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Refinement Engineering Properties of Clay Soils By Adding Cement And Ceramic Dust of Al-Dair Area, Northwest of Basrah

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Abstract

This study investigates the effect of adding construction waste, specifically ceramic dust and cement, on the geotechnical properties of clay soils in Al-Dair area, located in the northwestern part of Basrah Governorate, southern Iraq. This study focuses on solving various problems that the soil suffers from, such as swelling and shrinkage, which generate pressures on shallow foundations, including collapses of structures in the area. The kind of soil, the amount of clay and silt it contains, and the type of clay minerals in its composition exacerbate these problems. In addition, the research aims to reduce these problems and reduce environmental pollutants that negatively affect human health and reduce economic costs. Conducting a comprehensive study and a new management strategy is necessary to address the challenges related to shallow foundation collapses and reduce material losses. The main objective of the research is to develop a method to improve the geotechnical properties of soil in Al-Dair area. Field visits were conducted, and multiple soil samples were collected from different positions using a hand drill to a depth of 1.5 m. The results showed that soil samples treated with cement dust (C) at 2%, 4%, 6%, and 8% and ceramic dust (CD) at 5% and 10% showed significant changes. The addition of both ceramic dust and cement reduced the plastic limit, liquid limit, plasticity index, and optimum moisture content of clayey soils. Conversely, there were significant increases in compressive strength, California bearing ratio, and maximum dry density.

Keywords:

Improved Soil, Compressive Strength, Maximum Dry Density, Optimum Moisture Content.

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1. Introduction

Soil is the first and most important raw material for any building work. The strength and longevity of any structure depend on the strength properties of soil. Many studies have shown that cement with clay soils improves the strength properties of stabilized soil, as cement creates a link between clay particles, removes excess water from the soil, and fills the empty spaces in the clay structure (Hesham, 2006).Research indicates that the issues associated with plastic clay soil can be resolved by adding specific proportions of cement (2%, 4%, 6%, 8%), which enhances compressive strength and significantly improves various properties (Al-Soul, 2007).Some previous experiments have shown the use of cement in soil stabilization and chemical additives in road construction and infrastructure development (Ismaiel, 2006). The components of clayey soil are montmorillonite (bentonite) or kaolinite (kaolin). These two minerals flex quite strongly under pressure. Kaolin has little effect on the hardening process, unlike bentonite, which requires big amounts of cement to get the appropriate strength properties (Bell,1978). Many studies have also been conducted on a larger scale in the field of soil improvement with cement, and the most desirable results are a more solid and stronger soil, which leads to a decrease in plasticity and an increase in soil strength (Arman et al.,1990;

and Eskisar, 2015). Cement is considered the most widely used agent among all modern applications in soil stabilization (Kezdi, 1979). The stress-strain relationship for cement-stabilized soils is often unclear, and the strength properties need clarification (Bowles, 1979) found that adding specific amounts of cement, fly ash, bitumen, or a combination of these materials to the soil is necessary. The choice of the type of additive and the percentage used depends on the soil classification and the level of soil improvement required. In general, smaller amounts of additives are needed to modify soil properties (Ismaiel, 2013). One aim of using cement for improvement is to reduce the water content of clay of low plasticity, as cement particles fill the gaps within the soil (Eskisar,2015). Ceramic components have resistance to the forces of physical and chemical damage. This material property creates an effective and acceptable alternative for stabilization (Agrawal, 2017). Taking advantage of ceramic waste tiles to develop the features of the soil is an economical and robust method. The use of ceramic is not merely to develop soil properties; it can also remedy issues related to its dumping. Ceramic is composed of natural substances, including a significant percentage of clay minerals. It undergoes a method of dehydration and burning between the temperatures of 700°C and 1000°C (Cabalar et al., 2017). It has a higher silica content, iron oxide, and aluminum oxide, ensuring up to 89.1% of its original. Abdul-Amir (2024) used lime and nano-carbonates to improve the geotechnical properties of Al-Faw soil and found in her study that the soil resistance increased five times compared to the untreated soil. Adding a certain percentage of about 8% of cement reduces liquid limit and plasticity limit while increasing the percentage of additives and improving the engineering specifications of the soil (Khadiur et al., 2022). Seasonal changes affect the moisture content when adding buildings or cities with relatively large and extended areas. In the dry season, the changes are concentrated at the edges of the structure and its surroundings and are less than in its center, which leads to the edges subsiding. This phenomenon is called soil doming. On the contrary, in the rainy season, the edges of the structure rise from the center, and this is called soil concavity (Al-Rawas et al., 2002). Swelling behavior is affected by several physical, chemical, and environmental factors such as the kind of clay mineral and its amount in soil, the physicochemical properties of pore water, soil density, moisture content, plasticity, temperature, and time (Abdul Wahab, 2015). Some clay minerals such as montmorillonite and bentonite show high swelling resistance due to their absorption of water between the mineral layers. Pure montmorillonite may swell up to 15 times its volume when dry, causing significant damage to engineering structures, roads, canal linings, etc., (Lew, 2010) indicated that the swelling conduct of Al-Faw soil is overdone by by several physical, chemical and environmental factors due to the swelling nature of the soil cohesion or resistance to friction and increasing the materials necessary for physical and chemical change and reducing the area of groundwater or replacing poor soil in two ways, which are mechanical settlement and chemical fixing by adding improved materials (Mahmoud and Daham, 2012). Therefore, in this study, the use of clay with low plasticity and low bearing capacity and compressive strength will be implemented using different proportions of ceramic (5%, 10%) and cement (2%, 4%, 6%, and 8%) to compared the properties of serve and untreated clay samples and determine the effects of what is required in the soil sample.

2. Aim of study

Ceramic materials are sourced in large quantities from different countries, including Iran, Turkey, and China. In Basrah Governorate, the reconstruction of old cities has led to an increase in construction waste. There is potential to utilize industrial waste, such as ceramics or cement, to improve the geotechnical properties of weak soils in the region. This approach can help reduce environmental risks, lower economic costs, extend the life of construction facilities, and manage ceramic waste and debris effectively.

3. Justifications for the Study

This study focuses on the Al-Deir area located in the northwest of Basrah Governorate, southern Iraq. This study aims to enhance the engineering, service, and recreational uses in this area, making the area more beneficial to the community.

4. Geological Setting and Climate

Basrah Governorate is situated in the southeastern part of Iraq, located in the middle of latitudes 29.5°and 29.31° north and longitudes

46.40° and 48.30° east. The region is geomorphologically divided into two sections: the eastern section represents the southern tip of Mesopotamia, while the western section forms the southwestern area of the western plateau. The terrain in the eastern part of Basrah is predominantly flat, with a gradual slope from both the north and south. In contrast, the western part features varying elevation levels and a gentle incline that slopes from the west toward the north and northeast (Baridi, 2012). The location of the AL-Dair was selected as indicated in Fig. 1 and Table 1.

Table1: Location of samples of the study area.

Station	longitude	latitude
S1	30° 47' 14.965	47° 33' 42.29" E
S2	30° 48' 40.055"	47' 44.41.70" E
S3	30° 47' 59.637"	47° 33' 37.38" E

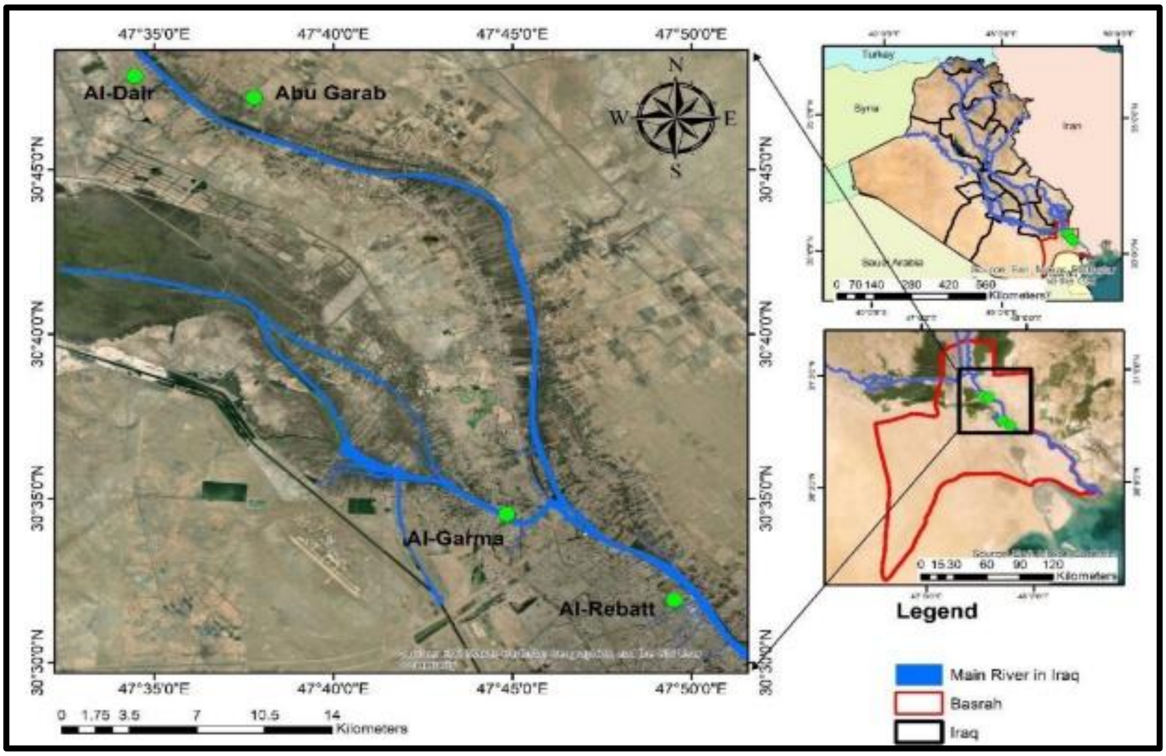

Fig. 1. Study area map

5. Materials and Methods

Untreated soil properties

Sampling was done in October 2023, where the site to be tested was identified using GPS. After removing the soil surface to a depth of 10 cm, dirt and waste were removed. A 1.5 m deep pit was dug using hand drilling techniques, and the sample type collected was disturbed soil. Three samples were collected. The samples were immediately placed in Nylon bags after collection to maintain the natural water gradient and then transported to the laboratory. The soil was classified according to the American Standard Soil Classification System before adding any amendments using an American Type Hydrometer (USA, 151 chase). It was identified as low plasticity clay (CL). Analysis of the soil composition indicated that it was composed of 2% sand, 55% clay, and 46% silt. The liquid limit was measured at 42%, and the plasticity index was found to be 22. In addition, the expansion coefficient was recorded at 39.6, the specific gravity was evaluated at 2.68, the maximum dry density (MDD) was 1.68 g/cm^3, and the optimum moisture content was determined at 22%. The head oxides here in the soil were in the soil were mainly SiO2 (33.4%) and CaO (16.40%). The soil was divided into three groups. The first group added (5% and 10%) ceramic dust. The second group added cement in certain proportions as follows (2%, 4%, 6%, 8%). The third group was to select the best proportions (10% ceramic and 8% cement) from the results, add them to the model, and observe and compare the results before and after addition, as shown in Table (2). Also, the components of the additives (cement and ceramic) were tested in the laboratory as shown in Tables 3 and 4.

Table 2: Geotechnical properties of untreated soil

Sand%	2	ASTM D6913	Basrah University, College of Sciences, Department of Geology
Silt %	43	ASTM D6913	
Clay%	55	ASTM D6913	
Liquid limit%	42	ASTM D4318	
Plasticity index%	22	ASTM_D4318	
Expansion index	39.6	Abbas &Rashid, 2017	
Soil type (USCS)	CL	ASTM_D2487	
OMC (%)	22	ASTM_D698	
MDD gm/cm^3	1.68	ASTM_D698	
Specific gravity	2.68	ASTM D854	AL-Mqeass construction laboratory
UCS (KN/m2)	88	ASTM_D2166	
CBR%	12	ASTM D1883–16	
SiO_2	33 .4	ASTM C114	Department of Laboratories and Quality Control at Basrah Oil Company
Al_2O_3	10.5		
Fe_2O_3	4.4		
MgO	7.1		
CaO	16.40		
Na_2O	0.9		
K_2O	0.50		
SO_3	4.41		

Table 3: Chemical components of ceramic dust.

Constituents	By Mass %	Test Method reference
Silicon dioxide (SiO2)	65.49	ASTM -C323-56 (Reapproved 2011)
Aluminum Oxide (Al_2O_3)	22.57	
Iron Oxide (Fe_2O_3)	1.45	
Calcium Oxide (CaO)	2.46	
Sodium 0zide (Na_2O)	1.44	
Potassium Oxide(K_2O)	2.76	
Zirconium Oxide (ZrO_2)	1.51	

Table 4: Chemical components of cement.

Tested	Result W/W%	Required specification	Test method reference
Cao	63.4	67% Max	ASTM C114
Al_2O_3	3.5	6.0% Max	
Fe_2O_3	5.35	6.0%Max	
MgO	2.2	3.0%Max	
K_2O	0.18	0.75% Max	
Na_2O	0.22	0.75%Max	

A. Grain size analysis

Particle size analysis test was done in the study region, where a 75 micron sieve was used to separate the sand, and volumetric analysis was carried out on three samples from the same site taken from a depth of 1.5 m according to the British Standard (BS: 1377, 1975). The examination was carried out according to ASTM 1989 C77S-7a using a USA CHASE (151H) condenser hydrometer.

B. Atterberg's limit tests

The Atterberg limits are an important property used to evaluate the plasticity properties of fine-grained clay with low plasticity. This evaluation involves two main tests: the liquid limit test and the plasticity limit test. The liquid limit test is performed using a Casagrande apparatus, according to ASTM D423-66.To test the plasticity limit, a soil sample is spun on a glass saucer until it reaches a thickness of 3 mm. The sample is then bent by hand until it fractures or breaks. At this point, it is weighed while still wet. The sample is then put in an electric convection oven at 105 °C for a specified period of time, after which it is weighed once more while dry. The water plastic limit measured at this point is used to calculate the plasticity limit, according to the procedure in ASTM D424-59. Finally, the plasticity index (PI) of all samples is determined using the following formula:1

PI = LL – PL ……………… (1)

Where:

PI = Plasticity index

LL = Liquid limit

PL = Plastic limit

EI =PI * 1.8 ………… (2)

Where:

EI = Expansion index

C. Moisture content

Soil moisture content is the fraction of the weight of water in the soil space to the mass of the solid particles, and it is determined using the drainage method specified in the American standard (ASTM D. 2216-05). The moisture content is calculated using the formula-3

Moisture content (%) = (Weight of sample before drying - Weight of sample after drying) / Weight of sample before drying × 100%" ---------2

D. Specific gravity (Gs)

Specific gravity is one of the main bulk properties of soil, representing the density of the material relative to the density of water. According to the American Standards (ASTM D-854), it is used to calculate various soil phase relations, such as void ratio, degree of saturation, and soil density. Specific density may scale from 2.68 to 2.90 for clay and silt soils (Das, 2005). Understanding specific density is essential for foundation design, soil stability analysis, and stability calculations in fill soils.

E. Proctor compaction test

Soil compaction is a mechanical process that increases the density of soil by expelling air from its pores, which redistributes and rearranges the soil particles, soil strength, and pore size and shape (Holtz et al., 2010). The primary aim of compaction is to reduce the compressibility of soil, thereby improving its strength and stiffness. Proper soil compaction is critical to ensuring that the soil can adequately support various loads. In the test specimens, the height was divided into three levels, and compaction was performed using a specialized hammer and mold. This process aims to determine the maximum dry density and optimum moisture content. The standard Proctor test, according to ASTM D698-12, is used to measure these parameters.

F. Unconfined Compression Test (qu)

The unconfined compressive strength test is a widely used method to determine the unconfined compressive strength of soil. The unconfined compressive strength is then calculated through laboratory work. According to ASTM standards, the unconfined compressive strength (qu) is defined as the compressive stress. A basic compression test on an untreated cylindrical specimen can indicate failure (Murthy, 2003). During this test procedure, the unconfined compressive strength is considered to be the maximum load achieved per unit area, which is about 15% of the axial stress, whichever happens first through the test. The. The unconfined compressive strength of soil is essential for evaluating the load-bearing capacity of foundations. For clayey soils, the unconfined shear strength (Su) is often derived from the unconfined compressive strength, where Su is half of qu when the angle of friction of the soil (φ) is equal to 0.3. The main purpose of the test is to evaluate the undrained compressive strength before and after the addition of improving materials. The test is performed using a uniaxial compression machine, according to ASTM D2166/D2166M-16.

$S_u = C = \frac{qu}{2}$ …………………. 4

Where:

su= shear strength

C= cohesion

qu= compressive strength

G. California Bearing Ratio (CBR%)

The California bearing ratio (CBR) of base materials is essentially determined by their ability to resist stress, which largely depends on the properties of both coarse and fine aggregates. The

California bearing ratio is widely accepted as a performance mark for evaluating the strength of soil in pavement design (Liu et al, 2009). investigated various factors affecting the CBR values of base materials in alluvial roads. To evaluate the suitability of foundations for asphalt, it is necessary to control the materials used in their building. Initially, the California Bearing Ratio of soil was tested and found to be 9.5 before adding any settlement materials. After incorporating cement in varying proportions (2%, 4%, 6%, and 8%), the results indicated that the optimum ratio was 9.86%, which increased the CBR value to 9.86. In addition, construction waste, especially ceramic dust, was included in proportions of 5% and 10%. The study found that the optimum improvement ratio of the CBR value was at 10% ceramic dust. When combining the highest cement and highest ceramic dust ratios, the CBR value was 15%. To determine whether the material should be classified as a foundation or part of a foundation, Equation 4 will be used. According to ASTM D1883-07, a CBR value between 0 and 7 indicates that the layer is considered unsuccessful, while a CBR value between 7 and 20 indicates that the layer is considered successful.

$$\text{CBR} = \frac{P}{PS} \times 100\% \text{----------}5$$

Where:

P=measured pressure for site soil (N/mm^2)

PS=Pressure to achieve equal penetration on standard soil (N/mm^2)

6. Results and Discussion

A. Grain size analysis

The soil worn in the test was classified using the unified classification system as plasticity (CL) soil, and the particle size distribution of the soil was as follows: containing 2% sand, 55% clay, and 43% silt; the liquid limit is 42%; the plasticity index is 22%; the expansion coefficient is 6.39; the specific gravity is 2.68; the maximum dry density (MDD) is 1.68 g/cm^3; and the optimum moisture content is 22% as shown in (Table 1).

B. Atterberg's Limits Test

Soil index values, such as liquid limit, plasticity index and expansion index, were measured before and after adding different proportions of ceramic dust (5% and 10%) and cement (2%, 4%, 6% and 8%), as shown in Fig.(2) The results indicate that both liquid limit and plasticity index decreased with increasing cement content, with an approximate increase of 8%. This shows that soil improvement through cement addition positively affects soil properties (Aderomalos et al., 2000). The effect is particularly significant in low-plasticity clay soils (Koncagul et al., 1999). Mixing 5% ceramic dust improved soil properties to a certain extent, but doubling the proportion improved the properties positively due to the small size of ceramic dust particles, which act as internal binders, filling the structural voids between the mixture components. Specifically, with the highest cement content of 8%, the liquid limit decreased from 42% to 28%, the plasticity index decreased from 22% to 14%, and the expansion index decreased from 39% to 26%. Other investigators have reported similar results to carry these observations (Ibrahim et al., 2020; Igwe and Adebehin, 2017). Figure 3 shows the positions of untreated and mixed soils in the plasticity chart. According to the Unified Soil Classification System, it is clear that the properties of untreated soil are improved by the insertion of ceramic dust and cement. The decrease in Atterberg's limits is primarily attributed to the fact that soil stabilization with cement binds soil particles by filling the interlayers between the mineral composition of soil-forming clay minerals such as montmorillonite, kaolinite, and illite, preventing water molecules from entering between the clay mineral layers, which form interlocking crystals, thus enhancing the compressive strength. To achieve effective bonding, cement must cover a large portion of the soil particles to ensure morality touch between soil and cement. Therefore, soil stabilization with cement is effective, provided that the particles are well distributed. Soil particles are replaced with ceramic dust and cement during soil treatment (Capallar et al., 2017; Saper and Iravaniyan, 2022). Fig. (2) shows the plasticity plot of both soils before and after additions.

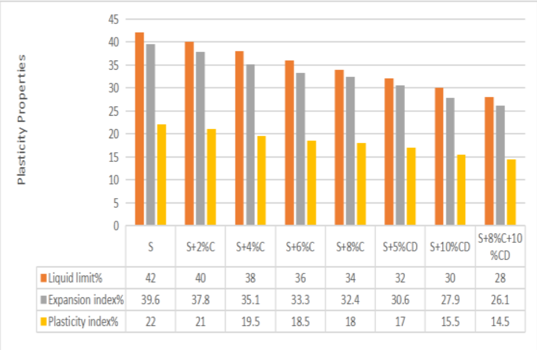

Fig. 2. Plasticity chart of untreated and treated soil of study

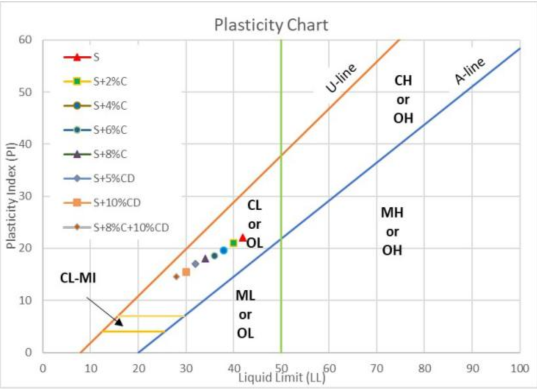

Fig. 3. Index properties variation with additives

C. Specific Gravity (Gs)

The specific gravity of low-plasticity soil before treatment is 2.65. In comparison. As shown in Fig. 4, the specific gravity increases gradually with the addition of a certain percentage of cement, ranging from 2% to 8%. In addition, there is a slight increase in the specific gravity with the addition of ceramic dust, ranging from 5% to 10%. The optimum ratio for enhancing the density was found to be 8% for cement and 10% for ceramic dust. However, when the best ratios were added and mixed, the specific gravity increased significantly, from 2.65 to 2.98, indicating that the specific gravity of the treated soil is greater than that of the untreated soil. These effects are consistent with those reported by Tak et al. (2018).

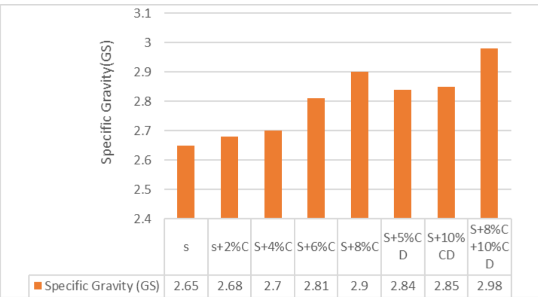

Fig. 4. Specific gravity variations with additives.

D. Proctor Compaction Test

In Fig. 5, it is clear that increasing the ceramic dust content by 5%, 10%, and the cement added to the soil by 2%, 4%, 6%, and 8% leads to an increase in the maximum dry density values accompanied by a decrease in the optimum moisture content. The results show that the optimum moisture content is 25% and the maximum dry density of the clay soil is 1.75 g/cm^3. However, after treating the soil with different proportions of cement, it was found that the optimum water content became 21% and the maximum dry density (1.95 g/cm^3) when adding 8% cement. As for adding certain proportions of ceramic dust (10%) to the same soil, the optimum water content value after treatment with ceramic dust was 23%, and the maximum dry density was 1.90 g/cm^3. The best proportions of ceramic dust and cement were selected and mixed with the soil (10% ceramic and 8% cement), as they increased the geotechnical properties of the soil by 2.10 g/cm^3 for the maximum dry density and 22% for the maximum water content. We conclude from this that adding a certain amount of ceramic dust and cement improves the compressive properties of the soil, and this is consistent with the work of (Ahmed et al, 2024).

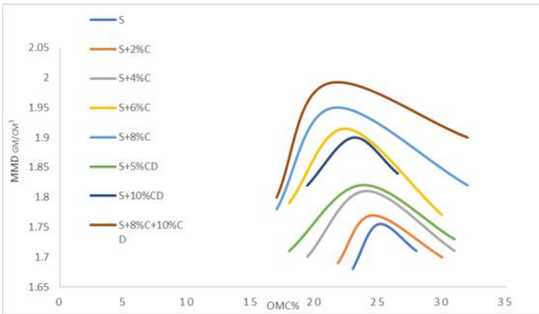

Fig . 5. MDD and OMC variations with additives.

E. California Bearing Ratio (CBR%)

The California Bearing Ratio (CBR) of the untreated soil specimen was measured at 9.5. When the soil was varied with cement and ceramic dust, the CBR values showed important improvement Fig 6. Specifically, increasing the cement content from 2% to8% enhanced the CBR values, with laboratory tests showing an increase from 9.5 for untreated soil to a maximum of 15.3% after adding 8% cement. This improvement can be attributed to the crucial role that cement plays in boosting the strength and balance of the soil samples. Additionally, incorporating 8% cement enhanced the soil properties by filling voids, as noted by Takahashi (2012). This enhancement resulted in increased soil compressive strength and maximum dry density while reducing water content, further contributing to the higher CBR values. The addition of ceramic dust (CD) also had a positive effect on the CBR values. The CBR increased from 9.5% to 13.5% with the addition of 10% CD (Fig. 6). Since ceramic dust has higher tensile strength than clay, its inclusion increases the friction and interlocking between clay particles (Saber et al., 2021). The highest CBR value, reaching 18%, was observed when mixing 8% cement with 10% ceramic dust (Fig. 6).

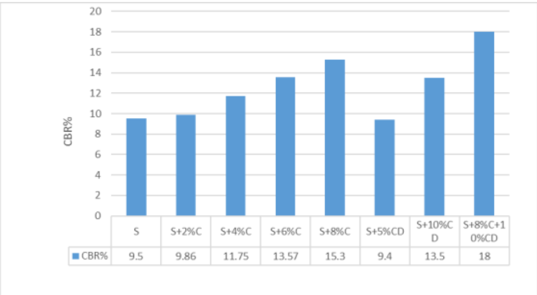

Fig. 6. CBR variations with additives

F. Unconfined Compression Strength (UCS)

The compressive strength of the untreated soil was even in a standard laboratory test and was 88 kPa. When Iraqi salt-proof cement (Mabrouka) was added to the soil in varying proportions of 2%, 4%, 6%, and 8%, the results showed that the highest compressive strength of 169 kPa was reached with the 8% cement mixture. This increase in strength can be attributed to the add to cohesion to the materials, the interplay of water within the blend, and the filling of the interstitial spaces between the clay mineral pieces. With the addition of 8% cement, the voids in the soil were filled more effectively, contributing to the overall strength. For the 6% cement mixture, the laboratory recorded a compressive strength of 130 kPa. In addition, when 5% ceramic dust was added, the compressive strength increased to 95 kPa, and with 10% ceramic dust, it rose to 125 kPa due to the small size of ceramic dust that acts as cement particles. It is worth noting that when the highest percentage of cement (8%) was mixed with the highest percentage of ceramic dust (10%), the compressive strength increased significantly to 225 kPa. This upgrade is likely due to the incorporation of these materials into a cohesive mix of non-plastic materials, which improves the bonding properties of the soil mixture (Fig. 7).

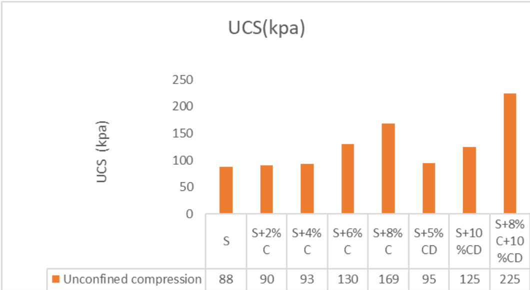

Fig. 7. Unconfined compression strength variations with additives.

7. Conclusions

The practical study aimed to gain insights from trial experiences. The point was to enhance the geotechnical properties of low-plasticity clayey soils by containing materials such as cement and building waste, mostly ceramic dust. This study also seeks to address the environmental and vigor risks posed by waste generated during the building process. The key findings of the study are as follows:

1. The plasticity index of soil reduces with the addition of up to 8% cement. Also, when 10% ceramic dust is blended with this 8% cement, the plasticity index continues to wane. The fine particles of cement act as a binder between the soil particles, while the ceramic dust fills the voids in the blend. This combination enhances the effectiveness of the mixture over several contents and increases the overall strength.
2. The research addressed the effect of adding ceramic dust at two levels: 5% and 10%, and varied amounts of cement at rates of 2%, 4%, 6%, and 8%. The results showed that before and after the use of ceramic dust, the combination of cement and ceramic dust adds to the geotechnical properties of the soil.
3. Soil wetness is affected by the presence of cement, which forms cementation bonds with water in the soil. All soil additives contributed to an increase in the California Bearing Ratio (CBR) value, with the best results observed when mixing 10% ceramic dust with 8% soil cement.

4. Gradually increasing the amount of cement as well as ceramic dust. This reinforcement increased the soil compressive strength and maximum dry density while decreasing the water content, which further contributed to higher CBR values. The addition of ceramic dust (CD) also had a positive effect on the CBR value.

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9. Conflict of Interest

The authors have no conflicts of interest for this manuscript's publication.

10.References

Abdul Wahab, Z.M., 2015. Study of the swell characteristics of surface loading layers in selected areas of Basra Governorate / Southern Iraq, Unpublished MSc. Thesis, College of Science - University of Basra.

Abdulameer, H.N. and Huda, A., 2024. Studying Al-Faw City Expansive Soil (South Iraq) their Improvement by Nano Calcium Carbonate and Lime Material Additives. Thesis, University of Basrah, College of Science, 93 P.

Agrawal, A., 2017. Utilization of ceramic waste as a replacement of aggregate and its effect on vibration of expenditure. International Journal of Engineering Research-Online, 5 (3), 2321-7758.

Al-Soul, A.A.S., 2007. Fluctuation and Variation in Rain Rates in the Popularity of Misurata and the Possibility of Exploiting It, Unpublished Master's Thesis, Seventh of October University, Faculty of Arts, Libya, 209 P. (In Arabic).

Al-Tai, M., 2005. Improvement of Selected Parts of Basrah Governorate Soil Using Polymer Resins.University of Basrah, College of Science, Unpublished PhD Thesis, 162 P.

Andromalos, K.B., Hegazy, Y.A., and Jasperse, B.H. 2000. Stabilization of soft soils by soil mixing. Proceedings of the Soft Ground Technology Conference, Noorwijkerhout, Netherlands.

Arman, A., Barclay, R.T., Casias, T.J., Crocker, D.A., Adaska, W.S., De Graffenreid, R.L., Hess, J.R., Kuhlman, R.H., Mueller, P.E., Roof, H.C. and Super, D.W., 1990. State-of-the-art report on soil cement. ACI Materials Journal, 87(4), pp.395-417.

Baridi, H., 2012. Basra clans: their history - lineage - branches - residences. Dar Al-Rafidain for Printing, Publishing and Distribution. Archived from the original on 11/13/2022.

Bell, F.G., 1978. Foundation Engineering in Difficult Ground. Butterworths, London.

Bowles, J. (1979) Physical and Geotechnical Properties of Soils. McGraw-Hill, Tokyo.

Cabalar, A.F. and Mustafa, W.S., 2017. Behavior of sand–clay mixtures for road pavement subgrade. Int J Pavement Eng 18(8):714–726.

Das, B.M., 2005. Principles of Geotechnical Engineering, 7th Edition. Handbook, Printed in the United States of America, 683 P.

Eskisar, T., 2015. Influence of Cement Treatment on Unconfined Compressive Strength and Compressibility of Lean Clay with Medium Plasticity. Arabian Journal for Science & Engineering (Springer Science & Business Media BV), 40(3).

Hesham, A.H., 2006.Treatment and improvement of the geotechnical properties of different soft fine-grained soils using chemical stabilization. ISBN-10: 3-8322-5508-7, Shaker-Verlag, Germany

Holtz, R.D., Kovacs, W.D. and Sheahan, T.C., 2011. An Introduction to Geotechnical Engineering. Prentice Hall, New Jersey

Ibrahim, H.H, Alshkane, Y. M., Mawlood, Y.I, Noori, K.M.G., and Hasan, A.M., 2020. Improving the geotechnical properties of high expansive clay using limestone powder. Innov Infrastruct Solut 5(3): 112.

Ismaiel, A.H., 2013. Cement kiln dust chemical stabilization of expansive soil exposed at El Kawther Quarter, Sohag Region, Egypt. International Journal of Geosciences, pp. 1416-1424.

Ismaiel, H.A.H., 2006. Treatment and Improvement of the Geotechnical Properties of Different Soft Fine-grained Soils Using Chemical Stabilization. Shaker, Aachen

Kezdi, A., 1979. Stabilized earth roads development in geotechnical engineering. Elsevier Company

Khudhair, A.H., Mahmood, R.A., and Jaber, M.A., 2022. Improving Some Geotechnical Properties of Cohesive Soils by Adding Basalt Fibers and Portland Cement in Basra Governorate - Southern Iraq. Department of Geology, College of Science, University of Basrah, Basrah, Iraq; Center of Polymer Research, University of Basrah, Basrah, Iraq.

Lew, B., 2010. Structure Damage Due to Expansive Soils: a Case Study, EJGE, Vol. 15, Bund .M, pp 1317-1324

Liu, Z., Zhang , Y., and Di, J., 2009. Analysis on the factors affecting the CBR value of silt roadbed, International Conference on Transportation Engineering, ASCE, pp. 1814-1819.

Mahmoud, R.A. and Daham, H.A., 2012. Expansive properties of surface soils in selected areas of Al-Faw city - Basra Governorate / Southern Iraq. Basra Research Journal, College of Education, Issue 38.

Mohamed, A.I., Saadi, S.W., Gart, I.H., and Mohammed, F.O., 2024. Assessing the Improvement of Geotechnical Properties of Clayey Soil Using a

Substrate Cement Mortar Material, from Ilgin, Konya City, Turkey.Department of Geology, University of Sulaimani, Sulaymaniyah, Iraq

Murthy, V.N. S., 2003. Geotechnical engineering: principles and practices of soil mechanics and foundation engineering. Handbook. 1048 P.

Saber, S.A. and Iravanian, A., 2022. Using Waste Ceramic Dust in Stabilization of Clay Soils. International journal of sustainable construction engineering and technology. Vol. 13 no. 1 68-80.

Saber, S.A., 2021. Using Waste Ceramic Dust in Stabilization of Clay Soils, M.S. Thesis, Near East End University.

Tak, J.K.S. and Grover, K., 2018. Use of Kota stone powder to improve engineering properties of black cotton soil. In: Paper presented at the Indian geotechnical conference IGC, Bengaluru, p 13.

Takahashi, A., 2012. Strength reduction of cohesionless soil due to internal erosion induced by one-dimensional upward seepage flow. Soils Found 52(4):698–711.

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تحسين الخواص الهندسية للتربة الطينية بإضافة الأسمنت وغبار السيراميك لمنطقة الدير، شمال غرب البصرة

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الملخص

تتناول هذه الدراسة تأثير اضافة غبار السيراميك والأسمنت على الخواص الهندسية للترب الطينية. تركز على حل المشاكل التي تعاني منها التربة مثل الانتفاخ والانكماش والتي تولد ضغوطاً على الأسس الضحلة بما في ذلك انهيارات المنشآت في المنطقة. لما تحتويه التربة من معادن طينية مثل معدن المونتموريلونيت والايليت وغيرها. حيث تتكون المعادن من صفائح من طبقتين من الألومنيوم وطبقة بينهما من السيليكا تسمى (ثلاث طبقات طينية) حيث تدخل المياه بين المسافات البينية للتلك الصفائح مما يسبب زيادة في المحتوى المائي وبتالي زيادة مشاكل التربة مثل الانتفاخ والتمدد. إن إجراء دراسة شاملة واستراتيجية إدارية جديدة ضرورية لمعالجة التحديات المتعلقة بانهيارات الأسس الضحلة وتقليل الخسائر المادية. والهدف الرئيسي من البحث هو تطوير طريقة لتحسين الخواص الهندسية للتربة. أظهرت النتائج أن عينات التربة المعالجة بغبار الأسمنت بنسبة 2٪ و4٪ و6٪ و8٪ وغبار السيراميك بنسبة 5٪ و10٪ تغيرات كبيرة. أدت إضافة كل من غبار السيراميك والأسمنت إلى تقليل حد اللدونة وحد السيولة ومؤشر اللدونة ومحتوى الرطوبة الأمثل للتربة الطينية. وكانت هناك زيادات كبيرة في قوة الضغط ونسبة تحمل كاليفورنيا والكثافة الجافة العظمى. الان غبار السيراميك ملء الفراغات الهيكلية بين مكونات الخليط مما يقلل المحتوى المائي، اما الاسمنت يربط مكونات للخرسانة مع جزيئات التربة، بتفاعل سيليكات ثنائي وثلاثي الكالسيوم الموجودة فيه مع الماء الموجود في التربة الطينية. ينتج عن ذلك مركب من هيدرات سيليكات الكالسيوم وهيدروكسيد الكالسيوم، والذي يتفاعل مع السيليكات الموجودة في التربة، مما يزيد صلابتها بمرور الوقت.

الكلمات المفتاحية :

تحسين التربة , مقاومة الانضغاط , الكثافة الجافة العظمى , المحتوى المائي الأمثل.

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