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Study on Compressive and Durability of Nominal Mix Concrete with Triple Blend Mix Concrete

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ABSTRACT: Within this investigation After water, concrete is the substance that is used the most globally. It consists of cement, water, admixtures, coarse aggregates, and fine aggregates. Concrete is typically bound with ordinary Portland cement (OPC), which has been used for centuries. According to estimates, one tonne of carbon dioxide is released into the atmosphere during the production of one tonne of OPC. This emission from cement production accounts for 7% of all carbon dioxide emissions worldwide. Therefore, it's critical to develop an alternative binder that has a lower carbon impact than cement. This study used GGBS and PFA as partial replacements for OPC cement to conduct experimental investigations on the compressive strength and durability qualities of concrete. Together, GGBS and PFA were replaced in the range of 0% to 30% with different percentage combinations between them. Various material tests were done on M30 grade concrete

KEYWORDS: OPC, GGBS, PFA, Conventional Concrete (CC), Triple Blend Concrete (TBC).

1. INTRODUCTION

One of the most popular building materials, concrete has excellent compressive and flexural strengths as well as solid characteristics. The cost of making cement is rising alarmingly today, and the natural resources that supply the basic materials for its production are running out. Due to their intrinsic cementation capabilities, fly ash (FA) and ground granulated blast furnace slag (GGBS) were waste products that could substitute some of the cement in concrete. In this project, we'll talk about using fly ash and ground granulated blast furnace slag (GGBS) in place of some of the usual cement. Our study compares the outcomes of three M30 grade mixtures, including traditional aggregate. As a partial replacement for OPC, the use of fly ash and ground granulated blast furnace slag (GGBS) would help the environment, the economy, and providing the essential workability, durability, and strength for the design of structures. Fly Ash is one of the byproducts of thermal power plants, and GGBS is a result of the production of pig iron. The process of creating ground-granulated blast-furnace slag (GGBS), which is a by-product of the production of iron and steel, involves quenching molten iron slag from a blast furnace in water or steam to create a glassy, granular product that is then dried and ground into a fine powder. Compared to concrete prepared with ordinary Portland cement, concrete made using GGBS cement sets more slowly. However, it continues to gain strength over a longer period in production conditions. in manufacturing circumstances. The byproduct of coal combustion known as "fly ash," also referred to as "pulverised fuel ash," is made up of tiny particles that are released from the boiler with the flue gases. By adding a super fine mineral additive like GGBS to the binary blended concretes of Fly Ash, researchers from all over the world are creating ternary blended concretes. Fly Ash enhances the characteristics of concrete at a later age, while GGBS in the ternary blend enhances performance at a younger age.

II. RELATED WORK

OPC 53 grade cement of specific gravity 3.15 was used for the study. Locally available sand of specific gravity 2.65 and coarse aggregates of size less than 20 mm of specific gravity 2.74 were used. GGBS of specific gravity 2.85 and Fly ash of specific gravity 2.2 was used. Portable water was used for the mix. As per IS Code 10262-2019 the mix proportion for M30 concrete was designed with following Cement, Fly ash & GGBS Proportions respectively

Mixes	Binder Materials Mix Proportions in %		
	Cement	Fly Ash	GGBS
CC	100	0	0
TBC 1	70	10	20
TBC 2	70	12.5	17.5
TBC 3	70	15	15

Admixtures were used in this investigation. Four mixes were done for strength and durability tests.

III. METHODOLOGY

1. Mixing: A batch weight is taken based on each mix's precise mix design. Small 0.045 cum batch size mixer was used for the mixing.

2. Casting: Standard cast iron metal modules were used to cast the cubes. The entire casting process has been verified to meet Indian Standard 10086-1882. The following specimen was created to conduct testing at 3 days, 7 days, 28 days, and 56 days on both conventional concrete (CC) and triple blend concrete (TBC).

3. Curing: Following casting, the moulded specimen is kept in the lab for 24 hours at room temperature, in moist air, and free from vibration. Following this time, the specimens are taken out of the moulds and dropped into the curing tank's clean, fresh water. After three days, the healed water is removed. The sample is cured for 3 days, 7Days, 28Days, 56 Days.

4. Testing of Specimen: The specimen was removed from the water at the mentioned age days, left to dry in the shade, and then its strength was assessed at room temperature..

(i) Compressive strength: Cube Compression tests were performed on standard cubes

5. Durability: This test also carried i) Acid attack test ii) Alkali attack test

IV. EXPERIMENTAL RESULTS

4.1 TESTING OF MATERIALS

The physical properties of materials used for this investigation are arrived by testing of cement, FA, GGBS, fine aggregate, coarse aggregate. The details of the results are given below.

Cement

Specific gravity : 3.15

Brand : Ultratech OPC 53 grade.

Coarse aggregate

Specific gravity : 2.68

Finess modulus : 7.016

Fine aggregate

Specific gravity : 2.63

Finess Modulus : 3.2 ZONE II

4.2 Mix Design

The mix proportion for M30 grade concrete is 1:1.9:3.4 at W/C0.43 for Nominal mix and 1:1.53:2.82 at 0.38 W/C ratio have been used in Triple Blend Mix Concrete.

i) Cube specimens (150 mm x 150 mm x 150 mm) used

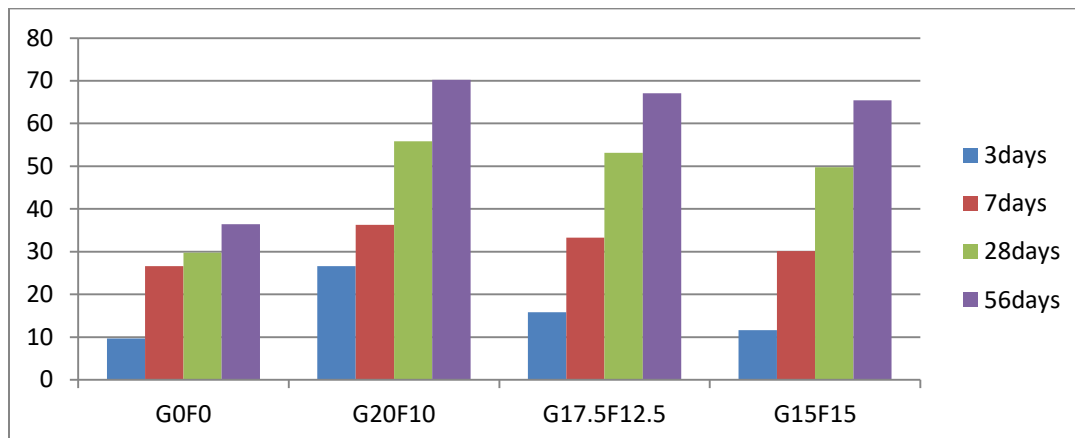
ii) Durability tests like acid attack test and alkali attack test were done. These tests were performed on cube specimens. A cube was cast for acid and alkali attack test respectively.

iii) First concrete cubes were cast and cured in mould for 24 hrs for all mixes. Cubes were demoulded and cured for 7 days in water and kept in atmosphere for 2 days and were weighed

iv) Later cubes were kept in 5% Sulphuric acid solution (for acid attack test) and 5% Sodium sulphate solution (for alkali attack test) separately for 60 days. The percentage weight loss was determined after exposing it to atmosphere for 2 days.

4.3 COMPRESSIVE STRENGTH VALUES:

Concrete Mix	3days	7days	28days	56days
G0F0	9.66	26.62	29.77	36.44
G20F10	26.62	36.25	55.8	70.2
G17.5F12.5	15.8	33.25	53.1	67.08
G15F15	11.64	30.16	49.75	65.45



4.4 DURABILITY TEST VALUES

4.4.1 Acid attack test

Percentage weight loss for control mix specimen is found to be 0.232.

The maximum percentage weight loss is found for G20F10 mix of value 0.59.

Minimum weight loss is for G15F15 mix. Compared to control mix, percentage weight loss is more for GGBS-Fly Ash concrete.

Concrete mix	Weight before placing in Acidic Solution (kg)	Weight after placing in Acidic Solution (kg)	% weight loss
G0F0	8.897	8.880	0.213
G20F10	8.464	8.412	0.59
G15F15	8.378	8.349	0.35
G10F20	8.320	8.283	0.44



4.4.2 Alkali test

Alkali attack test was performed on the cubes.

The weight of the concrete cubes before placing in alkaline solution was noted and weight of the cubes after immersing in alkaline solution was noted to find out the weight loss.

Percentage weight loss of control mix was found to be 0.118. Higher weight loss is found for G15F15 mix. The GGBS-Fly Ash mixes have nearly same percentage weight loss. Hence we can conclude that alkali attack resistance of GGBS-Fly Ash concrete is nearly same as that of the control concrete.

Concrete mix	Weight before placing in Acidic Solution (kg)	Weight after placing in Acidic Solution (kg)	% weight loss
G0F0	8.993	8.985	0.118
G20F10	8.572	8.56	0.14
G15F15	8.487	8.472	0.17
G10F20	8.304	8.29	0.16



V. CONCLUSION

Experimental investigations were performed on the strength and durability properties of M30 concrete with GGBS and Fly Ash as partial replacement of cement. GGBS and Fly Ash together were replaced in the range of 0% to 30% with different percentage combinations between them. Various material tests were done on M30 grade concrete. Based on experiments and test results on this ternary blended concrete, the following conclusions were drawn:

- ⊙ Partial replacement of cement by FA and GGBS in concrete increases strength properties. Therefore the utilization of waste materials like FA and GGBS in concrete as cement replacement is possible.
- ⊙ Cost reduction is possible by effectively using GGBS and FA as Cost –Benefit analysis shows higher strength with lesser cost can be achieved.
- ⊙ Compressive strength increases maximum for 20% GGBS and 10% Fly Ash replacement
- ⊙ The increase in strength was higher for GGBS-Fly Ash concrete compared to control concrete beyond 28 days. Hence later age strength is more for GGBS-Fly Ash concrete.
- ⊙ Durability characteristics of GGBS-Fly Ash concrete is nearly the same as that of control concrete

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