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To Study The Effect Of Recycled Aggrigate in High Strength Concrete

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Abstract - *This research was conducted with the use of recycled aggregate as modification. In terms of the use of recycled aggregate, the percentage of recycled aggregate should be determined because the strength of concrete would not be obtained by the high percentage of recycled aggregate. So as to determine the appropriate percentage of replacement the interval of replacement is closely spaced. The scope of study is about comparison between recycle coarse aggregate and natural aggregate in terms of specific gravity, absorption. This research will compare the results of compressive and flexural strength of recycled aggregate concrete and conventional concrete by replacing recycled aggregate for 25%, 50%, 60%, 70% ,80%, 90% & 100% replacement.*

Keywords – conventional concrete, recycled aggregates, natural aggregates, compressive strength, flexural strength, workability

1.INTRODUCTION

Construction and demolition wastes are produced every day around the world. Thus the idea of using recycled concrete aggregate in new concrete production appears to be an effective utilization of concrete waste. Consumption of natural resources and also with the greatest production of waste around 900 million tons of waste per year. Landfills for C&DW are reaching their volume capacity limits and it is not allowed to store C&DW with municipal refuse. Fundamental problems of recycling are the cleanliness and quality of sources. Impurities in demolition waste for production of secondary raw materials play a main role in sense of quality of new secondary raw materials. Concrete is the most used building material in the world and aggregates constitute around 70% of its volume. Recycled aggregates could come from demolished buildings, airport runways, bridge supports, and even concrete roadbeds. Concrete that is constructed or made using this kind of aggregates is referred to as recycled aggregate concrete.

Central Pollution Control Board has estimated current quantum of solid waste generation in India to 48 million Tons per annum of which waste from Construction Industry accounts for 25%. Construction waste is bulky, heavy and is mostly unsuitable for disposal by incineration or composting. The growing population in the country and requirement of land for other uses has reduced the availability of land for waste disposal. Re-utilization or recycling is an important strategy for management of such waste. Above all, the fast depleting reserves of conventional natural aggregate has necessitated the use of recycling/ re-use technology in order to be able to conserve the conventional natural aggregate for other important works. Apart from mounting problems of waste management, other reasons which support adoption of reuse/ recycling strategy are reduced extraction of raw materials, reduced transportation cost, reduced capital investment on raw materials, improved profits and reduced environmental impact.

This research mainly emphasizes on the determination of the optimum strength of concrete in fresh and hardened states. Therefore, this research is focused on the effectiveness of using recycled aggregates as a replacement for common aggregates to produce a concrete structure as there is a lack of research done in regards to the properties of recycled concrete mix designs for high strength. The use of RCA for the production of concrete involves breaking, removing, and crushing existing concrete into a material with specified size and quality. Recycling concrete is important because it helps to promote sustainable development by protecting natural resources and reducing the disposal of demolition waste from old concrete.

1.1 MATERIALS

Following are the materials used for the experimental work.

1.1.1 Cement

The cement used in this experimental work is 43 grades Ordinary Portland Cement. All properties of cement are tested by referring IS 12269 - 1987 Specification for 43 Grade Ordinary Portland cement. The specific gravity of the cement is 3.15. The initial and final setting times were found as 108 minutes and 222 minutes respectively. Standard consistency and strength of cement was 32% and 43.7 N/mm2.

1.1.2 Water

Potable water used for the experimentation.

1.1.3 Fine aggregate

Locally available sand passed through 4.75mm IS sieve is used. The specific gravity of 2.80 and fineness modulus of

3.895 are used as fine aggregate. The water absorption is of 4.08%.

1.1.4 Coarse Aggregate

Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 20mm having the specific gravity value of 2.78 and fineness modulus of 7.136 are used as coarse aggregate. The water absorption is of 1.95%.

1.1.5 Recycled Concrete Aggregate

The aggregates available from demolished buildings and waste concrete from precast factory has been used. The aggregate with a maximum size of 20mm having the specific gravity value of 2.54 are used as recycled aggregates. The water absorption is of 6%. Figure no 1 shows sample specimen of RCA

1.2 Physical properties of natural and recycled aggregate

Before using materials in mix design it needs to know the physical properties of natural aggregates as well as recycled concrete aggregates. For this purpose, bulk density, water absorption and specific gravity experiments were conducted. Due to some adhered mortar on aggregate possess high porosity which leads to show the results in higher percentage water absorption than natural aggregates. Specific gravity of NA is higher than RCA. And also the bulk density of RCA is lesser than NA due to angular rough surface and adhered mortar on aggregates.
The lower specific gravity of RCA is due to the presence of old cement paste/ mortar on the aggregate particles that makes it less dense than NCA because of greater porosity

Table 1 Physical properties of NA and RCA

Sr. No	Physical property	NA	RCA
1	Water Absorption (%)	1.95	6
2	Specific Gravity	2.78	2.54
3	Bulk Density (kg/m^3)	1680	1250

2. MIX DESIGN

Concrete like other engineering materials needs to be designed for properties like strength, durability, workability and cohesion. Before having any concrete mixing, the selection of mix materials and their required materials proportion must done through a process called mix design. Concrete mix design is the science of deciding relative proportions of ingredients of concrete, to achieve the desired properties in the most economical way. With advent of high-rise buildings and pre-stressed concrete, use of higher grades of concrete is becoming more common. Even the revised IS 456-2000 advocates use of higher grade of concrete for more severe conditions of exposure, for durability considerations. With advent of new generation admixtures, it is possible to achieve higher grades of concrete with high workability levels economically. Use of mineral admixtures like fly ash, slag, meta kaolin and silica fume have revolutionized the concrete technology by increasing strength and durability of concrete by many folds There are lots of methods for determine concrete mix design. In this project IS Method of Design shall be used.

Table 2 IS Method of Design for M40 Concrete

Cement	Water	Fine aggregate	Coarse aggregate
400	168	742	1361
1	0.42	1.86	3.29

Figure 1 Recycled concrete aggregates

2.1 Slump test:

The slump is taken for each mixing of concrete with 0%, 25%, 50%, 60%, 70%, 80%, 90% and 100% with 0.4w/c ratio replacement of RCA. The results show that slump of concrete made with natural aggregates is higher while the concrete with 100% replacement of RCA has less slump. The low slump in RCA is caused by the high absorption of RCA which absorbs water during the mixing process.

Table 3 Results of Slum Test

Percentage of recycled aggregates	Slump (mm)
0	90
25	93
50	75
60	73
70	70
80	69
90	65
100	65

Table 4 7 days Compressive strength of cubes

Sr. No	Percentage of RCA	Compressive strength (N/mm^2)
1	0	33.35
2	25	32.86
3	50	32.53
4	60	34.12
5	70	30.44
6	80	29.92
7	90	26.73
8	100	25.66

3. Experimental Program

3.1 compressive strength test:

The compression test is carried out according to determine the characteristic strength of the concrete. In this test, 150 mm standard cube mould is used for concrete mix. The apparatus should be clean and free from hardened concrete and superfluous water before testing. The test is carried out for each cube. The reported compressive strength is the average of 3 measurements tested at the age of 7 and 28 days. Figure no 2 shows specimen of cube tested in compression testing machine.

Based on the research result and the previous research the existence of recycled aggregate will influence the characteristic Strength. However The more recycled aggregate added will decrease the value of characteristic Strength because recycled aggregate has different characteristic, such as the ability to water Absorption. Recycled aggregate can absorb more water than natural aggregate because recycled aggregate has many pores to absorb the water and it will influence the characteristic Strength. From results it is observed that the compressive strength of concrete decreases with increasing RCA but at 60% replacement it is found that the compressive strength is similar to conventional concrete (0% replacement). This can be happened due to some unhydrated cement present on RCA which gets hydrated while new mixing and this results in attaining similar strength as of conventional concrete.

Table 5 28 days Compressive strength of cubes

Sr. No	Percentage of RCA	Compressive strength (N/mm^2)
1	0	49.35
2	25	48.55
3	50	46.32
4	60	49.10
5	70	45.50
6	80	36.97
7	90	35.16
8	100	32.05

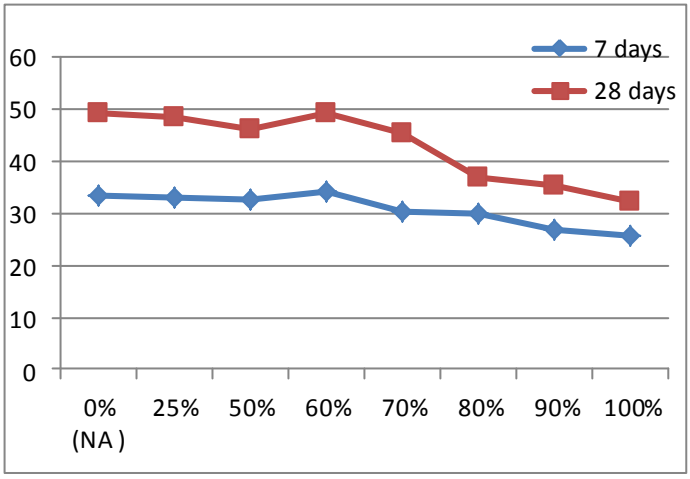

Chart 1. Compressive strength of cubes

Figure 2 Compressive strength test

3.2 Flexural strength test:

The flexural test is carried out according to determine the characteristic flexural strength of the concrete. In this test, 100 x 100 x 500 mm standard beam mould is used for concrete mix. The moulds should be clean and free from hardened concrete and superfluous water before testing. The test is carried out for each beam. The reported flexural strength is the average of 3 measurements tested at the age of 7 and 28 days. Figure no 3 shows specimen of beam tested on universal testing machine.

The flexural strength of RCA concrete is generally lower than that of NCA concrete. The flexural strength of RCA concrete is typically 0–10% lower than that of NCA concrete. RCA did not produce any significant negative impact on the flexural strength of concrete.
From results higher the percentage of RCA lower the flexural strength. But in case of 60% replacement it shows similar strength as that of for 0% replacement which may occurred due to some unhydrated cement present on RCA earlier. So this condition affects the flexural strength

Table 6 7 days Flexural strength of beams

Sr. No	Percentage of RCA	Flexural strength (N/mm²)
1	0	4.25
2	25	4.11
3	50	4.03
4	60	4.15
5	70	3.79
6	80	3.74
7	90	3.56
8	100	3.50

Table 7 28 Day Flexural strength of beams

Sr. No	Percentage of RCA	Flexural strength (N/mm²)
1	0	5.86
2	25	5.79
3	50	5.50
4	60	5.81
5	70	5.02
6	80	4.59
7	90	4.33
8	100	4.16

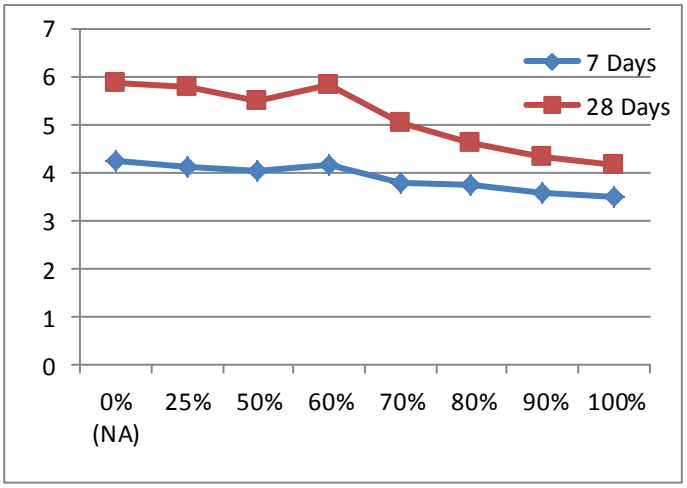

Chart 2. Flexural strength of beams

Figure 3 Flexural strength test

4. Conclusion

1. The value of Recycled Aggregate with 0% that is conventional concrete was the highest score for compressive strength, Then, on other hand using 60% of RCA gives similar compressive strength. When Recycled Aggregate was added to the mixture, the value of compressive strength, were decrease when it exceeds more than 60%. It shows lowest strength at 100% replacement. It can be concluded that the value of compressive strength will be decreased when more than 60% Recycled Aggregate was used.
2. The value of Recycled Aggregate with 0% and 60% replacement was the highest score for Flexural Strength,. Then, when Recycled Aggregate was added to the mixture, the value of Flexural Strength, were decrease. It can be concluded that the value of Flexural Strength will be decreased when Recycled Aggregate added beyond 60% , however there is no significant change in Flexural Strength test.
3. Based on the research result The decrease in compressive strength with 25% replacement is 0.88% , with 50% replacement is 3.0%, for 60% replacement it is 0.21% further for 70% replacement is 3.85%, for 80% replacement is 12.38%, for 90% replacement is 14.20%,and for 100% replacement is 17.35%
4. The percentage from Recycled coarse Aggregate that can be used in concrete is maximum 60% replacement of Recycled coarse Aggregate.

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