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Study on the Strength of Glass Fiber Reinforcement Concrete with Fragmentary Replacement of Cement with Fly Ash

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Abstract: ***Concrete is one of the most widely used construction material in today's world. Cement being one of the essential constituent of the concrete. Environmental issues are also playing a vital role in today's world, the production of cement one of the major constituent of concrete leads to release the of significant amount of carbon dioxide a greenhouse gas contributing 7% of greenhouse gas emission to the earth atmosphere, beside deforestation and burning of fossil fuels. Safe disposal of glass waste generated in day to day life due to limited life span and after use it is either stock piled or sent to land fill is also a challenging task. There is now a significant world-wide interest to solve the environmental problem caused by industrial waste and other material by including such material in the manufacture of concrete. Effort have been made in concrete industry to use waste glass in concrete production not only provide significant environmental benefits but also enhances performances of concrete when used at optimum amounts. Efforts have been made in the concrete industry to use fly ash & waste glass as partial replacement of cement, fine & coarse aggregates. Recently the research has shown that the waste glass can be effectively used in concrete as several alternatives for the constituent of concrete under proper fraction and grade. Waste glass when ground to a very fine powder show pozzolanic properties as it contains high SiO2 and therefore to some extent can replaced cement in concrete and contributes strength development. In this study, glass fibers in different volume fraction with 20%, 30% and 40% replacement of cement by fly ash has been to study the effect on compressive strength, split tensile strength, of concrete and compared it to the conventional concrete. The overall test result shows glass fiber could be utilized in concrete. The result indicates that the maximum strength of concrete occurs at around 20% glass powder. Beyond 20% glass fiber the strength of concrete reduces and is lower than that of the control.***

Keywords: Glass fiber, Concrete, Fly ash, Compressive Strength, Tensile Strength.

I. NTRODUCTION

A. General

Cementious materials in the form of mortars or concretes are used as construction material since they are cheap, durable and have adequate compressive strength and stiffness for structural use. Due to its very low tensile strength and low ductility it cannot be used directly for structures. Concrete is probably the most widely used man made construction material in the world. Also any type and shape of the component of the structural member can be fabricated when the concrete is green either in factory or at the place of casting. Fibers prevent micro cracks from widening. Addition of fibers makes components ductile and tough. Conventional concrete cracks easily. When concrete is reinforced with random dispersed fibers, we get favorable behavior for repeated loads. Advanced cement based materials and improved concrete construction techniques provide opportunities for the design of structures to resist severe load resulting from earthquakes, impact, fatigue, and blast environments. In case of structure of odd shapes it is very difficult to ascertain the proper placement of reinforcements however, this problem does not arise in case of fiber reinforced concrete and also the progress of work can be achieved at much faster rate.

FRC is very ductile and particularly well suited for structures which required to exhibit:

1) Shrinkage control of concrete:
2) High thermal resistance
3) Resistance to impact, blast and shock loads and high fatigue
4) Resistance to seismic hazards
5) The degree of improvement
6) Very high flexural, shear and tensile strength.

The Specific Objectives Were:

a) Determine the optimum waste glass content to be added as partial replacement of cement.
b) To determine an optimum mix proportion of cement, fine ground glass waste, sand, course aggregate and water cement ratio for a given grade of concrete.
c) To determine the mechanical and chemical properties of the optimized concrete.
d) To economically compare conventional concrete with the concrete modified glass waste.
e) Review the merits of using powdered waste glass as supplementary cementitious material, replacing a portion of the cement powder used.
f) Study the influence of waste glass on hardened and fresh properties of concrete mixes.
g) Utilization of industrial waste in a useful manner in cement production and diverting a waste material from landfills.
h) Protect the environment by the use of industrial waste in concrete in order to improve the environmental impact on concrete industry by reducing the greenhouse effect gases produced.

II. MATERIAL AND PROPERTIES

A. Material

The raw materials of casting are cement, coarse aggregate, fine aggregate, water fly ash has been collected and the aggregate are cleared and preserved.

1) Cement

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by calcination at high temperature ranging from 1400 to 1600^0C. It is a mixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete and it is available in different forms. When cement is mixed with water, a chemical reaction takes places as a result of which the cement paste sets and hardens to a stone mass. Depending upon the chemical compositions, setting and hardening properties, cement can be broadly divided into various categories.

OPC is most important type of cement. The OPC was classified into three grades namely (i) 33 grades (IS: 269-1989), (ii) 43 grade (IS: 8112-1989), (iii) 53 grade (IS: 12269-1987). If the 28 days compressive strength is not less 33n/mm2 (Mpa), it is called 33 grade cement, if the strength is not less than 43 MPa, it is called 43 grade cement and if the strength is not less than 53 MPa, it is called 53 grade cement. IS: 10262-1982 has classified OPC grade wise from A to F depending upon the 28 days compressive strength.

Table 1: Cement Properties

S.No.	Description of Test	Test Results
1	Cement used	OPC 43 grade
2	Specific gravity of cement	3.15
3	Finesse (Sieve Analysis)	95% passing (90mm)
4	Standard Consistency	33%

2) Fine Aggregates

The material we have used as fine aggregate in this project is locally available river sand obtained from Yamuna river bed near Badarpur conforming to Grading zone II of IS: 387-1970. Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens. River sand (0.4.75mm is suitable for all concrete preparations and is used across all segments such as independent houses, builders RMC Plants, Concrete Batching Plants and Infrastructure Concrete works.

Table 2: Fine Aggregate Properties

S.No.	Description of Test	Test Results
1	Specific gravity of fine aggregate	2.64
2	Water absorption of fine aggregate	0.80%
3	Grading of fine aggregate	Zone-II

3) Coarse Aggregates

The material whose particles are of size as are retained on I.S. Sieve No. 480 (4.75mm) is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of work.

Table 3: Coarse Aggregate Properties

S.No.	Description of Test	Test Results
1	Specific gravity of coarse aggregate	2.7
2	Water absorption of coarse aggregate	0.81%
3	Grading of coarse aggregate	2nd Grade
4	Aggregate Impact Value	26.33%
5	Crushing Value	22.56%

The coarse aggregate used in this experimental investigation are of 20mm, 10mm and 6mm sizes, crushed angular in shape. The aggregates are free from dust before used in the concrete.

4) Water

The water used was portable water that is clean and may not impair the strength or durability of the concrete and that is free of detrimental amounts of chlorides, acids, alkalis, salts, sugar and other organics or chemical substances that may adversely affect the concrete. Casting and curing of specimens were done with the portable water that is available in the college premises. Water to be used in the concrete work should have following properties:

- It should be free from injurious amount of soils it should be free from injurious amount of acids, alkalis or other organic or inorganic impurities.
- It should be free from iron, vegetable matter or any other types of substances, which are likely to have adverse effect on concrete or reinforcement.

5) Glass Fiber

Glass is defined as a hard, brittle, translucent and commonly transparent substance, white or colored, made by fusing together sand or silica with lime, potash, soda or lead oxide. Class E fiber was used. Fiberglass is an immensely versatile material due to its light, inherent strength, weather resistant finish, and variety of surface texture.

Table 4: Basic Properties of Glass fiber

S.No.	Description of Test	Test Results
1	Specific gravity	2.68
2	Modulus of Elasticity	72 Gpa

6) Fly Ash

Fly ash is a fine, glass powder recovered from the gases of coal fired plants during the production of electricity by electrostatic precipitators. These micron-sized earth elements consist of silica, alumina and iron. When combines with lime and water the fly ash forms a cementitious compound with properties similar to that of Portland cement.

Table 5: Basic Properties of Fly Ash

S.No.	Description of Test	Test Results
1	Fineness of test fly ash	8.4%
2	Specific gravity of fly ash	2.55

Table 5: Chemical Properties of Fly Ash

Chemical	Percentage
SiO_2	61.24
Al_2O_3	25
Fe_2O_3	8.71
Na_2O	0.09
MgO	0.09
CaO	4.22
So_3	0.49

III. SCOPE OF FUTURE STUDY

In this paper, I made an attempt to study the properties of glass fiber reinforced concrete with partial replacement of fly ash with cement. The maximum compressive strength value for 28 days is obtained when 20% cement replaced with fly ash along with 2% glass fiber. Compressive Strength increases with the increase of glass fiber. And with an increase of fly ash Compressive Strength decreases. However, 20% replacement of cement with fly ash along with 1%, 1.5% & 2% glass fiber showed an increase in the compressive strength by increasing fiber percentage. The maximum split tensile strength value for 28 days is obtained when 20% cement replaced with fly ash along with 2% glass fiber. Due to the addition of glass fiber split, tensile strength increased and is optimum when. 20% cement replaced with fly ash along with 2% glass fiber.

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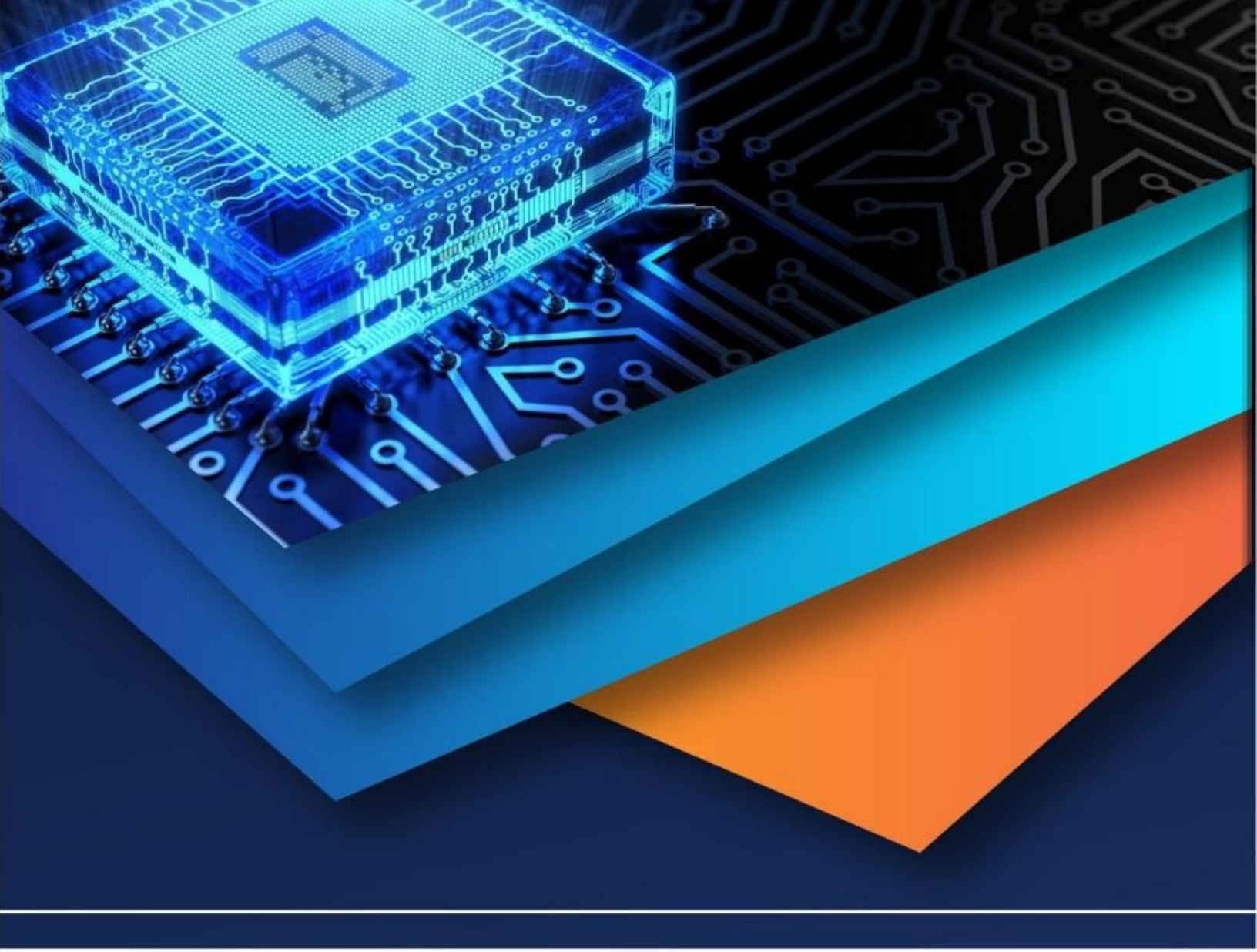

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