Experimental Analysis of High Strength Concrete Prepared by Bagasse Ash and Glass Fiber

Rishikesh Sarode and Khushpreet Singh

February 27, 2023

Experimental Analysis of High Strength Concrete prepared by Bagasse Ash and Glass Fiber

RISHIKESH SARODE[1] and KHUSHPREET SINGH[2]

[1]*ME Scholar, Civil Engineering Department, Chandigarh University, India*
[2]*Assistant Professor, Civil Engineering Department, Chandigarh University, India*

Abstract:-One of the most commonly used building materials is concrete, which is often produced using readily available materials. The increment in the use of concrete has created a critical demand for chemical and mineral additives to enhance concrete performance. In today's world advancement in infrastructure, the high need is to use the High Strength Concreteso that we can use the small section in the concrete. Before 2019 Indian standards have not published the ideal criteria for the production of High Strength Concrete. This paper deals with the experimental study of high-strength concrete prepared by the new IS 10262:2019 and the use of bagasse ash and glass fiber in high-strength concrete to increase the strength of concrete. It is seen in the research that the use of bagasse ash can be uneconomical in concrete due to its low replacement ratio. For planned concrete with a slump of 120mm, bagasse can only be substituted up to a certain amount, giving a replacement of just 2%. Glass fiber inclusion results in an increase in the concrete's flexural and split tensile strength of up to 1.75% when combined with 2% bagasse ash. However, the ideal is discovered to be 0.75% for Coconut Fiber since too much fiber results in cavities, which Creates a problem in Mixing reduces the concrete's ability to withstand compression.

Keywords:economicalconcrete, Marble Powder, Glass Fiber, High Strength Concrete.

1 INTRODUCTION

1.1 High-Strength Concrete

Concrete mixes are proportioned by employing specific relationships derived from experimental data, which provide a reasonably reliable guide for selecting the ideal combination of materials to achieve the desired qualities.High-strength concrete is necessary in engineering projects with concrete components that must withstand high compressive loads. High-strength concrete is commonly utilized in the construction of high-rise buildings[1]. It has been employed in components such as columns (particularly on lower floors where loads are expected to be the greatest), shear walls, and foundations. High strengths are also utilized in bridge applications on occasion. The problem of High Strength Concrete's brittleness can be solved by utilizing fibers[2]. Fiber reinforcements come in a variety of forms, including steel, carbon, polypropylene, polyvinyl, as well as glass fibers. The tensile and fracture toughness of High Strength Concrete is significantly improved by the addition of fibers. The requirement for certain strengths or performances from concrete is another element in the concept of high-strength concrete.

1.2 Bagasse Ash

Environmental protection can also be supported by the partial replacement of Cement with Sugarcane bagasse ash in Concrete[3]. We know that the production of sugar leaves behind a huge mass of sugarcane waste. Then this waste is sent for the combustion process[4]. Ash produced from the waste of sugarcane is 20% of the weight of total waste produced. Also, bagasse ash is said to be rich in silicaand thus has high pozzolanic action. Thus, this property makes it fit to be used as a replacement for cement in concrete as the rate of gain in strength is high with concrete containing sugarcane bagasse ash. Also, due to the pozzolanic action of sugarcane bagasse ash, it can replace fine aggregates up to 30% in concrete. the use of Sugarcane Bagasse Ash in concrete is found to be economical. The addition of Bagasse Ash at a replacement level of up to 30% improves resistance to chloride penetration[5]. It was discovered that Sugarcane Bagasse Ash might favorably substitute cement up to a 30% maximum bagasse ash is said to be rich in silica and thus has high pozzolanic action. Thus, this property makes it fit to be used as a replacement for cement in concrete as the rate of gain in strength is high with concrete containing sugarcane bagasse ash. The use of sugar cane bagasse ash in high-strength concrete can reduce the cost of concrete making it an economical material to be used in concrete.

1.3 Marble Powder

Marble powder is the dust that remains after breaking marble. It can be used as a fine aggregate or as filler[6]. Waste marble powder has silica levels that range from 1.4% to 23.5%, significant quantities of calcium oxide (30%-65%), and low levels of other substances including magnesium, alumina, ferric, sodium, potassium oxide, and others (zinc, manganese oxide, and titanium dioxide). During the cutting, sculpting, and polishing of marbles, 20-25 percent of the stone is powdered. The specific gravity is 2.63. Marble powder has a moisture content of 0.6. Because it is produced in vast quantities, it might be employed as a cost-effective material in concrete[7]. It also has some cement-like properties. By using marble dust, the concrete industry can maximize material consumption, make financial gains, and build strong, long-lasting structures that blend in with their surroundings.

1.4 Glass Fibre

The primary role of fiber-reinforced materials is to offer appropriate strength and stiffness along component development directions and to sustain structural component mechanical traction. Their primary advantages are low cost and strong strength. Glass fibers of various sorts (code E, S, AR, C) have the same elastic modulus but differ in mechanical strength and endurance. Fiberglass refers to glass fiber-reinforced plastics in general. To date, this is the most economically viable reinforced fiber[8]. It is more malleable and durable than metal. It is also nonmagnetic, nonconductive, and electromagnetic radiation permeable. It also remains inactive under a variety of chemical conditions. The main load-bearing components are often fibers, whereas the surrounding matrix maintains their ideal positions and orientation, serves as a medium for load transmission between the fibers, and shields them from the elements[9]. In fiber-reinforced composite materials, the fibers serve as the matrix's reinforcement as well as other beneficial roles

2. METHODOLOGY

2.1 Materials -OPC cement of grade 43 having a specific gravity of 3.13 is used in the experimental study its compressive strength es found to be 48n/mm2. and its setting time was 34 min and 603 in. consistency and fineness were found to be 29%and 98%[10]. *Marble Powder* is white in color and the fines modulus is 100% when passed with a 75-micron sieve having a specific gravity of 2.62. Clearwater was taken for analysis having a pH of 6.9. *Admixture is* Master gellenium Sky8228 provided by BASF is a polycarboxylic-based superplasticizer having Specific gravity of 1.17.Fine aggregate has the fineness modulus of 2.8 and specific gravity of 2.54 specifying that sand belongs to zone 3. Sand passes the criteria to pass from the 4.75mm sieve.*C*oarse aggregate taken for the study is taken from a local quarry having a specific gravity of 2.8. and fineness modulus of 7.8. aggregates are taken in equal proportions of 8mm 10mm 12mm 16mm and 20mm each as per gradation and design and as per IS Standard [11]. The clay clumps and other extraneous objects were carefully removed. Before testing, the sand was cleaned and dried. The coarse aggregates were cleaned to get rid of dirt and dust, and then they were dried until the surface was dry.

Glass fiber having a length of 30 mm is used in the study. the used Glass fiber is used is of the S 2 class due to its high Strength. Its modulus of elasticity is 85.5Gpa.*Bagasse Ash is* Black in color has the fineness 95% from 75 Micron Sieve having a water absorption capacity of nearly 100%. Having specific gravity 2.3.

2.2 Process

For the Experimental Study the Concrete of Grade M80 is being Prepared by Taking Considerations of IS10262:2019[12]. The Mix ratio 1:1.3:2.8 is taken and examined. Use of 20% marble powder is done in cement to meet the max cement content given in IS 456[13]. The material are tested according to there is specifications . Water cement is taken as 0.28.Standard cubical molds are 150mm x 150mm x 150mm in dimension and were cast by the mix percentage.

The dimensions of specimens with cylinder sizes of 150 mm in diameter and 300 mm in height and Rectangular Beam sizes of 100 x 100 x 500 mm were also cast by the mix proportion as well as by partially substituting sand and cement with marble powder in various ratios.About 24 hours after a specimen had hardened, cast concrete specimens were placed in water free of chlorides and sulfates for curing. They were then tested after the necessary curing period.

Table 1 Cost and Mix design of M80 Concrete

Ratio Designation	Cement Kg/m^3	Marble Powder Kg/m^3	Water Kg/m^3	Admixture Kg/m^3	Sand Kg/m^3	Coarse Aggregate Kg/m^3
R00	428	107	141	2.675	589	1229
(Cost Per Kg)	8	2	0.1	20	2.5	3.8

Table 2 Mix Design of Cement Replacement

Ratio Designation	Cement		Bagasse Ash (cost only Transportation 0.02rs per Kg)	
	%	Kg/m^3	%	Kg/m^3
RB01	99	423.72	1	4.28
RB02	98	419.44	2	8.56
RB03	97	415.16	3	12.84
RB04	96	410.88	4	17.12
RB05	95	406.6	5	21.4
RB06	94	402.32	6	25.68
RB07	93	398.04	7	29.96

Table 3 Mix Design Glass Fiber Treatment

Ratio Designation	Glass Fiber (Cost 70 Rs per Kg)	
	%	Kg/m^3

RGF1	0.25	1.07
RGF2	0.5	2.14
RGF3	0.75	3.21
RGF4	1	4.28
RGF5	1.25	5.35
RGF6	1.5	6.42
RGF7	1.75	7.49

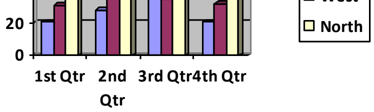
2.3 Testing of Specimen

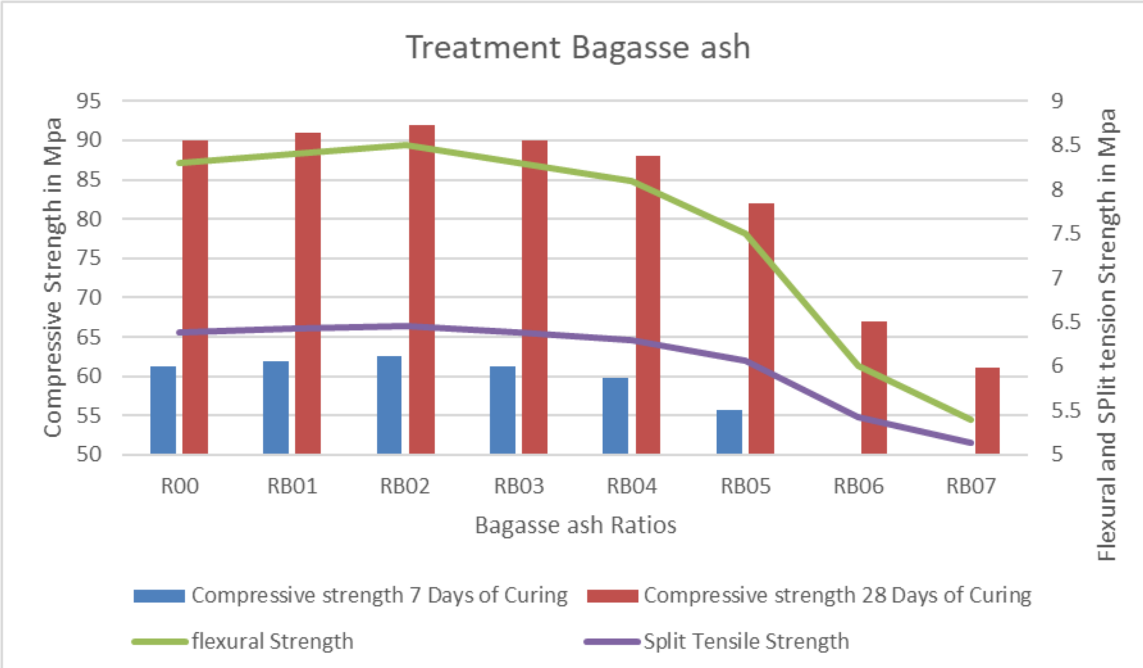
Three tests were done in order to analyze the Properties of Concrete. Compressive Strength, Flexural Strength, and Split tensile Strength. Three types of Specimens are prepared i.e. cube(150mm), beam(150mmX100mmX100mm) and Column(150mmX300mm The Specimens are tested as per the Codal provisions of Indian Standard[14]. The cost of material in the concrete is Taken AS per the Schedule of Rates provided by the PWD Punjab Government.

3 RESULTS

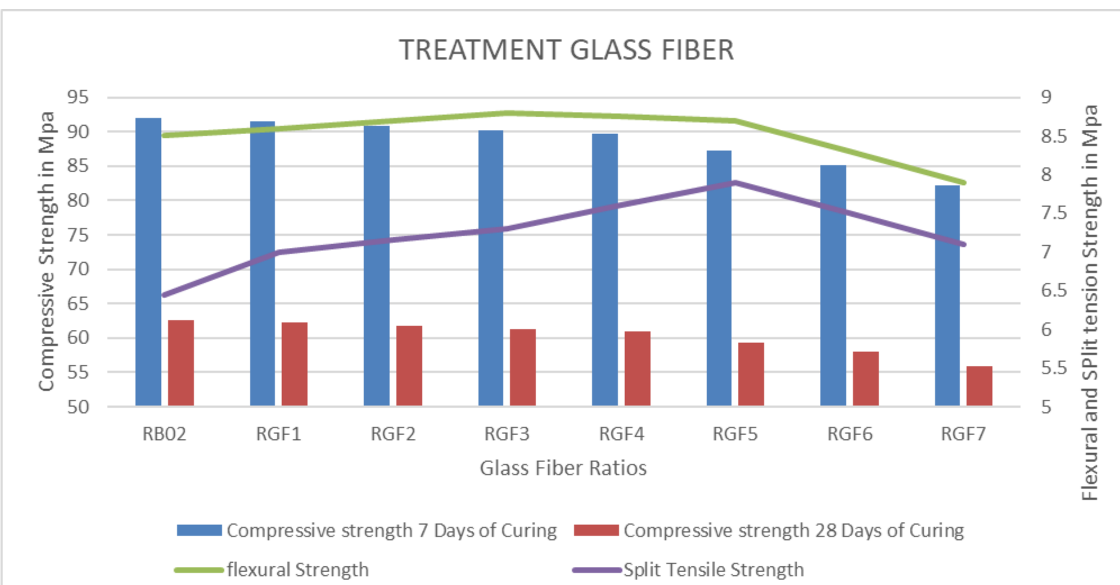
Bagasse ash is the waste product of that plant which possesses around 75% of water in it. Its ash being very water-absorbent absorbs water when mixed with concrete. The nominal grade of concrete makes a convenient percentage of ash when added in concrete and the slump is adjusted according to it. But in High-strength concrete, slump and t workability is achieved by the use of admixture. The proposed concrete has a slump of 130mm. Due to the pozzolanic action ash contributes to the increment of the strength. Water is in very less Quantity in the High Strength ConcreteAsh absorbs water, which Results in decreases the strength of the concrete. Due to this absorption the workability of the Concrete also gets Decreases.

Ratio Designation	**Workability**	**Compressive Strength (MPa)**		**Flexural Strength**	**Split Tensile Strength (MPa)**	**Cost (INR)**
	In mm	**7 Days**	**28 Days**	**(MPa)**		
R00	130	61.2	90	8.3	6.38	9848.300
RB01	130	61.88	91	8.4	6.42	9814.146
RB02	125	62.56	92	8.5	6.45	9779.991
RB03	125	61.2	90	8.3	6.38	9745.837
RB04	125	59.84	88	8.1	6.30	9711.682
RB05	120	55.76	82	7.5	6.06	9490.028
RB06	120	45.56	67	6	5.42	9493.374
RB07	120	41.48	61	5.4	5.14	9474.219





Using Glass fiber in high-strength concrete can increase the flexural and split tension of the concrete but the higher the grade of concrete higher the brittleness. if the concrete is brittle the fiber can only be added up to some percentage. After, that concrete losses, its brittleness, and the strength of the compression of concrete also start decreasing. Excessive fibers also make voids in



Ratio Designation	Workability	Compressive Strength (MPa)		Flexural Strength (MPa)	Split Tensile Strength (MPa)	Cost (INR)
	In mm	28 Days	7 Days			
RB02	125	92	62.56	8.5	6.45	9779.991
RGF1	120	91.5	62.22	8.6	7	9854.891
RGF2	120	90.78	61.73	8.7	7.15	9929.791
RGF3	115	90.2	61.336	8.8	7.3	10004.691
RGF4	115	89.7	60.996	8.75	7.6	10079.591
RGF5	115	87.2	59.296	8.7	7.9	10154.491
RGF6	110	85.2	57.936	8.3	7.5	10229.391
RGF7	110	82.2	55.896	7.9	7.1	10304.291

the concrete which makes decrement in the strength of the concrete. In proposed concrete 0.75% is found to be an optimum percentage of addition of Glass fiber. Glass Fiber Tries to bind the concrete material therefore the workability is decreases when the quantity of fibers have increased in the concrete.

4 DISCUSSION

Bagasse ash helps increase in strength due to its possession of pozzolanic properties. But due to its water absorption phenomenon it absorbs water and creats decrease in water content. Which decreases the strength of concrete. On the same hand glass fiber binds the material which increases the flexural and split tension capacity of the concrete. But excess use makes voids in the concrete which decreases the strength of the concrete

5 CONCLUSIONS

Bagasse can be replaced only up to some percentage for proposed concrete having a slump of 130mm giving the replacement of ASH 2% only. Glass fiber addition to the concrete with 2% bagasse ash gives adds up to 1.75% which makes an increment in the flexural and split tensile strength of the concrete. But the optimum is found to be .75% because excess fiber creates voids which decrease the compression capacity of the concrete.• Waste material like bagasse ash can make a good contribution towards saving the environment when used n concrete. but using it in high-strength concrete can fulfill the economy of the concrete due to its less replacement in the concrete.

References

[1] H. Vani and S. Arora, “Experimental Study Of High Strength Concrete Prepared By Bagasse Ash, Debris, And Polypropylene Fiber,” International Journal of Advance Science and Technology, vol. 29, no. 10S, pp. 5231–5242, 2020.

[2] H. Vani, Kaamun, and S. Arora, “Experimental Study of High Strength Concrete by Alccofine and Bagasse Ash,” in IOP Conference Series: Earth and Environmental Science, Dec. 2021, vol. 889, no. 1. doi: 10.1088/1755-1315/889/1/012058.

[3] S. Padma, N. Pasupuleti, and K. Chandra Mouli, “Utilization of Bagasse Ash as Partialreplacement of Cement in High Strength concrete,” 2018. [Online]. Available: http://www.internationaljouralssrg.org
[4] K. Ganesan, K. Rajagopal, and K. Thangavel, “Evaluation of bagasse ash as supplementary cementitious material,” CemConcr Compos, vol. 29, no. 6, pp. 515–524, Jul. 2007, doi: 10.1016/j.cemconcomp.2007.03.001.
[5] S. Deepika, G. Anand, A. Bahurudeen, and M. Santhanam, “Construction products with sugarcane bagasse ash binder,” Journal of Materials in Civil Engineering, vol. 29, no. 10, pp. 1–10, 2017, doi: 10.1061/(ASCE)MT.1943-5533.0001999.
[6] E. TugrulTunc, “Recycling of marble waste: A review based on strength of concrete containing marble waste,” Journal of Environmental Management, vol. 231. Academic Press, pp. 86–97, Feb. 01, 2019. doi: 10.1016/j.jenvman.2018.10.034.
[7] S. HameedM, “Performance assessment of pervious concrete using marble dust and silica fumes.” [Online]. Available: www.internationaljournalssrg.org
[8] D. Chaitanya Kumar Jagarapu et al., “Experimental Studies on Glass Fiber Concrete,” no. 5, pp. 100–104, [Online]. Available: www.ajer.org
[9] M. M. Hilles and M. M. Ziara, “Mechanical behavior of high strength concrete reinforced with glass fiber,” Engineering Science and Technology, an International Journal, vol. 22, no. 3, pp. 920–928, Jun. 2019, doi: 10.1016/j.jestch.2019.01.003.
[10] IS: 8112- 2013, “Ordinary Portland Cement, 43 Grade,” Indian Standard, no. March, 2013.
[11] IS 383: 2016, “Coarse and fine aggregate for concrete - specification (third revision),” Indian Standard, vol. third edit, no. January, 2016.
[12] IS 10262:2019, “Concrete Mix Proportioning — Guidelines,” Indian Standard, no. January, 2019.
[13] IS 456:2000, “Plain And Reinforced Concrete - Code Of Practice,” Indian Standard, no. July, 2000.
[14] IS 516:1959, “Methods Of Tests For Strength Of Concrete,” 1959.