AN EXPERIMENTAL STUDY ON STRENGTH CHARACTERSTICS OF HYBRID FIBER REINFORCED HIGH PEROFRMANCE CONCRETE WITH MULTIPLE MINERAL ADMIXTURES

[1]Kishore Kumar Reddy S, [2]Rajendra Kumar K M, [3]Mahesh Sajjan

[1]PG student, [2] Assistant Professor, [3] Assistant Professor
[1, 2, 3] Department Of Civil Engineering
[1, 2] Rao Bahadur Y Mahabaleshwarappa Engineering College, *Ballari, Karnataka, India*
[3] BITM, Ballari, Karnataka, India.

Abstract: One of the well know and commonly used construction material is concrete. Due to the requirements of high quantity of concrete study on high performance concrete is gaining the importance to obtain the required properties of concrete by limiting the quantity and not sacrificing the required quality and also maintaining the cost efficiency and because cement is mostly used in concrete and production of concrete is not ecofriendly as it releases lots of carbon dioxide and hence research are being done to replace the cement in the concrete ,some of the replacements known are ,fly ash, silica fume and metakaolin etc. .Many researchers have used these types of waste products which were considered as waste materials in concrete and conducted many tests and found that these admixtures helped to boost the properties of the concrete greatly and hence This project also examines the properties changes in the high performance concrete(HPC) on compressive strength and the mechanical behavior of concrete made of fly ash and silica fume and Metakaolin, each of 0% ,5%,7.5% and 10% to the weight of cement. and fibers (Polypropylene Fibers and steel fibers) by referring to various articles which have been mentioned in the literature .Hence Specimen were casted under laboratory conditions with high quality materials by considering a constant water cement ratio and varying percentage of admixtures and also water binder ration and they were cured properly and tested for 7^{th} and 28^{th} days strength test such as compressive strength test, split tensile strength test and flexural strength tests were done on specific machines the results were tabulated and concluded

Key Words **- Metakaolin, Silica fumes, Polypropylene fibers, Fly ash, Compressive strength, Steel Fibers, Flexural strength Split tensile strength**

1. INTRODUCTION

High performance concrete has their properties surpassing that of the normal concrete. New type of materials are used in mixing to meet the required properties. Extra care and new techniques are used while dealing with high performance concrete. New and strict experiments are processed to determine the properties of the high performance concrete .high performance concrete is generally used in big structures like bridges and also tunnels .these are also used in agricultural and irrigation applications .The general application are in the field where high strength and high initial strength are required and other requirements may be in the field to resist chemical attach and weather attack and high durability and in some case increased modulus of elasticity and temperature effects.

One of the issue in the ground of concrete usage is pollution caused during the manufacture of the materials and hence in order to minimize the effects on surroundings or environment many researches are undergoing to replace or minimize the usage of cement ,because is produces lots of pollution in its production by giving rise to lots of carbon dioxide and hence causing pollution .some of the replacements are used in this experiment by using the industrial waste products. These waste products were considered as nothing but waste products until some researchers have started considering them in using them concrete and proved experimental results that these admixtures actually help boosting many properties of concrete without causing any major damage to the concrete. since these materials are cost efficient and were easily available the usage of these products have gained lots of attention and are now used world wide

High performance concrete hence is nothing but a concrete made up of different or special materials just to optimize the properties of the concrete built on the requirement of the construction And the usage of high performance concrete is increasing because of the changes of climate and also due to earthquakes occurring in various portions of the world ,one of the other important reason is the cost efficiency and lack of enough space for the construction

2. OBJECTIVE OF STUDY

The purpose of this study is to examine the strength changes in compressive, split tensile and flexural properties by using such as Metakaolin, silica fume, fly ash, steel fibers and polypropylene fibers in a concrete mix and then compare the results with a plane concrete mix Aggregate binder ratio is to be kept constant 2.5 and with varying percentage of admixtures of 0%,5%,7.5%,10%(each) and water binder ratio 0.275,0.30,0.325 specimen are to be casted in strict laboratory conditions and then the examination of strength changes in the specimen are to be tested and concluded by comparing with ordinary concrete mix

3. MATERIALS

The details of the materials used are mentioned below

1. **Ordinary Portland Cement** grade of 43 with specific gravity of 3.03 was used in the experiments
2. **Metakaolin** is often obtained from kaolin which is heated up to an extent from 650 to 900°C and then processed Metakaolin helps by increasing the compressive strength of concrete. Specific gravity of 2.60 was used
3. **Silica fumes** is obtained from silicon as well as ferrosilicon industries as byproducts and its particles are very fine in size. The silica fumes used for work have the specific gravity of 2.30.
4. **Fly ash** is the residue that can be often obtained from the coal combustion units having a specific gravity of 1.90.
5. **Coarse aggregate** Aggregates of 20mm size and below were used in the project which were locally available and the specific gravity of 2.70.
6. **Fine Aggregate** containing specific gravity of 2.5 is used and the were free from silts and clay
7. **Portable Wate**r is one of the main reason for hydration and also for reactions in that takes place in the concrete mix but if not used in proper limits it will cause very adverse effect to the mix and may decrease the strength and lifespan of concrete
8. **Super plasticizers**: The name of plasticizer used in the project was FOSROC Conplast -SP430 ,mainly used to reduce the water content in the mix
9. **Steel fibers** of 30mm dimension in length and a dia of 0.6mm, aspect ratio of 45 have been used. Generally Steel fibers density is of 7840 kg/m3 and specific gravity of 8 is chosen.
10. **Polypropylene fibers** are mainly used to help the concrete resist the load at post cracking stage and for workability at early stage of the mix, the fibers are obtained by polymerization of crude material made of hydrocarbon. Specific gravity of 0.90 are used.

4. METHODOLOGY

In this experimental analysis (6 cubes + 3 cylinders + 3 beams) sets for every variation of admixture high performance concrete specimen were casted at laboratory. The dimensions of cube is of 100mm x100mm x 100mm moulds , while the cylinder was 150mm x 150mmx300mm and Beams had the dimension of 100mmx100mmx500mm. Three types of mineral admixtures namely Metakaolin, silica fume and fly ash were mixed with percentage like. 0%, 15%(5%each) , 22 .5% (7.5% each)& 30% (10% each) and 2 types of fibers such as steel fibers (S.F) and polypropylene fibers (P.F) with fiber volume 0.25%,0.75% & 1%.The purpose is to know the effects of Metakaolin, silica fume and fly ash and by altering the percentage of 2 types of fibers volume content on strength, properties of concrete

5. EXPERIMENTAL STUDY

5.1 Compressive strength

Fig 1: compressive strength test for 7th day containing 0% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

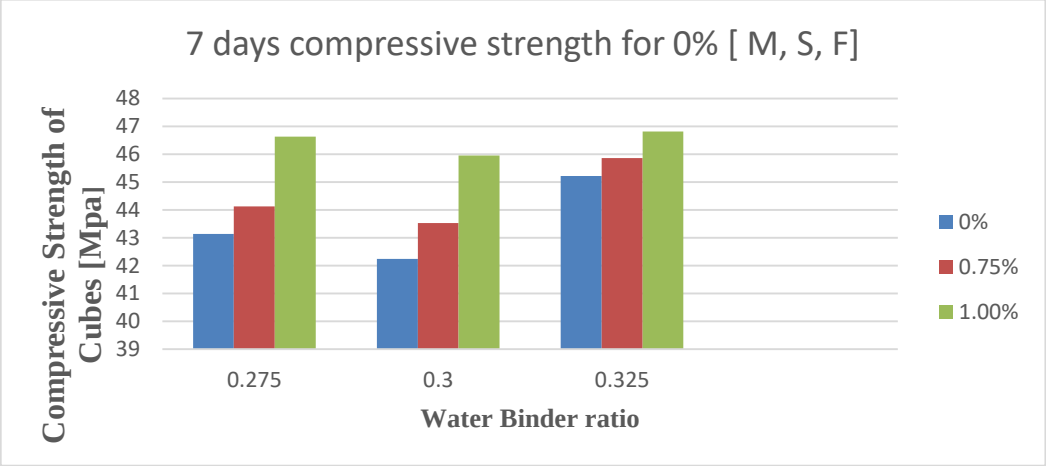


Fig 2: compressive strength test for 28th day containing 0% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

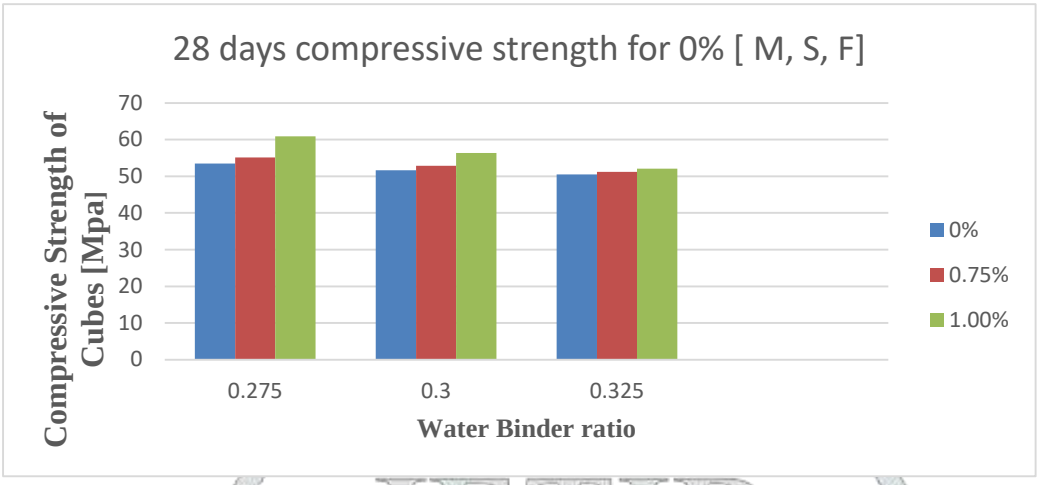


Fig 3: compressive strength test for 7th day containing 5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

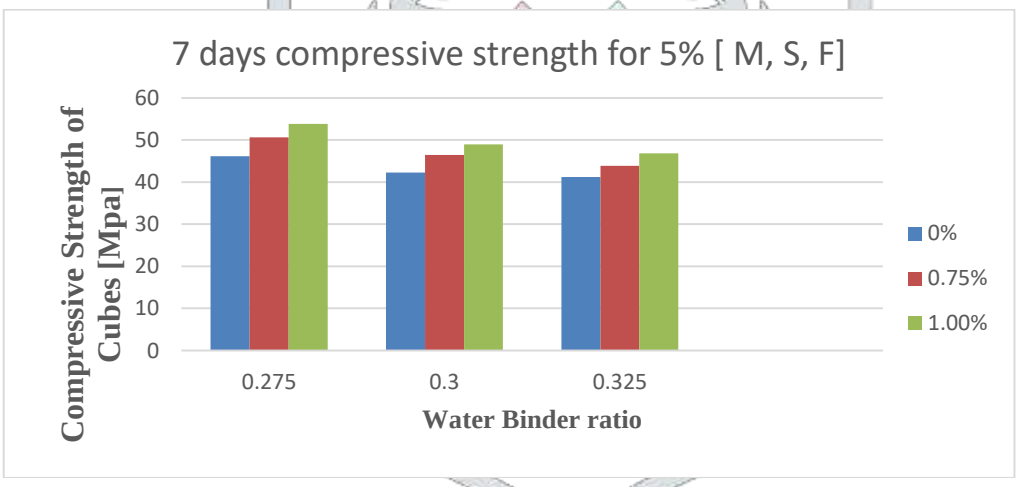


Fig 4: compressive strength test for 28th day containing 5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

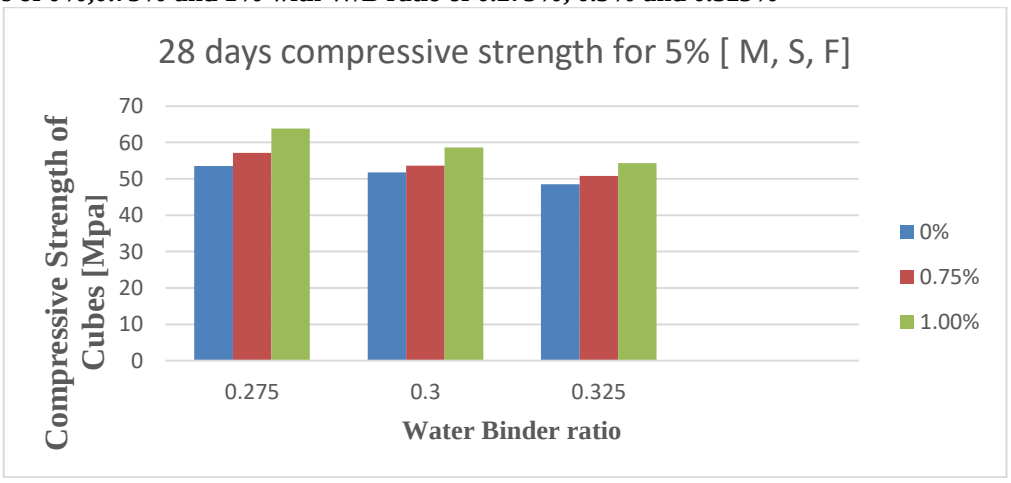


Fig 5: compressive strength test for 7th day containing 7.5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

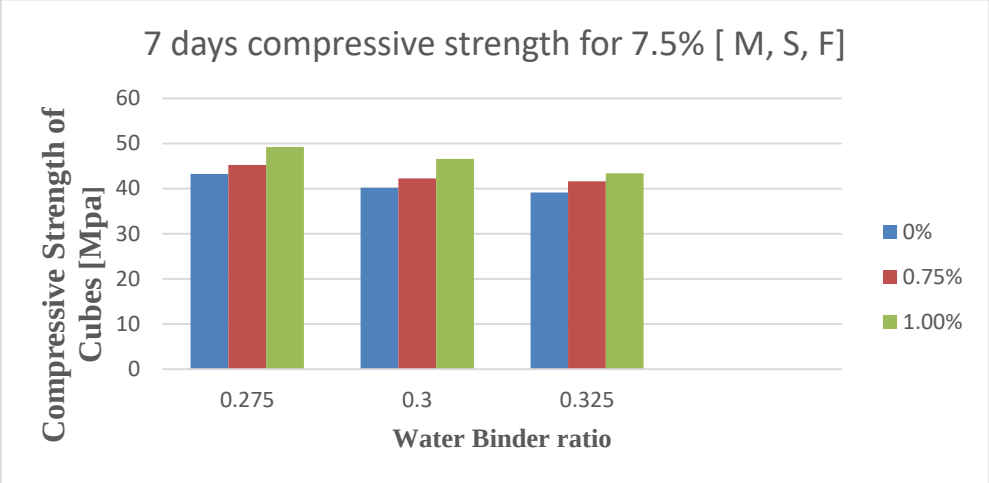


Fig 6: compressive strength test for 28th day containing 7.5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

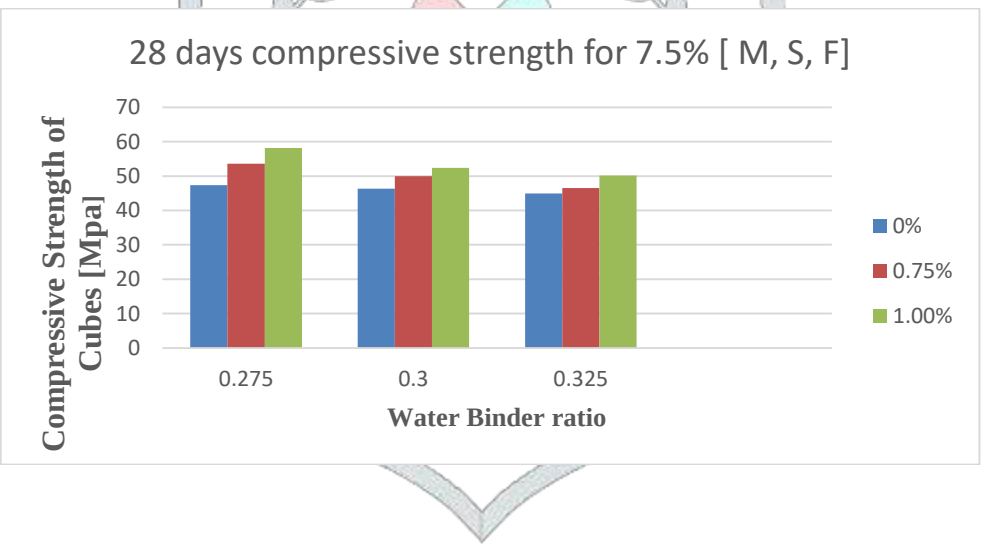


Fig 7: compressive strength test for 7th day containing 10% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

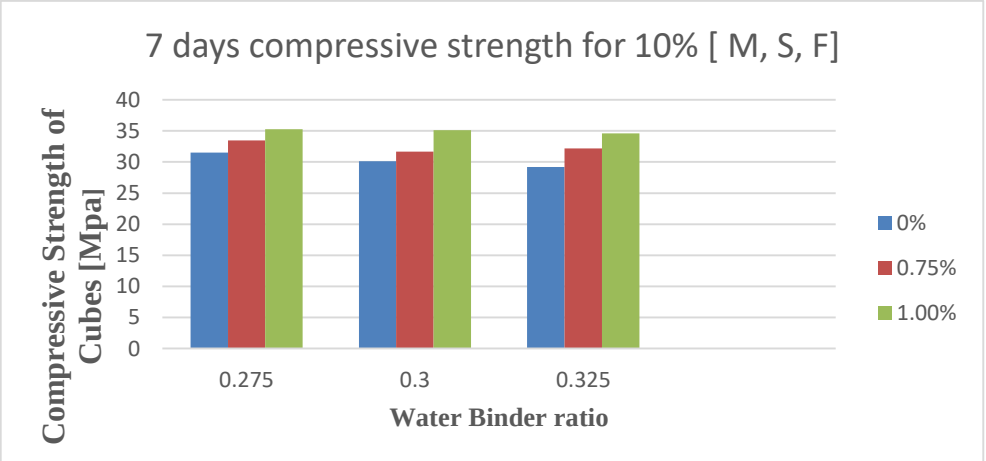
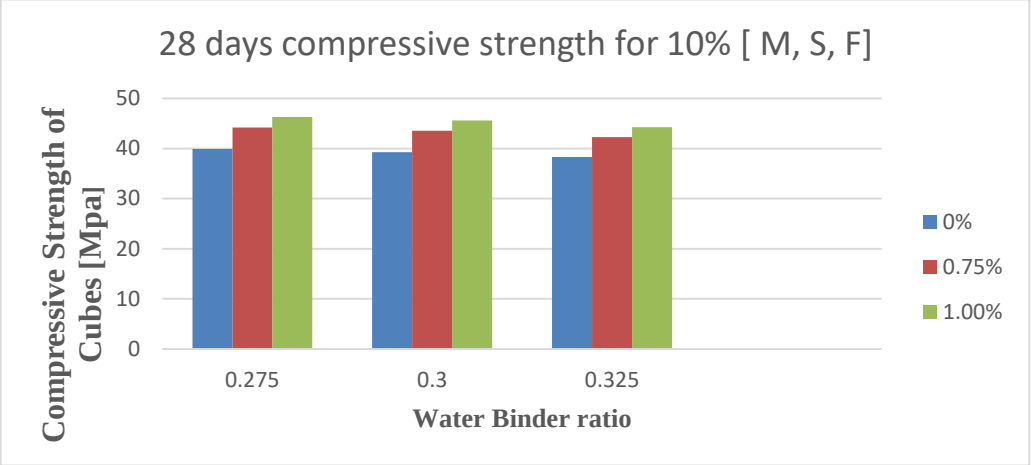


Fig 8: compressive strength test for 28th day containing 10% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%



5.2 Split Tensile Strength

Fig 9: split tensile strength test for 28th day containing 0% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

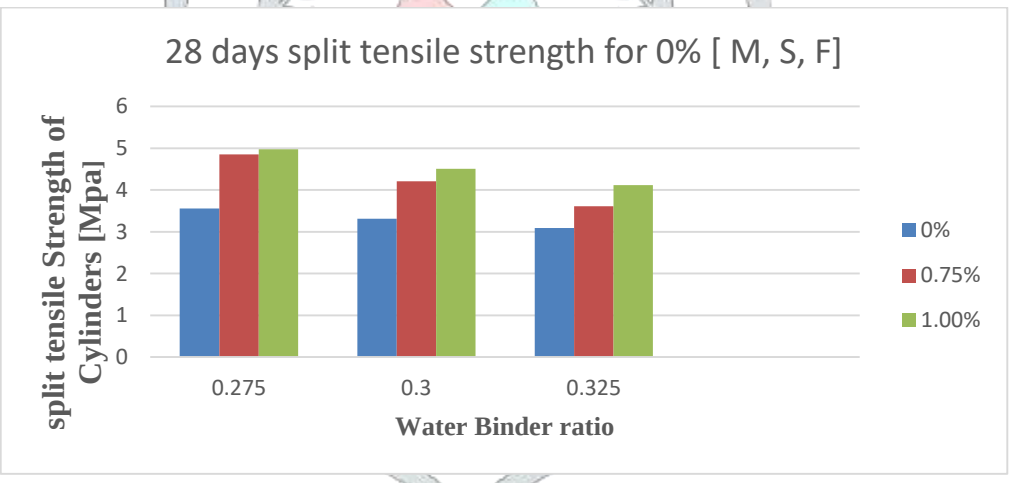


Fig 9: split tensile strength test for 28th day containing 5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

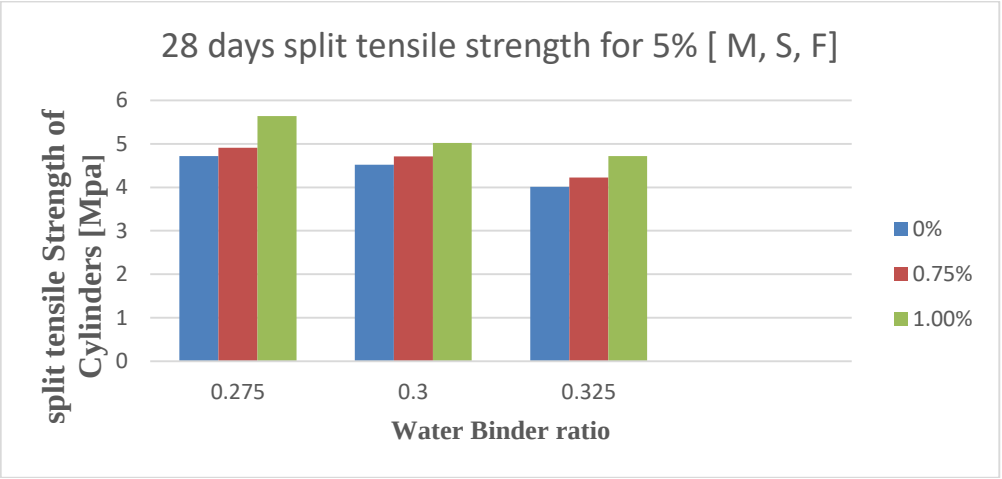


Fig 10: split tensile strength test for 28th day containing 7.5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

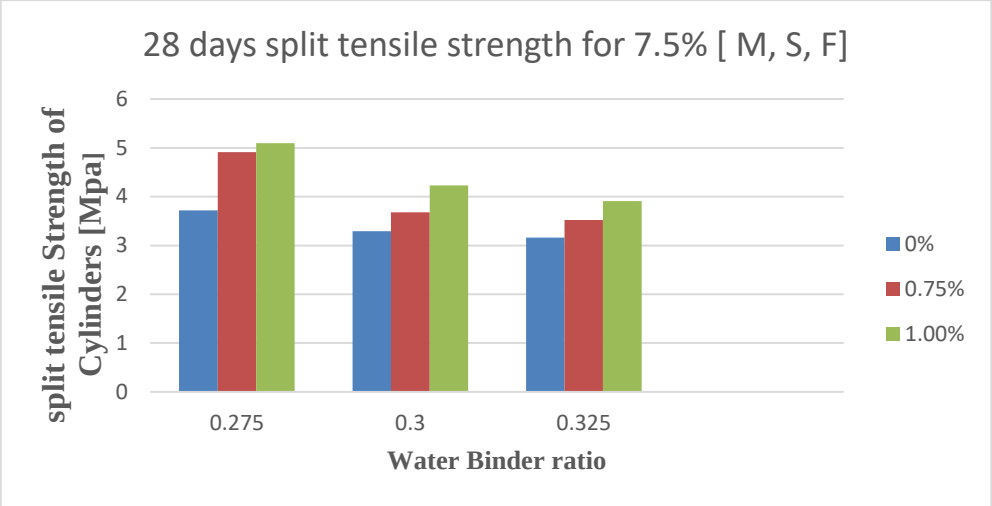
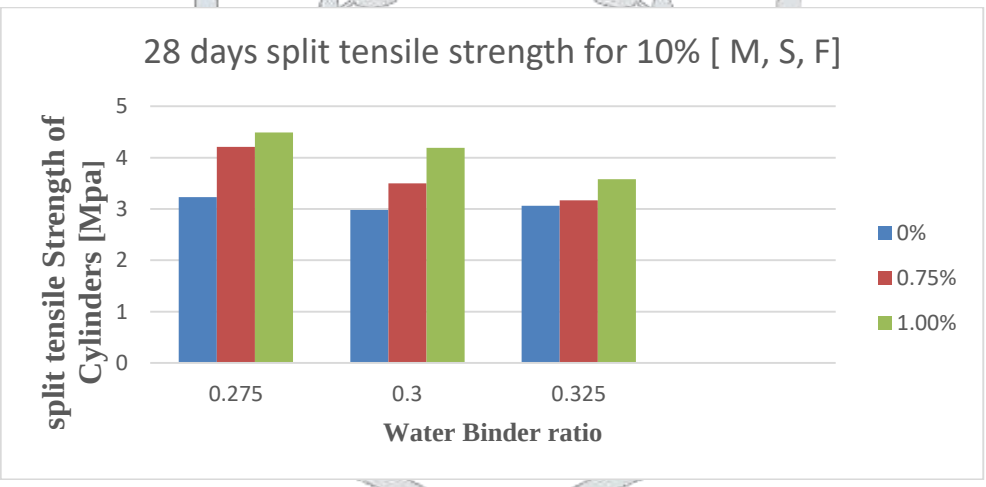


Fig 11: split tensile strength test for 28th day containing 10% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%



5.2 Flexural Strength

Fig 12: flexural strength test for 28th day containing 0% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

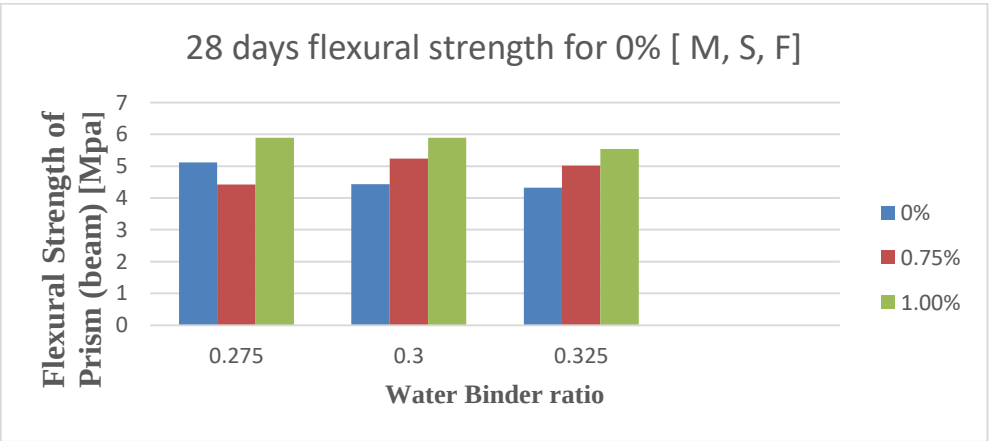


Fig 13: flexural strength test for 28th day containing 5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

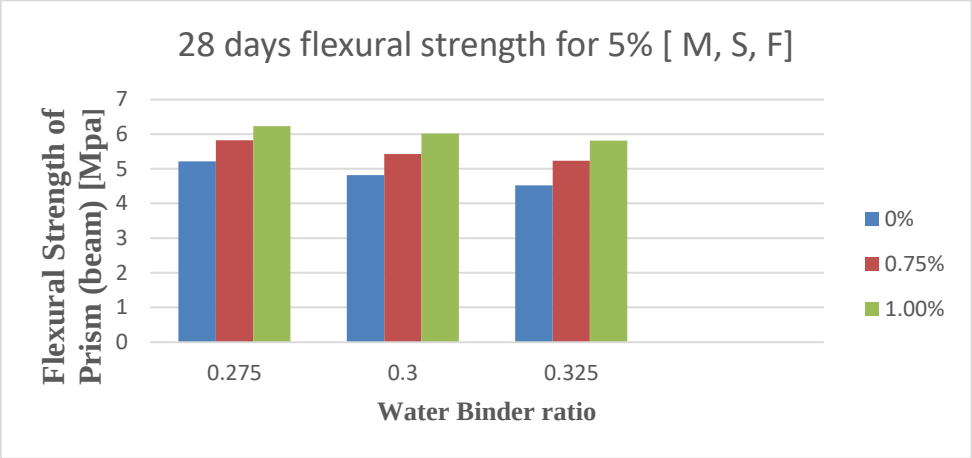


Fig 14: flexural strength test for 28th day containing 7.5% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%

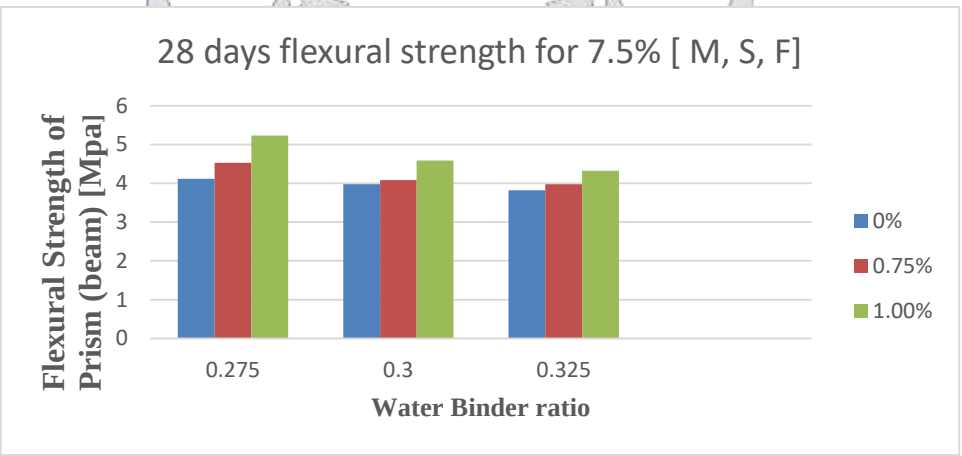
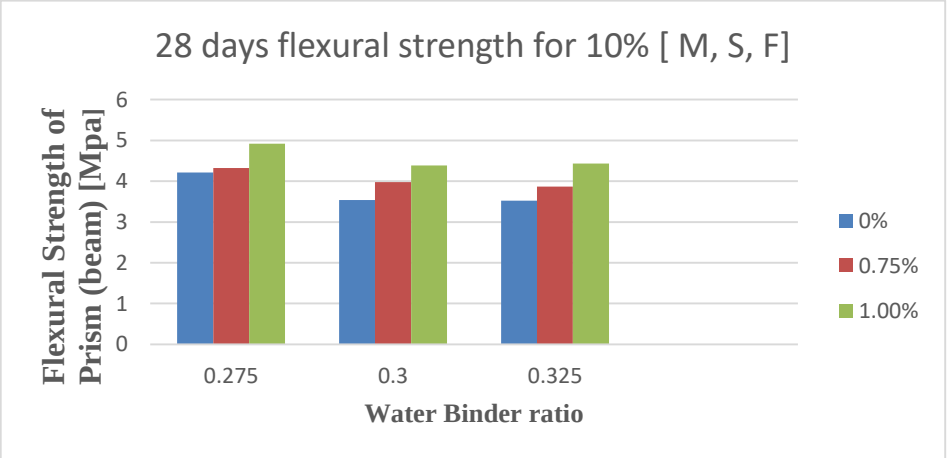


Fig 15: flexural strength test for 28th day containing 10% M S F admixtures with a constant A/B ratio of 2.5 and composite fibers of 0%,0.75% and 1% with W/B ratio of 0.275%, 0.3% and 0.325%



6. CONCLUSIONS

- The HPC consisting fibers have helped the concrete to act as a ductile unit up to some extent and hence solving the brittle nature problems
- With the addition of admixtures, it was evident that the HPC can be used to reduce the cost of bulk concrete works without reducing the quality of the concrete
- The usage of these admixtures which are industrial wastes have made the concrete to be eco friendly
- Due to the presence of fibers the resistance to sudden collapse problem was improved
- The weight of the HPC was found to be very less when compared with conventional concrete due to replacement done with admixtures
- Based on the results it was evident that the compressive strength of HPC when compared to 0% MSF has good increased when 5% MSF along with 0.275 w/b ratio was used, and also it was see that the strength decreased as them percentage of MSF increased
- Split tensile test for 28-day test reviled that the strength was of 5% and 7.5% was more than the 0% MSF concrete and 5% MSF and 0.275 w/b ration being the highest and the strength for 10% MSF was lesser than conventional normal concrete
- As for flexural strength only 5% MSF with 0.275 w/b ratio has strength results more than 0% MSF concrete.
- It is not clearly seen that with increase of admixtures the concrete will have its strength properties decreased and hence it is suggested to use them up to some limit

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