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Effective Reuse of Demolished Concrete

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Abstract: The paper deals with the partial replacement of the demolished concrete which is crushed and proportioned to cement, fine aggregate and coarse aggregate and replaced to the ratios of (0%, 20%, 40%, 60%, 80%, 100%) to the concrete mix. The results show that the concrete has equal strength and cost effective. The waste demolished concrete has been used only for earth filling or else it is damped in certain areas. These demolished concrete can be utilized and it can be used in an effective manner is the main aim of the project. The demolished concrete is collected and crushed then it is proportioned to cement, fine aggregate and coarse aggregate. These are partially replaced in the concrete mix to be used to build a construction. This method is cost effective and based upon the type of structures we may increase the replacing ratios. In general, present status and utilization of recycled demolished concrete in India with their future need is discussed.

Keywords: Cement, Fine aggregate, Coarse aggregate, proportion, partial replacement.

Introduction

Today, there are critical shortages of natural resources in present scenario. Production of concrete and utilizationof concrete has rapidly increased, which results in increased consumption of natural aggregates and cement as the largest concretecomponent. A possible solution of these problems is to recycle demolished concrete and produce an alternative for structural concrete in this way. Recycled concrete is generally produced by two stages crushing ofdemolished concrete. Recycled Concrete reduces the impact on landfills; decreases energy consumption and can provide cost savings.

However, there is totally the beneficial use of recycled concrete in concrete construction. The aim of this project is to determine the strength characteristic ofrecycled aggregates,cement for application in structural concrete. An attempt has been made to study the possibility of reusing the demolished concrete fromdemolished structures in the place of normal concrete. The basic properties of concrete and strength parameters of hardened concrete, such as compressive strength, flexural strength and split tensile strength were studied.

The preceding properties were tested for three different periods of curing of 7, 14, and 28 days. All these mixes weredesigned for M40 grade of concrete. In the present work, a comparison was made between the results of a laboratoryinvestigation on various physical properties of concrete made with demolished concrete and found that the results are encouraging to use concrete with demolished concrete.

Concrete is the most widely used construction material across the world. It is used in all types of civil engineeringworks like infrastructure, low and high-rise buildings, defense structure, and environment protection structure. Concrete isa man-made product, essentially consisting of cement, coarse & fine aggregates, water and/or admixture(s).

Recycling of concrete is needed from the viewpoint of environmental preservation and effective utilization ofresources. At present, utilization of recycled concrete is limited mainly to sub bases of roads and backfill works. A largeportion of concrete waste ends up at disposal sites. It is anticipated that there will be an increase in the amount of concretewaste, a shortage of disposal sites, and depletion in natural resources especially. These lead to the use of recycledaggregate in new concrete production, which is deemed to be a more effective utilization of concrete waste. However,information on concrete using demolished concrete is still insufficient, and it will be advisable to get more detailedinformation about the characteristics of concrete using

recycled aggregate.

Experimental Materials

Cement

The most common cement used is an ordinary Portland cement of 53 grade conforming to IS: 8112-1989 is being use.

Table 1: Properties of Cement

S.no	Physical properties of cement	Results	Requirements as per IS: 8112-1989
1	Specific gravity	3.15	3.10-3.15
2	Standard consistency (%)	31.5	30-35
3	Initial setting time (min)	30	30 minimum
4	Final setting time (min)	211	600 maximum
5	Compressive strength (N/mm^2)	53	53 N/mm^2 (minimum)

Aggregates

Aggregates are the important and large used constituents in concrete. They give bond to the concrete, reduceshrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation ofaggregates. It indicates that fractions of aggregates in required proportion such that the sample contains minimum voids.Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in theaggregates. Minimum paste is mean less quantity of cement and less water, which are further mean increased economy, higher strength, lower shrinkage and greater durability.

Coarse Aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates conforming to IS: 383 is being use. The Flakiness and Elongation Index were maintained well below 15%.

Properties of Coarse Aggregate

Particle Size Distribution

The result of sieve analysis carried out as per IS 2386 for different types of crushed recycled concrete aggregateand natural aggregates. It is found that recycled coarse aggregate are reduced to various sizes during the process ofcrushing and sieving (by a sieve of 4.75mm), which gives the best particle size distribution.

Specific Gravity and Water Absorption

The specific gravity (saturated surface dry condition) of recycled concrete aggregate was found from 2.35 to 2.58which are lower as compared to natural aggregates. Since the RCA from demolished concrete consist of crushed stoneaggregate with old mortar adhering to it, the water absorption ranges from 3.05% to 7.40%, which is relatively higher thanthat of the natural aggregates.

Bulk Density

The rodded & loose bulk density of recycled aggregate is lower than that of natural aggregate. Recycled aggregatehad passed through the sieve of 4.75mm due to which voids increased in rodded condition. The lower value of loose bulkdensity of recycled aggregate may be attributed to its higher porosity than that of natural aggregate.

Table 2: Properties of Natural & Recycled Aggregates

S.no	Particulars	Natural aggregate	Recycled aggregate
1	Max. aggregate size	20mm	20mm
2	Specific gravity	2.8446	2.74
3	Fineness modulus	7.086	7.476

4	Density	1805.62Kg/m^3	1660.44 Kg/m^3

Crushing and Impact Values

The recycled aggregate is relatively weaker than the natural aggregate against mechanical actions. As per IS 2386,the crushing and impact values for concrete wearing surfaces should not exceed 45% and 50% respectively. The crushing& impact values of recycled aggregate satisfy the BIS specifications except recycled aggregate for impact value asoriginally it is low grade rubbles.

Table 3: Impact Test Value

	2.36mm passing	Total weight	Impact value
Natural aggregate	26 gm.	326 gm.	8
Recycled aggregate	38 gm.	294 gm.	12.92

Fine Aggregate

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed sand is beingused in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is wash and screen, toeliminate deleterious materials and over size particles.

Table 4: Properties of Fine Aggregate

Synod	Particulars	Fine Aggregate
1	Specific Gravity	2.5
2	Fineness modulus	2.77
3	Density	1753 Kg/m^3

Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Sinceit helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into verycarefully.

Design Mix Methodology

A mix M40 grade was designed as per IS 10262:2009 and the same was used to prepare the test samples.

Table 5: Concrete Design Mix Proportions

W/C ratio	Proportion	Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water
0.50	1:1.03:2.5	503	520.04	1257.98	186

Table 6: Details of M40 Grade Concrete Mix

Mix	Recycled coarse aggregate
M1	0%
M2	20%
M3	40%
M4	60%
M5	80%
M6	100%

Experimental Work

This experimental study includes research work for the workability test and hardened concrete specimens test.The whole test program is as follows: The experimental study was divided into three major segments viz.

- Materials and their testing
- Concrete mix design.
- Tests on Hardened concrete specimens:
    1. Compressive Strength Test.
    2. Flexural Strength Test.
    3. Split tensile Strength Test.

Experimental Methodology

Concrete contains cement, water, fine aggregate, coarse aggregate. With the controlconcrete, i.e.0%, 20%, 40%, 60% and 100% of the natural aggregate is replaced with the recycled aggregates. Three cubesamples were cast on the mould of size 150x150x150 mm for each 1:1.03:2.5 concrete mix with partial replacementofcoarse aggregate, fine aggregate, cement with w/c ratio as 0.50 were also cast. After about 24 h the specimens were de-moulded and water curingwas continued till the respective specimens were tested after 7,14 and 28 days for compressive strength, flexural strength, split tensile strength and workabilitytests.

Compressive Strength

Three samplesper batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm^2 permin. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.03:2.5 with partialreplacement of natural aggregate with recycled aggregates as 0%, 20%, 40%, 60%, 80% and 100%.

Flexural Strength

Three samplesper batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm2 permin. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.03:2.5 with partialreplacement of natural aggregate with recycled aggregates as 0%, 20%, 40%, 60%, 80% and 100%.

Split Tensile Strength

Three samplesper batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm^2 permin. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.03:2.5 with partialreplacement of natural aggregate with recycled aggregates as 0%, 20%, 40%, 60%, 80% and 100%.

Experimental Results

Table 7: Different Types of Concrete Mix V/S Compressive Strength of Cubes at 7, 14 and 28 Days

S.no	Mix	Average Compressive strength in N/mm^2		
		7 days	14 days	28 days
1	M1	20.81	29.78	42.29
2	M2	22.14	30.11	40.50
3	M3	25.26	31.41	42.96
4	M4	27.29	32.92	40.28
5	M5	25.07	27.63	35.51
6	M6	21.14	31.40	32.07

Graph showing results of compressive strength
Days Vs Compressive strength in N/mm^2

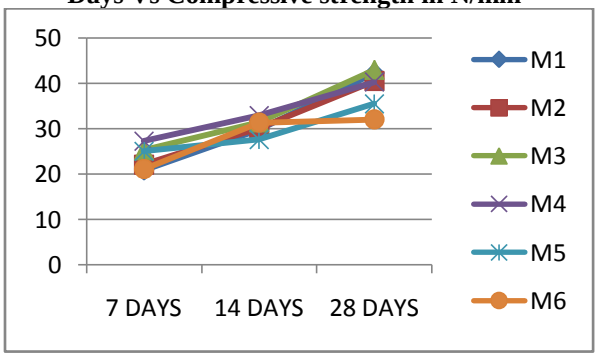


Table 8: Different Types of Concrete Mix V/S Flexural Strength of Cubes at 7 and 28 Days

Mix	Average Flexural strength in N/mm^2	
	7 days	28 days
M1	4.98	6.69
M2	5.32	6.90
M3	4.96	6.67
M4	4.78	6.34
M5	4.43	5.92
M6	4.95	6.09

Graph showing results of flexural strength
Days Vs flexural strength in N/mm^2

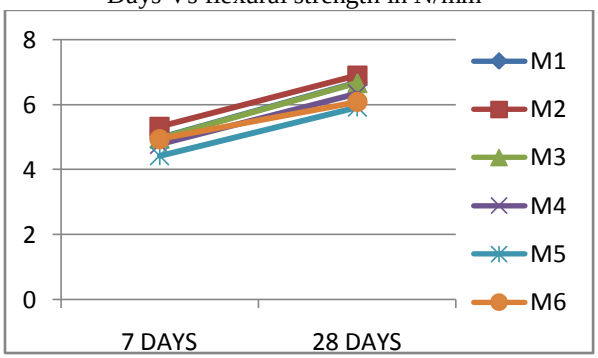
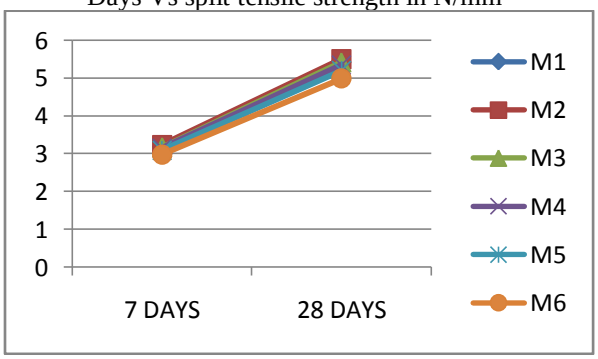


Table 9: Different Types of Concrete Mix V/S Split Tensile Strength of Cubes at 7 and 28 Days

Mix	Average Split Tensile strength in N/mm^2	
	7 days	28 days
M1	3.18	5.41
M2	3.23	5.50
M3	3.17	5.42
M4	3.15	5.35
M5	3.09	5.20
M6	2.98	4.99

Graph showing results of Split tensile strength
Days Vs split tensile strength in N/mm^2



Conclusions

Research on the usage of waste construction materials is very important due to the materials waste is graduallyincreasing with the increase of population and urban development. The reasons that many investigations and analysis had been made on demolished concrete are because they are easy to obtain and the cost is cheap. The main aim of the project is to overcome the demand of fine aggregates, coarse aggregates and

cement by demolished concrete. After detailed study of the result and analysis the following conclusions were made for M40 grade concrete.

- The experimental results show that the early compressive strength, flexural strength and split tensile strength of concrete made of natural mix and partial replaced demolished concrete mix are approximately same.
- The compression test result indicates an increasing trend of compressive strength in the early age of the concretespecimens with 60% replacement. However, it shows that the strength of these specimenswere gradually increase up to 40% replacement of demolished concrete& then it decreases at the 100%replacement of demolished concrete after 28 days. The target strength for M40 grade is 48.25MPa that are achieved for all the specimens tested in the study. The results also show that the concrete specimens with 40% replacement of demolished concrete get the highest strength when compared to the concrete specimens with different percentageof recycled aggregate. From the obtained result, it is possible to use 40% replacement for higher strength ofconcretes.
- It shows that the strength of these specimenswere gradually increase up to 40% replacement of demolished concrete& then it decreases at the 100%replacement of demolished concrete after 28 days. The target strength for M40 grade is 6.69MPa that are achieved for all the specimens tested in the study. The results also show that the concrete specimens with 40% replacement of demolished concrete get the highest strength when compared to the concrete specimens with different percentage of recycled aggregate. From the obtained result, it is possible to use 40% replacement for higher strength ofconcretes.
- It shows that the strength of these specimenswere gradually increase up to 40% replacement of demolished concrete& then it decreases at the 100%replacement of demolished concrete after 28 days. The target strength for M40 grade is 5.41MPa that are achieved for all the specimens tested in the study. The results also show that the concrete specimens with 40% replacement of demolished concrete get the highest strength when compared to the concrete specimens with different percentage of recycled aggregate. From the obtained result, it is possible to use 40% replacement for higher strength ofconcretes.
- Hence the demolished concrete can be used in concrete with 40% replacement.

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