EXPERIMENTAL STUDY OF STEEL FIBRE AND FOAMED REINFORCED CONCRETE BEAM

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Abstract - *Lightweight foamed concrete has been a recent approach for construction material. It is a concrete product that contains entrapped air bubble that acts as the aggregate which is lighter than the normal concrete. Ordinary reinforced concrete has heavy dead load hence self-weight of the building is increased. By using light weight foam concrete, self-weight is much reduced. By using steel fiber and silica fume compressive strength is increased. Thereby it gives the similar compressive and flexural strength on ordinary reinforced concrete beam. In this investigation five different mix ratios are to be trialed. M1 mix was a conventional concrete as M20. M2 mix has 2.5 % of steel fiber and 15gms/lit foam. M3 mix has 2.5 % of steel fiber and 15gms/lit foam. And M4 mix has 5 % of steel fiber and 30gms/lit foam .M5 mix has 30gms/lit foam and 5% of steel fiber. In this experiment maximum compressive strength, tensile strength and flexural strength among the mixes is concluded.*

***Key Words*: CLC foam, steel fiber, silica fume.**

1. INTRODUCTION

By introducing gas bubbles into conventional concrete which produces a material of lower density called foam concrete. It is used not only as an insulating material for sound and heat, but also as a fire-resistant material. Light weight foam can be used to reduce the dead load, minimize the inertia effect due to earthquakes and the sections of the building members is decreased. Thus, the structural foundations become less demanding and the building cost is decreased [1], [2]. However, this type of concrete has lower mechanical properties and more cement may be required for the same strength as a normal concrete [3]. Typical lightweight concrete has densities from 1000 to 2000 kg/m^3, compressive strengths varies from 1 to 110 N/mm^2. [4] The workability of concrete significantly reduced as the fibre dosage rate increases. [5] silica fume prevent corrosion of the concrete.it absorbs excess water and hence avoids bleeding of the fresh concrete.

1.1 Objectives of Study

In this investigation to decrease the self weight by using foam and steel fibre in the concrete. Study the compressive, split tensile and flexural behavior of concrete contains foam in concrete.

- To reduce the self-weight of concrete beam and also to develop the stability of concrete using foam.
- To reduce the crack of the concrete after it attains its plastic limit.
- To differentiate the flexural strength of steel fibre Foamed Beam with conventional Beam.
- To compare the Percentage increase in the stability of Foam Concrete over Normal Concrete.

2. MATERIALS

The foamed concrete has been produced by using the following constituents' viz. cement, sand, water and foaming agent, reinforcement bars. And additionally added with steel fiber, silica fume to improve the strength of the hardened concrete.

2.1 Foam and Foaming Agent

CLC concrete has very good probable which helps to construction the cellular light weight applications. It should be reduced the density of concrete. In this investigation two ratio of foam is to be used, that is 15gms/lit and 30gms/lit.

Table 1: Physical properties of CLC

Type	synthetic based foaming agent
Colour	brown
State	liquid
Specific gravity	1.15
Ph at 20ºC	6.5 to 7.5
water solubility	infinite
Freezing point	3 to -5 °C

2.2 Silica Fume

Silica fume used was observing to ASTM- C (1240-2000) and was provided by "elkem industries" was called elkem – micro silica 920 d. the silica fume is used as a partial substitution of cement.

Table 2: Properties of Silica Fume

Specific Gravity	2.25
Bulk Density	575 (Kg/m^3)
Size	0.10 (Micron)
Surface Area	20,100 (m^2/kg)
$Si0_2$	95 %
Al_2O_3	0.6 %

2.3 Steel fiber:

In this investigation hooked end steel fiber is to be used. Cold-drawn hooked end steel fiber is produced by standard base steel bar, which has outstanding mechanical properties as well as high tensile strength. Hook-end steel fiber benefits for substantially enhance initial crack strength. Continuously provide post-crack strength, increase speed of construction, stronger joints lower the possibility of maintenance, save money and time.

Table 3: Characteristics of steel fiber

Diameter	0.5 mm
Length	45 mm
Aspect Radio	90
Tensile strength	≥1000Mpa
Material	Low carbon steel bar
Coating	Non, Bright
Packaging	1000kg per plastic bag and/or 20kg per paper bag

3. MIX PROPORTION:

In this study mix design was done as per Indian standard guidelines in IS: 10262-2009. Depending upon the level of quality control available at the site, the concrete mix has to be designed for the target mean strength, which is higher than the characteristic strength.

The following details are mix design for M20 concrete.

Table 4: Mix Proportion

Cement	Fine aggregate	Coarse aggregate	water
395	670	1160	198
1	1.45	2.5	0.5

- Additionally foaming agent is to be used based on water content (15,30gms/lit)
- And added with 2.5%, 5% of steel fibre, 5% of silica fumes in concrete.

4. TEST AND RESULTS

4.1 Compression test:

Compressive strength is consequence property of the hardened concrete. The concrete cubes were casted, cured and tested following with IS standard with 7 days & 28 days. Compare with M1, M2, M3, M4 and M5 beams. M5 beam have a high compressive strength. And also steel fiber to avoid the failure and reduces the cracks on the concrete.

Table 4.1 denotes compressive strength about the concrete cube at 7 days and 28 days. In this table compression strength of five mix ratios is obtained. Of these values M5 provides maximum compressive strength by 28 days.

Table 5: Compressive Strength of Cube

mix	7 days N/mm^2	28days N/mm^2
M1-F0% SF0%	17.12	26.65
M2-F30 SF 2.5%	23.53	36.2
M3-F15 SF2.5%	21.52	33.11
M4- F15 SF5%	26.07	40
M5-F30 SF30%	26.46	42

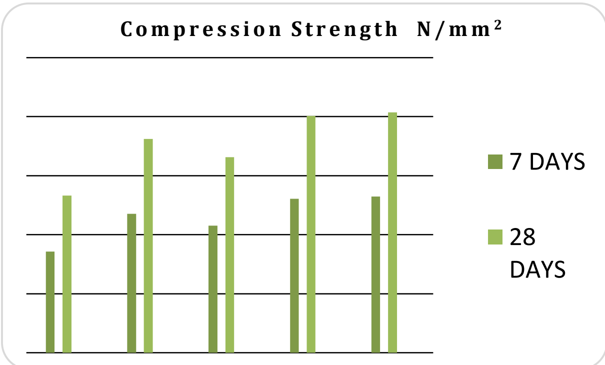

Figure1: compressive strength of cube

Figure 2: compressive strength of cube

Compressive strength result of concrete is listed in Table 4.1 the maximum compressive strength value is 40.71N/mm². It should be obtained by M5 mix. Compressive strength is to be used to find out optimum value of foam in concrete.

4.2 Split Tensile Strength

Steel fiber is to be increased the tensile strength of concrete, because steel fiber should create as a bonding between concrete particles. Compare with M1, M2, M3, M4And M5. M4 and M5 have a high tensile strength compare with conventional concrete.

Table 4.2 denotes split tensile strength by the concrete cylinder at 7 days and 28 days. In this table spilt tensile strength of five mix ratio is obtained. Of these values M5 provides maximum split tensile strength by 28 days.

Table 6: Split Tensile Strength of Cylinder

mix	7 days N/mm²	28days N/mm²
M1-F0S F0%	1.88	2.9
M2-F30 SF 2.5%	2.01	3.10
M3-F15 SF2.5%	2.15	3.32
M4- F15 SF5 %	2.25	3.47
M5-F30 SF 5%	2.30	3.54

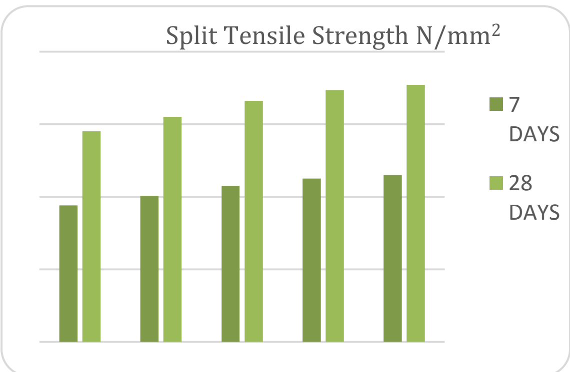

Figure 3: Split Tensile Strength of cylinder

Figure 4: Split Tensile Strength of cylinder

4.3 Flexural Strength:

After curing of concrete beam specimens, they were placed in testing machine having a highest capacity about 100KN. The load is applied on the beam specimens. Compare with M1, M4 and M5 beams. And also steel fiber beam have a gradually failure is to be occur.

Table 4.3 denotes flexural strength based on the concrete beams at 7 days and 28 days. In this table flexural strength of five mix ratio is obtained. Of these values M5 provides maximum compressive strength by 28 days. Flexural strength is denoted by N/mm².

Table 6: Flexural Strength of Beam

mix	7 days N/mm²	28days N/mm²
M1-F 0 SF 0%	2.03	3.13
M4- F 15 SF 5%	3.12	4.8
M5-F 30 SF 5%	3.32	5.12

Figure 5: Flexural Strength of beam

Figure 6: Flexural Strength of beam

4.4 Deflection of Beam:

Table 4.4 denotes the deflection of beam in M1 mix ratio, M1 mix was a conventional concrete as M20 grade of concrete.

Table 4.5 denotes the deflection of beam in M5 mix ratio, M5 mix have an 30gms/lit foam and 5% of steel fiber.

Figure 4.7 shows that load vs deflection on M1. M1 is denoted as conventional concrete that is M20 grade of concrete. Its ratio was 1:2:4. In M1 mix deflection is gradually increased.

Figure 4.8 shows that load vs deflection on M5. M5 is denoted as foam and steel fiber concrete that is M20 grade of concrete. Its ratio was 1:2 and also added with 5% of steel fibre, 30gm/lit foaming agent and 5% of silica fume is to be added. In M5 mix deflection is gradually increased.

Table 7: Deflection on M1

S.NO	Load (KN)	Deflection (mm)	Stress N/mm²
1	1.96	0.2	1
2	5.88	0.95	0.63
3	9.81	1.8	5.45
4	13.73	2.75	4.99
5	17.65	3.7	4.77
6	21.58	4.6	4.69
7	25.50	5.6	4.55
8	29.43	6.7	4.39
9	33.35	8.15	4.09
10	37.27	15	2.48

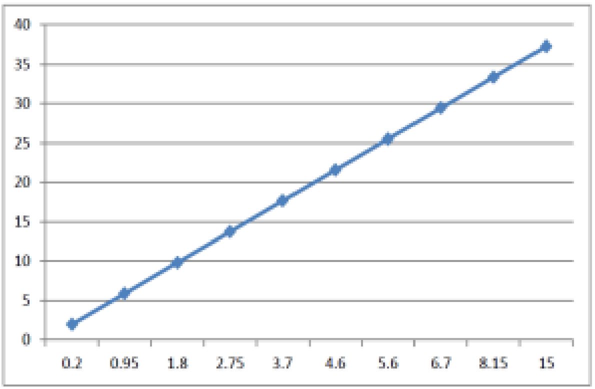

Figure 7: load vs deflection on M1

From figure 4.7and 4.8 denoted as X axis refered as deflection, y axis refered as load.

Table 8: Deflection on M5

S.NO	Load (KN)	Deflection	Stress (N/mm²)
1	1.96	0.1	0.196
2	5.88	0.46	12.78
3	9.81	1	9.81
4	13.73	1.75	7.845
5	17.65	2.4	7.35
6	21.58	2.7	7.99
7	25.50	3.45	7.39
8	29.43	4.1	7.17
9	33.35	4.8	6.94
10	37.27	5.6	6.65
11	41.20	6.8	6.05
12	45.12	7.9	5.711
13	51.01	10.3	4.95
14	54.93	13	4.22

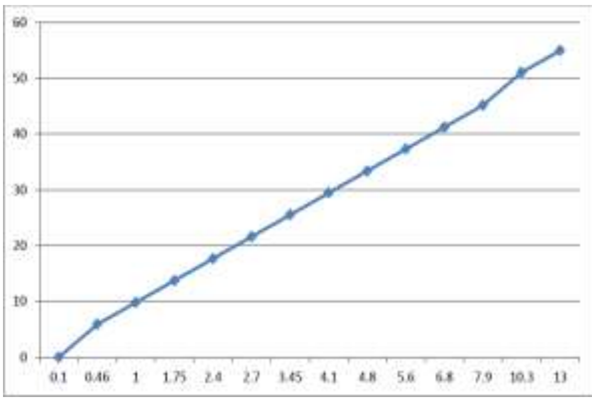

Figure 8: load vs deflection on M5

5. CONCLUSIONS:

From the test results the following conclusions are made

i. Foam concrete specimen with steel fibre added with silica fume gained more density with conventional concrete.
ii. Five mixes with different proportions of foam, steel fibre and silica fume were adopted M5 was found to be optimum.
iii. M5 was adopted for the optimum mix. It was seen that the 7 days and the 28 days' compressive strength corresponding to M20 grade of concrete.
iv. From the investigation it was clear that 30gms foam has pronounced effect on the propertied concrete for M20 mix. Further increase in foam content does not shows significant increase in mechanical properties of concrete.
v. The split tensile strength of M5 is found to be high in 28 days by 45.3% as compared to the mix without fibres.
vi. Better flexural strength was achieved with 5% of steel fibre. On comparison of mix without fibre is an increase of 42% by 28 days.

From the about test results M5 attains maximum compression strength. When compare to M1, M2, M3 and M4. And hence M5 attains the optimum for light weight concrete. Which rust on reduces the self-weight of structure.it also withstand flexural and split tensile strength.

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