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RESEARCH ARTICLE

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STRENGTH CHARACTERISTICS OF PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE BY INDUSTRIAL WASTES IN CONCRETE.

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ABSTRACT

This report presents experimental study on strength parameters of partial replacement of cement, fine aggregate by fly ash and quarry dust. Quarry dust is the alternative material to reduce the demand of fine aggregate in construction industry. To reduce the wastages produced by the industries and also make it into profitable materials. The fly ash and quarry dust as partially replaced at 20%, 30%, 40%, 50%, 60% for cement and fine aggregate. The compressive strength test is to be made for 7, 14, 28 days of curing of concrete. The main objective of this experimental work is to be made a low cost concrete and also reduce the environmental degradation.

Key Words: Fly ash, Quarry dust, Compressive strength.

I. INTRODUCTION

The fly ash is the mostly used cementitious material in concrete. The fly ash production in India is approximately 80 million tons per year but the amount of utilization of fly ash is 10 % only. The construction companies starting to using the fly ash for manufacturing of cement but still the amount of fly ash usage is low. Class C Fly ash is generally used for the replacement of cement. Were the lime content is more than 20% is called the class C fly ash. The class C fly ash is made the concrete to have higher workability, long term strength and to make the concrete more economically.

The increasing rate of demand of natural sand is increased more and the cost of the sand also increased. Quarry dust is the replacing material for fine aggregate. Quarry dust is a by-product of crushing stones. It will increasing the strength of concrete over concrete made with natural sand but it causes a reduction in the workability of concrete. To reduce the impact of these materials on environment by using these wastes as admixtures in concrete. This investigation carried out the strength characteristics of concrete by the different percentages and also the quality of concrete.

II. LITERATURE REVIEW

The literature survey presented that there is a possibility of partially replacing cement and fine aggregate by fly ash and quarry dust. Further study in this direction will be helpful in looking for alternatives for cement and fine aggregate as well as solving the problem of fly ash and quarry dust disposal and minimize the demand of river sand by utilization of waste such as fly ash and quarry dust.

III. MATERIALS

a) **OPC (Ordinary Portland cement):** The cement used for this investigation work is ordinary Portland cement (OPC) 53 grade conforming to IS: 12267 – 1987. The properties as shown in table 1

Table1. Properties of ordinary Portland cement

S.No	Properties	Values
1	Specific gravity	3.14
2	Normal consistency	28%
3	Initial setting	30 min
4	Final setting	256 min
5	Fineness	3%

b) **Fine aggregate:** Locally available river sand passing through 4.75 mm and retained on 150 micron IS sieves is taken as fine aggregate conforming to zone-III as per IS 383 – 1970. The properties of fine aggregate as shown in table 2

Table2. Properties of fine aggregate

S.No	Properties	Test values of Sand
1	Specific gravity	2.72
2	Bulking of sand	22%
3	Fineness modulus	2.57
4	Water absorption	0.75%
5	Particle size range	0.15 to 4.75 mm

c) **Coarse aggregate:** Locally available coarse aggregates are taken. The aggregate is passing through is sieve 20 mm. the properties of coarse aggregates are shown in table 3.

Table3. Properties of Coarse aggregate.

S.No	Properties	Test values
1	Specific gravity	2.88
2	Fineness modulus	3.44
3	Water absorption	0.97%
4	Bulk density	1477 kg/m^3
5	Size	20 mm

d) Fly ash: In this investigation class C fly ash having specific gravity of 2.35 obtained from Thermal power station which is located at Mettur in Tamil Nadu is used for the replacement of cement.

Table4. Properties of fly ash

S.no	Properties	Values
1	Specific gravity	2.35
2	Fineness	3%
3	Initial setting	40 min
4	Final setting	320 min

e) **Quarry dust:** The quarry dust used for this investigation work is obtained from the quarry near Melmaruvathur in Tamil Nadu. The quarry dust passing through 4.75 mm retained on 150 micron IS sieves are taken. The properties of quarry dust are shown in table 5.

Table5. Properties of quarry dust

S.No	Properties	Test values of quarry dust
1	Specific gravity	2.68
2	Bulking of sand	23.50%
3	Fineness modulus	2.55
4	Water absorption	1.20%
5	Particle size range	0.15 to 4.75 mm

f) **Water:** Water is the important ingredient for preparing concrete mixture for casting and also for curing.

IV. **Chemical properties:** The rocks which contain reactive constituents include traps, andesitic, hyalites, siliceous limestone and certain types of sand stones. The reactive constituents may be in the form of opals, cheers, chalcedony, volcanic glass and zeolites etc., the reaction starts with attacks on the reactive siliceous minerals in the aggregate by the alkaline hydroxide derived from the alkalis cement. As a result, the alkalis silicate gels of unlimited swelling type are formed.

Table6. Chemical properties of materials

S.no	Property	Quarry dust	Fly ash
1	Silica (SiO_2)	62.48 -65.5	10.8-39.6%
2	Iron (Fe_2O_2)	5.78-6.54	0.6-2.5%
3	Titanium(TiO_2)	1.10-1.31	-
4	Aluminium(Al_2O_3)	16.12-19.10	1.1-2.7%
5	Calcium (CaO)	4.10-4.92	14.1-41.3%
6	Magnesium(MgO)	2-2.78	3.1-9.2%
7	Sodium(Na_2O)	0-0.78	1.0-15.45%
8	Potassium(K_2O)	3.10-3.78	-
9	Sulphurtrioxide(SO_3)		11.2-20.0%

V. Mix design: In this investigation concrete mix design M30 was designed based on IS 10262. This method is limited to high strength concrete production using conventional materials and production techniques. The mix proportioning for mixes are given below.

Table7. Mix proportion

S.No	Water	Cement	Fine aggregate	Coarse aggregate
1	191.6	383	516	1226
2	0.5	1	1.35	3.2

The mix proportion becomes 1:1.35:3.20.

VI. EXPERIMENTAL PROCEDURE

The physical properties of all constituent materials should be tested before starting the work. It is very important to find out the specific gravity of materials. The test should be made by the relevant code practices. The fresh concrete was subjected to the slump and compaction factor tests followed by casting of concrete in mould for the further investigation. All mixes were prepared by mixing the concrete in laboratory mixer along with water. For compressive strength 90NOS cube specimens of size 150 mm x 150 mm x 150 mm, were prepared. Moulds are removed after 24 hours of casting and cured in water up to the date of testing. The cubes are analyzed after their curing periods.

VII. **Result and analysis:** In the present investigation, compression test strengths were carried out on conventional concrete and fly ash, quarry dust concrete of M30 grades.

a) Compressive strength: Compressive strength test of conventional concrete and fly ash and quarry dust for 7, 14 and 28 days are shown in tables and in bar charts.

Compressive strength tests of conventional concrete as well as replacement of cement by fly ash, replacement of sand by quarry dust and replacement of cement and sand by fly ash and quarry dust respectively were conducted and the test results are presented in Tables

Table8. Compressive strength of normal concrete

S.No	No of days	Initial crack (KN)	Compressive strength
1	7	326.55	26.5
2	14	556.62	32.6
3	28	599.62	39

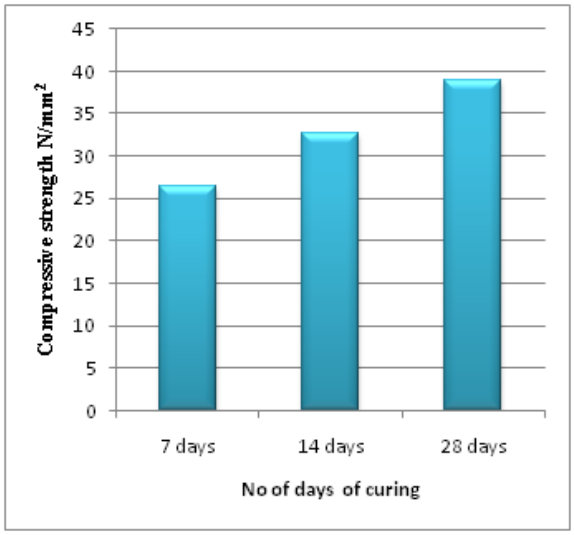

Fig1. Comparison of compressive strength for normal concrete

Table9. Compressive strength of partial replacement of fly ash cubes at various days of curing

S.No	Partial replacement of fly ash in %	Compressive strength (N/mm^2) 7 days	14 days	28 days
1	20	25.49	28.48	35.37
2	30	26.29	29.22	36.28
3	40	26.68	31.58	37.16
4	50	25.66	30.26	35.61
5	60	24.24	27.71	34.15

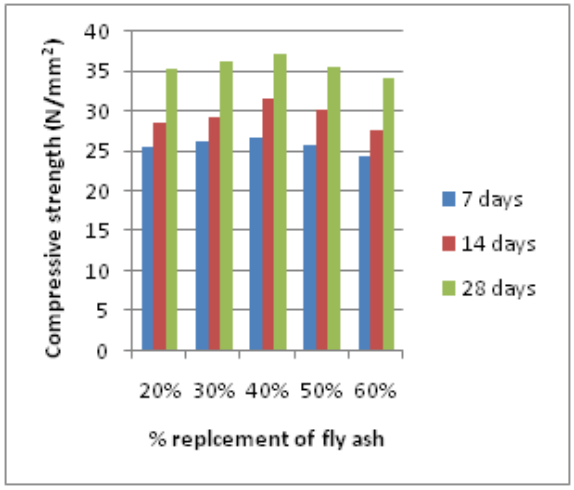

Fig2. Compressive strength of partial replacement of fly ash cubes at various days of curing

Table10. Compressive strength of partial replacement of quarry dust cubes at various curing days

S.No	Partial replacement of quarry dust in %	Compressive strength (N/mm^2)		
		7 days	14 days	28 days
1	20	24	26.77	32.26
2	30	24.36	27.33	32.89
3	40	25.14	29.39	33.9
4	50	23.56	25.29	32.56
5	60	23.33	26.39	31.73

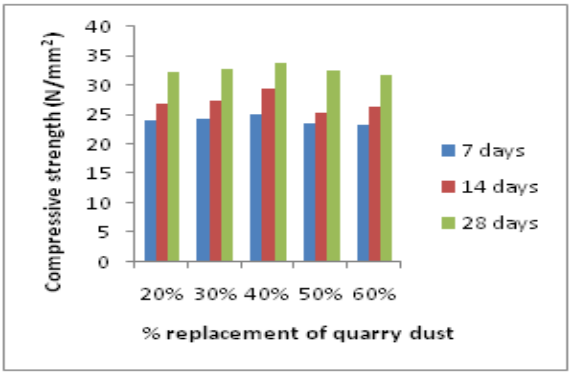

Fig3. Compressive strength of partial replacement of quarry dust cubes at various curing days**.**

Table 11. Compressive strength of partial replacement of both fly ash and quarry dust cubes at various curing days

S.No	Partial replacement of fly ash and quarry dust in %	Compressive strength (N/mm^2)		
		7 days	14 days	28 days
1	20	26.73	34.43	42.3
2	30	27.26	35.26	43.03
3	40	29.68	36.56	43.62
4	50	26.35	34.29	42.8
5	60	25.45	32.7	41.84

Overall comparison of compressive strength of concrete cubes at various days of curing

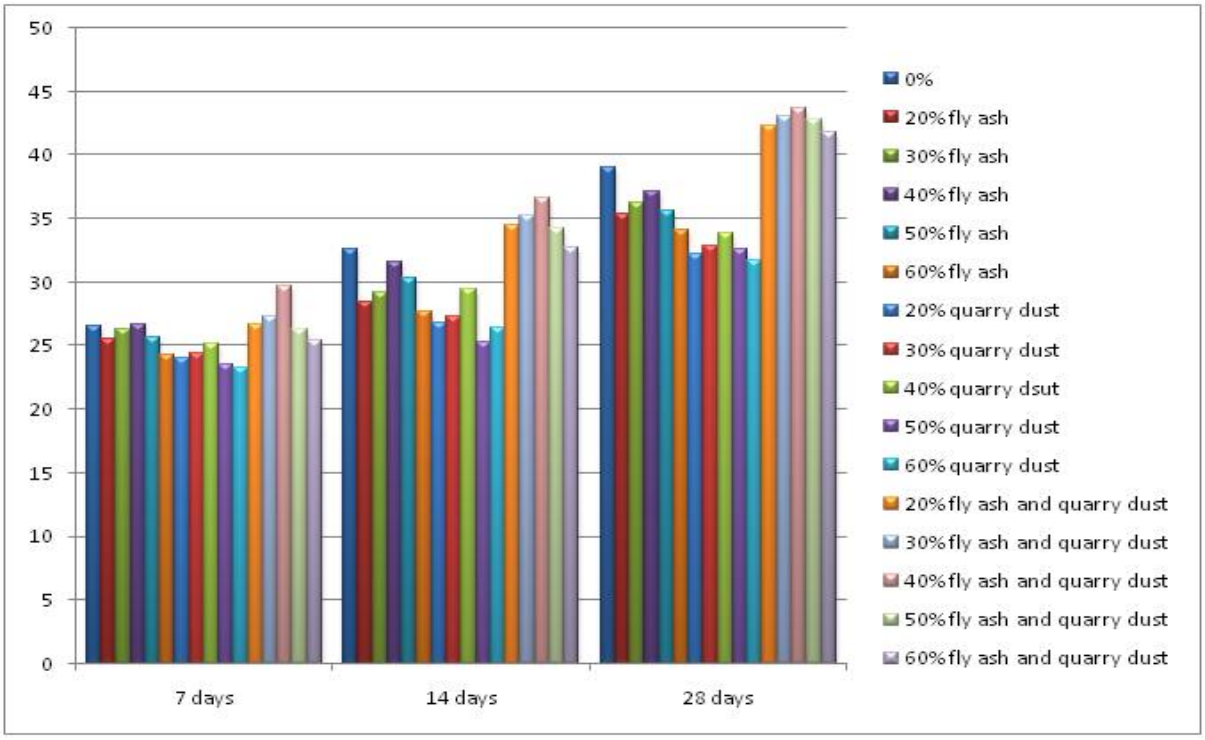

Fig4. Compressive strength of partial replacement of both fly ash and quarry dust cubes at various curing days

VIII. Conclusion

Comparing the various percentages on partial replacement of cement by fly ash and sand by quarry dust as 20%, 30%, 40%, 50% and 60% presented in the experimental work it can be concluded that 40% replacement of fly ash and quarry dust produces higher compressive strength to other replacement at 28 days. Therefore, it can be concluded that 40% replacement of cement by fly ash and quarry dust is encouraging and acceptable.

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