International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Issue-3, May 2022
https://doi.org/10.55524/ijircst.2022.10.3.49
Article ID IRP1197, Pages 299-308
www.ijircst.org

Investigation on Carbon Fiber Based Concrete with Use of Silica Fume

Marya Bashir[1], and Manish Kaushal[2]

[1] M-Tech Scholar, Department of Civil Engineering, RIMT University, Mandi, Gobindgarh, India
[2] Assistant Professor, Department of Civil Engineering, RIMT University, Mandi, Gobindgarh, India

Correspondence should be addressed to Marya Bashir; mariabashir321@gmail.com

ABSTRACT- For the construction of civil engineering works, concrete play main role and a large quantum of concrete is being utilized. Both coarse aggregate and fine aggregate which is a major constitute used for making conventional concrete, has become highly expensive and also scarce. The investigation was prepared to examine the harden properties of concrete on the replacement of cement with silica fumes and fine aggregate with the carbon fibers. Carbon fibers are thin, tough and adjustable so it has high tensile strength, low weight, high chemical resistance, low thermal expansion and have tolerance to high temperatures. Silica fume has impact on various characteristics of fresh and cured concrete including increase in workability and lowering bleeding and segregation. One nominal mix was prepared and combination mixes were prepared. M35 grade was used for mix design. The harden properties of concrete like compression, split and flexural strength was examined on replacement of cement with silica fumes and fine aggregate with carbon fibers. The percentage replacement was taken as 0%, 5%, 10%, and 20% for silica fumes and fine aggregate with carbon fibers with 0%, 2.5%, 5 % and 7.5%. The cylindrical specimens, cubes and beams were prepared for testing after the recommended curing period of 7 days and 28 days respectively.

KEYWORDS- Carbon fibers, Silica fume, Fiber reinforced concrete, Aggregates, Cement

I. INTRODUCTION

India has done a major leap on developing the infrastructures such as buildings construction, express highways, power projects and industrial structures, dams, etc. to meet the requirements of globalization . For the construction of civil engineering works, concrete play the main role and a large quantity of concrete is being utilized [1]. Both coarse aggregate and fine aggregate, which is a major constituent used for making conventional concrete, has become highly expensive and also scarce. In the backdrop, there is large demand for alternative materials from wastes. Waste tyre management is a serious global concern [2]. Millions of waste tyres are generated, dumped or burned every year, often in an uncontrolled manner, causing a major environmental and health problem (Stephan al et. 2012). Carbon fibers which remain in dump sites with little degradation for a long time, leads to environmental hazard [3].

Recycling of waste is the vital procedure but industrial waste recycling is the most problematic source of waste. This substance is environmentally hazardous due to its mass manufacture, inexpensive accessibility, bulk, and non-biodegradable nature.

A. Fiber Reinforced Concrete

Fiber-reinforced concrete may be developed as a stuff composed of discontinuous, discrete, and equally distributed appropriate cement, mortar, or concrete and G-fibers. Fiber-reinforced concretes are available in wide range and qualities, each with distinct advantages [4]. Discrete Fibers don't include continuous meshes, woven textiles, and lengthy wires or rods. Fiber is a tiny piece of reinforcement elements that has certain qualities. It can be either round or hat-shaped [5]. The fiber is defined by a useful metric known as "aspect ratio." This ratio is calculated by taking the fiber's diameter against its length. Concrete that contains fibers increases its structural integrity, that is fiber reinforced concrete (FRC). There are short discrete fibers that are randomly oriented and uniformly distributed [6]. Natural fibers, steel fibers, glass fibers, and synthetic fibers are some of the fiber types. The nature of reinforced composite concrete differs with varied concrete, fiber component designs, dispersion, inclination, and intensities.Concrete supplemented with fiber (often steel, glass, or "plastic" fiber) is [7]less costly than hand-tied rebar while boosting mechanical properties by a factor of 10.The structure, size, and length of the fiber are all critical considerations. A tiny and small fiber, such as shofar-shaped glass fiber, will be beneficial just hours following the laying of concrete (minimises breaking while the concrete stiffens), but does not raise the compressive strength of the concrete [8].

B. Effect Of Fibers In Concrete

Fibers are typically used in concrete to reduce thermoplastic shrinkage contravention and dimensional durability cracking. They help avoid water leakage by decreasing flexural and compressive strength. Some fibers have stronger effect, erosion, and break tolerance in concrete. Because [9] fiber does not typically improve the compressive strength of the concrete, it cannot be used in substitute of period resistant or fundamental reinforced concrete. Some fibers lower compressive strength of concrete. The relative density of fiber incorporated to a concrete mix is expressed as a percentage of the total amount of the composition (concrete and fiber) (V) [10]. V typically ranges from 0.1 to 3%. Aspect ratio (l/d) is calculated by dividing G fiber length (l) by its diameter (d). In the case of fibers with a noncircular cross section, the aspect ratio is calculated using an equivalent diameter. If the elastic modulus of the fiber is greater than that of the material (concrete or mortar binder), they aid to share the load by enhancing the substance's compressive properties [11]. Increase in the aspect ratio of fiber often enhances the matrix's tensile strength and durability. Fibers that are overly long, on the other hand, tend to "ball" in the mixture and cause durability issues [12]. According to current studies, adding fiber in concrete has little influence on the abrasion resistance of concrete structures. This crushing is critical because people have long believed that when concrete is fortified with fibers, its ductility rises. The findings also revealed that micro fibers outperform longer fibers in terms of impact tolerance [13].

C. Different Types of Fiber Reinforced Concrete

In the construction industry, the following types of fibers are commonly used

- Reinforced Concrete with Steel Fibers
- Cement mortar and concrete with polypropylene fiber reinforcement (PFR).
- Glass Fiber Reinforced Concrete (GFRC)
- Asbestos Fibers
- Carbon Fibers
- Organic Fibers

D. Carbon Fibers

Carbon fibers shown in figure 1 have a low density, strong thermal conductivity, outstanding chemical resilience, and remarkable damage tolerance, and they may be utilised to reduce or eliminate cracking and shrinking. These fibers boost structural qualities like as compressive strength and flexural strength, ductility, and damage tolerance. Carbon fibers also aid in the reduction of freeze-thaw endurance and dry deformation. The use of carbon fibers reduces impedance [10] as shown in figure 1:

Figure 1: Sample of carbon fiber

E. Silica Fume

Silica fume is an ultrafine material with spherical particles less than 1 µm in diameter, the average being about 0.15 µm. This gives it around 100 times lower than a typical cement particle. The relative density of silica fume varies according to the extent of increased density in the silo, ranging from 130 kg/m3 (undensified) to 600 kg/m3. The specific gravity of silica fume is typically between 2.2 and 2.3. The BET procedure or the nitrogen adsorption technique can be used to determine the precise contact area of silica fume. It classically varies from 15,000 to 30,000 m2/kg.

Portland cement concrete contains silica fume, which is utilized to increase its qualities, particularly its compressive and flexural, ductility, and damage tolerance [10]. These enhancements are the consequence of both mechanical advantages caused by the introduction of an extremely fine powder to the cement paste mix and pozzolanic interactions between the silica fume and free lime hydrate within the paste. The addition of silica fume lowers the permeability of concrete to chloride ions, which safeguards the reinforcing [9] steel of concrete from oxidation, particularly in chloride-rich environments like coastal regions, continental climate roadways and runways (due to the employment of deicing salts), and saltwater bridges before the mid-1970s, practically all silica fumes were released into the environment. After environmental concerns necessitated the collection and land filling of silica fume, it became economically viable to use silica fume in various applications, in particular high-performance concrete. The impacts of silica fume on various characteristics of fresh and cured concrete include the following:

- Workability: Over the inclusion of silica fume, the slump loss with duration is directly related to the rise in silica fume concentration due to the advent of a high specific surface area into the concrete mix. Even when the slump subsides, the combination stays very coherent [10].
- Segregation and bleeding: Silica fume considerably lowers bleeding because the excess water is utilised in soaking the silica fume's enormous surface area, and therefore the free water remaining in the mixture for bleeding diminishes. Silica fume often clogs the gaps in fresh concrete, preventing water inside the concrete from reaching the top [10]. Sample of silica fume shown in Figure 2 below

Figure 2: Sample of silica fume

II. OBJECT OF STUDY

- To investigate the compressive strength by partial replacement of cement with silica fumes and fine aggregates with carbon fibers.
- To investigate the split tensile strength by partial replacement of cement with silica fumes and fine aggregates with carbon fibers.
- To investigate the flexural strength by partial replacement of cement with silica fumes and fine aggregates with carbon fibers
- To minimize the overall environmental effects of concrete production using these materials as partial replacement.

III. METHODOLOGY

The procedure of methods used for testing coarse aggregates, fine aggregate , fresh and harden concrete are given below

A. Sieve Analysis

The particle size distribution of fine and coarse aggregates may be determined via sieve analysis. This is accomplished by screening the aggregates in accordance with IS: 2386 (Part I) – 1963. In this case, we employ multiple sieves that are standardised by the IS code and then feed aggregates through them to gather various sized particles that are left over from various sieves.
The apparatus used are:-

- A set of IS Sieves of sizes – 80mm, 63mm, 50mm, 40mm,31.5mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm,4.75mm, 3.35mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm.
- Balance or scale with an accuracy to measure 0.1 percent of the weight of the test sample.

Procedure

- The sample was dried on a hot plate or in an oven at a temperature of 230 degree F (110 degree C).
- The air sample was weighed and sieved successfully on the appropriate sieves starting with the large.
- Every sieve was agitated individually over a fresh tray until no more than a trace passed through, but no less than two minutes. The shaking was conducted in a variable manner, from left to right, backward and forward, circular clockwise and anti-clockwise, and with periodic shocks, to keep the material flowing across the sieve surface in constantly changing directions.
- If fine material clumps were present, they were broken by gently pressing fingertips on the sieve's side. To clean the sieve apertures, a little cleaning with a soft brush on the backside of the sieve was utilized.
- After sifting, the material remained on each sieve, as well as any material removed from the sieve, was assessed.

B. Compressive Strength

The compressive strength of concrete is affected by a variety of elements, including the water-cement ratio, cement strength, the quality of the concrete material, and quality control throughout the manufacturing process, among others [12]. Compressive strength tests are performed on either a cube or a cylinder. Different standard codes indicate that the conventional way for the test is a concrete cylinder or a concrete cube. The American Society for Testing Materials ASTM C39/C39M specifies a Standard Procedure for Compressive Strength of Cylindrical Concrete Specimens. For cube tests, either cubes of 15 cm X 15 cm X 15 cm or cubes of 10cm X 10 cm x 10 cm are employed, depending on the size of aggregate. For the majority of the works, cubical moulds 15 cm x 15 cm x 15 cm are typically utilized [12].

Procedure

- Just after allotted curing period, remove the sample from the water and wipe remove the excess water from the surface.
- Take the specimen's length to the closest 0.2m.
- Clean the bearing surface of the testing machine.
- Put the sample in the equipment so that the load is placed to opposing sides of the cube cast.
- Place the sample in the centre of the machine's base plate.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Slowly and consistently put the load at a rate of 140kg/cm2/minute until the sample fails.
- Record the maximum load and note any unusual features in the type of failure.

C. Split Tensile Strength

- Age at Test – Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ± ½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients.
- Number of Specimens – At least three specimens, preferably from different batches, shall be made for testing at each selected age.
- Testing Machine – The testing equipment can be of any dependable kind, with the capacity for the tests and the ability to apply the load at the rate. The maximum allowable inaccuracy must be no more than 2% of the maximum load.
- Cylinders – The cylinder mould must be 150 mm in diameter and 300 mm in height, in accordance with IS: 10086-1982. Weights and weighing devices, mixing tools and containers, tamper (square in cross section), and so forth.

Procedure

- Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable.
- The quantities of the ingredients, including water, in concrete mixes used to determine the appropriateness of the materials available must be identical in every way to those used in the job.
- The amounts of cement, aggregates of each size, and water for each batch must be specified by weight, with an accuracy of 0.1% of the batch's overall mass.
- The concrete must be blended by hand, or better in a lab batch mixer, in order to minimize water or other

material loss. Each sample of concrete must be large enough to allow around 10% surplus after shaping the required number of test specimens.

- The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.
- The test samples must be created as soon as possible after combining and in such a way that the concrete is fully compacted with no separation or severe laitance.
- The test samples must be stored in a vibration-free environment, in moist air with at least 90% relative humidity, and at a temperature of 27° +- 2C° for 24 hours after the water is added to the dry materials.
- The worn surfaces of the supporting and carrying rollers must be cleaned, and any loose sand or other debris must be cleaned out from surfaces of the sample where they will come into contact with the rollers.

D. Flexure Strength

- Beam mould: 15 x 15 x 70 cm (where aggregate size is less than 38 mm) or 10 x 10 x 50 cm (when size of aggregate is less than 19 mm).
- The taming bar: (40 cm long, weighing 2 kg and tamping section having size of 25 mm x 25 mm).
- Flexural test machine: The testing machine's bed must include two steel rollers 38 mm in diameter to support the sample, and these rollers must be set such that the length from centre to centre is 60 cm for 15.0 cm specimens and 40 cm for 10.0 cm samples. The load should be applied by two comparable rollers installed at the third locations of the supporting span, i.e. 20 or 13.3 cm centre to centre.

Procedure

- Fill the mould with concrete in three layers of about similar thickness to create the test sample. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer.
- Clear the specimen of the supported and loading rollers, and eliminate any loose sand or other debris from the sample surface that will come into contact with the rollers.
- Circular rollers made of steel with a cross section diameter of 38 mm will be utilised to provide support and loading points for the specimens. The rollers must be at least 10 mm longer than the breadth of the test piece. A total of four rollers will be employed, with three of them capable of spinning along their respective axes. The spacing between the outside rollers (i.e. span) is 3d, while the distance between the inner rollers is d. The inner rollers must be evenly positioned between the outer rollers in order for the system to be methodical.
- The specimens housed in water must be analysed immediately after being removed from the water, while they are still wet. The test sample must be properly oriented in the device, with the specimen's longitudinal axis at right angles to the rollers. The mould filling direction for moulded specimens must be normal to the loading direction. The load must be applied at a rate of 400 kg/min for the 15.0 cm specimens and 180 kg/min for the 10.0 cm specimens.

IV. RESULTS

Values for Compressive strength of concrete after 7 days given below in Table 1

Table 1: Compressive strength after 7 days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Compressive strength after 07 days (N/mm2)
MB00	100	0	100	0	100	25.09
MB01	95	5	100	0	100	25.46
MB02	90	10	100	0	100	26.55
MB03	85	15	100	0	100	25.79
MB04	80	20	100	0	100	26.61
MB05	95	5	97.5	2.5	100	27.20
MB06	90	10	97.5	2.5	100	28.58
MB07	85	15	97.5	2.5	100	27.90
MB08	80	20	97.5	2.5	100	27.41
MB09	95	5	95.0	5	100	29.17
MB10	90	10	95.0	5	100	29.50
MB11	85	15	95.0	5	100	30.28
MB12	80	20	95.0	5	100	30.02
MB13	95	5	92.5	7.5	100	29.21
MB14	90	10	92.5	7.5	100	28.88
MB15	85	15	92.5	7.5	100	28.61
MB16	80	20	92.5	7.5	100	28.15

Figure 3: Variation of compressive strength of concrete after 7 days in graphical manner:

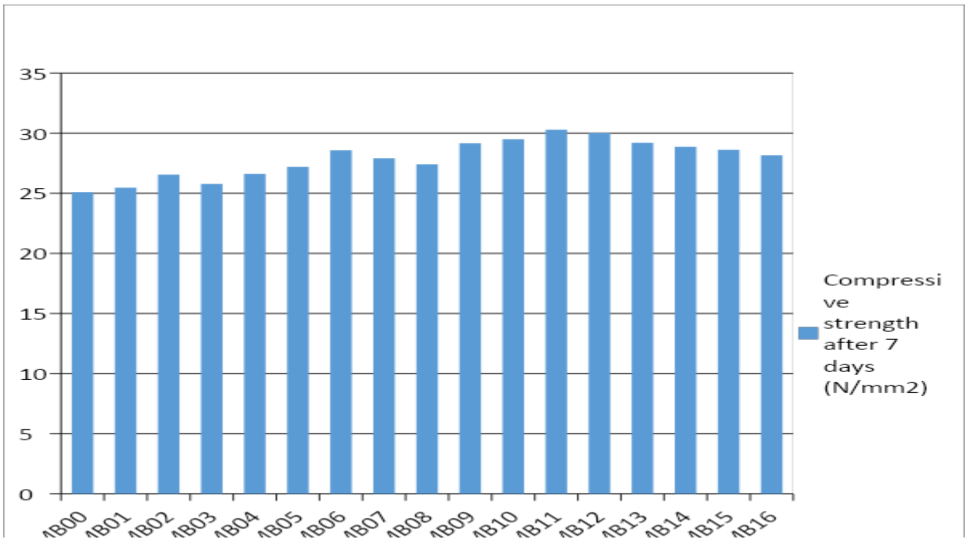

Figure 3: Compressive strength after 7 days

Values of compressive strength of concrete after 28 days given in Table 2 and Figure 4 shows the variation of compressive strength of concrete after 28 days in graphical manner:

Table 2: Compressive strength after 28 days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Compressive strength after 028 days (N/mm2)
MB00	100	0	100	0	100	37.21
MB01	95	5	100	0	100	38.42
MB02	90	10	100	0	100	38.81
MB03	85	15	100	0	100	40.15
MB04	80	20	100	0	100	40.03
MB05	95	5	97.5	2.5	100	41.28
MB06	90	10	97.5	2.5	100	41.81
MB07	85	15	97.5	2.5	100	42.92
MB08	80	20	97.5	2.5	100	42.17
MB09	95	5	95.0	5	100	44.62
MB10	90	10	95.0	5	100	46.15
MB11	85	15	95.0	5	100	47.30
MB12	80	20	95.0	5	100	46.81
MB13	95	5	92.5	7.5	100	45.91
MB14	90	10	92.5	7.5	100	45.09
MB15	85	15	92.5	7.5	100	44.88
MB16	80	20	92.5	7.5	100	44.36

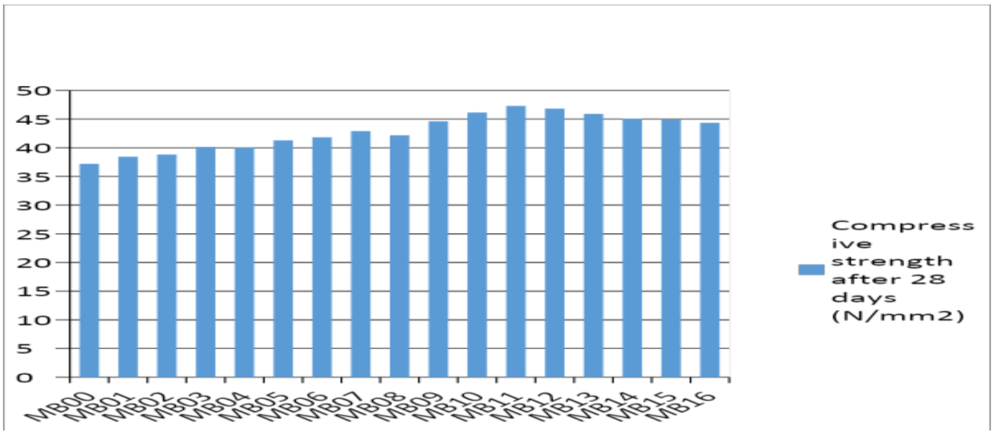

Figure 4: Compressive strength after 28 days

Values of Split Tensile strength of concrete after 7 days given in Table 3 and Figure 5, shows the variation of Split Tensile strength of concrete after 7 days:

Table 3: Split tensile strength after 7 days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Split Tensile strength after 07 days (N/mm2)
MB00	100	0	100	0	100	2.78
MB01	95	5	100	0	100	3.13
MB02	90	10	100	0	100	3.34
MB03	85	15	100	0	100	3.55
MB04	80	20	100	0	100	3.41
MB05	95	5	97.5	2.5	100	3.64
MB06	90	10	97.5	2.5	100	3.70
MB07	85	15	97.5	2.5	100	3.76
MB08	80	20	97.5	2.5	100	3.56
MB09	95	5	95.0	5	100	3.81
MB10	90	10	95.0	5	100	3.92
MB11	85	15	95.0	5	100	3.63
MB12	80	20	95.0	5	100	3.56
MB13	95	5	92.5	7.5	100	3.54
MB14	90	10	92.5	7.5	100	3.48
MB15	85	15	92.5	7.5	100	3.24
MB16	80	20	92.5	7.5	100	3.05

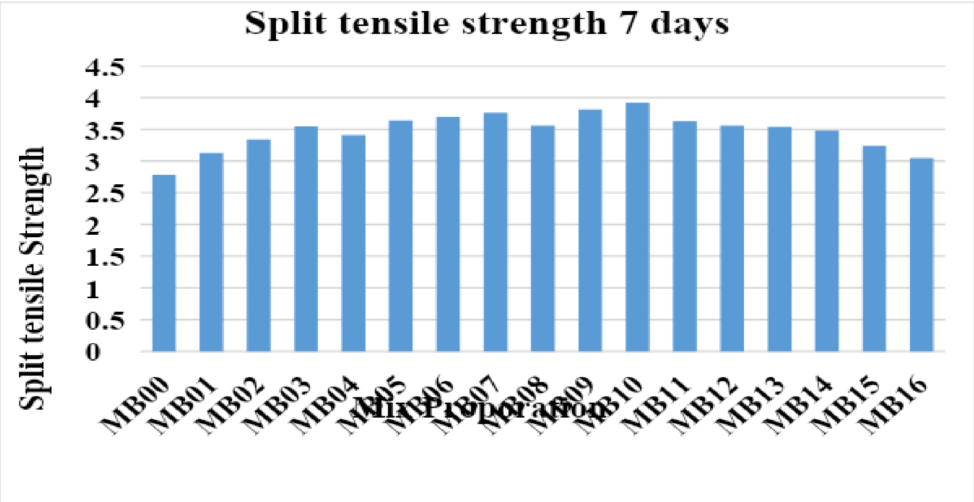

Figure 5: Split strength after 7 days

Values of Split Tensile strength of concrete after28 days given in Table 4 and Figure 6 shows the variation of Split Tensile strength of concrete after 28 days

Table 4: Split tensile strength after 28days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Split tensile strength after 028idays (N/mm2)
MB00	100	0	100	0	100	4.24
MB01	95	5	100	0	100	4.61
MB02	90	10	100	0	100	4.95
MB03	85	15	100	0	100	5.21

MB04	80	20	100	0	100	5.01
MB05	95	5	97.5	2.5	100	5.27
MB06	90	10	97.5	2.5	100	5.36
MB07	85	15	97.5	2.5	100	5.41
MB08	80	20	97.5	2.5	100	5.20
MB09	95	5	95.0	5	100	5.55
MB10	90	10	95.0	5	100	5.61
MB11	85	15	95.0	5	100	5.58
MB12	80	20	95.0	5	100	5.52
MB13	95	5	92.5	7.5	100	5.45
MB14	90	10	92.5	7.5	100	5.38
MB15	85	15	92.5	7.5	100	4.98
MB16	80	20	92.5	7.5	100	4.65

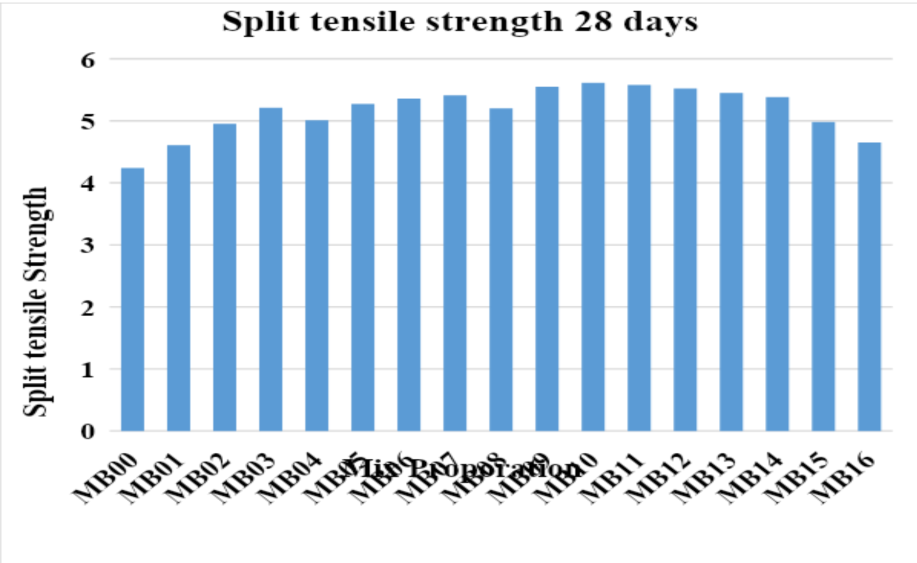

Figure 6: Split strength after 28 days

Values of Flexural strength of concrete after 7 days given in Table 5 and Figure 7 shows the variation of Split Flexural strength of concrete after 7 days:

Table 5: Flexural strength after 7 days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Flexural strength after 07 days (N/mm2)
MB00	100	0	100	0	100	3.96
MB01	95	5	100	0	100	4.15
MB02	90	10	100	0	100	4.61
MB03	85	15	100	0	100	4.95
MB04	80	20	100	0	100	4.82
MB05	95	5	97.5	2.5	100	5.20
MB06	90	10	97.5	2.5	100	5.16
MB07	85	15	97.5	2.5	100	5.71
MB08	80	20	97.5	2.5	100	5.92
MB09	95	5	95.0	5	100	6.28
MB10	90	10	95.0	5	100	6.31
MB11	85	15	95.0	5	100	6.40
MB12	80	20	95.0	5	100	5.15
MB13	95	5	92.5	7.5	100	5.28
MB14	90	10	92.5	7.5	100	5.21
MB15	85	15	92.5	7.5	100	5.19
MB16	80	20	92.5	7.5	100	5.12

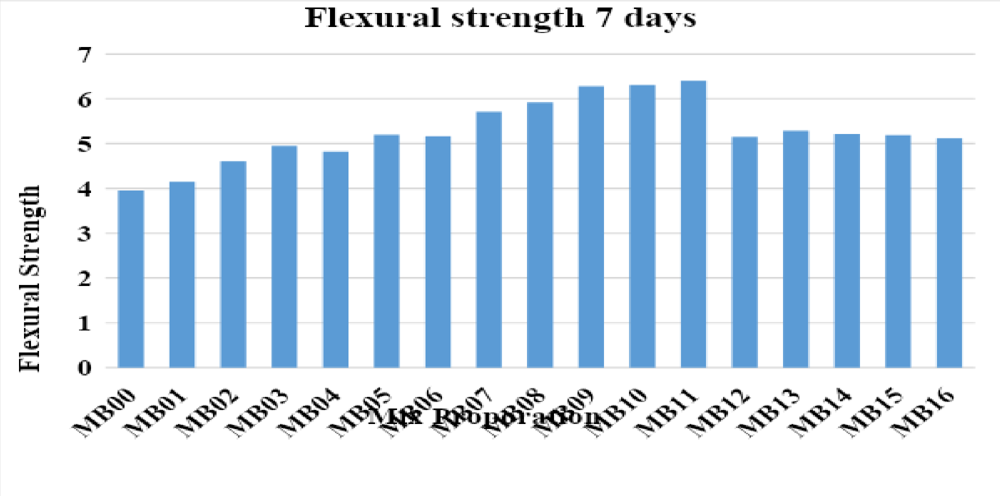

Figure 7: Flexural strength after 7 days

Values of Flexural strength of concrete after 7 days given in Table 6 and Figure 8 shows the variation of Split Flexural strength of concrete after 7 days:

Table 6: Flexural strength after 28 days

Mix	Percentage of cement	Percentage of silica fume	Percentage of fine aggregate	Percentage of carbon fibber	Percentage of coarse aggregate	Flexural strength after 028idays (N/mm2)
MB00	100	0	100	0	100	5.21
MB01	95	5	100	0	100	5.34
MB02	90	10	100	0	100	6.05
MB03	85	15	100	0	100	6.41
MB04	80	20	100	0	100	6.35
MB05	95	5	97.5	2.5	100	6.48
MB06	90	10	97.5	2.5	100	6.51
MB07	85	15	97.5	2.5	100	7.12
MB08	80	20	97.5	2.5	100	7.49
MB09	95	5	95.0	5	100	7.66
MB10	90	10	95.0	5	100	7.72
MB11	85	15	95.0	5	100	7.85
MB12	80	20	95.0	5	100	6.69
MB13	95	5	92.5	7.5	100	6.25
MB14	90	10	92.5	7.5	100	6.64
MB15	85	15	92.5	7.5	100	6.58
MB16	80	20	92.5	7.5	100	6.53

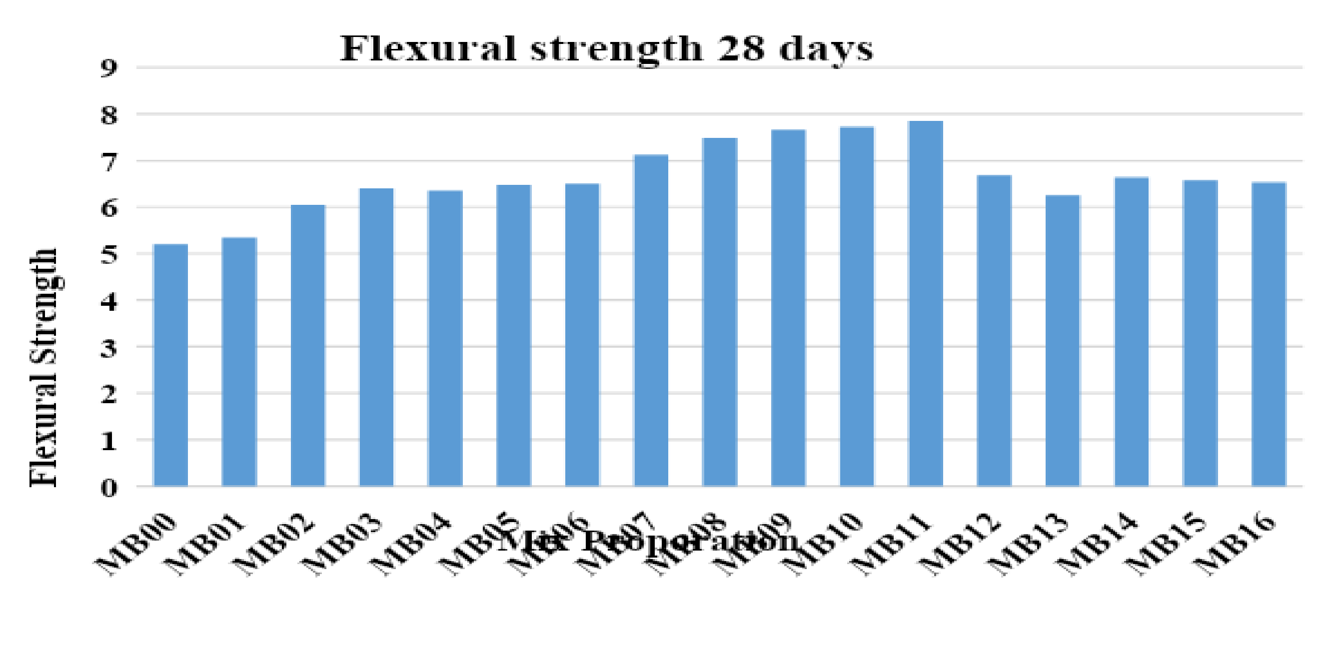

Figure 8: Flexural strength after 28 days

V. RESULT & DISCUSSION

The harden properties of concrete like compression strength, split strength and flexural strength was examined on replacement of cement with silica fumes and fine aggregate with carbon fibers. The percentage replacement was taken 0%, 5%, 10%, and 20% for silica fumes and fine aggregate with carbon fibers with 0%, 2.5%, 5 % and 7.5%. The cube, cylindrical and beam specimen were prepared for testing after the recommended curing time of curing period of 7 days and 28 days respectively and their maximum strength was attained which is discussed below:

- The maximum compressive strength was attained at 7 days was in mix MB11 i.e. the mix in which percentage of cement was 85%, silica fume was 15%, and fine aggregates was 95% and coarse aggregate was 100% which was 30.28 N/mm2.
- The maximum compressive strength was attained at 28 days was in mix MB11 i.e. the mix in which percentage of cement was 85%, silica fume was 15%, and fine aggregates was 95% and coarse aggregate was 100% which was 47.30 N/mm2.
- The maximum split tensile strength attained at 7 days was in mix MB10i.e. the mix in which percentage of cement was 90%, silica fume was 10%, and fine aggregates was 5% and coarse aggregate was 100% which was 3.92 N/mm2.
- The maximum split tensile strength was attained at 28 days was in mix MB10 i.e. the mix in which percentage of cement was 90%, silica fume was 10%, and fine aggregates was 5% and coarse aggregate was 100% which was 5.61 N/mm2.
- The maximum flexural strength was attained at 7 days was in mix MB11 i.e. the mix in which percentage of cement was 90%, silica fume was 10%, and fine aggregates was 5% and coarse aggregate was 100% which was 7.85 N/mm2.
- The maximum flexural strength was attained at 7 days was in mix MB11 i.e. the mix in which percentage of cement was 90%, silica fume was 10%, and fine aggregates was 5% and coarse aggregate was 100% which was 6.40 N/mm2.

CONFLICTS OF INTEREST

I Marya Bashir declare that I have no affiliations with or involvement in any organization with any financial or non-financial interests and have no conflicts of interest.

ACKNOWLEDGMENT

While writing this piece of work I Marya Bashir has received great assistance from my guide Er, Manish Kaushal. I am grateful to him that his expertise and feedback has helped me formulate my ideas into this research work.

REFERENCES

[1] ACI234R – 96 "Guide for the use of silica fume in concrete" by ACI committee 234.
[2] Afroughsabet, V.; Ozbakkaloglu, T. Mechanical and durability properties of high-strength concrete containing steel and polypropylene fibers. Constr. Build. Mater. 2015, 94, 73–82.
[3] Ajileye, E.V. (2012). Investigations on Microsilica (Silica Fume) As Partial Cement Replacement in Concrete. Global Journal of Researches in Engineering Civil and Structural engineering 12 (1), 17-23.
[4] Ambrish E, Dhavamani Doss S, Shanmuga Nathan N and Ganapathi Raj S (2017), "Partial Replacement of Copper Slag as Fine Aggregate", SSRG International Journal of Civil Engineering, Volume 4, Issue 3, pp.18-23.
[5] Amit S. Kharade, Sandip V. Kapadiya and RavindraChavan (2013), "An Experimental Investigation of Properties of Concrete with Partial or Full Replacement of Fine Aggregate Through Copper Slag", International Journal of Engineering Research & Technology, Volume 2, Issue 3, pp.1-10.
[6] Amudhavalli, N. K. & Mathew, J. (2012). Effect of silica fume on strength and durability parameters of concrete. International Journal of Engineering Sciences & Emerging Technologies. 3 (1), 28-35

[7] Anurag Jain, Sandeep Gupta &Mayank Gupta (2018), 'STEEL SLAG AS REPLACEMENT OF FINE AGGREGATE IN TERMS OF HIGH STRENGTH concrete' international journal of engineering sciences & research technology, Value: 3.0 ISSN: 2277-9655.

[8] B. T. Chen, T. P. Chang, J. Y. Shih, and J. J. Wang, "Estimation of exposed temperature for fire-damaged concrete using support vector machine," Computational Materials Science, vol. 44, no. 3, pp. 913–920, 2009.

[9] Bayasi, Zing, Zhou, Jing, (1993) "Properties of Silica Fume Concrete and Mortar", ACI Materials Journal 90 (4) 349 - 356.

[10] BhanjaSantanu, and Sengupta, Bratish, (2003) "Optimum Silica Fume Content and its Mode of Action on Concrete," ACI Materials Journal, V (100), No. 5, pp. 407-412.

[11] Bhanjaa.S, Sengupta.B, "Influence of silica fume on concrete", IOSR-Journal of Mechanical and Civil Engineering , e-ISSN: 2278-1684,pISSN: 2320-334X , pp: 44-47, 2014.

[12] BiswajitJena,Asha Patel, 2016. Study of the Mechanical properties and Microstructure of Chopped Carbon Fiber Reinforced Self-Compacting Concrete. International Journal of Civil Engineering and Technology, 7(3), p. 223–232.

[13] Concrete, Bureau of Indian Standards, New Delhi,India.

ABOUT THE AUTHOR

Marya Bashir, received diploma degree in civil engineering in 2015 from Kashmir Government Polytechnic, Kashmir, B-Tech in civil engineering in 2018 from Maharshi Dayanand University, Rohtak Haryana, presently doing M-Tech in Building Construction and Management from RIMT University, Punjab, India.

Manish Kaushal, received his B-Tech degree in civil engineering in 2011 from Punjab Technical University, Jalandhar, M-Tech from Punjab Technical University, Jalandhar in 2015.Presently, he is working as Assistant Professor in Department of Civil Engineering RIMT University, Punjab, India.