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Study of the effect of adding Portland cement on the thermal insulation of compressed earthen bricks produced from the Daquq area - South of Kirkuk - Northeast of Iraq

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Abstract

Earthen bricks are a common building material in developing countries, where more than 50% of the people live. They are cost-effective, have high thermal insulation, and are abundant in raw materials. Portland cement, a good stabilizer, was added to improve the thermal conductivity of compressed earthen bricks. The study aimed to investigate the effect of adding Portland cement on the thermal insulation of compressed earthen bricks in the Daquq area, northeastern Iraq. The study included laboratory tests of raw materials for producing earthen bricks, including water content, dry density, Atterberg limits, specific gravity, particle size, and chemical tests. The soil was prepared by mixing 6 kg of soil with 12% water content, and 0.20 g of Portland cement, then manufacturing bricks under a pressure of 15 MPa according to international specifications. The results showed that the soil is suitable for producing compressed earthen bricks. Compressed earthen bricks had the highest water retention of any type, while other types had very low water retention due to their interaction with water or expulsion. The thermal conductivity results of the compressed earthen bricks without addition were less than the thermal conductivity value of the bricks with added Portland cement.

Keywords: Portland cement, thermal conductivity, compressed earth blocks

Introduction

Earth is without a doubt one of the most commonly used building materials in the world; the Mesopotamian civilization, one of the oldest, used it to construct buildings that can still be seen today, some 6000 years after man first created the first earthen homes. Currently, over 50% of people in developing countries, including most rural residents, live in earthen buildings. This is because soil and clay are still widely available as building materials and have several advantages, including low cost, high thermal insulation, and abundant supply of raw materials. Despite being the earliest known building material, dirt has been excluded from when contemporary building materials like concrete blocks - whose raw materials are cement, sand, and gravel - and conventional bricks - whose raw materials are clay and silt - were discovered, it was out of place. These construction materials are regarded as environmental pollutants. Following that, people started employing non-polluting construction materials, such as dirt, which has been used by humans to build homes for thousands of years. Because compressed earth bricks (CEBs) are so easy to produce, it is anticipated that society will accept them more than earthen construction approaches, also known as the new generation of molded mud bricks known as adobe bricks. Due to the ease of production, low cost resulting from the availability of their raw materials, soil, and favorable properties, as well as the environmental qualities of buildings made of compressed earthen bricks - which are thought to be environmentally friendly - and the fact that producing compressed earthen bricks uses only 1% of the energy required to produce other types of bricks. In addition, compared to other technologies - of which presses are the most crucial - it requires less specialized equipment). CINVA-RAM.

However, some may face problems in terms of compressibility and others, so it is necessary to add stabilizers that can improve its properties. Portland cement was added, which is a good stabilizer. Therefore, its effect on the thermal conductivity value of the produced bricks

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was studied and whether it falls within the safety and security conditions for building materials.

Study area

The study area for the purpose of studying the effect of adding Portland cement on the thermal conductivity value of compressed earthen bricks is located in the Daquq area - south of Kirkuk - Northeastern Iraq within the Quaternary Formation at longitudes 35.1638660 north and latitude 44.4907348 east.

Aim of study

Study of the effect of adding Portland cement on the thermal insulation of compressed earthen bricks.

Methodology

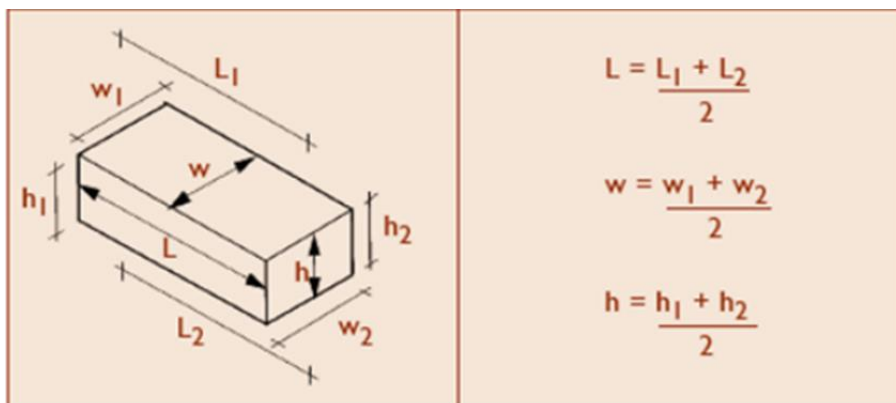
The method of work included several stages, including:

a) Laboratory tests of raw materials required for the production of earthen bricks according to Laboratory tests of raw materials required for the production of earthen bricks according to the international specification (ARS 674:1996, ARS 671:1996) ^[16]. Which includes water content, dry density, Atterberg limits, specific gravity,

particle size, as well as chemical tests which include calcium carbonate percentage, gypsum content, organic matter percentage, pH value and amount of dissolved salts according to international specifications.

Preparing the soil for the production of compressed earthen bricks by mixing 6 kg of soil with 12% of the water content, mixing it well and then fermenting it for 24 hours. At the same time, 6 kg of soil are mixed with 0.20 grams of Portland cement. They are mixed well while dry so that the ingredients stick together well. Then water is gradually added in an amount of 12%. They are also placed in a polyethylene bag and fermented for 24 hours. After 24 hours, they are manufactured by pressing them in a mechanical pressing device under a pressure of 15 mega pascals for 2 to 3 seconds, where the dimensions of the mold are (2.5 cm, 6 cm, 8.8 cm) Fig.1. Then they are placed on a wooden board and left to dry naturally during a drying period of 28 days according to the international specification (ARS 674:1996, ARS 671:1996) ^[16].

The final stage includes mechanical and engineering tests of the produced bricks, which include water content, density, compressive strength, and thermal insulation.





Results and Desiccation

The laboratory tests of the raw materials were as follows (Table 1), (Table 2):

Table 1: Physical properties

No.	Dry density	Moisture content	Specific gravity	Article distribution & hydrometer analysis	Texture of the soil
1.	1.847 g/cm ³	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.	1.902 g/cm ³	13.7%	2.83	Gravel 0%	L.L =34.95
				Sand 5%	P.L =20.53
				Silt 68%	P.I =14.42
				Clay 27%	

Table 2: Chemical analyzes

رد	Gypsum content	pH measurement	T.D.S	(CaCO ₃ %)	Organic materials
1	6.92	6.11	7.86	2.88	1.02%
2	6.19	6.32	8.93	3.22%	1.1%

As for the geotechnical tests for block, they were as follows (Table3):

Table 3: Geotechnical evaluation of the bricks

	Type of sample	M.C %	Gravel	Sand	Silt	Clay
1	Without addition	7days 12.5 14day 11.7 21day 10.9 28day 9.4	0	5%	(68-70)%	(25-27)%
2	Morcemcolor	7day 1.99 14day 1.94 21day 1.60 28 day 1.95	0	5%	(68-70)%	(25-27)%

While the thermal conductivity results were as follows (Table 4):

Table 4: Thermal conductivity

Type of block	Thermal conductivity K (w/m .C° (at 36 C°)
Without addition	0.2624 W/mK
Portland cement	0.29944 W/mK

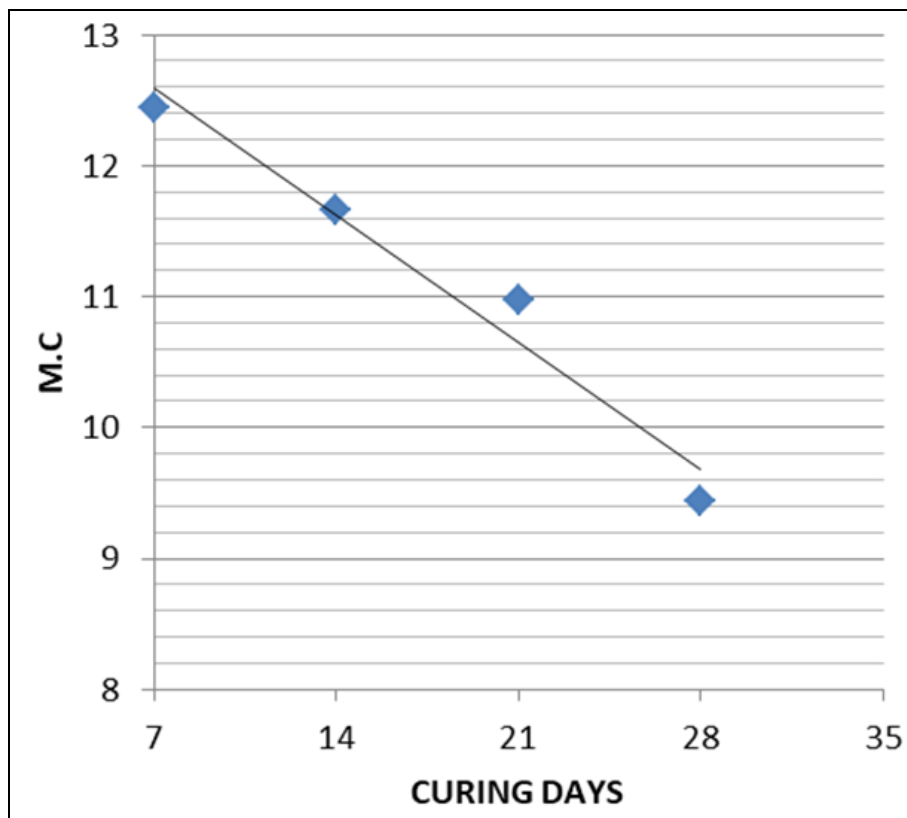


Fig 1: M.C &Curing days for block without additions

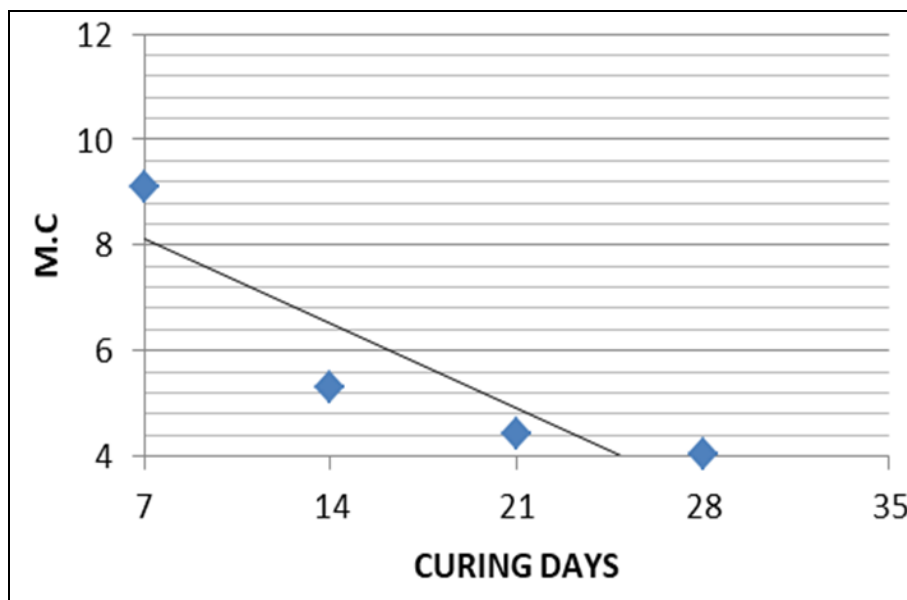


Fig 1: M.C &Curing days for block by adding Portland cement

The soil was categorized in accordance with international standards after the required testing were completed on the raw materials both before and after the various types of bricks were manufactured. Given that the percentage of clay and silt in the soil reached 95% and that their presence is crucial for the construction of bricks, it was determined that the specific gravity of the soil under study was (2.83-2.82), or within the range of clay and silt clay according to the categorization. Additionally, the soil was categorized as having a low liquidity limit (Kerbs and Walker, 1971) ^[10] and medium plasticity, as the plasticity chart for soft soils based on the unified classification (U.S.C.S.) indicates that it is within the CL range. Regarding the Concerning the

chemical analyses, Scott (1974) classified organic matter as having no effect on soil resistance and compressibility; Al-Asha (1991) ^[13] classified the effect of dissolved salts as unclear; Al-Adli (1998) ^[12] classified the percentage of calcium carbonate as harmless; Al-Kahlout (2015) ^[14] classified the soil as slightly acidic; and Al-Barzanji (1973) classified the percentage of gypsum as slightly gypsum. The aforementioned results demonstrate that the soil at the Daquq site near the Ottoman Bridge was suitable for producing compressed earth bricks both with and without the addition of, and that the compressed earth bricks had the highest water retention of any type. In contrast, other types had very low water retention because of their interaction

with water or expulsion of water, as demonstrated by the Portland cement type, which had a water content of 4.02% after breaking after 28 days, while the compressed earth bricks without additives had a water content of 9.4%. While the thermal conductivity results of the compressed earthen bricks without addition were less than the thermal conductivity value of the compressed earthen bricks with Portland cement added to them.

Conclusion

The thermal conductivity value of the brick produced without addition is less than the thermal conductivity value of the compressed earthen brick to which Portland cement has been added. Therefore, the thermal insulation of the earthen brick without addition is greater than that of the improved brick, but it is not by a big difference. In the end, the two types provide very high thermal insulation due to the amount of clay present, which increases the thermal insulation, while the cement contains some compounds with low thermal conductivity, which increased the thermal conductivity by a very small percentage. Therefore, it is not considered a thermal conductor at all, and thus achieves the safety and security conditions for building materials.

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