

INVESTIGATION OF STRENGTH IN CONCRETE BY PARTIAL REPLACEMENT OF PORTLAND SLAG CEMENT

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Abstract:The paper presents the laboratory investigations carried out on Portland slag cement (factory blended), and 53 grade OPC cement concrete to study and compare the different parameters of concrete prepared from the above two types of cement and a comparison is made to ascertain the quality and performance of the concrete. The 53 grade OPC cement is replaced separately with 10% , 20%, & 30% of PSC blended cement. Concrete cubes are tested at the age of 7 and 28 days of curing. A design mix for M30 was made as per IS code and the results are compared with the conventional concrete.

Key words:BlendedCement, OPC cement, Compressive strength, Tensile strength.

I. INTRODUCTION

A hydraulic cement consisting of an intimate and uniform blend of (a) granulated blast-furnace slag and hydratedlime, (b) Portland cement and granulated blast-furnace slag and (c) Portland cement and pozzolana, or (d) Portland-blast-furnace slag, cement, and pozzolana. Blendedcement is produced by intergrading Portland cement clinker with the other materials or by a combination of intergrading and blending. Blended cement is obtained by mixing OPC with mineral admixtures or additives like fly ash, slag or silica fumes. Blended cements are now being considered superior as compared to conventional OPC category of cements.This led to the resurgence of blended cements. The thrust was clearly on conservancies of natural resources, usage of waste materials & on the durability of concrete.

Energy saving: Blended cements are obtained by adding mineral admixtures with OPC. The energy, which would have otherwise been utilized for production of OPC, is thus saved. This saving is to the tune of 0.8 to 1.2 MWH/ton of cement.**Conservation of natural resources:** The used mineral admixtures are the waste products of thermal and steel plants. By using these products, we are conserving the precious minerals like lime stone, clay and silica etc.**Pollution control:** By reducing the production of cement, pollution is also controlled as cement is an energy intensive product. It has been estimated that 7% of total pollution is only due to cement production which can proportionately be reduced if more blended cement is used.

II. MATERIAL USED

A.Cement: Ordinary Portland cement 53 grade from Birla A1 Cement Company was used for this study. This cement is the most widely used one in the construction industry in India.

B.Coarse and fine aggregates:Locally available river sand with specific gravity 2.65 and fineness modulus 3.39 and locally available quarried and crushed stones of 20 mm and down size withspecific gravity 2.76 and fineness modulus 7.81 were used as fine and coarse aggregatesrespectively throughout the investigation in all concrete mix.

C.Water: Water is required for the cement to hydrate and solidify. Water having qualities of potable water was used in the experiment.

D.Portland slag cement:PSC or Portland Slag cement is manufactured by either grinding the Portland clinker with gypsum and granulated slag or blending the ground granulated blast furnace slag (GGBS) with Ordinary Portland cement by means of mechanical blenders. slag is by product of processing iron ore to iron and steel in a blast furnace. Molten slag which floats on the top of the molten iron ore, is separated and granulated. Granulation is the rapid quenching with water of the molten slag into the solid hydraulically reactive glassy granules. Granulation is done by using granulators. These granules are then ground to a suitable fineness to produce slag cement or in corporate as an ingredient in the manufacture of blended cement.

PSC chemical properties: The Portland slag cement shall comply with the following chemical properties

	maximum
Magnesium Oxide (MaO)	8%
Sulphur trioxide (SO,)	3%
Sulphide sculpture (S)	5%
Insoluble residue	4%

Physical Properties of PSC cement:

Property	Value
Specific gravity	3.03
Initial setting time	60 minutes
Fineness of cement	3%

As per IS 455: 1989, the results are within maximum limits.

III. MIX DESIGN

A. Mix Ratio:-

Mix Design is carried out by using Indian standard codes i.e. IS 456 -2000, & IS 10262-1982. In my dissertation work I am using M30 grade conventional concrete & the mix details are as follows.

M30 Grade	Cement (kg)	FA (kg)	CA (kg)	Water
Quantity	432.5	653.3	1168.6	186
Proportions	1	1.51	2.70	0.42

B.TRAIL MIXES:-

Conventional Mix:

Mix 1[100% cement+100% Fine Aggregate+100% Course Aggregate]

% of Replacement Mix:

Trial 1[90% cement+ 10%PSC +100% Fine Aggregate+100% Course Aggregate]

Trial 2[80% cement+ 20%PSC +100% Fine Aggregate+100% Course Aggregate]

Trial 3[70% cement+ 30%PSC +100% Fine Aggregate+100% Course Aggregate]

IV. TESTING RESULT

A. Compressive strength Test:

A compression testing apparatus is used to determine the compressive strength of the concrete. The cubes were tested and the ultimate loads were recorded.

$$\text{Compressive strength} = P/A$$



B. Split tensile strength test:

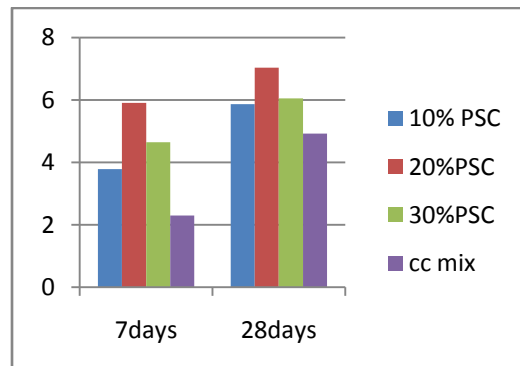
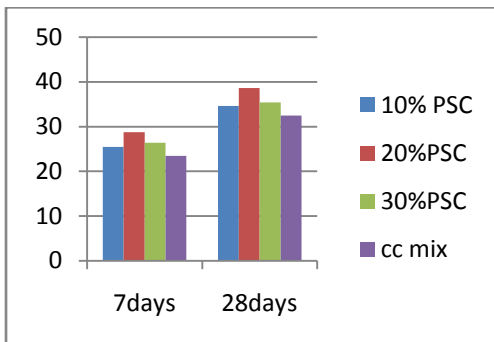
To determine the behaviour of materials under axial loading, a split tensile test method is used.

$$\text{Split tensile strength} = 2P/\pi ld$$



% of Replacement	7 days(N/mm ²)	28 days(N/mm ²)
CC mix	23.44	32.5
Trial 1	25.49	34.65
Trial 2	28.74	38.62
Trial3	26.38	35.41

% of Replacement	7 days(N/mm ²)	28 days(N/mm ²)
CC mix	2.3	4.92
Trial 1	3.78	5.87
Trial 2	5.91	7.04
Trial3	4.65	6.05



V. RESULT AND DISCUSSION

The following conclusions were made based on experimental study

- The experimental investigation, it's found that Portland slag cement can be used as alternative material to the Ordinary Portland cement.
- The physical and chemical properties of Portland slag cement satisfy the requirement of Ordinary Portland cement.
- Using of Portland slag cement in concrete reduces the environmental pollution control.
- The formation of drying shrinkage in concrete gets reduced by using Portland slag cement.
- Portland slag cement are economical and it's easily available, it can be easily mixed with concrete.
- The results show that the composites with Portland slag cement material to be used in structural elements to be used in civil construction.
- The compressive strength of concrete reaches the satisfactory value at replacement level of 20% of Portland slag cement.
- The Split tensile strength of concrete reaches the satisfactory value at replacement level of 20% of Portland slag cement.

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