

Analysis on Processing and Properties of Recycle Aggregate Concrete

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ABSTRACT: The generation of huge amounts of construction waste is anticipated due to the demolition of older structures such as power stations built more than 30 years ago. On the other hand, the reuse of construction waste is highly essential from the viewpoint of Life Cycle Assessment (LCA) and effective recycling of construction resources. In order to promote the reuse of construction waste, it is necessary to achieve three basic concepts: (1) assurance of safety and quality, (2) decrease of environmental impact, and (3) increase of cost effectiveness of construction. This paper outlines the development of a recycling system, application of recycled aggregate concrete produced by the aggregate replacing method, which is effective in reducing both cost and environmental impact from the viewpoint of LCA for concrete waste generated by the demolition of large-scale buildings such as powerhouses.

The Result of this study showed that recycled aggregate concrete using the aggregate replacing method can acquire sufficient quality as structural concrete and/or precast concrete products through material design based on the value of the relative quality method. Moreover, with the adoption of the developed recycling system, it was confirmed possible to recycle concrete waste produced from the demolition buildings in a highly effective manner reducing both recycling cost and environmental impact.

I. INTRODUCTION

Global Construction industry growth is substantial in size. Report by Global Insight, predicts an increase in construction spending from 4800 billion US dollars in 2008 to 6200 billion US dollars in 2013. These figures indicate a tremendous growth in the construction sector almost one and a half times in the coming 5 years. The construction industry Worldwide is a conspicuous consumer of the raw material of many types and thus large material inventories are required to sustain the growth. The raw materials used in construction are largely naturally occurring and non-renewable resources hence using these materials meticulously is the need of the time. Also proportionately related are the issues of cost that is rising since material inventory is becoming scarce and material has to be procured from distant places. Among the various raw materials used in construction, aggregates are important components for all the construction activities and the demand in 2007 has seen an increase by five percent, to over 21 billion tones, the largest being in developing countries like China, India, etc. Keun- Hyeok Yang has reported construction industry's global requirement of natural aggregate Around 8 - 10 billion tons annually after the year 2010.

II. LITERATURE REVIEW

Demolished concrete was crush to provide as new coarse aggregate. Recycle is the reprocessing of wastes to recover an original raw material. Recycling Concrete is becoming an increasingly popular way to utilize aggregate left behind when structures are demolished. The results of an extensive experimental programmer aimed at examining the performance of Portland cement concrete produced with Fresh coarse and recycled coarse aggregates are reported in this paper. Then determine and analysis the properties of recycling coarse aggregates and recycle coarse aggregate's concrete. Then compare their properties corresponding to fresh coarse aggregate and its concrete. The effects of 100% recycled concrete coarse aggregate are used in the Portland cement concrete. It is suitable for use in designed application.

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Waste arising from construction and demolition constitutes one of the largest waste streams in the world, of this a large proportion of potentially useful material disposed of as landfill. When structures made of concrete are demolished or renewed, concrete recycling is a progressively common method of consuming the rubble. Concrete was once regularly truck to landfills for throwing away, but recycling devours a number of aids that have made it a more attractive option in this age of greater conservational awareness, more conservation rubrics, and the craving to keep construction costs down.

Concrete is the second most consumed material after water and it shapes our built environment. Homes, schools, hospitals, offices, roads and runways all make use of concrete. Concrete is extremely durable and can last for hundreds of years in many applications. However, human needs change and waste are generated more than 900 million tons per annum in Europe, the US and Japan alone, with unknown quantities elsewhere. Concrete recovery is achievable concrete can be crushed and reused an aggregate in new projects.

Recycling or recovering concrete has two main advantages: (1) it reduces the use of new virgin aggregate and the associated environmental costs of exploitation and transportation and (2) it reduces unnecessary landfill of valuable materials that can be recovering and redeployed.

The main objective of this report is to promote concrete recycling as an issue and encourage thinking in this area. It provides some discussion of key issues without going into significant technical details. The report ultimately promotes a goal of “zero landfills” of concrete. With good initial planning and design, well-considered renovation and managed demolition, sustainable development using concrete are achievable. The report recommends that all players adopt sustainable thinking when it comes to concrete. It also recommends a series of key indicators. There is a lack of reliable and consistent statistics. Improved reporting coupled with clear objectives will ultimately lead to improved performance and less concrete in landfills.

III. DESIGN METHODOLOGY

The overall experimental program consisted of two stages: (1) a comprehensive study of the properties of new concrete made with recycled aggregate that was prepared by crushing partially hydrated old concrete; (2) a study of the effect of recycled fines only on the properties of new concrete. This paper presents the results of stage 1 of the study. Demolished concrete blocks were collected from the structural members of the demolished buildings. The collected concrete samples were broken into pieces mechanically in particular sizes as 5 mm to 20 mm which FM is 4.20. The aggregates were tested for absorption capacity, specific gravity, moisture content, unit weight, and FM. The specific gravity and absorption capacity are determined as per ASTM C128, unit weight as per ASTM C29. The FM, water absorption and specific gravity of sand used in this investigation were 1.83, 3.95%, and 2.55, respectively. After investigation of aggregates, concrete cube specimen of size 100 mm x 100 mm x 100 mm in were made for evaluation of compressive strength at 7, 21, 28 and 60 days as per ASTM C39. W/C ratios of RAC were 0.65, 0.61 and 0.52. In addition, W/C ratio of FAC was 0.48, 0.45 and 0.39. Cement content of concrete was 185 kg/m³ as per ACI211.1-91 (Table-6) for all cases. After mixing concrete, the workability of concrete was measured by slump cone test. Then the specimens are cured under water continuously. The compressive strength of concrete was measured at 7, 21, 28 and 60 days by using Universal Testing Machine (UTM). The failure surfaces of concrete were also checked carefully after crushing of the concrete cube. About 72 concrete cubes were investigated for 6 cases as summarized.

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RESULTS AND DISCUSSION

Sample: Recycled Aggregate Concrete

Design Data,

Design Strength, (F_{min})	= 21 MPa	
Standard deviation, (S)	= 4.5	{S value is taken from Table-8, P-24}
Specific Gravity of (F.A)	= 2.54	
Specific Gravity of (C.A)	= 2.14	
Unit wt. of (C.A)	= 1235 kg/m ³	
Fineness Modulus of (F.M)	= 1.83	
Maximum Size of C.A	= 20 mm	
Slump value	= 50 mm	
Absorption Capacity of C.A	= 8.64 %	
Free surface Moisture in (F.A)	= 2.38 %	
(K)	= 1.64	{K value is taken from Table-1, P-20}

Step-1: Mean Strength

$$\begin{aligned}
 F_{m} &= F_{min} + K S \\
 &= 21 + 1.64 \times 4.5 \\
 &= 28.81 \\
 &= 28 \text{ MPa}
 \end{aligned}$$

Step-2: Water /Cement Ratio

For Mean strength, f_m	= 28 MPa
W/C	= 0.57
For Exposure	= 0.50

Step-3: Amount of Water & Cement

Water content	= 185	kg/m ³	{From Table-6, P-23}
Cement content	$= \frac{185}{0.50}$	kg/m ³	
	= 370	kg/m ³	

Step-4: Volume of Coarse Aggregate

F.M of fine Aggregate	= 1.83
Bulk Volume of C.A	= 0.72 m ³ /m ³ of Concrete

Step-5: Weight of Coarse Aggregate

$$\begin{aligned}
 \text{Weight of coarse Aggr.} &= 0.72 \times 1235 \\
 &= 889.2 \text{ kg/m}^3 \text{ of Concrete}
 \end{aligned}$$

Step-6: Unit weight of Concrete

Unit weight of Concrete	= 2355 kg/m ³	{From Table-7, P-24}
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Step-7: Resulting Amount of Materials

Weight of Water	= 185	kg/m ³
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Weight of Cement = 370 kg/m³
Weight of C.A = 889 kg/m³
Weight of F.A = 2355-(185+370+889)
= 911 kg/m³

Step-8: Proportion

Materials = Cement: F.A: C.A: Water
= 370: 911: 889: 185
Ratio = 1: 2.46: 2.40: 0.50

Step-9: Proportion required for field application

Free Surface Moisture in F.A = $\frac{2.38 \times 911}{100}$ = 21.68 kg
F.A in field application = 911 + 21.68 = 933 kg/m³
Water absorption by C.A = $\frac{8.64 \times 889}{100}$ = 76.8 kg
Water in field application = 185+76.8-21.68 = 240 kg/m³

Step-10: Final Proportion

Materials = Cement: FA: CA: Water
= 370: 933: 889: 240
Ratio = C: FA: CA: W
= 1: 2.52: 2.4: 0.65

Table: .1 Concrete mix design ratio by (ACI-211.1-91):

Using Recycled Aggregate				
Strength	Cement	Sand	Stone	W/C
M 21 (±3000 psi)	1	2.53	2.39	0.65
M 28 (±4000 psi)	1	2.33	2.26	0.61
M 32 (±4600 psi)	1	1.83	1.92	0.53
Using Fresh Aggregate				
Strength	Cement	Sand	Stone	W/C
M 21 (±3000 psi)	1	1.81	3.10	0.48
M 28 (±4000 psi)	1	1.65	2.93	0.45
M 32 (±4600 psi)	1	1.25	2.49	0.39

Table 2 Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 21

Recycled vs Fresh Concrete Strength M-21 (±3000 psi)				
Days	Recycle (MPa)	Fresh (MPa)	Recycle (psi)	Fresh (psi)
7	7.54	11.91	1093.10	1726.41
21	15.64	20.72	2267.64	3004.02
28	16.31	20.90	2364.92	3030.90
60	17.60	22.61	2551.47	3278.11

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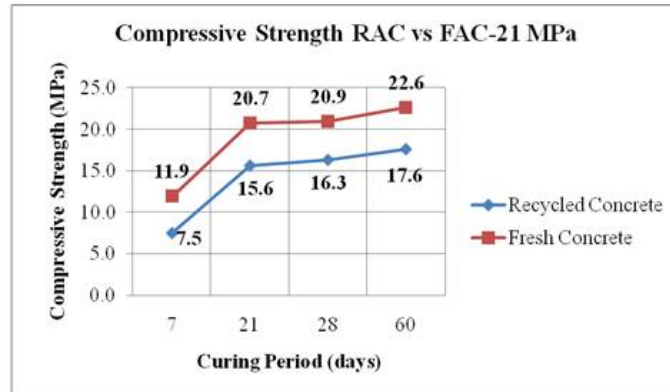


Fig 1 Graph showing Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 21.

Table 3 Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 28

Recycled vs Fresh Concrete Strength M-28 (± 4000 psi)				
Days	Recycle (MPa)	Fresh (MPa)	Recycle (Psi)	Fresh (Psi)
7	11.16	16.02	1617.62	2322.68
21	17.78	23.04	2577.72	3340.51
28	17.95	27.69	2602.95	4014.74
60	19.60	28.23	2842.12	4094.03

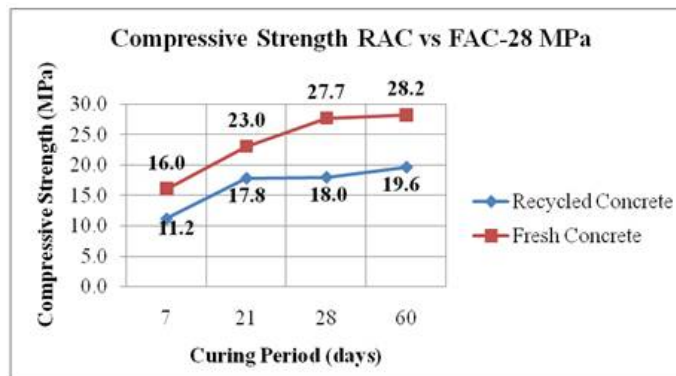


Fig 2 Graph showing Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 28.

Table 4 Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 32

Recycled vs Fresh Concrete Strength M 32 (± 4600 psi)				
Days	Recycle (MPa)	Fresh (MPa)	Recycle (Psi)	Fresh (Psi)
7	14.99	16.47	2173.26	2388.41
21	21.08	31.63	3056.93	4586.08
28	22.41	31.90	3249.92	4625.41
60	22.89	32.13	3319.63	4658.74

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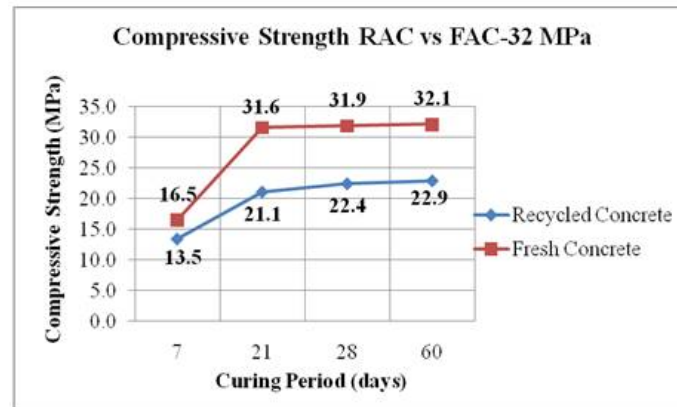


Fig. 3 Comparison of concrete compressive strength Recycle Aggregate Concrete (RAC) vs. Fresh Aggregate Concrete (FAC) between Curing Periods M 32.

IV. CONCLUSION

Based on the laboratory investigations, the following conclusions are made:

1. Concrete strength from 17.5 ~ 23.0 MPa can be obtained using recycled coarse aggregate.
2. The water requirement for all the mixes is different and especially for mixing with recycled coarse aggregates, so workability is poor then fresh aggregate concrete.
3. The density of concrete is another important factor. The results indicated that all the concrete mixes with recycled aggregate have less density as compared to fresh aggregate concrete.
4. Recycled aggregate concrete is not suitable for high strength concrete..

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