MAKING OF MIX PROPORTION RECRON-FIBER REINFORCED CONCRETE

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ABSTRACT : *High performance concrete is fast getting acceptability for a wide range of applications in the construction of concrete structures. High Performance Concrete (HPC) is used to explain concrete with special properties. Earlier HPC was known to be a concrete with high strength. But, advancement in concrete technology has made a new definition for HPC. Synthetic fiber (i.e Recron fiber) in various percentage i.e 0.0%, 0.1%, 0.2%, 0.3% and 0.4% to that of total weight of concrete and casting was done. Finally, different percentage of silica fume 0%, 10%, 20%, 30% and 40% with the replacement of cement keeping constant fiber content and concrete was casted. In the present work two types of cement, Portland Slag Cement and Ordinary Portland Cement has been used to get optimum results. Special size mortar, cubes, cylinder and prism were casted. At last compressive test, splitting test, flexural test are conducted. Also to obtain such performances that cannot be obtained from conventional concrete and by the current method, a large number of trial mixes are required to select the desired combination of materials that meets special performance. It is observed from the research that 0.2% Recron fiber and 20% SF is the optimum combination to achieve the desired need.*

KEYWORDS: High Performance Concrete, Recron Fiber.

1 INTRODUCTION

Right through the beginning of last century, strength of the structure was the primary objective of concrete rather than durability. As the time passes the durability of concrete and concrete structures is on a southward journey; a journey that seems to have gained momentum on its path to self– destruction. It is true about the concrete structures which were constructed since 1970 or thereabout by which time (a) the use of high strength rebars started (b) noteworthy changes in the constituents and properties of cement were commenced, and (c) the use of supplementary materials and admixtures in concrete in place of cement. These changes bring bad results about performance of prompted newly constructed infrastructure and due to this world are suffering from deterioration when exposed to real environments. Basically, concrete is an artificial conglomerate stone made essentially of Portland cement, water, and aggregates. In 1824 Joseph Aspdin (1779-1835) patented the clay and limestone cement known as Portland cement. Insertion of fly ash (FA) to concrete enhance its workability [2]. Very fine sands needs more water for a given workability due to the increased surface area [6]. The inclusion of blast furnace slag to concrete subjected to lactic acid solutions, provides no appreciable improvement [9]. The admixtures and the sand present in HPC is all very fine [7]. Alkalis in cement can react with aggregates containing silica or carbonate mineral constituents, particularly for concrete used in warm, moist environments. In cured cement these reactions lead to different types of expansion that cause harmful effects such as internal cracking, surface cracking, and aggregate pop-outs. This expansion in turn may cause dislocation, distortion, or misalignment of structural elements [4]. Spherical glassy particle of FA in concrete curies an associated surface film of water as a consequence of its geometry and hydro philic nature. The adding of FA to concrete will, therefore, attain a form of water-entrainment, ensuring wide distribution, and preservation of a noteworthy share of the mix water throughout the plastic concrete [3]. The addition of very small amounts of SF to normal structural concrete does not require the use of extra water or water-reducing admixtures to keep up the desired slump [21]. GGBFS concrete is better at both resisting chloride ingress and alkali-silica reactions than PC concrete The increase in the maximum aggregate size lessens the overall specific surface and consequently decreases the water demand of concrete for a specified workability [13]. The absorption is the process by which concrete takes in a fluid due to capillary suction in pores in order to fill the space within the material [12]. The packing density of concrete plays a vital role in the performance of concrete to an enormous extent. Size of particles and the number of different sizes particularly affects the Optimum particle packing. It is also claimed that water will not be able to penetrate through the outskirts of dense matrix of HPC and thus will not be able to reach most cement in the interior of the structural part since HPC has low permeability. To avoid such problem, it is recommended to cure the concrete from the inside core [23]. Inclusion of blast furnace slag at 60% reduced corrosion of the concrete by silage effluent by 18–37% [15]. To evaluate the strength and durability performance of the HPC concrete, it is important to produce them with the similar set of materials and test them underneath the favorable environmental conditions. But, a protected examination of published data would point out that the effects of SF addition on high performance concretes containing large quantities of fly ash (FA) and GGBFS are not consistent [17]. Silica fume and fly ash, has similar function to be delivered, both are very useful in lowering the water-to-cement ratio needed for workable concrete in combination with superplasticizers due to its sub-micron particle size permits it to bunch between the cement grains [14]. The 28 day compressive strengths are equal or slightly more with 20% fly ash replaced concrete at elevated temperatures up to 250°C than in no fly ash concrete [18]. The most vital effects on cementitious paste microstructure due to these fine particles are changes in pore structure produced by the reduction in the grain size caused by the pozzolanic reactions and the hindrance of pores and voids by the action of the finer grains [10]. The performance of GGBFS and the consequence of it on fresh concrete and hardened concrete. GGBFS concrete have high strength, lower heat of hydration and resistance to chemical corrosion [22]. Volcanic ash, which is similar to fly ash but is more abundant in volcanic disaster areas, can also be used as partial cement replacement material to manufacture HPC [8]. Effect of curing method on the compressive strength development of cement mortar and concrete incorporating ground granulated blast furnace slag [19]. The potential of GGBS activated by cement and lime for stabilization/solidification treatment of a mixed contaminated soil. It has been find out from the results that GGBFS activated by cement and lime would be effective in reducing the leach ability of contaminants in contaminated soils [11]. [5] discussed the effects of mineral admixtures on water permeability and compressive strength of concretes containing silica fume and fly ash. The results were cross matched with the control concrete, ordinary Portland cement concrete without admixtures. A 10% optimum cement replacement by FA and SF was taken during the experiment. It was resulted that the strength and permeability of concrete containing silica fume, fly ash and high slag cement could be valuable in the utilization of these waste materials in concrete work, especially in terms of durability. [20] stated in their research presents that the effectiveness of GGBFS, silica fume and fly ash as cement replacement to achieve high performance and sustainable concrete, can lead not only to improving the performance of the concrete but also to the reduction of CO2.

2 EXPERIMENTAL INVESTIGATION

Concrete specimens were casted to develop Recron fiber reinforced concret and to study the effect of silica fume keeping fiber percentage constant. Two types of cement i.e Portland slag cement and ordinary Portland cement (53 grades) was used for this purpose. Coarse aggregate of maximum size 20 mm size and sand of Zone- II were used. In case of fiber reinforced concrete, Recron fiber in different percentages i.e 0, 0.1, 0.2, 0.3% and 0.4% to the weight of concrete was used. Then it was varied the percentages of silica fume i.e 10, 20, 30% and 40% simultaneously keeping the percentage of Recron fiber constant to study the after effects of silica fume.

In case of OPC, mixture was obtained by keeping water cement ratio 0.38 and admixture at 0.8% for normal concrete mix. Then with different percentage of silica fume (10, 20, 30% and 40%) with constant 0.2% fiber content keeping water cement ratio (0.41, 0.43 and 0.45) and admixture (1.5, 1.7 and 1.8%). Admixture Sika was used for ordinary fiber reinforced concrete %) and FRP with the addition of silica fume by keeping water cement ratio in the range of 0.36- 0.42 (0.36, 0.38, 0.40 and 0.42) and super plasticizer rages from 0.6%-1.5% (0.6, 0.9, 1.2 and 1.5) respectively. Conventional rotary drum concrete mixer was used to mix the material. Coarse aggregate and a portion of the mixing water were loaded first, after that sand, cement and the rest of water were added and mixed for 3 min. The fibers in the case of fibrous mixtures was randomly distributed. Admixture Sika was added to the mixing water. In case of cement and silica fume it was added with cement. Then concrete was casted in vibrating machine and moulded to cubes, cylinders and prisms. The cube was having a length of 160mm each, cylinder of height 320mm and diameter 150, prism of length 400 mm height and breadth of 80 mm and height of 100mm. All then specimens were then demoulded after 24 hour. Finally all the specimens were cured for 7 days and 28 days. Compressive strength, splitting tensile strength and flexural strength were evaluated on cubes, cylinders, prisms respectively according to the Indian standard codes. i.e IS 456: 2000, IS 561: 1959, IS 5816:1999, IS 9399-1979 and IS 10262-1982.

Compressive Strength (σCS) = P/A

Where, P= Load (Newton)

A= Cross-sectional area of cube in mm2

Splitting Tensile Strength (σST) = 2 P/ π d l

Where, P= load (Newton)

l= length of cylinder in mm i.e 320mm

d= diameter of cylinder in mm i.e 150mm

Flexural Strength (σFS) = P l/ b h2

Where, P= load (Newton)

l= length of rectangular prism in mm i.e 400 mm

h= height of rectangular prism i.e 100 mm
b= breadth of rectangular prism i.e 80 mm
Consistency test was conducted on silica fume before using it as a replacement of cement for measuring the water absorption capacity. Initially the effects of fiber and SF on strength of concrete are shown below with Portland slag cement, then using OPC.

Table 1: Effect of Recron Fiber on Compressive Strength of mixture with Slag Cement

Fiber Content (%)	0.0	0.1	0.2	0.3	0.4
7 Days Compressive Strength (MPa)	29.28	24.78	26.60	17.32	14.30
28 Days Compressive Strength (MPa)	38.08	27.70	32.33	25.80	21.97

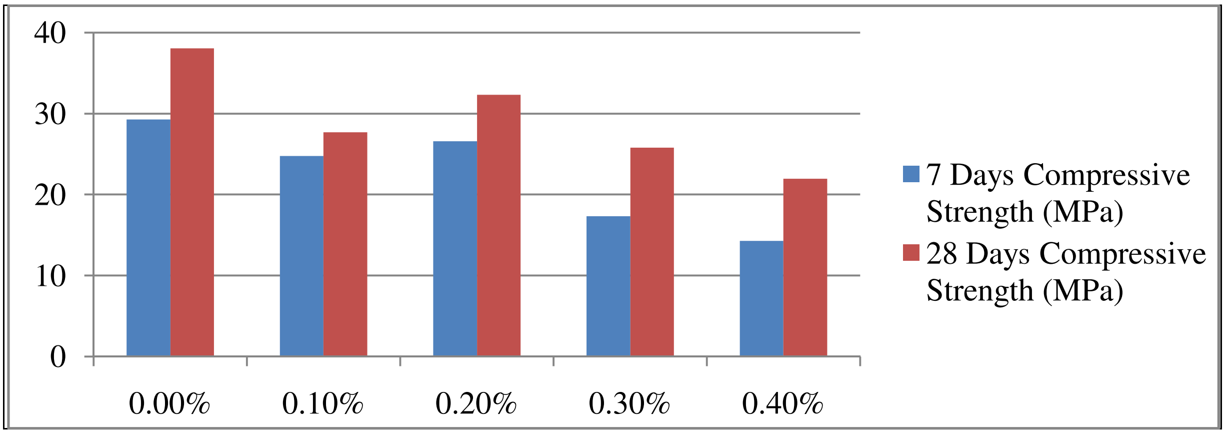

Fig. 1: Effect of Recron Fiber on Compressive Strength

Table 2: Effect of Recron Fiber on Splitting Tensile Strength using Slag Cement

Fiber Content (%)	0.0	0.1	0.2	0.3	0.4
7 Days Splitting Tensile Strength (MPa)	2.618	2.202	2.598	1.573	1.278
28 Days Splitting Tensile Strength (MPa)	2.895	2.477	3.59	2.303	2.012

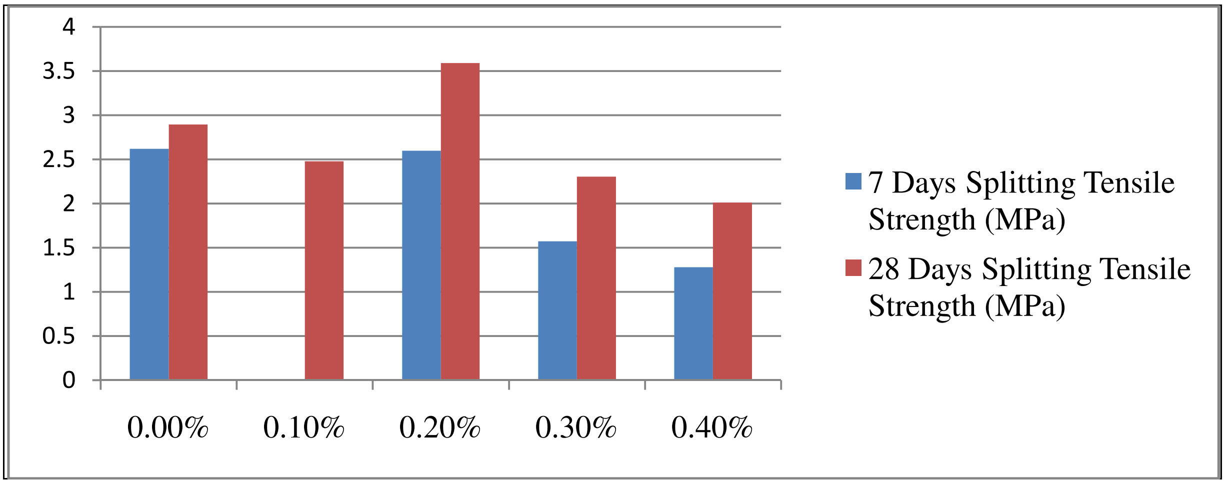

Fig. 2: Effect of Recron Fiber on Splitting Tensile Strength

Table 3: Effect of Recron Fiber on Flexural Strength using Slag Cement

Fiber Content (%)	0.0	0.1	0.2	0.3	0.4
7 Days Flexural Strength (MPa)	5.802	5.919	6.609	4.537	3.243
28 Days Flexural Strength (MPa)	7.768	6.458	8.091	5.994	4.612

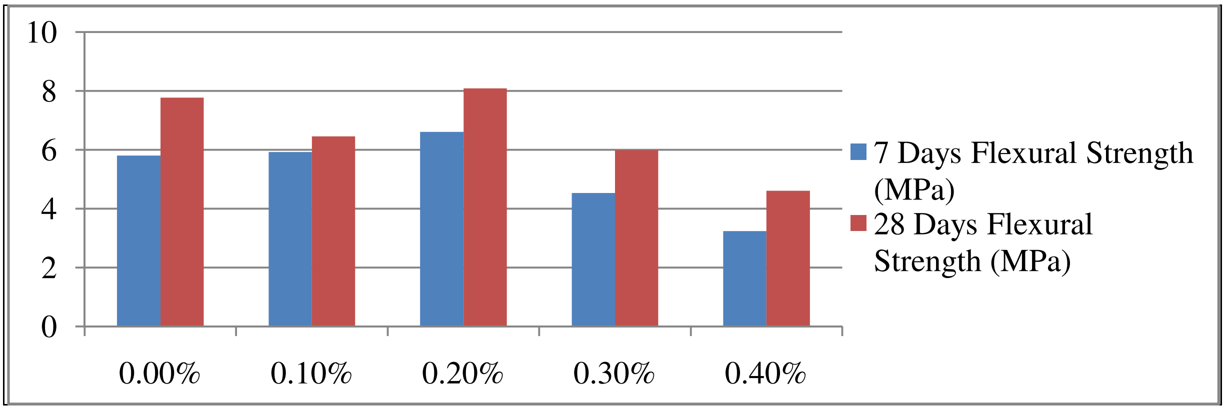

Fig. 3: Effect of Recron Fiber on Flexural Strength

Table 4: Effect of Silica Fume on consistency of Cement

Cement replaced by Silica Fume (in %)	0	10	20	30	40
Consistency (%)	32	38.5	42	45.5	47.5

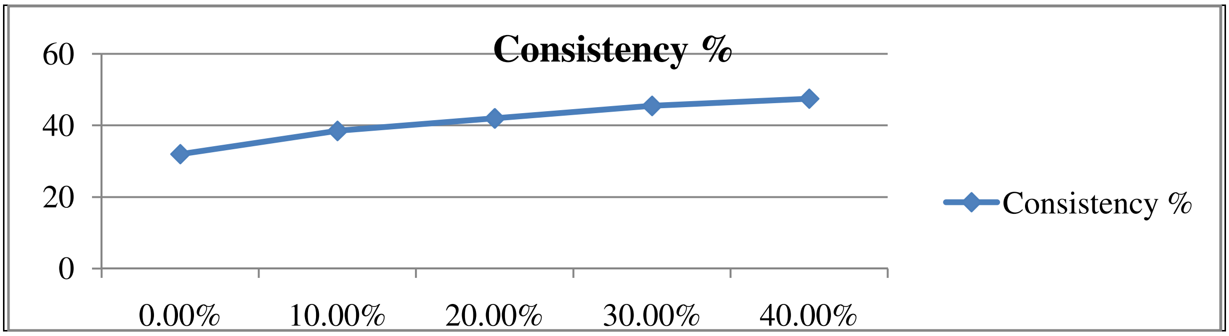

Fig. 4: Effect of Silica Fume on consistency of Cement

Table 5: Effect of Silica Fume on Compressive Strength with 0.2% Fiber using Slag Cement

Silica Fume (%)	0	10	20	30	40
7 Days Compressive Strength (MPa)	26.587	23.722	26.901	21.905	19.206
28 Days Compressive Strength (MPa)	32.267	30.626	35.024	29.217	26.615

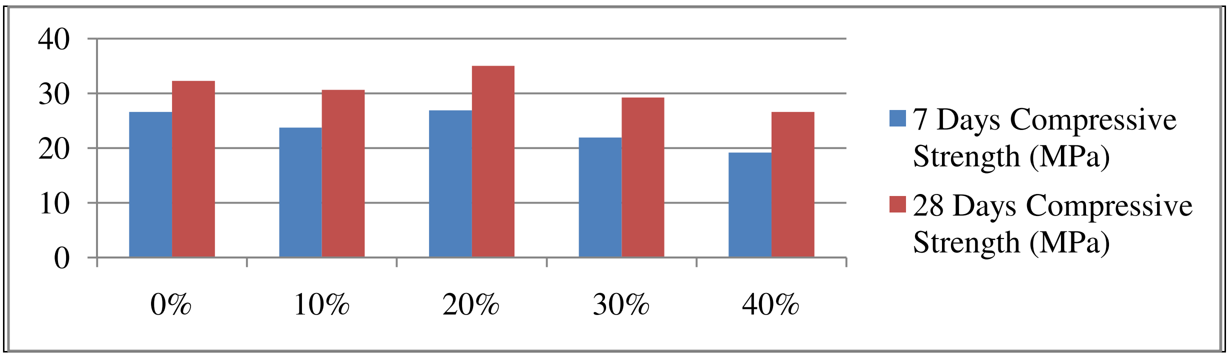

Fig. 5: Effect of Silica Fume on Compressive Strength at 0.2% Fiber with Slag Cement

Table 6: Effect of Silica Fume on Splitting Tensile Strength with 0.2% Fiber using Slag Cement

Silica Fume (%)	0	10	20	30	40
7 Days Splitting Tensile Strength (MPa)	2.607	2.496	2.723	2.190	1.928
28 Days Splitting Tensile Strength (MPa)	3.047	2.952	3.324	2.811	2.671

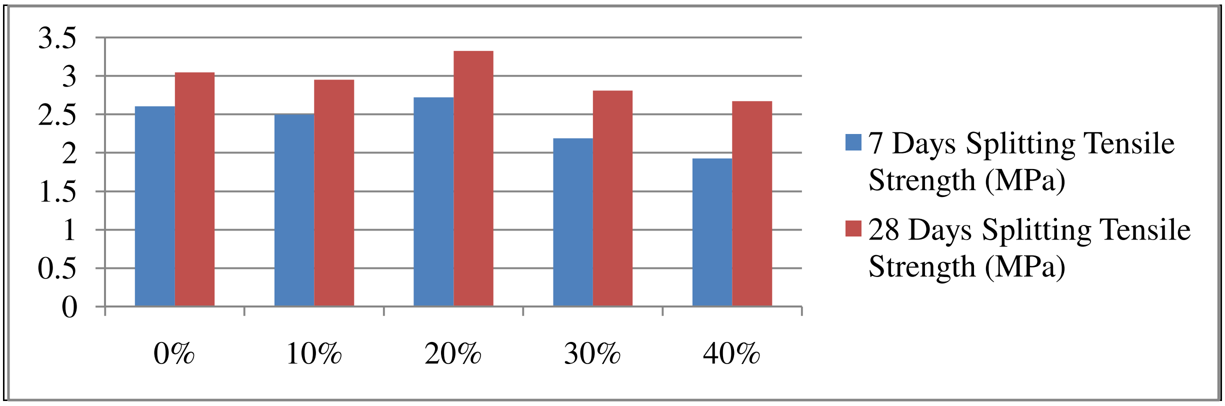

Fig. 6: Effect of Silica Fume on Splitting Tensile Strength at 0.2% Fiber with Slag Cement

Table 7: Effect of Silica Fume on Flexural Strength with 0.2% Fiber using Slag Cement

Silica Fume (%)	0	10	20	30	40
7 Days Flexural Strength (MPa)	6.617	6.589	6.692	6.078	5.428
28 Days Flexural Strength (MPa)	8.142	7.952	8.524	7.831	7.074

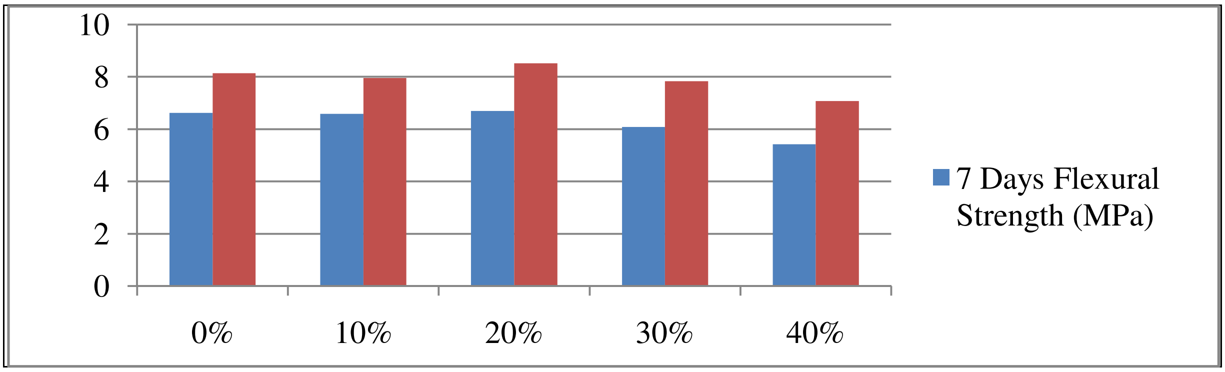

Fig. 7: Effect of Silica Fume on Flexural Strength at 0.2% Fiber with Slag Cement

Table 8: Effect of Silica Fume on Compressive Strength using OPC

Silica Fume (%)	0 (0.2% fiber)	10 (0.2% fiber)	20 (0.2% fiber)	30 (0.2% fiber)	40 (0.2% fiber)
7 Days Compressive Strength (MPa)	29.30	30.20	32.50	34.30	35.70
28 Days Compressive Strength (MPa)	34.88	36.20	38.50	42.30	43.90

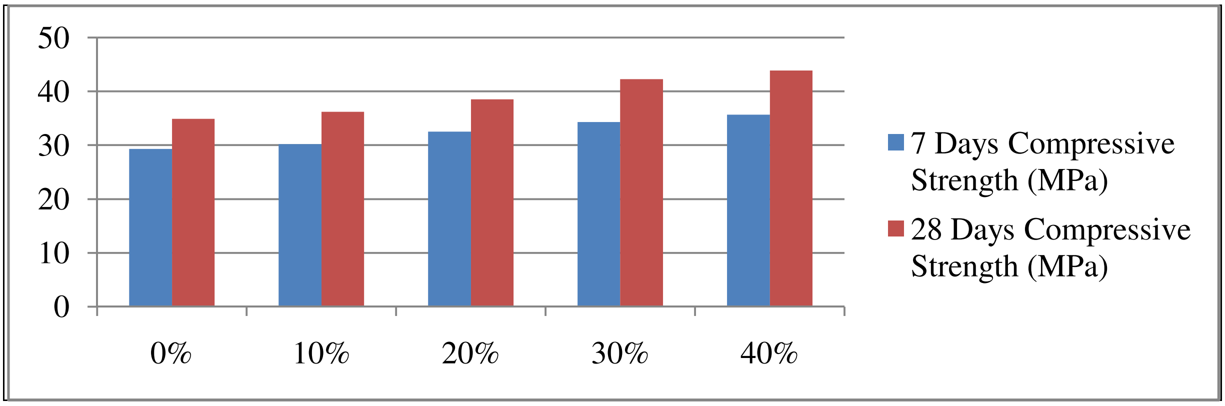

Fig. 8: Effect of Silica Fume on Compressive Strength at 0.2% Fiber and OPC

Table 9: Effect of Silica Fume on Splitting Tensile Strength using OPC

Silica Fume (%)	0 (0.2% fiber)	10 (0.2% fiber)	20 (0.2% fiber)	30 (0.2% fiber)	40 (0.2% fiber)
7 Days Splitting Tensile Strength (MPa)	2.578	2.702	2.419	2.300	2.105
28 Days Splitting Tensile Strength (MPa)	2.888	3.194	2.899	2.784	2.345

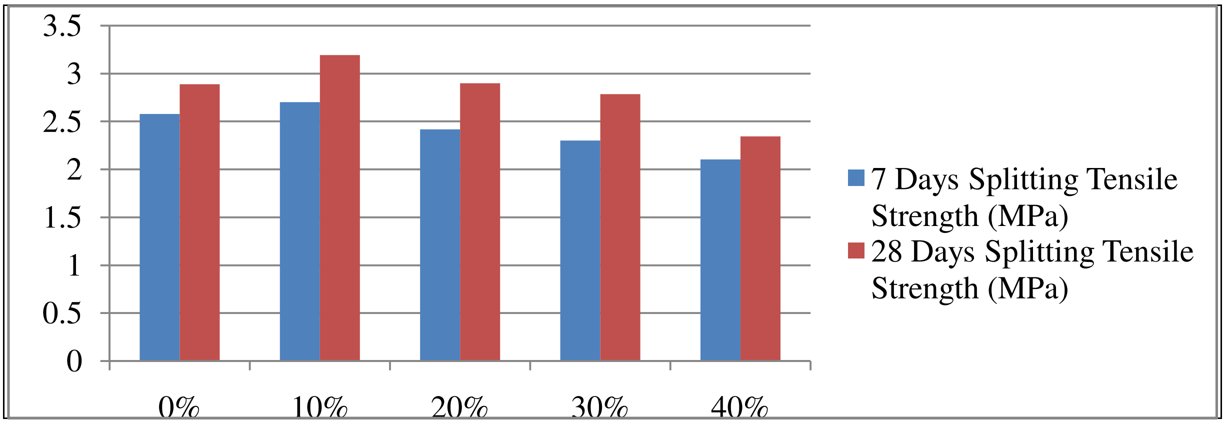

Fig. 9: Effect of Silica Fume on Splitting Tensile Strength at 0.2% Fiber and OPC

Table 10: Effect of Silica Fume on Flexural Strength using OPC

Silica Fume (%)	0 (0.2% fiber)	10 (0.2% fiber)	20 (0.2% fiber)	30 (0.2% fiber)	40 (0.2% fiber)
7 Days Flexural Strength (MPa)	9.612	7.910	6.824	6.042	5.678
28 Days Flexural Strength (MPa)	11.375	9.308	8.499	6.784	6.105

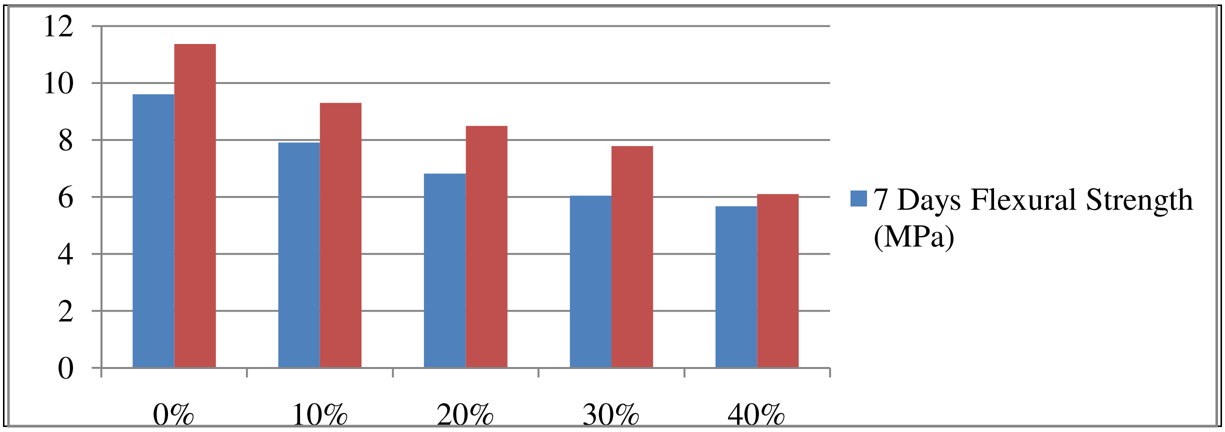

Fig. 10: Effect of Silica Fume on Flexural Strength at 0.2% Fiber and OPC

3 RESULT DISCUSSION

As we know the consistency of cement primarily depends upon its fineness. Simultaneously, silica fume also have better fineness than cement and greater surface area that's why the consistency increases significantly, when silica fume percentage increases compare to plain cement. It is resulted from test that the normal consistency increases approximately 47.5% when silica fume percentage increases from 0% to 40%.

In case of Portland slag cement it is resulted that on addition of Recron fiber from 0.0% to 0.1% the compressive strength decreases. While on increasing the fiber percentage further upto 0.2% the 7 days and 28 days compressive strength increases but this strength decreases further on addition of more fiber. In addition to fiber, silica fume was used as a partial replacement to cement. The different percentage of silica fume such as 10%, 20%, 30% and 40% replacement was used with 0.2% Recron fiber. The 7 day and 28 days compressive strength of concrete is higher at 20% silica fume when compared to any other composition at 0.2% fiber but lower than unreinforced concrete So, when 20% of the slag cement is replaced with silica fume it gave maximum strength when compared to other replacement percentages.

Simultaneously, splitting strength decreases on addition of Recron fiber from 0.0% to 0.1% in case of Portland slag. But on increasing the fiber percentage further, at 0.2% the 7 days and 28 days splitting tensile strength increases but with further addition of fiber the strength reduces. In addition to fiber, silica fume with different percentage of 10%, 20%, 30% and 40% replaced the cement with 0.2% Recron fiber. At 20% silica fume replacement to cement and at 0.2% fiber content the splitting tensile strength is maximum than any other composition. Simultaneously, the splitting tensile strength at this composition is also more than that of the strength in case of OPC. For 7 days and 28 days it is about 11% and 13% more, respectively. The strength reduces gradually on other percentages of silica fume and for OPC.

In case of Portland slag cement, 7 days flexural strength increases using Recron fiber from 0.0% to 0.2%. But 28 days strength decreases as fiber percentage increases from 0.0% to 0.1% and strength increases as the fiber percentage increases from 0.1% to 0.2%. In case of silica fume replacement at 0.2% fiber content the flexural strength gives positive outcome. At 20% silica fume the flexural strength is higher than normal concrete and this is the maximum strength than other percentages of silica fume replacement. In case of OPC, keeping 0.2% fiber content and varying silica fume percent it was observed that the 7 days and 28 days flexural strength decreases as the of silica fume percentage increases.

4 CONCLUSION

It has been concluded from the research that:

1. If we replace cement with GGBS there is increase in consistency. GGBS passing 75 micron sieve not giving good strength of mortar. By replacing cement with RHA the consistency increases. Use of RHA which is properly burned in controlled temperature improves the strength of mortar. Strength doesn’t increase satisfactorily by the use of RHA.By using superplasticizer, it probable to get a mixture with low water to cement (w/cm) ratio to get the desired strength of concrete. In case of Portland slag cement with the use of Recron fiber , the 28 days compressive strength at 0.2% fiber content the result obtained is maximum. The 28 days splitting tensile and flexural strength also increases at 0.2% fiber content to that of normal concrete. On increasing the fiber percentage then there is a significant loss in the strength. With Portland slag cement keeping 0.2% Recron fiber constant and varying silica fume percentage the compressive, splitting tensile and flexural strength are influenced amazingly. Therefore, it is observed from the research that 0.2% Recron fiber and 20% SF is the optimum combination to achive the desired need. In case of OPC the compressive strength is increasing as the percentage of silica fume increases from 0 to 40% at 0.2% Recron fiber and flexural; strength decreases for the same conditions.The splitting tensile strength is maximum with 10% SF and at 0.2% fiber for both 7 days and 28 days.

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