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Investigation On, The Effect Of Polypropylene Fiber And Waste Glass Powder On High Performance Concrete

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Abstract:

The process of producing the concrete by utilizing the waste and end-production of different industries gives rise to a new concrete which is known as "Green concrete or Sustainable Concrete". All the raw materials of concrete can be replaced either partially (at different proportions) or fully which ultimately improves the various properties and characteristics of concrete. In current experimental study work, an attempt has been made to replace the cement with waste glass powder to obtain sustainable concrete so that the environment and raw material can be saved. Glass powder in proportion of 4%, 8%, 12% and 16% was added to the concrete mix by replacing the cement along with the polypropylene fibre to enhance the tensile behaviour of concrete. It was concluded from the results that the concrete mix GP12 is the optimum concrete mix. GP12 having 12% Glass Powder and 0.5% PP fibre is recommended for future use to obtain maximum strength of concrete.

Keywords: Concrete, Glass Powder, PP fibres.

I. INTRODUCTION

The process of producing the concrete by utilizing the waste and end-production of different industries gives rise to a new concrete which is known as "Green concrete or Sustainable Concrete". All the raw materials of concrete can be replaced either partially (at different proportions) or fully which ultimately improves the various properties and characteristics of concrete. The extent of enhancement depends upon the material which is being replaced, the material which is being used as a replacement, and the proportions of the replacement material. These findings have been applied at the constructions sites also. These replacement substances not only protect the environment but also save cost and preserved raw materials.

Several specialists have come to the conclusion that raw material i.e. cement can be substituted by replacement materials which entails pozzolanic characteristics. Glass power, which is considered as a waste product from the glass industry, is one of the replacement materials that can be utilized in concrete instead of cement (partially). It is an amorphous substance that entails high silica content which makes it high pozzolanic material having a size smaller than 75µm. This has been proved by many different research works which were conducted under different conditions. Fly ash, being an impeccable material in replacing cement, is one of the most used materials and has high pozzolanic properties that help and enhances the properties of concrete. Fly ash bricks, wall panels, etc are available in the market as it is very useful in the construction industry due to its diverse nature and properties. In terms of enhancing the bonding between the material of concrete, additives or PP fibres are being used frequently. All such kinds of replacements and the addition of additional material enhance the properties of fresh and hardened concrete. The process of producing the concrete by utilizing the waste and end-production of different industries gives rise to a new concrete which is known as "Green concrete or Sustainable Concrete."

The glass powder is one of the major waste products of construction industries and it is being produced on a very large scale. Therefore, various researches have shown that the utilization of waste glass powder in concrete results in better properties of concrete while reducing the cost of manufacturing. They are very fine particles that are sieved through 75µm. Due to the presence of high content of silica in Glass powder, this material is considered as a pozzolanic material that has the capacity to replace the cement i.e. pozzolanic material of concrete. Various proportions of glass powder have been taken to produce the desired concrete.

To curb the phenomenon of cracking in concrete, random distribution of short and very fine fibres is done into the concrete which acts as a reinforcing agent. This process makes the concrete more ductile while increasing its capacity under tension. For this purpose, Polypropylene fibres are used which is an effective material for produced concrete having good tensile strength. The addition results in enhancing various parameters such as toughness, shrinkage, resistance to cracking, etc. PP fibres were introduced as an admixture in the late 1900s where fire resistance material is to be produced. Since then, these fibres are modified and are being utilized in the construction industries tremendously.

II. OBJECTIVES

Following were the objectives of current experimental work:

1. To design concrete mix of grade M30 as reference concrete using raw materials.
2. To design replacement concrete mix by replacing cement with Waste Glass Powder (4%, 8%, 12% and 16%) and fixed proportion (0.5%) of polypropylene fiber.
3. To compare the different strength parameters of M30 grade concrete at 7, 28days.
4. To optimize the replacement of glass powder and polypropylene fibers for M30 grade of concrete.

III. RESULTS

The test results of different tests have been shown below of all the concrete mixes i.e. CM (0% Glass powder and 0% PP fiber), GP4 (4% Glass powder and 0.5% PP fiber), GP8 (8% Glass powder and 0.5% PP fiber), GP12 (12% Glass powder and 0.5% PP fiber) and GP16 (16% Glass powder and 0.5% PP fiber).

SLUMP TEST RESULTS

Table 1: Results of Slump Test.

S. No.	Concrete Mix	Slump Value, mm
1	CM	81
2	GP4	74
3	GP8	65
4	GP12	59
5	GP16	55

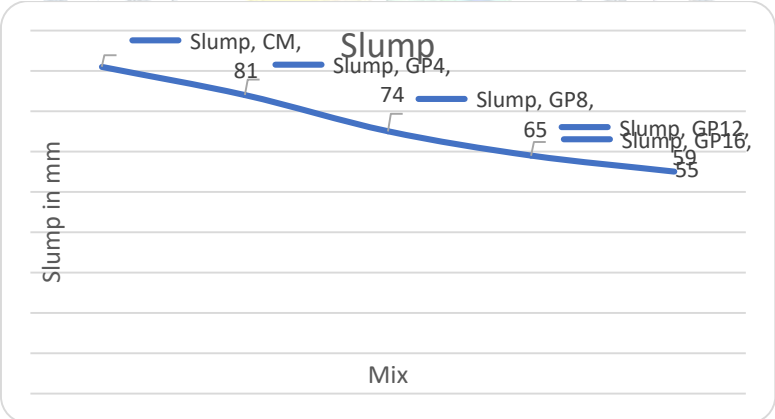

Figure 1. Slump Test Results.

It has been observed from the above fig that the addition of glass powder and PP fibre causes the declination of the slump value of concrete. This decrease in slump value of concrete keeps on increasing as the content of glass powder increases in concrete mix. The slump value of control mix comes out to be 81 mm whereas the slump of GP16 comes out to be 55 mm.

STRENGTH TEST RESULTS

To determine the strength parameter of various concrete mixes, compressive strength test, split tensile strength test and flexural strength tests were conducted in laboratory. The results of aforementioned tests at 7 and 28 days are represented below:

Table 2: Results of Compressive, Split Tensile and Flexural Strength Test.

Concrete Mix	Compressive Strength At 7 days	Compressive Strength At 28 days	Split Tensile Strength At 7 days	Split Tensile Strength At 28 days	Flexural Strength At 7 days	Flexural Strength At 28 days
CM	25.43	39.06	2.72	3.52	3.95	5.42
GP4	25.98	40.79	2.78	4.03	4.21	5.78
GP8	28.84	41.51	3.34	4.78	4.55	6.45
GP12	29.46	43.87	4.04	5.46	5.1	6.99
GP16	26.49	40.54	2.98	4.61	4.78	6.81

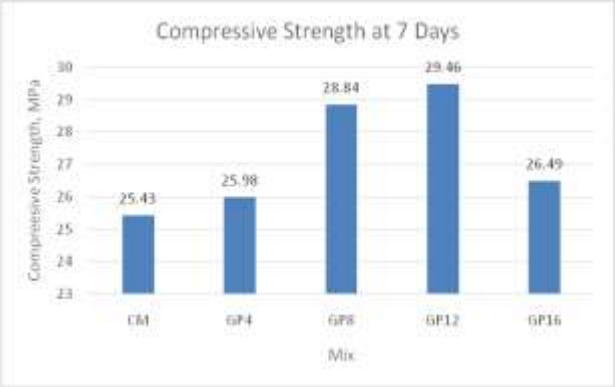

Figure 2. Compressive Strength Test Results at 7 Days.

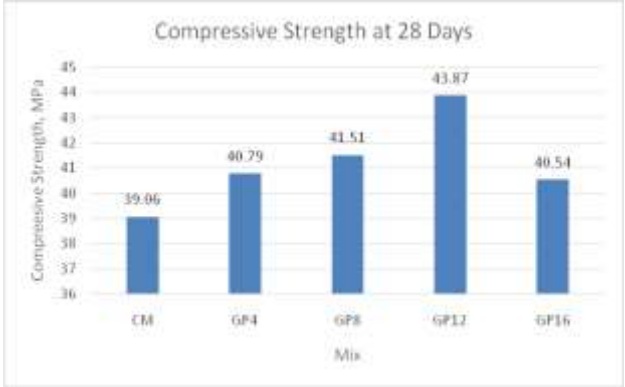

Figure 3. Compressive Strength Test Results at 28 Days.

The comparison was done from fig 2 and 3 and it was revealed that the GP12 concrete mix showed maximum compressive strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum compressive strength at 7 days and 28 days is 29.46 N/mm2 and 43.87 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 25.43 N/mm2 and 39.06 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 2.2%, 13.4%, 15.9%, 4.2% at 7 days and 4.4%, 6.3%, 12.3% and 3.8% at 28 days respectively.

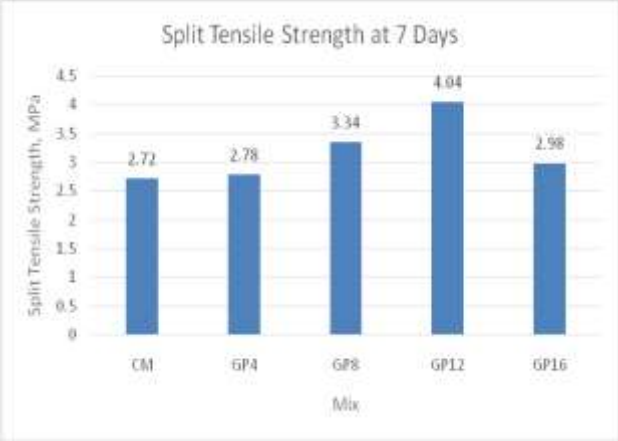

Figure 4. Split Tensile Strength Test Results at 7 Days.

Figure 5. Split Tensile Strength Test Results at 28 Days.

The comparison was done from fig 4 and 5 and it was revealed that the GP12 concrete mix showed maximum split tensile strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum split tensile strength at 7 days and 28 days is 4.04 N/mm2 and 5.46 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 2.72 N/mm2 and 3.52 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 2.2%, 22.8%, 48.5%, 9.6% at 7 days and 14.5%, 35.8%, 55.1% and 31% at 28 days respectively.

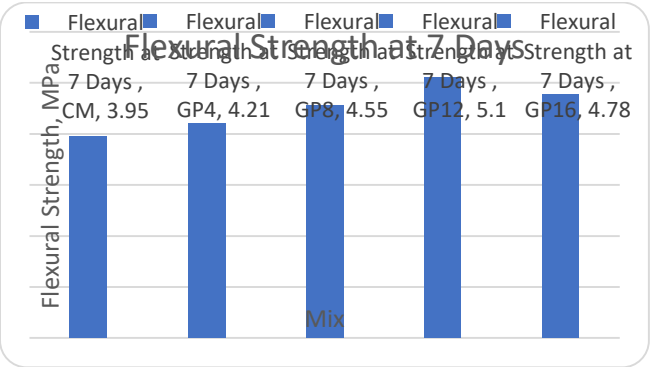

Figure 6. Flexural Strength Test Results at 7 Days.

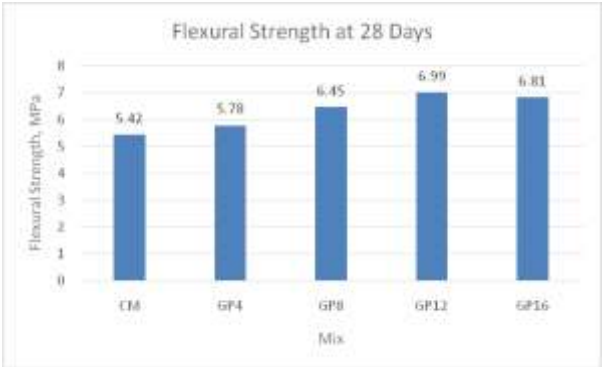

Figure 7. Flexural Strength Test Results at 28 Days.

The comparison was done from fig 6 and 7 and it was revealed that the GP12 concrete mix showed maximum flexural strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum flexural strength at 7 days and 28 days is 5.1

N/mm2 and 6.99 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 3.95 N/mm2 and 5.42 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 6.6%, 15.2%, 29.1%, 21.0% at 7 days and 6.6%, 19.0%, 29.0% and 25.6% at 28 days respectively.

IV. CONCLUSIONS

The final conclusions of the current experimental study work have been mention below:

- From the results of slump test, it has been concluded that the addition of glass powder and PP fiber causes the declination of the slump value of concrete. This decrease in slump value of concrete keeps on increasing as the content of glass powder increases in concrete mix.
- From the results of compressive strength test, it was concluded that the GP12 concrete mix showed maximum compressive strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum compressive strength at 7 days and 28 days is 29.46 N/mm2 and 43.87 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 25.43 N/mm2 and 39.06 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 2.2%, 13.4%, 15.9%, 4.2% at 7 days and 4.4%, 6.3%, 12.3% and 3.8% at 28 days respectively.
- From the results of split tensile strength test, it was concluded that the GP12 concrete mix showed maximum split tensile strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum split tensile strength at 7 days and 28 days is 4.04 N/mm2 and 5.46 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 2.72 N/mm2 and 3.52 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 2.2%, 22.8%, 48.5%, 9.6% at 7 days and 14.5%, 35.8%, 55.1% and 31% at 28 days respectively.
- From the results of flexural strength test, it was concluded that the GP12 concrete mix showed maximum flexural strength out of all the other concrete mixes i.e. plain concrete, GP4, GP8 and GP16. The maximum flexural strength at 7 days and 28 days is 5.1 N/mm2 and 6.99 N/mm2 respectively whereas the plain concrete compressive strength at 7 days and 28 days is 3.95 N/mm2 and 5.42 N/mm2. The increase in compressive strength shown by GP4, GP8, GP12 and GP16 are 6.6%, 15.2%, 29.1%, 21.0% at 7 days and 6.6%, 19.0%, 29.0% and 25.6% at 28 days respectively.
- All the results were scrutinized while analyzing and it has been concluded that the concrete mix GP12 is the optimum concrete mix. GP12 having 12% Glass Powder and 0.5% PP fiber is recommended for future use to obtain maximum strength of concrete.

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