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Effect of Aggregate Types on Flexural Strength of Concrete

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Abstract- The paper represents the study of the flexural strength of concrete with different aggregate which are compare with conventional concrete. Flexural strength of plain cement concrete for the various combinations studied for the four proportions. From the study it observed that, in case of flexural strength of plain cement concrete for Cement, Artificial sand, Stone crushed aggregate (CAS), Cement, Natural sand, Recycled aggregate (CNR), Cement, Artificial sand-Recycled aggregate (CAR) reduced by 4.65%, 13.56% & 14.15% respectively in comparison with Cement, Natural sand, Stone crushed aggregate (CNS). It's observed that there is consistent decrease in the flexural strength of plain cement concrete of CAS, CNR & CAR compare with CNS.

Keywords- Artificial sand, natural sand, stone crushed aggregate, cement, recycled aggregate, flexural strength

I. INTRODUCTION

A. General

The choice of aggregates is important, their quality plays a great role, they can not only limit the strength of concrete but owing to their characteristics, they affect the durability and performance of concrete. Concrete is considered to be the most widely used and versatile material of construction all over the world. In recent years, concrete technology has made significant advances which have resulted in economical improvements in strength of concretes. This economical development depends upon the intelligent use of locally available materials. One of the important ingredients of conventional concrete is natural sand or river sand, which is expensive and scarce. Generally, sands and natural gravels obtained by screening or sometimes through crushing are satisfactory, as the igneous rocks or those sedimentary crushed ones. We cannot consider the structures without concrete. Concrete is a main constituent of the Civil Engineering structures. It is becoming the backbone of infrastructural development of whole world. Concrete has capacity to enhance its properties with the help of other suitable constituents.

The bond between cement paste and aggregate depends largely on the interface zone characteristics. The cement-aggregate bond results from some combination of mechanical interlocking of cement hydration products with the aggregate surface and chemical reaction between aggregate and cement paste. Recycling material is a key solution in achieving sustainability that will enable the earth to continue to support human life. The potential use of recycled materials in construction has been explored previously. Several recycled materials were used in concrete for the purpose of improving the quality of concrete in terms of its performance under loads.

The main disadvantages of concrete are as follows -

- Brittleness
- Plastic and drying shrinkage
- Very low tensile strength
- Heavy mass (density)
- Less resistance to cracking
- Permeability and bleeding of water

This paper 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 beams to study the flexural 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. Aims of the study

1) During the past 10-15 years it has become evident that the availability of good-quality natural sand is decreasing.

2) To provide background information on use of artificial sands and recycled aggregates in plain cement concrete.

3) To draw conclusions and give recommendations based on the research findings and indicate areas for further study.

4) To assess existing concrete produced using artificial sand and recycled aggregate.

5) To study the influence of artificial sands and recycled aggregate on the flexural strength of concrete and compare the result with that of concrete produced using selected river sand and stone crushed aggregate.

II. LITERATURE REVIEW

A literature review is made to understand the previous efforts, which include the review of journals, seminars, conference and research papers textbooks, periodicals and academic. 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 [6]. 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. These studied by Kanawade Bhimaji Dashrath, Prof. Kulkarni V.P., Prof. Kandekar S.B., Prof. Mehetre A.J. in Compressive and split tensile strength of concrete containing different aggregate.[3] 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. [5]. 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 IS 383:1970 [11]. Concrete mix design is defined as the appropriate selection and proportioning of constituents to produce a concrete with predefined characteristics in the fresh and hardened states. In general, concrete mixes are designed in order to achieve a defined workability, strength and durability.

The selection and proportioning of materials depend on:

i. The structural requirements of the concrete,
ii. The environment to which the structure will be exposed,
iii. The job site conditions, especially the methods of concrete production, transport, placement, compaction and finishing,
iv. The characteristics of the available raw materials.

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 flexural 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. 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 one 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. 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

The test program consists of casting and testing of six beams for each combination. For the total four combinations casting of twenty four beams. These casted beams tested for 7 days and 28 days after the curing.

A. Flexural Strength Test

Flexural strength calculated by the formula

$$F_{bt} = PL/bd^2$$

Where

F_{bt} = Flexural strength
P = Failure point load,
b = Width of beam,
d = depth of beam

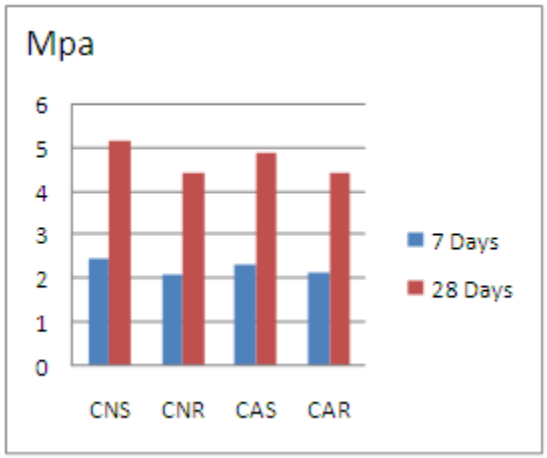
Test results of concrete produced using Cement-Natural sand-Stone crushed aggregate (CNS), Cement-Natural sand-Recycled aggregate (CNR), Cement-Artificial sand-Stone crushed aggregate (CAS) and Cement-Artificial sand-Recycled aggregate (CAR) were carried out. The experimental results and results discussion for various combinations described below. For flexural strength test reduction in strength for CAS, CNR & CAR by 4.65%, 13.56% & 14.15% 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.

Fig.1 Flexural test

Fig.2 Test specimen of flexural test

Table 1 Test results of flexural test

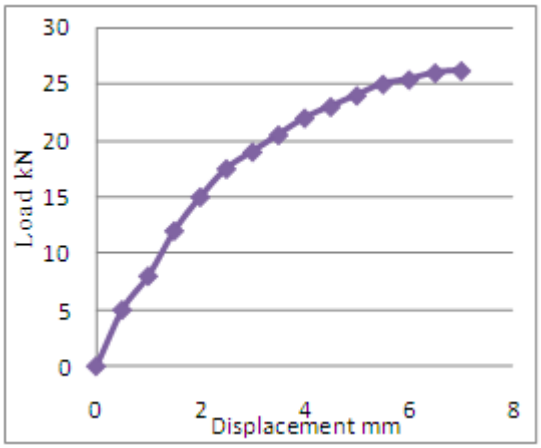
Specimen	Sr.No.	Load at Failure (kN)	7 days Strength (Mpa)	Load at Failure (kN)	28 days Strength (Mpa)
CNS	1	11.60	2.40	24.50	5.08
	2	12.20	2.53	26.20	5.43
	3	11.80	2.45	23.90	4.96
	Avg.		2.46		5.16
CNR	1	10.80	2.24	20.30	4.21
	2	9.40	1.95	21.60	4.68
	3	10.20	2.12	21.30	4.42
	Avg.		2.10		4.43
CAS	1	11.40	2.37	22.40	4.65
	2	10.80	2.45	23.30	4.83
	3	10.60	2.20	25.40	5.27
	Avg.		2.34		4.92
CAR	1	11.30	2.34	21.40	4.44
	2	10.40	2.16	22.30	4.63
	3	9.60	1.99	20.80	4.31
	Avg.		2.16		4.46



Graph 1 Comparative results for flexural test days Vs strength (Mpa)

B. Load vs Displacement curve

For the drawing of load verses displacement curve for each combinations of beam tested under universal testing machine. In graph maximum load taken by combinations of beam is to be plotted. In that note down readings of beam load taken with displacement. Load vs Displacement curve for CNS, CNR, CAS & CAR combinations of mix proportions for maximum load shown as follows-



Graph 2 Load Vs Displacement curve for CNS

V. CONCLUSION

A. General

From the above comparative study conducted on concrete for flexural test with full replacement of natural sand and stone crushed aggregate by artificial sand & recycled aggregate.

The methods followed to achieve the objectives are-

a) Assessment is made on the existing mix design methods and test results of concrete. Produced using CNS, CNR, CAS & CAR combinations.

b) The results were presented in graphical form and interpretation and discussion were made on the research findings.

c) Based on the findings conclusions are drawn and recommendations are forwarded.

These four mix proportions shows variations in the results of flexural test.

From the above study following conclusions drawn

1) It's observed that there is consistent decrease in the flexural strength of plain cement concrete of CAS, CNR & CAR compare with CNS.

2) The use of artificial sand in construction industry helps to prevent unnecessary damage to environment and provide optimum development to environment of natural resources.

3) 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.

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.

B. Scope for future work

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

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

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

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

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