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REPLACEMENT OF FINE AGGREGATES BY BUILDING DEMOLISHED WASTE FOR ESTABLISHING SUSTAINABLE CONCRETE

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Abstract

Concrete is the most extensively used construction material because of its high compressive strength and flexibility in structural forms as it can be placed and molded into many shapes. The main constituents of concrete are coarse aggregate, fine aggregate, cement and water. Fine aggregate is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Fine aggregates are weathered and worn-out particles of rocks and are of various grades or sizes depending upon the amount of wearing. River sand is becoming a scarce commodity nowadays. The natural resources due to excessive use are also exhausting very rapidly. Shortage of fine aggregate and coarse aggregate may affect the construction industry directly, therefore there is a need to find an alternative material which can replace the fine aggregate fully or partially so that the damage due to excessive erosion to the environment is prevented. As a result of the rapid infrastructure development, production of construction and demolished waste is massive. This paper deals with the partial replacement of fine aggregates by demolished waste and the reduction of dependency on the natural resources such as river sand and it provides new way of disposing waste brick debris. Different percentage replacement levels of 25% and 50% are determined. Experimental investigation has been carried out to assess the effect of partial replacement of fine aggregates by building demolished debris on the compressive strength and workability of the concrete. These results are compared with the conventional concrete.

Key Words: *Building demolished waste, Fine aggregate, Compressive strength, and Conventional concrete.*

1. INTRODUCTION

Several research have been carried out looking for substitutes for Concrete's traditional ingredients. Various industrial waste materials like quarry dust, glass powder, ceramic dust and coal dust are used as partial replacement of fine aggregate and assessed the strength parameters and compared the profit percentages after replacement with waste materials.

India is a developing country, consumption of various materials such as fine aggregate and coarse aggregate is increasing at a faster rate due to developing infrastructure for the development. Sand has been used as a fine aggregate since ages and is one of the oldest and extensively used construction materials in today's world. The concrete industry, on the other hand, is one of the major consumers of natural resources. The widely used material in the construction industry is concrete and mortar. When preparing mortar or concrete fine aggregate is an essential ingredient. Sand has a big value in concrete and the construction industry. This increased demand for fine and coarse aggregate is exhausting natural resources and also has a greater impact on construction sector. Hence to mitigate this impact and preserve our natural resources, we must discover a suitable alternative material for natural sand.

Aggregates obtained from sources such as mine tailings, building demolition and other construction debris are known as recycled aggregates. Disposal of this waste have major consequences since it takes up a lot of space and it also pollutes the environment. Building Demolished Waste (BDW) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastics and gypsum. High demand of natural resources due to rapid urbanization and the disposal problem of demolished wastes in developed countries have created opportunities for use of demolished waste in the construction industry.

2. AIM AND OBJECTIVES OF THE STUDY

This study aims at investigating the building demolished waste (BDW) as a fine aggregate replacement in concrete mixture. The effect of incorporating BDW as partial fine aggregate replacement from 0 to 50% by weight will be investigating on the fresh and hardened properties of M25 concrete.

The specific objectives are as follows: -

1. To evaluate and judge the BDW for suitability to be used in concrete as alternative fine aggregate.

2. To substitute the fine aggregate in the concrete by the building demolished waste with percentage replacement ranging from 0% to 50% on the strength criteria of M25 concrete.

3. MATERIALS AND METHODOLOGY

Material used

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Building demolished waste as fine aggregate
5. Water

Methodology:

1. Selection and procurement of materials.
2. Evaluation of material properties.
3. Mix design calculation and preparation of moulds.
4. Casting and curing of cubes.
5. Conduction of test to determine strength of cubes (7, 14 & 28 days).

Fine aggregate: The fine aggregate is locally available river sand, which is passed through 4.75 mm sieve. Result of sieve analysis of fine aggregate and physical properties are given in Table 2 and 3 respectively.

Coarse aggregate: The coarse aggregate locally available crushed stone aggregate, 20 mm maximum of single lot size has been used throughout the experiment the specific gravity of coarse aggregate was 2.76. The grading of coarse aggregate is given in the Table 4 & 5.

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 for water requirement but the specimens having 0% demolished waste, W/C of 0.40 has been used.

Concrete: The concrete mix design is done in accordance with IS: 10262 (1982). The cement content in the mix design is taken as 380 kg/m^3 which satisfies minimum requirement of 300 kg/m^3 in order to avoid the balling effect. Good stone aggregate and natural river sand of zone-II was used as coarse aggregate and fine aggregate respectively.

Maximum size of coarse aggregate was 20 mm sieve analysis conforming to IS: 383-1970 was carried out for both the fine and coarse aggregate.

For this study cubes of 150 mm size were cast by replacing fine aggregate by demolished waste. Compressive strength of this recycled concrete was observed and compared with those of natural aggregate concrete.

To achieve this comparative study, cubes were cast replacing fine aggregates by 25%, and 50% with demolished waste for a comparative study with respect to conventional concrete.

These specimens were tested after 7, 14 and 28 days. To identify cube strength, a mix proportion of 1:1:2 was used during the investigation.

TABLE 1: Properties of cement

Sl.No	Properties	Observed Values
1	Fineness of cement	7.83%
2	Specific Gravity of cement	2.13
3	Normal Consistency test	32%

TABLE 2: Sieve analysis test on fine aggregates

IS Sieve Size(mm)	Weight Retained	Cumulative Weight Retained(g)	% Cumulative Weight Retained
4.36	0	0	0
2.36	46	4.6	4.6
1.18	185	18.5	23.1
0.6	573	57.3	80.4
0.3	163	16.3	96.7
0.15	16	1.6	98.25
pan	17	1.7	100.0

TABLE 3: Specific gravity test on fine aggregates.

Sl.No	Properties	Observed Values
1	Specific gravity of fine aggregate	2.4
2	Specific gravity of Building waste	1.696

TABLE 4: Sieve analysis test on coarse aggregate.

IS sieve size (mm)	Weight retained	Cumulative Weight retained(g)	% Cumulative weight retained
80	-	-	-
60	-	-	-

40	-	-	-
20	110	2.2	2.2
1.6	690	13.8	16.0
12.5	1640	32.8	48.8
10	520	10.4	59.2
4.75	2030	40.6	99.8

TABLE 5: Properties of coarse aggregate.

Sl.No	Properties	Observed Values
1	Fineness modulus	2.26
2	Specific Gravity	2.76
3	Water Absorption	1.5%

3.1 CUBES PREPARATION

1. Mould is cleaned properly and greased with oil.

2. Concrete is poured into a mould of dimension 150mm X 150mm in three layers. Each layer must be at least 50mm thick approximately.

3. After the placement of first layer of concrete it is compacted by a tamping rod of 16mm diameter and 0.6m long.

4. Each layer shall be compacted either by hand or by the vibration.

5. Each layer is compacted with 35 blows and next scoop of concrete is placed followed by the same manner of compaction and top layer is finished.

Fig 1: Preparation of cubes

3.2 CURING OF SPECIMENS

1. The casted cubes shall be stored under shed at free from the vibration at a temperature 220°C to 330°C for 24 hours covered with wet straw or gunny sacking.

2. Immediately after initial curing of the cubes they should be marked clearly. This can be done by writing the details of the cube in ink on a small piece of paper and placing on top of the concrete until it is demoulded.

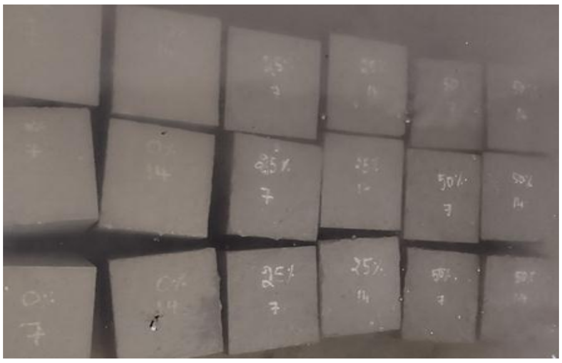


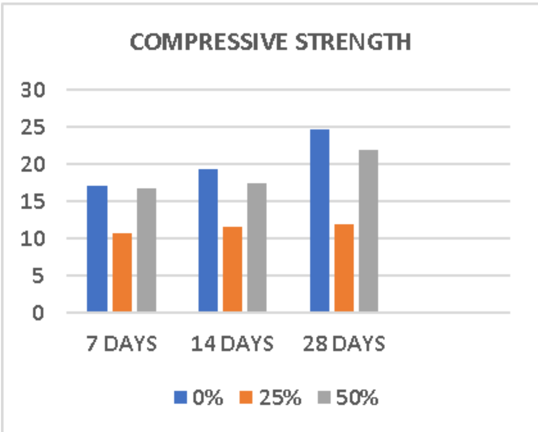
Fig 2: Curing of Specimens

4. RESULTS AND DISCUSSION

The observations made during the test compressive strength of cubes are tabulated below (Table 6). Three specimens each having 0%, 25%, and 50% demolished waste as fine aggregate replacement for mix of 1:1:2 was cast and tested after 7 days, 14 days and 28 days of curing in order to have a comparative study.

TABLE 6: Compressive strength results

Sl.No	Percentage of Replacement of Fine Aggregate	Average Compressive Strength(N/mm^2)		
		7 days	14 days	28 days
1	0%	17.1	19.33	24.68
2	25%	10.72	11.52	11.89
3	50%	16.82	17.37	22.00



GRAPH 1: Compressive strength results

TABLE 7: Difference of average Compressive strength of 25% and 50% building demolished waste concrete compared to conventional concrete.

Sl.No	% Usage of aggregate	% Difference of average Compressive strength		
		7 days	14 days	28 days
1	25% of recycled aggregate	37.3	40.4	51.8
2	50% of recycled aggregate	1.63	10.13	10.8

5. CONCLUSION

1. The test values of compressive strength of cubes of demolished concrete aggregate for 7 days, 14 days and 28 days are obtained, and the values are compared with the conventional concrete.

2. From the above investigation, it can be hence concluded that the optimum replacement for this mix for high strength concrete is found to be 50%, thereby reducing the consumption of M-sand and contributing to sustainable concrete.

3. As we observed that the difference in compressive strength of conventional and demolished waste aggregate concrete at a 28 days curing is 10.8%.

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