Replacement of Fine Aggregate in Concrete using Construction Demolished Waste

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Abstract:- Demolition of structures to make way for new and modern ones is common features in metropolitan areas due to rapid urbanization. Very little demolished concrete is recycled or reused. Due to strict environmental laws and lack of dumping sites in urban areas, demolished waste disposal is of great problem. The study is a part of comprehensive program wherein experimental investigations have been carried out to assess the effect of partial replacement of fine aggregate by demolished waste on workability and compressive strength of recycled concrete for the study, at a period of 7 and 28 days. The compressive strength thus observed has been compared with strength of conventional concrete. Test results showed the compressive strength of recycled concrete with 12% fine aggregate replacement by demolished waste at the end of 28 days has been found to be marginally lower than that of conventional concrete.

Keywords: Workability, Fine aggregate, Recycle aggregate, compressive strength, conventional concrete.

1. Introduction

Researchers of every era have put their extra efforts on environment and conservation of natural resources. This study is an attempt to explore recycled concrete as a material of hope for next generation. Demolished waste obtained from a structure mainly made up of concrete has several foreign matter such as various type of finishes, cladding materials, lumber, dirt, steel, hardware's, woods, plastics etc, attached to them directly or indirectly. The process of removal of impurities and crushing of rubble into suitable and desirable aggregate particle size can be carried out in a continuous and sequential manner using appropriate mechanical devices such as jaw crushers, impact crushers, swing hammer crushers etc. There are three processes, for processing of demolished waste: Dry, Wet and Thermal, which are used individually or in combination with one another. Due to high water absorption of recycled aggregates, it is sometimes suggested to use pre-soaked aggregates for production of recycled aggregate.

2. Literature Review

Hansen and Marga (1992) found that based on equal slump, the water requirement of recycled aggregate concrete made with both coarse and fine recycled aggregate was 14% higher than that of control concretes made with natural sand and gravel. When concrete was produced with coarse recycled aggregate and natural sand, the increase in water demand was only 6%. **Masood et al. (2001)** compared the strength and economy of standard and recycled concrete with partial replacement of cement and fine aggregates. The recycled concrete achieved up to 77% compressive strength, and above 90% for splitting tensile and flexural strength and a cost saving of 15%. These indicate the potential of C and D wastes as valuable building materials on technical, environmental and economic grounds. **Khalaf and DeVenny (2004)** concluded that concrete can be successfully produced using recycled aggregates that have been produced from demolition and construction waste. Concrete produced with these aggregates does not perform as well as concretes produced with natural aggregates in terms of strength. However, concrete still has a strength that would make it suitable for some applications, with the added benefit that density values are much lower; making it suitable in situations where self-weight is a problem and very good fire resistance is required. Against these backdrops, this study was aimed to assess the effect of partial replacement of fine aggregate by demolished waste on workability and compressive strength of recycled concrete for a period of 7 and 28 d.

3. Materials and methods

Demolished waste: Demolished waste was collected from Morar Cantonment, Gwalior, India. Demolished waste on being tested in laboratory showed pozzolanic properties. Demolished waste as a pozzolanic material was used to partially replace cement and similarly fine aggregate.

Cement: In this work, ordinary Portland cement of Birla (43 grade) brand obtained from a single batches trough out the investigation was used. The ordinary cement content mainly has two basic ingredients namely, argillaceous and calcareous. The cement satisfies the requirement of IS: 8112-1989.

Fine aggregate: The fine aggregate is locally available river sand, which is passed through 4.75mm sieve.

Coarse aggregate: The coarse aggregate locally available crushed stone aggregate, 12 mm maximum of single lot size has been used trough out the experiment the specific gravity of coarse aggregate was 2.7.

Water: Potable water is used for mixing and curing. On addition of higher percentage of demolished waste the requirement of water increases for the same workability. Thus a constant slump has been the criteria fir water requirement but the specimens having 0% demolished waste, w/c of 0.50 has been used.

Properties of Demolished waste

Properties	Values
Specific Gravity	2.67
Aggregate Crushing Value ACV	27
Aggregate Impact Value AIV	14

Table-1

Fig.1 Curing of Specimen

Fig.2 Compression Testing Machine

Properties of OPC cement

Properties	Values
Specific Gravity	3.12
Normal Consistency	29%

Initial Setting time	65min
Final Setting time	275 min
Fineness	330 kg/m^2
Soundness	2.5mm
Bulk Density	830-1650 kg/m^3

Table-2

4. Experimental Analysis

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures.

Test Procedure

For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15cm x 15cm x 15cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

SNO.	**SAMPLE 1**	**SAMPLE2**	**SAMPLE2**	**Avg. Compressive Strength of Concrete in Mpa.**
Conventional cubes	**20.59**	**21.70**	**21.9**	**21.39**
Cubes after replacement with construction demolition waste	**33.20**	**37.10**	**36.80**	**36.11**

Table-3 Compressive Strength of Specimen

Workability Test of concrete:

Various tests for workability of concrete at construction sites i.e slump test, Vee-bee test, Compaction factor test. Workability of concrete describes the ease or difficulty with which the concrete is handled, transported and placed between the forms with minimum loss of homogeneity. This test is carried out with a mould called slump cone whose top diameter is 10cm, bottom diameter is 20 cm and height is 30 cm. the test may be performed in the following steps:

1. Place the slump mould on a smooth flat and non-absorbent surface.

2. Mix the dry ingredients of the concrete thoroughly till a uniform colour is obtained and then add the required quantity of water.

3. Place the mixed concrete in the mould to about one-fourth of its height.

4. Compact the concrete 25 times with the help of a tamping rod uniformly all over the area.

5. Place the concrete in the mould about half of its height and compact it again.

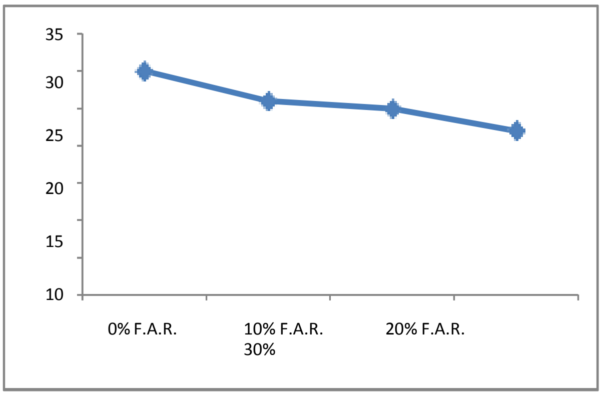
6. Place the concrete up to its three fourth height and then up to its top. Compact each layer 25 times with the help of tamping rod uniformly. For the second subsequent layers, the tamping rod should penetrate into underlying layers.

7. Strike off the top surface of mould with a trowel or tamping rod so that the mould is filled to its top.

8. Remove the mould immediately, ensuring its movement in vertical direction.

9. When the settlement of concrete stops, measure the subsidence of the concrete in millimetres which is the required slump of the concrete.

Workability Slump (mm)



Compressive Strength (Kn/m²)

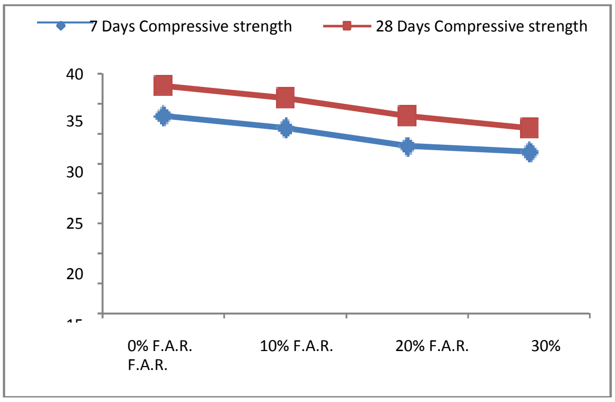


Fig.3 Graph Showing Variation between Workability & Compressive strength VS Fine aggregate Replaced (FAR)

5. Results and discussion

The observations made during the test of cubes are summarized as workability and compressive strength are presented in tabular form (Table 7). Three specimens each having 0%, 6%, 12%, and 18% demolished waste as fine aggregate replacement for mix of 1:1.67:3.33 were cast and tested after 7 days and 28 d in order to have a comparative study.

Workability: Workability is the relative ease with which concrete can be mixed, placed, compacted and finished. While casting specimens, slump test were carried out to determine the workability of different samples as per IS: 6461-1973 (Fig. 1).

6. Conclusions

The following conclusions are drawn from the experimental study.

1. Recycled aggregate concrete may be an alternative to the conventional concrete.
2. Water required producing the same workability increases with the increase in the percentage of demolished waste.
3. Optimum replacement level of fine aggregate with recycled aggregate is 12%.

7. References

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