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AN EXPERIMENTAL STUDY OF SELF-COMPACTING CONCRETE USING MULTI WALL CARBON NANOTUBE AND BLAST FURNACE SLAG

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Abstract — *Self-compacting concrete is an innovative concrete that does not require vibration for placing and compaction. It can flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of Self compacting concrete ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. In this study an attempt is made to understand the effect of multiwall carbon nano-tube on self-compacting concrete of M40 grade with different proportion of CNT and BFS in relation with the weight of cement by adding super plasticizer (Sikkamet 4061 NS). The scope of this study is to determine the physical properties of self-compacting concrete by using different percentage of blast furnace slag and Carbon nano tube .There were total of three batches of concrete mixes, consists of CNT (0% ,0.2%,0.4%) and BFS (10%, 20% and 30 %).The experimental was carried out with workability tests such as slump flow test, V-funnel test, and L-Box. The compressive strength and split tensile strength were also studied. In this study the comparison made by compressive strength and spite tensile strength of SSC by replacing with CNT and BFS.*

Keywords*- CNT, BFS, Super Plasticizer (Sikkament 4061 NS), Compressive strength and Spilt tensile strength*

I-INTRODUCTION

Single wall carbon nanotube: -

Most single-walled nanotubes (SWNT)Have a diameter of close to 1 nanometer, with a tube length that can be many millions of times longer. The structure of a SWNT can be conceptualized by wrapping a one-atom-thick layer of graphite called graphene into a seamless cylinder. Single-walled nanotubes are an important variety of carbon nanotube because they exhibit electric properties that are not shared by the multi-walled carbon nanotube (MWNT) variants. Their band gap can vary from zero to about 2 eV and their electrical conductivity can show metallic or semiconducting behavior, whereas MWNTs are zero-gap metals. Single-walled nanotubes are the most likely candidate for miniaturizing electronics beyond the micro electromechanical scale currently used in electronics. The most basic building block of these systems is the electric wire, and SWNTs can be excellent conductors.

Multiwall carbon nanotube: -

The multi-walled carbon nanotube has the outer diameter of 50-80nm, inner diameter of5-15nm, therefore the thickness of the wall is about 45-65nm. And because the distance between each wall is about 0.34nm, therefore the number of layers can be calculated between45/0.34=132 to 65/0.34=191

Self compacting concrete: -

Self-compacting concrete (SCC) is a flowing concrete mixture that can consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help minimize hearing-related damages on the worksite that are induced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced. In, Japan the volume of SCC in construction has risen steadying over the years. To mixture proportion for SCC differ from those of ordinary concrete, in that former has more powder content and less coarse aggregate. Constitute the bulk of a concrete mixture and give dimensional stability to concrete. Among the various proprieties of aggregate the important once for SCC are the shape and graduation.

Blast Furnace slag

Blast furnace slag is a by-product from blast furnaces which is used to produce iron. Blast furnace slag has been used extensively as a successful replacement material for Portland cement in concrete materials to improve durability, produce high strength and high-performance concrete, and brings environmental and economic benefits together, such as resource conservation and energy savings. Blast furnace slag is a nonmetallic material consisting of silicates and alumina silicates of calcium and magnesium together with other compounds of Sulphur, iron, manganese and other trace elements. Blast furnace slag aggregate is a non-metallic product obtained from Facor Bhadrak. It is produced from a molten state simultaneously with pig iron in a blast furnace.

II: Experimental Problem:

Materials:

2.1 Cement: - Cement used in composite was an ordinary Portland cement of 53 grade which had to average compressive strength 53 N/mm2

2.2 Sand: - Sand is naturally occurring granular materials composed of finely divided particles. Sand grades as fine, medium and coarse with ranges 0.053 mm to 0.2 mm.

2.3 Aggregate: - Aggregate normally used to for concrete are natural of sand and gravel. To deposits are hard to obtain and large rocks must be crushed to form the aggregate. Roads was the second largest category (26%) and while 20% of were used in other construction

2.4 Blast Furnace Slag (BFS): - Blast furnace slag is a by-product from blast furnaces which is used to produce iron. Blast furnace slag has been used extensively as a successful replacement material for Portland cement in concrete materials to improve durability, produce high strength and high-performance concrete.

2.4 Mechanical properties of an aggregate: -

Table 1**.** Test in aggregate for an impact test

Size	Specific gravity	Impact value
20 MM	2.75	20%
10 MM	2.65	24%

2.5 Superplasticizer: - The superplasticizer added for sikamet 4061 NS.

2.6 L box Test: - It is used to assess the passing ability of SCC to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking L-box has arrangement and the dimensions test procedure is to support the L-box on a level horizontal base and close the gate between the vertical and horizontal sections. Pour the concrete from the container into the filling hopper of the box and allow standing for (60±10) s.

2.7 V funnel test: - It is used to assess the viscosity and filling ability of SCC. Procedure is to clean the funnel and bottom gate, then dampen all the inside surface including the gate. Close the gate and pour the sample of concrete into the funnel, without any agitation or rotting, then strike off the top with the straight edge so that the concrete is with the top of the funnel. Place the container under the funnel to retain the concrete to be passed. After a delay of (10±2) s from filling the funnel, open the gate and measure the time 0.1 s.

2.8 U Box Test: -About 20 liters of concrete is needed to perform the test, sampled normally. Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it. Moisten the inside surface of the apparatus, remove any surplus water, fill the vertical section of the apparatus with the concrete sample.it stand for 1 minute. Lift the sliding gate and allow the concrete to flow out into the other compartment. After the concrete has come to rest, measure the height of the concrete in the compartment that has been filled, in two places and calculate the mean (H1). Measure also the height in the other equipment (H2). Calculate H1-H2, the filling height. The whole test must be performed within 5 minutes.

2.9 Slump Test: - The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete **S**lump flow test ASTMC 1611

To check flow property, the mixes are tested to flow intensity after mixing a slump flow between 60 to75 cm should be obtained.

Mix proportion

Table 2. Mix Design

Mix id (SCC)	Cement (kg)	Coarse Aggregate (kg)	Fine Aggregate (kg)	superplasticizer	Water (lit)
M40	470	456.67 (20 mm)	818.88	2.82	178
		556.06 (10 mm)			

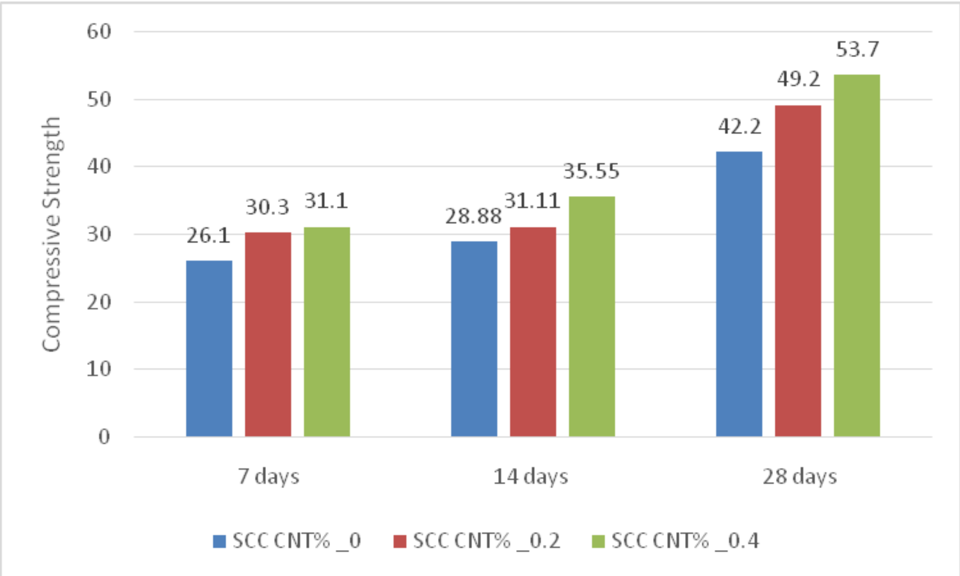
The design is for M40 grade of concrete for the volume of 1 m³done

III. Results and Discussion

3.1 Experiment for Added material CNT

Table 3. Compressive strength test results for 7,14 and 28 days added different proportion of CNT

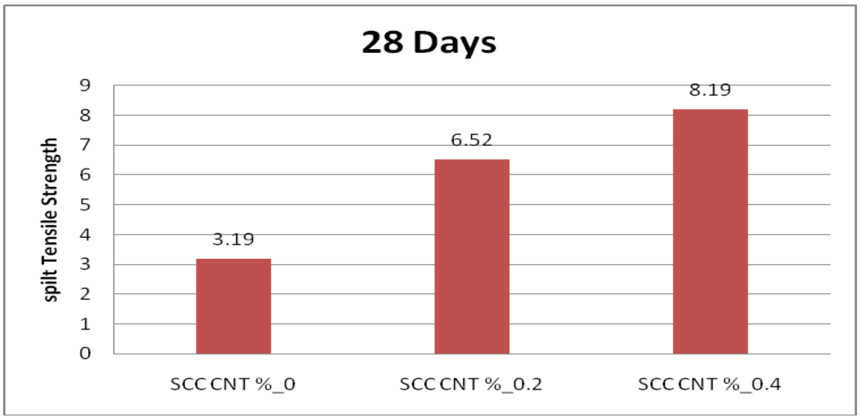
Mix id	CNT (%)	7 days	14 days	28 days
SCC 0	0	26.1	28.88	42.2
SCC 0.2	0.2	30.3	31.11	49.2
SCC 0.4	0.4	31.1	35.55	53.7



Graph 1. Compression test result graph for a 7,14 and 28 Days.

Table 4. Test result of split tensile strength test results for 28 days added different proportion of CNT

Mix ID	CNT %	28 Days
SCC 0	0	3.19
SCC 0.2	0.2	6.52
SCC 0.4	0.4	8.19

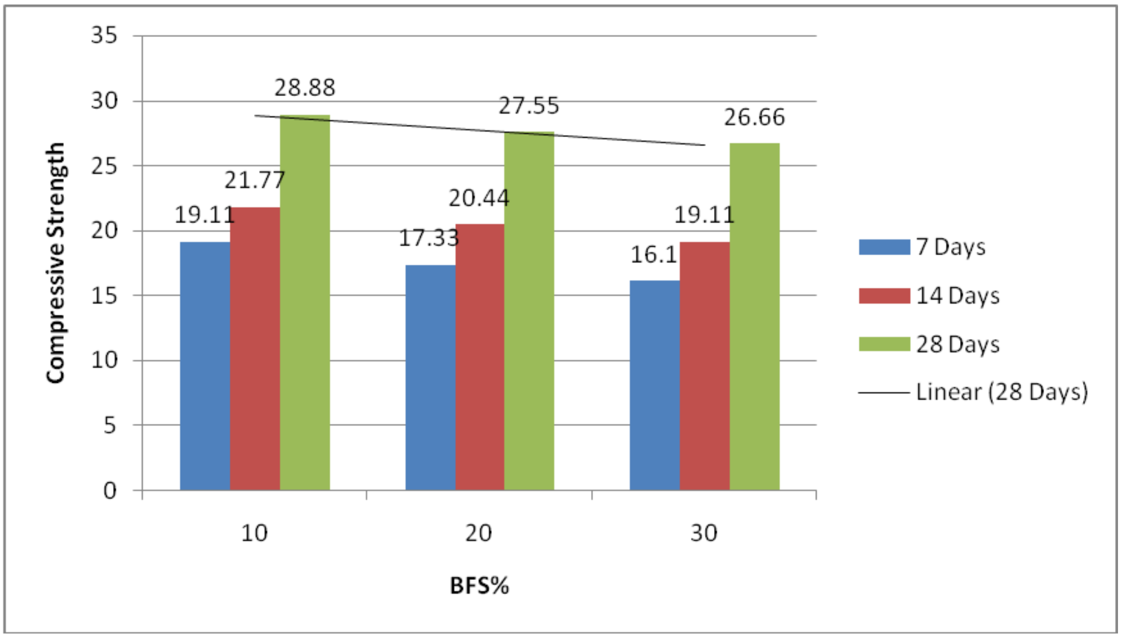


Graph 2. Spilt tensile testing for a 28 Days

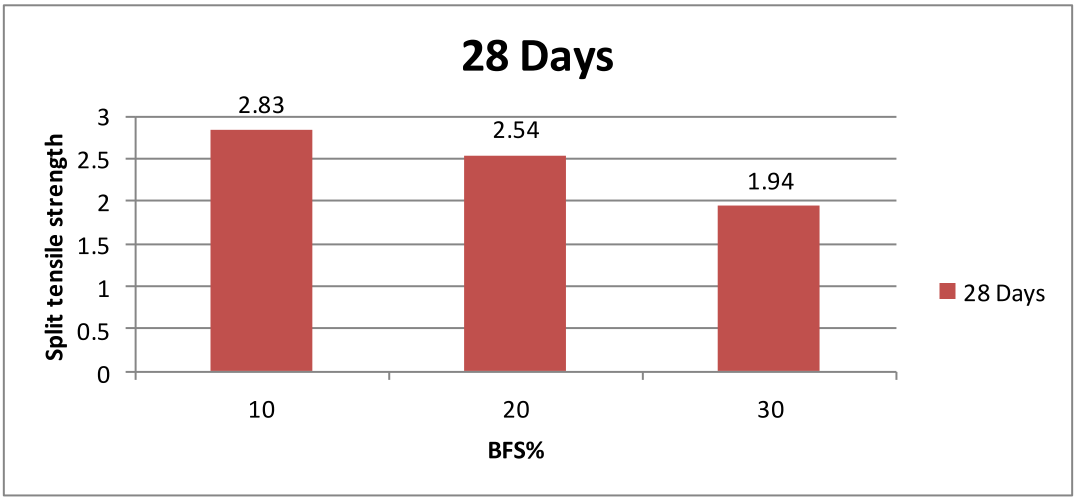
3.2 Experiment for Added material BFS

Table 5. Compressive strength test results for 7,14 and 28 days added different proportion of CNT

Mix id	BFS (%)	7 Days	14Days	28 Days
SCC 10	10	19.11	21.77	28.88
SCC 20	20	17.33	20.44	27.55
SCC 30	30	16.10	19.11	26.66



Graph 3. Compression test result graph for a 7,14 and 28 Days.

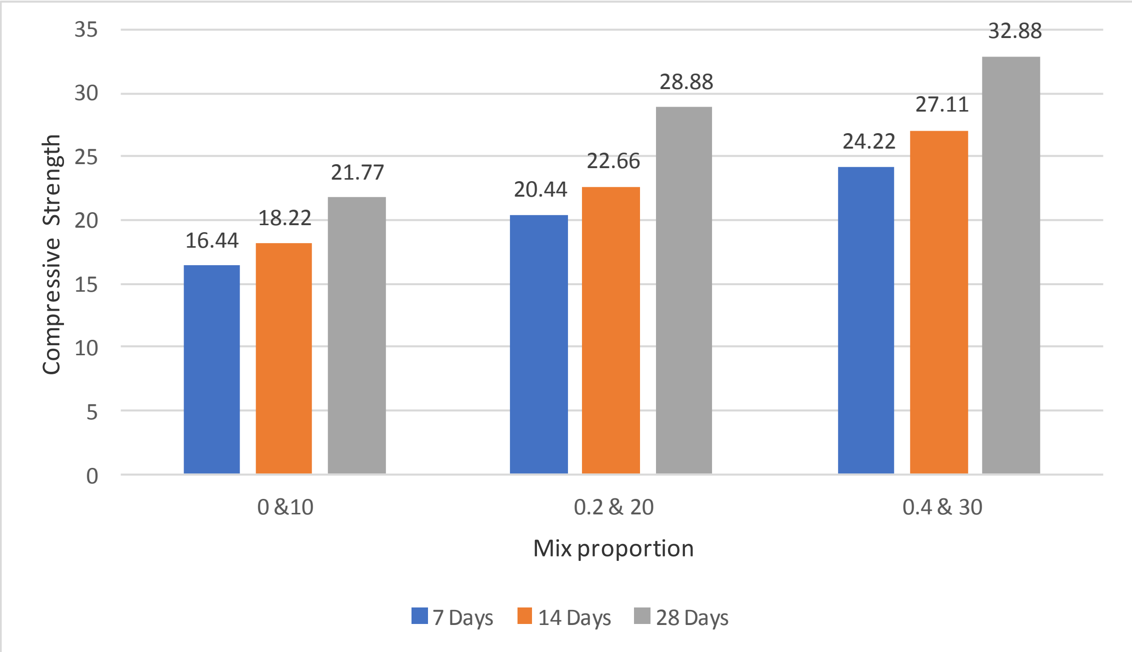


Graph 4. Spilt tensile testing for a 28 Days for a different Proportion of a BFS

3.3 Experiment for Combination of material BFS & CNT

Table 6. Compressive strength test results for 7,14 and 28 days added different proportion of CNT & BFS

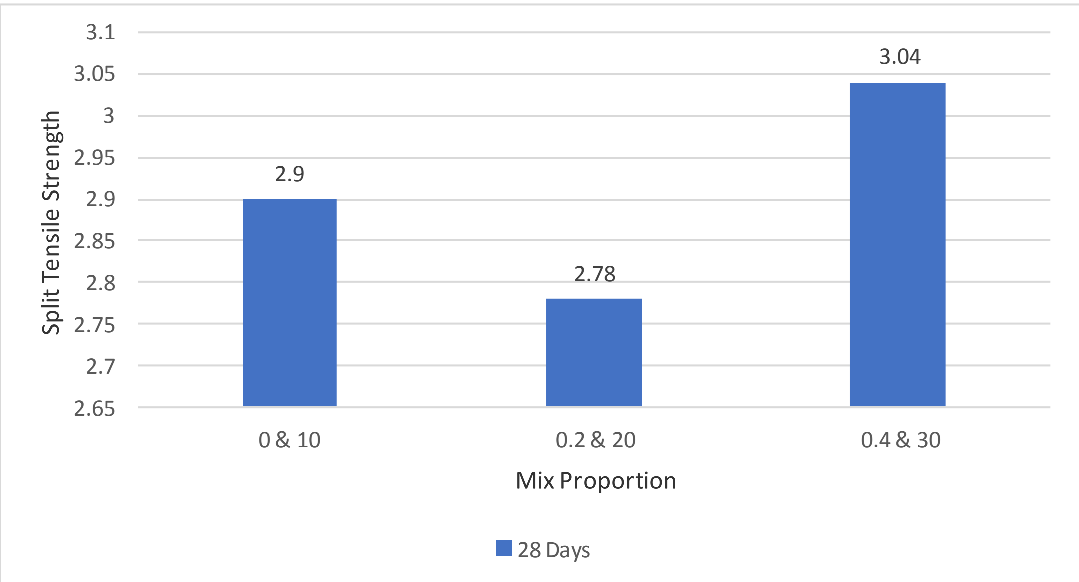
Mix id	CNT (%)	BFS%	7 days	14 days	28 days
SCC 0 &10	0	10	16.44	18.22	21.77
SCC 0.2 &20	0.2	20	20.44	22.66	28.88
SCC 0.4 &30	0.4	30	24.22	27.11	32.88



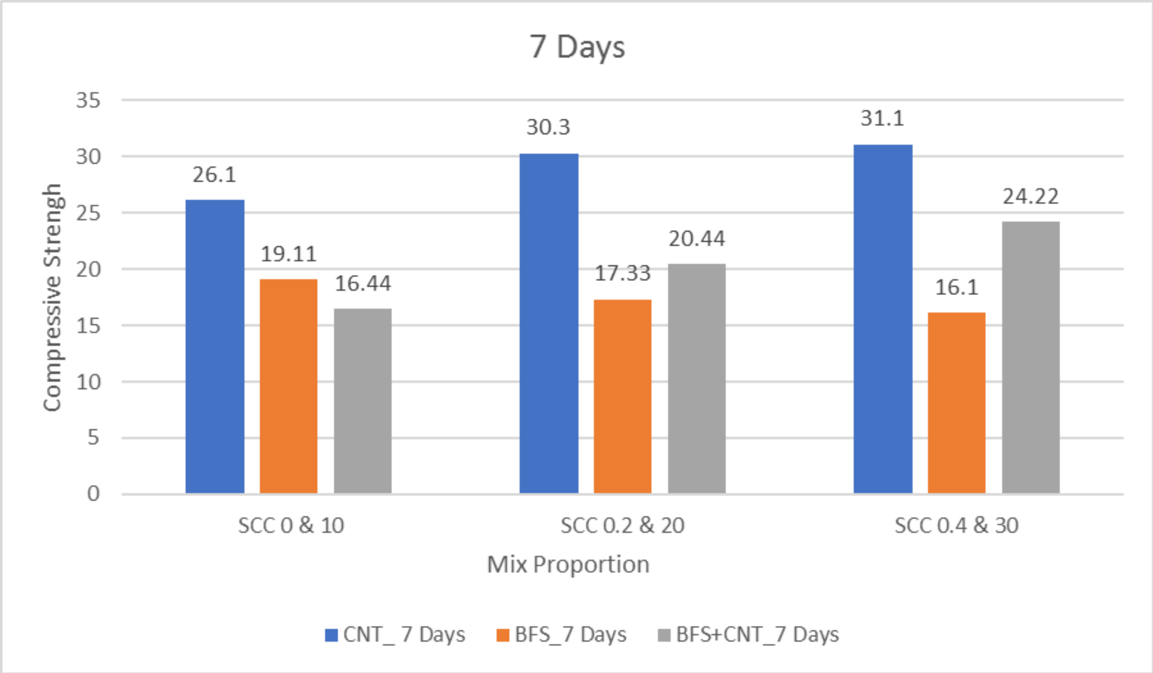
Graph 5. Compression test result graph for a 7,14 and 28 Days

Table 7. Split tensile strength test results for 7,14 and 28 days added different proportion of CNT & BFS

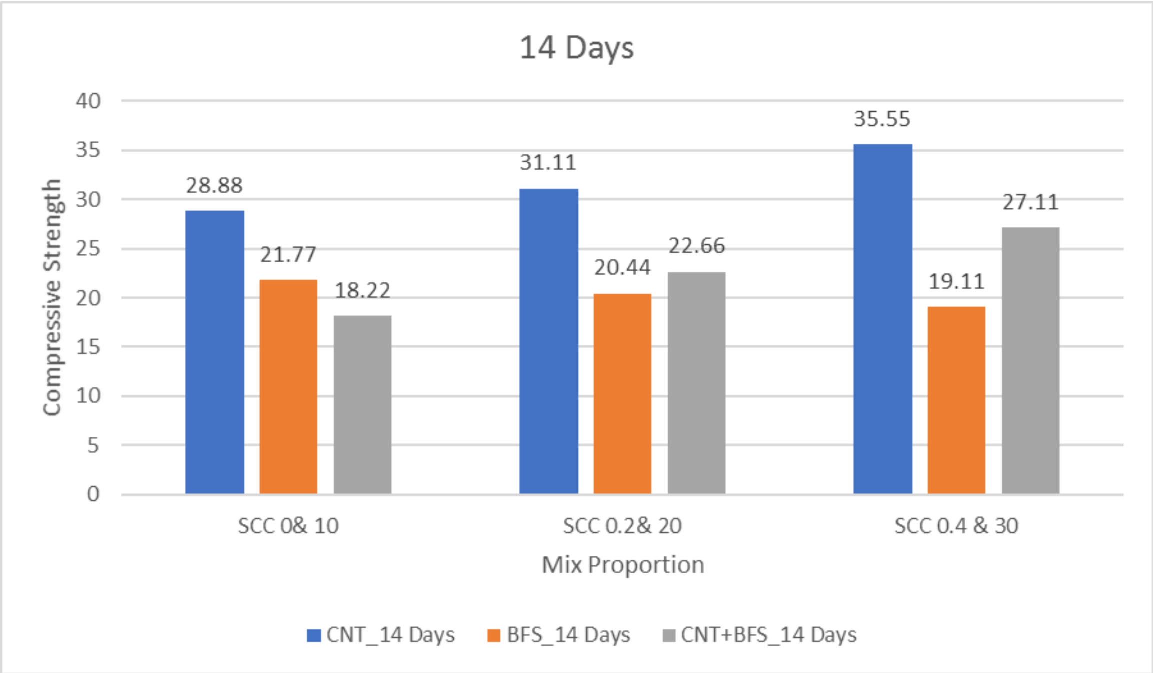
Mix ID	CNT%	BFS %	28 Days
SCC 0 &10	0	10	2.90
SCC 0.2 &20	0.2	20	2.78
SCC 0.4 &30	0.4	30	3.04



Graph 6. Spilt tensile testing for a 28 Days for a different Proportion of a BFS & CNT



Graph 7. Comparison of 7 Days Compressive Strength of Different Material CNT, BFS and combination of CNT & BFS.



Graph 8. Comparison of 14 Days Compressive Strength of Different Material CNT, BFS and combination of CNT & BFS.

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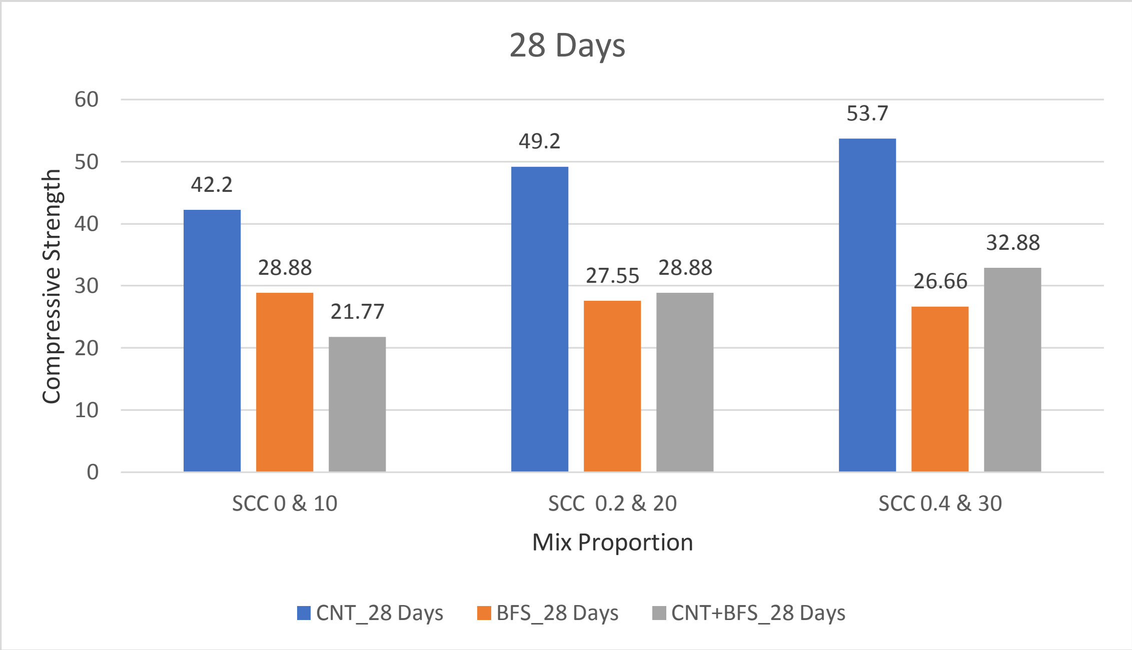
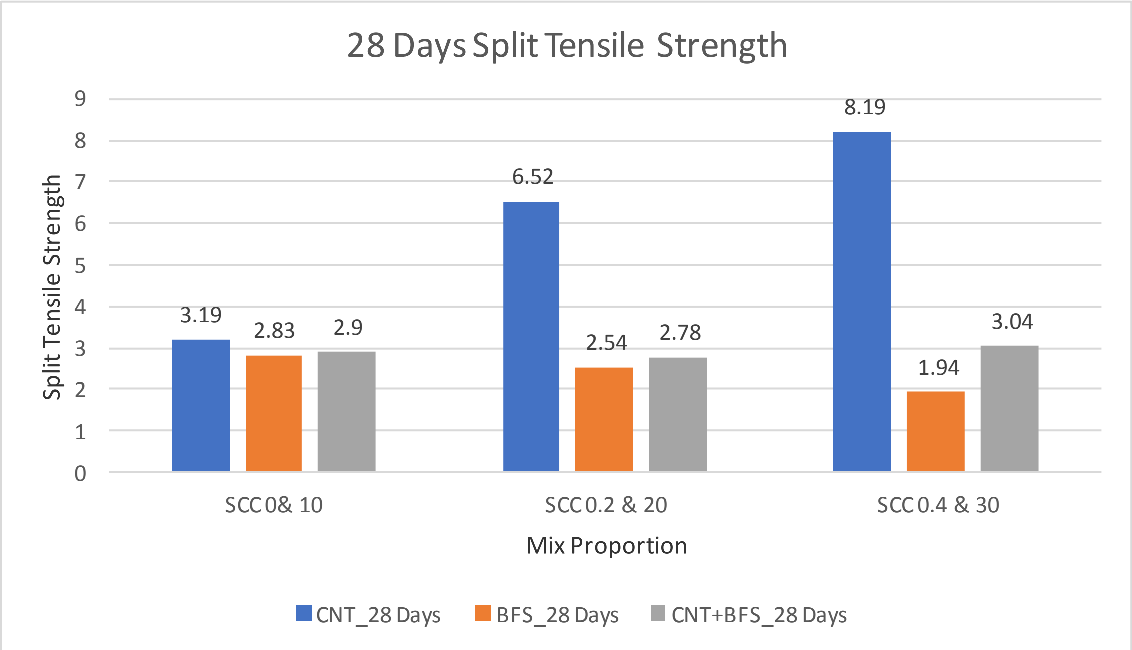


Graph 9. Comparison of 28 Days Compressive Strength of Different Material CNT, BFS and combination of CNT & BFS.



Graph 10. Spilt tensile testing for a 28 Days for a different Proportion of a BFS, CNT and combination of CNT and BFS material.

VI: CONCLUSION:

The tests were performed to determine the fresh and mechanical properties of Self Compacting Concrete mixtures and the results of the tests are as

- All the self-compacting concrete with replacement of slag as coarse aggregate up to 30% mixes had a satisfactory performance in the fresh state.
- The slump value gets about 600 mm to 650 mm with increase in percentage of slag from SCC-0 to SCC-30.
- There is decrease of 8% in compressive strength for SCC-30 over SCC-0.

- The increase in split tensile strength is up to 1.50% over self-compacting concrete SCC-0 with natural aggregate for 30% replacement.
- By using MWCNT the increment in the compressive strength, split tensile strength.
- So, we can conclude that by using this material we can increase the strength 8%,5% and 3% respectively.
- So, we can enhance the strength criteria by using this MWCNT.
- So, by use of this advanced material we can improve the strength parameter i.e. compressive strength, split tensile strength.
- By using combination of the material CNT and BFS we can improve the strength parameter i.e. compressive strength, split tensile strength.

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