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The Effect of Adding Fillers on The Mechanical Properties for Foam Concrete

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ABSTRACT

This research included the effect of fillings on the mechanical properties of lightweight concrete, as different percentages of the raw materials used in the production of this type of concrete were used. Several engineering and physical tests were conducted on lightweight concrete models in this research, where it was reached to produce light concrete with a compressive strength ranging between (1.18 - 1.5) Mpa, and the density was measured and the recorded values ranged between (718-818) kg/m3, and the water absorbency of the models was recorded, and the recorded values ranged between (26.7-56.6%)%. The research aims to produce lightweight concrete with good physic and mechanical properties that can be used in the manufacture of building units, with a focus on the economic aspect of producing this type of concrete from available materials and at the lowest possible cost.

Keywords: cement; cellular light weight concrete; mechanical properties; fillers and foam content.

INTRODUCTION

Cellular light weight concrete, as indicated by its name, the concrete having self-weight lighter than the conventional concrete. This provides almost similar strength to normal strength concrete having lower grades. Lightweight concrete is defined as concrete having density (air-dry) below 2000 kg/m^3 as compared to normal concrete with a density in the region of 2350 kg/m^3 [1]. Many types of materials such as silica fume fly ash, lime chalk, crushed concrete, incinerator bottom ash, recycled glass, foundry sand, quarry finer, expanded polystyrene, oil palm shell, and Lytag fines were used to reduce the density of the foam concrete and/or make use of waste/recycled materials [2-3].The concept behind the manufacturing of the CLWC is to create porous microstructure by entrapment of air bubbles in the concrete mix. This can be done by adding preformed foam or chemical surfactant which reacts during the mixing to create air bubbles in the mix. The air bubbles continue their size, shape and remain stable for the period of the setting process. Diameter of air bubbles ranging from 0.1 and 1 mm. The "skin" of voids or bubbles must be able to withstand mixing, transportation, and compaction. These air bubbles give foamed concrete its lightweight property. As there is no coarse aggregate [4]. Chemical expansion and mechanical foaming have been used. In chemical foaming, a foaming agent (FA) such as aluminum powder, CaH2, TiH2, orMgH2 is mixed with the base-mix ingredients, and, during the mixing process, foam is produced from the chemical reactions, which forms the cellular structure in the concrete. In mechanical foaming, the foam is prepared in advance using a special device, a foam generator, where the water and chemical admixture are mixed with a certain proportion, and the premanufactured foam is mechanically mixed with the concrete mixture. After molding, the concrete hardens under normal atmospheric conditions [5-6]. FC belongs to the broader category of cellular concrete in which air-voids are trapped in the mortar matrix using a suitable aerating agent. It is lightweight and has moisture protection, fire protection, sound insulation, and good heat insulation; therefore, it has been successfully applied in oil well cementing projects, used as a backfill material in excavation projects, and used for sound and heat insulation in building panels, fire-protection wall, energy-absorbing pads in roads, road subbase, structural fill, foundations, and geotechnical and mine fill applications [7–10]. In this study, a type of ultralight FC was produced, which can be used as a new energy-conservation and environmental-protection building material, and is particularly suitable for the thermal insulation engineering of building external walls. The influences of different mixing amounts of Cellular Light Weight Concrete on the mechanical properties for compressive strength.

Experimental Programs, Materials

The cement used in this study was a SAQR AL-Keetan Co. for Cement production company limited made according to Iraq standard No.5 for 2019, IQS 5 CEM I 42.5 R. Its density is 740 kg/m3, and its chemical composition is given in Table (1). The filler used in this research is iron wire, and foam content it is a self-made, white powder. Foam is a chemical substance formed by trapping pockets of gas within a liquid or solid. Well-known examples are sponges and suds. In most foams, the gas volume is large, and the gaseous regions are separated from the liquid or solid regions by a thin film.

TABLE 1: Chemical properties of the cement that were used [11].

Name of material	CaO	Al2O3	Fe2O3	SO3
Cement	65.23	5.23	3.30	0.98
Name of material	K2O +Na2O	Loss on ignition	Soluble residue	MgO
Cement	1.6	1.5	0.19	2.76

Test Equipment

A high-speed blender: auto control with a rotating speed of 0~1200 r/min. A standard tester for consistency and setting time of the cement and Multifunction rock mechanics test (RMT)machine: a series of RMT systems was developed at our institute. The machine has a unique multifunction design and control technology; it can conduct many types of tests such as uniaxial compression, triaxial compression, tension, shear, and fatigue tests. Its maximum load is1MN, and its maximum confining pressure is 650 BAR. A universal testing machine HUMBOLDT (650 BAR) was used. The compressor modulus was calculated as the ratio of stress to concrete. A photograph showing a mechanical measuring device shown in Figure 1.

FIGURE 1: a photograph showing a mechanical measuring device.

Preparation of foam concrete

We add water into other materials such as cement, foam stabilizer, filler (iron wire) and evenly stir while maintaining the temperature of the slurry at approximately 40 (oC). In general, this process lasts approximately (4) min., while stirring at high speed, quickly add cellular light weight concrete and continue stirring for approximately 30 seconds. Pour the evenly stirred slurry into a (15 ×15 × 15) cm, mold and wait until it foams; the foam process is shown in Figure 2. Take apart the mold after two hours and keep it in the curing box with constant temperature and humidity until the test age ends. The key to foam concrete structure formation using chemical foaming is to make the foaming speed match the setting and hardening speed of the slurry.

FIGURE 2: (A)The foam process of foam concrete and (B) foam concrete with filler

Results and discussion

Effect of foam content on compressive strength. Foam content is one of the basic raw materials for the preparation of lightweight aerated concrete. The foam content generates chemical reactions in the evenly stirred slurry, resulting in a lot of gas. The gas diffuses inside the slurry and is gradually fixed in the hardened concrete as the slurry condenses; Finally, the gas forms the stable and stable vesicular structure. Table 2 shows the values of compressive strength, absorbance and density of models for lightweight aerated concrete. Where we note that the compressive strength of lightweight aerated concrete decreases when adding fillers (iron wires) to concrete because the amount of air holes inside lightweight aerated concrete also increases and the walls of air holes become thinner. Therefore, the dry mass density of lightweight aerated concrete decreases, and so does the strength. Where the compressive strength without filler was recorded (1.5 MPa). While the compressive strength with the filler is (1.8 MPa). Also, the density was recorded where the density of the concrete model with the filler was (7 1 2 kg / m3) while the density of the model without the filler is (8 1 8 kg / m3) , That is, the grouting works by increasing the porous holes between the concrete particles, thus creating voids within the concrete matrix and thus reducing the density.

TABLE 2: shows the values of compressive strength, absorbency and density for pure concrete models and with fillers.

Number of content	compressive strength (MPa)	density (kg / m^3)	Absorption %
pure concrete	1.58	818.9	26.7
concrete with filler	1.18	718.8	56.6

The increase in the absorbance values, which was calculated by dividing the difference between the value of the two states of the impure (concrete with filler) and the pure (pure concrete) by their value in the pure state (pure concrete), showing the percentage change in the absorbance values as a function of the percentage of weight added to the filler (wires). iron). The pure state is given by the equation:

$$\text{Absorption percentage} = \frac{A-B}{B} * 100\%.$$

Where:
A: The weight ratio of concrete in the impure state (concrete with filler).

B: The ratio of the weight of concrete in the pure state (pure concrete).

Where the increase in the absorption values between concrete samples was shown in Table 3.

TABLE 3: shows the values of absorption and Percentage of increase in absorption values for pure concrete models and with fillers.

Number of content	Absorption %	Percentage of increase in absorption values %
pure concrete	26.7	-
concrete with filler	56.6	111

CONCLUSIONS

The amount of foam is getting more attention nowadays because its use usually improves the properties of cement-mixed concrete and reduces adverse environmental effects. The properties of foam concrete vary depending on the type and composition of the mixture. In this paper, the effect of the filler on the mechanical properties of foam concrete was studied. The cubes are poured with different target densities from 7 00 to 1000 kg/m3, by changing the amount of foam content from 1% to 1.5%. The water content of all mixtures is kept constant by adding a liter of water to the weight of cement and foam together. where it was reached to produce light concrete with a compressive strength ranging between (1.18 - 1.5) Mpa, and the density was measured and the recorded values ranged between (718-818) kg/m3, and the water absorbency of the models was recorded, and the recorded values ranged between (26.7-56.6%)%, and the increase in absorbance values is (111%).

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