International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON PROPERTIES OF SELF COMPACTING CONCRETE WITH PARTIAL REPLACEMENT OF NATURAL COARSE AND FINE AGGREGATE WITH RECYCLED COARSE AND FINE AGGREGATE

R. Pravallika[1], M. Ramachandra Rao[2]

[1]Post Graduate Student, NRI Institute of Technology, Pothavarappadu, Andhra Pradesh, India.
[2]Associate Professor, M.Tech(IIT-Bombay), Dept. of Civil Engineering, NRI institute of technology.

Abstract - *An Experimental study on properties of self compacting concrete with partial replacement of natural coarse and fine aggregates with recycled coarse and fine aggregates. Now a day's most of the researches concentrate on recycling of non renewable resources to renewable resources. In this study natural coarse and fine aggregates are partially replaced with recycled coarse and fine aggregate (RCA, RFA) with percentages of 25% and 50% of NCA with RCA, 10% and 20% of NFA with RFA, by which the solid waste produced by the destruction of structures can be reduced and also the non renewable resources can also be partially renewable. Mix design is carried out as per IS 10262 (2009) guide lines for M40 grade concrete. Tests are conducted on different samples to determine the properties of SCC in fresh state (Slump cone test, V-Funnel test) and in hardened state (i.e., compressive strength, flexure strength and split tensile strength). The experimental results indicates that there is no significant effect on fresh properties of concrete up to 50% replacement of RCA and 20% of RFA, but the hardened properties like compressive strength, flexural strength and split tensile strength of the SCC are decreased with increase in replacement percentages of RCA and RFA.*

***Key Words*: *Natural Coarse Aggregate (NCA), Recycled Coarse Aggregate (RCA), Self Compacting Concrete (SCC), Natural fine aggregate (NFA), Recycled fine aggregate(RFA), Fresh Concrete, Hardened concrete*.**

1. INTRODUCTION

Self-compacting concrete (SCC) is a type of concrete which can be placed and consolidated under its own weight without any vibration effort due to its excellent deformability, and at the same time which is cohesive enough to be handled without segregation or bleeding[1]. Now a day's SCC is most desirable type of concrete which is mainly used in heavy reinforced structures due its properties like high flowablity, non-segregating, and it can easily settle into formworks, encapsulates, and heavily reinforced narrow and deep sections by means of its own weight. As the part of development, constructions and demolishing of structures are being increasing which leads to the increase of solid waste and effects the environment due to scarcity of such land filling sites, unplanned disposal, and environmental cost of transporting demolition waste [4]. As per the report from the Ministry of Environment, Forest and Climate Change the waste produced from construction and demolition of buildings is about 530 million tons annually [2]. In order to reduce the land filling problems and environmental issue caused to deposition of construction waste most of the researches are trying to use that waste as recycled fine and coarse aggregates which is the sustainable solution to reduce solid waste from demolition of buildings[5-7]. However, the use of RCA may reduce the quality of concrete as coarse RCAs are generally of poorer quality than natural coarse aggregates, with greater water absorption [3] and lower density. The quality of the RCA depends not only on the original aggregate, but also on the quality and quantity of adhered mortar [5]. The previous researches confirmed that the reduction in stiffness (i.e., elastic modulus) is higher than the reduction in strength [8,9]. In this paper fresh and hardened properties of self compacting concrete like workability, compressive strength, Split tensile strength and flexure strength with partial replacement of natural coarse and fine aggregate with recycled coarse and fine aggregates are determined.

2. SCOPE AND OBJECTIVES OF THE STUDY

The main scope of the study is

- To study the necessity of using of recycling concrete as the partial replacement of raw materials used in concrete mixing.
- To examine the effectiveness of using Recycled coarse (RCA) and fine aggregates (RFA) as partial replacement by studying strength parameters.

The main objective of the experimental investigation is to determine the utility of recycled coarse and fine aggregates as replacements of natural aggregates in concrete mixing.

- To study the properties of recycled aggregates that can be used in concrete mixing.
- To Study the strength characteristics of concrete like compressive strength, split tensile strength and

flexural strength at different replacement percentages.

3. MATERIALS AND METHODOLOGY

The raw materials that are used in preparation of SCC are ordinary Portland cement of 53 grade confirming to IS12269-2013[10] which has the specific gravity of 3.15, natural fine aggregates from locally available river sand which is in zone II confirming to IS 383-1987[14] having the specific gravity of 2.58, natural coarse aggregates of size 10mm to 12.5mm which are having specific gravity of 2.67 are used, recycled coarse and fine aggregates. Recycled coarse aggregate are obtained from crushing of concrete which contains original aggregate attached with mortar. The attached mortar is light and porous in nature. Therefore, the specific gravity and density of recycled aggregate are relatively less when compared to natural aggregate [13]. In this paper recycled coarse and fine aggregates are obtained by crushing of concrete cubes of M20 grade which are already used for various experiments in concrete lab without any replacements, the cubes are crushed to reduced the size of aggregates varies between 10 to 12.5mm and the recycled fine aggregates is from the crushed powder of concrete cubes which passes through the 4.75mm sieve is collected of required amount. The specific gravity of the recycled coarse aggregates used in this experiment is 2.54, fineness modulus is 6.9, density is 1356 kg/m3 and crushing value is 29.3%. Specific gravity of recycled fine aggregates used in the experiment is 2.28 and fineness modulus is 3.1. And the super plasticizer used to reduce W/C ratio is master glenium sky B233. MasterGlenium SKY 8233 is an admixture of a new generation with modified polycarboxylic ether[15]. MasterGlenium SKY 8233 is used as admixture because of its properties like free of chloride & low alkali and it is also compatible for all types of cements. The water used in the experiment is drinking water of Ph range from 6.2 to 6.5 and it is also free from oil, alkali, acid, etc.

The experiment was conducted by replacing natural coarse aggregates with 25% and 50% of recycled coarse aggregate and natural fine aggregates with recycled fine aggregates at 10% and 20%. The results were compared with the results of SCC concrete without any replacements. 3 cubes and 3 cylinders were casted for each and every replacement. Specimens were demoulded after 24hours and placed in curing tank till the specimens were tested after 7, 28 and 90 days for compression, flexural strength and split tensile strengths.

FIGURE-1

FIGURE-2

4. Mix Design

Mix design used in the project is M40 grade designed per IS10262: 2009[11] and the same grade is used for prepare the test samples.

Mix design proportions

Table:1 Mix design proportions for M40 grade concrete

Mix type	cement	Fine aggregate	Coarse aggregate
M40	1	1.95	2.85

Table:2

Mass proportions for 1m3 of M40 grade concrete in Kg/m3 at different percentage replacements of recycled aggregates.

Cement	F.A	C.A	% RFA	RFA	% RCA	RCA	water	SP	VMF
410	801	1168	0	0	0	0	155	7.38	2.05
410	721	876	10	80	25	292	155	7.38	2.05
410	721	584	10	80	50	548	155	7.38	2.05
410	641	876	20	160	25	292	155	7.38	2.05
410	641	584	20	160	50	284	155	7.38	2.05

5. Results and Discussion

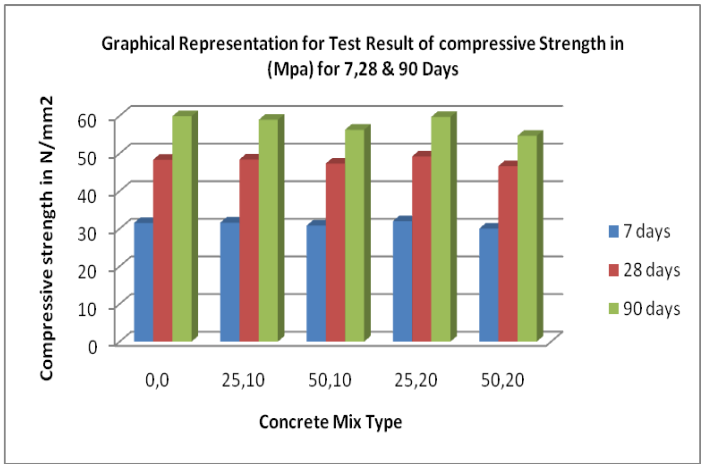
Compressive strength test, Flexural strength test and Split tensile strength test were conducted at the end of 7, 28 and 90 days on the concrete specimens. The test results are indicated in the corresponding graphs are as follows:

a. Compression test

Concrete cubes of size 150mmX150mmX150mm are used to determine the compressive strength. Results are shown in following table in N/mm2.

Table -3: Compressive Strength of Cubes for M40 mix

Concrete type (RCA%,RFA%)	7 days	28 days	90 days
0,0	31.52	48.34	59.89
25,10	31.61	48.4	58.93
50,10	30.82	47.32	56.28
25,20	30.48	47.68	58.72
50,20	30.01	46.65	54.69



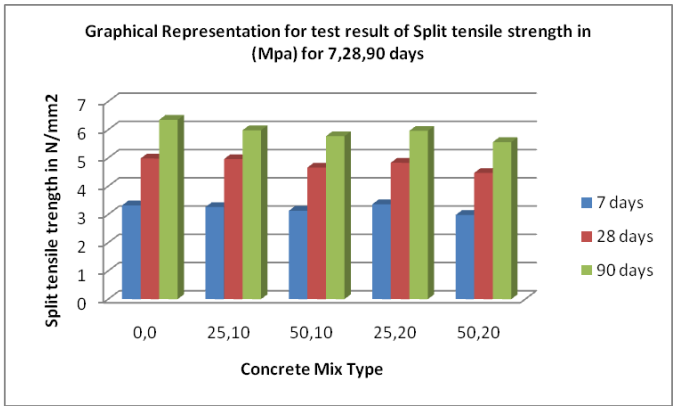
Graph-1

b. Split tensile strength test

Concrete cylinders of size 300mm*150mm are used to determine the split tensile strength. Results are shown in following table in N/mm2.

Table -4: Split-Tensile Strength of Cylinders M40 mix

Concrete type (RCA%,RFA%)	7 days	28 days	90 days
0,0	3.32	4.98	6.35
25,10	3.26	4.96	5.98
50,10	3.13	4.66	5.77
25,20	3.19	4.83	5.93
50,20	2.98	4.47	5.56



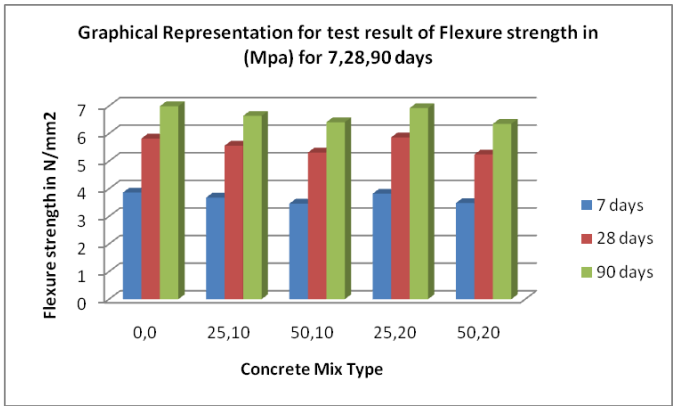
Graph-2

c. Flexure strength test

Concrete beams of size 500mm*100mm*100mm are used to determine the flexure strength. Results are shown in following table in N/mm2.

Table -5: Flexure Strength of Cylinders M40 mix

Concrete type (RCA%,RFA%)	7 days	28 days	90 days
0,0	3.86	5.82	6.99
25,10	3.68	5.56	6.64
50,10	3.46	5.31	6.41
25,20	3.57	5.46	6.58
50,20	3.48	5.24	6.35



Graph-3

6. CONCLUSIONS

In this study recycled coarse and fine aggregates are used for replacing of natural aggregates with recycled coarse aggregates up to 50% and recycled fine aggregates upto 20%.

1). Using of Recycled aggregate as raw material in concrete reduces the cost of construction and also reduces the solid waste produced by construction and destruction operations.

2). Test results shows that the workability of SCC concrete does not show any significant effect by replacing natural aggregates with recycled aggregates. It is similar to SCC with 0% replacements.

3) The use of recycled aggregates as the replacement of natural aggregates increases the w/c ratio because the water absorption percentage of recycled aggregates is much higher than the normal aggregates.

4) From the experimental results the compressive strength, split tensile strength and flexure strength are decreased with increase in replacements percentages of coarse aggregates.

5) At 25% and 20% of replacements of recycled coarse and fine aggregates respectively the strength values are similar to normal SCC concrete without replacements.

REFERENCES

[1] Construction and Building materials 2015.

[2] The Construction and Demolition (C&D) Waste Management Rules, 2016 was notified vide G.S.R. 317(E) 29th March, 2016 by the Ministry of Environment, Forest and Climate Change (MoEF&CC).

[3] Use of Recycled Aggregate Concrete Mr. Tushar R Sonawane1 ,Prof. Dr. Sunil S. Pimplikar2 1 research Graduate Maeer's Mit Pune, 2 h. O. D. Civil Engg.Department, Maeer's Mit Pune.

[4] M. D. Safiuddin, U. J. Alengaram, M. A. Salam, M. Z. Jumaat, F. F. Jaafar, and H.B. Saad, "Properties of high-workability concrete with recycled concrete aggregate," Materials Research, vol. 14, no. 2, pp. 248–255, 2011.

[5]Properties of Self-Compacting Concrete with Recycled Coarse Aggregate W. C. Tang,1 P. C. Ryan,2 H. Z. Cui,3 and W. Liao4

[6] Er. Rajan Vinayak1, Er. Gurprit Singh Bath2,Er. Vineet Garg3 "COMPARISON OF PROPERTIES BETWEEN NATURAL AGGREGATES & RECYCLED AGGREGATES"

[7] GRA -GLOBAL RESEARCH ANALYSIS X 73 "A Study on Recycled Aggregate as a Substitute to Natural Aggregate for Sustainable Development in India" by Hiren A. Rathod, Jayeshkumar Pitroda.

[8] J. Xiao, J. Li, and C. Zhang, "Mechanical properties of recycled aggregate concrete under uniaxial loading," Cement and Concrete Research, vol. 35, no. 6, pp. 1187–1194, 2005.

[9] A. Katz, "Properties of concrete made with recycled aggregate from partially hydrated old concrete," Cement and Concrete Research, vol. 33, no. 5, pp. 703–711, 2003.

[10] IS 12269 : 2013 "ORDINARY PORTLAND CEMENT, 53 GRADE -SPECIFICATION".

[11] IS 10262 (2009): Guidelines for concrete mix design proportioning [CED 2: Cement and Concrete].

[12] IS 456 (2000): Plain and Reinforced Concrete - Code of Practice [CED 2: Cement and Concrete]

[13] Study on Use of Recycled Coarse Aggregate In Concrete Hardik Gandhi# , Dr.Dharshana Bhatt*, Chetnaben Vyas** #PG student Structural Engineering Department, B.V.M.Engg, college, v.v.nagar, Gujarat

[14] IS 383 (1970): Specification for Coarse and Fine Aggregates from Natural Sources For Concrete [CED 2: Cement and Concrete]

[15] MasterGlenium SKY 8233 - High-performance super plasticiser based on PCE (polycarboxylic ether) for concrete