University of Baghdad
College of Engineering
JOURNAL OF ENGINEERING

Journal of Engineering

journal homepage: www.jcoeng.edu.iq

Volume 31 Number 2 February 2025

The Use of Geotextiles for Controlling on The Collapse of Gypseous Soils

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ABSTRACT

Gypseous soil is classified as problematic soil, characterised by its characterized by complicated and erratic behavior, and is mostly found in arid and semi-arid areas of the globe. As for Iraq. Gypseous soils cover about 30-35% of the total area of Iraq, as this type of soil is found in the Western Desert and extends to the southern parts of the country. Gypseous soils are considered strong but susceptible to sudden collapse when wet. To control the collapse of gypsum soils, Geotextiles are among the most popular kind of geosynthetic material used for soil reinforcement. The goal of this study is to determine whether woven geotextiles can improve the ultimate bearing capacity of foundations constructed on gypsum soil. The foundation is built from a strong 10mm thick steel plate measuring 100mm x 100mm. In this study, the depth of the geotextile layer that was placed at depths of (0.1B, 0.2B, 0.4B, 0.8B, B) was determined from the width of the foundation used, the number of layers of the reinforcement material (one layer, two layers, and three layers), and the layer-to-layer vertical spacing. Geotextiles: The geotextiles' breadth was also examined. The trials' findings demonstrated that adding geotextile reinforcement to soil can help it have a higher bearing capacity. and reduce the settlement of the gypsum soil. It was found that placing geotextiles at depths of (0.8B-B) is the best depth chosen, and the results were also revealed. The test showed that using three layers of geotextile gave positive results. Additionally, the test findings demonstrated that the reinforcement's composition had a significant impact on the behavior of the foundation.

Keywords: Gypseous soil, Geotextile, Collapsibility, Square footing, Bearing capacity.

1. INTRODUCTION

When the gypseous soil gets wet, it is thought to be a collapsible soil that experiences volume changes due to a major reorganization of soil particles that does not impact loading **(Nashat, 1990; Nashat et al., 2001; Almurshedi et al., 2020)**. Gypsum, or hydrated calcium sulfate,

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Peer review under the responsibility of University of Baghdad.
https://doi.org/10.31026/j.eng.2025.02.08

Article received: 24/06/2024
Article revised: 13/08/2024
Article accepted: 02/09/2024
Article published: 01/02/2025

is the mineral salt that makes up gypseous soil. Its chemical formula is $CaSO_4.2H_2O$. **(Nafie, 1989; Saaed and Khorshid, 1989).** Gypseous soils are robust when they are dry, damp, or drenched in water; when they are soaked, they become significantly weaker and can cause rapid collapse and soil pressure. When gypseous soils are soaked or submerged in water, they dissolve Calcium sulfate, it attempts to lessen the connections between soil particles by stabilizing them soil particles **(Al-Busoda, 2008; Karkush et al., 2020; Karkush et al., 2023).** Many additives can be used to stabilize gypseous soils and improve their behavior, preventing them from collapsing. Examples of these additives include emulsified asphalt, lime, and cement. **(Latha and Somwanshi, 2009; AlMurshidi et al., 2020; AlMurshidi and Karkush, 2023; Thajeel et al., 2023).** Geotextiles materials have been applied, which are thought to be among the modern methods to improve the geotechnical engineering properties of the soil. Soils with poor engineering qualities can be substituted with treated or well-engineered soils in civil engineering projects. However, when the treated soils are deep, this method is deemed unfeasible (expensive). Many researchers are currently searching for new ways to enhance the geotechnical qualities of soil prior to construction.. **(Naseri et al., 2016; Changizi and Abdolhosein, 2016).** Using physical, mechanical, and chemical procedures, soil treatment, also known as stabilization, increases the soil's durability and resilience to external stresses, hence lowering pressure, swelling limits, and permeability.

(Abood, 1994; Al-busoda and Salman, 2013; Iranpour, 2016; AlMurshidi et al., 2023). Standard stabilizers cement, cement dust, fly ash, rice husk ash, leaf ash, lime, and bitumen are used extensively by researchers and engineers in a variety of sources, and their effects on the geotechnical characteristics of gypseous soils have been examined. **(Al-Obydi, 1992; Luo et al., 2012; Salman, 2014; Salman and Hamoudi, 2015; Kalhor et al., 2019).**

The current experimental work includes improving the geotechnical properties of gypseous soil using geotextiles such as shear and collapse properties and the bearing capacity of soil. The good effect of additional geotextiles is mainly due to how it is used in the treatment of soils. Some previous studies presented the use of geotextiles in soil improvement, as many geotechnical engineers studied the effect of soil reinforcement with geotextile layers.

(Akinmusuru and Akinbolade, 1999) Studied the effect of the height and number of layers of reinforcement on sandy soil after conducting a set of tests on square foundations with three layers of geotextile and concluded that the ideal depth for the first layer of reinforcement is (0.5B). It has been shown that the interlocking of the geotextile layer depends on the friction between it and the sandy soil.

(Yetimoglu et al., 1999) evaluated the ultimate bearing capacity of rectangular foundations built on sandy soil reinforced with one or more layers of geotextile. They found that the highest bearing value for the soil is at the depth (0.3B), which is considered the best reinforcement depth with one layer. **(Gabr et al., 1998)** Investigated the stress distribution in sandy soils treated with layers of geotextile, and the results showed that soil reinforcement leads to significant stress relief using plate loading experiments with pressure cells **(Sitharam and Sireesh, 2004; Shewnim, 2006; Bushra et al., 2013)** carried out model experiments in the lab to assess the bearing capability of circular foundations on a sand basis reinforced with multiple geotextile layers. The ultimate bearing capacity improves with the base's embedment depth ratio, according to the test findings. The current study deals with the effect of geotextile materials in controlling the collapse of gypseous soil (layer width, layer depth, and number of layers), and treated some geotechnical properties of gypseous soils in the dry and saturated state.

2. MATERIALS

2.1 Soil Sampling and Properties

The study's gypseous soil sample came from Tikrit University, which is 20 kilometers from Tikrit city (220 kilometers from Baghdad). The sample was collected between 0.5 and 1.5 meters below the surface of the ground, with a gypsum content of roughly 54%. After that, the dirt was brought to the lab and allowed to dry for two days in the open. As indicated in **Table 1**, it was well-broken after drying to create fine soil for a number of physical and chemical testing. The gypseous soil's granular distribution is depicted in **Fig. 1**.

Table 1. Physical and chemical properties of the gypseous soil.

Properties	Value	Specification	Properties	Value	Specification
Gs (Specefic gravity)	2.54	**(ASTM D854, 2010)**	pH	8.01	**(BS 1377-3, 2018)**
γ_{dmax} (Maximum Dry Unit Weight)	17.6 kN/m^3	**(ASTM D698, 2021)**			
O. M.C. (Optimum moisture content)	11.8%		$CaCO_3$	4.6%	
D_{10} mm Effective Size (The portion of particles with diameters smaller than this value is 10%)	0.18	**(ASTM D-422, 2007)**	Cl^-	0.057 mg/L	**(BS 1377-3, 2018)**
D30 mm (Effective Size The portion of particles with diameters smaller than this value is 30%)	0.21	**(ASTM D-422, 2007)**			
D60 mm (Effective Size (The portion of particles with diameterssmaller than this value is 60%	0.41	**(ASTM D-422, 2007)**			
Sand, S	94.4%	**(ASTM D-422, 2007)**	Gpsum content	54%	
Fines	5.6%		EC	2.43 µS/cm	**(ASTM D1125, 2014)**
Gravel	0%		ESP	13%	
Soil type	SP	(USCS)	CEC	6.54me/100g	**(ASTM D7503, 2010)**
TSS (Total soluble salts)	78.5%	**(BS 1377-3, 2018)**	Ca	49.5%	**(BS 1377-3, 2018)**
SO_3 (Total sulphate content)	26.75%		S	41.7%	
Fe	5.35%		XRD	Quartz, Gypsum, and Dolomite	

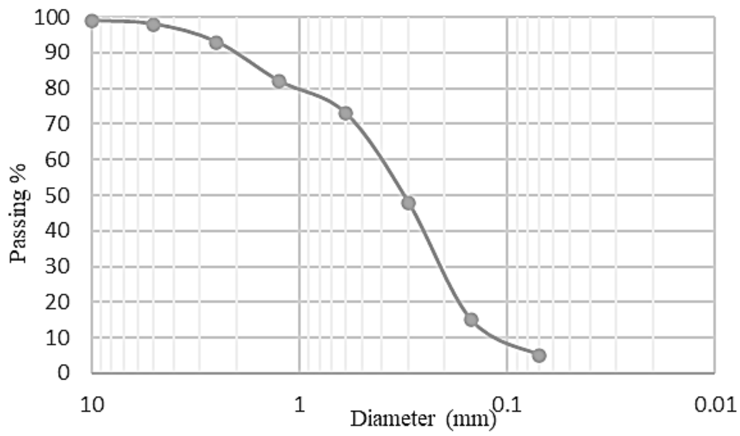


Figure 1. Grain size distribution of gypseous soil sample.

2.2 Geotextile

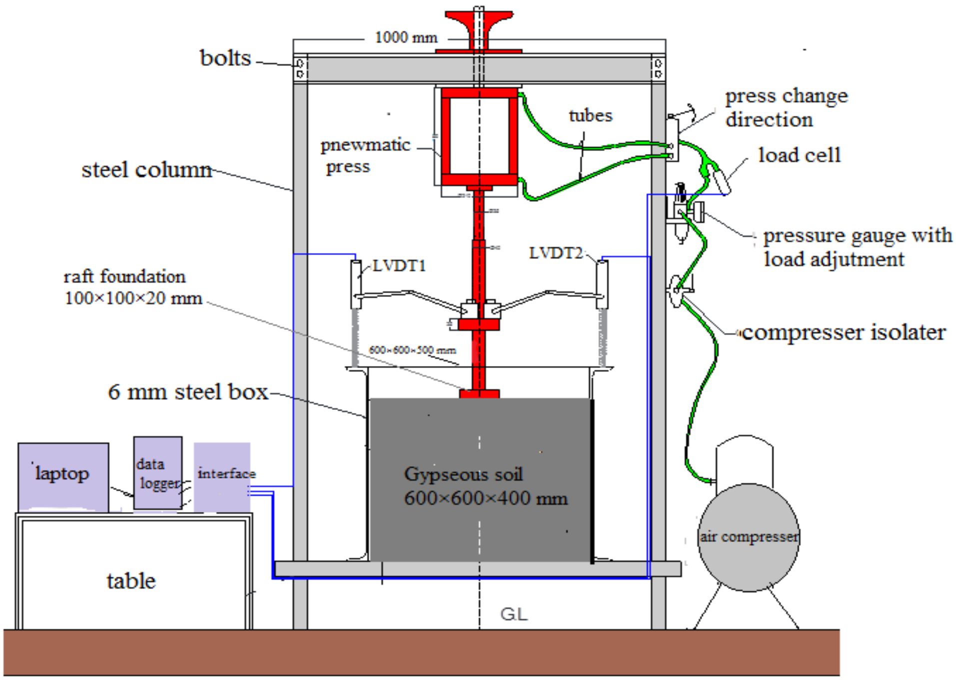
The physical and mechanical characteristics of the woven geotextile used in this investigation.

Table 2. Properties of geotextile

Elongation	Tensile strength	Thickness	Opening Size	Mass / unit area
13%	50 kN/m^2	1.5mm	80 µm	200 g/m^2

2.3 Physical Model

The setup of the physical model as shown in **Fig. 2** and the instruments



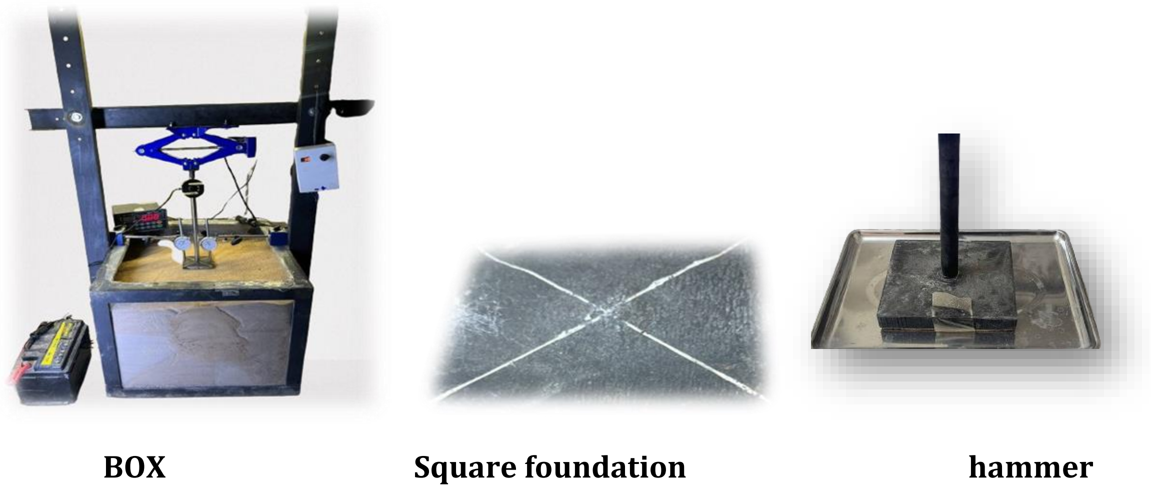


Figure 2. Schematic diagram of the physical model.

1. Soil container (600 × 600 × 400) mm. and loading frame.
2. Square foundation plate (10× 10 × 20) mm.
3. Mechanical hydraulic jack.
4. Movable raining system
5. Linear Variable Differential Transformer (LVDT) and Data Logger.

Fig. 3 shows the model's geometry in terms of the height and width of the geotextile layer, where the letter (N) shows the inspection number in terms of the placement of the geotextile layer.

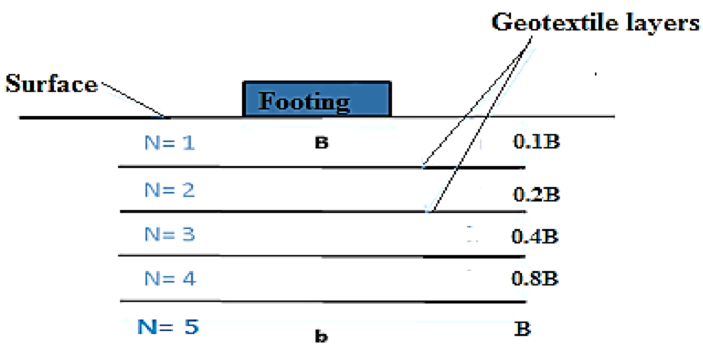


Figure 3. The model's geometry

4. RESULTS AND DISCUSSION

4.1 Load-Settlement Tests Influence of The First Geotextile Layer

The effect of geotextile on the bearing and compressibility of gypseous soils was calculated by performing the load-settlement test. The uniformity test was performed according to the physical model, where the steel container (600×600×400) mm and height of 400 mm was filled with gypseous soil by raining technic. Then we gradually apply the loads (axially load) to the base of the foundation the settlements caused by the axially vertical force, and continue to apply the gradual loads until failure occurs in the foundation or soil.
Ten models were performed on the gypseous soils with different with geotextile layers five models in the dry and five models in soaking conditions at (0.1B, 0.2B, 0.4B, 0.8B, and B).

The loading test was performed at the end of treatment by geotextile for gypseous soil samples. **Fig. 4** shows the load-settlement curve of tested soil samples in dry conditions. The loading capacity of footing is considered as the stress at failure condition. These figures show that the loading capacity of square footing increased with the increase of the geotextile layers. The loading capacity of gypseous soils treated with geotextile layers is higher than gypseous soils untreated (the loading capacity is calculated by applied load divided by foundation area). It can be noticed that the soil with a high value of shear strength is more affected by the variation of the moisture content than the soil with a low value of shear strength. **Fig. 5** shows the load-settlement curve of the tested gypseous soil samples in soaked conditions. A significant increase in the settlement was noticed when the loads were placed on the foundation, and this means that untreated soil can collapse. After completing the loading test at a stress of 225 kPa, the model was immersed in water by the valve at the bottom of the container, immediately after flooding, the settlement of the untreated gypseous soil started to develop at a rapid rate compared with the treated soil. **Fig. 6** shows the time versus settlement of treated gypseous soil samples. Ultimately, the reduction in the settlement was 40-60% after 6 days of soaking.

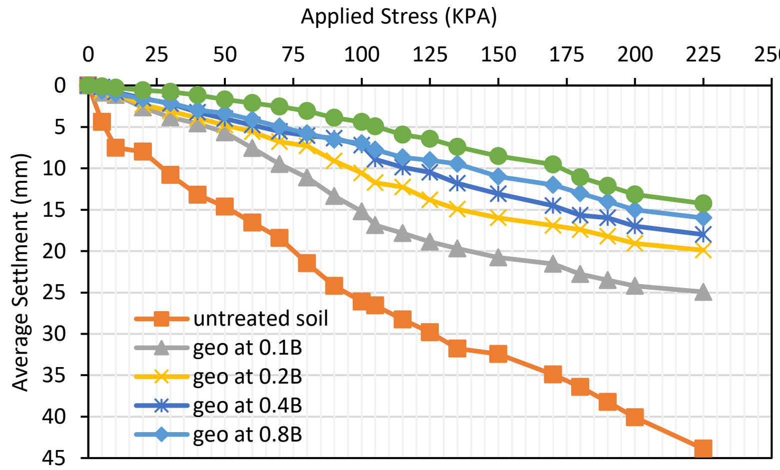


Figure 4. Applied stress versus settlement of gypseous soil treated with geotextile before soaking.

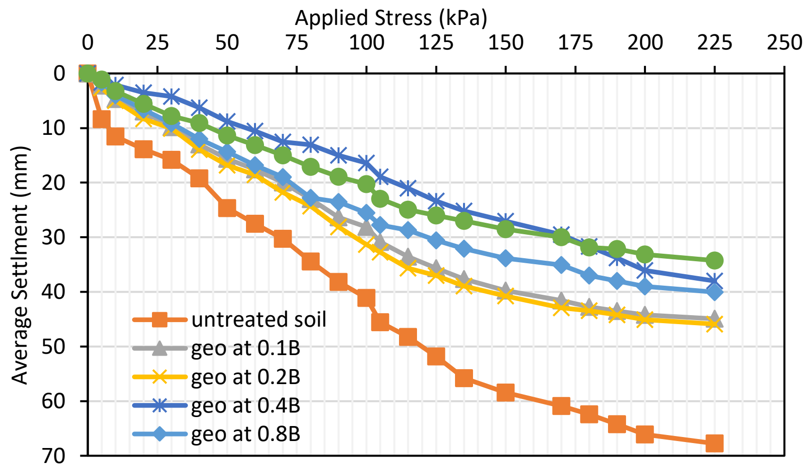


Figure 5. Applied stress versus settlement of gypseous soil treated with geotextile after soaking.

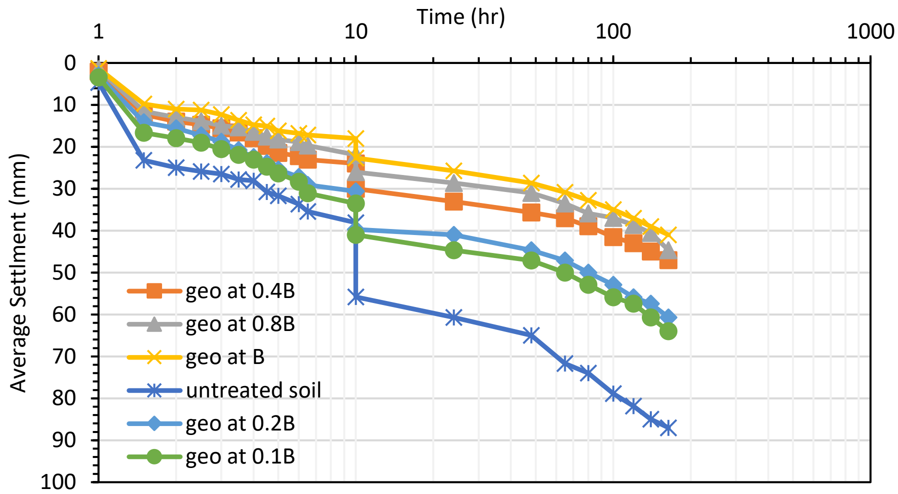


Figure 6. Time versus settlement of soaked gypseous soil treated with geotextile.

4.2 The Influence of Geotextile Layers Number

As anticipated, the bearing capacity increased as the number of reinforcement layers increased. But when the number of geotextile layers rises, the significance of the additional reinforcement layer falls. **Figs. 7 and 8** show the results of models with one, two, and three layers of geotextiles to the equivalent unreinforced form. **Figs. 9 and 10** show the results of models with two layers at (0.2B and 0.4B) and (0.4B and 0.8B) of geotextiles to the equivalent unreinforced form at two conditions dry and soaked. As shown in the figures, The number of geotextile layers rises with the final bearing capacity.

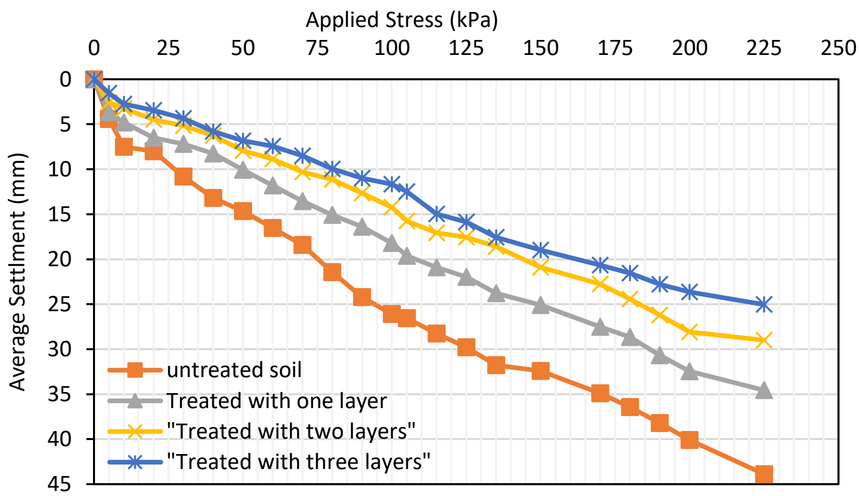


Figure 7. Stress settlement of the model foundation using one, two, three layers of geotextile (dry condition).

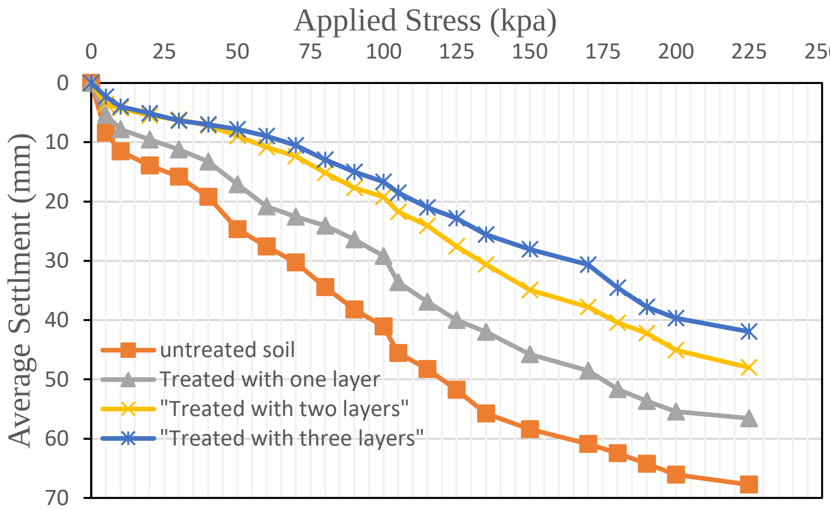


Figure 8. Stress settlement of the model foundation using one, two, three layers of geotextile (soaked condition).

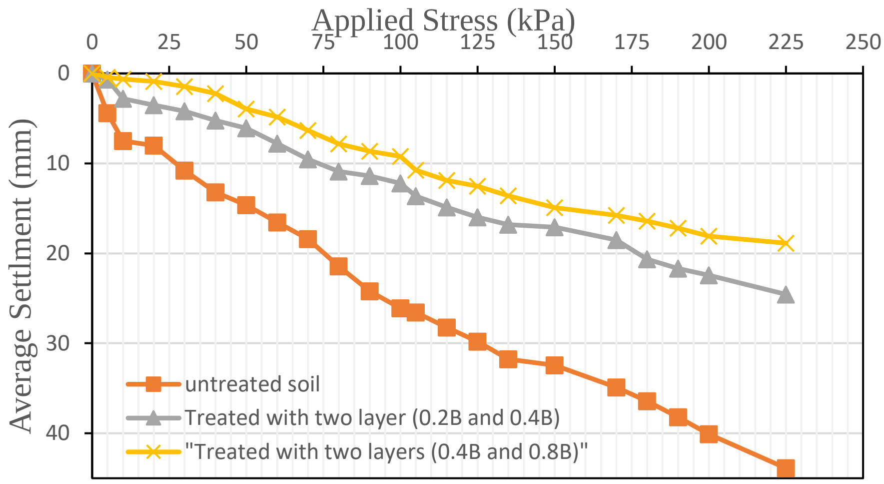


Figure 9. Stress settlement of the model foundation using different two layers one thickness of geotextile (dry condition).

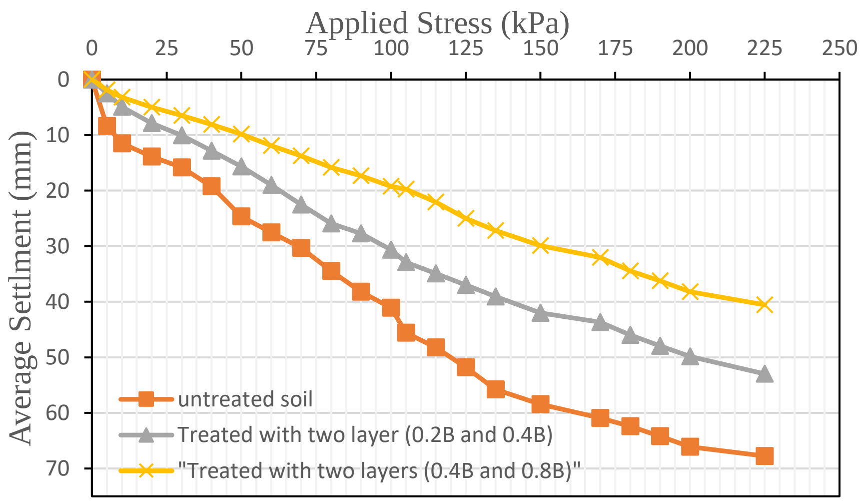


Figure 10. Stress settlement of the model foundation using different two layers one thickness of geotextile (soaked condition).

Figs. 11 and 12 show the stress settlement of the model foundation using two different layers of double thickness of geotextile (dry and soaked condition). It was observed that settlement decreases when using a double layer of geotextile at a specific depth.

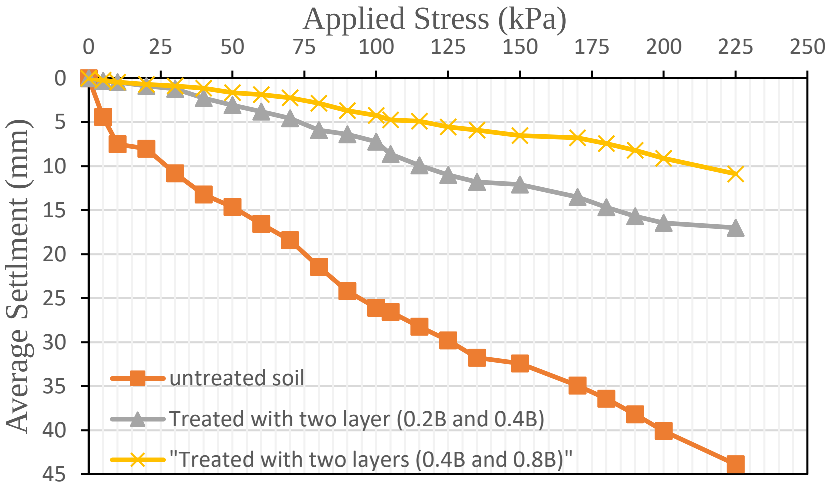


Figure 11. Stress settlement of the model foundation using different two layers of geotextile double thickness (dry condition).

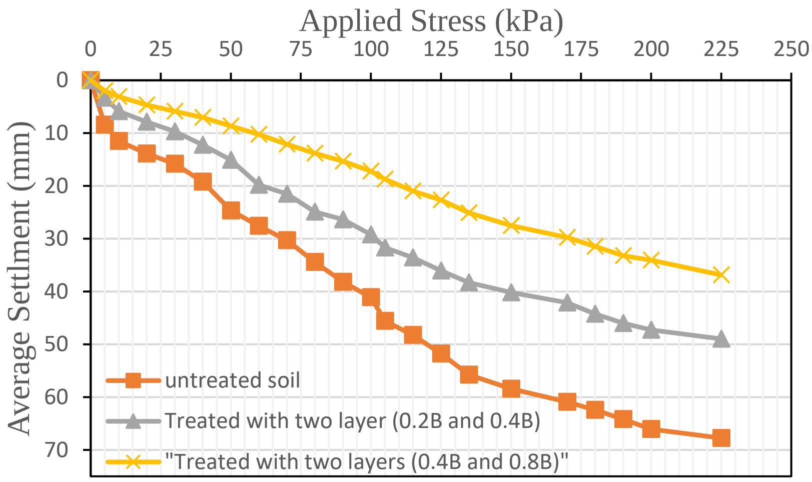


Figure 12. Stress settlement of the model foundation using different two layers of geotextile double thickness (soaked condition).

4.3 The Influence of The Geotextile Layer's Width

Figs. 13 and 14 show the optimal width of the geotextile layer (W) for gypseous soils reinforced with a single geotextile layer in both dry and flooded cases . The tensile behavior of geotextiles can greatly reduce the pressure exerted on the soil surface. The optimal reinforcement width indicates that the reinforcement portion within the shear zone below the footing will have efficient tensile strength. To enhance tensile strength, An additional length outside the shear zone is required as an anchor. Thus, the width of the shear zone plus the anchorage zone on both sides adds up to the ideal reinforcement width. Because of this, the reinforcement needs to be five or six times the base's breadth.

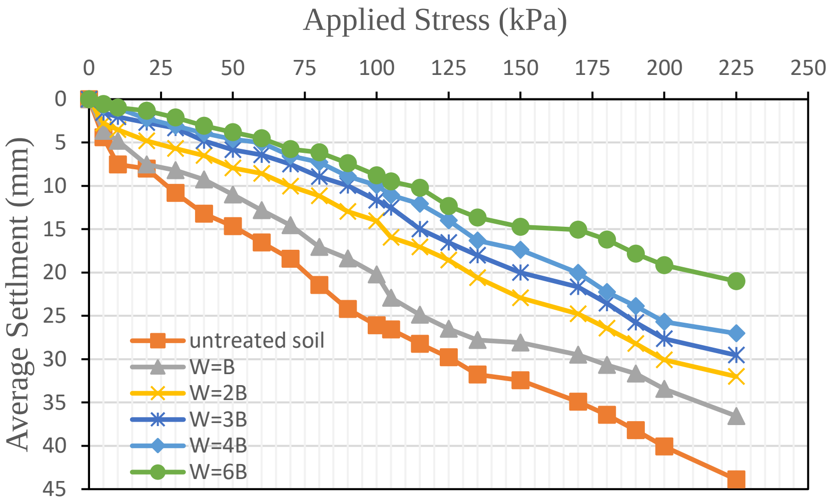


Figure 13. Stress leveling with a single layer of reinforced geotextile of various widths (dry condition).

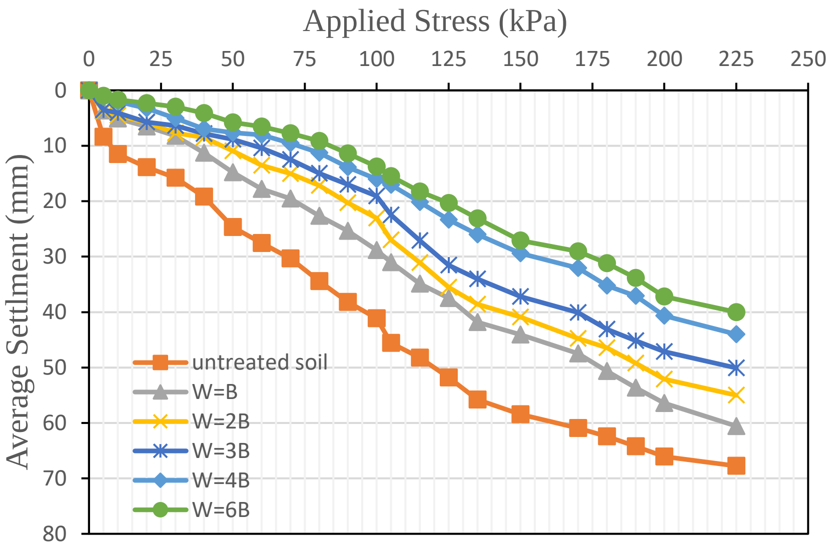


Figure 14. Stress leveling with a single layer of reinforced geotextile of various widths (soaked condition).

5. CONCLUSIONS

The main purpose of this research is to use geotextile layers to increase the bearing of gypseous soils and reduce the settlement of shallow foundations.

- In every instance, the bearing capacity of gypseous soils reinforced with geotextiles exceeds that of gypseous soils without reinforcement.

- At depth, the bearing capacity increases (0.8B-B) for the reinforcement with geotextile.
- Settlement is the lowest possible when the geotextile layer is placed at a depth of B or at a depth of 0.8B in both dry and soaked cases.
- As the collapse findings amply illustrated, the compressibility of gypsum soil is much reduced when the number of reinforcement layers in the geotextile of gypseous soils is increased.
- Optimum embedment depth to achieve maximum benefit from the soil's bearing capacity and minimum settlement of about (0.4-0.8) B, even when the reinforcement is wrapped around the edges.

NOMENCLATURE

Symbol	Definition	Symbol	Definition
D10	Effective Size (The portion of particles with diameterssmaller than this value is 10%)	O.M. C %	Optimum moisture content
D30	Effective Size (The portion of particles with diameterssmaller than this value is 30%)	C	Effective cohesion
D60	Effective Size (The portion of particles with diameterssmaller than this value is 60%)	Ø	The Angle of Internal Friction
Gs	Specific gravity	X%	Gypsum content
γd	Dry Unit Weight	SO3 %	Total sulphate content
γd (max)	Maximum Dry Unit Weight	TSS %	Total soluble salts
γd (min)	Minimum Dry Unit Weight	SP-SM	poorly graded sand

Acknowledgements

The authors extend appreciation to Tikrit University and Dr. Alaa Daoud Salman for their support in completing the research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Abood, M.K., 1994. Treatment of gypseous soils with Sodiume Silicate. *M.Sc. Thesis, Building and Construction Department, University of Technology. Baghdad, Iraq*

Al-Busoda, B.S., 2008. Treatment of collapsibility of gypseous soil. *Journal of Engineering,* 13(03), pp. 544-557. https://doi.org/10.31026/j.eng.2008.03.04.

Al-Busoda, B.S., and Al-Rubaye, A.H., 2015. Bearing capacity of bored pile model constructed in gypseous soil. *Journal of Engineering*, 21(3), pp. 110-129. https://doi.org/10.31026/j.eng.2015.03.07

Al-busoda, B.S., and Salman, R., 2013. Bearing capacity of shallow footing on compacted filling dune sand over reinforced gypseous soil. *Journal of Engineering*, 19(5), pp. 532–542. http://dx.doi.org/10.31026/j.eng.2013.05.01.

Akinmusuru, J.O., Akinbolade, J.A., 1981. Stability of loaded footings on reinforced soil. *Journal of the Geotechnical Engineering Division*, 107(6), pp. 819-827.

Al-Murshedi, A.D. Karkush, M.O. and Karim, H.H., 2020. Collapsibility and shear strength of gypseous soil improved by nano-silica fume (Nsf). Key Engineering Materials.2 857 KEM, pp. 292–301. https://doi.org/10.4028/www.scientific.net/KEM.857.292.

Almurshedi, A.D., Karkush, M., 2023. Experimental and numerical modeling of load settlement behavior of gypseous soils improved by MICP. *Smart Geotechnics for Smart Societies*, pp. 583–589. https://doi.org/10.1201/9781003299127-74.

Almurshedi, A.D., Thijeel, J.K., Al-Awad, K., 2020. Mitigation of collapse of marshes soil by nano-silica fume. *IOP Conference Series: Materials Science and Engineering*. 737 (1), P. 012110. https://doi.org/10.1088/1757-899X/737/1/012110 .

Al-Obydi, M.A., 1992. Lime Stabilization of Gypseous Soils. *M.Sc. Thesis, Civil Engineering Department, University of Musul. Musul, Iraq.*

ASTM D1125, 2014. Standard test methods for electrical conductivity and resistivity of water, *ASTM International. American Society for Testing and Materials International, West Conshohocken*.

ASTM D-422, 2007. Standard Test Methods for Particle-size Analysis of Soils. *Annual Book of ASTM Standards, ASTM International, West Conshohocken, PA.*

ASTM D7503, 2010, Standard test method for measuring the exchange complex and cation exchange capacity of inorganic fine-grained soils. *American Society for Testing and Materials International, West Conshohocken.*

ASTM D854, 2010. Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer. *Annual Book of ASTM Standards, Vol.04.08, Philadelphia, P&A, ASTM, USA.*

Changizi, F. and Haddad, A., 2016. Effect of nano-SiO_2 on the geotechnical properties of cohesive soil. *Geotechnical and Geological Engineering* 34(2), pp. 725-733. https://doi.org/10.1007/s10706-015-9962-9.

Gabr, M.A., Dodson, R., Collin, J.G., 1998. A study of stress distribution in geogrid-reinforced sand. *In Geosynthetics in Foundation Reinforcement and Erosion Control System*, pp. 62-76. https://doi.org/10.1016/j.geotexmem.2009.12.011.

Head, K.H., 1998. Manual of Soil Laboratory Testing Vol. 1,2 prentch, press, London. https://doi.org/10.1144/qjegh2015-015.

Iranpour, B., 2016. The influence of nanomaterials on collapsible soil treatment. *Engineering geology*, *205*, pp. 40-53. https://doi.org/10.1016/j.enggeo.2016.02.015 .

Karkush, M.O., Al-Murshedi, A.D., Karim, H.H., 2020. Investigation of the impacts of nano-clay on the collapse potential and geotechnical properties of Gypseous soils. *Jordan Journal of Civil Engineering*. 14(4), pp. 537–547.

Karkush, MO., Almurshedi, A.D., 2023. Investigation of the impacts of nanomaterials on the micromechanical properties of gypseous soils. *Arabian Journal for Science and Engineering*, 48(1), pp.665–675. https://doi.org/10.1007/s13369-02 2-07058-z.

Kalhor, A., Mahmoud G., Mahya R., and Mirhosseini S., 2019. Influence of nano-SiO_2 on geotechnical properties of fine soils subjected to freeze-thaw cycles. *Cold Regions Science and Technology*,161, pp. 129-136. http://dx.doi.org/10.1016/j.coldregions.2019.03.011.

Latha, G.M., Somwanshi, A., 2009. Bearing capacity of square footing on geosynthetics reinforced sand. *Geotextiles and Geomembranes*, 27(4), pp. 281-294. https://doi.org/10.1016/j.geotexmem.2009.02.001.

Luo, H.L., Hsiao, D.H., Lin, D.F. and Lin, C.K., 2012. Cohesive soil stabilized using sewage sludge ash/cement and nano aluminum oxide. *International Journal of Transportation Science and Technology*, *1*(1), pp.83-99. http://dx.doi.org/10.1260/2046-0430.1.1.83.

Nafie, F.A., 1989. The Properties of High Gypseous Soils and their Significant for Land Management, *Ph.D. Thesis, University of London*.

Naseri, F., Irani, M. and Dehkhodarajabi, M., 2016. Effect of graphene oxide nanosheets on the geotechnical properties of cemented silty soil. *Archives of Civil and Mechanical Engineering*, *16*, pp. 695-701. https://doi.org/10.1016/j.acme.2016.04.008.

Nashat, I.H. 1990. Engineering Characteristics of some Gypseous Soils in Iraq, *Ph.D. Thesis, Department of Civil Engineering, University of Baghdad, Baghdad, Iraq.*

Nashat, I.H., Al-Mufty, A.A., and Al-Badran, 2001. Collapse behavior of Gypseous Soils, *The 4th Scientific Conference of the Ministry of Housing, Iraq.*

Saaed, S.A. and Khorshid, N.N. 1989. Some Essential Characteristics of the Gypseous Soils of Al-Dour Area. *Proceeding of the 5th Scientific Conference, Vol.4, part 2, Scientific Research Council, Baghdad*.

Salman, A.D. and Hamoudi, A., 2015. Analytical approach for load capacity of large diameter bored piles using field data. *Journal of Engineering*, *21*(8), pp. 40-54. https://doi.org/10.31026/j.eng.2015.08.03.

Salman, A.D., 2014. Improvement of Geotechnical properties of expansive soils using cement. *Kufa Journal of Engineering*, 5(02), pp. 155-167. https://doi.org/10.30572/2018/KJE/521317.

Sitharam, T.G., Sireesh, S., 2004. Model studies of embedded circular footing on geogrid-reinforced sand beds. *Proceedings of the Institution of Civil Engineers Ground Improvement*, 8(2), pp. 69-75. https://doi.org/10.1139/t04-117.

Seleam, S. N., 2006. Evaluation of collapsibility of gypseous soils in Iraq. *Journal of engineering*, *12*(03), pp. 712-726. https://doi.org/10.31026/j.eng.2013.05.01 .

Thajeel, J.K., Shaia, H.A., Al-Mamoori, S.K., and Almurshedi, A.D., 2023. Effect of emulsified asphalt on expansive soil strength and swelling. *E3S Web of Conferences. 427, 03009.* http://dx.doi.org/10.1051/e3sconf/202342703009.

Yetimoglu, T., Wu, J.T., Saglamer, A., 1994. Bearing capacity of rectangular footings on geogrid-reinforced sand. *Journal of Geotechnical Engineering*, 120(12), pp. 2083-2099. https://doi.org/(ASCE)0733-9410(1994)120:12(2083).

استعمال المنسوجات الأرضية للسيطرة على انهيارية التربة الجبسية

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الخلاصة

تتميز التربة الجبسية بسلوكها المعقد وغير المنتظم، لذلك تصنف من التربة الإشكالية، والتي تتركز بشكل رئيسي في المناطق القاحلة وشبه القاحلة من العالم. أما في العراق فتغطي الترب الجبسية حوالي % (35 – 30) من المساحة الكلية للعراق، حيث يتواجد هذا النوع من التربة في الصحراء الغربية ويمتد إلى الأجزاء الجنوبية من البلاد. تعتبر التربة الجبسية من التربة القوية إلا أنها معرضة للانهيار المفاجئ عند البلل. للتحكم في انهيار التربة الجبسية، فإن أحد أكثر أنواع الأقمشة الأرضية شيوعًا المستخدمة لتقوية التربة هي المنسوجات الأرضية. تختبر هذه الدراسة الفوائد المحتملة للتكسية الأرضية المنسوجة في زيادة قدرة التحمل النهائية للأساسات المبنية على التربة الجبسية. تم بناء الأساس من لوح فولاذي قوي بسمك 10 مم بقياس 100 مم × 100 مم. تم في هذه الدراسة تحديد عمق طبقة التكسية الأرضية التي تم وضعها على أعماق (0.1B, 0.2B, 0.4B, 0.8B, (Bمن عرض الأساس المستخدم، وعدد طبقات مادة التسليح (طبقة واحدة، طبقتين وثلاث طبقات) والتباعد العمودي بين طبقات التكسية الأرضية وكذلك تم دراسة عرض التكسية الارضية. أظهرت نتائج التجارب أن التربة المدعمة بالمواد التكسية الأرضية يمكن أن تساعد في زيادة قدرة التحمل وتقليل تسوية التربة الجبسية، حيث وجد أن وضع التكسية الأرضية على أعماق (0.8B–B) هو أفضل الأعماق المختارة، وأيضاً كشفت نتائج الاختبار أن استخدام ثلاث طبقات من النسيج الأرضي يعطي نتائج ايجابية. كما أظهرت نتائج الاختبار أن تكوين التسليح أثر بشكل كبير على التربة الجبسية المسلحة على سلوك الأساس.

الكلمات المفتاحية: التربة الجبسية، الجيوتكستيل، قابلية الانهيار، القاعدة المربعة، قدرة التحمل ، الانضغاطية.