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Study On Concrete By Partial Replacement Of Cement And Coarse Aggregate By Using Fly Ash And Pebble Stone Aggregate

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***Abstract*— The utilization of pozzolanic materials in concrete as partial replacement of cement is gaining immense importance today, mainly on account of the improvements in the long-term durability of concrete combined with ecological benefits. Fly ash, Ground Granulated Blast Furnace Slag (GGBS) and High Reactive Metakaolin (HRM) are the pozzolanic materials, which conform to these requirements and largely available in India.**

In this paper properties of concrete were studied by replacing coarse aggregate by pebble stone aggregate and cement by fly ash in the proportion of 20%, 40% and 60%. Results shows increase in the strength by the replacement of fly ash up to 40%.

I. INTRODUCTION

The utilization of pozzolanic materials in concrete as partial replacement of cement is gaining immense importance today, mainly on account of the improvements in the long-term durability of concrete combined with ecological benefits. Fly ash, Ground Granulated Blast Furnace Slag (GGBS) and High Reactive Metakaolin (HRM) are the pozzolanic materials, which conform to these requirements and largely available in India.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact.

Fly ash, Ground Granulated Blastfurnace Slag, High Reactive Metakaolin, Micro silica, and so on are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging.

Fly ash is finely divided residue that results from the combustion of coal and transported by flue gas. India is a resourceful country for fly ash generation with an annual output of over 110 million tonnes, but utilization is still below 20% in spite of quantum jump in last three to four years. Availability of consistent quality fly ash across the country and awareness of positive effects of using fly ash in concrete are pre- requisite for change of perception of fly ash from 'A waste material' to 'A resource material'. Now a days due to strict control on quality of coal and adopting electrostatic precipitators, fly ash of consistent quality is separated and stocked, and it is gaining popularity as a good pozzolanic material for partial replacement of cement in concrete.

Ground Granulated Blastfurnace slag (GGBS) is a byproduct for manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. If slag is properly processed then it develops hydraulic property and it can effectively be used as a pozzolanic material. However, if slag is slowly air cooled then it is hydraulically inert and such crystallized slag cannot be used as pozzolanic material. Though the use of GGBS in the form of Portland slag cement is not uncommon in India, experience of using GGBS as partial replacement of cement in concrete in India is scanty.

High Reactive Metakaolin (HRM) is a quality enhancing pozzolana. HRM is manufactured from natural kaolin, which is available in abundance in the country. It is produced by calcination of natural kaolin at a temperature of 650oC to 700oC through either dry process or wet process. In India, extensive deposits of kaolins are found in almost all the states. The best quality of kaolin deposits is found in Kundara in Kerala and Singhbum in Jharkhand. The data on studies of use of HRM as a pozzolanic material is very limited. At present refractories, paints, and paper industries etc., are the major users of HRM in India. However, use of HRM in concrete is hardly observed.

II. MATERIALS

43 Grade ordinary Portland cement purchased locally was used for casting the specimens.

River sand and 20mm size coarse aggregate used for casting the specimens.

It is generally stated that the water fit for drinking is fit for making concrete. Potable drinking water was used for both mixing and curing of concrete specimens

III. EXPERIMENTAL RESULTS

Compressive strength is defined as resistance of concrete to axial loading. Cubes are put in the machine and after tighten its wheel start button is pressed as pressure is begin to apply. Reading of meter is note down when cracks are there on cubes. Compressive strength is calculated by following formula:

$$\text{Compressive Strength} = \frac{P}{A},$$

Where P is load and A is area of cube ; Values of compressive strength at different percentage of replacement at different age are given below:

Compressive Strength of Concrete (N/mm^2)

Days	Mix-A	Mix-B	Mix-C	Mix-D	Mix-E
7	22.25	18.84	20.45	22.76	18.21
28	33.85	27.12	30.94	34.25	27.01

The maximum compressive strength of 34.25 N/mm^2 was attained at 40% replacement, while the minimum strength of 27.01 N/mm^2 was attained at 60% replacement. The strength reduced as the percentage of replacement increased above 40 % replacement.

Split Tensile Strength Test

In this test a concrete cylinder of the type used for compression test, is placed with its axis horizontal between the platens of a testing machine, and the load is increased until failure by indirect tension the form of splitting along the vertical diameter take place.

Split Tensile Strength, = 2P/ΠLD

Where P = Maximum load applied, N

L = length of the concrete cylinder, mm

D = Diameter of the concrete cylinder, mm

Values of split tensile strength at different percentage of replacement at different age are given below:

Split tensile Strength of Concrete (N/mm^2)

Days	Mix-A	Mix-B	Mix-C	Mix-D	Mix-E
7	3.30	3.04	3.16	3.34	2.99
28	4.07	3.65	3.89	4.09	3.64

The maximum split tensile strength of 4.09 N/mm^2 was attained at 40% replacement, while the minimum strength of 3.64 N/mm^2 was attained at 60% replacement. The strength reduced as the percentage of replacement increased above 40 % replacement.

Flexural Strength Test

The flexural strength of the specimen shall be expressed as the modulus of rupture fb, which, if 'a' equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows:

$$fb = p\,l/(b\,d^2)$$

when 'a' is greater than 20.0 cm for 15.0 cm specimen,

where

b = measured width in cm of the specimen,

d = measured depth in cm of the specimen at the point of failure,

l = length in cm of the span on which the specimen was supported,

p = maximum load in kg applied to the specimen.

Values of flexural strength at different percentage of replacement at different age are given below:

Flexural Strength of Fly ash Concrete (N/mm^2)

Days	Mix-A	Mix-B	Mix-C	Mix-D	Mix-E
7	3.41	3.14	3.25	3.43	3.07
28	4.19	3.78	4.08	4.22	3.74

The maximum flexural strength of 4.22 N/mm^2 was attained at 40% replacement, while the minimum strength of 3.74 N/mm^2 was attained at 60% replacement. The strength reduced as the percentage of replacement increased above 40 % replacement.

Workability

The word 'workability' signifies much wider and deeper meaning than the other terminology "consistency" often used loosely for workability. Consistency is to indicate the degree of fluidity or degree of mobility. Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

Workability of Concrete

Test	Mix-A	Mix-B	Mix-C	Mix-D	Mix-E
Slump (mm)	84	93	98	103	110
Compaction Factor	0.912	0.915	0.917	0.921	0.925

CONCLUSIONS

1. Concrete acquires maximum increase in compressive strength at 40% fly ash replacement.
2. Split tensile strength is maximum at 40% replacement of cement by fly ash.
3. Maximum flexural strength is also at 40% replacement of cement by fly ash.
4. The slump of the concrete increased as the percentage of replacement fly ash increases.
5. The compaction factor of the concrete increased as the percentage of replacement fly ash increases. he compressive strength decreases with the increment in replacement level of pistachio shells and increases with age.

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