The influence of cement, gypsum and lime on the compressive strength of unfired earth bricks

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Introduction

Earth as mud bricks has been used in the construction for thousands of years, and approximately 30% of the world's present population still lives in earthen structures. Earth is cheap, environmentally friendly and abundantly available building material. Agricultural wastes were used for animal feed, fertilizer and fuel for energy production, but little work has been carried out to develop utilization of these wastes in the production of building materials. The needs to conserve traditional building materials that are facing depletion have obliged engineers to look for alternative materials. Environmentally friendly, energy saving recycle property of material production has been one of the very important research fields for decades. Due to environmental policy, the demand for high insulation ability bricks is increasing. This paper outlines results of a comprehensive investigation to assess the influence of cement, gypsum and lime content for unfired earth bricks.

Materials:

To assess the influence of constituent materials on earth blocks properties, different materials such as cohesive soil, cement, gypsum and lime were formed by mixing together. Ordinary Portland cement was used throughout for chemical stabilization. The composition of the cohesive soil texture is as follows: 28.7% clay, 52.8% silt, 2% gravel and 16.5% sand. The cement, gypsum and lime were mixed (by dry weight). For the mixture of cement, gypsum and lime were added in different percentages such as 1%, 2.5% and 5% from soil dry weight as shows in Fig.1.

Fig.1. Samples of the unfired earth bricks

Compressive strength test:

Specimens used for the compressive strength tests were 24 cm x 12cm x 6 cm.
The compressive strength of each block was determined from its failure load.
The compression tests were carried out according to ÖNORM B 4415. The brick sample was placed between the loading piston and the pedestal and loaded until failure (Fig.2). The load and the displacement were measured during the tests.

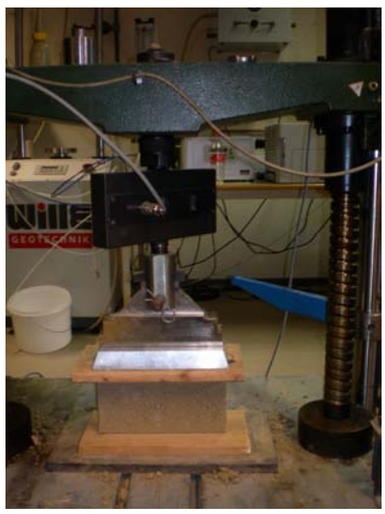

Fig.2. The compressive test for the unfired earth bricks

The test results showed that, adding cement ratios from 1% to 5% lead to increase compression strength from 2.16 to 5.79MPa. While compressive strength of earth bricks stabilized with gypsum are 2.94, 3.17 and 4.7 MPa for gypsum ratios 1, 2.5 and 5 % respectively. On the other hand, the addition of lime does not improve bricks performance so much. It ranges between 0.21 and 0.83 MPa as illustrated in Fig.3.

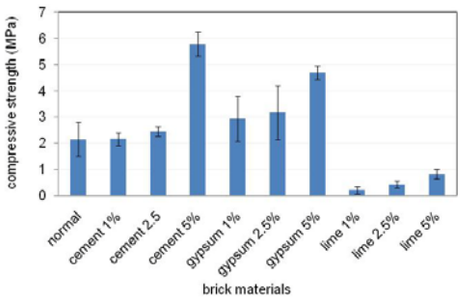

Fig.3. Histogram of the compressive strength of earth bricks

The results revealed that adding cement content from 1% to 5% lead to increase failure load 'F' from 0.62 to 1.67 kN. The addition of lime does not improve performance so much (Fig.5). Adding gypsum lead to increase the failure loads from 0.85to 1.35 kN.

Bending strength:

The three point bending tests were carried out according to DIN EN 12390-5 (Fig.4).

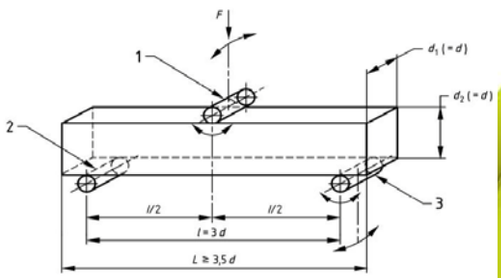

Fig.4. Bending strength test

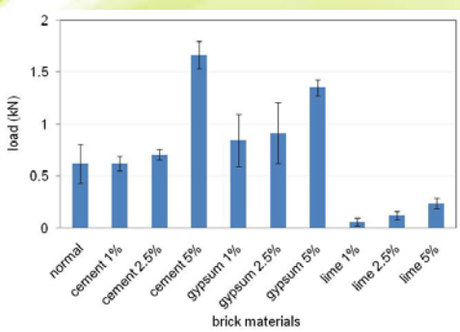

Fig.5. Bending strength of earth bricks

Conclusions:

The results confirmed that the compressive strength of earth bricks increased with increasing cement and gypsum contents[1, 2.5 and 5%]. Moreover, the compressive strength is slightly increased by adding lime to the earth bricks. The results revealed that, the addition of cement, gypsum and lime lead to improve the bending strength of the unfired earth bricks.

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