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Performance study of concrete against the compressive and flexural strength by adding micro silica and polyester fibers

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Abstract -Concrete has great compressive strength and comparatively less flexure, shear and tensile strength. To strengthen the performance of structure we use reinforcements in concrete. The most popular one is the steel. Another option for reinforcements is using fibers. Fibers are more economical than steel reinforcements. Or fibers are also combined with steel in reinforcements which in turn will reduce the requirements of steel. Hence using fibers in concrete has a lot of scope in research and study. This report aims to find out the optimum proportions of micro silica and polyester fiber for increasing compressive strength and flexural strength respectively. Silica powder or micro silica were used in concrete to study the improvements in compressive strength. Polyester fiber were used in concrete to study the improvements in flexural strength. For compressive test we casted cubes and for flexural test we casted beams. The aim of the project is improvement in compressive strength and flexural strength by adding micro silica and polyester fibers. This aim not only benefits the strengths but also reduces the use of cement content, acceleration in workability and reduction in void percentage. Through indoor test of concrete cubes to explore the compressive strength of silica powder cement concrete, When the silica powder mixing content is 5%, 10% and 15% (weight of cement) in concrete compared with ordinary cement concrete, the 7 days and 28 days compressive strength were varied significantly. Similarly addition of0.1% and 0.3% in concrete beams showed significant changes in flexural strength comparatively to ordinary concrete beams.The report also explains the chemical reactions of silica powder with cement. Use of this fibers also benefit in environment point of view which is elaborated in following report. For this project we casted 24 cubes and 9 beams and tested the for 7 days and 28 days strength. The practical experiment took around 3 months. The experiment was accurately followed by considering standard timings, proportions, tools and machines and materials. This report concludes the optimum mix proportion of micro silica and polyester fibers in concrete as 5 % and 0.1 % respectively.

Key Words:micro silica, polyester fibre, compressive strength, flexural strength, mix proportion.

1. INTRODUCTION

The construction industry uses concrete to a large extent. It is the most used manmade material worldwide. In 2013, about 3.97 billion tons of cement was produced around the world. Based on this estimated value and considering average cement content of 11% and 70% of the cement-based product shared market, the worldwide production of concrete is about 30.6 billion tons. Another statistic estimated that on average, approximately 1 ton of concrete is produced each year for every human being in the word. The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminum combined. Concrete's use in the modern world is exceeded only by that of naturally occurring water. Concrete is used in infrastructure and in buildings. The overall grading of the mix, containing particles from 300 nm to 32 mm determines the properties of the concrete. The properties in fresh state (flow properties and workability) are for instance governed by the particle size distribution, but also the properties of the concrete in hardened state, such as strength and durability, are affected by the mix grading and resulting particle packing. One way to further improve the packing is to increase the particle size spectrum, e.g. by including particles with sizes below 300 nm. Possible materials which are currently available are ground minerals like limestone and silica fines such as silica flour, micro-silica and nano-silica. Because of extensive use of concrete worldwide, it is necessary to evaluate the environmental impact of this material. Additionally, to ensure the future competitiveness of concrete as a building material, it is essential to improve the sustainability of concrete structures.

2. 1 Material Properties

Micro Silica:

Fig – 1: Micro silica

White silica fume which is the by-product of high performance decorative concrete. The color of our white silica fume may vary from pure white to slightly off white, as shown in Fig – 1.

White Silica Fume improves the properties of both fresh and hardened concrete.The most important property is the permeability, Lower the ingress of movement of water or chemicals; lower the adverse reactions such as sulfate attack, the reaction between silica fume and the calcium hydroxide, released as the cement hydrates, provides a dense impermeable pore structure.

The Silica fume reacts with the cement paste to form additional strong Calcium Silicate Hydrate (CSH) providing higher strength.

Silica fume reduces bleeding and enhances the cement paste bond to the aggregates. Thanks to its pozzolanic effect (reaction with $Ca(OH)_2$), and therefore to the strength improvement.

Polyester Fibers:

Polyester is very important manmade fiber. Polyester is produced with a long chain synthetic polymer with ester. Polyester is produced by melt spinning process. Polyester fibers are alkali resistant. Polyester Fiber is used to improve the tensile and flexural strength, ductility, toughness and to arrest the crack of the concrete. Fig – 2 shows the Polyester fibres used for out project work.

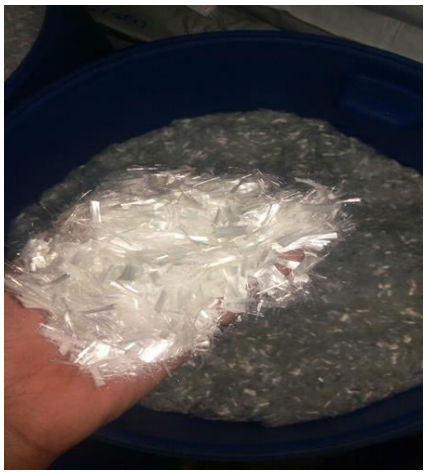

Fig. – 2: Polyester Fibre

2.2 Methodology

After Selecting and testing the basic material properties, we planned to select the concrete mixes with reference to the literature. We planned to perform the tensile and compressive strength testing on M20 grade concrete. The following Table – 1 shows the mix proportions and doses of micro silica and polyester fibres.

Table -1: Details of concrete mixes for compressive and flexural strengths.

Compressive Strength			Flexural Strength		
Type of Mix.	Micro silica (% of wt. of cement)	Polyester fibres (% of volume of concrete)	Type of Mix.	Micro silica (% of wt. of cement)	Polyester fibres (% of volume of concrete)
M1	0	-	M5	5	0
M2	5	-	M6	5	0.1
M3	10	-	M7	5	0.3
M4	15	-			

To get the compressive strength the concrete cubes are tested on compression testing machine and for flexural strength the concrete beams are tested on Universal Testing Machine under two point load. Fig – 3 shows the cube testing and Fig – 4 shows the beam testing.

Fig – 3: Testing of concrete cubes

Fig – 4: Testing of concrete beams

3. RESULTS AND CONCLUSIONS

The abbreviations used in above table such as M1, M2, M3 and M4 represents 'M' as mix and 1,2,etc. as its number of proportions. Micro silica proportions are taken in percentage of the weight of cement required for one concrete cube. For each mix proportions, 6 cubes were casted. 3 cubes of them were tested after 7 days and remaining 3 cubes were tested after 28 days.

From the tests we have performed, we conclude that maximum compressive strength is observed for addition of 5% microsilica. Also it has been observed that addition of microsilica beyond 5% decreases its compressive strength.

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Chart – 1: Compressive Strength comparison

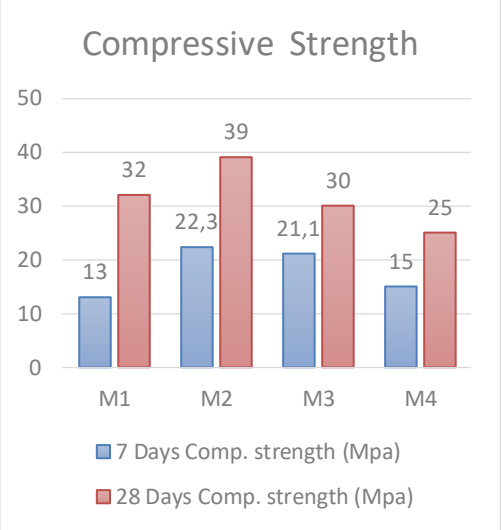
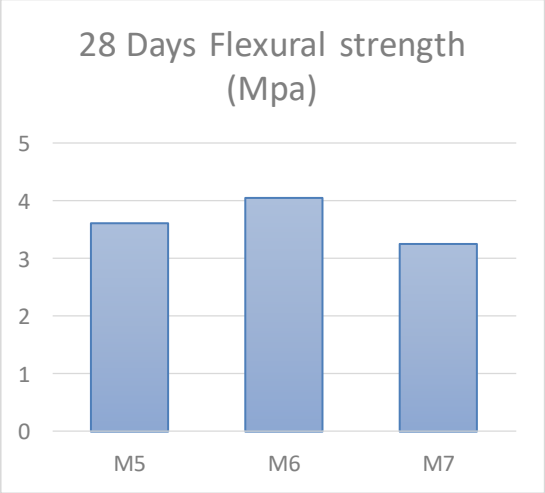


Chart – 2: Flexural Strength comparison



For each mix proportions, 3 beams were casted and tested after 28 days curing.

From the tests performed we have concluded that 0.1% polyester fibregave maximum result. Also it has been observed that addition of polyester fibre beyond 0.1% significantly decreased the flexural strength.

The project work has been quite helpful for aspiring the knowledge about concrete technology. We gained the knowledge about, various tests to be conducted, materials required, tools, instruments, machines, procedures and evaluations, for this project. This project is conducted to evaluate the optimum values of micro silica and polyester fibers to be used in concrete.

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