A Study on Strength Characteristics of Metakaoline and G.G.B.F Slag as a Partial replacement of Cement in Concrete

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Abstract— Concrete is an important material used for construction throughout the world because of the properties of concrete that made it to use in construction in almost all type of structures due to which the consumption of concrete is increasing day by day, which results in increase of extraction of stone crush aggregate, sand and lime etc as result the environment is getting polluted day by day and creating a matter great concern. In this dissertation work the cement is replaced partially with metakaolin and G.G.B.F slag at various %ages respectively, and their corresponding strength properties are compared with that of conventional concrete. Metakaolin and G.G.B.F slag which are the two most commonly available and economic industrial bi products which minimizes the consumption of cement required for construction by partially replacing it with cement, without compromising the corresponding concrete strength properties.

Key words: Metakaolin, GGBF Slag, Cement, Material Test

I. INTRODUCTION

The word concrete is derived from a Latin word i.e.is concretus which means compact or consolidated; concrete can be defined as mixture of cement, coarse aggregate, fine aggregate and water in an appropriate proportion A good concrete is one which gives the strength for which it has been designed, the designed strength can only be achieved by proper mixing the constituent of concrete and by proper curingIn this dissertation work the cement is replaced with the two materials i.e. is metakaolin and ground granulated blast furnace slag (G.G.B.F.S).The partial replacement of cement with metakaolin is done first for MIX-1 in 5%, 10%, 15%, 20%.and secondly the cement is replaced partially with G.G.B.F.S in MIX-2 for different %ages i.e. is 10%, 20%, 30%, 40% for M30 grade of concrete

II. MATERIAL

A. Cement (OPC):

Cement is produced by blending the mixture of lime stone and clay or shale together and the mix is heated up to 1450 c in a kiln to form clinkers. The clinkers are pulverised into small sizes less than 75 micron and gypsum is added to it to form portland cement.

B. Metakaolin(MK):

Metakaolin is defined as refined kaolin clay, it is neither a naturally occurring material nor a industrial product, it has white colour and is used in the manufacturing of porcelain and because of its pozzolanic properties it is used as a cement replacing material The metakaolin used for this experiment is which passes, 85% through 90 micron sieve.

C. G.G.B.F.Slag:

Ground granulated blast furnace slag is an important mineral admixture which is obtained as an bi-pro-duct in iron producing industries when the lime stone, iron ore, coke are heated @ a temperature of around 1400c -1600c and rapidly allowed to cooled down..It has a specific gravity of 2.84 and posses the cementious properties same as that of portland cement.

Properties	Results of OPC	Results of MK	Results of GGBF
Specific gravity	3.15	2.6	2.9
Fineness	2.9	2.68	6.8
Bulk density kg/m^3	1480	1533	1150

Table 1:

D. Fine Aggregate (F.A):

The aggregate which passes through 4.75 mm sieve and retained on 75 micron are known as fine aggregate the river sand which is free from all sort of impurities is used in this project work.

E. Coarse Aggregate (C.A):

The aggregates which are retained on 4.75 mm sieve are known as the coarse aggregate. The maximum size of coarse aggregate used in this project is 20mm which are angular are in shape.

Properties	Results of F.A	Results of C.A
Fineness modulus	2.88	5.12
Specific gravity	2.65	2.75
Water absorption	1%	0.45%

Table 2:

III. MIX DESIGN

In my project work M30 grade of concrete design as per 10262-2009 with water cement ratio 0.45 with mix proportion 1:1.55:2.74

IV. TEST RESULTS

The following are the test results of compressive strength and split tensile strength for various days.

A. METAKAOLIN:

% OF O.P.C, METAKAOLIN	Average comp strength for 7 days in N/MM^2	Average comp

O.P.C 100%, Metakaolin 0%	28.52	35.50
O.P.C 95%, Metakaolin 5%	30.89	37.24
O.P.C 90%, Metakaolin 10%	37.34	42.07
O.P.C 85%, Metakaolin 15%	34.19	39.61
O.P.C 80%, Metakaolin 20%	31.79	34.59

Table 3:

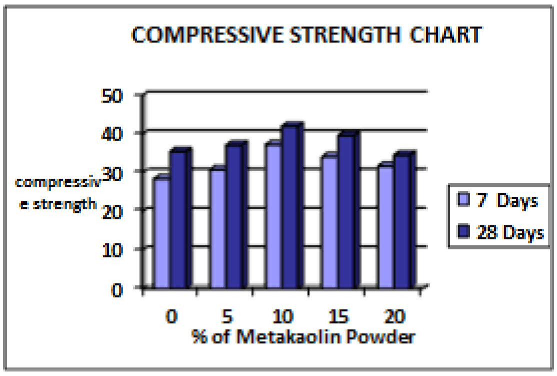

Fig. 1: Compressive Strength Chart

B. G.G.B.F Slag:

% OF O.P.C, G.G.B.F.slag	Average compressive strength 7 days (N/mm^2)	Average compressive strength 28 days (N/mm^2)
O.P.C 100%, G.G.B.S 0%	28.52	35.50
O.P.C 90%, G.G.B.S 10%	27.32	38.01
O.P.C 80%, G.G.B.S 20%	29.47	41.13
O.P.C 70%, G.G.B.S 30%	32.26	46.76
O.P.C 60%, G.G.B.S 40%	30.30	43.42

Table 4:

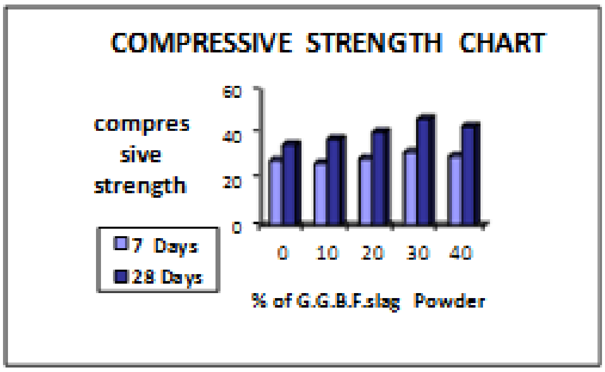

Fig. 2:

% OF O.P.C, METAKAOLIN	Average split tensile strength 28
O.P.C 100%, Metakaolin 0%	2.85
O.P.C 95%, Metakaolin 5%	2.98
O.P.C 90%,. Metakaolin 10%	3.10
O.P.C 85%, Metakaolin 15%	2.87
O.P.C 80%, Metakaolin 20%	2.69

Table 5:

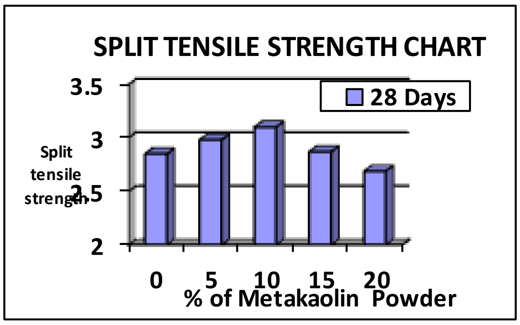

Fig. 3: SPLIT Tensile Strength Chart

% OF O.P.C and G.G.B.F.slag	Average split tensile strength 28 days (N/mm^2)
O.P.C 100%, G.G.B.S 0%	2.85
O.P.C 90%, G.G.B.S 10%	3.05
O.P.C 80%, G.G.B.S 20%	3.18
O.P.C 70%, G.G.B.S 30%	3.27
O.P.C 60%, G.G.B.S 40%	3.01

Table 6:

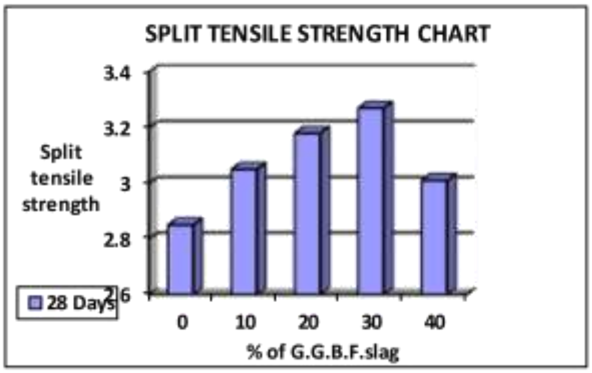

Fig. 4:

V. RESULTS & DISCUSSION

1) When the cement is replaced partially replaced with metakaolin powder with various %ages the strength of the concrete was found to be increased with an increase in %age of replacement upto certain limit beyond it with the further increase in %age of replacement decreases the strength of concrete.
2) For up to 10% of inclusion of metakaolin powder the initial strength was found to be high.

3) For more than 10% of inclusion of metakaolin powder the initial strength was found to be decreased.
4) At 10% inclusion of metakaolin powder there is 23.62% increase in compressive strength for 7 days.
5) At 10% inclusion of metakaolin powder there is 15.62% increase in compressive strength for 28 days.
6) At 10% inclusion of metakaolin powder there is 8.06 % increase in split tensile strength for 28 days.
7) When the cement is replaced partially replaced with G.G.B.F.slag with various %ages the strength of the concrete was found to be increased with an increase in %age of replacement up to certain limit beyond it with the further increase in %age of replacement decreases the strength of concrete.
8) For up to 30% of inclusion of G.G.B.F.slag the initial strength was found to be more.
9) For more than 30% of inclusion of G.G.B.F.slag the initial strength was found to be decreased.
10) At 30% inclusion of G.G.B.F.slag there is 11.59 % increase in compressive strength for 7 days.
11) At 30% inclusion of G.G.B.F.slag there is 24.08% increase in compressive strength for 28 days.
12) At 30% inclusion of G.G.B.F.slag there is 12.84 % increase in split tensile strength for 28 days.

VI. Conclusion

1) The Compressive strength of Cubes are increased with addition of waste i.e.Metakaolin up to 10% in case ofMIX-1 and G.G.B.F.slag up to 30% in case of MIX-2replace by weight of cement and further any addition of waste the compressive strength decreases.
2) The Split Tensile strength of Cylinders are increased with addition of waste Metakaolin up to 30% replace by weight of cement and further any addition of waste metakaolin the Split Tensile strength decreases.
3) The Split Tensile strength of Cylinders are increased with addition of waste G.G.B.F.slag up to 30% replace by weight of cement and further any addition of waste G.G.B.F.slag the Split Tensile strength decreases.
4) Thus we found out the optimum percentage for replacement of metakaolin with cement and it is almost 10% of the total cement for cubes, cylinders and prisms.
5) Thus we found out the optimum percentage for replacement of G.G.B.F.slag with cement and it is almost 30% of the total cement for cubes, cylinders and prisms.

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