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A Study on Demolished Concrete by Partial Replacement of Coarse Aggregate

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Abstract— There is a large amount of demolished waste generated every year in India and other developing countries .Demolished waste includes concrete blocks which can be recycled into stone aggregates through pre-screening, crushing, screening and separating of aggregate. The experimental investigations are carried out to evaluate the effect of partial replacement of coarse aggregate by demolished waste on compressive strength and workability of demolished concrete.

***Index Terms*— Recycled Aggregates, Recycled Aggregate Concrete (RAC), Natural Aggregate Concrete (NAC), Compressive Strength, etc**

I. INTRODUCTION

Any construction activity requires several materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete remains the main construction material used in construction industries. For its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and by products in cement and concrete used for new constructions. The utilization of recycled aggregate is particularly very promising as 75 percent of concrete is made of aggregates. Recycling of concrete is needed from the viewpoint of environmental Preservation and effective utilization of resources. Due to modernization, demolished materials are dumped on land & not used for any purpose. Such situations affect the fertility of land. As per report of Hindu online India generates 23.75 million tons demolition waste annually. As per report of Central Pollution Control Board (CPCB) Delhi, in India, 48million tons solid waste is produced out of which 14.5 million ton waste is produced from the construction waste sector, out of which only 3% waste is used for embankment. A large portion of concrete waste ends up at disposal sites. It is anticipated that there will be an increase in the amount of concrete waste, a shortage of disposal sites, and depletion in natural resources especially.

These lead to the use of recycled aggregate in new concrete production, which is deemed to be a more effective utilization of concrete waste. However, information on concrete using recycled aggregate is still insufficient, and it will be advisable to get more detailed information about the characteristics of concrete using recycled aggregates. The main reasons for increase of volume of demolition concrete / masonry waste are as follows:-

- Many old buildings, concrete pavements, bridges and other structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished;
- The structures, even adequate to use are under demolition because they are not serving the needs in present scenario; New construction for better economic growth;
- Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.
- Creation of building waste resulting from manmade disaster/war.

The primary objective is to foment the reuse and recycling of this waste and other forms of valorisation with a view to contributing to the sustainable development of activities in the construction sector.

II. MATERIALS & METHDOLOGY

A. Materials Used

- Ordinary Portand Cement 53 Grade
- Fine Aggregates
- Coarse Aggregates
- Recycled Aggregates

B. Material Properties

TABLE I. TEST ON FINE AGGREGATES

property	results
Fineness modulus	2.35
Specific gravity	2.6

TABLE II. TEST ON CEMENT

property	results
Fineness	0.08

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Specific gravity	3.2
Standard consistency	29%
Setting time	Initial-35 min Final- 10hr 35 min

TABLE III. TEST ON COARSE AGGREGATES

property	Natural aggregate	Recycled aggregate
Specific gravity	2.87	2.06
	1.404kg/L	1.31kg/L
Abrasion value	31.4%	41.5%
Impact value	5.8%	13.66%
Attrition value	0.311	9.1%

C. Mix Design(M_{30} GRADE)

Indian Standard Recommended Method of Concrete Mix Design (IS 10262-1982) .The Bureau of Indian Standards recommended a set of procedure for design of concrete mix mainly based on the work done in national laboratories. The mix design procedures are covered in IS 10262-82. The method given can be applied for both medium strength and high strength concrete.

Type of cement : OPC 53 grade

Slump : 50mm

Degree of quality control : good

Type of exposure : mild

Size of aggregate : 20mm

For normal aggregate

Cement	:	Fine Agg	:	Coarse Agg
456	:	604	:	1252
1	:	1.32	:	2.74

For recycled aggregate

Cement	:	Fine Agg	:	Coarse Agg
456	:	604	:	1252
1	:	1.32	:	1.94

Demolished concrete (recycled aggregates) is taken in the ratio of 25%, 50%, 75%, and 100% by the weight of the coarse aggregates.

III. CASTING & TESTING

➢ *CUBE CASTING & CURING*

Initially the constituent materials were weighed and dry mixing was carried out for cement, sand and coarse aggregate and admixtures. This was thoroughly mixed manually to get uniform color of mix. The mixing duration was 2-5 minutes and then the water was added as per the mix proportion. The mixing was carried out for 3-5 minutes duration. Then the mix poured in to the cube moulds of size 150 x 150x 150 mm and then compacted manually using tamping rods as in fig -1.

The cubes are demoulded after 1 day of casting and then kept in respective water for curing at room temperature with a relative humidity of 85% the cubes are taken out from curing after 7, 14, 21 & 28 days for testing. The demolished concrete has been collected from the ongoing demolishing activities in Pragati Engineering College campus,Surampalem.

FIG -1: CASTING OF CUBES

FIG -2: CURING OF CUBES

TABLE-IV: SLUMP CONE TEST RESULTS

s.no	% usage of recycled aggregates	Workability (mm)
1	0% recycled aggregate concrete	50mm
2	25% recycled aggregate concrete	45mm
3	50% recycled aggregate concrete	42mm
4	75% recycled aggregate concrete	35mm
5	100% recycled aggregate concrete	25mm

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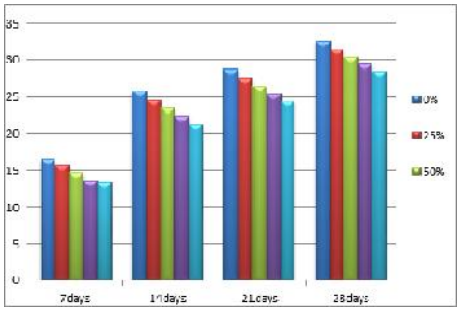
FIG -3:SLUMP CONE TEST

FIG-4: COMPRESSIVE STRENGTH TEST

TABLE-V: COMPRESSIVE STRENGTH RESULTS

S.No	Usage of aggregates	Average Compressive Strength (N/mm^2)			
		7 days	14 days	21 days	28 days
1	0% of recycled aggregates	16.53	25.76	28.72	32.58
2	25% of recycled aggregates	15.68	24.52	27.53	31.47
3	50% of recycled aggregates	14.56	23.47	26.40	30.43
4	75% of recycled aggregates	13.54	22.33	25.35	29.43
5	100% of recycled aggregates	13.29	21.33	24.40	28.44

GRAPH-I : COMPRESSIVE STRENGTH TEST RESULTS



➢ SLUMP CONE TEST

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site work. For the present work, slump tests were conducted. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of frustum of a cone having the internal dimensions as under:

Bottom diameter : 20 cm

Top diameter : 10 cm

Height : 30 cm

The thickness of the metallic sheet for the mould should not be thinner than 1.6 mm. for tamping the concrete; a steel tamping rod is 16 mm diameter 0.6 m along with bullet is used. The mould is placed on a smooth, horizontal, rigid and non – absorbent surface. The mould is then filled in four layers, each approximately ¼th of the height of the mould. Each layer is tamped 25 times by the tamping rod taking care to distribute the strokes evenly over the cross section. After the top layer has been compacted, the concrete is struck off level with trowel and tamping rod.

The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete subside. The subsidence is referred as slump of the concrete. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. The difference in height in mm is taken as slump of concrete.

➢ *COMPRESSIVE STRENGTH TEST OF CONCRETE*

By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm 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 this specimen 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.

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TABLE-VI : % DIFFERENCE OF AVERAGE COMPRESSIVE STRENGTH OF 25%, 50%, 75%, 100% DEMOLISHED CONCRETE COMPARED TO STANDARD CONCRETE

S.no	%Usage of aggregates	%difference for			
		7 days	14days	21days	for28days
1	25% of recycled aggregates	5.74%	4.81%	4.14%	3.406%
2	50% of recycled aggregates	11.91%	8.88%	8.07%	6.59%
3	75% of recycled aggregates	18.0%	13.31%	11.73%	9.66%
4	100% of recycled aggregates	19.6%	17.19%	15.04%	12.70%

IV. CONCLUSION

- The test values of compressive strength of cubes of demolished concrete aggregate for 7days, 14days, 21days, and28daysare obtained and the values are compared with standard concrete.
- The test values of compressive strength 25% and 50% of demolished concrete aggregates are near to the value of standard concrete or conventional concrete.
- As we observed that the difference in compressive strength of standard and demolished concrete aggregate for a 28days is about 12%
- The compressive strength of demolished aggregate concrete is relatively lower up to 20% than standard concrete.
- From the above investigations it can be hence concluded that the optimum replacement for this particular mix for high strength concrete is in between 25-50%. Up to this replacement good compressive strength can be achieved using recycled aggregates.
- Beyond this replacement the strength acquired reduces gradually and does not cross the target strength and in order to overcome this problem, suitable adjustment in mix design is required.

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