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Experimental Study on Concrete Cube Test for Compressive Strength by using Recycled Coarse Aggregate

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Abstract - *Compressive strength is the basic mechanical properties and one of the indicators to determine the performance of a concrete. In this paper, the effects of various percentages (25%, 50%, 75% and 100%) of Recycled Aggregate (RA) on compressive strength of Recycled Aggregate Concrete (RAC) were investigated. RA is used to replace natural aggregate (NA) as coarse aggregate in concrete mixes. This research also covered RAC mixtures at different water-cement ratio (0.65). It was found that RAC had lower compressive strength compared to Natural Aggregate Concrete (NAC). Using M20 Grade at the age of 28 days and RAC with water-cement ratio 0.65 had the highest strength.*

Key Words: Compressive strength, recycled aggregate.

1. INTRODUCTION

In Recycled Aggregate Concrete (RAC) is concrete that using Recycled Aggregate (RA) as partially or fully replacement in coarse and fine aggregate. It is believed RA have been used from 1945 in concrete producing and started when World War II damaged a large quantity of concrete structures and the high demand of aggregate to rebuild the structures. They recognized the factors like depletion of natural aggregates, tightly environmental law and waste disposal problems which influenced the application of RA. Recently Malaysia is not yet practicing RA in its construction industry. Hong Kong, Japan and China have become pioneer counties in Asia which are actively conducted study on RA application in construction industry. United Kingdom is one good example of western countries which practicing RA in its construction industry. In DOE 1996, the '1995 UK Government White Paper Making Waste Work' had targets to increase the using of waste and recycled materials as aggregates to 30 million tons per year by 2006. In UK, Construction and Demolition (C&D) waste has been identified were had value in engineering materials for construction industry and also reported that 51.1% or 27.4 million tones of (C& D) waste were disposed directly to landfill, 39.6 % or 21.2 million tons were excepting from licensed disposal and were primarily used for land modeling during the construction projects and 9.2 % or 5 million tons were either crushed to produce a graded product or directly recovered. Recycling and reuse (C&D) waste and produced as RA is expected to improve on supplying of construction material and also can solve the disposal of waste construction material RAC has attracted many researchers to study its performance. Previous researchers have conducted study on application of RA and found that RAC have lower compressive strength compared to Natural Aggregate Concrete (NAC). Concrete cubes are made in workshop to check that the strength recycled aggregate based on different curing days. The section applicable to workshop cubes are:-

CS1:1990: section 1: sampling fresh concrete on workshop.

CS1:1990: section 7: Making test cubes from Recycled concrete.

They have conducted some experimental investigations and found that RA had a potential functioning as aggregate that can be applied in concrete roads,

2. MATERIAL

Cement:-

Joseph Aspidin has invented the cement which is the most commonly used binding material in 1824. The manufacturing of cement is done with various calcareous materials like lime stone and clay and various argillaceous materials like clay and shale.

Fine Aggregates:-

As per code IS 383, if the size of the aggregates is less than 4.75 mm then it is called as fine aggregate. I.e. The aggregates going through 4.75 mm size sieve and holding on 75 micron size sieve then that type of aggregates are considered as finer aggregates. The various finer aggregates utilized in various construction activities are Sand, crushed stone ash, surkhi, cinder etc.

Recycled coarse aggregates:-

The recycled coarse aggregate contains original aggregate attached with mortar. The attached mortar is light and porous in nature. Therefore, it is obvious that the specific gravity and density of recycled aggregate are relatively less when compared to natural aggregate.

Water:-

At the time of construction activity the water is given less importance by the people. A vital role is played by the water in the construction activity. There should be no compromises in the quality of water used in construction activity. Only good quality of water should be used which is having the good ph value.

3. METHODOLOGY

The Test is conducted following ASTM C 143-90a. Meanwhile, compressive test is conducted by following BS 1881: Part 108:1983 and three cubes of 150mm x 150mm x 150mm were tested at 3, 7, 21 and 28 days.

1. Properties of various constituents of concrete viz, Cement, fine aggregates and recycled coarse aggregates were determined, by carrying out various tests.

2. Grade M20 concrete was designed as per IS: 10262 - 2009, which was used as reference mix.

3. Recycled coarse aggregate were added in 25%, 50%, 75%, and 100% by volume of Concrete.

4. Cube were casted and curing was done.

5. Compressive strength test was done.

Mix proportions for M20 grade of concrete:

1. In the designation the letter M refers to the mix& the numbered to the specified 28days cube strength of mix in N/mm^2
2. The mix of grade M20 correspond approximately to the mix proportion (1:1.5:3) respectively
3. Cement: 1440 kg/m^3
4. Fine Aggregate:1600 kg/m^3
5. Recycled Coarse Aggregate:1450 kg/m^3
6. Water:1000 kg/m^3
7. Recycled coarse aggregate kg/m^3 25%=362.5kg/m^3 50%=725kg/m^3, 75%=1087.5kg/m^3 and 100%=14750kg/m^3.

Mixing cement, fine aggregate (sand), recycled coarse aggregate and water.

Sampling of cubes for test:-

1. Clean the mounds and apply oil.
2. Fill the concrete in the molds in layers approximately 5cm thick.
3. Compact each layer with not less than 35strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm.
4. Level the top surface and smoothen it with a trowel.

Curing of cubes:-

- The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the moulds and kept submerged in clear fresh water until taken out prior to test.

- After curing the cubes should be covered with damp matting and stored in a place where the temperature can be kept at 27 + 5° C for approximately 16 to 24 hours.

4. RESULTS AND DISCUSSIONS

All the tests have been performed in standard procedures and the results and load values obtained were tabulated and calculated in following sections.

Compressive strength:-

Compressive strength tests were conducted on cured cube specimen at 7 days and 28 days age using a compression testing machine of 200 KN capacities. The cubes were fitted at center in compression testing machine and fixed to keep the cube in position. The load was then slowly applied to the tested cube until failure.

Compressive strength = Applied load / Cross sectional area.

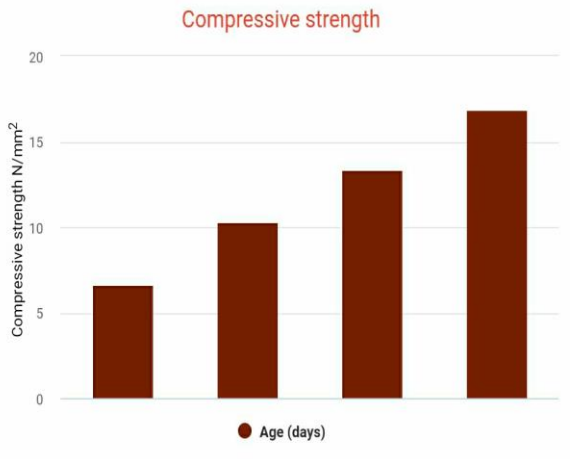
COMPRESSIVE STRENGTH OF M20 GRADE CONCRETE AT THE AGE OF 3, 7, 21, AND 28 DAYS:

GRADE OF CONCRETE	MINIMUM COMPRESSIVE STRENGTH N/mm² AT 3 DAYS	MINIMUM COMPRESSIVE STRENGTH N/mm² AT 7DAYS	MINIMUM COMPRESSIVE STRENGTH N/mm² AT 21 DAYS	SPECIFIED CHARACTERISTIC COMPRESSIVE STRENGTH N/mm² AT 28 DAYS
M20	6.67 N/mm²	10.67 N/mm²	13.33 N/mm²	16.89 N/mm²

AGE	STRENGTH PERCENTAGE
3 days	33%
7 days	53%
21 days	66%
28 days	85%

Compressive strength of concrete at various ages:-

- The strength of concrete increases with age.
- Table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting



5. CONCLUSIONS

The following conclusions have been made based on the results of this study:

1. With the same w/c ratio, the slump value decreases if percentage of RA is increased.

2. The compressive strength of Recycled Aggregate Concrete was lower than that of Natural Aggregate Concrete.

3. Lower water-cement ratio of Recycled Aggregate Concrete lead to higher in compressive strength.RAC could increase its compressive strength by reducing the water-cement ratio of concrete.

4. The relationship of w/c ratio and compressive strength of RAC is inversely proportional.

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