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RESEARCH ARTICLE

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STRENGTH PROPERTIES OF METAKAOLIN WITH FLYASH IN CONCRETE

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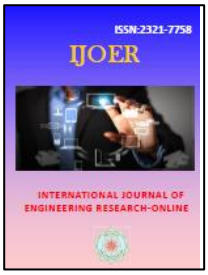


ABSTRACT

The infrastructure development is an important aspect for the overall development of country. India is developing as a major hub for service industry, automobile industry and for which the infrastructure development plays an important role. In case of infrastructure development construction of bridges, aqueducts, high rise buildings, off shore structures, nuclear power stations, dams, high strength concrete above M40 is commonly adopted. The necessity of high strength concrete is increasing because of demands in the construction industry.

Metakaolin looks to be a promising supplementary cementitious material for high performance concrete. Properties of concrete with metakaolin are at partial with flyash is mostly preferred additives in high performance concrete. A possible lower cost, due to large availability in our country itself may be advantages to metakaolin usage in HPC. A combination of flyash and metakaolin will allow higher absorption without compromising much on early age properties of concrete. The preliminary study for strength properties have already been conducted and it is proved that the metakaolin with fly ash is the best alternative materials for the partial replacement of sand and cement in the high performance concrete.

The substitution proportion of metakaolin is to be used was 10%, 20% , 30% by the weight of cement. To make this cubes to determine the strength and durability of concrete of it. The result indicates that the replacing mix up to till last percent has to noted and effect on compressive strength in comparing with mixer without metakaolin.

The test to be conducted are :

- COMPRESSIVE STRENGTH TEST
- WATER SURFACE ABSORPTION TEST

INTRODUCTION

For the preliminary investigation, metakaolin , flyash and cement was subjected to physical and chemical analyses to determine whether they are in compliance with the standard use. The experimental program was designed to investigate metakaolin and flyash as partial replacement with cement and sand respectively. The replacement was done at 10%, 20%, 30%, 40%, 50% for the standard size of cube 150 x 150 x150 mm^3 .The specimen was casted with M60 grade of concrete with different replacement levels of metakaolin and flyash.15 samples of cubes are kept for curing for 28 days and then compression test(10%,20%,30%,40%,50%) was carried out. Another six cubes are placed for 7 days curing and compression test was carried out. Four cubes of 10 and 20% were kept in oven for 1 hour and 2 hours

alternatively, at 250° C, compressibility test is then performed.

METAKAOLIN

Metakaolin, which is a relatively new material in the concrete industry is effective in increasing strength, reducing sulphate attack and improving air-void network. Pozzolanic reactions change the microstructure of concrete and chemistry of hydration products by consuming the released calcium hydroxide (CH) and production of additional calcium silicate hydrate (C-S-H), resulting in an increased strength and reduced porosity and therefore improved durability.

PHYSICAL PROPERTIES

Specific Gravity	2.40 to 2.60
Physical Form	Powder
Color	Off white, Gray to Buff
Brightness	80-82 Hunter L
BET	15 m2/gram
Specific Surface	8 – 15 m2/g.

CHEMICAL COMPOSITION

SiO_2	51-53 %	CaO	< 0.20%
$Al2O_3$	42-44-%	MgO	< 0.10%
$Fe2O_3$	< 2.20%	Na_2O	< 0.05%
TiO_2	< 3.0%	K_2O	< 0.40%
SO_4	< 0.5%	L.O.I	< 0.50%

The chemical equations describing this process is

$$Al_2O_3.2SiO_2.2H_2O = Al_2O_3.2SiO_2 + 2H_2O\ (g).$$

FLY ASH

Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particels that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal.

FLY ASH REUSE IN PORTLAND CEMENT

Owing to its pozzolanic properties, fly ash is used as a replacement for some of the Portland cement content of concrete.

Fly ash often replaces up to 30% by mass of Portland cement, but can be used in higher dosages in certain applications. Fly ash can add to the concrete's final strength and increase its chemical resistance and durability. Fly ash can significantly improve the workability of concrete.

MIX PROPORTION DESIGNATION

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios cement , fine and coarse aggregates for e.g:- a concrete mix of proportions 1:2:4 means that cement , fine and coarse aggregate in the ratio 1:2:4 or the mix contains one part of cement , two parts fine aggregates , four parts of coarse aggregates. The proportion are either by volume or by mass the water cement ratio is usually expressed in mass.

DATA AND PARAMETERS FOR MIX DESIGN

1. Target Strength: M40
2. Type of Cement : O.P.C-53 grade
3. Maximum Nominal Aggregate Size 20mm
4. Exposure Condition: normal
5. Degree of Supervision :Good
6. Type of Aggregate: Crushed Angular Aggregates

TEST DATA FOR MATERIALS

1. Cement Used : ULTRA TECH OPC 53 grade
2. Sp. Gravity of Cement : 3.15
3. Sp. Gravity of Water : 1
4. Sp. Gravity of Fine Aggregate: 2.61
5. Sp. Gravity of Coarse Aggregate : 2.66
6. Specific gravity of Metakaolin : 2.72
7. Specific gravity of Flyash: 2.55

COMPRESSIVE STRENGTH TEST

Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. When the limit of compressive strength is reached, materials are crushed. Concrete can be made to have high compressive strength

PREPARATION OF SPECIMENS

In this study, a total no of 6 cubes each for the control and cement replacement levels of 10%, 20% and 30% were produced respectively. For the compressive strength, 150mm X 150mm X 150mm cubes mould were used to cast the cubes and 2 specimens were tested for each age in a particular mix (i.e. the cubes were crushed at 7 and 28 days respectively). All freshly cast specimens were left in the moulds for 24 hours before being de-molded and then submerged in water for curing until the time of testing.

Specimen (% of Metakaolin & Flyash used)	Testing age(Days)	
	7 Days	28 Days
0%	3	3
10%	3	3
20%	3	3
30%	3	3

TESTING OF SPECIMENS

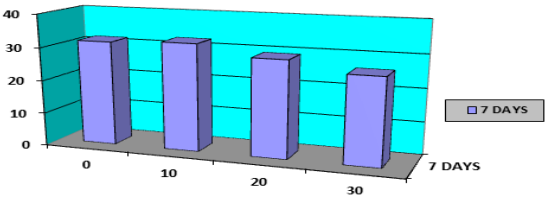
Until failure at which point the load require for failure of compressive strength test were carried out at each cube was noted, prior to testing, the specify ages on the cubes.

The test was carried out conforming to IS: 456 to obtain compressive strength of M40 grade of concrete. The compressive strength of high strength concrete with OPC and Metakaolin and Flyash at the age of 7 and 28 days are presented in table

	Average Concrete Strength Mpa	
% Replacement of Metakaolin and Flyash	7 days	28 days
0%	31.6	41.32
10%	32.4	43.13
20%	29.24	37.16
30%	26.15	35.14

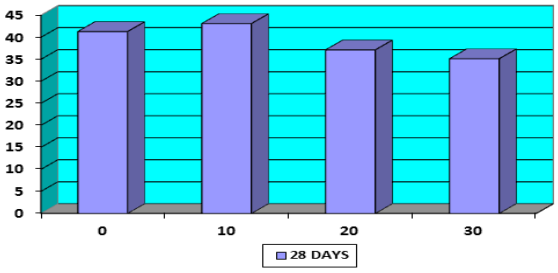
GRAPHICAL REPRESENTATION OF COMPRESSIVE STRENGTH OF CONCRETE

FOR 7 DAYS



Metakaolin and Fly ash in %

FOR 28 DAYS



WATER ABSORPTION TEST

The pore structure of concrete is known to be of high importance for the durability of the material. A characterization of this pore structure by means of a simple water absorption test is often investigated, in order to find a very simple compliance criterion with respect to concrete durability.Water absorption is used to determine the amount of water absorbed under specified condition. Factors affecting water absorption include: type of plastic, additive used, temperature and length of exposure.

Percept Water Absorption = [(Wet weight - Dry weight)/ Dry weight] x 100

TABULATION

FOR 0% METAKAOLIN & FLYASH

No of sample	Wet Weight W1 in Kgs	Dry Weight W2 in Kgs	% Absorption	% Average
1	8.75	8.70	0.57	0.666
2	8.35	8.30	0.60	
3	8.45	8.38	0.83	

FOR 10% METAKAOLIN & FLYASH

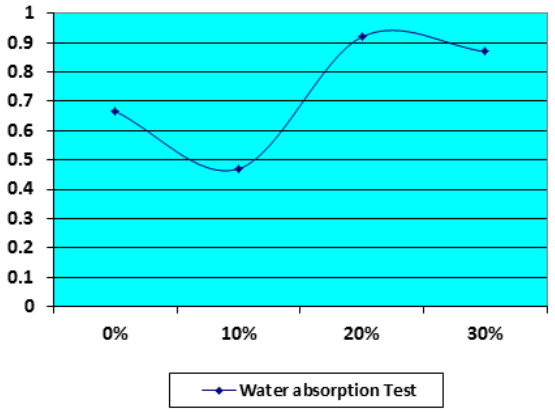
No of sample	Wet Weight W1 in Kgs	Dry Weight W2 in Kgs	% Absorption	% Average
1	8.50	8.45	0.59	0.47
2	8.45	8.41	0.47	
3	8.55	8.52	0.35	

FOR 20% METAKAOLIN & FLYASH

No of sample	Wet Weight W1 in Kgs	Dry Weight W2 in Kgs	% Absorption	% Average
1	8.45	8.35	1.19	0.92
2	8.15	8.10	0.62	
3	8.25	8.17	0.97	

FOR 30% METAKAOLIN & FLYASH

No of sample	Wet Weight W1 in Kgs	Dry Weight W2 in Kgs	% Absorption	% Average
1	7.80	7.75	0.64	0.87
2	8.65	8.55	1.16	
3	8.50	8.43	0.83	



- Table show that water absorption results M40 grade concretes
- Its shows 28 days results and We got optimum water absorption at 10% replacement for M40 grade of concrete

CONCLUSION

The use of metakaolin and fly ash give rise to an increase in the strength as well as durability properties concrete,with less cement and a concrete having better resistance for freezing and thawing than ordinary concrete. Durability is improved through significant improvement to chemical attack. The chief reasons for this are reducded permeability and reduced level of calcium hydrodxided.

Reinforcement corrosion is vastly reduced due to improved permeability, increased restitivity and improve the tensile strength.

Based on the investigation conducted on the strength and durability characteristics metakaolin and flyash with metakaolin and fly ash as the replacement materials the following conclusions were drawn.

1. In mixes blended with high percentage metakaolin and flyash the water demand will be more. Because of the greater finess of metakaolin to maintain constant workability, use of plasticizer become necessary.
2. An optimum of 10% metakaolin and fly ash gives better strength.
3. The gain in strength of metakaolin and fly ash concrete with age is normal compared to that of ordinary concrete.
4. Metakaolin and flyash helps concrete in having better sulphate resistance. Metakaolin can be recommended as useful admixture to enchance the durability of concrete in aggressive enivironment consisting of sulphates.
5. Cement replacement upto 10% with metakaolin and flyash leads to increase in compressive strength, for M40 grade of concrete. From 30% there is a decrase in compressive strength for 7& 28 days curing period.
6. The maximum replacement level of metakaolin and fly ash is 10% for M40 grade of concrete.

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