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An Experimental Study on Recycled Aggregate Concrete

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Abstract- In this paper an experimental study has been done to study the behavior of recycled aggregate concrete. Comparative study has been done between the normal concrete and recycled aggregate concrete compressive strength for M 20 grade. The curing period is kept same as 7, 14 and 28 days for the measurement of compressive strength. The materials used are collected from the recycling plant and their initial properties are also tested. There has been a noticeable loss in compressive strength noticed during the experimental study.

Index Terms- Compressive Strength, Recycled Aggregate (RA), Recycled Coarse Aggregate (RCA), Construction Demolition and Debris (C&DD).

1. INTRODUCTION

Over the last five to six years, India's first and only recycling plant for construction and demolition (C&D) waste has saved the already-polluted Yamuna and the overflowing landfills of Delhi from 15.4 lakh tonnes of debris. A Ministry of Urban Development circular on June 28, 2012, directed States to set-up such facilities in all cities with a population of over 10 lakh. But, till now the existing facility at Burari is the only one.

Fig 1. Demolition of Old Existing Structure.

Efforts are on to increase the plant's production, as well as set up more facilities to reduce the amount of waste dumped at landfills. The erstwhile unified Municipal Corporation of Delhi (MCD) had started the plant in 2009, with Infrastructure Leasing & Financial Services (IL&FS) operating the 10-acre site at Burari at Jahangirpuri in North Delhi. With near-constant buzz of construction activity across the Capital, 5,000 tonnes of waste is produced by building, demolition and land-clearing activities every day. Though the plant was set up with 500 tonnes per day (TPD) capacity, it has more than doubled today. As of now, most of the C&D waste produced in Delhi ends up being dumped along the Yamuna or in the Ridge area. Making recycling difficult, it is usually mixed with municipal solid waste. The plant uses manual segregation for bigger plastic pieces as well as a magnetic separator for metallic objects. The waste is crushed, washed and used to make ready-mix concrete, kerb stones, cement bricks, pavement blocks, hollow bricks and manufactured sand. The plant uses manual segregation for bigger plastic pieces as well as a magnetic separator for metallic objects.

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2. EFFECT OF RECYCLED AGGREGATE ON STRENGTH OF CONCRETE

A sustainable construction has become a great concern over construction practice at the expense of the future of our planet. This is due to the fact that the construction industry is a massive consumer of natural resources and a huge waste producer as well [PB Cachim et al, 2009]. High value of raw material consumption in the construction industry becomes one of the main factors that causes environmental damage and pollution to our mother earth and the depletion of natural and mineral resources. The resources such as coarse aggregates, sands and cements will be at a disadvantaged position, as these resources are not able to cope with the high demand in the construction industry [PK Mehta et al 1999.]. Therefore, utilizing the recycled aggregate may be one of the significant efforts in achieving a sustainable construction.

Various methods have been attempted to compensate for the lower quality of the recycled aggregates for

concrete production. Recycled aggregate has been used as a replacement of the natural aggregate for a number of years. The potential benefits and drawbacks of using recycled aggregate in concrete have been extensively studied [Qikonomou, 2005]. The use of recycled aggregate generally increases the drying shrinkage, creep and water sortivity and decreases the compressive strength and modulus of elasticity of recycled aggregate concrete compared to those of natural aggregate concrete [TC Hansen et al , 1985]. The poor performance of the recycled aggregate concrete is associated with the cracks and fissures, which were formed in recycled aggregate during processing, thereby rendering the aggregate having weaker and more susceptible to permeation, diffusion and absorption of fluids [FT Olorunsogo et al 2002]. This may also be due to the presence of old ITZ and adhesive mortar in the recycled aggregate, which makes recycled aggregate concrete more permeable than normal aggregate concrete [N Otsuki et al 2003]. These drawbacks limit the utilization of the recycled aggregate with higher percentages (>30%) in structural concrete. For a variety of reasons, reuse of construction and demolition (C&D) materials by the construction industry has become more significant. In addition to environmental protection, conservation of natural aggregate resources, shortage of waste disposal land, and increasing cost of waste treatment prior to disposal are the main reasons for the growing interest in recycling C&D materials [MC Limbachiya, et al 2004]. Already many countries have introduced legislation and policy measures to encourage the use of recycled aggregates in civil engineering works.

3. EXPERIMENTAL SETUP

3.1. *Properties of Ingredients*

The properties of concrete are significantly influenced by the basic properties of constituent materials. Therefore, the preliminary properties of Ordinary Portland cement, fine aggregates, coarse aggregates, recycled aggregates and mixing water are evaluated according to relevant codes.

3.1.1 Cement:

The cement used throughout the test programme was OPC (43 grade) confirming to IS: 8112-1989. The chemical and physical properties of the cement were tested as per the IS: 4032-1985 & IS: 4031-1988 respectively.

3.1.2 Water:

Portable drinking water was used.

3.1.3 Fine Aggregate :

Fine aggregate was locally available badarpur sand and tested for its physical requirements as per relevant IS 2386 (Part I toVII)-1963 and it confirmed to IS: 383-1970.

3.1.4 Coarse Aggregate :

Properties of the aggregates which influence the properties of both the fresh and the hardened concretes have to be considered when the concrete is proportioned. The coarse aggregates were locally available crushed quartzite aggregates. The coarse aggregate was tested for its physical properties as per relevant IS 2386 (Part I to VII)-1963.

3.1.4 Recycled Fine Aggregate:

Fig 2. Recycled Fine Aggregate.

Properties of RFA were tested and following results were observed –

Water absorption - 12%
Specific gravity - 2.4
Fineness Modulus – 2.3
Silt content - 1%

3.1.4 Recycled Coarse Aggregate

Fig 3. Recycled Coarse Aggregate.

Properties of RCA were tested and following results were observed –

Specific gravity – 2.5
Water absorption – 2%
Fineness modulus - 2.2

4. MIX DESIGN PROCEDURE

The main object of concrete mix design is to select the optimum proportions of the various ingredients of

concrete which will yield fresh concrete of desirable properties like workability and hardened concrete possessing specific characteristic compressive strength and durability. The mix proportions were calculated as per IS 10262-2004. Trial mixes were done to complete the mix design.

Table 1. Quantity of materials per cube.

S. No.	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	water
1.	1.520	2.540	3.780	0.760

4.1. *Preparation of Specimens*

The cubes of size 150mm x 150mm x 150mm were casted as per the procedure to determine the compressive strength after curing period for 7, 14 and 28 days. Figure given below shows the mixing and casting of cubes.

Fig 4. Recycled Aggregate Concrete Casted Cube.

4.2. *Curing of cubes*

The cubes casted were removed from moulds after 24hrs and were labeled for identification before curing in water tank. These were cured for required curing period for calculating their compressive strength.

4.3. *Compressive Strength Test*

It is the strength of a material and is defined as the value of uni-axial compressive stress reached when the material fails completely. The cubes were tested in accordance with IS: 516-1969. The loading rate was 10 kN/min and maximum capacity was 2000kN. The test setup is shown below in figure.

Fig 5. Compressive Strength Testing Machine.

5. RESULTS AND DISCUSSION

In this paper compressive strength and a comparison between normal and C&DD waste concrete is made. Also, the paper represents the loss in compressive strength due to the usage of recycled aggregates.

5.1. *Evaluation of Compressive Strength*

The compressive strength of 150mm size cubes were tested after curing period of 7, 14 and 28 days for both normal and recycled aggregates respectively.
The recycled aggregates were replaced 100% for both fine and coarse. The properties of both the aggregates were initially calculated and analysed as per the requirement. The water-cement ratio for recycled aggregate is kept 0.5.
The compressive strength obtained is discussed in this section for both the types of concrete cubes and represented graphically. The compressive strength after curing period of 7 days is 13.82 kN and 12.10 kN, after 14 days of curing period a reduction of compressive strength was seen from 18.18 to 14.09 kN and after 28 days of curing period a reduction from 24.40 to 18.80 kN was observed.

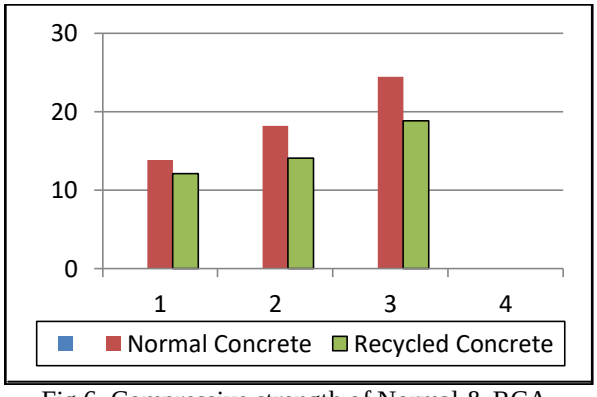

Fig 6. Compressive strength of Normal & RCA concrete.

5.1.1 Reduction in compressive Strength

Reduction in compressive strength observed was almost negligible in initial period by recycled

aggregate concrete in comparison to normal concrete. After 14 days of curing period the loss in strength observed was 22.5 % and after 28 days curing 23%.

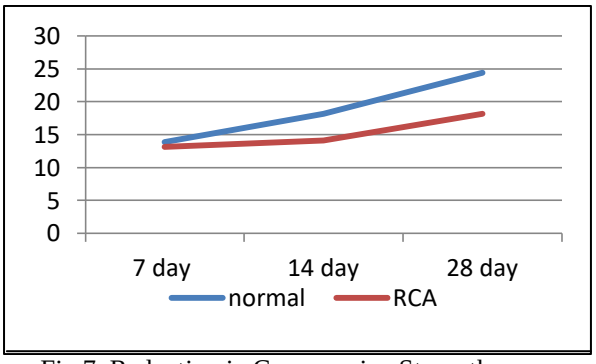

Fig 7. Reduction in Compressive Strength.

6. CONCLUSION

i. The compressive strength of recycled aggregate concrete is low as compared to normal concrete.

ii. The gain in strength in initial days is similar to normal concrete but later it decreases.

iii. The water absorption of aggregates is high, hence keeping water-cement ratio high as 0.5.

iv. The strength of recycled aggregate concrete can be increased by decreasing water-cement ratio and by adding admixture for maintain workability.

v. Partial replacement of aggregates can be done instead of 100 % replacement of aggregates.

vi. Replacement of aggregates can be done separately instead of replacing both the aggregates.

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REFERENCES

[1] Topcu Bekir Ilker, Guncan Fuat Nedim, Using waste concrete as aggregate Cement Concrete Research 1995. pp: 85–90.

[2] Buck, A. D. Recycled concrete as a source of aggregate ACI Journal, 2011. pp 212–219.

[3] Mirjana Malešev 1, Vlastimir Radonjanin 1 and Snežana Marinković Recycled Concrete as Aggregate for Structural Concrete Production Sustainability 2010, pp 1204-1225;

[4] Oikonomou, N. Recycled concrete aggregates Cement and Concrete Composites, 2005 Pp 315–318.

[5] M. Chakradhara Rao, S. K. Bhattacharyya ,S. V. Barai, Influence of field recycled coarse aggregate on properties of concrete, Materials and Structures 2011 pp 205–220.

[6] Shant A. Dajadian1, Daphene C. Koch(2014), Waste Management Models and Their Applications on Construction Sites International Journal of Construction Engineering and Management, , pp 91-98

[7] Brett Tempest, Tara Cavalline, Janos Gergely, David Weggel(2010), Concrete Sustainability Conference, Construction and Demolition Waste used as Recycled Aggregates in Concrete, Solutions for Increasing the Marketability of Recycled Aggregate Cement & Concrete pp 1-13

[8] Fisher, C.; Werge, M. EU as a Recycling Society; ETC/SCP Working Paper 2/2009; 14 August 2009.

[9] U.S. Department of Transportation Federal Highway Administration. Transportation Applications of Recycled Concrete Aggregate FHWA State of the Practice National Review 2004;. Washington, DC, USA, 2004; pp. 1-47

[10] Recycling of Demolished Concrete and Masonry; Hansen, T.C., Ed.; Taylor and Francis: Oxfordshire, UK, 1992; p. 316.

[11] Jianzhuang Xiao , Wengui Li , Yuhui Fan , Xiao Huang An overview of study on recycled aggregate concrete in China (1996–2011) Construction and Building Materials 31 (2012) 364– 383

[12] S.C. Kou, C.S. Poon Enhancing the durability properties of concrete prepared with coarse recycled aggregate Construction and Building Materials 35 (2012) 69–76 Contents lists

[13] Benito Mas, Antoni Cladera , Teodoro del Olmo, Francisco Pitarch Influence of the amount of mixed recycled aggregates on the properties of concrete for non-structural use Construction and Building Materials 27 (2012) 612–622

[14] Wai Hoe Kwan , Mahyuddin Ramli, Kenn Jhun Kam, Mohd Zailan Sulieman Influence of the amount of recycled coarse aggregate in concrete design and durability properties Construction and Building Materials 26 (2012) 565–573

[15] Akmal S. Abdelfatah and Sami W. Tabsh Review of Research on and Implementation of Recycled Concrete Aggregate in the GCC Department of Civil Engineering, American University of Sharjah, P.O. Box 26666, Sharjah, UAE

[16] Kirtikanta Sahoo, Robin Davis Pathappilly, Pradip Sarkar Behaviour of Recycled Coarse Aggregate Concrete: Age and Successive Recycling J. Inst. Eng. India Ser. A (April-June 2016) 97(2):147–154

[17] Sudhir patil, Ganesh Ingle, Prashant D sathe Recycled coarse aggregates International Journal

of Advanced Technology in Civil Engineering, ISSN: 2231 –5721, Volume-2, I-1, 2013

[18] Bharat, K.; Broder, A. (1998): A technique for measuring the relative size and overlap of public Web search engines. Computer Networks, **30**(1–7), pp. 107–117.

[19] Olorunsogo FT, Padayachee N. Performance of recycled aggregate concrete monitored by durability indexes. Cement Concrete Research 2002; 32:179–85.

[20] Otsuki N, Miyazato S, Yodsudjai W. Influence of recycled aggregate on interfacial transition zone, strength, chloride penetration and carbonation of concrete. J Mat Civil Eng 2003;15(5):443–51.

[21] Limbachiya MC, Roberts JC. Sustainable waste management and recycling: construction and demolition waste. Thomas Telford; 2004.