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Strength and Workability Properties of Concrete Replaced by Quarry Dust and GGBS

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***Abstract* – Concrete is the most widely used construction material in civil engineering because of its high structural strength and stability. Quarry dust and GGBS, the waste material which is obtained from manufacturing of coarse aggregate and slag material obtained from furnaces. The replacement of sand as a major ingredient of concrete by quarry dust will be a techno economic solution to the above problem .The present research work was carried out to study the strength and stability of concrete containing quarry dust and GGBS as partial replacement of sand and cement at various percentages . In this research the experimental investigations carried out in three phase M30 mix grade concrete is used with quarry dust in proportions of 0%,10%,20%,30%,40%,50%,60%,70%,80%,90% and 100% In second phase GGBS in various proportions of 10%,20%,30% were tested . In third phase combination of GGBS and quarry dust were tested .From this research this results are much better as compare to conventional concrete.**

Keywords: Quarry dust (QD), compressive strength, , spilt tensile strength.

I. INTRODUCTION

Sustainable development is mandatory to protect the environment. Over million tonnes of Sustainable development is mandatory to protect the environment. Over 300 million tones of industrial wastes are being produced per annum by various industrial and agricultural processes. These materials causes problems of disposal, health hazards and anaesthetic. The challenge in front of civil engineering community is to provide a sustainable construction material without compromising on its strength properties which will help in solid waste management.

II. MATERIALS USED

The materials used in experimental investigation include:

A. Cement

An ordinary Portland cement 53 grade conforming to IS 12269: 2013 was used. The specific gravity of cement was 3.11.

B. Fine aggregates

Good quality river sand was used as a fine aggregate conforming to grading zone I of IS: 383 1970 was used. Its specific gravity was 2.6.

C. Coarse aggregate

Coarse aggregate obtained from local quarry units has been used for this study. Maximum size of aggregate used is 20mm with specific gravity of 2.67.

D. Quarry dust

Quarry dust a by-product of stone crushing has been proposed as an alternative to sand that gives additional benefit to concrete. It is used to increase the strength of concrete over concrete made with equal quantities of sand. Quarry dust has been used for different activities in the construction industry such as in road construction and manufacture of building materials such as light weight aggregates, bricks and tiles. High percentage of dust in the aggregate increases the fineness and the total surface area of aggregate particles. The surface area is measured in terms of specific surface, the ratio of total surface area of all the particles to their volume. The main objective of this research is to provide more information about the effects of various proportion of dust content as partial replacement of natural sand.

In this investigation quarry dust is collected from local stone crushing units. It was initially dry in condition and Specific gravity was observed for quarry dust is 2.54.

E. GGBS

Ground granular blast furnace slag, a fine powder which is obtained by quenching molten iron slag from a blast furnace in water. In this investigation specific gravity for GGBS is 3.09

F. Water

In this experimental investigation portable water which is free from organic substances is used for mixing and curing.

III.EXPERIMENTAL INVESTIGATIONS

In present study M30 grade concrete were designed as per IS: 10262-2009

A.Workability

Freshly mixed concrete were tested for workability by slump value. In this investigation, M30 mix concrete is considered to perform the test by-weight basis by replacing

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0%, 10%, 20%, 30% ,40% ,50% ,60% ,70% ,80%,90% and 100% of fine aggregate replaced by quarry dust. In phase two only cement is replaced by GGBS 10%,20% ,30%.

B.Compressive Strength

In this investigation, M30 mix concrete is considered to perform the test by-weight basis with 0%,10%,20%30%,40%,50%,60%,70%,80%,90% and 100% of fine aggregate replaced by quarry dust and 10%,20%,30% of cement by GGBS and combination of both quarry dust and GGBS. A 150x150 mm concrete cube was used as test specimens to determine the compressive strength of concrete cubes. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes were properly compacted. All the concrete cubes were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory at an age of 28 days. Compression test was conducted on a 2000KN capacity universal testing machine.The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without shock until the failure of the specimen occurred.

C.Split Tensile Strength

In this investigation, M30 mix concrete is considered to perform the test by-weight basis by replacing 0% ,10% ,20%30%,40%,50%,60%,70%,80%,90% and 100% of fine aggregate by quarry dust and 10%,20%,30% of cement by GGBS and combination of both quarry dust and GGBS. Cylinders of 150 mm diameter and 300 mm length were used as test specimens to determine the split tensile strength of concrete .The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cylinders were properly compacted. All the cylinders were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory for an age of 28 days. The split tensile strength was conducted as per IS 5816-1976.The specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without shock until the failure of the specimen occurred.

IV.RESULTS AND DISSCUSSIONS

A. Workability

Slump test of various mix proportions of quarry dust and GGBS in concrete are shown below

Table1: Slump values with various proportions of Quarry dust replacing fine aggregates in M30 grade concrete

S.no	Quarry dust content	slump
1	0%	96
2	10%	94
3	20%	92
4	30%	90
5	40%	88
6	50%	86
7	60%	84
8	70%	82
9	80%	80
10	90%	77
11	100%	75

Table2: Slump values with various proportions of GGBS replacing cement in M30 grade concrete

S.no	GGBS content	slump
1	0%	96
2	10%	97
3	20%	98
4	30%	99

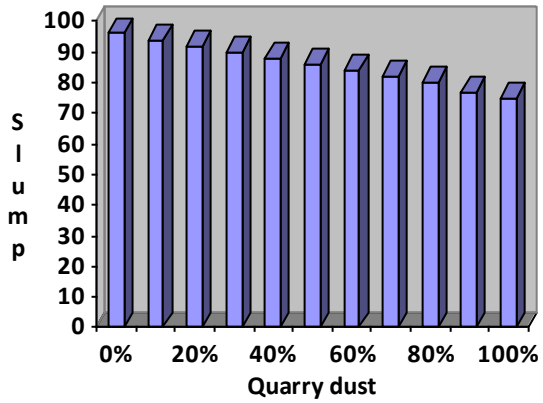

Fig 1: slump values when replacement of sand by quarry dust

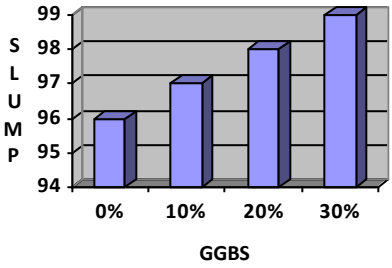

Fig 2: slump values when replacement of cement by GGBS

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B. Compressive Strength Test

The compressive strength of concrete was achieved in 28 days of various proportions and presented below The specimens were cast and tested as per IS: 516-1959.

Table 3: Compression test at 28 day with various Proportions of Quarry dust replacing fine aggregates in M30 grade concrete

S.no	Quarry dust content	Compressive strength N/mm2
1	0%	32
2	10%	34.67
3	20%	35.11
4	30%	37.33
5	40%	36.11
6	50%	35.33
7	60%	32.44
8	70%	31.11
9	80%	24.4
10	90%	20
11	100%	18.66

Table 4: Compression test at 28 day with various Proportions of GGBS replacing with cement in M30 grade concrete

S.no	GGBS content	Compressive strength N/mm^2
1	0%	32
2	10%	36.44
3	20%	39.55
4	30%	23.55

Table 5: Compression test at 28 day with various Proportions of Quarry dust and GGBS replacing fine aggregates and cement in M30 grade concrete

S.no	GGBS and Quarry dust	Compressive strength N/mm^2
1	10% GGBS+30%QD	33.95
2	20%GGBS+30%QD	35.77
3	30%GGBS+30%QD	32.34

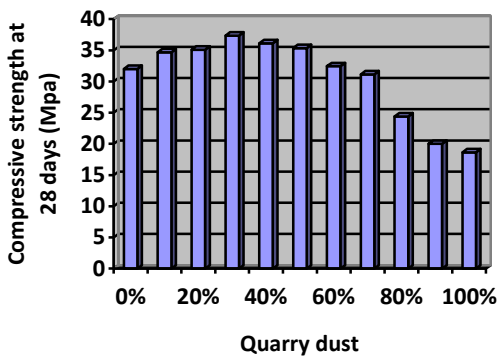

Fig 3: Compressive Strength when replacement of Natural Sand by Quarry dust

From the figure 3 and table 3 it is observed that 30% quarry dust (QD) achieved maximum strength in comparison to normal concrete.

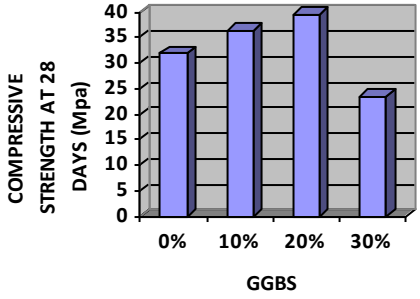

Fig 4: Compressive Strength when replacement of cement by GGBS

From the figure 4 and table 4 it is observed that 20% GGBS achieved maximum strength in comparison to normal concrete.

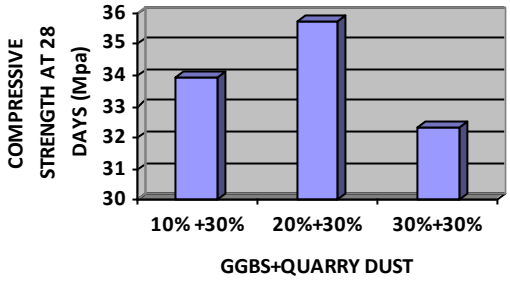

Fig 5: Compressive Strength when replacement of cement by GGBS and Quarry dust

From the figure 5 and table 5 it is observed that 20% GGBS and 30% QD achieved maximum strength in comparison to normal concrete.

C. Split Tensile Test

The tensile strength of concrete with 28 days curing period for various proportions and presented below The specimens were cast and tested as per IS: 516-1959.

Table 6: Split tensile test at 28 day with various Proportions of Quarry dust replacing fine aggregates in M30 grade concrete

S.no	Quarry dust content	Split tensile strength N/mm^2
1	0%	3.56
2	10%	3.96
3	20%	4.59
4	30%	5.37
5	40%	4.95
6	50%	3.54
7	60%	2.46
8	70%	2.26
9	80%	2.19
10	90%	2.12
11	100%	1.9

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Table 7: Split tensile test at 28 day with various Proportions of GGBS replacing Cement in M30 grade concrete

S.no	GGBS content	Split tensile strength N/mm^2
1	0%	3.56
2	10%	3.58
3	20%	3.65
4	30%	3.01

Table 8: Split tensile test at 28 day with various Proportions of GGBS and quarry dust replacing Cement and QD in M30 grade concrete

S.no	GGBS and Quarry dust	Split tensile strength N/mm^2
1	10% GGBS+30%QD	3.6
2	20%GGBS+30%QD	3.89
3	30%GGBS+30%QD	3.71

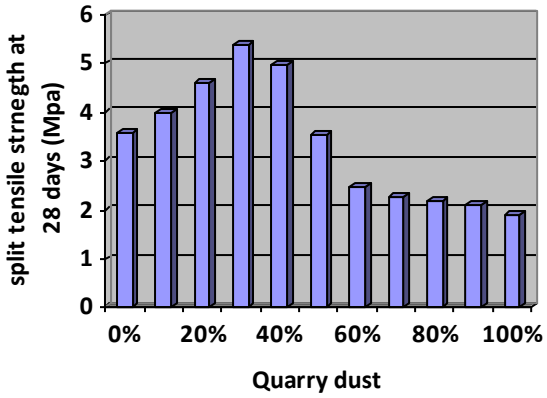

Fig 6: Split tensile Strength when replacement of Natural Sand by Quarry dust

From the figure 6 and table 6 it is observed that 30% quarry dust (QD) achieves maximum strength in comparison to normal concrete.

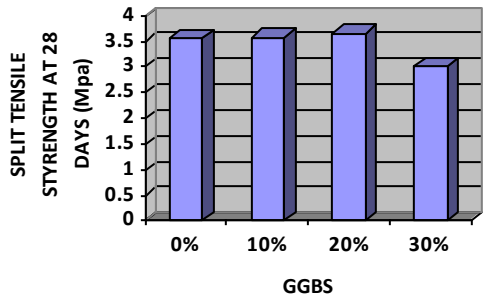

Fig 7: Split tensile Strength when replacement of cement by GGBS

From the figure 7 and table 7 it is observed that 20% GGBS achieves maximum strength in comparison to normal concrete.

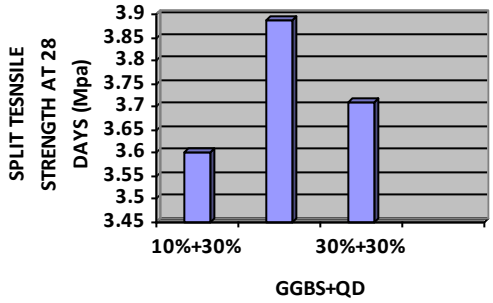

Fig 8: Split tensile Strength when replacement of cement and sand by GGBS and QD

From the figure 8 and table 8 it is observed that 20% GGBS and 30% QD achieves maximum strength in comparison to normal concrete

V. CONCLUSIONS

Based on the experimental investigations the following conclusions are drawn:

- As the sand is not available or use of sand creates environmental problems need to find alternative material. Quarry dust is a waste material from stone crusher plant as per physical properties of quarry dust, it is a suitable substitute for sand at very low cost.
- Quarry dust and GGBS is the waste material so as per the environmental impact view use of waste material is helpful to maintain effective sustainable development.
- By adopting critical mix and replacing fine aggregates by quarry dust and, it is found that by increasing the percentage of quarry dust workability decreases because of its increased water absorption and strength decreases gradually.
- similarly replacing cement with GGBS increases the workability
- From the above compressive strength results, it is observed that quarry dust based concretes have achieved an increase in strength for 30% replacement of fine aggregate and 20% replacement of cement by ggbs and combine 20% GGBS and 30% quarry dust at the age of 28 days when compared to conventional concrete.
- From the above split tensile strength results, it is observed that quarry dust based concretes have achieved an increase in strength for 30% replacement of fine aggregate and 20% replacement of cement by ggbs and combine 20% GGBS and 30% quarry dust at the age of 28 days when compared to conventional concrete.
- From the above experimental investigation quarry dust can be used as alternate material to fine aggregate up to 30% ,20% ggbs and 20%and 30% combine effect of ggbs and QD .
- Hence as per the results obtained, it can be suggested that use of quarry dust and ggbs can be a replacement for sand and cement in concrete will be beneficiary.

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