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Improving Stress and Stress Curve of Concrete by Reinforcing Glass Fibers

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ABSTRACT

Concrete is the most widely used construction material on the planet. The reason being its strength in compression. But it is very weak in tension. Therefore, many microcracks will be developed. These occur due to shrinkage in general. Concrete also has very little ductility and resistance to the cracks developed. To improve the nature of the concrete, Glass Fibers have been added while testing to improve the mentioned characteristics. The cement used is Ordinary Portland Cement (OPC) without any admixtures. In this investigation, glass fibers have been added in percentages ranging from 0.00% to 0.10%. The results after each interval of addition have been described and the changes in the properties (both mechanical and ductility) have been shown.

Keywords: Concrete, Ductility, Glass Fibers, Reinforcement, Investigation.

I. INTRODUCTION

Concrete is widely used and it was observed concrete developed cracks under excess loading. These cracks develop due to various factors such as plastic shrinkages, drying shrinkages and due to the practices followed during laying the concrete. In addition, there are many factors that play a role in decrease in strength.

In order to decrease the crack formation and to increase the strength of concrete in flexure, fibers can be added. These fibers will keep the concrete linked and prevent the propagation of microcracks. These fibers are also an additional reinforcement in the concrete, covering the complete volume along with weighing less and not disturbing the properties of the derived concrete.

II. Reinforcing using Fibers

Fibers of very thin, short in length and random shapes are used. These are embedded in the concrete during the mixing. Due to this, there are 2 effects: First, there will be drastic reduction in the rate of workability; Second there will be very viscous mixture preventing the segregation and bleeding. All the aggregate particles will be engulfed in the fibers and hence there will be strong contact between the aggregate particles and the cement. Since there is locking, the fibers shall act as a reinforcement in addition to the steel reinforcement provided.

III. About Fiber Reinforced Concrete

Fiber Reinforced Concrete (FRC) is made of conventional concrete added with a limited amount of fibers. It is to be noted that the fibers are discontinuous and of random lengths.

Fibers are the main load carrying entities while their surrounding cement keeps them in the fixed position. Therefore, they are less exposed to the surroundings. Hence the structural properties provided by these materials will remain unaffected even after years. The fibers in length, but here fibers of length 6mm, 12mm have been used.

IV. Experiment

The experiment has been carried out using 6mm, 12mm glass fibers in M20 and M40 concrete respectively. M20 and M40 concrete cubes without any addition of fibers are also prepared to correlate the findings.

The cube that has been used as a mold for carrying out the experiment has been shown in Figure 1.

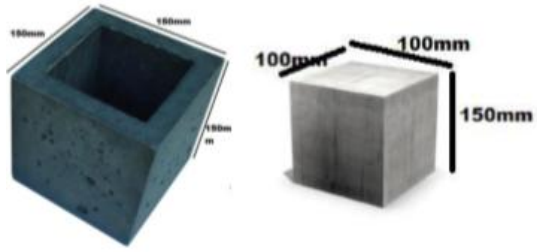


Figure 1: Dimensions of the mold used

Its outer dimensions are 150×150×150 (all in mm) and the inner dimensions are 100×100×150 (all in mm).

	Grade of Concrete	Length of Fibers (mm)	Concrete type	Glass Fiber Percentage	Number of cubes
1	M20	6	no fibers	0	3
			with fibers	0.03	3
				0.06	3
				0.09	3
2	M20	12	no fibers	0	3
			with fibers	0.03	3
				0.06	3
				0.09	3
3	M40	6	no fibers	0	3
			with fibers	0.03	3
				0.06	3
				0.09	3
4	M40	12	no fibers	0	3
			with fibers	0.03	3
				0.06	3
				0.09	3

Figure 2: Number of cubes prepared for testing

a. Materials needed

The following are the materials that are needed to make the cubes.

- Ordinary Portland Cement (Grade 53)
- Fine Aggregates
- Coarse Aggregates
- Glass Fibers (6mm and 12 mm length)
- Water

i. Ordinary Portland Cement

OPC conforming to IS 12269 the has been used.

Properties of the cement are as follows

Specific gravity	:	3.14
Standard Consistency	:	34%
Initial Setting Time	:	36 min
Final Setting Time	:	214 min

ii. Fine Aggregates

Fine aggregate conforming to Zone 2 of IS 383 has been procured and used.

Properties of the fine aggregate are as follows

Bulk Density	:	1.40g/cc
Specific Gravity	:	2.69
Fineness Modulus	:	2.85

iii. Coarse Aggregates

Coarse aggregate conforming to IS 383 has been used. 20mm size well-graded aggregates have been used.

Properties of the coarse aggregate are as follows

Bulk Density	:	1.47g/cc
Specific Gravity	:	2.79
Fineness Modulus	:	7.2

iv. Water

Potable water has been used for mixing and curing the special concrete.

b. Mixing

Mix all the ingredients dry in the pan mixer. This shall ensure uniformity when adding water. At the end of dry mixing, water is added. The mixing is continued for the next 4 minutes.

c. Casting

Molds were filled so that there was no gap between the walls of the mold and the specimen filled.

d. Curing

After casting is complete, specimens were stored at 27 degrees temperature for 24 hours. After drying, they were placed in water bath and were cured for 28 days.

e. Testing

At the end of the 28-day curing period, the specimen cubes are taken out and tested for Ultimate Strength on the Universal Testing Machine (UTM). The capacity of the UTM is 2000 KN.

V. RESULTS

Table 1: Results for all specimens with 6mm fibers

Fiber Percentage	Specimen	Compressive Strength	Average of 3 cubes
0	1	28.46	28.48
	2	28.43	
	3	28.55	
0.03	1	34.19	31.76
	2	31.99	
	3	29.1	
0.06	1	36.32	36.33333333
	2	36.26	
	3	36.42	
0.09	1	37.64	37.49666667
	2	38.23	
	3	36.62	

Table/Figure 2: Compressive Strength of concrete specimens with 6mm fibers used during production

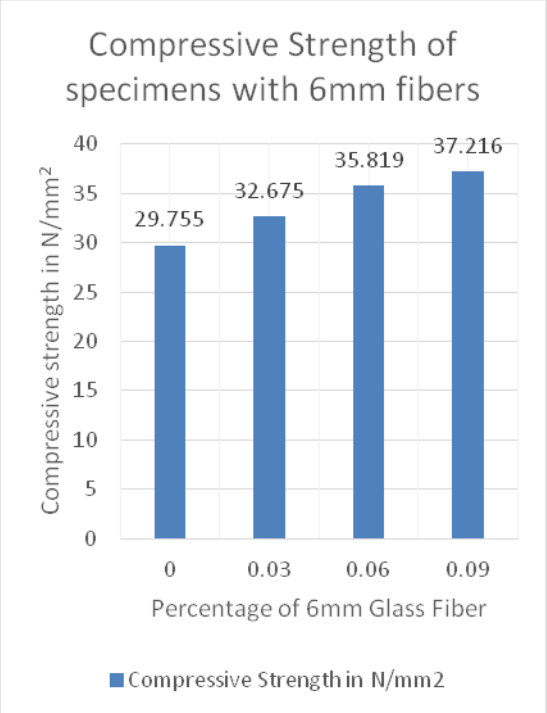
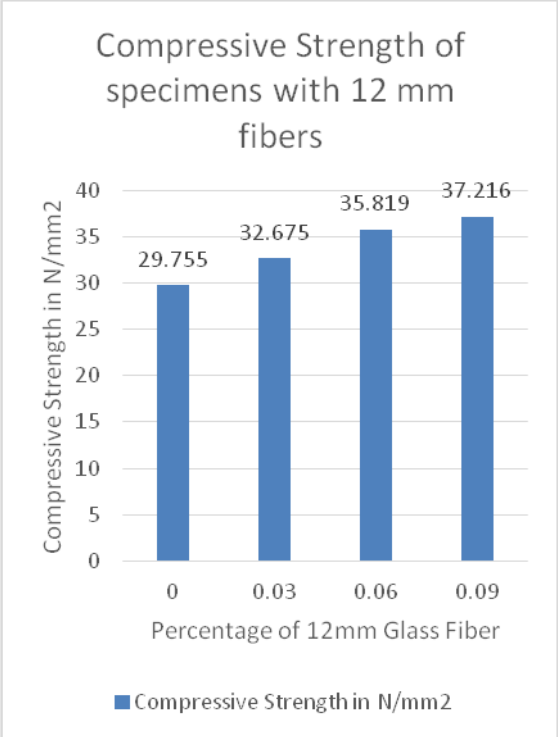


Table 3: Results for all specimens with 12mm fibers

Fiber Percentage	Specimen	Compressive Strength	Average of 3 cubes
0	1	29.369	29.75533333
	2	29.721	
	3	30.176	
0.03	1	33.698	32.67533333
	2	32.324	
	3	32.004	
0.06	1	35.129	35.81933333
	2	35.989	
	3	36.34	
0.09	1	38.017	37.21633333
	2	37.02	
	3	36.612	

Table/Figure 4: Compressive Strength of concrete specimens with 12mm fibers used during production



VI. CONCLUSION

The following are the points that have been deduced from conducting these experiments.

The compressive strength of the concrete cubes increased with addition of the fibers.

The fiber content of 0.09% gave the highest compressive strength of all.

The FRC specimens showed improved deformation capacity even after reaching the ultimate load.

There was an increase in the ductility of the concrete specimen.

VII. ACKNOWLEDGEMENT

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