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Experimetal Study of Partial Replacement of Fine Aggregate And Cement With Poly-Ethylene Terephthalate and GGBS In Concrete

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Abstract : PET fiber is an amazing material that requires careful handling and disposal. When disposed of, it contaminates groundwater and has detrimental impacts on people. Waste bottles are used to make PET fiber. To prepare the trial mix, little fragments of empty transparent bottles are taken out. GGBS is a byproduct of the iron industry with cementitious qualities. As is well known, the most beneficial material in the construction industry is cement. Carbon and other pollutants produced by cement manufacturing industries have a negative impact on the environment. The usage of ground granulated blast furnace slag (GGBS) and polyethylene terephthalate (PET) fiber in concrete is discussed in this paper. PET fiber has strong bonding qualities as well. Tests are carried out on hardened concrete using test specimens that have been partially prepared by substituting the fine aggregate with PET fiber and the cement with GGBS. To make the trial mix, GGBS is used as the replacement of some of the OPC 53 grade cement, and PET fiber is used in place of fine aggregate. The GGBS mix percentage is 30%. 40% and 50%, and PET are, in that order, 2%, 4%, and 6%. After seven days and twenty-eight days, test observations are recorded.

IndexTerms **– GGBS, PET fiber, Partial replacement.**

I. INTRODUCTION

Concrete is absolutely the most frequently used building material in the world, with an annual production of almost six billion tons; only water surpasses it in terms of per capita usage. However, the manufacture of cement results in CO2 emissions and harms associated to raw material exploitation, generating concerns about environmental sustainability. There was pressure on researchers to use less cement by using other materials in place of some of the cement. These substances may be found in nature, low-energy by products, or waste from industry. When these compounds (known as pozzolanas) are combined with calcium hydroxide, they demonstrate cementation capabilities.

The pozzolanas that are most frequently used are ground granulated blast furnace slag (GGBS), fly ash, silica fume, and metakaolin. When fine aggregate is needed in concrete, Polyethylene Terephthalate (PET) bottles are crushed into a fine powder. By lowering the structure's dead weight and increasing its resistance to vibrations like earthquakes, the addition of plastic to concrete makes the structure lightweight. In addition to improving concrete's strength, using Polyethylene Terephthalate (PET) in concrete has shown to be a better use of plastic waste. Granulated blast furnace slag (GGBS) was substituted for Portland cement in amounts of 30%, 40%, and 50%, while Polyethylene Terephthalate PET bottles were substituted in amounts of2%, 4%, and 6%, respectively.

The strength characteristics of the concrete can be evaluated by conducting compressive strength test, splitting tensile strength test and flexural strength test. The compression test can be conducted for 7 days and 28 of curing and also split tensile strength test and flexural strength test were conducted for 7 days and 28 days of curing on M20 grade concrete

II. RESEARCH METHODOLOGY

Sieve analysis of Coarse Aggregate

As per IS 383:2016 the Indian Standard for Coarse and Fine Aggregates from natural sources for concrete, the sieve analysis of coarse aggregate involves determining the particle size distribution of the aggregate. This helps in determining the grading of the aggregate, which is an essential parameter in concrete mix design**.**

Compressive strength of concrete as per (456:2000)

The samples should be taken in accordance with the relevant standards. Before testing, prepare the cubical specimens from the concrete samples. The dimensions of the specimens, such as diameter and height, should conform to the standards specified in IS 516:1959

Split tensile strength of concrete as per (IS 5816:1999)

The split tensile strength test is conducted to determine the tensile strength of concrete. It involves applying a diametric compressive load to a cylindrical concrete specimen until it fractures. The test procedure, according to the Indian Standard code IS 5816:1999.

Cylindrical concrete specimens with a diameter of 150 mm and a height of 300 mm are prepared. Ensure that the specimens are properly compacted and cured according to standard curing procedures.

Flexural strength of concrete as per (IS 516:2018)

IS 516:2018 is the Indian Standard code for the methods of test for strength of concrete. The flexural strength of concrete is determined using a test called the "flexural strength test" or "modulus of rupture test." Here's a general procedure we conducted the flexural strength test as per IS 516:2018.

III. MIX DESIGN

Mix design of this study are taken with the reference of IS 10262-2019. The combinations of materials for creating concrete that are most feasible and affordable are provided by the I.S. 10262: 2009 code. The mix design requirements for mass concreting, self-compacting concrete, ordinary, standard, and high strength concrete are covered in the 2019 edition of the code.

The guidelines for adding substitute materials that partially replace aggregate and cement are also mentioned in the code. Admixtures, fly ash, GGBS, rice husk ash, metakaolin, and super plasticizers are a few common components. These are inexpensive and do not lower the concrete's quality in the concrete mix design**.**

The design mix ratio is taken for trial mixes is, Cement: Sand: Aggregate 1: 2.123: 3.055

IV. RESULTS AND DISCUSSION

The compression test, split tensile test and flexural test are conducted on the sample specimen of the ordinary concrete (3 specimen for each test) having dimensions 150mm X 150mm X 150mm, 150mm in diameter & 300mm long & 100 mm X 100mm X 500mm respectively.

A) Comparison between conventional concrete and GGBS plus PET reinforced concrete after 7 & 28 Days according to its compressive strength

The compression test are conducted on the sample specimen of the conventional concrete (3 specimen for each test) and Concrete Partially replacement of Cement by 30%, 40%, 50% GGBS & fine aggregate by 2%, 4%, & 6% PET respectively, having dimensions 150mm X 150mm X 150mm, 150mm in diameter & 300mm long & 100 mm X 100mm X 500mm respectively.

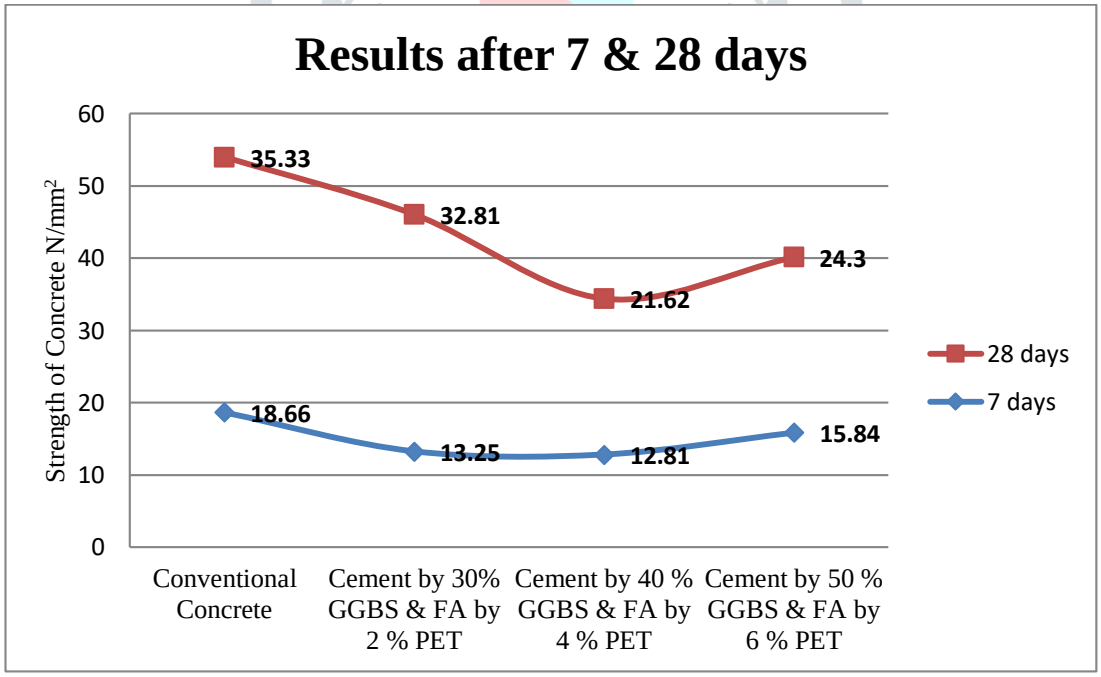

Fig. 1 Results of Compressive strength after 7 & 28 days

B) Comparison between conventional concrete and GGBS plus PET reinforced concrete after 7 days & 28 Days according to its Split tensile test

The Split tensile test are conducted on the sample specimen of the conventional concrete (3 specimen for each test) and Concrete Partially replacement of Cement by 30%, 40%, 50% GGBS & fine aggregate by 2%, 4%, & 6% PET respectively, having dimensions 150mm X 150mm X 150mm, 150mm in diameter & 300mm long & 100 mm X 100mm X 500mm respectively

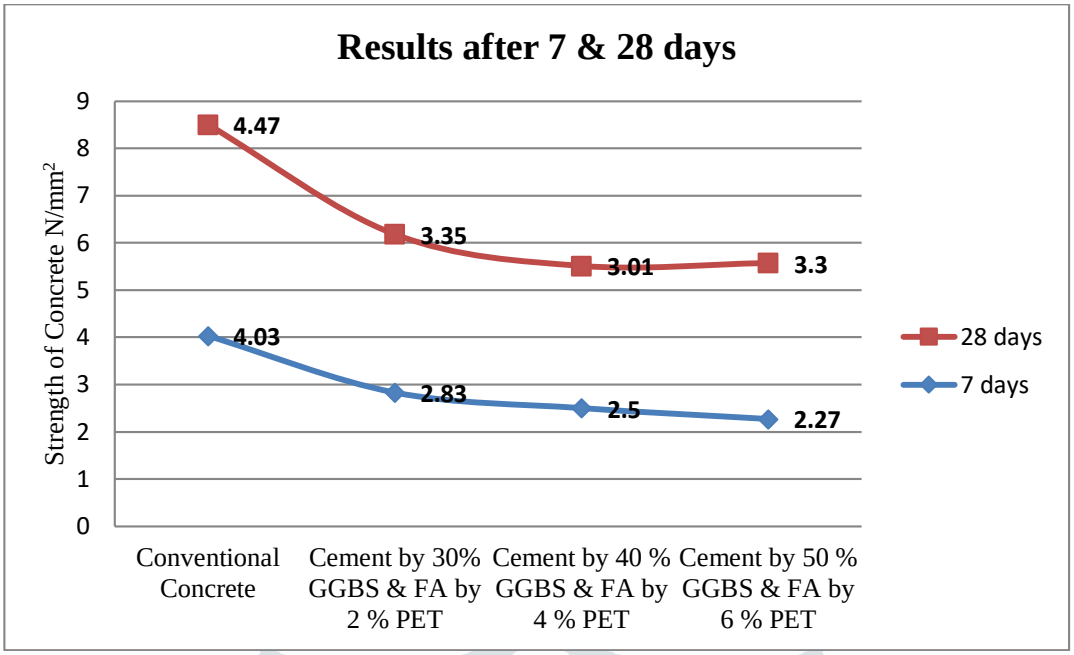

Fig. 2 Results of Split tensile test after 7 & 28 days

C) Comparison between conventional concrete and GGBS plus PET reinforced concrete after 7 days & 28 Days according to its Flexure test

The Flexure test are conducted on the sample specimen of the conventional concrete (3 specimen for each test) and Concrete Partially replacement of Cement by 30%, 40%, 50% GGBS & fine aggregate by 2%, 4%, & 6% PET respectively, having dimensions 150mm X 150mm X 150mm, 150mm in diameter & 300mm long & 100 mm X 100mm X 500mm respectively

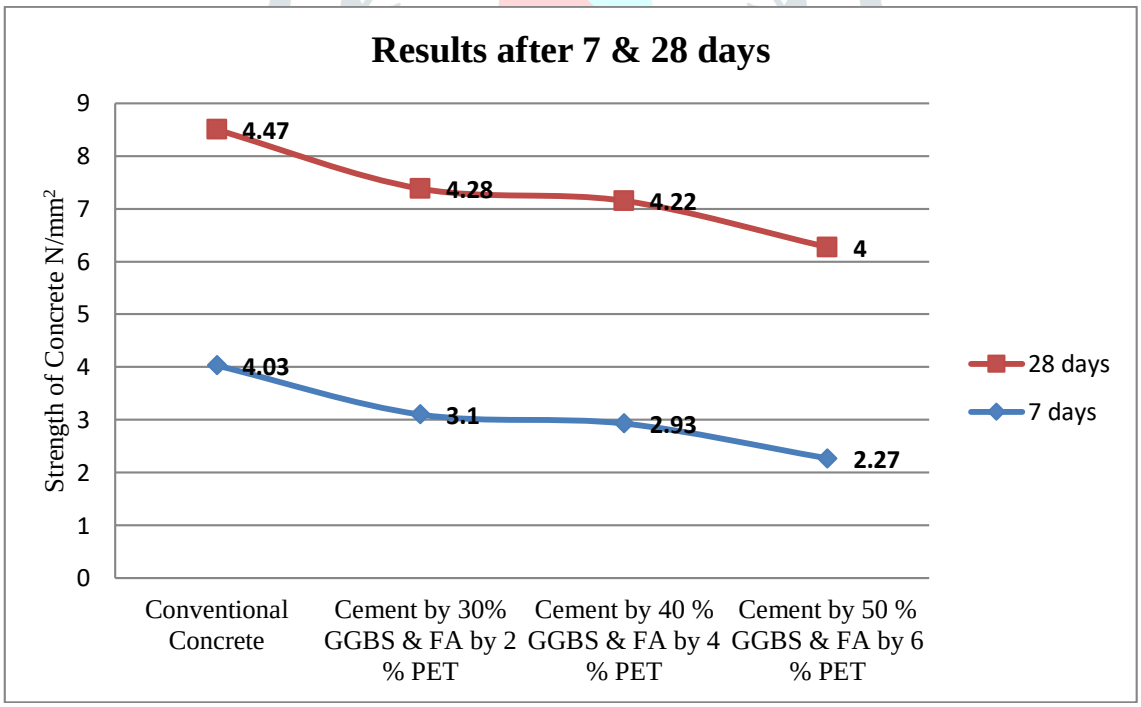

Fig. 3 Results of Flexure test after 7 & 28 days

D) Comparison between conventional concrete and GGBS plus PET reinforced concrete after 7 days

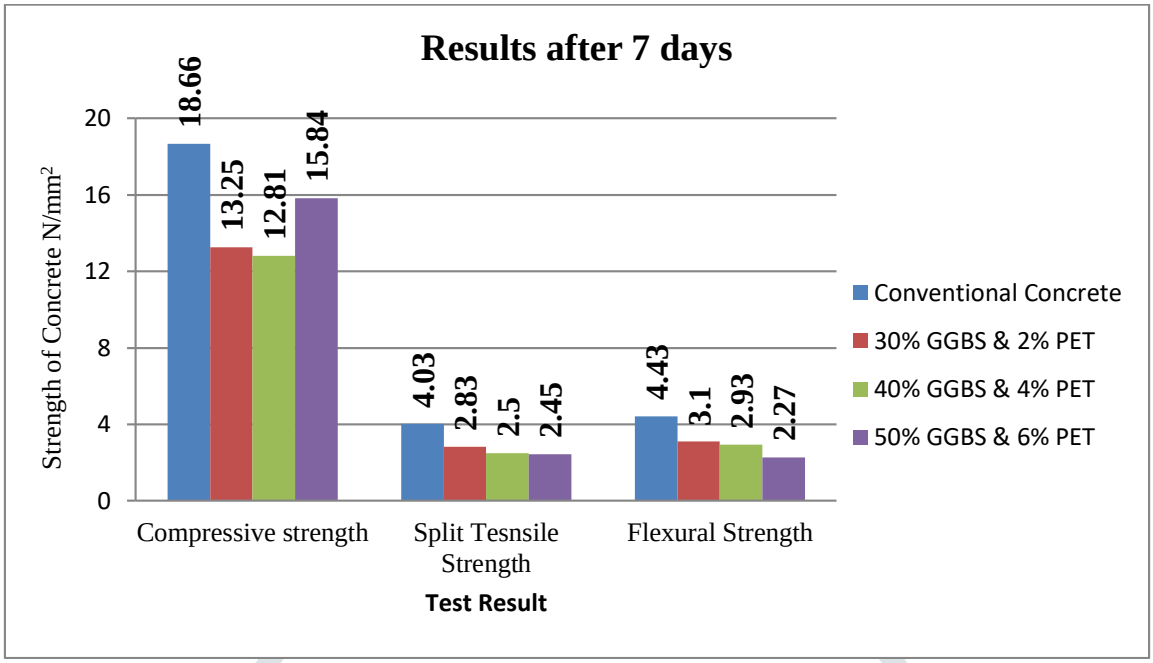

Fig. 4 Comparison of Conventional concrete and GGBS plus PET reinforced concrete after 7 days

E) Comparison between conventional concrete and GGBS plus PET reinforced concrete after 28 days

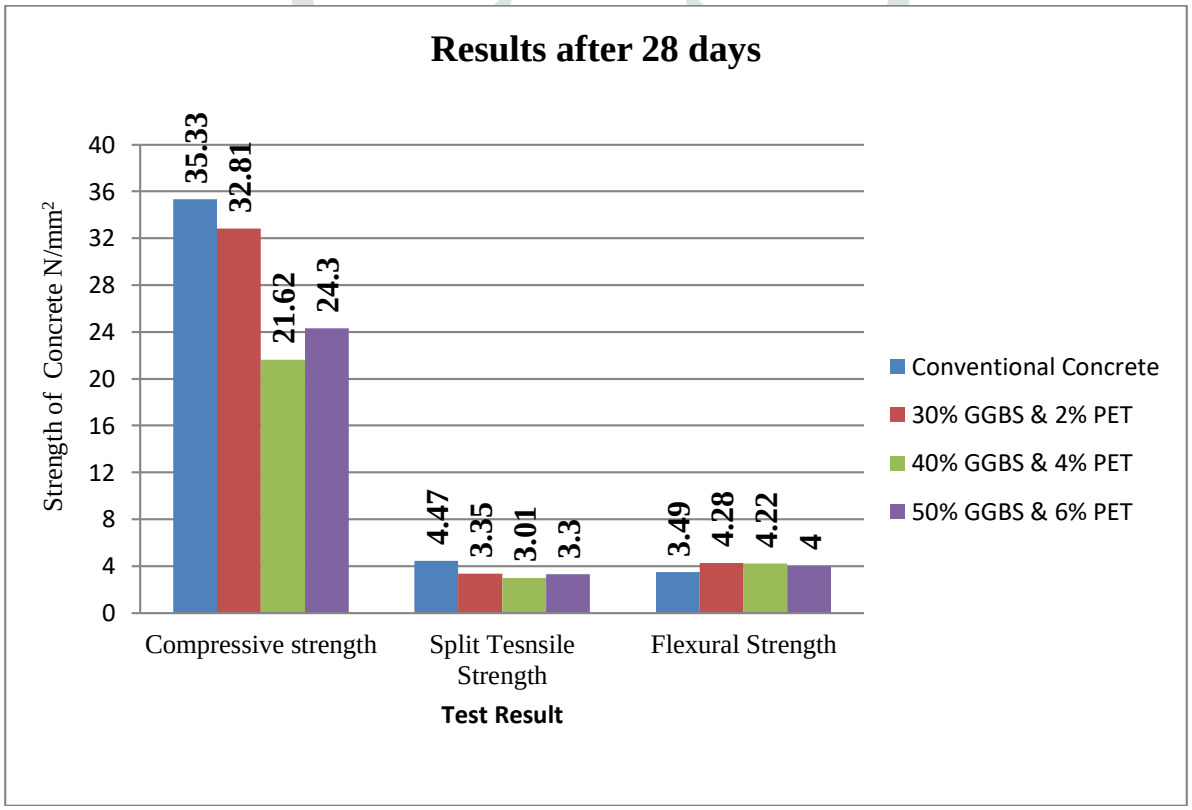

Fig. 5 Comparison of Conventional concrete and GGBS plus PET reinforced

V. ACKNOWLEDGMENT

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VI. CONCLUSION

Portland cement was partially replaced by 30%, 40%, 50% of Ground Granulated Blast Furnace Slag (GGBS) and fine aggregates by Poly-Ethylene Terephthalate (PET) by 2%, 4%, 6% respectively. The strength characteristics of the concrete were evaluated by conducting compressive strength test, splitting tensile strength test and flexural strength test. The compression test was conducted for 7 days and 28 of curing and also split tensile strength test and flexural strength test were conducted for 7 days and 28 days of curing on M20 grade concrete.

From this experimental study, following results are observed.

1. Observations after 7 days curing
    a) The compressive strength, split tensile strength, flexural strength of conventional concrete are more than that of mixtures which had been experimented.
    b) Out of the results obtained by replacement of cement by 30%, 40%, & 50% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 50% GGBS & F. A. by 6% gives more compressive strength.
    c) Out of the results obtained by replacement of cement by 30%, 40%, & 50% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 30% GGBS & F. A. by 2% gives more split tensile strength.
    d) Out of the results obtained by replacement of cement by 30%, 40%, & 50% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 30% GGBS & F. A. by 2% gives more flexural strength.
2. Observations after 28 days curing
    a) The compressive strength, split tensile strength, flexural strength of conventional concrete are more than that of mixtures which had been experimented.
    b) Out of the results obtained by replacement of cement by 30%, 40%, & 0% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 30% GGBS & F. A. by 2% gives more compressive strength.
    c) Out of the results obtained by replacement of cement by 30%, 40%, & 50% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 30% GGBS & F. A. by 2% gives more split tensile strength.
    d) Out of the results obtained by replacement of cement by 30%, 40%, & 50% GGBS and F. A. by 2%, 4% & 6% PET, replacement of cement by 30% GGBS & F. A. by 2% gives more flexural strength.

VII. REFERENCES

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