Compression and Split Tensile Strength of Concrete Containing Different Aggregates

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***Abstract*- The paper represents the study of the compressive and tensile split strength of concrete with different aggregate which are compare with conventional concrete. Strength of concrete for the various combinations studied for the four proportions. From the study it observed that, in case of compressive strength of concrete for Cement, Artificial sand, Stone crushed aggregate (CAS), Cement, Natural sand, Recycled aggregate (CNR), Cement, Artificial sand-Recycled aggregate (CAR) reduced by 1.09%, 5.16% & 8.56% respectively in comparison with Cement, Natural sand, Stone crushed aggregate (CNS). In case of tensile split strength test reduction in strength for Cement, Artificial sand, Stone crushed aggregate (CAS), Cement, Natural sand, Recycled aggregate (CNR), Cement, Artificial sand-Recycled aggregate (CAR) by 2.89%, 4.80% & 7.05% respectively in comparison with CNS. It's observed that there is consistent decrease in the strength of plain cement concrete of CAS, CNR & CAR compare with CNS.**

Keywords- Artificial sand, recycled aggregate, compressive strength, split tensile strength.

I. INTRODUCTION

A. General

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce.

This report presents the feasibility of the usage of artificial sand & recycled aggregate as hundred percent substitutes for conventional concrete. Conventional concrete contains stone crushed aggregate. Tests were conducted on cubes and cylinders to study the compressive & tensile split strengths of concrete made of four combinations with artificial sand & recycled aggregate. Studies were done for CNR, CAR, CAR and compared with the conventional Concrete i.e. CNS.

B. Objectives

1) To provide background information on use of artificial sands and recycled aggregates in concrete by full replacement and mix design processes.
2) To assess existing concrete produced using artificial sand and recycled aggregate.
3) To draw conclusions and give recommendations based on the research findings and indicate areas for further study.
4) During the past 10-15 years it has become evident that the availability of good-quality natural sand is decreasing.
5) For the aggregate producer, less waste material will be produced and high value sand will increase sales potential.
6) To study the influence of artificial sands and recycled aggregate on the compressive and tensile split strength of concrete and compare the result with that of concrete produced using selected river sand and stone crushed aggregate.

II. LITERATURE REVIEW

A comprehensive literature review is made to understand the previous efforts, which include the review of textbooks, periodicals and academic journals, seminars, conference and research papers. A study on the effect of size of aggregate on the strength and sorptivity characteristics of cinder based light weight concrete. The largest maximum size of aggregate possible to handle could be used in concrete under a given set of conditions. There are benefits of choosing a correct maximum size of aggregate. Variation in the size of aggregate alters the micro cracking of concrete which there by modifies the strength and durability as well studied by researchers Rathish Kumar P. and Krishna Rao M. V. [1]. Experimental Investigation on concrete with different waste stone as a aggregate studied by G. Murali, R. Saravanakumar, C. Balaji,

R. Muthuraman, V. SreeKavitha & S. Archana. Advancements in technology get better not only human comforts but also harm the environment. Use of waste stone as aggregate in construction industry has become popular and safe [2]. Effect of aggregate type on Compressive strength of concrete studied by Abdullahi M. [4]. The utilization of three types of aggregate for concrete work is investigated in that paper. Normal concrete is being produced from different types of aggregate and that imparts different property to the resulting concrete. The most important property of concrete is its compressive strength. The use of quarry rock dust as a fine aggregate in concrete draws serious attention of researchers and investigators studied by S. B. Kandekar, A. J. Mehetre, and V.A. Auti [9]. Quarry rock dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated elements. From all above study conclude that concrete with different combinations also gives satisfactory strength. Conventional concrete not single options know a days.

III. MATERIALS AND METHODOLOGY

A. *Materials*

Assessment is made on the existing mix design methods as per IS10262-2009[10]. Tests conducted on cement, natural sand, artificial sand, stone crushed aggregate and recycled aggregate IS383:1970 [11]. Test results of concrete produced using Cement, Natural sand, Stone crushed aggregate (CNS), Cement, Natural sand, Recycled aggregate (CNR), Cement, Artificial sand, Stone crushed aggregate (CAS) and Cement, Artificial sand-Recycled aggregate (CAR) are studied. These concreting tested for compressive & tensile split strength. Firstly testing on materials was made. Testing preferred for cement such as consistency test, initial setting time and final setting time and fineness test. Testing for both fine aggregate and coarse aggregate water absorption test, sieve analysis and impact value. Test done for concrete was slump test. As per mix of nine cubes for each proportion was casted. These cubes tested for 3 days, 7 days & 28 days tests strength.

B. *Mix praportions*

Concrete of M_{20} grade used for whole casting work. Mix proportions were different for all combinations as per mix designed by IS 10262-2009 [10]. The proportions used Cement-Natural sand-Stone crushed aggregate (CNS- 1:1.87:2.95), Cement-Natural sand-Recycled aggregate (CNR- 1:1.87:2.78), Cement-Artificial sand-Stone crushed aggregate (CAS- 1:1.90:2.95) and Cement-Artificial sand-Recycled aggregate (CAR- 1:1.90:2.78). All ingredients cement, natural sand, artificial sand, stone crushed aggregates and recycled aggregate measured with digital balance. Water measured with measuring cylinder of 1 liter capacity. The fresh concrete is placed in the moulds by trowel. It is ensured that the representative volume is filled evenly in all the specimens to avoid accumulation of aggregates, segregation, etc. while placing concrete in moulds compaction is done to remove entrapped air or voids in concrete. The concrete is worked with trowel to give uniform surface. Care is taken not to add any extra cement, water or cement mortar for achieving good surface finish. The additional concrete is chopped off from the top surface of the mould for avoiding over sizes etc. Identification marks are given on the specimens by embossing over the surface after initial drying. The plain cement concrete specimens were remolded after 24 hours of casting and kept in water tank for curing. Similarly for other mixes concrete specimen were remolded after 24 hours of casting and kept in water tank for curing at 3days, 7days and 28days. The specimens were remolded after 24 hours of casting and immediately stored for curing.

IV. RESULTS AND TABLES

In the study for compression strength test done on cubes of size 150mm x 150mm x 150mm and split tensile strength test on cylinders of size 150mm diameter & 300mm height on four combinations. Test results of concrete produced using Cement-Natural sand-Stone crushed aggregate (CNS), Cement-Natural sand-Recycled aggregate (CNR), Cement-Artificial sand-Stone crushed aggregate (CAS) and Cement-Artificial sand-Recycled aggregate (CAR) were carried out. The experimental results and results discussion for various combinations described below.

A. *Compressive Strength Test*

A cube compression test performed on standard cubes for four combinations as per IS: 516–1959 [12]. The arrangement of test shown in fig. 1. Cubes tested after 3days, 7days and 28days. The results for the test are shown in Table 1. The Compressive strength of the specimens was calculated by the following formula.

$$F_{cr} = P/A$$

Where,

F_{cr} = Crushing load,

P = Failure load in compression (kN),

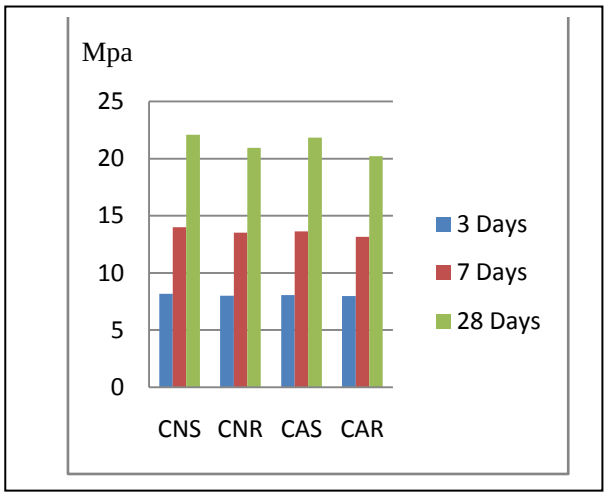
A = Loaded area of cube (mm^2).

Fig.1 Compression test

TABLE 1 TEST RESULTS FOR COMPRESSIVE TEST

Specimen	*Sr.No.*	*3 days Strength (Mpa)*	*7 days Strength (Mpa)*	*28 days Strength (Mpa)*
CNS	1	8.27	13.96	22.13
	2	8.09	14.04	22.04
	3	8.18	14.00	22.09
	Avg.	8.18	14.00	22.09
CNR	1	8.00	13.51	20.97
	2	8.09	13.47	20.84
	3	7.91	13.56	21.02
	Avg.	8.00	13.51	20.95
CAS	1	8.04	13.60	21.86
	2	8.13	13.69	21.78
	3	8.00	13.64	21.91
	Avg.	8.06	13.64	21.85
CAR	1	7.95	13.06	20.22
	2	8.04	13.24	20.13
	3	7.91	13.20	20.27
	Avg.	7.97	13.17	20.20

As shown in table 1 the results CNS gives comparatively high. The strength of CAS, CNR & CAR lower than CNS. In compression strength of concrete for CAS, CNR & CAR reduced by 1.09%, 5.16% & 8.56% respectively.



Graph 1 for comparative test result for compressive test days Vs strength (Mpa)

B. Split Tensile strength test`

The split tensile strength at which failure occurs is the tensile strength of concrete. In this Investigation the test is carried out on cylinder by splitting along its middle plane parallel to the edges by applying the compressive load to opposite edges as per IS: 516-1959 [12]. The arrangement for the test is as shown in fig. 2. The split tensile strength of cylinder is calculated by the following formula. Experimental test results are shown in Table 2.

$$F_t = 2P/3.14DL$$

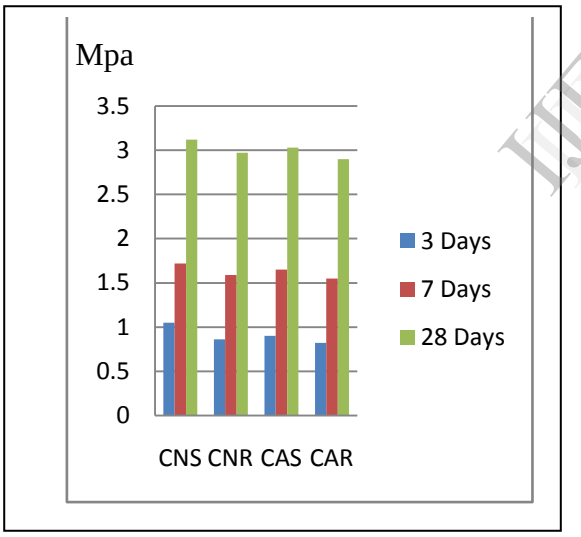
Where,

F_t = Split tensile strength (N/mm^2),
P = Load at Failure (N),
L = Length of Cylinder (mm),
D = Diameter of cylinder (mm).

Fig. 2 Split Tensile test

TABLE 2 TEST RESULTS FOR SPLIT TENSILE TEST

Specimen	*Sr.No.*	*3 days Strength (Mpa)*	*7 days Strength (Mpa)*	*28 days Strength (Mpa)*
CNS	1	1.05	1.73	3.13
	2	1.08	1.69	3.15
	3	1.02	1.74	3.09
	Avg.	1.05	1.72	3.12
CNR	1	0.89	1.61	2.97
	2	0.85	1.59	2.98
	3	0.84	1.56	2.96
	Avg.	0.86	1.59	2.97
CAS	1	0.90	1.67	3.01
	2	0.88	1.61	3.07
	3	0.92	1.66	3.00
	Avg.	0.90	1.65	3.03
CAR	1	0.82	1.54	2.89
	2	0.85	1.60	2.93
	3	0.80	1.51	2.87
	Avg.	0.82	1.55	2.90



Graph 2 for comparative test result for split tensile test days Vs strength (Mpa).

For tensile split strength test reduction in strength for CAS, CNR & CAR by 2.89%, 4.80% & 7.05% respectively in comparison with CNS. The recycled materials used in construction work should free from dust and other impurities. Recycled concrete aggregate gives low strength as compare to other combinations.

V. CONCLUSION

A. *General*

From the above comparative study conducted on concrete with full replacement of artificial sand & recycled aggregate. These four mix proportions shows variations in the compressive and tensile split strength.

From the above study following conclusions drawn

1) It's observed that there is consistent decrease in the strength of plain cement concrete of CAS, CNR & CAR compare with CNS.
2) The cost of artificial sand is in the range of 45% to 75% to that natural sand. In that considering cost of screening, washing & wastage due to oversize particles of natural sand.
3) The use of artificial sand in construction industry helps to prevent unnecessary damage to environment and provide optimum development to environment of natural resources.
4) The acute shortage of river sand, huge short coming on quality of river sand, high cost, greater impact on road damages and environmental effects.
5) Artificial sand concrete will be about 15% to 25% cheaper than that of natural sand concrete.
6) The Local Authorities/PWD/ Government shall encourage the use of artificial sand in Public Construction Works.
7) The Government shall come out with, policy on sand encourage the industry people to set up more number of sand crushing units across the all districts, states to meet the sand requirements of the construction industry.
8) The use of recycled aggregate by partial replacement in construction industry tends to prevent environment.
9) The uses of recycled aggregate reduce environmental problems and minimize the requirement of land.
10) It's observed that recycled aggregate concrete reduced strength by full replacement. It can give satisfactory strength by partial replacement by stone crushed aggregate.

B. *Scope for future work*

1) Maximum attempt of mix combinations with varying percentage replacement is made to maintain economy, strength and serviceability of concrete.

2) Checking the strength of concrete by adding steel fibers with different percentage in the same work.

3) Checking the strength of concrete by adding fly ash, silicon fumes in same work.

4) Study of resistance to chemical attack on the CNS, CNR, CAS & CAR combinations and compare results.

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