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Analyse the Strength Properties of Pozzolana (Ground Granulated blast Furnace Slag) and Marble waste Powder with opc

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Abstract:- GGBFS is primary constituent of partial replacement of cement in this study. It is a specially processed product based on high glass content with high reactivity obtained through the process of controlled granulation. Use of GGBFS causes dense packing of cementitious material, producing low void content and the resulted hydrated cement matrix comprises of very small pores.In this study GGBFS was partially replaced at 3%, 6%, 9% and 12%, while percentage replacement of marble powder was kept constant at 10%, w.r.t cement. Mixed design was prepared with M30 grade of concrete. Different test was performed for the mixed design of concrete. After mix design 72 samples were prepared for compressive strength test and 72 for split tensile strength test.Result shows that there is, good gain in strength with respect to compressive as well as split tensile strength with addition of GGBFS and MWP as compared to conventional concrete samples.

Keywords: -Concrete, OPC, GGBFS, MWP, Split tensile strength Test, Compression Test.

I. INTRODUCTION

In construction industry, consumption of cement increases day by day and cost is also increasing. So to reduce consumption of cement, partial replacement was done in this study by using ground granulated blast furnace slag (GGBFS) and marble powder.Concrete is the most versatile building material in the world for any forms and shape and allowing the construction of structures of great size and scale. Concrete can be made with OPC (Ordinary Portland cement) or PPC (Pozzolanas Portland cement).Among the above two, PPC is widely used in the construction world. Concrete is a mixture of cement, fine aggregates (size less the 4.75mm), coarse aggregates (size more than 4.75mm) and water.Regular studies are conducted to reduce carbon from environment and there is need to produce such green materials with which global warming decreases. So, GGBFS and MWP are such materials in construction world, in whose manufacturing, there is no emission of carbon dioxide. So, in this research work detailed analytical and parametric study on GGBFS and MWP with partial replacement of cement is done.GGBFS is primary constituent of partial replacement of cement in this study. It is a specially processed product based on high glass content with high reactivity obtained through the process of controlled granulation.Use of GGBFS causes dense packing of cementitious material, producing low void content and the resulted hydrated cement matrix comprises of very small pores.

Main objective of this experimental work is to study the influence of partial replacement of cement with GGBFS and MWP, and to compare its compressive and flexural strength with standard M30 concrete. This work also finds the optimum percentage of cement that can be partially replaced with GGBFS and MWP corresponding to minimum cost. In this experimental work pozzolanic materials like, Ground Granulated Blast Furnace Slag and Marble Waste Powder are used. We also study the influence of partial replacement of cement with Ground Granulated Blast Furnace Slag and Marble Waste Powder on the compressive and split tensile strength test of grade M30 concrete. As well as determine the optimum percentage replacement of cement with Ground Granulated Blast Furnance Slag and Marble Waste Powder.

II. PREVIOUS WORK

Amit Gavali et.al, (2016), research about the various properties of ground granulated blast furnace slag (GGBFS). As concrete being important component in construction industry, several developments need to be done in concrete. Utilization of GGBFS enhances the quality of concrete. GGBFS concrete is categorized by lower heat of hydration, resistance to chemical corrosion as well as high strength. From this research it can be figured, since the grain size of GGBFS is comparatively less than ordinary Portland cement, its strength at initial ages is quite less but continues to advance strength over a long time period. This report includes several impact of GGBFS on numerous physical as well as chemical properties of concrete. Low carbon concrete (LCC) can be formed by replacing ordinary Portland cement with GGBFS thus reducing the emission of CO2 by about 60% and at the same time quality of concrete is also improved.

Kishan Lal Jain, (2016), investigates about the over-all performance of concrete mixture in terms of Compressive strength for seven days and twenty-eight days, slump, Flexural strength of beam twenty-eight days, and splitting-tensile strength of Cylinder for twenty-eight days respectively. Total amount of specimens for cylinders 20, cubes 45, & beams 20 which were casted customarily for testing purpose so as to study the influence of GGBFS on concrete. These Concrete specimens were deep cured in water under normal atmospheric temperature. On the basis of result that Ground-Granulated Blast-Furnace Slag concrete was found to increase in all strength (Flexural, Compressive, & Splitting Tensile strength) and durability of variational mix of concrete on all age as compared to the normal concrete its utilization should be encouraged for environmental sustainability as well as for much better performance.

Syed Majeed and Nadeem Pasha, (2015), in this research work, cement has been replaced partly with Limestone (L.P) and Ground granulated blast furnace slag (G.G.B.F.S.) in several percentage respectively, and there corresponding strength properties are well-known with that of conventional concrete. Here in this work, the grade of concrete is chosen as M25 with W/C proportion of 0.5 & M30 with W/C Proportion of 0.45 and the replacement percentages of cement same for both the grades of concrete. Samples are tested for splitting tensile strength, compressive strength, and flexural strength.

Anwar, Abdullah, et.al, (2014), has done experiment by replacing (OPC & PPC) cement of 0%, 5%, 10%, 15% 20%, & 25% by weight with MP & M-20 grade concrete was also used. Concrete mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. It also analyze the behavior of concrete while replacing the Marble Dust Powder with Different proportions in concrete. The result attained for twenty-eigth day compressive strength which also verifies that the optimal percentage for replacement of cement with marble dust powder is approximately 10% (PPC & OPC). This will post less on the production of CO2 and resolving the environmental pollution by cement production.

Md M.A. and Hashmi S.M., (2014), has presented study for better understanding on various strengths characteristics of concrete by utilizing marble dust powder as a partial alternative of cement. The research work is performed using M30 grade concrete for which the marble powder is replaced by 0%, 5%, 10%, 15%, 20% by the actual weight of cement. The outcomes of their research point out that marble dusts incorporation results irrelevant improvements in the flexural, compressive & split tensile strengths of concrete up to 10% of replacement as well as also the outcomes of their research study indicates that stone dusts along with marble dust incorporation results irrelevant enhancements in the compressive strengths of concrete up to 20% of SD & 10% of MP of replacement.

Patel A.J et.al, (2014), explained the waste material which gives proper properties with concrete. This study includes review of different paper published in national and international journals or in conferences. Ceramic waste, Silica Fume, Alkofine, Marble Dust, Born Powder, Pond Ash, Granite Dust, GGBS Glass Powder, Fly Ash, Foundry Waste, Palm Oil Fuel Ash, Rise Husk, Quarry Dust and Saw Dust i.e. above materials can be used as a partial replacement of cement.

III. GROUND GRANULATED BLAST-FURNACE SLAG (GGBFS)

Ground granulated blast-furnace slag (GGBFS), sometimes simply referred to as “slag”, is a glassy granular material formed when molten blast-furnace slag is rapidly chilled, as by immersion in water. It is a non-metallic product, consisting of silicates and aluminosilicates of calcium and other bases, developed in a molten condition simultaneously with iron in a blast furnace. It is used as a cementitious material in Portland cement concrete.According to ASTM C989, GGBFS is classified into three grades according to its performance in the “slag activity test”.

The three grades are: Grade 80, Grade 100 and Grade 120. Slag activity is determined by the following formula:

Slag activity index, $\% = \left(\frac{SP}{P}\right) \times 100$

Where: SP = average compressive strength of slag-reference cement mortar cubes at designated ages, N/mm^2.
P = average compressive strength of reference cement mortar cubes at designated ages, N/mm^2.

Physical Properties:-

Colour	: Off White
Specific Gravity	: 2.85
Bulk Density	: 1200 Kg/m^3
Fineness	: 5000cm^2/g

Fig.1: Ground Granulated Blast Furnace Slag

A. Advantages of GGBFS

1. Better workability, making placing and compaction easier.
2. Lower early age temperature rise, reducing the risk of thermal cracking in large pours.
3. Elimination of the risk of damaging internal reactions.
4. High resistance to chloride ingress, reducing the risk of reinforcement corrosion.
5. High resistance to attack by sulphate and other chemicals.
6. Considerable sustainability benefits.

IV. MARBLE WASTE POWDER (MWP)

Marble is obtained from metamorphic rock. Marble dust powder is an industrial waste obtained from cutting of marble stone. The marble processing is one of the most flourishing material in construction industries. India generates more than 3500 metric ton of marble powder slurry per day. Marble is chemically obtained from crystalline rock composed predominantly of serpentine, calcite, dolomite materials and other mineral constituents. Its composition varies from place to place. MWP is hard and compact which is composed of very fine grained structure. MWP is an industrial waste which is obtained at the time of cutting and manufacturing of marble. The disposal of MWP is also a big problem for industries. They dispose of MWP into natural streams which further cause water pollution. Therefore, MWP is used as a partial replacement of cement in concrete because of its identical properties. It is also used as filler material in concrete i.e. fine aggregates. It also reduces the overall cost of concrete.

Fig. 2: Marble Waste powder used in this study

V. MATERIALS AND METHOD

The materials used for the investigation are described with respect to their sources and relevant physical properties. The laboratory testing on the materials for studying the properties of cement, sand, Coarse aggregate, marble waste powder and GGBFS is done.

a) b)

Fig. 3:a) Cement (Ultra Tech OPC with grade 43) and b) Aggregates

Fig. 4: a) Cement mixed with GGBFS and MWP usedin this study& b) Marble Waste Powder mixed with cement

A. Method Adopted

1. Properties of various constituents of concrete viz, cement, fine aggregates, coarse aggregates, ground granulated blast furnance slag and marble waste powder were determined, by carrying out various tests.
2. Grade M30 concrete was designed as per IS: 10262-2009, which was used as reference mix.
3. Partial replacement of cement with GGBFS and marble waste powder was done at varying percentage.
4. GGBFS was partially replaced at 3%, 6%, 9% and 12%, while percentage replacement of marble powder was kept constant at 10%.
5. Cube and cylinders for 7, 14 and 28 days testing and four sample for each varying percentage was casted,
6. Total 72 cube and 72 cylinders was casted and curing was done.
7. Compressive strength test and split tensile strength test was done.

VI. RESULTS AND DISCUSSION

In this unit detailed study about all the results and testing was described. Result was calculated and also compared with conventional concrete as per IS codes.

A. Results Of Cement Testing

Fineness of cement = 226.5 m3/kg.
Soundness of cement = 7.98mm
Specific gravity of cement =3.15
Initial setting time of cement = 29 minutes
Final setting time =600 minutes

B. Results Of Aggregate Testing

i. Fine Aggregates (FA)

Fine aggregates (FA) = River sand (Zone II)
Fineness Modulus of fine aggregates = 2.836
Free surface moisture content = 1.5%
Specific gravity of FA= 2.65

ii. Coarse aggregates (CA)

Coarse aggregates = Crushed aggregates
Maximum size of aggregates = 20mm
Fineness modules of coarse aggregates =6.414
Free surface moisture content=1.0%
Specific gravity =2.70

C. Results Of Ground Granulated Blast Furnance Slag (GGBFS)

Fineness of GGBFS = 5000cm2/g
Specific gravity of GGBFS =2.85

i. Chemical Composition of GGBFS:

Table 1: Chemical Composition of GGBFS

Element	Weight%	Atomic%
Ca O	24.37	32.86
Si O_2	56.41	57.11
Al_2 O_3	8.73	5.81
Fe_2 O_3	10.29	4.16
Mg O	0.20	0.06
Totals	100.00	

Comment: By comparing the physical results with the standard composition of cement as given in Table, we can correlate the composition of GGBFS with cement content.

D. Results Of Marble Waste Powder

Fineness of MWP=4843cm2/g
Specific gravity of marble waste powder =2.55

Table 2: Chemical Composition of Marble Waste Powder

Element	Weight %	Atomic %
Al_2 O_3	5.28	8.29
Ca O	54.89	64.68
Fe_2 O_3	19.47	13.60
Mg O	19.60	13.16
Na_2 O	0.33	0.13
K_2 O	0.24	0.08
S O_3	0.19	0.05
Totals	100.00	

Comments: MWP can be partially replaced with cement.
Conclusion: By comparing the physical and chemical results with the standard composition of cement, we can correlate the composition of MWP with cement content. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

E. Concrete: Workability

The degree of workability required depends on three factors i.e. the size of the section to be concreted, the amount of reinforcement, and the method of compaction to be used. For the narrow and complicated section with numerous corners or inaccessible parts, the concrete must have a high workability so that full compaction can be achieved with a reasonable amount of effort. This also applies to the embedded steel sections. The desired workability depends on the compacting equipment available at the site. Generally on site workability is increased by labour by adding extra water but it leads to low strength. So for having quality concrete one should add admixtures than water.

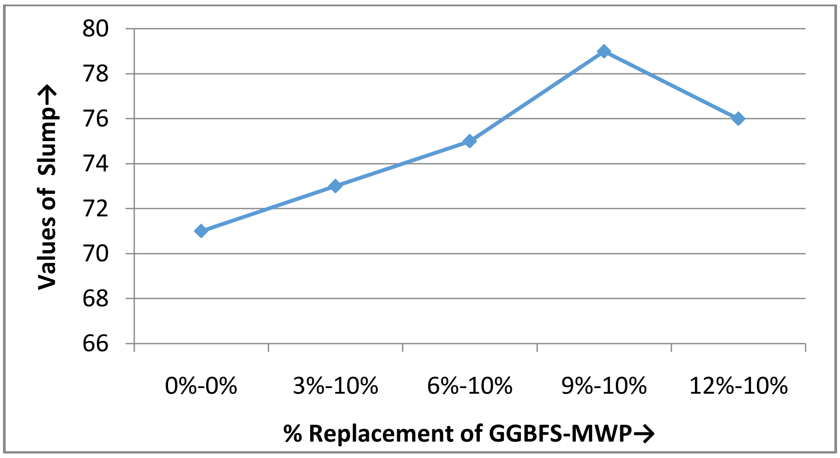

Fig. 5: Workability Analysis of Concrete

The slump value of the concrete increased from the different percentage addition of GGBFS and marble waste powder till 9% GGBFS and 10% MWP, after 9% GGBFS and 10%MWP, decrease in workability was observed.

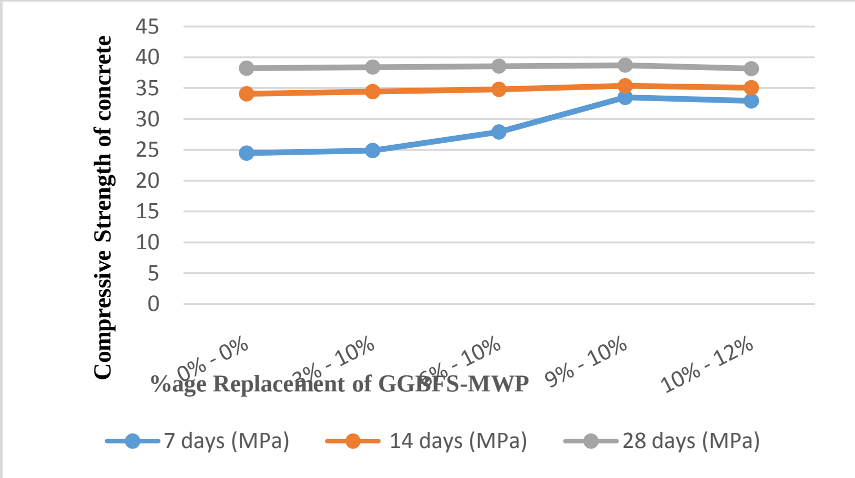

Fig. 6: Compressive strength of concrete at 7 days, 14 days and 28 days

It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength is required at 28 days. Compressive strength of concrete mainly depends up on water/binder ratio and also the curing at a prescribed temperature.Compressive strength of concrete can be calculated by cube testing. Compressive strength of concrete also defined by compressive strength of concrete at 28days and is directly related to characteristics strength which further depends upon the grade of concrete. In this study 72 cubes were casted and graph was prepared which show that compressive strength increase with the amount of addition of GGBFS -MWP till 9% and then decrease was observed. As 7 days, 14 days and 28 days has been conducted to check the gain, in initial strength of concrete, median strength of concrete and final strength of concrete respectively under complete curing.

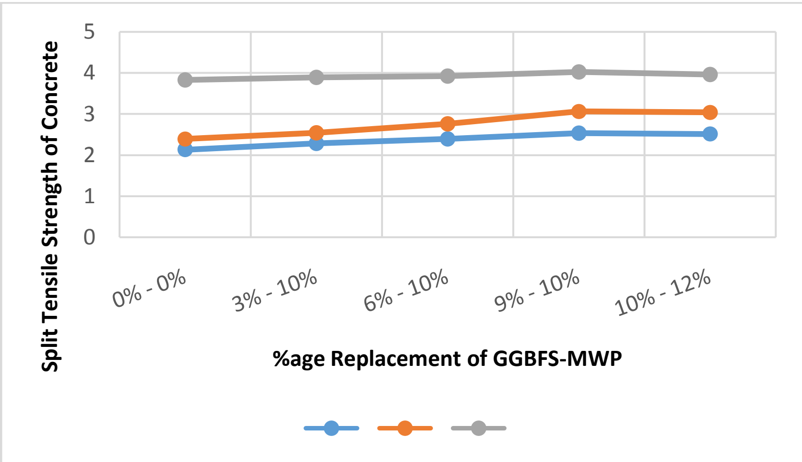

Fig. 7: Split Tensile Strength of Concrete at 7 days, 14 days, and 28 days

Above results show that there was gain in tensile strength with respect to increase in amount of GGBFS and constant amount of MWP. The optimized value is obtained at 9% of GGBFS-10% MWP and then there was small continues decrease in strength. There was no use of admixture in this test so there was great saving of money.

VII. CONCLUSIONS

In this work, Strength and durability properties of concrete with partial replacement of cement with GGBFS and MWP have been done. GGBFS & MWP with five different percentage fractions were examined and compared for their compressive and Split tensile strength of concrete with conventional concrete.The permeability test shows that there is decrease in permeability of concrete with the increase in amount of GGBFS and Marble waste powder addition.From the above discussion it is concluded that if cement is replaced with GGBFS up to 9% and 10% MWP, we will get better concrete from strength and durability point of view. It will also save 1 bag of cement per 8 bags of cement. Since there is no emission of carbon dioxide in manufacturing process of GGBFS -MWP, hence we get Green concrete and save environment. Hence all the objectives are achieved and results are analyzed.

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