Recycled Aggregate Concrete

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Abstract- *Using the products resulting from demolition of concrete as aggregate for new concrete is a well studied all over the world. The main objective of using recycled aggregate concrete instead of natural aggregates is for sustainable construction to reduce the environmental impact on the facility over the lifetime. For environmental production and also economical terms , recycle aggregates in concrete is very useful. Aggregates from demolition of old and damaged buildings and infrastructure are used for landfills due to which huge deposits of construction waste are created, creating a special problem of human environmental pollution, so instead of disposing them into landfills we can reuse this aggregates to make concrete which will be cheaper and less polluting. In this project test results of natural aggregate concrete and recycled aggregate concrete of different specimens (like cube, cylinder and beam) were compared. Recycled aggregate concrete (RAC) had a satisfactory performance, which did not differ much from the performance of control concrete in this project. But, for this to be fulfilled, it is quite necessary to use quality recycled concrete coarse aggregate and to follow the Indian standard codes for design and production of this new concrete type.*

Keywords:- Aggregates, Concrete, Natural Aggregates, Recycled Aggregates

I. INTRODUCTION

Recycled aggregate concrete is a concrete made of aggregates from waste materials from demolition of old and damage buildings and infrastructure. Recycled aggregates are the product of future. The scarcity of natural resources for aggregates encourage the use of waste from construction site as a source for aggregates. The application of recycled aggregate has been started in a large number of construction projects of many European, American, Russian and Asian countries. The use of natural aggregates is increasing day by day, due to which the natural aggregate resources are depleting. So an alternative source of aggregates has to be found, recycle aggregates is a good option as a replacement of natural aggregates. Also cost of cement, aggregates, sand, etc. is increasing day by day due to which cost of construction is also increasing. Recycle aggregates are cost effective so with the use of recycle aggregates cost of construction decreases. Recycled concrete aggregate is usually produced by two-stage crushing of demolished and waste concrete, and screening and removal of contaminants such as reinforcement, paper, wood, plastics and gypsum. Concrete made with such recycled concrete aggregate is called Recycled aggregate concrete. The main purpose of this work is to determine the basic properties of recycled aggregate concrete depending on the coarse recycled aggregate content, and to compare them to the properties of concrete made with natural aggregate concrete.

II. RESEARCH ELABORATION

Two types of concrete mixtures were tested, one which entirely has natural aggregates and other type made with 100% recycled aggregates. Total 24 specimens were made of M20 grade. In which 12 specimens were of Natural aggregate concrete and other 12 specimens of Recycled aggregate concrete.

Natural Aggregate Concrete and Recycled Aggregate Concrete		
Specimens	Size	No. Of Specimens
Cubes	150mmX150mmX15mcm	6
Cylinders	150 mm dia., 300mm depth	3
Beams	500mmX100mmX100mm	3

Now, the compressive, tensile and flexural strength of all these specimens were tested on 7 and 28 days of curing. Cubes were tested for its compressive strength for 7 and 28 days. Cylinders were tested for its tensile strength on 28 days same ways beams were tested for its flexural strength on 28 days. Cubes were tested on Compression testing machine(CTM) in the laboratory. While beams and cylinders were tested on Universal testing machine(UTM) in the laboratory

❖ **Mix Design of concrete mix**

Grade of concrete : M20
Type of cement : OPC 53 grade (IS:8112)
Max. nominal size of aggregates : 20 mm
Min. cement content : 300 kg/m3
Max.water cement ratio: 0.54
Workability : 20 mm (slump)
Exposure condition : Mild
Degree of supervision : Good
Type of aggregate : Crushed angular aggregate

- Materials test data

Cement used : OPC 53 grade
Specific gravity of cement : 3.15
Specific gravity of Coarse aggregate : 2.74
Fine aggregate : 2.63
Water absorption : Coarse aggregate: 0.5 percent
Fine aggregate: 1 percent
Free (surface) moisture:
Coarse Aggregate : Nil (absorbed moisture full)
Fine aggregate : Nil
Sieve analysis : Coarse aggregate (Table 2 of IS :383)

- Target strength for mix proportioning

f'ck = fck + 1.65 s
Where,
f'ck = Target average compressive strength at 28 days,
fck = Characteristic compressive strength at 28 days,
S = Standard deviation : From Table 1 standard deviation,
s = 4 N/mm^2

Therefore,
Target strength = 20 + 1.65 x 4 = 26.60 N/mm^2

- Selection of water cement ratio

From Table 5 of IS:456-2000, maximum water cement ratio = 0.55 (Mild exposure).

Based on experience adopt water cement ratio as 0.50

Where, 0.50< 0.55, Hence OK

- Estimation of air content

For maximum size of aggregate of 20 mm, the air content is taken as 2.0% (IS:456-2000)

- Selection of water and sand content

From 20mm nominal maximum size aggregate, maximum water content = 186 kg and sand content as percentage of total aggregate by absolute volume = 35%

Water = 186 kg/m^3 of concrete
Sand = 35% of total aggregate by absolute volume

For changes in volume in water-cement ratio, compacting factor and sand belonging to zone 3, by doing calculations:

Change in condition	Adjustment Required	
	Water content %	% sand in total aggregate
For decrease in water-cement ratio i.e. 0.10	0	-2.0
For increase in compacting factor = 0.1	+3.0	0
For sand conforming to zone 3 of table 4 of IS:383-1970	0	-1.5
total	+3	-3.5

Required water content = 186 + (186 X 3/100)
= 191.6 lit/m^3

Required sand content as percentage
P = 35-3.5
= 31.50%

- Calculation of cement content

Water cement ratio = 0.50
Cement content = 191.6/0.50= 383.20 kg/m^3>320 kg/m^3
From Table 5 of IS: 456, minimum cement content for mild exposure condition = 300 kg/m3

Hence OK.

- Proportion of volume of coarse aggregate and fine aggregate content

Volume of concrete = 1 m^3
Entrapped air in wet concrete = 2%
Absolute Volume of Fresh Concrete = 1- 2/100
= 0.98 m^3

For Fine Aggregates:
$V=(W+C/S_C + 1/p \text{ X } F_a/S_{fa}) \text{ X } 1/1000$
F_a=558.75 kg

For Coarse Aggregates:
$V=(W+C/S_C + 1/(1-p) \text{ X } F_a/Sc_a) \text{ X } 1/1000$
C_a=1256.24 kg

- Quantity of materials required

Cement = 383 kg/m^3
Water = 191.6 kg/m^3
Fine aggregate = 558.75 kg/m^3
Coarse aggregates = 1256.24 kg/m^3
Water cement ratio = 0.50

➢ Quantity per Specimen

Specimen/ Materials	Cement (Kg)	Fine Agg (Kg)	Coarse Agg. (Kg)	Water (Liter)
Cube	1.620	2.365	5.314	0.721
Cylinder	2.420	3.533	7.938	1.134
Beam	2.400	3.504	7.872	1.200

III. RESULTS AND DISCUSSION

Results:

Result of Load as on 7 days of Casting of Cube

Specimen	Type	1	2	3	Avg.
		Peak load KN	Peak load KN	Peak load KN	Peak load KN
NAC	M20	339.2	367.2	311.4	339.3
RAC	M20	314.7	306.8	320.5	314.0

Result of Load as on 28 days of Casting of Cube

Specimen	Type	1	2	3	Avg.
		Peak load KN	Peak load KN	Peak load KN	Peak load KN
NAC	M20	580	598.8	565.4	581.4
RAC	M20	490.1	506.2	485.9	494.1

Result of Stress as on 7 days of Casting of Cube

Specimen	Type	1	2	3	Avg.
		Peak Stress MPa	Peak Stress MPa	Peak Stress MPa	Peak Stress MPa
NAC	M20	15	16.2	13.8	15
RAC	M20	13.98	13.63	14.24	13.95

Result of Stress as on 28 days of Casting of Cube

Specimen	Type	1	2	3	Avg.
		Peak Stress MPa	Peak Stress MPa	Peak Stress MPa	Peak Stress MPa
NAC	M20	25.52	26.22	25.1	25.61
RAC	M20	21.78	22.39	21.59	21.92

Result of Load as on 28 days of Casting of Cylinder

Specimen	Type	1	2	3	Avg.
		Peak load KN	Peak load KN	Peak load KN	Peak load KN
NAC	M20	177.5	192.8	186.5	185.6
RAC	M20	106.5	115.6	112.8	111.6

Result of Stress as on 28 days of Casting of Cylinder

Specimen	Type	1	2	3	Avg.
		Peak Stress MPa	Peak Stress MPa	Peak Stress MPa	Peak Stress MPa
NAC	M20	3.76	4.09	3.95	3.93
RAC	M20	2.26	2.45	2.39	2.36

Result of Load as on 28 days of Casting of Beam

Specimen	Type	1	2	3	Avg.
		Peak Load KN	Peak Load KN	Peak Load KN	Peak Load KN
NAC	M20	9.6	9.5	9	9.36
RAC	M20	6.7	6.84	5.85	6.46

Result of Stress as on 28 days of Casting of Beam

Specimen	Type	1	2	3	Avg.
		Peak Stress MPa	Peak Stress MPa	Peak Stress MPa	Peak Stress MPa
NAC	M20	4.8	4.75	4.65	4.73
RAC	M20	3.35	3.42	3.02	3.26

DISCUSSION:

Compressive Strength

With replacing the natural aggregate with recycled aggregate 100%, compressive strength of cube decreases up to 20% in all specimen,compared to control concrete after 28 days.

Tensile Strength

For cylinder similar results were observed, With replacing the natural aggregate with recycled aggregate 100% tensile spilt strength decreases up to 42% compare to control concrete.

Flexural Strength

For beam flexural strength decreases up to 35%, With replacing the natural aggregate with recycled aggregate 100% compared to control concrete.

IV. CONCLUSION

From the results we can conclude that:

- ✓ Recycled aggregate concrete can be used in low grade applications.
- ✓ Use for construction of precast and cast in-situ gutters and cerb's.
- ✓ There are no detrimental effects on concrete and it is expected that the increase in cost of cement can be offset by the low cost of recycle aggregates.
- ✓ Less emission of carbon due to less crushing so there is less pollution.
- ✓ So, recycle aggregates can be for making concrete of non structural components of the buildings which will eventually decrease the cost and prove to be environment friendly.

REFERENCES

[1] Asolekar S. R.; Incorporation of waste matrixes into building materials in the context of regulatory framework; In: Saxena M, Pasad PK, Dasgupta R, editors. Proceedings of the recent trends in building materials. Bhopal, India: MRSI, and RRL; 2004. p. 66–75.

[2] Hansen T. C.; Recycling of demolished concrete and masonry, RIELM Report No. 6. UK: E&FN Spon, 1992.

[3] Collins R. J.; The use of recycled aggregates in concrete, BRE report. UK: Building Research Establishment, 1994.

[4] Poon C.S., Kou S.C., and Lam L; Use of recycled aggregates in molded concrete bricks and blocks; Const and Build Mat – 16(2002) 281–89.

[5] Task Force of the Standing Committee of Concrete, Draft of Spanish regulations for the use of recycled aggregate in the production of structural concrete. Use of recycled materials in buildings and structures. In: RILEM proceedings 40, Barcelona, November, 2004. p. 511–25.

[6] Kikuchi M, Dosho Y, Narikawa M, Miura T.; Application of recycled aggregate concrete for structural concrete, part-I: experimental study on the quality of recycled aggregate and recycled aggregate concrete. Proceedings of the International Conference on the Use of Recycled Concrete Aggregates. UK: Thomas Telford, 1998. p. 55–68

[7] López-Gayarre, F.; Serna, P.; Domingo-Cabo, A.; Serrano-López, M.A.; López-Colina, C. Influence of recycled aggregate quality and proportioning criteria on recycled concrete properties. Waste Manag. 2009, 12, 3022-3028.

[8] Domingo-Cabo, A.; Lázaro, C.; López-Gayarre, F.; Serrano-López, M.A.; Serna, P.; Castaño-Tabares, J.O. Creep and shrinkage of recycled aggregate concrete. Constr. Build. Mater. 2009, 7, 2545-2553.

[9] Gómez-Soberón, J.M.V. Shrinkage of concrete with replacement of aggregate with recycled concrete aggregate. ACI Spec. Publ. 2002, 209, 475-496.