness, density, damping factors, P-wave and S-wave velocities, and others, obtained by geotechnical boreholes and seismic surveys. This approach combines P-wave velocity data obtained from seismic refraction surveys with S-wave velocity data obtained from the multi-channel approach of Surface Waves (MASW) surveys.

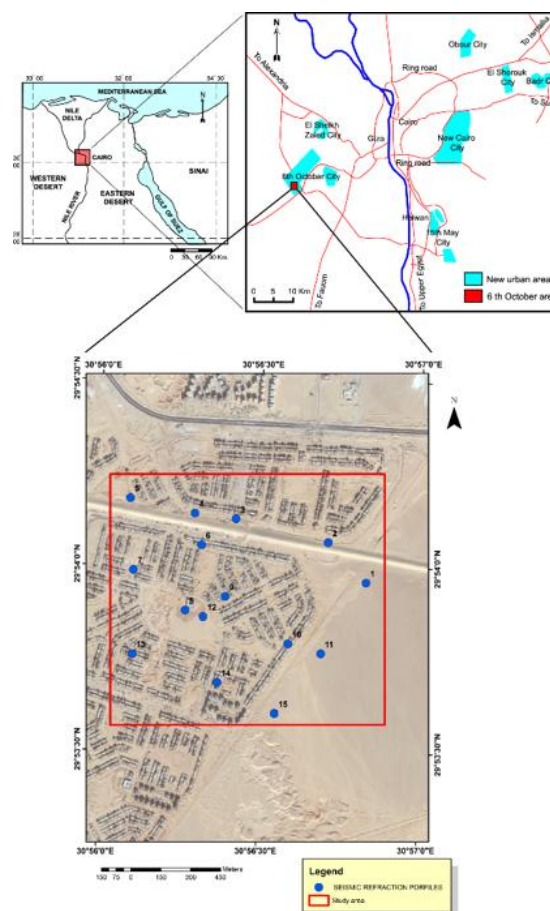


Fig. 1: Location map of the study area showing seismic refraction spreads in 6th of October City.

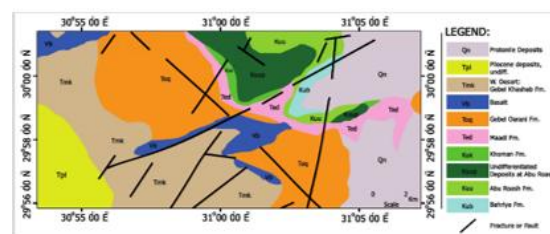


Fig. 2: Regional geologic map (modified after Conoco Coral, 1987).

2. Materials and Methods

A comprehensive geophysical investigation was carried out using both seismic refraction and Multi-Channel Analysis of Surface Waves (MASW) techniques to assess subsurface conditions in the selected area within 6th October City, Egypt.

Fifteen seismic refraction profiles were acquired across the study area using a linear array of 40 Hz vertical-component geophones spaced at 2-meter intervals, with a total spread length of approximately 94 meters. Seismic energy was generated using controlled hammer impacts at

multiple shot points located at both ends, midpoints, and along the profile line at 5-meter intervals. Data acquisition was performed using a Strata View seismograph (Geometrics Inc., USA), equipped with 48 channels for signal amplification and recording.

In addition to P-wave data obtained from seismic refraction, S-wave velocities were determined using the MASW method, which involves analyzing the dispersion characteristics of surface waves (Rayleigh waves). This method allows for reliable estimation of shear wave velocity profiles down to depths exceeding 30 meters.

The MASW data were collected using the same geophone array configuration as the refraction survey. Surface waves were generated using a sledgehammer and metal plate source, and the resulting wavefield was recorded by the multichannel seismograph. The recorded data were then processed using standard MASW procedures to generate phase velocity dispersion curves, which were subsequently inverted to obtain 1D shear wave velocity profiles for each survey line.

All field data processing and inversion steps were conducted by the author using specialized software tools. The final S-wave velocity models were integrated with P-wave velocity results to derive key elastic parameters, including Poisson's ratio, Young's modulus, rigidity modulus, and bulk modulus. These parameters were used to evaluate the geotechnical competence of the subsurface layers and their suitability for foundation engineering applications.

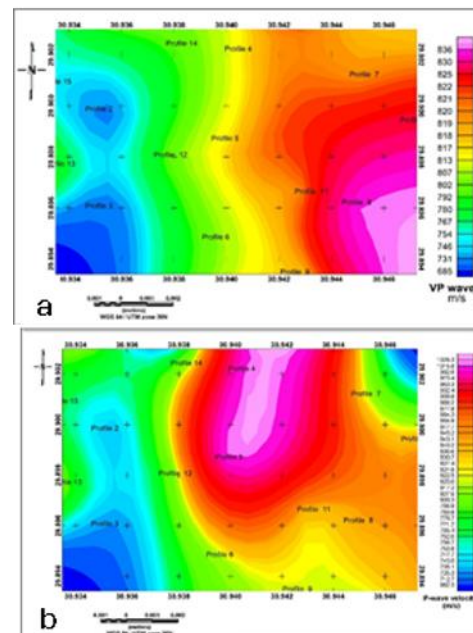
The shear wave velocity (V_s) values reported in this study were derived from field measurements using the MASW technique and subsequent data processing conducted by the author. The methodology followed standard procedures for surface wave analysis, including dispersion curve extraction and inversion modeling to produce reliable V_s profiles for each seismic line.

3. Seismic velocities

One important premise of the seismic refraction method is the rate of propagation, or seismic wave velocities, in a given medium. We have calculated the reciprocal slope of selected segments on the time-distance curve to find the seismic wave velocities for each sediment layer. A total of 31 seismic sites across the study region will

have their P-wave and SH-wave seismic velocities assessed for the three layers of underlying sediment. Fig. 3 illustrates the lateral variation of P-wave velocities across the study area for (a) the first layer (685–835 m/s), (b) the second layer (680–1030 m/s), and (c) the third layer (1340–1525 m/s), indicating lithological differences among the geoseismic layers. Fig. 4 displays the observed SH-wave velocity distribution for (a) the first layer (356–440 m/s), (b) the second layer (360–536 m/s), and (c) the third layer (690–790 m/s). The increasing velocities with depth reflect enhanced material stiffness and competence in deeper subsurface layers over the surface layers.

The primary wave velocity analysis in the studied region indicates the presence of three separate geo-seismic strata with velocities ranging from 685 to 835 m/s, 680 to 1030 m/s, and 1340 to 1525 m/s. Similarly, the distribution of shear wave velocity reveals the presence of three distinct geo-seismic strata with velocities ranging from 356 to 440 m/s, 360 to 536 m/s, and 690 to 790 m/s, respectively. The first layer has low velocity values, indicating the presence of sand with a composition that includes gravel. In contrast, the second layer consists of coarse, gravelly sand. The second layer is notable for its clearly differentiated top and lower sections. The velocity measurements of the third layer suggest that it has a texture characterized by the presence of clay and limestone.



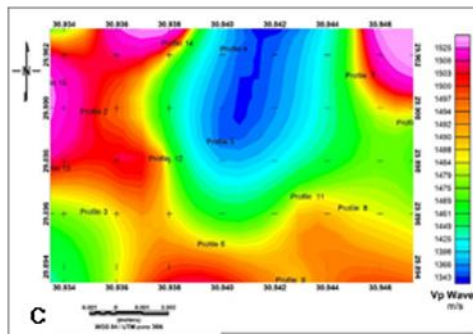


Fig. 3: Spatial distribution maps of P-wave velocities for (a) the first layer (685–835 m/s), (b) the second layer (680–1030 m/s), and (c) the third layer (1340–1525 m/s).

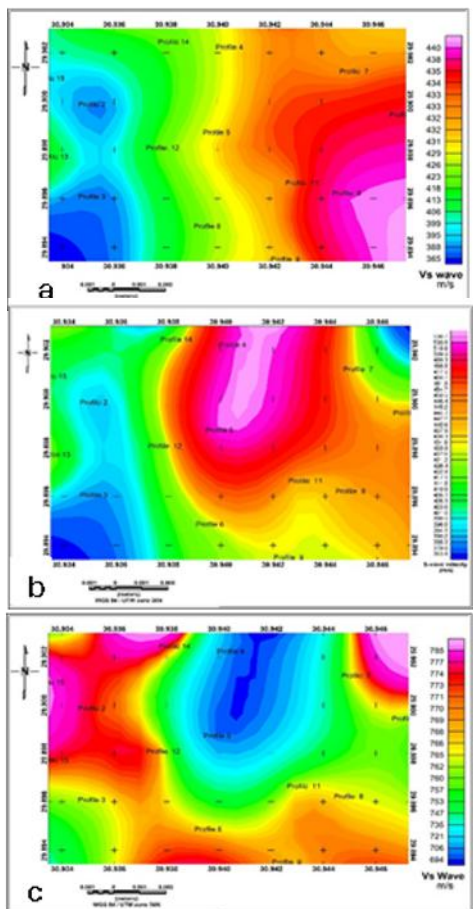


Fig. 4: Distribution of shear wave (SH-wave) velocities for (a) the first layer (356–440 m/s), (b) the second layer (360–536 m/s), and (c) the third layer (690–790 m/s).

4. Geotechnical characteristics of the foundation material

At the surveyed sites, measuring the P-wave and SH-wave velocities across the subsurface sediment layers is a critical tool for calculating their geotechnical properties, such as elastic moduli, competence scales, and bearing capacities. Understanding these geotechnical properties is

critical for determining the bedrock's competence in engineering and environmental work in the study area.

4.1 Elastic moduli

4.1.1. Poisson's Ratio (σ):

Fig. 5 displays the Poisson's ratio values distribution. The maps illustrate that the values in the first layer vary between 0.3016 and 0.3079. The lowest Poisson's ratio value is in the southwest, while the southeast exhibits larger values. Similarly, the second layer has a minimum value of 0.3015 in the southwest and higher values of 0.3129 in the northern region. Poisson's ratio values in the third layer exhibit lower values (0.3175) in the northern region and higher values (0.3200) in the northeastern region of the study area.

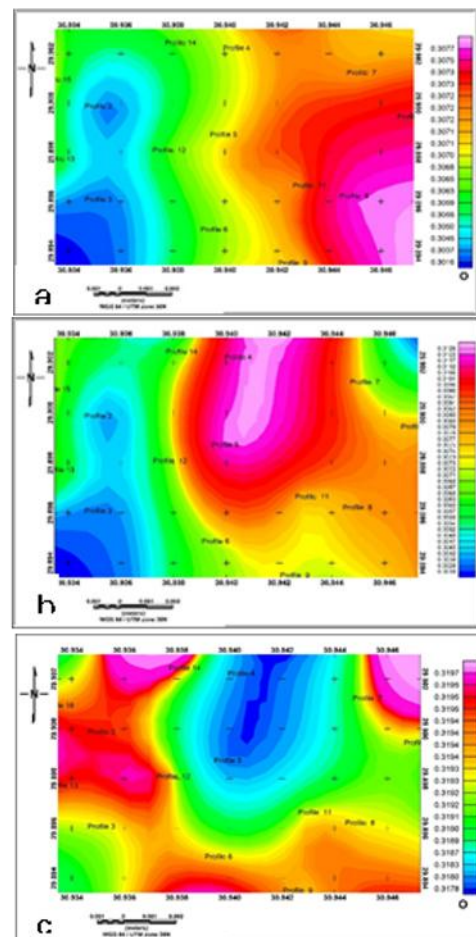


Fig. 5: (a) First, (b) Second, and (c) Third-layer Poisson's Ratio (σ).

4.1.2. Kinetic Rigidity Modulus (μ):

Fig. 6 depicts the measured values of the kinetic rigidity modulus for the sediment layers in the research region. The results in the first layer range from 174 dyn/cm² to 392 dyn/cm², showing the presence of soil components that vary from

quite low to competent. The minimum values represent the southwestern and western corners, progressively rising towards the southeastern portion of the region.

Conversely, the (μ) values for the second layer (Fig. 6.b) vary between 120 dyn/cm² and 896 dyn/cm², with the lowest values seen in the northeast and southwest corners. The (μ) of the second layer exhibits a progressive rise as one moves towards the northern region of the area. The overall results indicate materials that range from low to competent quality. In addition, the observed values of the kinetic stiffness modulus for the third sediment layer vary from 2470 dyn/cm² to 3972 dyn/cm². The results exhibit a minimal magnitude in the northern region and progressively escalate towards the northeastern and northwestern sections, suggesting the presence of less proficient and less stiff materials in that stratum.

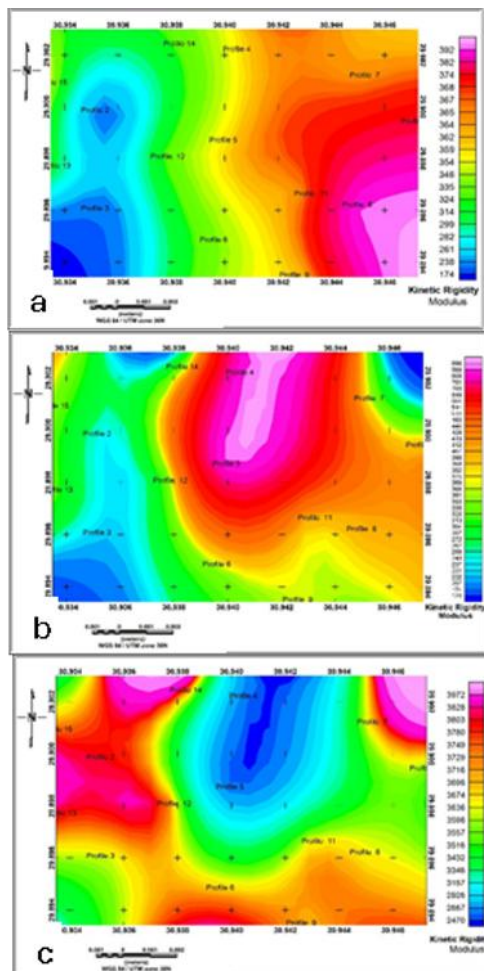


Fig. 6: (a) First, (b) Second, and (c) Third layer Kinetic Rigidity Modulus (μ).

4.1.3. Kinetic Young's Modulus (E):

Fig. 7 depicts the spread of Young's modulus values. The first layer has a range of values

spanning from 452.5 to 1025.5 dyn/cm², with lower values observed in the southern and western regions, gradually increasing towards the eastern region. Conversely, the values for the second layer vary between 309 and 2352 dyn/cm², with the lowest values seen in the northeast and southwest regions and gradually increasing towards the north and central parts. In addition, the (E) values for the third layer vary between 6509 and 9684 dyn/cm², with lower values seen in the northern and central regions and increasing towards the northeastern and western corners.

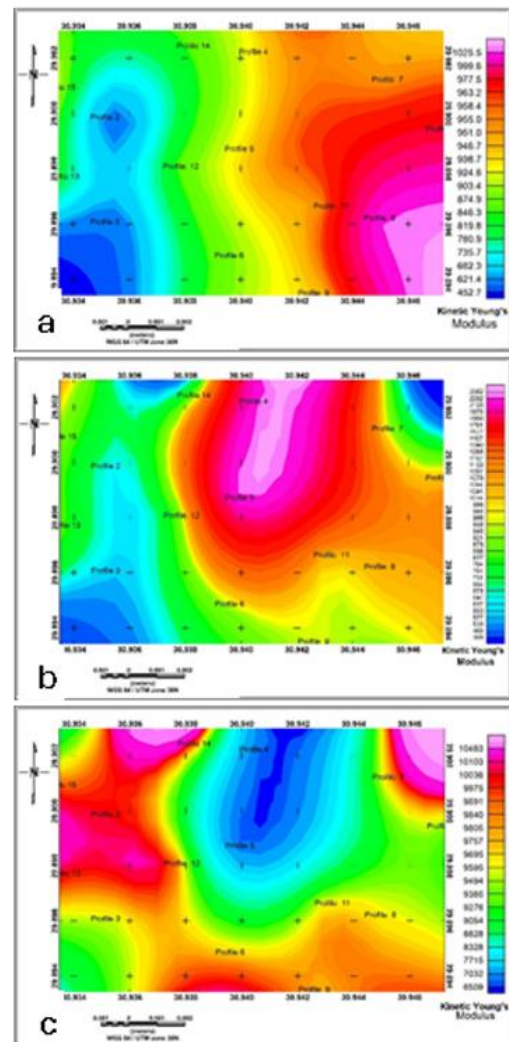


Fig. 7: (a) First, (b) Second, and (c) Third layer Kinetic Young's Modulus (E).

4.1.4. Kinetic Bulk Modulus (K):

Fig. 8 displays the bulk modulus values recorded in the region. The first layer records values ranging from 378.5 dyn/cm² to 888 dyn/cm², primarily in the southwestern and western parts, with the southeastern corner recording the highest values. In contrast, the values recorded in the second layer range from 235

dyn/cm² to 2096 dyn/cm², with lower values scattered across various sites, especially in the northeastern and southwestern parts. In comparison, higher values are more common in the central and northern parts of the region. The values recorded in the third layer range from 6509 dyn/cm² to 10483 dyn/cm², with lower values located in the northern part and the higher values scattered across various sites, especially in the northeastern and northwestern parts.

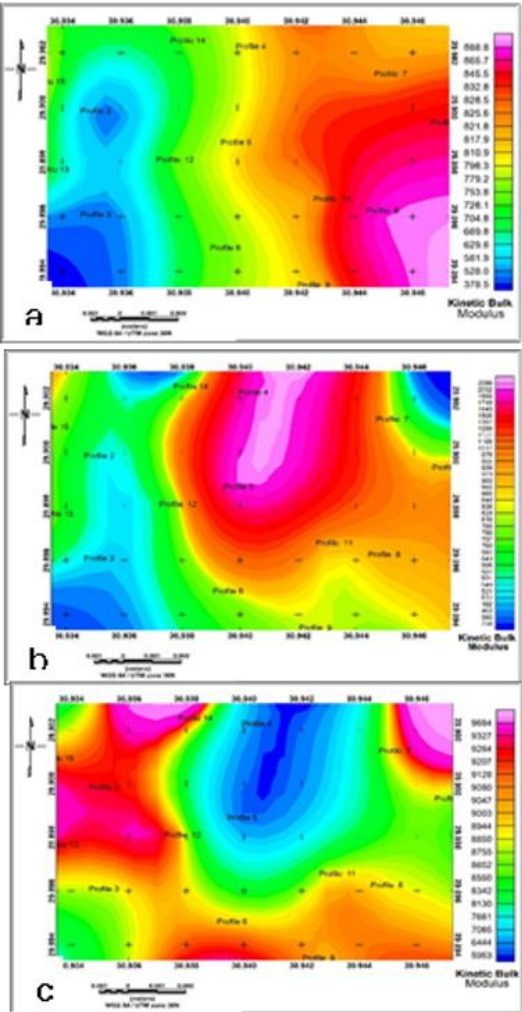


Fig. 8: Kinetic Bulk Modulus (K) for (a) first, (b) second, and (c) third layer.

4.2. Standard penetration test (SPT) [n-value]:

The SPT is a geotechnical method used to assess the resistance of sediment layers to penetration. Table 1 presents a categorization of N-values, which are determined by geophysical assessments of different soil types using the methodologies used by Imai and Yoshimura (1975) and Stumpel et al. (1984). Fig. 9 presents the recorded N-values for the sediment layers under investigation. The N-values of the first layer vary between 60 and 105.5. On the other hand, the

N-values for the second layer range from 50 to 190. The lowest values are seen in the southwest and northeast, suggesting the presence of hard and compact soil. The data indicate a steady rise in the center and northern areas. The N-values of the third layer vary between 401 and 569, suggesting the presence of a hard and very dense layer.

Table 1: Classification of N-values with types of soil (After Bowles, 1984).

Cohesionless soil					
N-values	0-10	11-30	31-50	> 50	
State	Loose	Medium	Dense	Very Dense	
Cohesive soil					
N-Value	< 4	4-6	6-15	16-25	> 25
State	Very Soft	Soft	Medium	Stiff	Hard

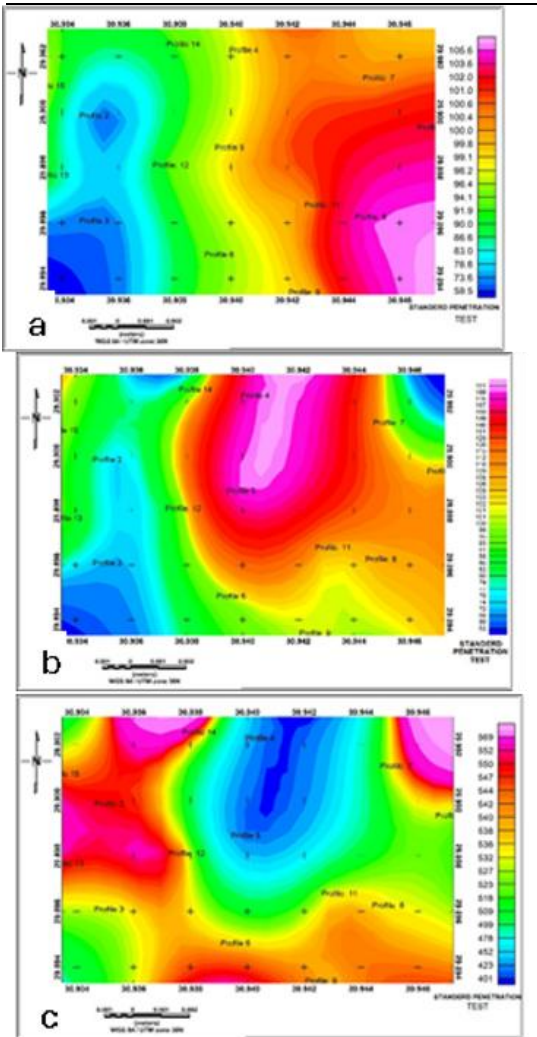


Fig. 9: N-values for the (a) first, (b) second, and (c) third layer.

4.3. Material competence scales:

4.3.1 The Material Index (v):

According to Abd Elrahman (1989), material index values range between (+1) and (-1), as shown in Table 2, which illustrates the

classification of the material index according to the foundation.

Table 2: Classification of the material index for foundation purposes (After Abd Elrahman 1989).

Category I $-1 < v < -0.5$	Category II $-0.5 < v < 0$	Category III $0 < v < 0.5$	Category IV $v > 0.5$
Soft recent river, stream deposits, wind blows sand, clay, and volcanic ashes	Partly consolidated. Highly porous alluvial deposits, highly fractured limestone, basalt, and cavernous carbonate deposits.	Non-porous hard indurated rocks	Very hard indurated sedimentary rocks
Non-competent to less competent	Fairly to moderately competent	Competent	Very high competent

Fig. 10 presents the material index values for the research area. The first layer values vary from -0.312 to -0.2119. The lower values in the southeastern sections indicate the presence of less capable material, while the higher values in the western and southwestern parts indicate the presence of material that is of good to fairly capable quality. In the central portion of the region, the data indicate a range of materials with varying degrees of competence, from reasonably competent to less competent. The numbers in the second stratum span from -0.2503 to -0.2072. The southwestern and western areas have the most elevated values, whilst the northern portion of the study zone has the most diminished values. The third layer values vary from -0.2797 to -0.2713, indicating the presence of fairly to moderately competent material.

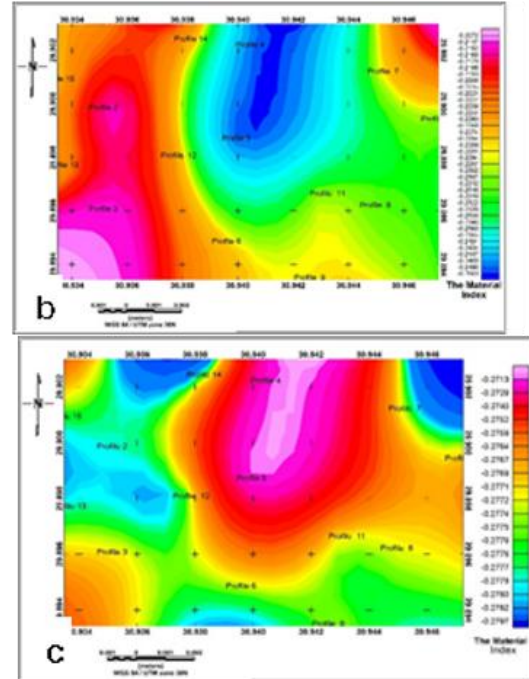
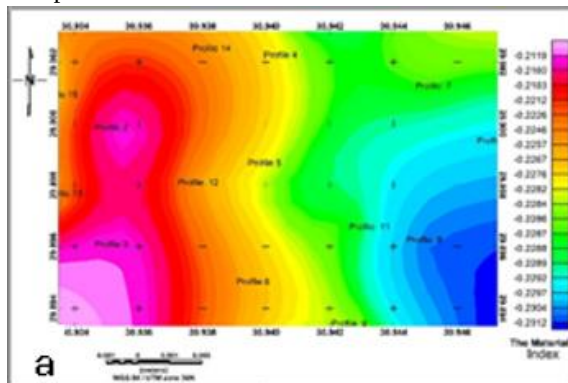
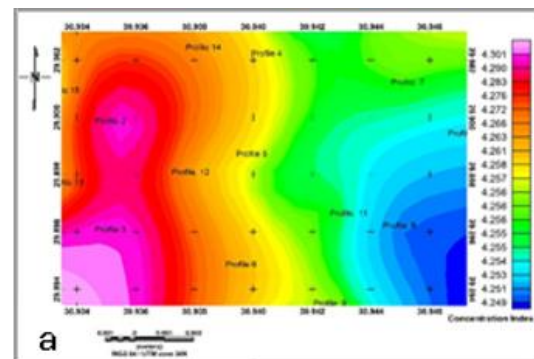


Fig. 10: (a) First, (b) Second, and (c) Third layer Material Index (v).

4.3.2. Concentration Index (Ci):

In civil engineering, soil compaction assesses competence via the concentration index (Ci). Fig. 11 displays concentration index values recorded in the study. Initially, values range from 4.249 to 4.301 in the first layer, lower in the east and southeast, denoting materials of modest quality. Conversely, higher values in the west and southwest suggest moderately highly competent materials. Similarly, the values of the second layer vary from 4.20 to 4.30, with lower concentrations in central and northern areas extending towards the west and southwest, indicating moderately competent materials. The third layer shows values from 4.1257 to 4.1463, with the highest values in the central and northern regions and the lowest in the northeast and west.



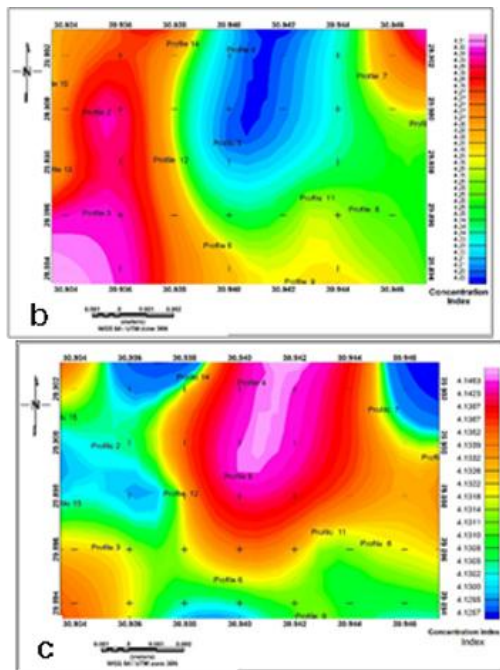


Fig. 11: (a) First, (b) Second, and (c) Third layer Concentration Index (Ci).

4.3.3 Stress Ratio (Si):

The seismic wave velocity through sediment materials correlates directly with the difference in pressure between the sediment layers and the fluids that occupy the intergranular pore spaces of these sediments (Buckingham, 2005) .

In Fig. 12, the Si values vary from 0.4319 to 0.4445 in the first layer, with lower values more common in the southwest. This suggests reasonably to moderately compact materials. Conversely, higher Si values are in the northeast and southeast regions, indicating relatively less compact to moderately compact materials. The Si values in the second layer vary from 0.4322 to 0.4547, with lower values primarily in the southwest and gradually increasing toward the north and central areas, indicating moderately compact materials.

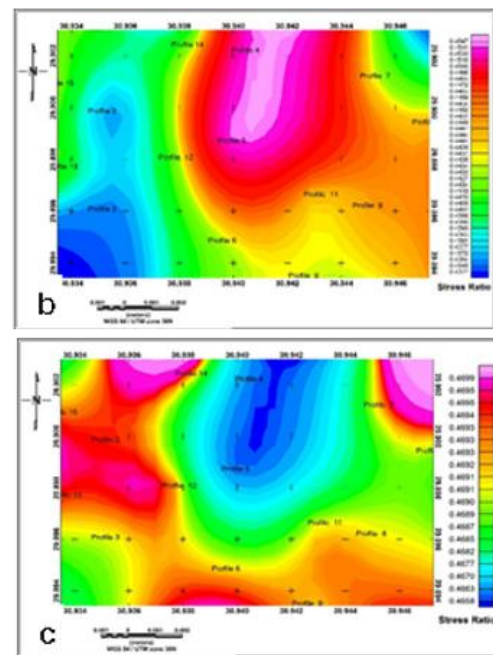
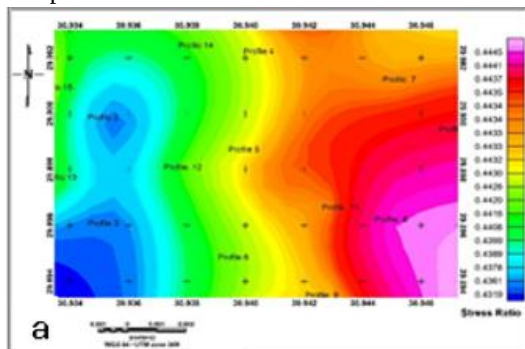


Fig. 12: (a) First, (b) Second, and (c) Third layer Stress Ratio (Si).

4.3.4. Density Gradient (Di):

From an engineering perspective, the density gradient value (Di) of materials is closely linked to their material competence and the compression velocity (Vp). As discussed by Cordier (1985), "Compaction" refers to sediments transitioning from their original loose state to a denser state due to overburden weight or tectonic movements.

Fig. 13 displays the range of density gradient values in the first layer, which exhibits minor fluctuations, ranging from 0.00000226 to 0.00000315. In this layer, the eastern and southeastern regions of the study region show lower density gradient values, suggesting the presence of fairly competent material. In contrast, the western and southwestern regions display elevated values, indicating the presence of materials with modest competence.

The Di values in the second layer vary between 0.15×10^{-5} and 0.34×10^{-5} . The northern and central regions display the lowest scores, indicating a modest degree of proficiency. In contrast, the western and southwestern regions display values that suggest the presence of exceptionally capable materials. In the third layer, the Di values vary from 0.64×10^{-5} to 0.85×10^{-5} . The center and northern areas have the highest values, while the western and northeastern regions display the lowest values.

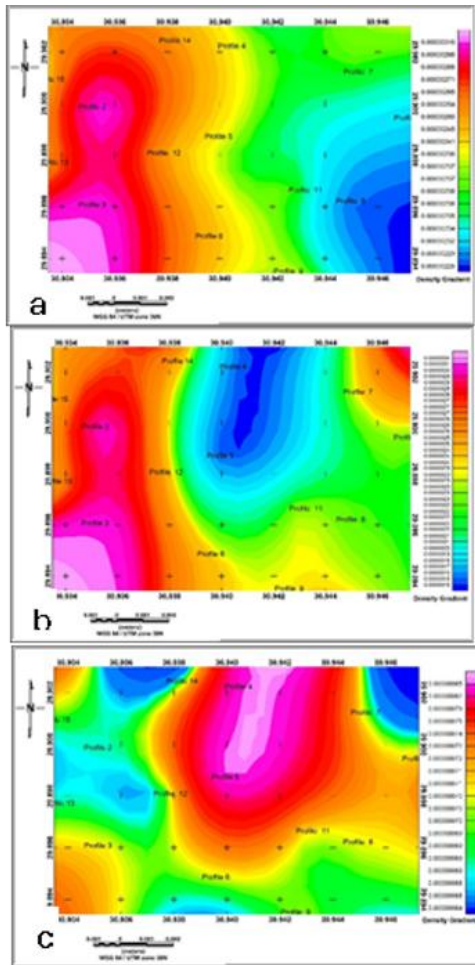


Fig. 13: Density Gradient (D_i) for first layer (a), second layer (b), and third layer (c).

5. Foundation materials bearing capacity

5.1. Ultimate Bearing Capacity (Q_{ult}):

The soil's ability to withstand the weight of the foundation without collapsing is referred to as its carrying capacity (Lukić et al., 2017). The Q_{ult} of soil refers to the highest pressure it can withstand before it fails, as stated by Damane (2019). The shear strength coefficient defines the maximum load-bearing capacity (Q_{ult}).

The Q_{ult} values depicted in Fig. 14 range from 1784 to 3169 kPa and are generally considered to be quite low. The first layer showed comparatively lower results in the southern and western regions of the research area. Conversely, the southern and eastern corners of the research area have elevated values of first layer bearing capacity, indicating that these regions are more prone to include materials with less ultimate bearing capacity. Conversely, the second layer exhibits a range of ultimate bearing capacity values ranging from 1590 to 5725 kPa. The western,

southwestern, and northeastern parts have notably low values, suggesting the existence of materials with inadequate ultimate bearing capability. In contrast, the central and northern areas have the highest values of ultimate bearing capacity for this layer, suggesting the presence of materials with relatively high ultimate bearing capacity. The values in the third stratum range from 12035 to 17060 kPa. The western and northeastern regions of the research area demonstrate the highest values, whilst the center and northern regions display the lowest values.

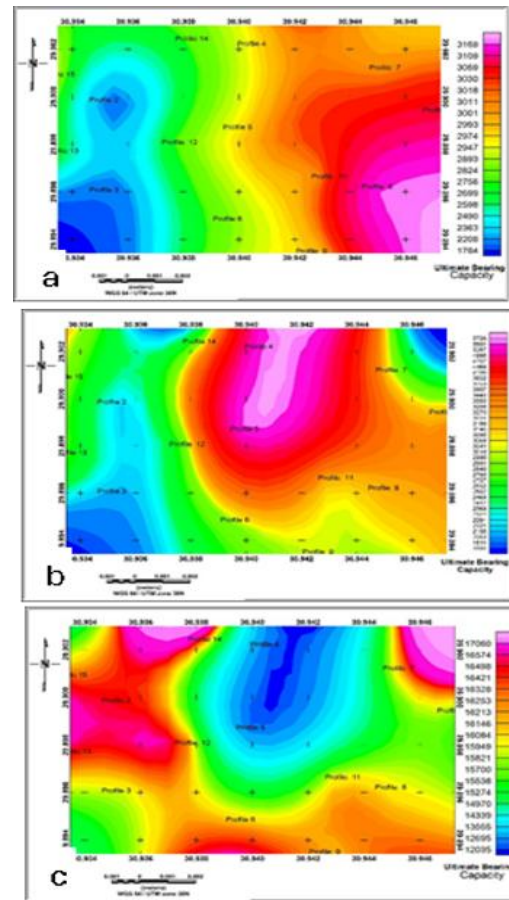


Fig. 14: (a) First, (b) Second, and (c) Third layer Ultimate Bearing Capacity (Q_{ult}).

5.2. Allowable Bearing Capacity (Q_a):

The Q_a refers to the highest level of stress that may be exerted on the soil to maintain its stability and prevent shear failure and excessive settlement (Bowles, 1988). Fig. 15 is a figure that shows the permissible range of bearing capacity values (Q_a). Upon a more detailed analysis of the figure, it becomes evident that the Q_a values for the first layer vary between 595 kPa and 1056 kPa. The southern and western regions demonstrate lower levels, whilst the eastern and southeastern regions display the greatest values. The Q_a values for the

second layer vary between 530 kPa and 1909 kPa. The southern and western regions have a higher concentration of materials with a low permitted bearing capacity, whereas the values steadily increase as you move towards the center and northern sections of the region. For the third layer, the acceptable range of bearing capacity values is from 4012 kPa to 5690 kPa. The western and northeastern regions have the highest values, while the center and northern regions have the lowest values.

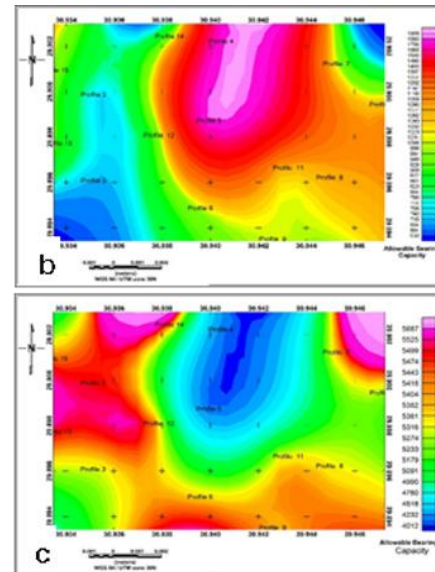
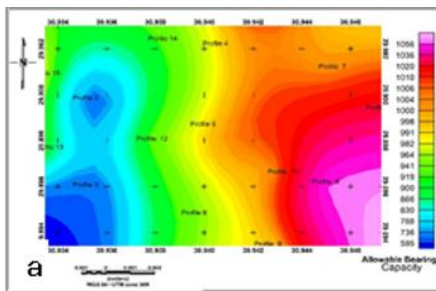


Fig. 15: (a) First, (b) Second, and (c) Third layer Allowable Bearing Capacity (Q_a).

Table 3: Presents a thorough overview of the estimated elastic moduli, material competency, and foundation material-bearing capability.

Mechanical Properties		Surface layer		Second Layer		Third Layer	
		From	To	From	To	From	To
Elastic moduli	Poisson's ratio	0.3016	0.3077	0.301	0.3126	0.3178	0.3525
	Kinetic rigidity modulus	174	390	120	896	2470	3972
	Kinetic Young's modulus	452.5	1025.5	309	2352	6509	10483
	Kinetic bulk modulus	378.5	888	235	2096	5953	9684
Material competence	N-value	60	105.5	50	190	401	569
	Material index	-0.312	-0.2119	-0.2503	-0.2072	-0.2797	-0.2713
	Concentration index	4.249	4.301	4.20	4.30	4.1257	4.1463
	Stress ratio	0.4319	0.4445	0.4322	0.4547	0.4658	0.4699
	Density gradient	0.00000226	0.00000315	0.0000015	0.0000034	0.0000064	0.0000085
Foundation material bearing capacity	Ultimate bearing capacity	1784	3169	1590	5725	12035	17060
	Allowable bearing capacity	595	1056	530	1909	4012	5690

6. Results

The subsurface investigation of the selected area in 6th October City, Egypt, using shallow seismic refraction and MASW techniques revealed the presence of three distinct geoseismic layers.

Layer 1 (sandy gravel): P-wave velocities range from 685 to 835 m/s, and S-wave velocities vary between 356 and 440 m/s. This layer is approximately 7 meters thick and exhibits low material competence. N-values range from 60 to 105.5, indicating medium to dense cohesionless soil.

Layer 2 (coarse gravelly sand): Characterized by P-wave velocities ranging from 680 to 1030 m/s and S-wave velocities from 360 to 536 m/s, with a thickness of about 11 meters. N-values here range

from 50 to 190, reflecting increasing competence compared to the upper layer.

Layer 3 (clayey limestone): Shows the highest seismic velocities, with P-waves ranging from 1340 to 1525 m/s and S-waves from 690 to 790 m/s. N-values exceed 400, reaching up to 569, indicating very high competence.

Elastic moduli were calculated for all layers as follows:

Poisson's ratio: Ranges from 0.3016–0.3079 (Layer 1), 0.3015–0.3129 (Layer 2), and 0.3175–0.3200 (Layer 3).

Kinetic Rigidity Modulus (μ): Increases with depth, ranging from 174 dyn/cm² to 3972 dyn/cm².

Young's Modulus (E): Varies from 452.5 dyn/cm² in layer 1 to 9684 dyn/cm² in layer 3.

•Bulk Modulus (K): Also increases with depth, showing values from 378.5 dyn/cm² to 9684 dyn/cm².

Foundation bearing capacities were estimated as follows:

Ultimate Bearing Capacity (Q_{ult}): Layer 1 ranges from 1784 to 3169 kPa, layer 2 from 1590 to 5725 kPa, and layer 3 from 12035 to 17060 kPa.

Allowable Bearing Capacity (Q_a): Values increase with depth, from 595 to 1056 kPa in layer 1, 530 to 1909 kPa in layer 2, and 4012 to 5690 kPa in layer 3.

7. Discussion

The variation in seismic wave velocities and geotechnical parameters across the three identified layers provides valuable insights into the engineering characteristics of the subsurface materials in 6th October City. Layer 1, composed of sandy gravel, exhibits relatively low P- and S-wave velocities, indicating limited load-bearing capacity and potential settlement risks under heavy structures. The moderate N-values suggest that this layer may require ground improvement techniques before construction. Layer 2, consisting of coarse gravelly sand, shows improved mechanical properties, making it suitable for light to medium infrastructure. However, its heterogeneous nature may lead to differential settlement if not properly evaluated. Layer 3, characterized by high P- and S-wave velocities and N-values exceeding 400, demonstrates excellent mechanical behavior and is interpreted as compact clayey limestone. This layer represents the most competent foundation stratum, ideal for supporting large-scale and critical infrastructure such as high-rise buildings and bridges.

The observed increase in elastic moduli (rigidity, Young's, and bulk) with depth further supports the progressive enhancement in material stiffness and strength. Poisson's ratio values also show an upward trend, suggesting increased compressibility in deeper layers, which should be considered in dynamic loading conditions such as earthquakes. These findings align with previous studies conducted in similar geological settings, including Sadat City (Abd Elrahman et al., 1992) and Mosul Dam (Al-Juraisy and Al-Saigh, 2010), where higher shear wave velocities correlated with greater foundation stability.

The integration of seismic refraction and MASW methods proved effective in delineating

subsurface stratigraphy and estimating key geotechnical parameters without invasive drilling. However, future work should include borehole verification and laboratory testing to refine these interpretations and enhance reliability for engineering design.

8. Conclusions

This study successfully applied seismic refraction and MASW techniques to assess subsurface conditions in 6th October City, Egypt. Three distinct geoseismic layers were identified based on variations in P- and S-wave velocities, elastic moduli, and geotechnical indices.

•Layer 1 (sandy gravel) is unsuitable for direct foundation support due to its low competence and requires treatment or deep foundations.

•Layer 2 (gravelly sand) offers moderate bearing capacity and is appropriate for light to medium structures.

•Layer 3 (clayey limestone) presents the highest mechanical strength and is recommended as the optimal foundation layer for heavy infrastructure.

The results indicate a clear correlation between seismic velocities and material competence, confirming the effectiveness of geophysical methods in preliminary site investigations. The allowable and ultimate bearing capacities increase significantly with depth, particularly in Layer 3, which exhibits Q_a values exceeding 4000 kPa.

These findings provide essential guidance for civil engineers and planners in selecting suitable foundation depths and designing safe and economical infrastructure projects in the study area. Future research should incorporate direct borehole data and dynamic site response modeling to further validate these results.

9. Conflict of Interest

The authors declare that they have no conflict of interest.

10. Funding Statement

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استخدام تقنيات سرعة موجة القص لتحديد التحديات الهندسية في مدينة السادس من

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الملخص:

في مصر، باتت المسوحات الجيوفيزيائية أكثر أهمية، لا سيما بعد الأثر الكبير الذي خلفه زلزال أكتوبر 1992 على المنشآت في القاهرة الكبرى. تهدف الدراسات الهندسية للمواقع إلى تحديد عمق وتكوين الصخور الأساسية، وعمق المياه الجوفية، والتغيرات الجانبية في التركيب الصخري، وتحديد الصدوع أو الشقوق. ولتحقيق هذه الأهداف، أُجريت مسوحات انكسار زلزالي سطحية في منطقة مختارة داخل مدينة السادس من أكتوبر بمصر، لتقييم خصائص باطن الأرض قبل البدء بأعمال البناء. تمثلت الخطوة الأولى في تحديد البنية الجيولوجية الأساسية من خلال الحصول على خمسة عشر مقطعاً انكسارياً زلزالياً فوق منطقة الدراسة. وكشف تحليل توزيع سرعة الموجة الأولية عن وجود ثلاث طبقات جيولوجية زلزالية منفصلة، تتميز بنطاقات سرعة تتراوح بين (685 إلى 835 م/ث)، و(680 إلى 1030 م/ث)، و(1340 إلى 1525 م/ث). تُظهر طبقات الرواسب سرعات موجات قص تتراوح بين 356 و440 م/ث، و360 و536 م/ث، و690 و790 م/ث على التوالي. تشير هذه النتائج إلى أن الطبقة الأولى تتميز بقيم سرعة منخفضة، مما يعكس تركيباً رسوبياً يتكون من حصى رملي. في المقابل، تتكون الطبقة الثانية من رمال حصوية خشنة، بينما تتكون الطبقة الثالثة من حجر جيري طيني. تم تحليل طبقات الرواسب باستخدام معادلة أساسية لاستخلاص الخصائص الجيوفيزيائية، والتي تشمل سرعة موجة القص، وكثافة الصخور، ومؤشرات المواد (بما في ذلك مؤشر المادة، ونسبة بواسون، وقيمة N ، ونسبة الإجهاد). وفقاً لهذه البيانات، تتمتع طبقات الرواسب تحت سطح الأرض في هذه المنطقة بمستوى صلابة يتراوح بين المتوسط والعالي.

الكلمات المفتاحية:

الهندسة الجيوفيزيائية، نسبة بواسون، موجة القص

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