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Experimental Analysis on Mechanical Properties of Concrete Made by demolished Concrete Aggregate and Quarry Dust

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ABSTRACT: Concrete has been the most preferred composite material in construction Industry from long ago. The preparation of concrete entails enormous quantity of natural aggregates. The use of natural aggregates is burden for the environment. It is essential to conserve natural resources and protect the environment. To achieve this, Demolished Concrete Aggregate, quarry dust were used to manufacture concrete. Use of Demolished concrete aggregate and Quarry dust can reduce the disposal will conserve the natural aggregate. In concrete the fine aggregates (sand) is also play important role because it is used to fill the voids in the coarse aggregate and to act as a workability agent. This study presents the findings from experimental work under taken to evaluate the suitability of quarry dust as partial replacement for sand or fine aggregates and demolished concrete aggregate for coarse aggregate. In present study conventional concrete was compared with the various mechanical properties of concrete made by replaced resources. The ingredients were replaced in the interval of 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%. At 60% replacement level of coarse aggregate by demolished concrete aggregate and fine aggregate by quarry dust found highest compressive strength, split tensile strength.

Keywords: Demolished concrete aggregate, quarry dust, compressive strength, sand.

1. INTRODUCTION

Concrete is the most widely used construction material. It is difficult to point out another material of construction which is versatile as concrete. It is the material of choice were strength, durability, impermeability, fire resistance and abrasion resistance are required. It is closely associated now with very human activity that it touches every human being in his day to day living. Cement concrete is one of the seemingly simple but actually complex materials. The behavior of concrete with respect to long term drying shrinkage, creep, fatigue, morphology of gel structure, bond, fracture mechanism and polymer modified concrete, fibrous concrete are some of the active research in order to have a deeper understanding of the complex behavior of these material. Strength of concrete is relatively defined according to the present technology, requirement and geographical basis. Behavior of concrete is obtained from four strength related parameters namely compressive strength, modulus of elasticity, creep and shrinkage. Concrete has been the most preferred construction material for over five decades. It is being increasingly used day by day all over the world due to its versatility, mouldability, high compressive strength and many more advantages. Fine aggregate and Coarse aggregate are filler ingredients in the concrete and till now there have been no substitute materials available which are cheaper than these materials. The only material that is relatively costly in concrete is cement.

2. MATERIALS AND METHODOLGY

Demolished concrete aggregate, Quarry dust, Fine aggregate, Coarse aggregate, Cement and Water were used for the experimental analysis of this study.

2.1 Cement

Portland cement (OPC) is the most common type of cement in general use around the world because it is a basic ingredient of concrete, mortar, stucco and most non-specialty grout. In present study OPC 43 grade cement were used. The tests were conducted on cement according IS 1890-1970.

Table 1: Physical properties of Cement

Test conducted	Results obtained	Specification as per IS 1890-1970
Fineness	3%	Should not exceed 10%
Setting time of cement		
1. Initial	68 min	Not less than 10 min
2. Final	252 min	Not more than 10 hour
Standard consistency	38%	------
Soundness	1mm	<10mm
Specific gravity	2.85	------

2.2 Fine aggregate

Locally available clean river sand collected from Netravathi River near Uppinangady was sieved, analyzed and tests were carried out. The collected sand sample was not containing any salt content, organic matters and it was available 65 KM way from the sea. The seasonal extraction of river sand from bed is carried in coastal Karnataka. The tests are carried as par the Indian standard IS 2386-1963. The tests results were compared with the standard values.

Table 2: Physical properties of Fine aggregate

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Test conducted	Results obtained	Specification as per IS 383 - 1970
Specific gravity	2.65	2.6-2.7
Bulking	22%	<40%
Surface moisture	0.2%	<0.4%
Water absorption	0.68%	----
Zone	III	----
Percentage of voids 1. Loose state 2. Dense state	 38.62% 29.23%	----
Density 1. Loose state 2. Dense state	 1.455gm/cc 1.684gm/cc	-----

2.3 Coarse aggregate

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The coarse arrogate were collected from Local Quarry. The tests are carried as par the Indian standard IS 2386-1963. The tests results were compared with the standard values.

Table 3: Physical properties of Coarse aggregate

Test conducted	Results obtained	Specification as per IS 383 - 1970
Specific gravity	2.68	2.6-2.7
Fineness modulus	7.1	
Surface moisture	0.54%	<0.4%
Water absorption	0.58%	----
Percentage of voids 1. Loose state 2. Dense state	 48.32% 40.23%	----
Density 1. Loose state 2. Dense state	 1.355gm/cc 1.584gm/cc	-----

2.4 Quarry Dust

Quarry dust is a byproduct from the granite crushing process in quarrying activities. The quarry dust was collected from the aggregate crushing unit nearby laboratory (Kabaka)

Table 4: Physical properties of Quarry dust

Test conducted	Results obtained
Specific gravity	2.65
Fineness modulus	4.1
Water absorption	3.2%
Density 1. Loose state 2. Dense state	 1.655gm/cc 1.984gm/cc

2.5 Demolished concrete aggregate

Demolished concrete aggregates are collected from demolished structure i.e, Mayura Cinema Theater at Puttur. The waste concrete were crushed into 20mm size aggregates and tested for various parameters according to Indian standard.

Table 5: Physical properties of demolished concrete aggregate

Test conducted	Results obtained
Specific gravity	2.61
Fineness modulus	7.82
Surface moisture	1.2%
Water absorption	6.2%
Percentage of voids 5. Loose state 6. Dense state	 50.35% 43.43%
Density 7. Loose state 8. Dense state	 1.155gm/cc 1.384gm/cc

2.6 Water

Clean potable water was used for mixing and curing of concrete. Used water not contained any impurities or does not effect to the concrete.

3. MIX PROPRTION FOR CONCRETE

For the present work, concrete of M20 grade is adopted and the mix proportions of demolished concrete aggregate with quarry dust was obtained as per IS method out lined in IS 10262:2009.

Table 6: Amount aggregate replaced in concrete for m3 of concrete

Replacement level in %	Coarse aggregate by demolished concrete aggregate (kg)	Fine aggregate by Quarry dust (kg)
10	112.56	72.055
20	225.6	144.11
30	337.68	216.165
40	450.24	288.22
50	562.8	360.275
60	675.36	432.33
70	787.92	504.385
80	900.48	576.44

4. RESULTS AND DISCUSSION

Present experimental investigation consists of compressive strength test, splitting tensile test and flexural strength test on the M20 grade concrete specimens, carried out to determine the strength of demolished concrete aggregate and quarry dust concrete at different replacement levels. The tests were

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conducted as per the standard specifications i.e., minimum three specimens were tested for each test and the average value is tabulated.

4.1 Compressive strength

Compressive strength of concrete is determined as per IS: 516 – 1959: The compressive strength of concrete i.e., ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in uniaxial compression, under a given rate of loading. To avoid large variation in the results of compression test, a great care is taken during the casting of the test specimens and loading as well. It is however realized that in an actual structure, the concrete at any point is in a complex stress condition and not in uniaxial compression.

Figure 1: Casted specimens for compressive strength

Table 7: Compressive strength of concrete at 0% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	19.71
2	14	23.94
3	28	28.16

Graph 1: Variation of compressive strength with curing days at 0% replacement level

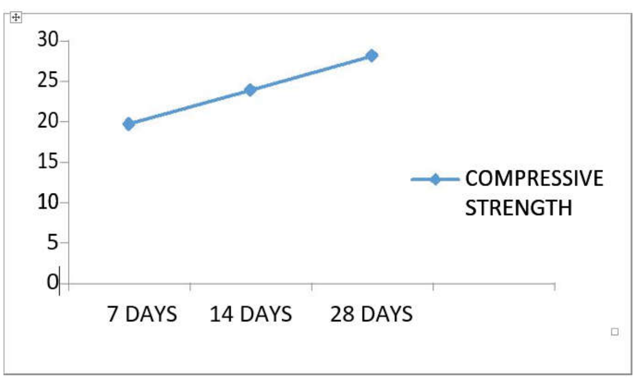

Table 8: Compressive strength of concrete at 10% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	22.14
2	14	23.56
3	28	28.56

Graph 2: Variation of compressive strength with curing days at 10% replacement level

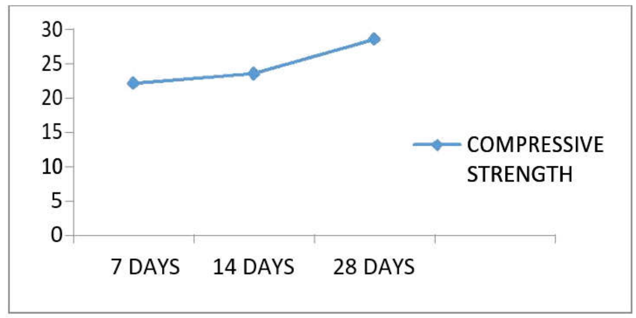

Table 9: Compressive strength of concrete at20% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	22.85
2	14	24.29
3	28	29.09

Graph 3: Variation of compressive strength with curing days at 20% replacement level

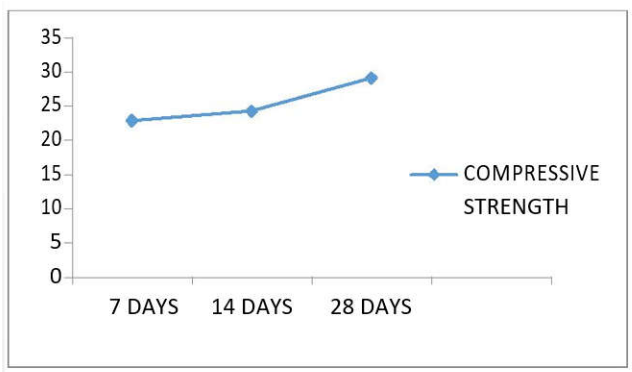

Table 10: Compressive strength of concrete at 30% Replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	23.98
2	14	26.21
3	28	29.31

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Graph 4: Variation of compressive strength with curing days at 30% replacement level

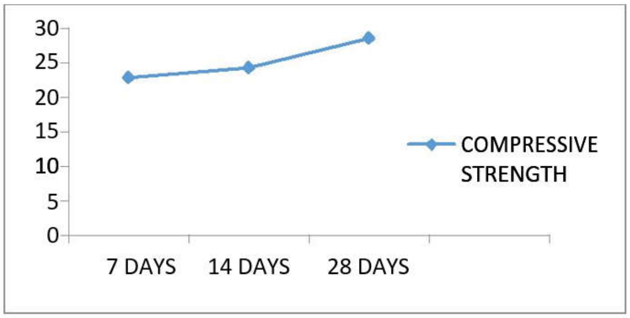

Table 11: Compressive strength of concrete at 40% Replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	25.05
2	14	27.85
3	28	29.98

Graph 5: Variation of compressive strength with curing days at 40% replacement level

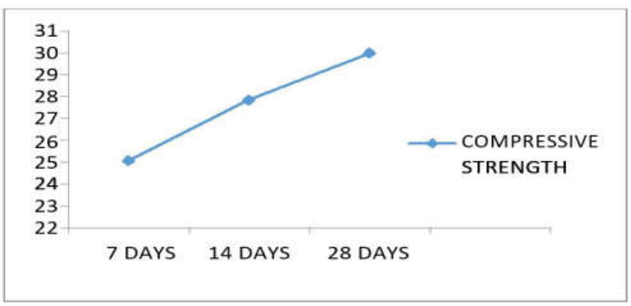

Table 12: Compressive strength of concrete at 50% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	28.70
2	14	31.33
3	28	34.92

Graph 6: Variation of compressive strength with curing days at 50% replacement level

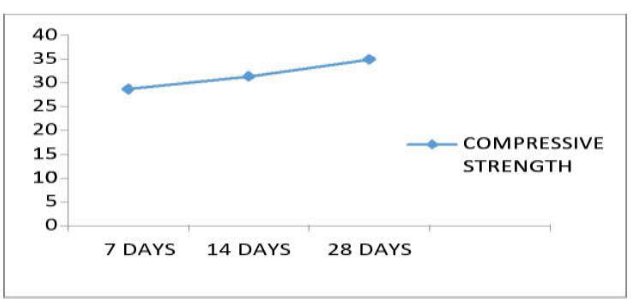

Table 13: Compressive strength of concrete at 60% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	29.00
2	14	32.17
3	28	36.92

Graph 7: Variation of compressive strength with curing days at 60% replacement level

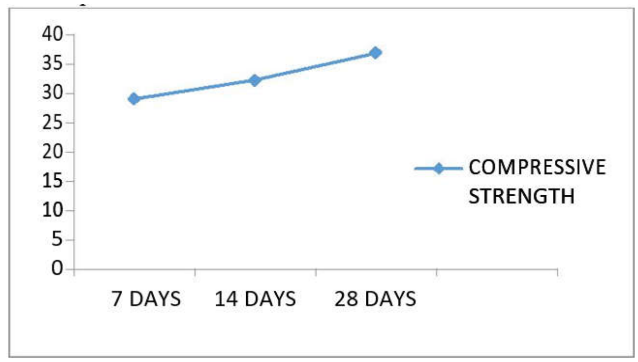

Table 14: Compressive strength of concrete at 70% Replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	27.50
2	14	35.10
3	28	32.94

Graph 8: Variation of compressive strength with curing days at 70% replacement level

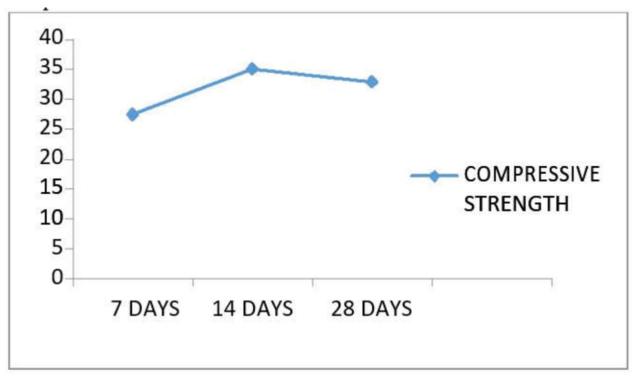

Table 15: Compressive strength of concrete at 80% Replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	26.83
2	14	30.26
3	28	31.54

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Graph 9: Variation of compressive strength with curing days at 80% replacement level

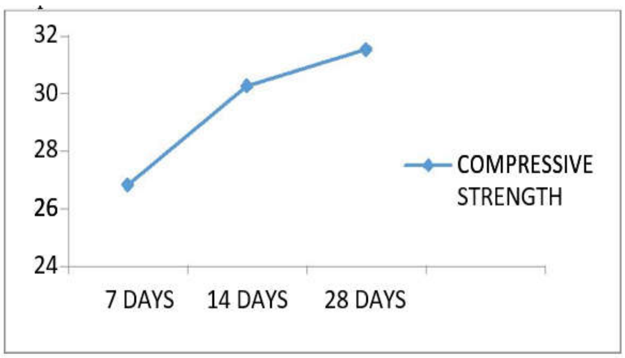


Table 16: Compressive strength of concrete at 90% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	27.24
2	14	29.12
3	28	30.06

Graph 10: Variation of compressive strength with curing days at 90% replacement level

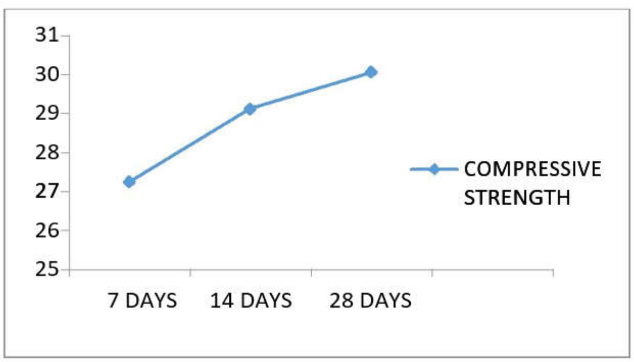
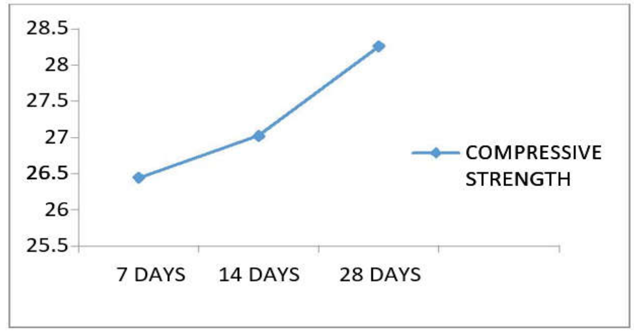


Table 17: Compressive strength of concrete at 100% replacement

S.NO	Curing Period (Days)	Compressive strength(N/mm^2)
1	7	26.44
2	14	27.02
3	28	28.26

Graph 11: Variation of compressive strength with curing days at 100% replacement level



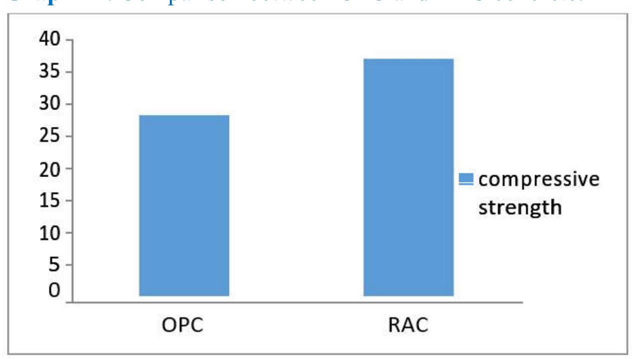
In replacement level from 10% to 100% maximum compressive strength obtained at 60%. Hence Comparison of compressive strength between conventional concrete and 60% replaced aggregate concrete at 28 days curing period was taken.

4.2 Comparison of Compressive Strength

Table 18: Comparison of compressive strength

S.NO	Parameters	Compressive strength(N/mm^2)
1	OPC concrete	28.16
2	Replaced Aggregate Concrete (RAC) at 60%	36.92

Graph 12: Comparison between OPC and RAC concrete.



4.3 Split Tensile strength

The split tensile strength of concrete was determined to know the tensile property of concrete. A cylinder was casted of diameter 150mm and 300mm length and tested in Universal Testing Machine. The Comparison between conventional concrete and replaced aggregate was also determined.

Table 19: Split tensile strength of concrete at 0% replacement

S.NO	Curing Period (Days)	Spilt tensile strength(N/mm^2)
1	7	1.75
2	14	2.12
3	28	2.50

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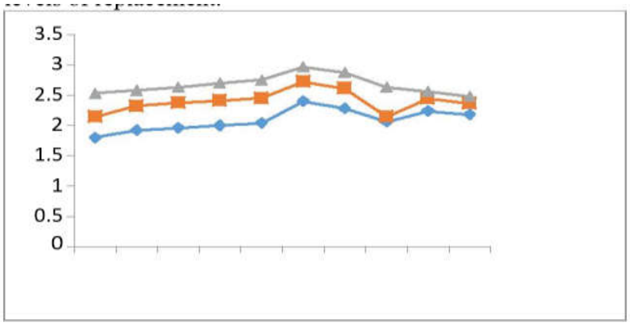
Table 20: Split tensile strength of concrete at different levels of replacement.

S.NO	Replacement level (%)	Spilt tensile strength(N/mm^2)		
		7 Days	14 Days	28 Days
1	10	1.80	2.14	2.53
2	20	1.92	2.32	2.58
3	30	1.96	2.37	2.63
4	40	2.00	2.41	2.70
5	50	2.04	2.45	2.75
6	60	2.40	2.72	2.96
7	70	2.28	2.61	2.87
8	80	2.06	2.14	2.63
9	90	2.24	2.44	2.56
10	100	2.18	2.36	2.48

Graph 13: Variation of split tensile strength at different intervals.



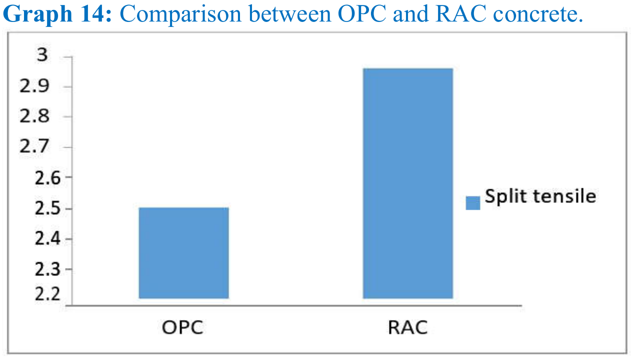
4.4 Comparison of Split Tensile Strength

Comparison of Split tensile strength between conventional concrete and 60% replaced aggregate concrete at 28 days curing period was taken.

Table 21: Comparison of compressive strength.

S.NO	Parameters	Spilt tensile strength (N/mm^2)
1	OPC concrete	2.50
2	Replaced Aggregate Concrete (RAC) at 60%	2.96

Graph 14: Comparison between OPC and RAC concrete.



5. CONCLUSION

Based on the limited study carried out on strength parameters of OPC concrete and Replaced aggregate concrete, the following conclusions are drawn:

i. From the experimental program it can be concluded that overall strength parameter of Replaced aggregate concrete as compared to OPC concrete is more.

ii. There will be 60% reduction in the quantity of coarse aggregate in concrete, which helps to conserve the natural resources.

iii. There will be 60% reduction in the quantity of fine aggregate in concrete, which helps to conserve the natural resources.

iv. The use of Replaced Concrete Aggregate in concrete reduces the disposal problems and reduces the bad impact on the environment.

v. The use of quarry dust in concrete will increases the complete utilization of dust in civil engineering field.

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