THE EFFECTS OF USING GGBFS, CERAMIC WASTE TILES AND JUTE FIBER ON THE STRENGTH PROPERTIES OF M30 GRADE CONCRETE

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Abstract - *The Construction Industry's key materials are mortar and concrete mix in which Cement acts as binder. In cement production, CO_2 gas is eminently evolved as a by-product, which adversely affects our environment. Waste materials can be used in the manufacture of concrete mix to minimize negative consequences and natural resource utilization. In Present Study, Various strength properties of concrete mix are evaluated with the effects of partially replacing the Cement and Coarse aggregates with Ground Granulated Blast Furnace Slag (GGBFS) and Ceramic Waste Tiles (CWT), respectively along with Jute Fiber (JF) in addition to mix. Various Strength Properties such as Slump values, Compressive Strength, Split Tensile Strength and Flexural strength are thus evaluated in this study with the percentage variations of materials used as GGBFS constantly replaced the cement content by 40%, Ceramic Waste Tiles as 0%,15%,20% and 25% replaced the Coarse aggregates along with Jute Fiber as 0.1%,0.2% and 0.3% . All specimens were cured for 7days, 14 days and 28 days before testing. From the study it has been observed that the results shows optimum proportion for M30 grade concrete is GGBFS as 40%, Ceramic Waste Tiles (CWT) as 20% and Jute Fiber (JF) as 0.3%. The Test results of this study are within acceptable limits.*

***Key Words*: Jute Fiber, Ground Granulated Blast Furnace Slag (GGBFS), Ceramic Waste Tiles (CWT), Mechanical Properties, Concrete.**

1. INTRODUCTION

The Construction Industry makes extensive use of mortar and concrete mix. Concrete is largely used human made material that ranks almost after water as most consumed material of about six billion tones every year. It is a hardened mass which is prepared by mixing appropriate proportion of cement, fine aggregates, coarse Aggregates, water and admixtures. The concrete cost is corresponds to its ingredients cost which is scarce and expensive, and leading to usage of economically alternative materials in its production. This requirement is drawn the attention of investigators and explore new replacements of Ingredients. The major problem is that the original conventional materials are depleted and our research for alternate materials results the usage of Ground Granulated Blast Furnace Slag (GGBFS), Ceramic Waste Tiles and Jute Fiber. Being a by-product and waste using it effectively up to some extent serves as a step for a green environment and at the same time keeping in mind that the strength of the concrete can't be degrade by the usage of GGBFS. The Ceramic Waste Tiles are not recycled; however the ceramic waste tiles are durable, hard and highly resistant to degradation forces so, we selected these waste tiles as a replacement material to the natural aggregate to reuse them and to reduce the solid waste production from construction demolition. Jute Fiber has been recognized; the addition of closely spaced and uniformly distributed Fibers in concrete would act as crack arrester and would substantially improve static and dynamic properties. Thus, the current study will focus on the effect of Ground Granulated Blast Furnace Slag (GGBFS), Ceramic Waste wall and floor tiles as aggregate with Jute fiber in addition to concrete mix.

2. LITERATURE REVIEW

Veeresh Karikatti et.al (2016) the present report surveys the research carried out on Geo Polymer Concrete (GPC) with fly ash (FA) and Ground Granulated Blast Funace Slag (GGBS) for ambient conditions. The review also includes the work that has been carried out, to date, accounting for the effects of various ingredients, ratios and structural aspects on the behaviour of geopolymer concrete and present applications in construction industry.

R. Nagesh Kumar et.al.(2018) presents the strength properties of M30 grade concrete mix with alternate materials for Portland Cement and Coarse aggregate as GGBS and Broken tiles. Portland cement is replaced GGBS, and coarse aggregate is replaced with broken tiles as 10%, 20%, 30%, 40% and 50% proportioning ratios. The influence of mineral admixture and inert aggregate on the workability, compressive strength, split tensile strength and flexural strengths of SCC is examined for M30 grade SCC. The test results shows that the optimum proportion for this grade is found at 30% and are within acceptable limits.

S.M. Leela Bharathi et.al.(2019) worked on the flexural behaviour of Natural Fiber Reinforced concrete with partial replacement of Flyash and GGBFS. It is noticed that Jute Fiber Reinforced Cement Concrete (JFRCC) mix with 30% GGBFS has maximum compressive strength which is 8.8% higher than normal concrete and 15.8% higher than JFRCC with 30% Flyash.

Pramodini Sahu et al. (2020) proposed a study on effect of Jute Fiber orientation and percentage on strength of JFRCC. In this research, the experiments related to Jute Fiber reinforced concrete are done by taking different Fiber percentage and the compressive strength and modulus of rupture value observed

Madhurima Dass et.al.(2020) concluded that the industrial waste GGBFS will be utilized to partially replace the cement content in the concrete mix. Cement was supplanted by GGBFS within range of 0 to 40% cement weight for M30 grade mix. Fresh concrete properties like workability and hard concrete properties like compressive strength, tensile strength and flexural strength was calculated for 7,28 and 56 days results average compressive strength and flexural strength by 40% GGBFS substitution as Cement.

3. MATERIALS

3.1 WATER

Water available in the laboratory with pH value of 7.0 and confirming the requirements of IS 456-2000 is used for making concrete mix and curing the specimens as well. Water is an important ingredient of concrete as it actively participates in chemical reaction with cement.

3.2 CEMENT

The ordinary Portland Cement (OPC 43 grade) confirming to IS 12269-1987. The physical properties of the cement are tested in accordance with IS: 4031-1988 and are satisfied.

3.3 FINE AGGREGATES

Fine aggregate should pass through I.S sieve 4.75 mm. Standard fine aggregate sand is to be used from the nearby river and the classification of sand according to IS 383-2016 code confirms the zone - 2.

3.4 COARSE AGGREGATES

Out of total aggregates, the aggregates that are retained on 4.75mm sieve are termed as coarse aggregates. The local available coarse aggregates (natural stone Aggregates) are used in the present work. The coarse aggregates with size of 20mm will be used in this present work.

3.5 GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

Granulated Blast Furnace Slag is produced from blast furnace slag, the iron steel company. The granulated slag is ground to desired fineness for producing GGBFS. The chemical composition of GGBFS contributes to the production of superior cement.

Figure 3.1 Ground Granulated Blast Furnace Slag (GGBFS)

Table 3.1: Chemical Properties of GGBFS

Chemical components	%age of chemical components
SiO_2	33.6942
CaO	21.9869
Fe_2O_3	23.7346
Al_2O_3	8.6925

3.6 JUTE FIBER

Jute Fibers are of silky texture, these are bio-degradable and eco-friendly. The common structural properties of the Jute Fibers are having high tensile strength and low extensibility. In the present study raw jute Fibers cut to a length of 10 mm are used. The content of Jute Fibers is determined with respect to the weight of cement.

Figure 3.2: Jute Fiber (JF)

3.7 CERAMIC WASTE TILES

Broken tiles will be collected from the solid waste of ceramic manufacturing unit and from demolished building sites. Ceramic Waste can be used in concrete to improve its strength and durability factors. In this study, it can be used to replace the coarse aggregates.

Figure 3.3: Ceramic Waste Tiles (CWT)

3. RESULTS AND DISCUSSIONS

4.1 SLUMP TEST

The Slump Cone test is performed to determine the workability in terms of consistency of the concrete mix of M30 grade on various samples. Workability is the ability of concrete to be easily mixed, transported, placed and compacted. The Slump of 85 mm initially are noticed on conventional mix and the maximum slump of about 90 mm is noticeable at combination of 40% GGBFS, 15% CWT and 0.1% JF. Its graphical representation is shown in Figure 4.1.

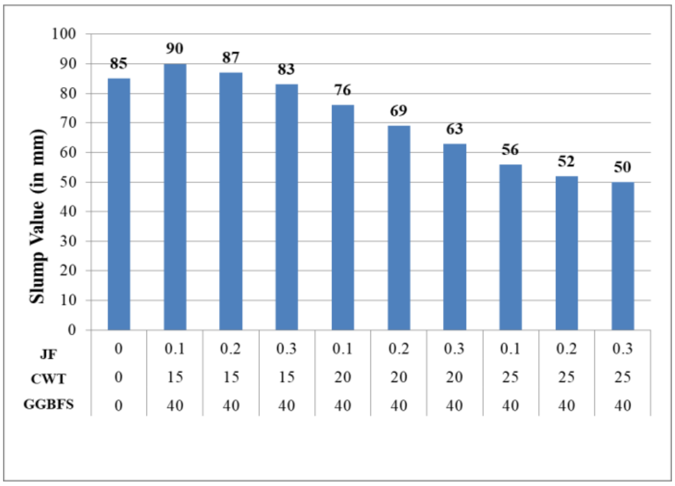

Figure 4.1: Slump Values of Concrete Mixe Using GGBFS, Ceramic Waste Tiles and Jute Fiber.

4.2 COMPRESSIVE STRENGTH TEST

The Compressive Strength Test is carried out by testing of cubes of sizes (150x150x150) mm for 7 days, 14 days and 28 days. The highest compressive strength of cubes is achieved with 40% of Ground Granulated Blast Furnace Slag (GGBFS), 20% of Ceramic Waste Tiles (CWT) and 0.3% of Jute Fiber (JF). The graphical representation of compressive strength of cubes for 7 days, 14 days and 28 days are shown in figure 4.2, figure 4.3 and figure 4.4.

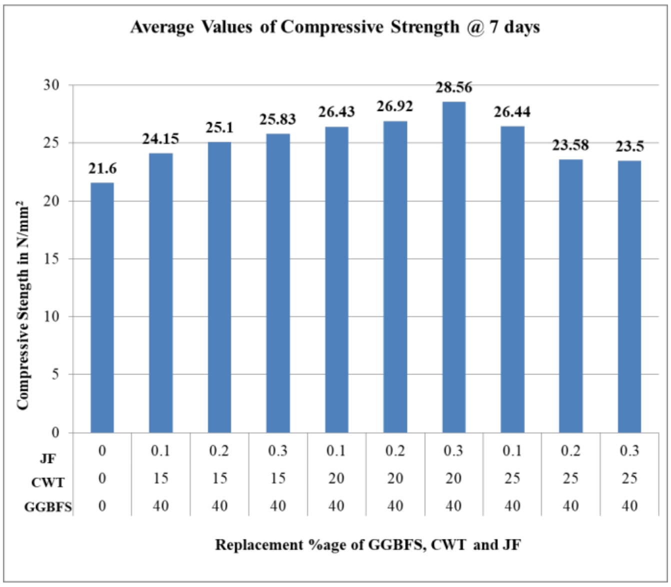

Figure 4.2: Compressive Strength of Concrete Mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 7 days of curing.

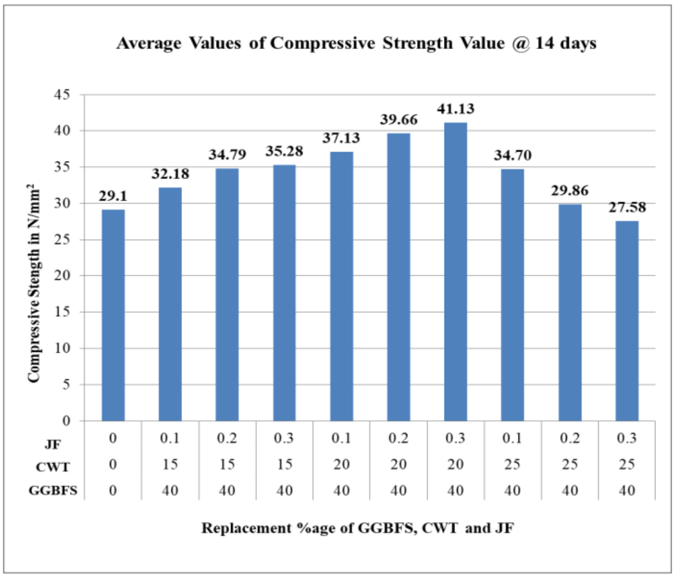

Figure 4.3: Compressive Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 14 days of curing.

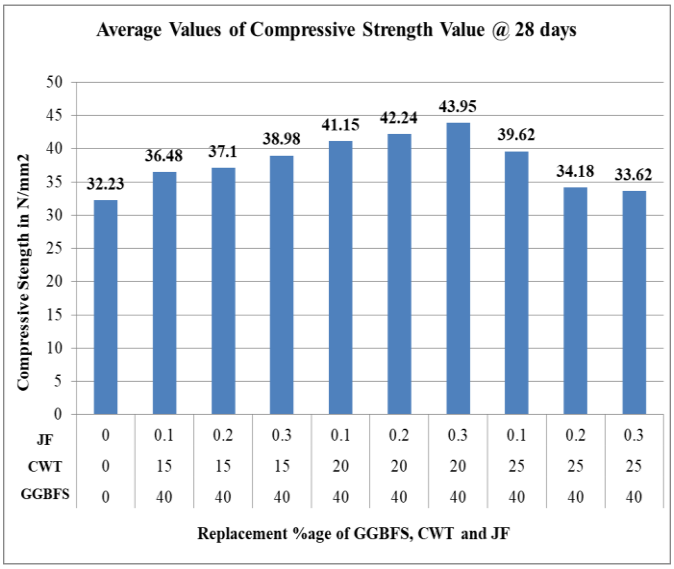

Figure 4.4: Compressive Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 28 days of curing.

4.3 SPLIT TENSILE STRENGTH

Split Tensile Strength of Cylinders increases gradually and attained maximum strength values at the combination of 40% GGBFS, 20% Ceramic Waste Tiles and 0.3% Jute Fiber in the concrete mix. The graphical representation of Split Tensile strength of cylinders for 7 days, 14 days and 28 days are shown in figure 4.5, figure 4.6 and figure 4.7.

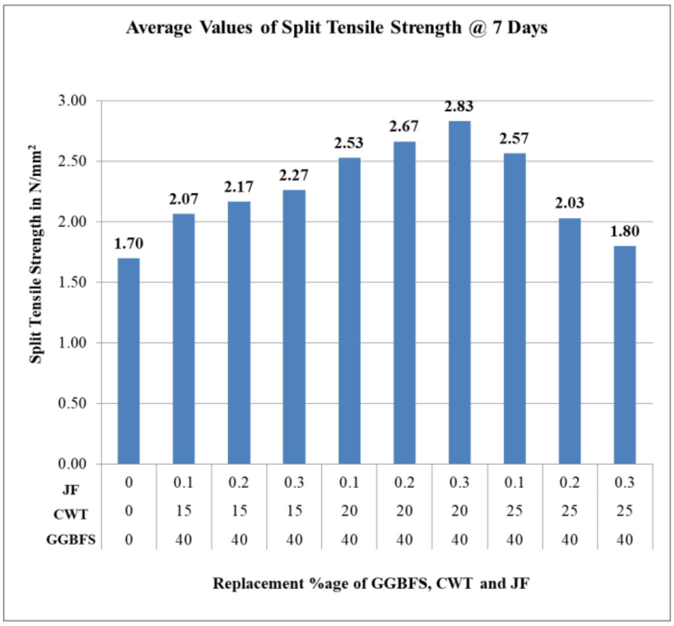

Figure 4.5: Split Tensile Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 7 days of curing

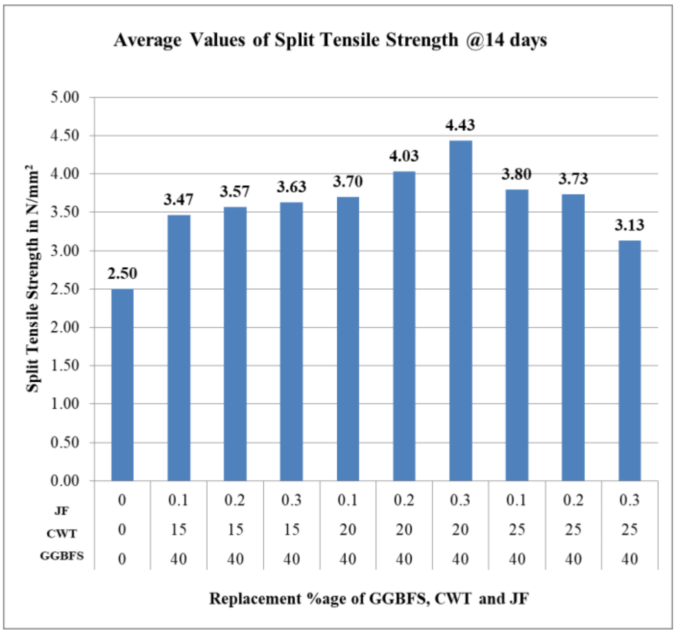

Figure 4.6: Split Tensile Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 14 days of curing.

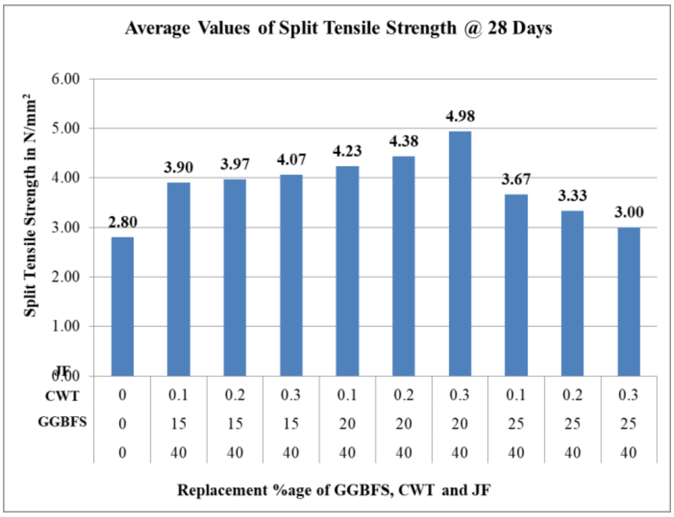

Figure 4.7: Split Tensile Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 28 days of curing.

4.4 FLEXURAL STRENGTH TEST

Flexural Strength or Ultimate Moment (Strength) for reinforced beams is defined as the moment that exists just prior to the failure of the beam. The maximum flexural strength of beams is achieved at the percentage of 40% GGBFS, 20% CWT and 0.3% Jute Fiber. The graphical representation of Flexural Strength of beams for 7 days, 14 days and 28 days are shown in figure 4.8, figure 4.9 and figure 4.10.

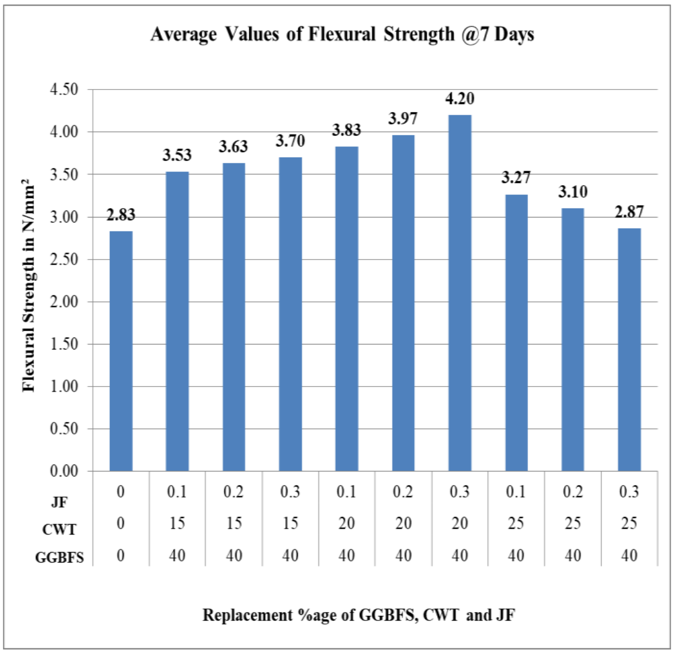

Figure 4.8: Flexural Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 7 days of curing.

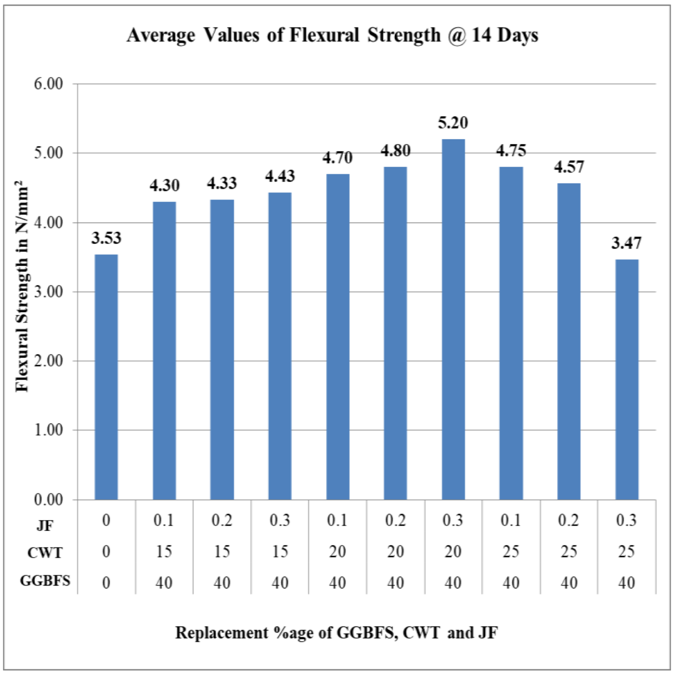

Figure 4.9: Flexural Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 14 days of curing.

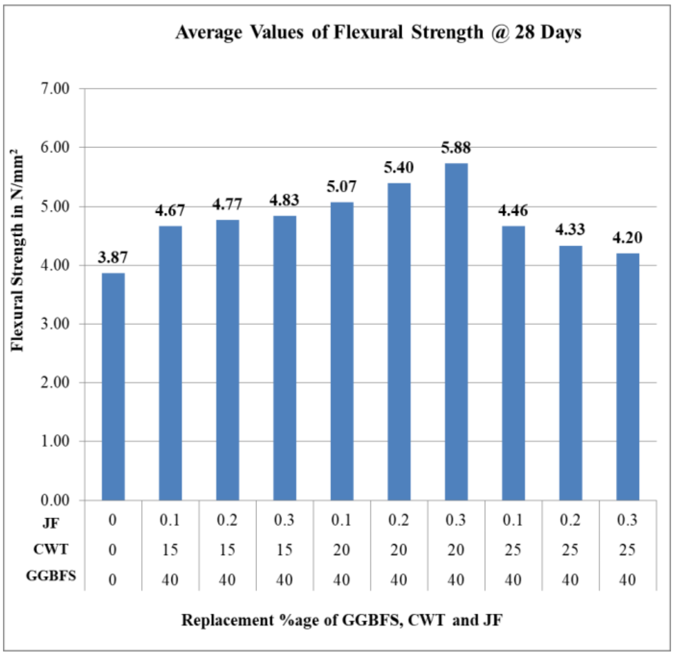

Figure 4.10: Flexural Strength of Concrete mix using GGBFS, Ceramic Waste Tiles and Jute Fiber after 28 days of curing.

5. CONCLUSIONS

Present study concludes the following:

1. The Compressive Strength of Concrete mix after 7days, 14 days and 28 days of curing increases gradually by replacement of cement and coarse aggregates with GGBFS and Ceramic Waste Tiles, respectively along with addition of Jute Fiber becomes maximum as 28.56 N/mm², 41.13 N/mm² and 43.95 N/mm² when GGBFS is 40%, CWT is 20% and Jute Fiber is 0.3%.

2. The Split Tensile Strength of concrete mix achieves maximum value of 2.83 N/mm2, 4.43 N/mm² and 4.98 N/mm² when GGBFS is 40%, CWT is 20% and Jute Fiber is 0.3%. is added to concrete mix after 7, 14 and 28 days of curing, respectively.

3. The Ultimate Flexural Strength observed maximum with 40% GGBFS, 20% CWT and 0.3% of Jute Fiber i,e. 4.20 N/mm², 5.20 N/mm² and 5.88 N/mm² of mix after curing of 7days, 14 days and 28 days, respectively.

4. Concrete mix $G_{40}C_{20}J_{0.3}$ can be used as structural concrete without compromising its strength properties as it is the optimum mix in terms of strength and economy.

5. The Slump value increases 85 mm to 90 mm due to addition of GGBFS at 40%. Maximum Slump of 90 mm was observed at $G_{40}C_{15}J_{0.1}$ Combination in concrete mix.

REFERENCES

1. Kimmi Garg (2016) Analysis of strength characterstic of GGBFS concrete, International Journal of Latest Research in Science and Technology.

2. N.Naveen Prasad (2016) Partial Replacement of Coarse aggregate by Crushed Tiles and Fine aggregate by Granite Powder to improve the Concrete Properties in IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

3. Mohammad Zakaria et.al. (2016) “Scope of using jute fiber for the reinforcement of concrete material” Zakaria et al. Textiles and Clothing Sustainability (2016) 2:11 DOI 10.1186/s40689-016-0022-5.

4. Qian Jueshi et.al., "High performance cementing materials from industrial slags — a review Resources" *Conservation and Recycling* 29, 1 June 2017, 195-207.

5. Ganesh Babu, K et.al. "Efficiency of GGBFS in concrete Cement. Concrete" Res., 2017, 1031– 1036.

6. M.N. Soutsos et al, "Fast track construction with high-strength concrete mixes containing Ground Granulated Blast Furnace Slag", *International Journal of Civil Engineering and Technology*, 255-263.