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Studying the Effect of Morcemcolor Cement as Stabilizing Material on Unconfined Compressive Strength on Compressed Earth Block Produced from Daquq Area, South of Kirkuk, Northen Iraq

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ABSTRACT

Since the Mesopotamian civilization, one of the oldest civilizations in history, soil has been used to construct buildings that still stand today. Soil is undoubtedly one of the most widely used building materials in the world. Man built the first houses made of soil. Clay and soil are still used as building materials. However, some soils have problems and need to be treated by adding other materials, such as cement. Soil samples were taken from northern Iraq, specifically the Daquq area, south of Kirkuk. The method of work includes conducting laboratory tests of the raw components of the soil before preparing the samples. Then, preparing the models to make compressed earth blocks under a pressure of 15 MPa with or without the addition of Morcemcolor cement as stabilizing material, which represents colored, water-repellent, and additive mortar with mixed binders, characterized by high fineness and plasticity. Then, geotechnical tests are conducted for (7, 14, 21, and 28) days to determine the extent of its effect on the unconfined compressive strength (UCS). The results show that the use of cement increases the UCS, resulting in very strong and safe brick blocks for construction, according to the safety and security conditions for building materials.

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دراسة تأثير إضافة أسمنت Morcemcolor كمواد مثبتة على المقاومة الانضغاطية اللامحصورة للطابوق الترابي المضغوط المنتج من منطقة داقوق, جنوبي كركوك, شمالي العراق

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الملخص

منذ حضارة بلاد ما بين النهرين وهي واحدة من أقدم الحضارات في التاريخ، استخدمت التربة لبناء المباني التي لا تزال قائمة حتى اليوم، فإن التربة بلا شك واحدة من أكثر مواد البناء استخدامًا على نطاق واسع في العالم. بنى الإنسان أول منازل كانت مصنوعة من التربة. ولا يزال الطين والتربة يستخدمان كمواد بناء. ومع ذلك، فإن بعض التربة تعاني من مشاكل وتحتاج إلى علاج بإضافة مواد أخرى، مثل الأسمنت. تم أخذ العينات من شمالي العراق، تحديدا منطقة داقوق، جنوبي كركوك. تضمنت طريقة العمل اجراء الفحوصات المختبرية للمكونات الخام للتربة في المختبر قبل تحضير العينات ومن ثم تهيئة النماذج لصنع طابوق ترابي مضغوط تحت ضغط 15 ميكا باسكال مع أو بدون إضافة أسمنت Morcemcolor كمادة مثبتة والتي تمثل ملاطًا ملونًا مقاومًا للماء ومضافًا إليه مواد رابطة مختلطة، ويتميز بدرجة عالية من الدقة والمرونة. ثم يتم إجراء الاختبارات الجيوتقنية لمدة (7 و 14 و 21 و 21)يومًا لتحديد مقدار تأثير ذلك على المقاومة الانضغاطية اللامحصورة (U.S.C). أظهرت النتائج أن استخدام الأسمنت يزيد من المقاومة الانضغاطية اللامحصورة (U.S.C) مما ينتج عنه طابوق ترابي مضغوط قوي جدًا وآمن للبناء حسب شروط الامان والسلامة لمواد البناء.

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Introduction

Since the day of creation, food, clothing, and shelter have been among the basic human requirements. Therefore, providing and meeting these basic needs is the basis for all technological progress initiatives. However, housing is the most expensive and challenging necessity. As a result, the construction of cheap housing complexes is a problem everywhere. The shortage of building materials, their high cost, and the pollution they cause to the environment during preparation are the main obstacles to finding a solution to the housing crisis (Kabiraj et al, 2011). Over the past forty years (Houben, 1998), the use of compressed earth blocks in the construction of affordable houses has gained popularity over the past fifty years (Walker and Stace, 1997) and (Houben et al., 1998), to denote affordable houses. Since compressed earth blocks are made from readily available local earth resources, they boost the local economy, and by low-cost homes, we mean that the compressed earth blocks are made from abundant and locally available earth materials, which boosts the local economy instead of having to purchase imported materials (Zami and Lee, 2009). In addition, since production is done locally, at work sites, transportation costs are reduced (Waziri et al., 2013). According to AS 1:2007, compressed earth blocks (CEB) are the smallest structural unit with regular, cohesive, and reinforced qualities. Its definition is a result of the pressure used during manufacturing when the earth blocks are crushed while they are still wet. Furthermore, structures made from this type of brick are widely recognized as environmentally friendly because they use less energy during the manufacturing process. In addition, during manufacturing, less carbon dioxide is produced, resulting in less waste and no direct environmental pollution (2011). Since compressed earth blocks can absorb moisture from the atmosphere and the surroundings during the day and thus slowing down the rate of heat loss and sound transmission, they also provide strong thermal and acoustic insulation properties (Arumal and Gondal, 2007; Anon, 2007; Walker et al., 1997). It does not produce direct environmental pollution. A healthy and balanced climate is produced inside buildings by evaporation, which helps release the heat that has been stored throughout the night (Riza et al., 2011). This is especially true in dry places where the weather is cool in summer and warm in winter. Therefore, construction with these types of clay bricks is suitable in subtropical and tropical climates (Vroomen, 2007). However, according to others (Geuttala et al., 2002), using earth resources directly without adding reinforcing materials has disadvantages that affect the compressive strength. However, by including stable and reinforcing elements, the strength of clay bricks can be increased and improved, Therefore, it was necessary to study the effect of adding Morcemcolor cement on the compressive strength, which is what the research study addressed, Study the effect of adding Morcemcolor cement as stabilized material to compressed earth blocks and whether it is possible to improve the compressive resistance of the block by adding it to benefit from it in construction works economically and successfully.

Location of Study Area

The research area is located in Daquq District, 45 km south of Kirkuk in northern Iraq, near the Ottoman Bridge. Samples were collected from the study site, which is located at a latitude (44°49’07”34) E and longitude (35°16’38”66) N. Demonstrating that the soil is suitable for making compressed earth blocks and that it can produce highly effective blocks with and without the use of cement, at a reduced cost (Fig. 1).

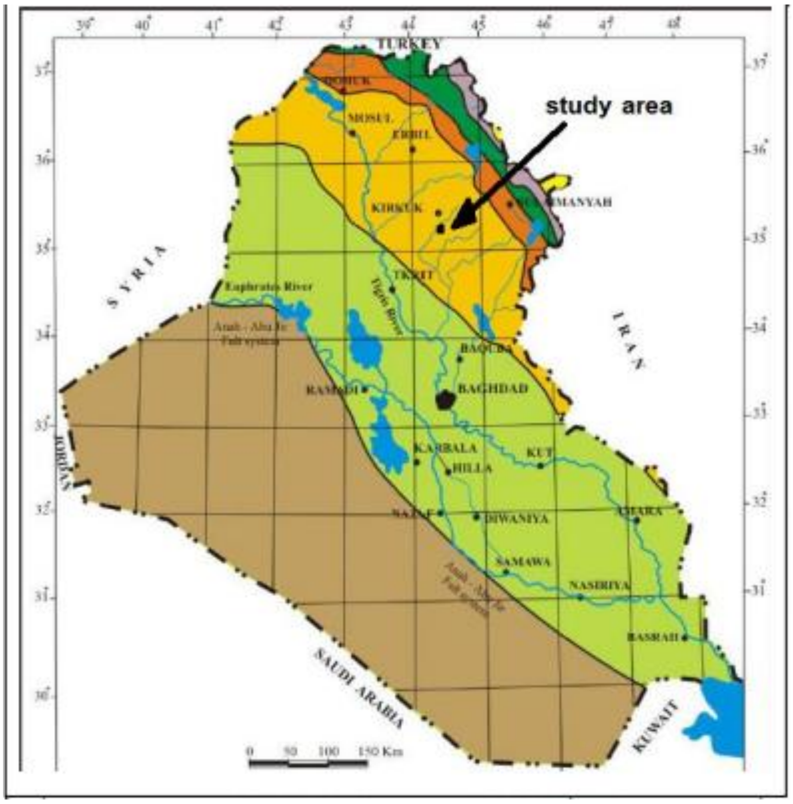

Fig. 1. Location of study area

Materials and Methods

Collection samples:

The stage included collecting soil samples from the study site in the Injana Formation in the Daquq area of Kirkuk to better understand the economic scope and enhance the properties of compacted earth blocks to which different types of cement were added.

It included collecting two soil samples from one site to prevent any abnormalities in the test results for the raw materials used in manufacturing, which may differ from the original location due to distortions caused by external factors such as litter, organic pollutants, or other distortions that alter the results.

The soil was taken from one meter below the surface to avoid soil exposed to weeds, organic debris, weathering, and erosion. For geotechnical tests and confirm the geotechnical properties of the soil, a quantity of soil was extracted and packed in polyethylene bags to prevent moisture loss.

Analysis of Soil Samples:

a) **Laboratory work stage:** When evaluating raw materials used in brick construction, their geotechnical properties must be evaluated in accordance with international standards for geotechnical testing of raw materials. Therefore, two models were taken from the study site in Daquq, southeast of Kirkuk, Iraq, and then evaluated in the laboratory to determine the possibility of using them in the manufacture of blocks**.**

It included: Dry density and moisture content, specific gravity based on the American standard (ASTM-D, 854, 2004; Ibrahim and Tokmachy, 2023), Particle size analysis, according to the American standard (ASTM, D-421, 2004), as steps, and texture of the soil (plastic limit & liquid limit). Based on the American international standard ASTM-D4318–00,2004) and American Specification (ASTM-D4318–00,2004), test (Proctor) compaction based on the standard (ASTM, D 1557-2004).

b) Chemical analyses included: Gypsum Content Based on the British Standard (B.s 1377/1990), pH measurement according to British Standard (B.S.1377:1990) (CaCO3%) According to the method mentioned in (B.S.1377:1990), organic materials according to British Standard (B.S.1377:1990), the percentage of dissolved salts According to the method mentioned in (B.S.1377:1990), Organic Materials content according to British Standard (B.S.1377:1990).

c) Geotechnical tests for compressed earth blocks: including: Verify the amount of moisture, density measurement, verifying the compressive strength without confinement, before and after adding Morcemcolor cement (Morcemcolor is a high-performance jointing mortar typically used for grouting tiles. Its chemical composition is primarily based on high-resistance cement, high-purity aggregates, pigments, and special additives that enhance performance. The additives improve its water-repellent properties and resistance to microbial growth, such as fungi and algae. This type of mortar is also designed to resist cracking and abrasion, with low water absorption, making it ideal for both indoor and outdoor use, including in areas prone to moisture like swimming pools (GRUPO PUMA).

Preparing and manufacturing blocks:

Which takes place in several stages without and with the addition of cement types (Morcemcolor):

After classifying the soil and knowing its properties, the soil was prepared for the manufacture of compressed earth blocks by lightly grinding the soil with a mortar without affecting the crystalline structure of the soil. After the soil classification and identification of its properties, the soil was prepared for the manufacture of compacted earth blocks by lightly grinding the soil with mortar without damaging the crystalline structure of the soil, taking 8 kg of soil and adding 12% water to it, and then rubbing it by hand to allow the water to penetrate well between the soil particles. The prepared samples were placed in polyethylene bags to prevent water loss and left to ferment for 24 hours. Then, the process of making compressed earth blocks is carried out, as stated in (Houben et al., 1998; Aya and Aomed (2024), according to the international standards (ASR 674, 1996; ASR 671, 1996). Where a quantity of fermented soil is taken after 24 hours and placed in a pressing device (CINVA-RAM) and pressed by 15MP with dimensions (2.5cm, 6cm, and 8.8cm) (Fig. 2). Then, leave it to dry naturally for 28 days, after which geotechnical tests are conducted to determine its suitability for construction

At the same time, compressed earth blocks are made by adding Morcemcolor cement by mixing an amount of 8 kg of soil with 0.20 g of Morcemcolor cement, with the addition of water at a rate of 12%. They are made as happened in the compressed earth blocks without addition, and then the geotechnical properties are evaluated. For both types of blocks and comparison between them, w hich was conducted in the Engineering and Geotechnical Laboratory - College of Science - Applied Geology - University of Kirkuk. (Figs. 3, 4, and 5).

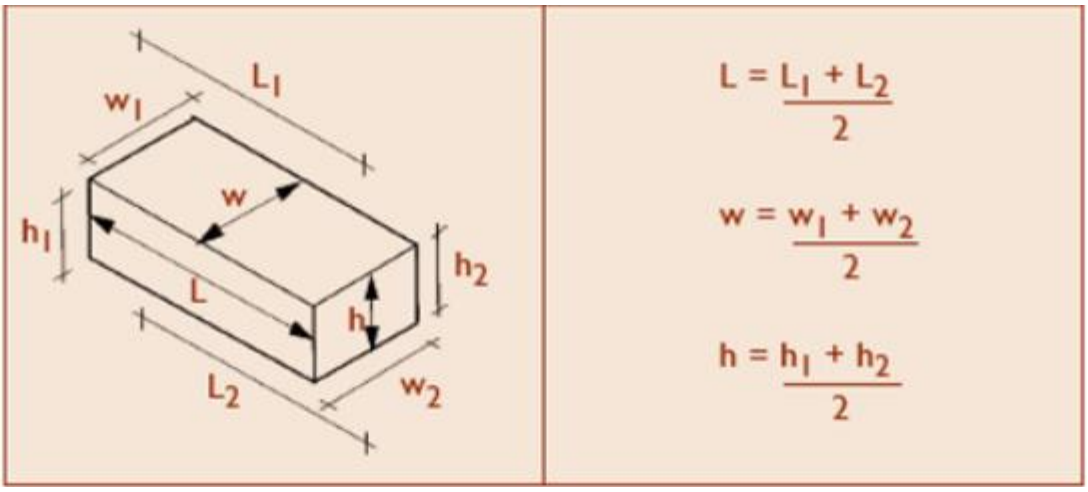

Fig. 2. The method of calculating the dimensions of compressed earth blocks (Adem and Agib, 2001)

Fig. 3. The stages of production of compressed earthen bricks without and with the addition of cement.

Fig. 4. Compressed earth blocks without additives.

Fig. 5. Compressed earth blocks with Morcemcolor cement.

Results and Discussion

The results of the geotechnical evaluation of the raw materials;

Table 1: Physical Properties

No	Dry density	Moisture content	Specific gravity	Grain Size distribution	Atterberg limits
1	1.847g/cm³	11.6%	2.82	Gravel 0%	L.L =32.47
				Sand 5%	P.L =21.81
				Silt 70%	P.I =10.67
				Clay 25%	
2	1.902g/cm³	13.7%	2.83	Gravel 0%	L.L =34.95
				Sand 5%	P.L =20.53
				Silt 68%	P.I =14.42
				Clay 27%	

The result of the chemical analysis:

Table 2: chemical analyses

No	Gypsum Content	pH measurement	T.D.S	(CaCO3%)	organic materials
1	6.92	6.11	7.86	2.88	1.02%
2	6.19	6.32	8.93	3.22%	1.1%

After drying the samples during the drying period specified according to the classification, which is 28 days, the geotechnical properties of the produced bricks were examined, and the results were as follows:

Table 3: geotechnical evaluation of the bricks

	Type of sample	M.C%	Density	Gravel	Sand	Silt	Clay	U.S.C(MP)
1	Without addition	7days =12.5 14day =11.7 21day= 10.9 28day= 9.4	7day= 1.98 14day= 1.99 21day =2.04 28day 1=.99	0	5%	(68-70)%	(25-27)%	7day=16.6 14day =21.6 21day= 24.6 28 day =28.8
2	With addition of Morcemcolor	7day =1.99 14day =1.94 21day 1=.60 28 day 1.=95	7day= 10.2 14 day= 7.33 21 day =6.01 28 day 5=.37	0	5%	(68-70)%	(25-27)%	7day =26.33 14 day =30.30 21 day= 38 28 day =41.33

After conducting the necessary tests on the raw materials of the soil to determine its suitability for the production of compressed earth blocks, the soil was classified according to international standards and it was found that the specific gravity of the soil in the study area was (2.83-2.82), i.e. within the range of clay and silt according to the classification (Das, 1985), where the percentage of clay and silt reached 95% and their presence is very important for the production of compressed earth blocks. The soil was also classified into (low fluidity soil) according to the classification (Kerbs and Walker, 1971) and (medium plasticity soil) according to the classification (Budnikov, 1964), where it falls within the CL range according to the plasticity chart for soft soils according to the unified classification (U.S.C.S.), which falls within the permissible range for the production of compressed earth blocks. As for the chemical analyses: the organic matter had no effect on the soil according to the classification (Scott, 1974), the effect of dissolved salts was unclear according to the classification (Al-Asha, 1991), the percentage of calcium carbonate was harmless according to the classification (Al-Adly, 1998), the soil was slightly acidic according to the classification (Al-Kahlout, 2015), and the soil was classified according to its gypsum content as (slightly gypsum) according to the classification (Al-Barzanji, 1973). According to the results shown above, the soil of the Daquq site near the Ottoman Bridge was within the permitted plan for the production of compressed earth blocks, i.e., it is suitable for the production of compressed earth blocks without and with the addition of Morcemcolor cement. Geotechnical and engineering tests of the bricks produced without and with the addition of cement showed that in terms of water content, the compressed earth blocks without additions retained the most water, unlike the compressed earth blocks with the addition of cement, which had a very low water content due to their interaction with water or water expulsion, as their water content after breaking after 28 days reached (5.37%) Fig.9, while the compressed earth blocks without additives were (9.4%) (Fig. 8), but the density increased with the passage of days during the drying period (28 days) of the compressed earth blocks without additives, while the density of the compressed earth blocks with additives decreased with the passage of days during the drying period (28 days). As for the unconfined compressive strength, we notice that it increased over time for both types, but with the addition of cement, the unconfined compressive strength was much higher, reaching (41.33 MP) for the compressed earth blocks with the addition of cement, while for the compressed earth blocks without addition, it reached (28.8 MP) (Figs.10 and 11). There is also an inverse relationship between water content and compressive strength; as the water content decreases, the compressive strength increases (Figs. 6 and 7).

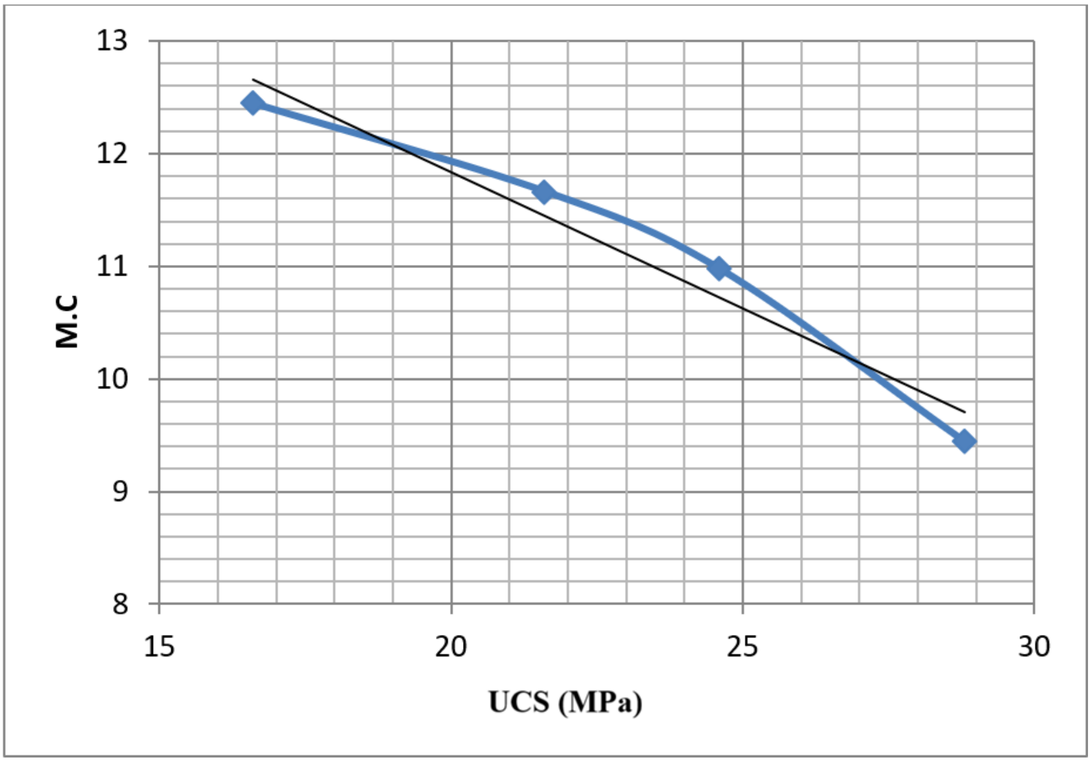

Fig. 6. U.S.C. and M.C.% for compressed earth blocks without additives

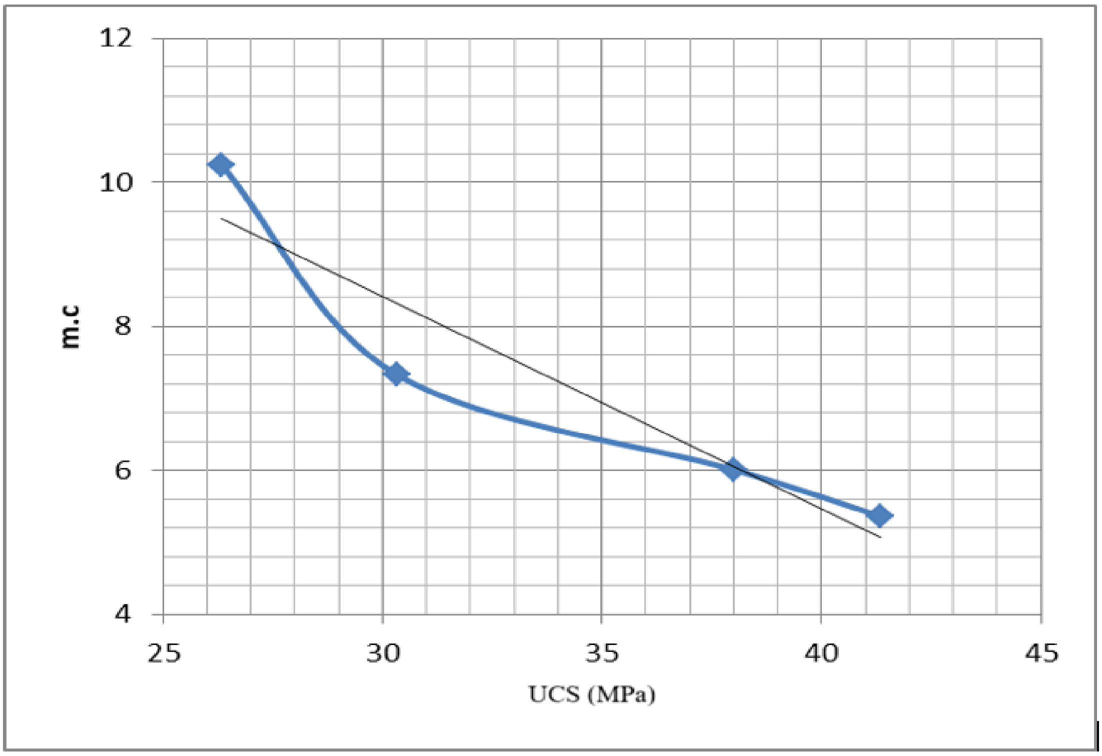

Fig. 7. UCS and M.C.% for compressed earth blocks by addition of Morcemcolor cement

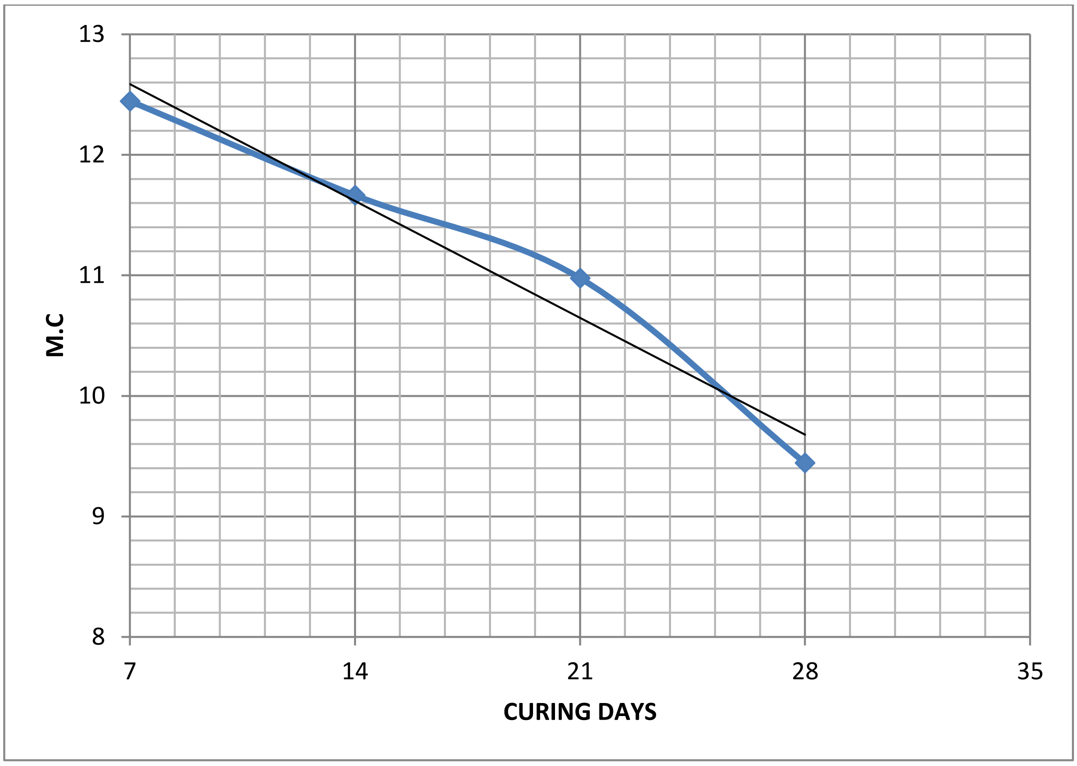

Fig. 8. M.C. and Curing days for compressed earth blocks without additives

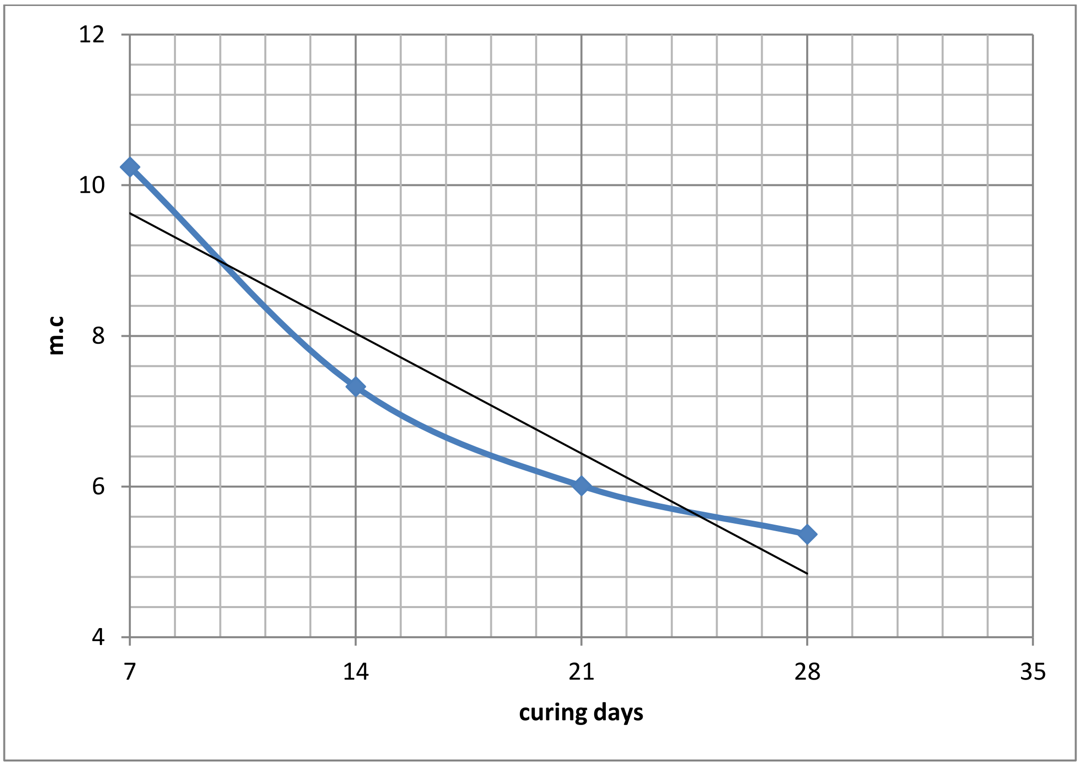

Fig. 9. M.C. and Curing days for compressed earth blocks by the addition of Morcemcolor cement

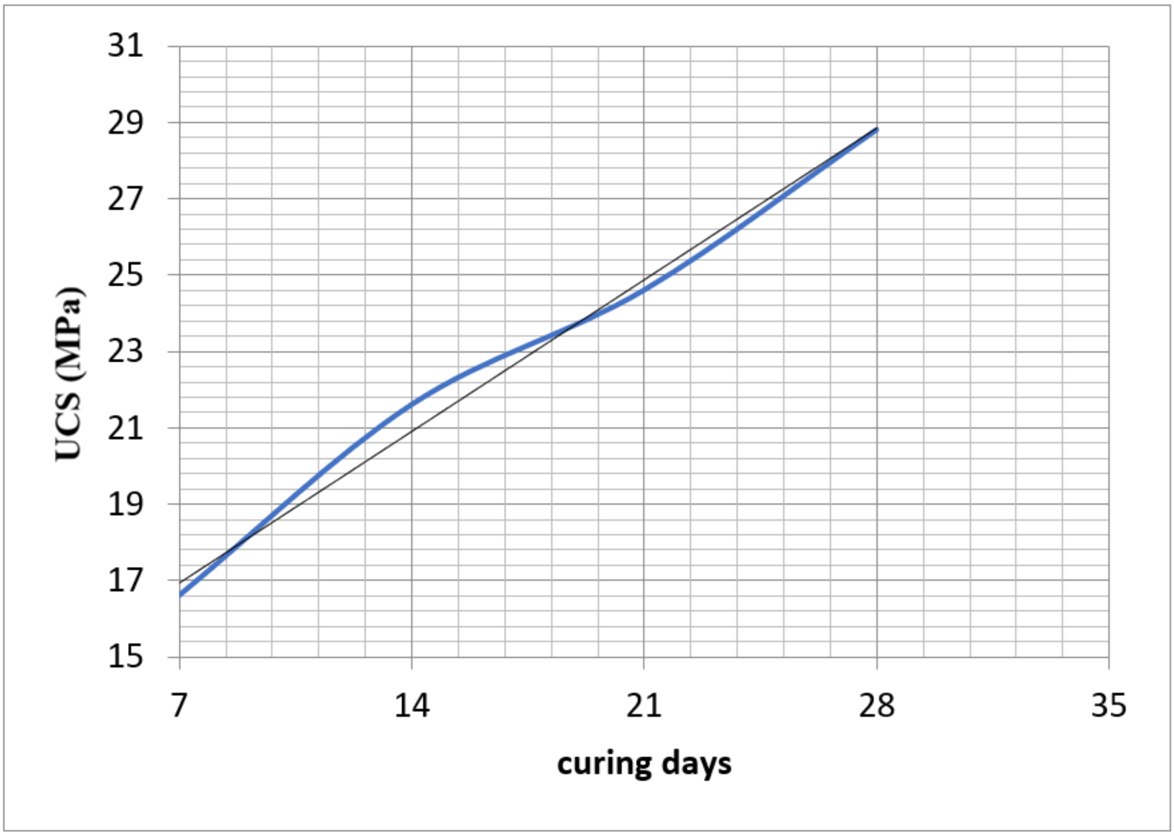

Fig. 10. UCS and Curing days for compressed earth blocks without additives

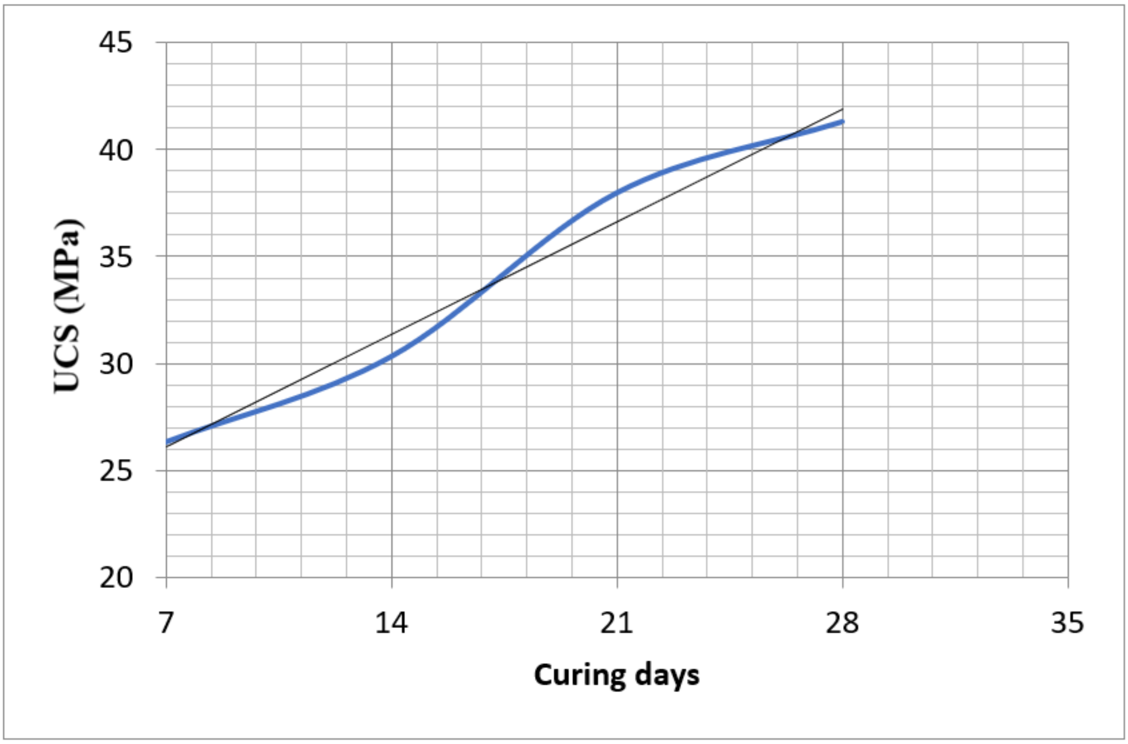

Fig. 11. UCS and Curing days for compressed earth blocks by the addition of Morcemcolor cement

Conclusion

The relationship between water content and drying days of compressed earth blocks is inverse. As the number of drying days increases, the water content of the block's decreases, which also leads to an increase in the unconfined compressive strength of the blocks, as it is inversely proportional to the water content and directly proportional to the drying days.

Therefore, the unconfined compressive strength of the compressed earth blocks to which Morcemcolor cement was added was more compressive than the compressed earth blocks without addition, and the water content was less than the earthen blocks without addition. Also, adding cement led to a reduction in the density of the earth blocks because cement has low density, which leads to a reduction in the total mass of the produced block over the days during the drying period. Therefore, by adding Morcemcolor cement, the unconfined compressive strength of the compressed earth blocks was improved, which meets the safety and security requirements for construction.

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