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"An Experimental Study on Sustainable Concrete Using Recycled Demolition Waste"

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Abstract: This paper presents an experimental investigation into the properties and performance of sustainable concrete In this study the natural aggregate replaced by recycled aggregate in different percentages (0%,20%,40%,60%,80%,100%). The percentage of recycled aggregate mixed in the definite proportion it improves the property of fresh and hardened concrete like slump test, compressive strength flexural strength & tensile strength test up to optimum percentage. The results demonstrate that sustainable concrete can achieve comparable, if not superior, performance to conventional concrete, while significantly reducing carbon footprint and resource consumption. This study underscores the potential of sustainable concrete to transform the construction industry towards more sustainable practices.

Keywords: Recycled aggregate, Slump Test, Crushing Value, Impact value, compressive strength, flexural strength, tensile strength

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I. INTRODUCTION

The construction industry is a major consumer of natural resources and a significant contributor to environmental pollution. Traditional concrete, a primary material in construction, is responsible for a substantial amount of carbon dioxide emissions due to the production of cement. Green concrete aims to mitigate these environmental impacts by incorporating waste materials and reducing the reliance on virgin resources. Using RA has big opportunity to maintain healthy atmosphere, the properties and characteristics of RA has not been fully investigate so far. While it is hard to regulate the characteristic of RA, every researcher who study recycled aggregate must execute experiment of their concrete, which will be used for RA, to increase the characteristics of their specimens. The quality of RA could be different by its parent concrete because the parent concrete was planned for its purpose such as permeable, durable and high strength concrete. For example w/ratio of concrete will give an impact on water absorption capacity of RA which is correlated to uniqueness of concrete issue such as durability, permeability, strength and elastic modulus. There is a remarkable turn down in high-quality aggregate accessible for construction use. Construction and demolition waste makes up a large portion of all generated solid waste. The charge of worth aggregate has enlarged beyond the rise rate and it is expected that this tendency will carry on as additional limitations are placed on this source in the future. Concrete construction and demolition waste will be recycled if it is less expensive than disposing of it in a landfill and RAC will be used if it is less costly than natural aggregate of comparable quality. RAC use is based on financial side, together with the charge of transport construction and demolition waste and natural aggregate, the charge of construction and demolition disposal, and government intervention on tipping fees and mandatory usage through legislation. Around 60% of aggregate charge is due to transportation.

II. MATERIAL USED

2.1 Cement: In this research work, OPC conforming to IS: 8112-1989 is used.

2.2 Sand: Locally existing sand with 4.75 mm maximum dimension is used as FA.

2.3 Natural Aggregate: Crushed stone with 20 mm maximum size are used as natural aggregate.

2.4 Recycled Aggregate: The RAC passing through 20mm and retained on 4.75mm size aggregate is used.

III. EXPERIMENTAL WORK & RESULT

3.1 Mix Design for M-40 Grade: Mix design as per IS 10262-2009 & IS 456-2000 the ratio of M-40 grade concrete are given below in the table

Table 3.1: Mix Proportions

Cement	Water	FA	CA	W/C Ratio
336 kg/m3	151 kg/m3	768 kg/m3	889 kg/m3	0.41
1	0.41	1.83	2.65	0.41

3.2 Testing of Aggregate:

The results for material tests like water absorption test, specific gravity test, Aggregate crushing value test, Aggregate Impact Value test are given in the Table 3.2 below.

Table 3.2: Final result of all tests on Materials

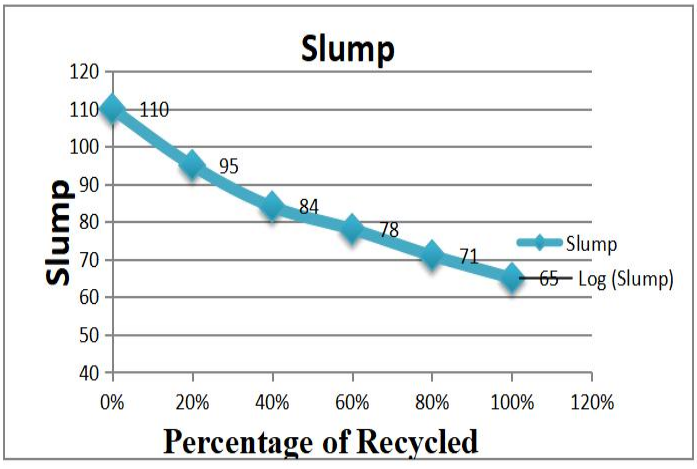
S. No.	Particulars	Natural Aggregate	Recycled Aggregate
1	Water Absorption	1.83%	4.4%
2	Specific gravity	2.75	2.85
3	Agg. Crushing Value	15.20 %	22.46 %
4	Agg. Impact Value	7.64%	11.33%

3.3 Test on Fresh Concrete:

3.3.1 Slump Test: From the below table 3.3 shows that the result of slump test the value of slump decrease when percentage of recycled aggregate increases.

Table 3.3: Slump Test Result

Percentage of Recycled Aggregate in the mix	Percentage of Natural Aggregate in the mix	Slump (mm)
0%	100%	110
20%	80%	95
40%	60%	84
60%	40%	78
80%	20%	71
100%	0%	65



Graph 3.1: Variation in Slump value

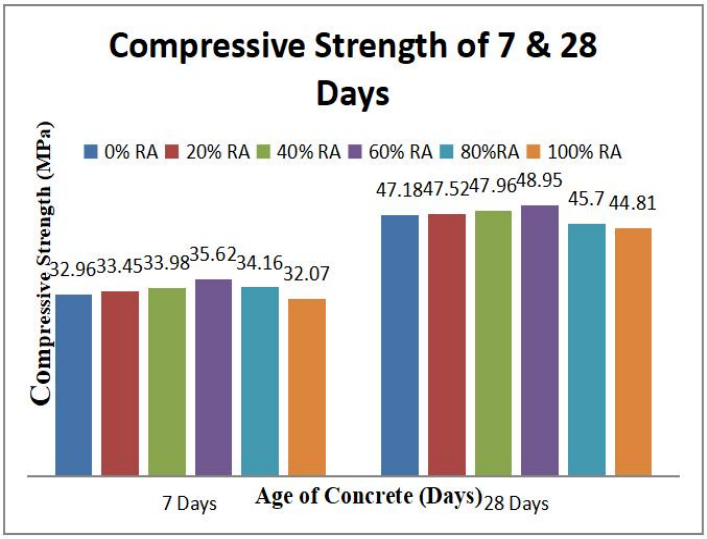
According to these test results, we found that the highest slump obtained was 60 mm and the lowest slump was 20 mm. It has been observed that the workability of the concrete mix was decreases with increase in the replacement level of natural aggregate with recycled aggregate.

3.4 Testing of Hardened Concrete:

3.4.1 Compressive Strength: The compressive strength test by Compression Testing machine shows an increasing trend of the compressive strength with age of the concrete specimens. Table-3.5 below shows the increase of the compressive strength with age recorded during the test.

Table 3.4: Variation of compressive strength with age

% of RA	0%	20%	40%	60%	80%	100%
7 Days	32.96 MPa	33.45 Mpa	33.98 Mpa	35.62 Mpa	34.16 MPa	32.07MPa
28 Days	47.18MPa	47.52 Mpa	47.96 Mpa	48.95 Mpa	45.70MPa	44.81MPa



Graph 3.2: Variation in Compressive Strength with increasing % of Recycled Aggregate

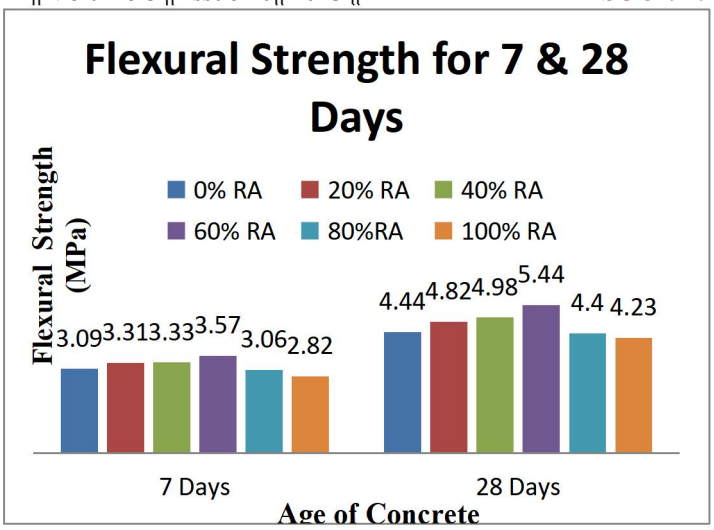
3.4.2 Flexural Strength

Flexural strength test is performed on 2 beams of each batch mix for 7 days & 28 days. There are 6 batch mixes and each one having 9 beams. Of these 9 beams, 3 beams are tested for 7 days & 28 days each. An average of 3 values as tabulated in table 3.5, are considered for discussions

Table 3.5: Variation of flexural strength with age

% of RA	0%	20%	40%	60%	80%	100%
7 Days	3.09MPa	3.31MPa	3.33MPa	3.57 MPa	3.06MPa	2.82MPa
28 Days	4.44MPa	4.82MPa	4.98MPa	5.44MPa	4.40MPa	4.23MPa

Graph 3.3: Variation in Flexural Strength with increasing % of Recycled Aggregate

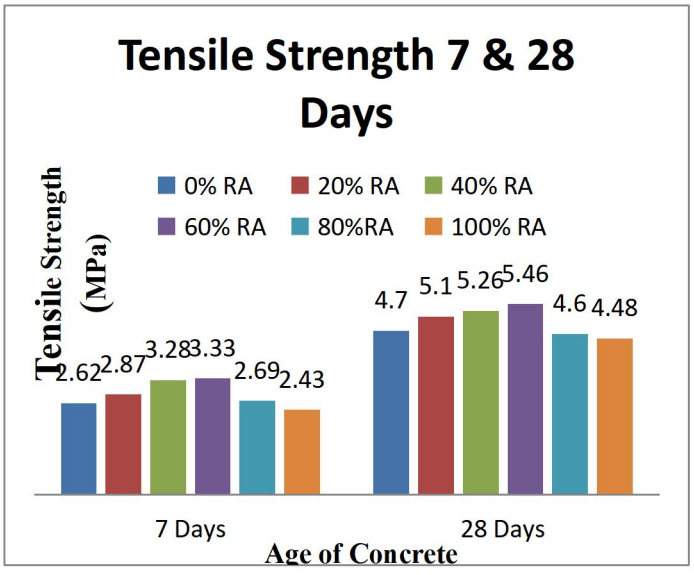


3.4.3 Split Tensile Strength

Split Tensile Strength is performed on 3 cylinders of each batch mix for 7 days & 28 days. There are 7 batch mixes and each one having 9 cylinders. Of these 9cylinders, 3 cylinders are tested for 7 days & 28 days each. An average of 3 values as tabulated in table 3.6, are considered for discussions.

% of RA	0%	20%	40%	60%	80%	100%
7 Days	2.62 MPa	2.87MPa	3.28MPa	3.33MPa	2.69MPa	2.43MPa
28 Days	4.70MPa	5.10MPa	5.26MPa	5.64MPa	4.60MPa	4.48MPa

Table 3.6: Variation of Split Tensile strength with age



Graph 3.4: Variation in Tensile Strength with increasing % of Recycled Aggregate

IV. CONCLUSION

After performing all the tests and analyzing their result, the following conclusions have been derived:

1. From the result of crushing value & impact test the recycled aggregate is having more resistance to the wear and tear than the natural aggregate.
2. The workability of the concrete considerably reduces as the amount of recycled aggregate increases in the concrete mixture
3. Maximum compressive strength was observed 35.62 Mpa & 48.95 Mpa (for 7 & 28 days) when recycled aggregate replacement is about 60% for M-40 grade concrete and after that there is decrease in compressive strength of concrete with further replacement of natural coarse aggregate.
4. Maximum flexural strength was observed 3.57 Mpa & 5.44 Mpa (for 7 & 28 days) when recycled aggregate replacement is about 60% for M-40 grade concrete and after that there is decrease in flexural strength of concrete with further replacement of natural coarse aggregate.
5. Maximum tensile strength was observed 3.33 Mpa & 5.46 Mpa (for 7 & 28 days) when recycled aggregate replacement is about 60% for M-40 grade concrete and after that there is decrease in tensile strength of concrete with further replacement of natural coarse aggregate.

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