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EXPERIMENTAL INVESTIGATION OF CONCRETE ON REPLACEMENT OF AGGREGATES WITH DEMOLISHED CONCRETE WASTE

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Abstract: As there is an ever increasing paucity of natural aggregate (N.A.) and an exponential rise in its price structure, there is a need to recycle aggregates from demolished concrete waste (D.C.W) obtained from non-functional and superseded structures, rubble acquired from earth-quake or further natural calamity such as flood and cyclone has developed obligatory and demand oriented work. As concrete accounts for approx. 75% of all construction resources used in construction industries, the D.C.W is estimated to constitute approx. 75% of entire demolished waste. There are areas where paucity of N.A. continues owing to large transport expenditures. In recent years, there has been a very little land available leading to this, dumping of D.C.W has become great problematic from the perspective of environment concerns. Concrete comprises of cement, water, fine aggregate and coarse aggregate that hardens to give a strong structure. Experiments were done in the research laboratory to analyze the concrete made of partial replacement of fine & coarse aggregate with construction and demolition waste. The produced concrete was investigated for compressive strength and its properties. The results were then compared with a plain cement concrete.

Keywords: Demolished Concrete Waste (D.C.W); Construction; Compressive Strength, Flexural Strength, Demolished Concrete Aggregate (D.C.A)

I. INTRODUCTION

As there is a very rapid development in the industries and urban areas, waste generation for concrete has been increasing which is unfavourably damaging the environment. Today about 27.8% of the Indian population resides in urban areas which is more than 13.8% than of the year 1947. A there is a huge demand and a low supply of aggregates, the prices are increasing exponentially. During any construction the waste generated is about 40 kg per Sq. metre to 60 kg per Sq. metre. Likewise, during any renovation, repair or maintenance work 40 kg per Sq. m to 50 kg per Sq. m waste is produced. When we demolish any building approx. 500 kg per Sq. m waste is generated [3]. Environmental Alertness must be there, sustainable development and conservation of natural resources must be kept in mind throughout any construction work and industrialization. As of now, the demolished waste is dumped into landfills which are not being utilized for any other purpose.

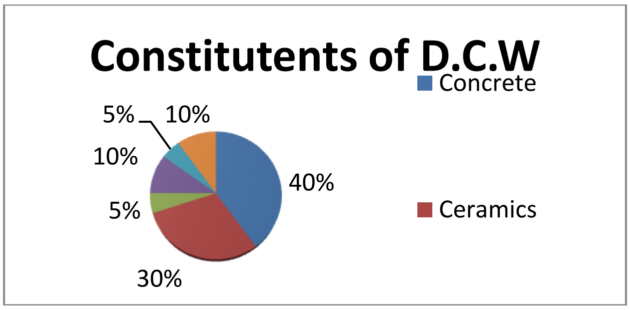

Chart.1: Constituents of D.C.W

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When this D.C.W is dumped in any landfill then the nearby soil loses its fertility. As per Central Pollution Control Board (C.P.C.B) Delhi, 14.5 million tonnes of the 48 million wastes is produced from D.C.W out of which only 3 % waste is utilized for the embankment etc. There has been a quiet increase in the consumption and demand of the N.A in India due to housing, roads, construction and infrastructural development. Demolished Concrete Aggregate (D.C.A) is generally generated by the crushing of D.C.W then screening and removal of contaminants such as plaster, paper, reinforcements, wood, and plastics. The main purpose of this investigation is to determine the basic properties of D.C.A made of coarse recycled D.C.A then to compare them with the properties of concrete made with N.A concrete.

II. METHODOLOGY & MATERIALS

2.1 Demolished waste

As our research is on reprocess of D.C.A, the fine aggregate and the coarse aggregate which we going to utilize for preparation of concrete by replacing River Sand or Crushed Sand and crushed stones will by crushing the D.C.A and sieving through 4.75 mm and other by 20 mm . Demolished waste was collected from the demolished fish market near Samta Nagar, Kandivali East, Mumbai. The collected material needed to be crushed as our research is on substitution of fine and coarse aggregate by D.C.W. Then we crushed the material by Hammer. Then the material was sieved to get the required sized quantity.

2.2 Laboratory Tests

2.2.1 Various Tests on Cement:
- Fineness.
- Consistency.
- Initial and Final setting time.
- Soundness.

2.2.2 Various Tests on Fine Aggregate:
- Sieve Analysis Test.
- Moisture Content Test.
- Water Content Test.
- Specific Gravity Test.
- Silt Content Test.
- Bulking of Sand Test.

2.2.3 Various Tests on Coarse Aggregates:
- Sieve Analysis.
- Moisture Content Test.
- Water Absorption Test.
- Specific Gravity Test.
- Bulk Density.

2.2.4 Tests on Fresh Concrete:
- Slump Cone Test.

2.2.5 Tests on Hardened Concrete:
- Compressive Strength.

After these entire tests the D.C.A was found having properties similar and in some cases exactly same to N.A. So by properties N.A and D.C.A can be replaced with each other, in simple words D.C.A can be a substitute for N.A.

2.3 Test Data for Materials.

Table.1: Comparison of properties of N.A with D.C.A

Sr. No.	Properties	N.A	D.C.A
1	Specific Gravity	2.4-3.0	2.52
2	Water Absorption	0.29%-0.3%	1.5 %
3	Bulk Density	1678.2 KN/m^3	1582.6 KN/m^3
4	Crushing Value	18.4%	29.4%
5	Impact Value	17.65%	28.6%

Table.2: Properties of Cement

Properties	IS:8112-1989 Recommendations	Obtained Values
Soundness Test	10 mm	8.3 mm
Fineness Test	<10%	0.86 %
Normal Consistency	-	27 %
Initial Setting Time	30 minutes (min)	45 minutes
Final Setting Time	600 minutes (max)	430 minutes

Table.3: Properties of fine aggregate (< 4.75 mm)

Properties	IS:383-1970 Recommendations	Obtained Values
Density	1625 kg/ m^3	1810 kg/ m^3
Specific Gravity	2.65	2.34
Water Absorption	1.15 %	1.5 %
Fineness modulus	2.73	2.33

Table.4: Properties of coarse aggregate (10 mm<= 20 mm)

Properties	IS:383-1970 Recommendations	Obtained Values
Density	1625 kg/ m^3	1810 kg/ m^3
Specific Gravity	2.63	2.34
Water Absorption	1.15 %	2 %
Fineness modulus	6.20	5.75

The Mix design calculations:
Wet Area = 1 m^3
Dry Area = 1.54
Mix Ratio = M25 = 1: 1: 2
Sum of ratios = 1 + 1 + 2 = 4
Quantity of Cement for 15*15*15 cm^3
= (1.54*1) / 4= 0.385 m^3
= 0.385 * 1440 = 554.4 kg/m^3
(Density of cement=1440 kg/m^3)
=554.4 * 0.003375 = 1.8711 Kg
(Volume of Cube = 0.003375 m^3)
Quantity of Fine Aggregate for 15*15*15 cm^3
= (1.54*1) / 4 = 0.385 m^3
= 0.385 * 1810 = 696.85 kg/m^3
(Density of aggregate=1810 kg/m^3)
=696.85 * 0.003375 = 2.3518 Kg
(Volume of Cube = 0.003375 m^3)
Quantity of Coarse Aggregate for 15*15*15 cm^3
= (1.54*2) / 4 = 0.77 m^3
= 0.77 * 1810 = 1393.7 kg/m^3
(Density of aggregate=1810 kg/m^3)
=1393.7 * 0.003375 = 4.7037 Kg
(Volume of Cube = 0.003375 m^3)
Thus Water Cement ratio being 0.5
The Quantity of water required will be equal to quantity of cement multiplied by 0.5
Thus, 1.8711*0.5 = 0.9355 kg

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Mix No.	Water (kg)	Cement (kg)	Natural Fine Aggregate (kg)	Natural Coarse Aggregate (kg)	Demolished Concrete Fine Aggregate (D.C.F.A) (kg)	Demolished Concrete Coarse Aggregate (D.C.C.A) (kg)	w/c ratio
Mix1 (PCC)	277.2	554.4	696.85	1393.7	0	0	0.5
Mix2 (10% D.C.F.A)	277.2	554.4	627.16	1393.7	69.69	0	0.5
Mix3 (20% D.C.F.A)	277.2	554.4	557.48	1393.7	139.37	0	0.5
Mix4 (30% D.C.F.A)	277.2	554.4	487.79	1393.7	209.06	0	0.5
Mix5 (40% D.C.F.A)	277.2	554.4	418.11	1393.7	278.74	0	0.5
Mix6 (10% D.C.C.A)	277.2	554.4	696.85	1254.33	0	139.37	0.5
Mix7 (20% D.C.C.A)	277.2	554.4	696.85	1114.96	0	278.74	0.5
Mix8(30% .D.C.C.A)	277.2	554.4	696.85	975.59	0	418.11	0.5
Mix9(40% .D.C.C.A)	277.2	554.4	696.85	836.22	0	557.48	0.5
Mix10(20% D.C.F.A & 10% .D.C.C.A)	277.2	554.4	557.48	1254.33	139.37	139.37	0.5
Mix11 (20% .D.C.F.A & 20% .D.C.C.A)	277.2	554.4	557.48	1114.96	139.37	278.74	0.5
Mix12 (20% .D.C.F.A & 30% .D.C.C.A)	277.2	554.4	557.48	975.59	139.37	418.11	0.5
Mix13 (20% .D.C.F.A & 40% .D.C.C.A)	277.2	554.4	557.48	836.22	139.37	557.48	0.5
Mix14 (30% .D.C.F.A & 10% .D.C.C.A)	277.2	554.4	487.79	1254.33	209.06	139.37	0.5
Mix15 (30% .D.C.F.A & 20% .D.C.C.A)	277.2	554.4	487.79	1114.96	209.06	278.74	0.5
Mix16 (30% .D.C.F.A & 30% .D.C.C.A)	277.2	554.4	487.79	975.59	209.06	418.11	0.5
Mix17 (30% .D.C.F.A & 40% .D.C.C.A)	277.2	554.4	487.79	836.22	209.06	557.48	0.5
Mix18 (40% .D.C.F.A & 40% .D.C.C.A)	277.2	554.4	418.11	836.22	278.74	557.48	0.5
Mix19 (10% .D.C.F.A & 10% .D.C.C.A)	277.2	554.4	627.16	1254.33	69.69	139.37	0.5

Table.5: Mix Design for M25 Grade concrete per m^3

III. RESULTS & DISCUSSION

Compressive Strength is the maximum load or stress and solid material can handle or resists before failing. Compressive Strength of the Mixes were done for 7 and 28 days along with the slump test during casting of the cubes of M25 grade. Two specimens for each Mix were casted, total 38 cubes were casted and tested and 19 slump tests were performed. For 30% replacement of D.C.F.A and 20% replacement of D.C.C.A the 28 days compressive strength is 85.73% of the

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ompressive strength of conventional concrete. The workability of D.C.A is lower than the conventional concrete because the D.C.A absorb more water than N.A.

Figure.1: Casted Cube

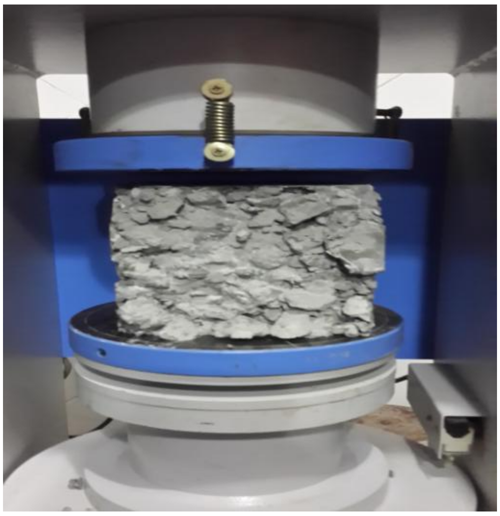

Figure.2: Compressive Testing of the Concrete Cube

Table.6: Results of Compressive Strength and Slump Tests

Mix No.	Slump Test (mm)	Compressive Strength (MPa)	
		7 Days	28 Days
Mix1	160	16.20	28.95
Mix2	154	13.25	22.56
Mix3	148	14.95	23.15
Mix4	134	12.51	23.54
Mix5	136	08.95	20.27
Mix6	167	13.84	20.13
Mix7	155	12.65	19.85
Mix8	140	11.17	21.28
Mix9	147	10.34	20.14
Mix10	169	15.29	24.06
Mix11	158	14.86	23.40
Mix12	138	14.08	23.26

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Mix13	142	13.96	24.01
Mix14	152	13.47	23.84
Mix15	168	14.29	24.81
Mix16	143	15.63	23.17
Mix17	157	13.82	22.63
Mix18	120	11.23	19.11
Mix19	131	15.42	24.15

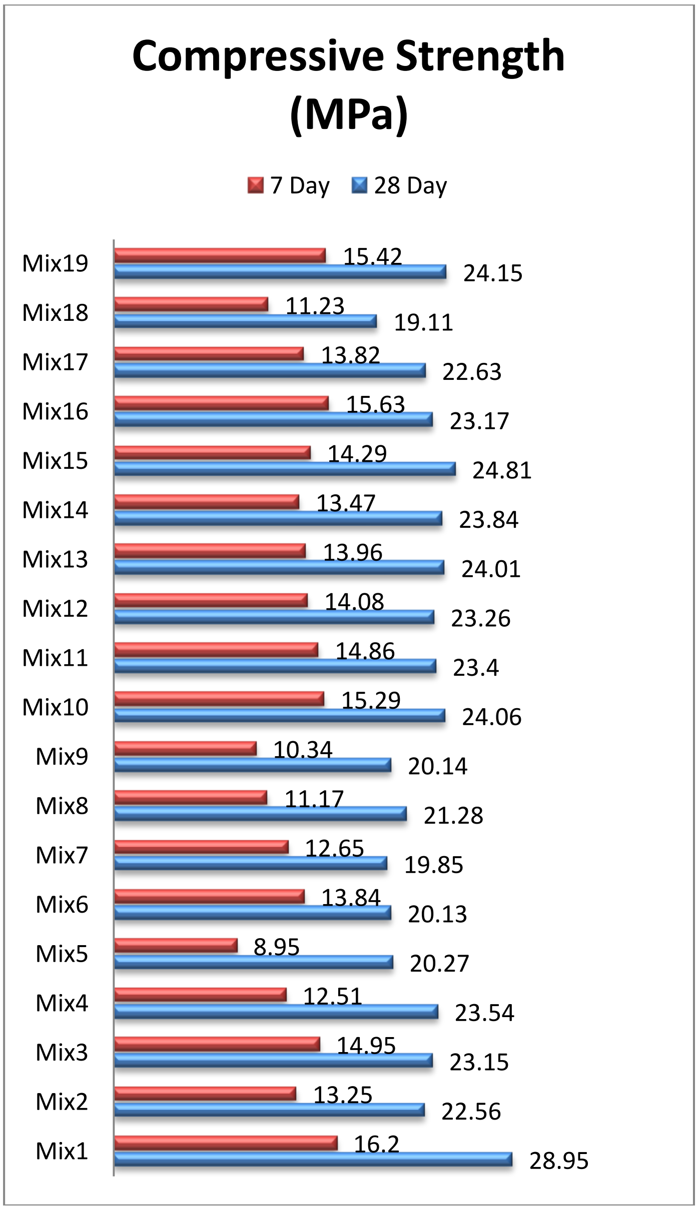

Chart.2: Comparative results of Compressive Strength Tests

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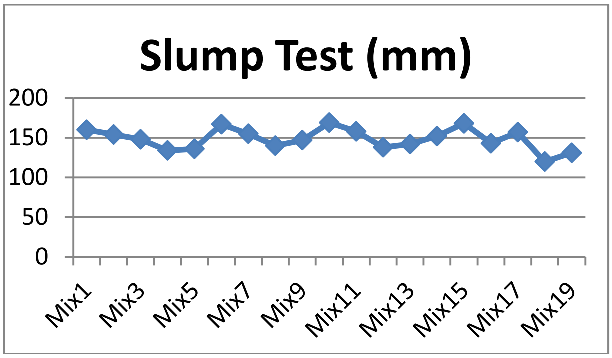

IV. APPLICATION AND BENEFITS[5]

4.1. Applications:

- D.C.A can be reused in PCC.
- It can be reused in a RCC framed structures.
- It can be reused in a load bearing structures.
- It can be reused for the construction of roads.

4.2. Benefits

4.2.1. Related to D.C.A:
D.C.A produces high strength, greatly durable, greatly workable, eco-friendly and economic concrete.
4.2.2. Related to Industry:
Reduction in cost of sand thereby dropping the overall cost of construction with less transportation cost.
4.2.3. Related to environment:
D.C.A concrete will decrease the construction waste in very large quantity therefore decreasing air pollution, producing healthy and natural environment for improvement and growth of societies.

CONCLUSION

As concrete is the dominant construction material its demand will keep increasing till its alternative comes up. The property of D.C.A depends on the source of its raw material and so selection of a good quality of D.C.A is very important for obtaining good quality of concrete. D.CA possess comparatively lower bulk density crushing and impact values and higher water absorption as compared to natural aggregate. Tests conducted on D.C.A and results compared with natural coarse aggregates are satisfactory as per IS 2386. The compressive strength of D.C.A is relatively lower up to 15% than N.A concrete. Utilization of D.C.A concrete as a base material for roadways can reduce the pollution involved in transporting the material. Cost of casting concrete with replacement of D.C.A when compared to Plain Concrete is very low and the properties tested are approx. equal to PCC. Up to 30% replacement of fine aggregate and 20% of coarse aggregate with D.C.A concrete was equivalent to conventional concrete. Up to 30% of fine aggregate and 20% of coarse aggregate replaced by D.C.A gave strength closer to the strength of plain concrete and strength withholding is 85.73% of conventional concrete.

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