Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2022, 9(3):72-76**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Study of the Mechanical Properties for the Cellular lightweight Concrete

Ahmed J. Mohammed[1], Ibrahim K. Ibrahim[2]

[1]Department of Materials Science ,Polymer Research Centre / University of Basra / Basra / Iraq
[2]Department of Chemistry and Polymer Technology, Polymer Research Center, University of Basra, Basra, Iraq
E-Mails: ahamd.jasim@yahoo.com

Abstract This study investigates the mechanical and physical properties of Cellular Light Weight Concrete (CLWC), specifically dry density, water absorption, and compressive strength. In this study, the cubes are cast for different target densities 500 to 1000 kg/m³, by varying the amount of foam content 1% to 1.5% , and the corresponding decrease in cement content 40% to 50%. The water content of all mixes is kept constant as 40% of the weight of cement and foaming combined. The foam consists of one part of the foaming agent diluted with 20 parts of water. As the amount of foam affects the dry density of concrete, hence foam content is varied from 1% to 1.5% to get different target densities. and tested for the same mechanical and physical properties.

Keywords Cellular Light Weight Concrete (CLWC), cement, foam content, mechanical and physical properties

1. Introduction

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 [1]. 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/m³ as compared to normal concrete with a density in the region of 2350 kg/m³ [2]. Foamed concrete (FC) belongs to the broader category of cellular concrete in which air-voids are trapped in themortar 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 [3–6]. In addition to cement, 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 [7-8]. Chemical expansion and mechanical foaming have been used. In chemical foaming, a foaming agent (FA) such as aluminum powder, CaH_2, TiH_2, or MgH_2 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 [9-10]. In this study, a type of ultralight (<300 kg/m^3) 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 (CLWC) on the mechanical properties for compressive strength.

2. Experimental Programs

2.1 Materials

1- **Cement**: 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/m^3, and its chemical composition is given in Table (1).

Table 1: Chemical properties of the cement that were used

Name of material	SiO_2	CaO	Al_2O_3	Fe_2O_3	SO_3	MgO	K_2O+Na_2O	Loss on ignition	Soluble residue
Cement	21.84%	65.23	5.23	3.30	0.98	2.76	1.6	1.5	0.19

2- **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.

2.2 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 is 1MN, 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

2.3 Preparation of Cellular Light Weight Concrete:

Add water into other materials such as cement, foam stabilizer, and evenly stir while maintaining the temperature of the slurry at approximately 45 ^{o}C. In general, this process lasts approximately 5 minutes. 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 150mm ×150mm × 150mm, mold and wait until it foams; the foam process is shown in Figure 2. Take apart the mold after 2 hours and keep it in the curing box with constant temperature and humidity until the test age ends. The key to Cellular Light Weight Concrete structure formation using chemical foaming is to make the foaming speed match the setting and hardening speed of the slurry.

Figure 2: The foam process of Cellular Light Weight Concrete

3. Results and Discussion

The Influence of foam content on the Compressive Strength. Foam content is one of the basic raw materials to prepare Cellular Light Weight Concrete. foam content generates chemical reactions in the evenly stirred slurry, which create a lot of gas. The gas scatters inside the slurry and is gradually fixed in the hardened concretes as the slurry condenses; finally, the gas forms the even and stable vesicular structure. Figure 3 shows the influence of the amount of foam content mixture on the 14-day compressive strength of Cellular Light Weight Concrete. From Figure 3, it can be observed that the compressive strength of the Cellular Light Weight Concrete decreases as the amount of foam content mixture increases because the amount of air holes inside the Cellular Light Weight Concrete also increases and the walls of the air holes become thinner. Therefore, the dry bulk density of Cellular Light Weight Concrete decreases, and so does the strength. It is observed that the pore wall of the sample with the cement admixture amount of 4% is the thickest with almost no interlocking pores; thus, this sample has the maximum compressive strength is (1.426 Mba). The pore wall of the sample with the cement mixing amount of 5% is the thinnest with many interlocking pores; thus, it has the minimum strength is (0.53 Mba). For the sample that was made using the foam content with the cement admixture amount of 4%, the pore wall thickness and the pore structures are relatively appropriate, and the strength is also qualified with the heat preservation requirement of the exterior wall. Therefore, the optimal amount of foam content admixture in this experiment is 4%.

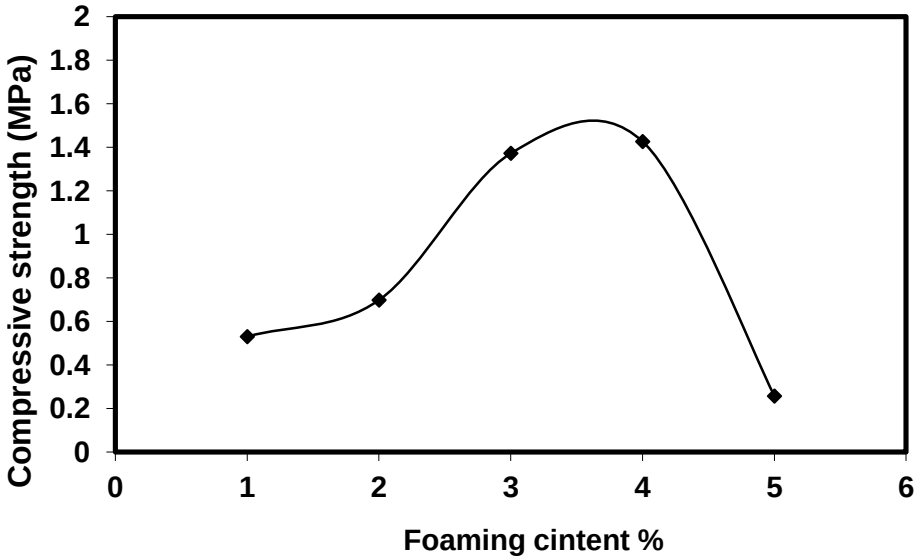

Figure 3: The influence of the foam content on the compressive strength of Cellular Light Weight Concrete

Its data in compressive strength is given in Table (2).

Table 2: The data in compressive strength

Percentage %	**1**	**2**	**3**	**4**	**5**
Compressive strength (Mba)	0.53	0.698	1.372	1.426	0.257

4. Conclusion

Cellular Light Weight Concrete (CLWC), fairly a new material as compared to conventional concrete, has become a more popular material in the construction industry. The amount of foam is getting more attention nowadays since its uses usually improve the properties of mixed cement concrete, economical and reduction of harmful environmental effects. The properties of CLWC vary according to a different type of mixture and its composition. This study investigates the mechanical and physical properties of Cellular Light Weight Concrete (CLWC), specifically dry density, water absorption, and compressive strength. In this study, the cubes are cast for different target densities 500 to 1000 kg/m³, by varying the amount of foam content 1% to 1.5% , and the corresponding decrease in cement content 40% to 50%. The water content of all mixes is kept constant as 40% of the weight of cement and foaming combined. The foam consists of one part of the foaming agent diluted with 20 parts of water. As the amount of foam affects the dry density of concrete, hence foam content is varied from 1% to 1.5% to get different target densities. And tested for the same mechanical and physical properties.

References

[1]. Neville and J. Brooks, Concrete Technology, 2, Ed., Harlow: Prentice Hall/Pearson, (2010), pp. 351-352.

[2]. H. J. Goodman, "Low-density Concrete. Fulton's Concrete Technology, EdAddis, B. J. Seventh (revised) Edition," Portland Cement Institute, Midrand, South Africa, pp. 281-285, (1994).

[3]. M. A. O. Mydin and Y. C. Wang, "Mechanical properties of foamed concrete exposed to high temperatures," Construction and Building Materials, vol. 26, no. 1, pp. 638–654, 2012.

[4]. U. J. Alengaram, B. A. Al Muhit, M. Z. bin Jumaat, and M. L. Y. Jing, "A comparison of the thermal conductivity of oil palm shell foamed concrete with conventional materials," Materials and Design, vol. 51, pp. 522–529, 2013.

[5]. E. P. Kearsley and P. J. Wainwright, "The effect of high fly ash content on the compressive strength of foamed concrete," Cement and Concrete Research, vol. 31, no. 1, pp. 105–112, 2001.

[6]. N. Narayanan and K. Ramamurthy, "Structure and properties of aerated concrete: a review," Cement and Concrete Composites, vol. 22, no. 5, pp. 321–329, 2000.

[7]. K. Ramamurthy, E. K. K. Nambiar, and G. I. S. Ranjani, "A classification of studies on properties of foamconcrete," Cement and Concrete Composites, vol. 31, no. 6, pp. 388–396, 2009.
[8]. U. J. Alengaram, H. Mahmud, and M. Z. Jumaat, "Comparison of mechanical and bond properties of oil palm kernel shell concrete with normal weight concrete," International Journal of Physical Sciences, vol. 5, no. 8, pp. 1231–1239, 2010.
[9]. S. B. Park, E. S. Yoon, and B. I. Lee, "Effects of processing and materials variations on mechanical properties of lightweight cement composites," Cement and Concrete Research, vol. 29, no. 2, pp. 193–200, 1999.
[10]. Laukaitis, R. Zurauskas, and J. Keriene, "The effect of foam polystyrene granules on cement composite properties," Cement and Concrete Composites, vol. 27, no. 1, pp. 41–47, 2005.