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EXPERIMENTAL TESTS OF FOAMED CONCRETE WITH STEEL FIBER INCLUSION BASED ON ELASTICITY PROPERTIES

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ABSTRACT: Basically in civil engineering foamed concrete is used for high quality buildings which have high density from 300 to 1850 kg/m3. The foamed concrete will have structures of load-bearing and insulation from heat and sound. Hence in this paper experimental test of foamed concrete with steel fiber based on elasticity properties is done. The experimental test mainly follows the flexural strength, modules of elasticity, splitting strength, compressive strength and density. Compressive strength test is conducted mainly on the cubes with dimensions 100*100*100 mm. According to ASTM C496 the dimensions splitting tests are measured which is about 150 x 300 mm. According to ASTM C79 the dimensions of flexural strength is taken about 100*100*500 mm. The specimen maintained the diameter for elasticity test module is at 150mm and height at 300 mm. Hence compared with other steel fibers, hybrid fibers gives better outcomes.

KEY WORDS: Foamed concrete (FC), Fibers, Steel Fiber, Different Aspect Ratio.

I.INTRODUCTION

Foamed concrete (FC) has as of late become far reaching building material for warm protection and primary purposes. FC's developing interest influenced its astounding warm seclusion execution, the capacity to discard different waste and other significant highlights. At its center, FC is produced using a substantial blend into which pre-arranged froth is presented, making an arrangement of shut voids inside the solidified composite. FC, which is one of the assortments of cell concrete, draws in much consideration of developers around the world. Frothed concrete has pleasant functionality and has a place with lightweight composite [1]. FC can be utilized for warm and sound confinement, fire security as well as impact thickness; by the by, low mechanical and actual qualities of FC essentially limit the extent of its application in substantial designs.

Like any remaining cements, it has a significant degree lower elasticity contrasted with compressive strength. Besides, inferable from a lot of entrained air, the solidifying blend is dependent upon shrinkage generally. As with other microstructure cements, the flexural and rigidity of FC is 15 to 35% of its compressive strength. The use of various strands in the substantial framework has been found to decrease shrinkage breaks and work on mechanical properties, especially elastic and flexural ones [2]. As of late indispensable energy-productive and harmless to the ecosystem building advancements are driving the improvement of green composites. The reason for fostering a large number of these lightweight composites is unadulterated concrete joined with fine sand and discrete, uniformly divided, miniature or naturally visible air cells. Accordingly, FC gives the above benefits, diminishes development expenses and takes into account feasible plans with low weight.

In the creation of high strength, low water to folio proportion (w/b) and the consideration of fly debris, silica rage, and ultrafine silica powder are prescribed as a substitute to sand [3]. To expand FC's mechanical qualities, the water-restricting proportion w/b is typically maximally diminished, as well as the utilization of finely scattered pozzolanic unrefined components as a swap for fine total. Consolidation of haphazardly arranged filaments into frothed cement can further develop load move every which way, and rigidity builds because of the production of an elastoplastic composite. Improvements of such kind can drive the production of frothed concrete using in load-bearing designs.

One of the consequences of dealing with green and ecological well disposed advancements has been the plan and creation of substantial items, among which are the utilization of lightweight total and circulated air through concrete. Notwithstanding it being a decent item in building material innovation, there are still vulnerabilities concerning the way of behaving of its mechanical properties and its toughness [4]. Contrasted with ordinary concrete, lightweight cement is absolutely no match regarding its mechanical properties, particularly in its compressive strength.

Moreover, its shrinkage conduct has been supposed to fundamentally deter. Be that as it may, numerous specialists are attempting to emerge with additional discoveries to upgrade the viability of lightweight cement. One of the most well known ways of improving its mechanical properties and toughness is fiber consideration. Lightweight Foam Concrete (LFC) is gotten from circulated air through cement to deliver a lightweight structure material item. Lightweight frothed (or cell) concrete is regularly produced using blending slurry mortars with stable froth. This activity encases little air rises inside the mortar which respond as the total accordingly making it lighter and having exceptional properties, for example, high imperviousness to fire and low warm conductivity [5]. During the plastic stage, gas-structure synthetic compounds are blended into the concrete mortar, bringing about an expansion in volume and a reduction in blend thickness, and when the gas get away, it leaves a permeable construction that frames the total.

II. EXPERIMENTAL WORK

A. Materials

1. Cement

Ordinary Portland cement is used in all concrete mixes as cement. The below table (1) shows the cement main components and chemical composition. The below table (2) shows the physical properties of cement.

TABLE 1. CHEMICAL COMPOSITION AND MAIN COMPOUNDS OF CEMENT

Compound Composition	Chemical Composition	Percentage By Weight	Limit of Iraqi Specification No.5/1984
Lime	CaO	61.19	-
Silica	SiO2	21.44	-
Alumina	Al2O3	4.51	-
Iron oxide	Fe2O3	3.68	-
Magnesia	MgO	2.31	5.0 (max)
Sulfate	SO3	2.7	2.8 (max)
Loss on ignition	L.O.I.	2.39	4.0 (max)
Insoluble residue	I.R.	1.18	1.5 (max)
Lime saturation factor	L.S.F.	0.87	(0.66-1.02)%
Main compounds (Bogue's equation)		***Limit of Iraqi Specification No.5/1984***	
Tricalcium Silicate	C3S	42.83	-
Dicalcium Silicate	C2S	29.4	-
Tricalcium Aluminate	C3A	5.73	-
Tetracalcium aluminoferrite	C4AF	11.19	-

TABLE 2. PHYSICAL PROPERTIES OF THE CEMENT

Physical Properties	Test result	Limit of IOS 5:1984 14].
Fineness using Blaine air permeability apparatus (m^2/kg)	405	> 230
Soundness using autoclave method	Not available	< 0.8 %
Setting time using Vicat's instrument Initial (min) Final (hrs.)	135 3.25	> 45 min < 10 hr.
Compressive strength for cement paste cube (70.7 mm) at 3 days (MPa) 7 days (MPa)	24.4 32.3	>15 > 23

2. Sand

The below table (3) shows the silica sand sieve analysis. In this utilization of fine standard silica sand aggregates are used.

TABLE 3. SILICA SAND SIEVE ANALYSIS

Sieve size	Passing %
600 μm	93
300 μm	23
150 μm	4.5
pan	0

3. Steel Fiber

The below figure (1) shows the steel fiber. Table (4) shows the steel fiber properties in detail manner.

Fig. 1: Steel fiber

TABLE 4 FIBER PROPERTIES

Fiber Properties	Quantity		
Type of steel Fiber	hooked-end	hooked-end	micro*(13)
Average Fiber Length (mm)	30mm	60mm	15mm-16mm
Average fiber width, (mm)	0.6	0.75 mm	0.2mm+/-0.02mm
Aspect Ratio (L/d)	50	80	40-80
Shape	hook	hook	Flat Straight
Tensile strength (MPa)	>1100	>1100	>2850
Ultimate elongation (%)	<2	<2	
Specific Gravity	7.85	7.85	7.85

4. Foaming Agent

According to ASTM C796/C796M foam generator will generates chloride free proportions liter foam to 30 liter water which is shown in table (5).

5. Silica fume

From table (5) silica fume percentage of foam control is given in detail manner. 10% of weight cement is obtained for silica fume.

6. Chemical Admixture (Super plasticizer)

For both mortar and cement the generation super plasticizer is taken as Sika Viscocrete-5930 according to ASTM-C- 494 Typos G and F.

B. Mix Proportion:

From table (5) mix proportion is given in detail manner. 1800kg/m^3 is the target of density.

TABLE 5. MIX PROPORTION

Name	Cement kg/m^3	fine aggregate kg/m^3	Silica fume kg/m^3	steel fiber %	Water Kg/m3	Sp kg/ m^3	Foam agent / m3
Foam control	708.0	786.7	78.7	0.0	220.3	6.3	21.6%
S60-.4	698.5	776.1	77.6	31.2	217.3	6.2	22.3%
S60-.2	703.2	781.4	78.1	15.6	218.8	6.3	21.9%
s30-.4	698.5	776.1	77.6	31.2	217.3	6.2	22.3%
micro - .4	698.5	776.1	77.6	31.2	217.3	6.2	22.3%
hyprid - .4	698.5	776.1	77.6	31.2	217.3	6.2	22.3%

Fig. 2: MIX PROPORTION

III. EXPERIMENTAL TESTS

The experimental test mainly follows the flexural strength, modules of elasticity, splitting strength, compressive strength and density. The below shows the description of each test in detail manner:

A. Flow test

The below figure 3 shows the mortar test flow. According to ASTM C1437 workability is measured.

Fig. 3: FLOW TEST

B. Compressive test

The below figure 5 shows the compressive strength tests according to ASTM C39. This test is conducted mainly on the cubes with dimensions 100*100*100 mm.

Fig. 4: COMPRESSIVE STRENGTH

C. Splitting tensile test

The below figure 5 shows the splitting test of concrete cylinders. According to ASTM C496 the dimensions are measured which is about 150 x 300 mm.

Fig. 5: SPLITTING TEST

D. Flexure test

The below figure (6) shows the flexural strength. According to ASTM C79 the dimensions are taken about 100*100*500 mm.

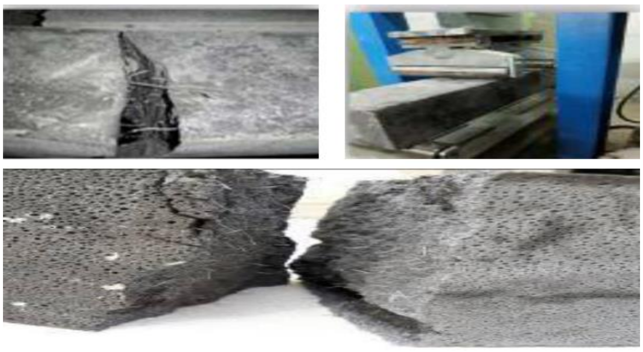

Fig. 6: FLEXURE TEST

E. Modules of elasticity

The below figure (7) shows the elasticity test module. In this two different values are utilized as strain and stress. The specimen maintained the diameter at 150mm and height at 300 mm.

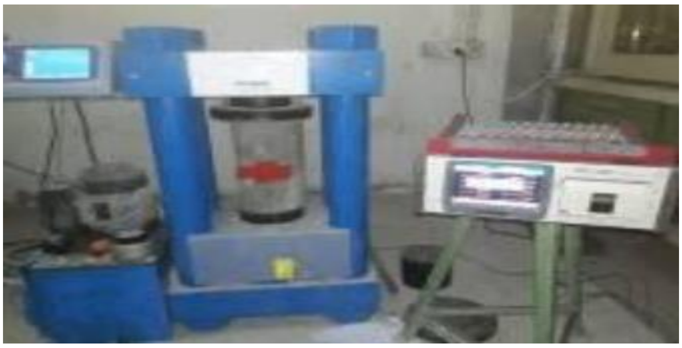

Fig. 7: MODULES OF ELASTICITY TEST

IV. RESULT ANALYSIS

The below figure (8) shows the test results of flow. Flow mainly depends on the aspect ratio type of fiber. Good workability is obtained because of flow. 0.2 % workability is obtained in the presence of mix and 0.4 % workability is obtained after the fresh mixes. Compared with other types of steel fiber, micro steel fiber gives better workability.

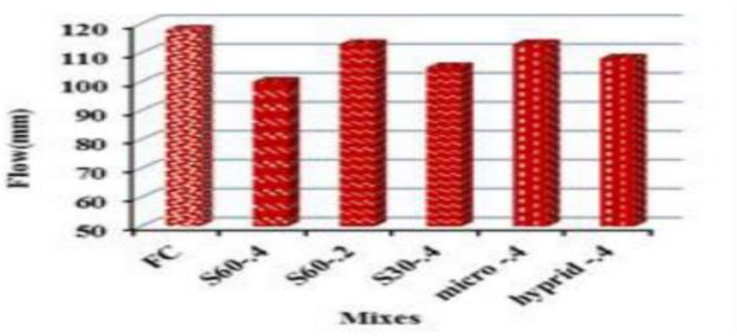

Fig. 8: FLOW TEST RESULTS

The below figure (9) shows the density results at 7 days and 8 days. According to ASTMC567M the density should be maintained at 1800 or lower. From this it can observe that better density is obtained when amount of foam in the mix depends on the homogeneity and distribution. There is a decrement in density with respect to time because of atmosphere and surrounding temperatures variations. Hence density should be maintained at 1800 or lower.

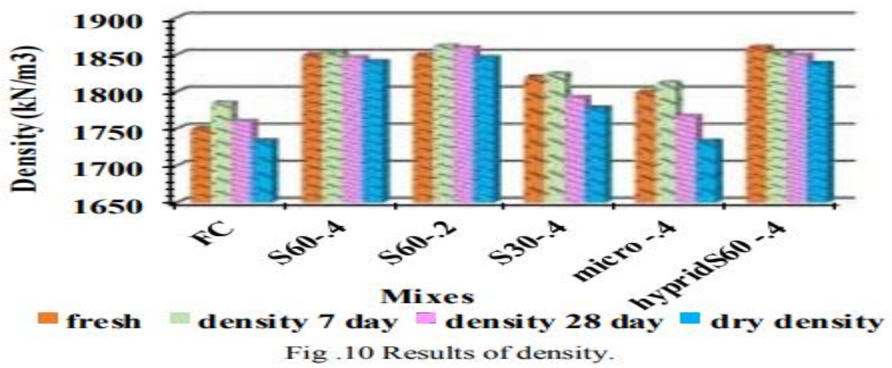

Fig .9: DENSITY RESULTS

The below figure (10) shows the compression strength test results which depends on the different aspect ratios and different mixes.

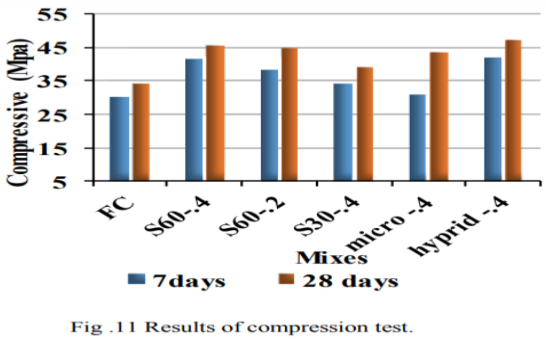

Fig. 10: COMPRESSION TEST RESULTS

The below figure (11) shows the splitting tensile strength results. This is based on the different aspect of ratio of fiber. Compared with single fiber reinforced concrete, hybrid steel fiber concrete gives better results.

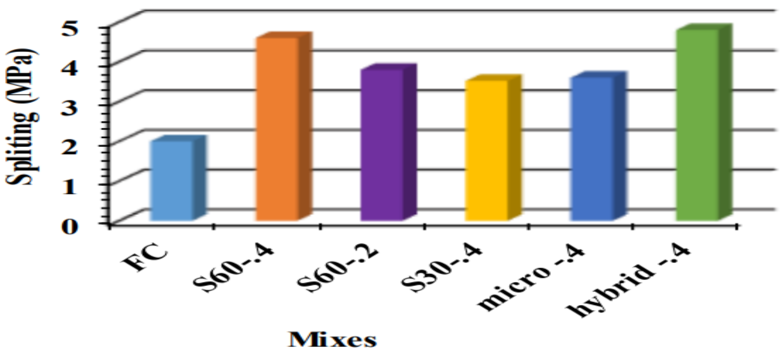

Fig. 11: SPLITTING TENSILE TEST RESULTS

The below figure (12) shows the results of flexural strength which depends on the different aspect ratio.

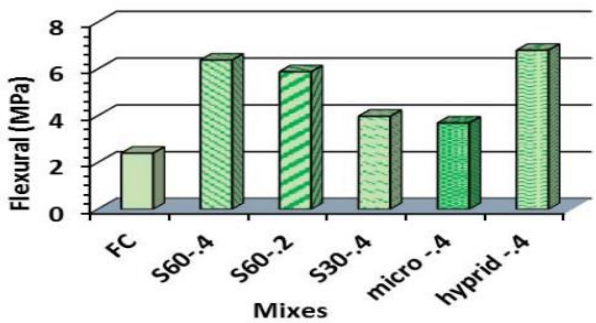

Fig. 12: FLEXURE TEST RESULTS

The below figure (13) shows the elasticity module test. There is an increment in hybrid steel fiber because of high bond in mix led.

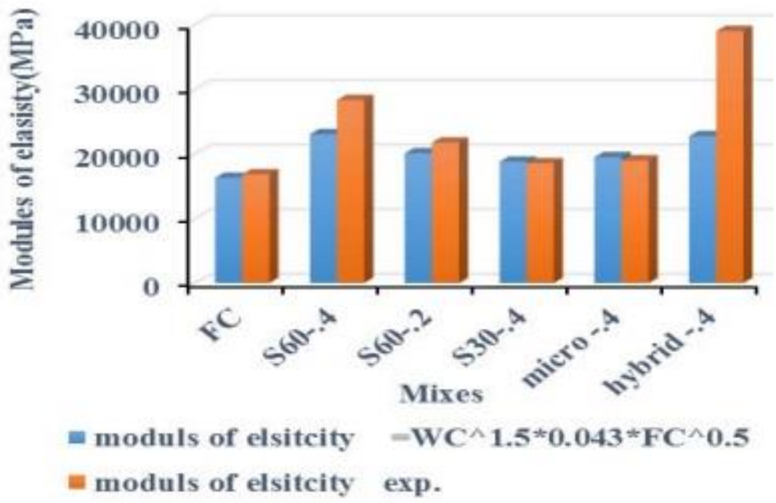

Fig. 13: MODULES OF ELASTICITY TEST

V. CONCLUSION

The below shows the conclusion of foamed concrete with steel fiber inclusion based on elasticity properties:

- The property of foamed concrete is improved under different aspect ratios of steel fiber
- Steel fiber volume percentage increases by reducing workability.
- Because of bond mechanism there is increment in the volume percentage of steel fiber in compressive strength.

- Based on different aspect ratio there is increases with increment in the percentage of steel fiber in splitting tensile strength.
- In steel fiber there is increase in the increase of aspect ratio of steel fiber in flexural strength.
- There is increase in the aspect ratio of steel fiber with increase in modules of elasticity.

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