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The Effect of Polycarboxylate as a Superplasticizer on the Engineering Properties of Foam Concrete

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ABSTRACT

The effect of polycarboxylate ether superplasticizer on engineering characteristics was explored which includes compressive, flexural strength and water absorption. The findings of the test revealed that 1.5% addition of polycarboxylate ether superplasticizer decrease the compressive strength but appreciate the flexural strength. However, the percentage of water absorption ability was found reducing due to the increase in the Polycarboxylate Ether Superplasticizer dosage. Conclusively, the addition of Polycarboxylate Ether Superplasticizer of 1.5% in foam concrete has effect on the compressive strength.

Keywords : Polycarboxylate, Superplasticizer, Properties and Concrete

I. INTRODUCTION

One of the most important and frequently elements which is extensively accepted and utilized in construction industry is concrete [1]. However, considering the self-weight of the conventional concrete and increase demand in construction industry, numerous forms of concretes are invented in attempt to meet the demand [1]. Lightweight concrete having low density that help decrease oneself load of structure, in this manner lessen adherent members size and lower material expense. Likewise, by and large concrete consumed had been broadly diminished in the construction industry [2]. Three significant sorts of lightweight concrete are lightweight aggregate concrete, no-fines concrete and foamed (frothed) concrete. Foamed concrete, or once in a while called aerated, cellular, or gas concrete, is kind of concrete with captured air either by infusing or blending air into the blend during the formation. Lightweight foamed concrete is known by its low thickness, high stream capacity, self-compacting, and great warm and acoustic protection [3]. It can be used in a wide range of construction applications including void filling, channel restoration, soil adjustment, warm and acoustic protection, and floor and rooftop tirades [3].

Superplasticiser known as chemical innovative water reducing agent that is capable of improving the workability by 10-15% and reducing water content by about 30% different from the general water reducer [4]. According to [3] states that various undertakings had been done to build the quality of frothed concrete by consolidating different added substance and admixture into the concrete, for example, fly debris, silica rage and superplasticizer. The incorporation of superplasticizer assists with expanding the stream capacity of foamed concrete with lower water content subsequently; yield better early age quality, long haul mechanical properties, sturdiness, and porousness among others [2]. Recently, Polycarboxylate ether superplasticizer is found to be most widely used over other conventional superplasticizer due to high-scope of water reducer which can perform up to 30% water decrease[5] .

An investigation conducted by [6]to determine the influence on the raw, rheological and strength properties of self-consolidated concrete of different types of superplasticizers. The test results showed that various forms of superplasticizers, including the polycarboxylic inclusion in the mix, had significantly affected the compressive strength. Chie et al., (2018) carried out a study on the impact of polycarboxylic ether superplasticizer on the mechanical properties of lightweight foamed concrete. The investigation was particular to determine the flexural, compressive and tensile splitting strength of the foamed concrete. Testing suggested that addition of the superplasticizer at 1.0% generated paramount performance in both compressive, split and flexural strength that indicate structural work potential and fulfillment of the ACI 318 requirements.

The success of improving the engineering performance of foamed concrete based on polycarboxylate ether superplasticizer dosage influence is relatively low. Hence, the study seeks to explore the effect of polycarboxylate ether superplasticizer addition up till 1.5% dosage as well compressive, flexural and water absorption characteristics.

II. METHODS AND MATERIAL

Portland cement was used in compliance to standard ASTM C150. The amount of cement needed for mix was weighed and remaining put away in a water/air proof holder so as to keep up the nature of cement. The available fine river sand was dried under the hot sun to extract the moisture content in it and was sieved through a 600 μm sieve to allow even size distribution for the foamed concrete before storing in airtight container. Portable tap water was used which comply with BS EN 1008 in the formation of lightweight frothed concrete blend. The faucet water contains no physical polluting influences that may influence the hydration procedure of concrete and furthermore the strength of froth concrete. In addition, similar water was utilized for making the froth.

The locally made frothing agent (Noraite PA-1) made in Malaysia was blended in with water to deliver the watery stable froth by utilizing the froth generator and blower. The frothing agent was diluted in water at a proportion of (1:30) by volume creating stable froth with a thickness scope of 60-75kg/m3. Frothing specialist is utilized by entraining the preformed stable froth into the new lightweight concrete so as to control the thickness of lightweight concrete and accomplish desired density of lightweight concrete range of 900 kg/m^3. Superplasticiser (Polycarboxylate Ether) substance water reducer was used in the foam concrete at different percentages (0.5%, 1.0% and 1.5%).

Fig 1: Foaming Agent Fig 2: Foam Produced

Mix Proportions Design

The design mix ratio of 1:1.5:0.45 was used for the study to prepare the specimen with a target density of 1000 kg/m^3 and a volume of 0.041m^3, 30% wastage was considered. The contrast among target and wet density is fixed at 136 kg/m^3. The mixes were replaced by the Polycarboxylate Ether Superplasticizer accordingly except for the control mix (0 %, 0.5%, 1% and 1.5%) with flow table test kept at a range between 18 cm to 20 cm.

Method of Trial

Fresh Characteristic Trial

The workability of the frothed concrete was conducted utilizing a slump cone and level base plate as per ASTM C1611. This test was done during the blending procedure. Slump cone was modified and put at the focal point of the damp base plate. It was then loaded up with new lightweight frothed concrete until it was full. The new lightweight frothed concrete was compacted by marginally slide by means of steel ruler to guarantee the surface is equally and permit solidification of new lightweight frothed concrete. Excessive new lightweight frothed concrete was struck off. At that point, the reversed slump cone was lifted within 3 seconds without meddling with the progression of concrete. The average diameter of the flow spread was taken at right angle to the flow of the slump to achieve the range of 18 to 20 in accordance with BS EN 12350-2. As anticipated, the flow value reduces as the admixture dosage increases [7].

Fig 4 : Slump Flow Trial Harden Characteristic Trial

Compression Strength Trial

Frothed concrete 3D (cubes) squares of 100 mm x 100mm were cast and utilized to decide the compressive quality for 7, 14, and 28 days by utilizing compression machine named GOTECH GT-7001-BS300 with 3000kN compressive limit agree to BS EN 12390-3 (2009). Specimens were kept in a stove at a temperature of 105°C and 24 hours preceding trying day. At that point, the specimens were taken out, weighed and left to cool prior trying. An axial compressive burden (load) is applied to the shape with explicit rate persistently. The compressive quality was dictated by taking the average mean for two specimens for each period of trying. The greatest burden conveyed by the specimen is recorded and compressive quality is determined dependent on condition as appeared in underneath. Mean estimation of compressive quality acquired from two cubes was then taken as solid shape compressive quality for every lightweight frothed concrete blend.

$Fc = F/Ac$

Where: Fc: Compressive strength (MPa);

F: Maximum load at failure (N);

Ac: Cross section of specimen (mm^2)

Fig 5: Compression Trial Machine (GOTECH GT-7001-BS300)

Flexural Strength Trial

Flexural trial was conducted in line with BS EN 196 Part 1. The trial was carried out with a center-point loading to prism having measurement of 100 mm x 100 mm x 500 mm until the experiments failed. The average load the specimen endured was registered and the flexural strength was measured.

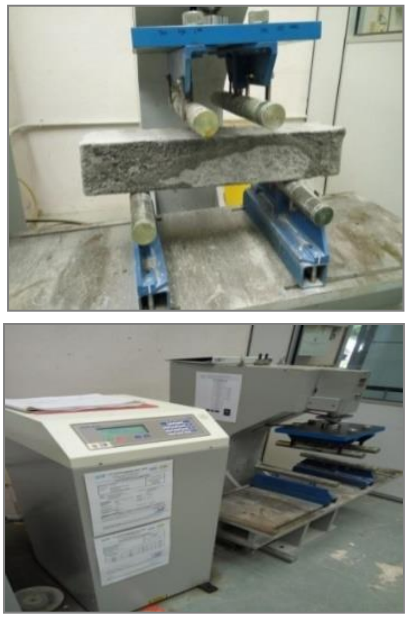

Fig 6:Four Points Flexural Trial

Water Absorption Trial

Water absorption experiments were carried out to determine the permeability of the capillary pores; this research method offers a methodology for assessing the relative characteristics of moisture absorption over time of the materials used for construction. A collection of two specimens in the form of 75±3 mm diameter and 150 mm height for core shall be collected for a representative sample. Firstly, the specimens were dried in the 72±2 hour oven. The samples were again taken out of the oven and cooled prior processing. The sample weight was measured and registered as W_d. Afterwards the specimens were completely immersed in the water for 30±0.5 minutes and removed from the water. The wet specimens were wiped off with cloth. Last, the specimens were weighted again and recorded as Ws. The equation to calculate the water absorption as shown in below:

$$Wa = (Ws - W_d) / W_d \times 100\%$$

Where: Wa: Water Absorption (%); Ws: Saturated mass of specimens after submerged in water (g);
Wd: Dry mass of specimens before immersed in water (g).

III. RESULTS AND DISCUSSION

Compressive Strength

Figure 7 displays the outcome of 100 mm x 100 mm compressive foam concrete cubes tested strength for 7, 14 and 28 days. The foam concrete mix of ratio1: 1.5: 0.45 with addition of Polycarboxylate Ether Superplasticizer at 0.5, 1 and 1.5% shows steady strength properties. The compressive strength at 0% is relatively low compared to when Polycarboxylate Ether Superplasticizer was added at 0.5% and 1%. In addition, the 28 days curing age, compressive strength for 1.0% stood the utmost point that was 7.064 MPa, while at 1.5% addition of Polycarboxylate Ether Superplasticizer admixture indicated decrease in strength in 7 days curing age. It can be inferred that the higher the Polycarboxylate Ether Superplasticizer there will be decrease in compressive strength which may be due to overdosing effect in the amount of Polycarboxylate Ether Superplasticizer.

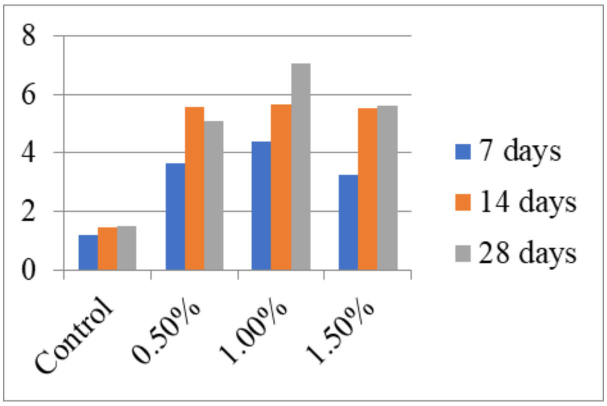

Fig. 7: Compression Strength Trial

Flexural Test

Agreeing to fig. 8, addition of Polycarboxylate Ether Superplasticizer at 0.5, 1 and 1.5% results showed that flexural strength development tendency was growing at a good pace throughout the curing ages (7, 14 and 28) days respectively. Hence, when subjected to bending stress, foamed concrete is capable of enjoying higher flexural strength, particularly where plain concrete is used. It can be deduced that Ether Superplasticizer Polycarboxylate appreciates the flexural strength of foamed concrete.

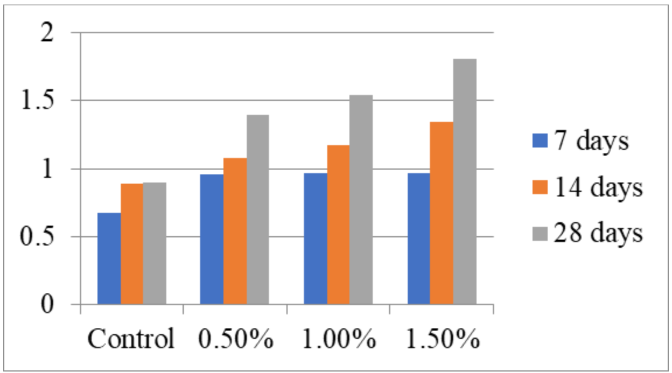

Fig 8: Flexural Strength Trial

Water Absorption Test for 28 days

Figure 9 showed the percentage of water absorption by various percentage of Polycarboxylate Ether Superplasticizer. It was deduced that the percentage of absorption of Polycarboxylate Ether Superplasticizer at 0.5% was the highest with percentage of absorption 8.65%. The percentage of Polycarboxylate Ether Superplasticizer at 1 and 1.5% had seen drop in its absorption to 6.49 % and 6.22% respectively. As the content of the Polycarboxylate Ether Superplasticizer increases, the percentage of absorption decreases, suggesting an opposite pattern showing the effect of Polycarboxylate Ether Superplasticizer on absorption mitigation.

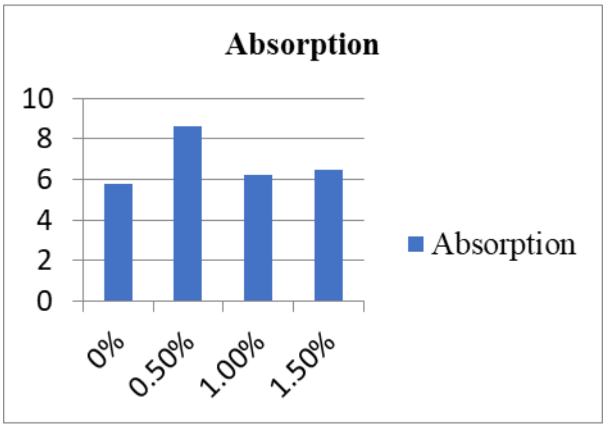

Fig 9: Water Absorption Test for day 28

IV. CONCLUSION

Conclusively, 1.5% Polycarboxylate Ether Superplasticizer in the foam concrete decreased the compressive strength which demonstrates that overdose had effects on the compressive strength, whereas, the incorporation of Polycarboxylate Ether Superplasticizer had increased the flexural strength of the foam concrete. However, the percentage of water absorption ability was found reducing due to the increase in the Polycarboxylate Ether Superplasticizer dosage.

V. REFERENCES

[1]. Y. L. Lee, C. H. Oh, M. H. Lim, and F. W. Lee, "Engineering Properties of Foamed Concrete Containing Water Repellent," E3S Web Conf., vol. 65, pp. 1–10, 2018.

[2]. P. Chie, H. Ling, K. C. Shim, L. A. Bennet, and C. Siang, "Mechanical properties of lightweight foamed concrete using polycarboxylate ether superplasticizer Mechanical properties of lightweight foamed concrete using polycarboxylate ether superplasticizer," 2018.

[3]. P. C. Hui Ling, K. C. Shim, L. A. Bennet, C. S. Tan, and E. L. Yong, "Mechanical properties of lightweight foamed concrete using polycarboxylate ether superplasticizer," IOP Conf. Ser. Mater. Sci. Eng., vol. 431, no. 6, 2018.

[4]. B. Mathonier, F. Application, and P. Data, "(12) United States Patent," vol. 2, no. 12, 2014.

[5]. L. Lei and J. Plank, "A concept for a polycarboxylate superplasticizer possessing enhanced clay tolerance," Cem. Concr. Res., vol. 42, no. 10, pp. 1299–1306, 2012.

[6]. A. Mardani-Aghabaglou, M. Tuyan, G. Yilmaz, o. Arioz, and K. Ramyar, "Effect of different types of superplasticizer on fresh, rheological and strength properties of self-consolidating concrete," Constr. Build. Mater., vol. 47, pp. 1020–1025, 2013.

[7]. Y. F. Houst, P. Bowen, and F. Perche, "Theme One : Advances in Admixture," pp. 10–20.

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