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Partial Replacement of Cement with Nano fly ash (class c) and Nano GGBS

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Abstract - ***The aim of this research is to enhance the performance of the concrete using Nanofly ash and also now-a-days we want to decrease the cement rate for reducing the cost and environmental problem. In our study Nano fly ash(c) is used for the replacement of cement. In this we use Ground Granulate Blast Furnace as an admixture. GGBS is the waste product of iron industry. We increase the compressive strength and tensile strength of concrete by preparing Nano fly ash in different proposition instead of using ordinary Portland cement. And the Nano GGBS was replaced in different proposition of fly ash to improve the various properties of concrete. Based on this partial replacement of Nano GGBS in fly ash study produces the better mechanical properties.Nano materials also improve the performance of the concrete. This is the main reason to use Nano materials. The Nano fly ash leads to reduce the water demand and this analysis promoting the use of fly ash. This paper reviews the utilization of fly ash and GGBS in partial replacement of cement to different proposition. We expect this Nano concrete gives better compressive and split tensile strength than the normal concrete.***

Key Words: *fly ash, ground granulate blast furnace, Nano materials*

1. INTRODUCTION

Now-a-days we are using concrete as a construction material, this is the very important building material for lots of development. Cement is the main raw materials of concrete. Manufacturing process of this raw material generates much amount of co_2. Co_2 is the main factors which affect the environment and it also stimulate the environmental problem. So we want to reduce co_2 emission from the concrete. The effective method of reducing co_2 emission is partial replacement of cement with other material. Here fly ash is used as replaced material and GGBS as an additive.

Use of Nano materials will reduce the carbon footprints and it will also give improvement in the characteristics of concrete. In many studies a very high strength concrete can be obtained by Nano materials. It will reduce the cement need, because it was very fine so its surface area was large. The fineness property will help the pores filling and it leads to increase the durability. We add the Nano material to cement for enhancing the strength at the short time. Therefore it reduces the construction period also.

Our concept is that, when we add the Portland cement with water the time cementitious material will produce, this cementitious material gives bonding property to the concrete and also excess lime content will produce in the process. This lime is unwanted product of this process. In our study we use fly ash as a partial replacement of cement, this Nano fly ash reacts with that lime and additional cementitious material will produced and more strength will be gain.

1.1 Need for the Study

The natural resources are to be preserved**.** We want to decrease the cement rate for reducing the cost and environmental problem. Nano materials also improve the performance of the concrete.The cost of construction can be minimized.

1.2 Objectives of the Study

The study, aims to enhance the performance of the concrete using Nano fly ash and GGBS. We expect this Nano concrete gives better compressive and split tensile strength than the normal concreteand also reducing the cost and environmental problem.

2. METHODOLOGY

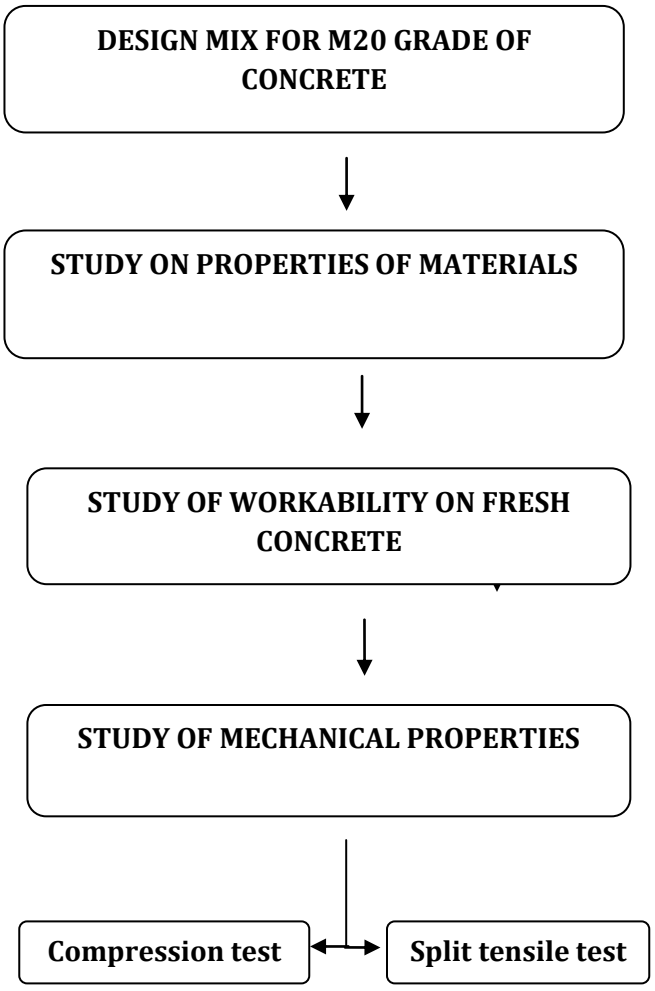

Fig 2.1 Methodology Flow Chart

3. MATERIALS PROPERTIES

Class c fly ash generally produced by burning lignite coal. Fly ash has cementitious properties. Fly ash will harden and gain strength. It contains 20% lime content. Good fly ash has high fineness and low carbon content. Initial strength of the fly ash concrete is lower than the normal concrete. Its pozzolonic property reaction develops greater strength at later age. This property making concrete as a dense material and this dense property resulting in reduces the water and gas permeability. These are the main reason for using fly ash.

Fly ash Nano size is found out from the XRD test. This test is adopted for phase identification and crystalline size is calculated by scherre formula. β, θ values are derived by using Origin software. From the analysis fly ash size is 21 nm. XRD of raw fly ash is shown below.

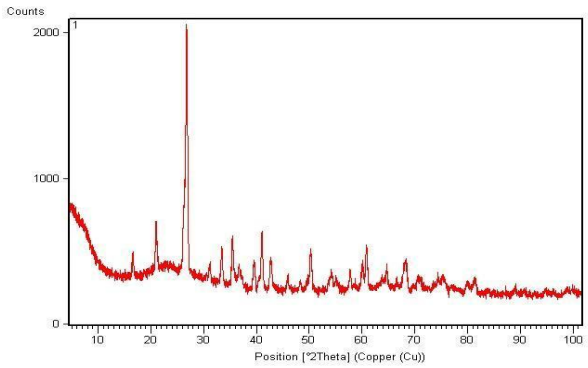

Fig 3.1 XRD of fly ash

Ground Granulate Blast Furnace is an important mineral admixture. GGBS is the waste material derived from iron industry. The molten slag is rapidly cooled by water. At that time the glassy powder material is produced. It is called as Ground Granulate Blast furnace slag. In fresh concrete, GGBS will reduce the unit water content. In hardened concrete, GGBS will reduce heat of hydration and also increase the resistance to chemical attack etc.

Nano GGBS is used for this study, its size is found out from the XRD analysis. Fig 3 represents XRD of GGBS.

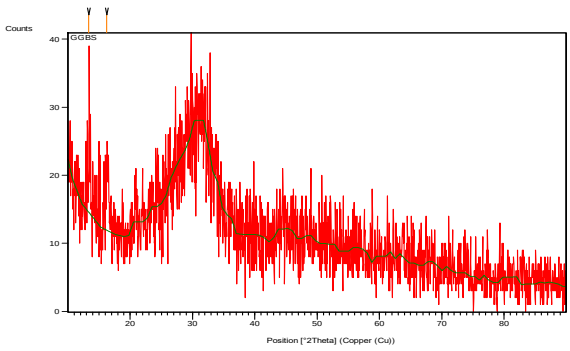

Fig 3.2 XRD of GGBS

Fig 3.3 Nano GGBS

3.1Mix Design

M25 grade of concrete is used and mix design is done as per IS 10262:2009.

Grade Designation : M25

Cement used :OPC 53 grade

Specific gravity of cement:3.15

Specific gravity of CA : 2.7

Specific gravity of FA : 2.65

Water cement Ratio : 0.45

Mix proportion is 1 : 1.75: 2.67

This mix proportion is carried out for replacement of cement by 30, 40 and 50% of Nano class-C fly ash.

3.2Specimen Preparation, Casting and Testing

In this study totally 4 mixes are prepared; FIRST one is control Mix - 0% replacement of cement that means concrete made with cement without fly ash and SECOND MIX - 30% replacement of cement with Nano fly ash and 3% of GGBS, THIRD MIX - 40% replacement of cement with Nano fly and 4% of GGBS, FOURTH MIX - 50% replacement of cement.

12 cubes and 12 cylinders made for this study. Size of the cube is 150*150*150 and size of the cylinder is length-200 diameter-100, 3 cubes and cylinders are in one mix. After making specimens they are kept into the curing tank for 7 days and 28 days.

After 7 and 28 days cubes are tested for compressive strength and cylinders are tested for split tensile strength by using compression testing machine.

Fig 3.4 split tensile test

Fig 3.5 compressive test

4.RESULT AND DISCUSSION

Compressive strength test

The cubes are tested for compressive strength after 7 and 28 days. The results of compressive strength test are tabulated in table 1 and 2

Sl: no	% of fly ash used	% of GGBS used	Maximum Load (kN)	Compressive Strength (N/ mm²)
1.	0%	0%	554	24.6

2.	30%	3%	520	23.1
3.	40%	4%	438	19.46
4.	50%	5%	373	16.57

Table 4.1 compressive strength test value

Graph plotted between compressive strength and percentage of fly ash, 7 days compressive strength graph is shown in the figure 4.1

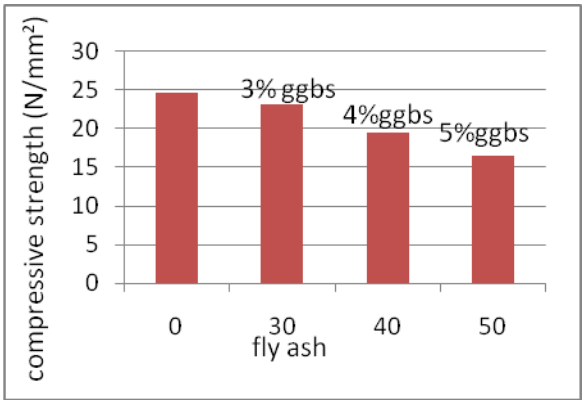

Fig 4.1 Compressive strength for 7 days

Sl: no	% of fly ash used	% of GGBS used	Maximum Load (kN)	Compressive Strength (N/ mm²)
1	0%	0%	783	34.8
2	30%	3%	840	37.3
3	40%	4%	796	35.3
4	50%	5%	605	26.9

Table 4.2 compressive strength test value

Graph plotted between compressive strength and percentage of fly ash for 28 days is given below

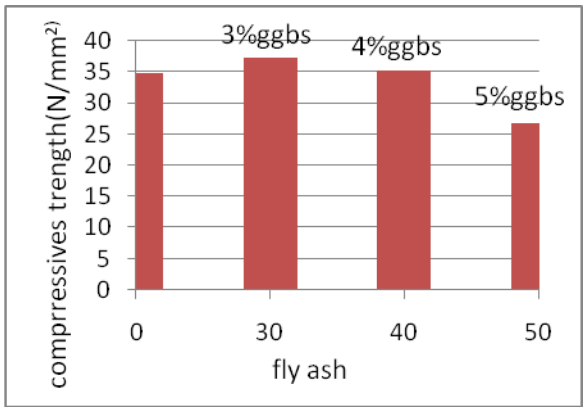

Fig 4.2 compressive strength for 28 days

From the compressive test results 30% replacement of cement with fly ash get maximum compressive strength. Because the Portland cement gets suddenly increase in strength and after 28 days it will be arrested in some points.

Split tensile strength test

The cylinders are tested for finding the split tensile strength after 7 and 28 days. In cylinders compression forces applied along two axial lines which are opposite. The results of split tensile strength test are tabulated in table

The splitting tensile strength was determined using the relation:

fs= 2P/(Π*D*L)

Sl: no	% of Fly ash used	% of GGBS used	Maximum Load (kN)	Split tensile Strength (N/mm²)
1	0%	0%	124	3.915
2	30%	3%	111	3.53
3	40%	4%	88.9	2.830
4	50%	5%	124	3.947

Table 4.3 Split tensile test results

Below graph is plotted between split tensile strength and percentage of fly ash used.

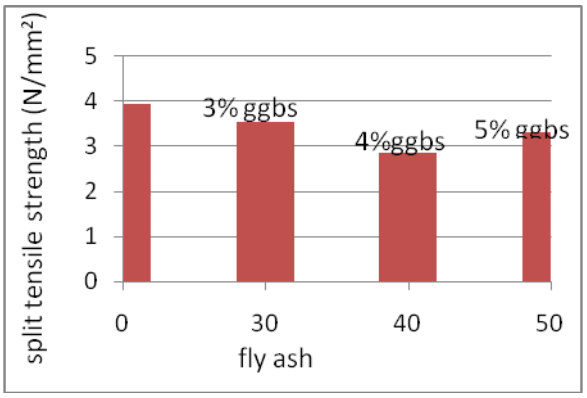

Fig 4.3Split tensile strength for 7 days

From the tensile test 30% of fly ash get high strength, but 40% of fly ash strength was reduced and 50% of fly ash strength was increased. These changes occurred because of the admixture.

Sl: no	% of Fly ash used	% of GGBS used	Maximum Load (kN)	Split tensile Strength (N/ mm²)
1	0%	0%	132	4.19
2	30%	3%	154	4.99
3	40%	4%	132	4.22
4	50%	5%	125	3.9

Table 4.4 split tensile strength test value

Below graph represents split tensile strength for 28 days

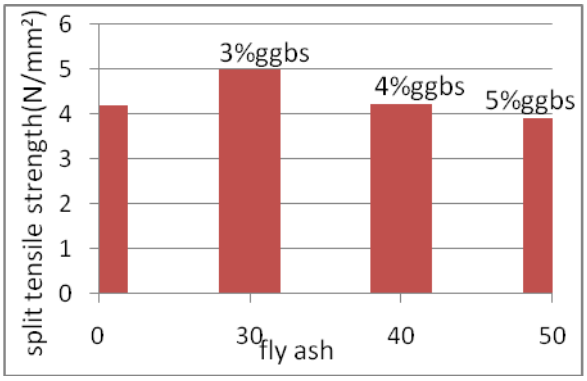

Fig 4.4 Split tensile strength for 28 days

4. CONCLUSION

In this study, the effect of Nano fly ash and Nano GGBS on the strength of concrete was investigated, from the results the following conclusion can be drawn.

30 to 40 percentage cement replacement with Nano material gives better results.

In 28 days 30% of fly ash strength is more because we added Nano fly ash and Nano GGBS.

50% of fly ash gives lesser values when compared with others the fly ash strength will be increased after a month. It takes 6 months for gradually increasing the strength.

In this study we tested specimen for 7 and 28 days only. Fly ash gets higher strength in the longer duration. So for 28 days, increasing the amount of fly ash was decreased the concrete strength than the normal concrete.The partial replacement of OPC in concrete by Nano fly ash and GGBS not only reduce the environmental problem, it will also provide the economy of constructions

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