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"Influence of Recycled Concrete Aggregates on Strength Properties of Concrete"

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Abstract: *To avoid the pollution and reuse the material natural coarse aggregate is replaced by recycled aggregate. By the use of recycled aggregate it is possible to reduce carbon di oxide. The recycled aggregate are eco-friendly to the environment. In this research covers the how to choose a material for recycled aggregate 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, flexural strength & split tensile strength test up to optimum percentage. From the laboratory test results indicates that the compressive strength of these mixtures goes on decreasing, however up to the 20% replacement level, it achieves target mean strength. Hence, for the structural concrete Natural Aggregate can be replaced by the Recycled Aggregate up to 20% range.*

Keywords: Recycled aggregate, Specific flexural strength, tensile strength, Ultrasonic Pulse Velocity, NDT

1. INTRODUCTION

To get sustainable issue in construction area, researchers and company center on using waste concrete as a fresh construction material. It is called recycled aggregate (RA) which can be produced by concrete crusher. 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. Globally aggregate use is estimated to be 10-11 billion tonnes every year, of this, about 8 billion tonnes of aggregate (sand, gravel, and crushed rock) are being used in PCC every year. The environmental impact of devastate concrete is considerable. Not just is there the environmental impact of transport the waste concrete away from the location but the waste concrete also fill up precious space in landfills. 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.

2. MATERIAL USED

2.1 Cement: In this research work, OPC conforming to IS: 8112-1989 is used. The properties of cement used are shown in Table 1.

Table 1: Properties of cement

Physical Property	Result
Fineness of cement	9%
Normal Consistency	27%

Initial setting time (minutes)	35
Final setting time (minutes)	370
Specific Gravity	3.14

2.2 Sand: Locally existing sand with 4.75 mm maximum dimension is used as FA, having specific gravity, fineness modulus and unit weight as given in Table 2

Table 2: Properties of sand (FA)

Physical Property	Result
Fineness modulus	3.2
Specific Gravity	2.67
Surface Texture	Even
Particle shape	Curved

2.3 Natural Aggregate: Crushed stone with 20 mm maximum size having specific gravity, fineness modulus and unit weight as given in Table 3 are used as natural aggregate.

Table 3: Properties of sand (FA)

Physical Property	Result
Fineness modulus	7.56
Specific Gravity	2.70
Particle shape	Angular

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

3. 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 4: 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

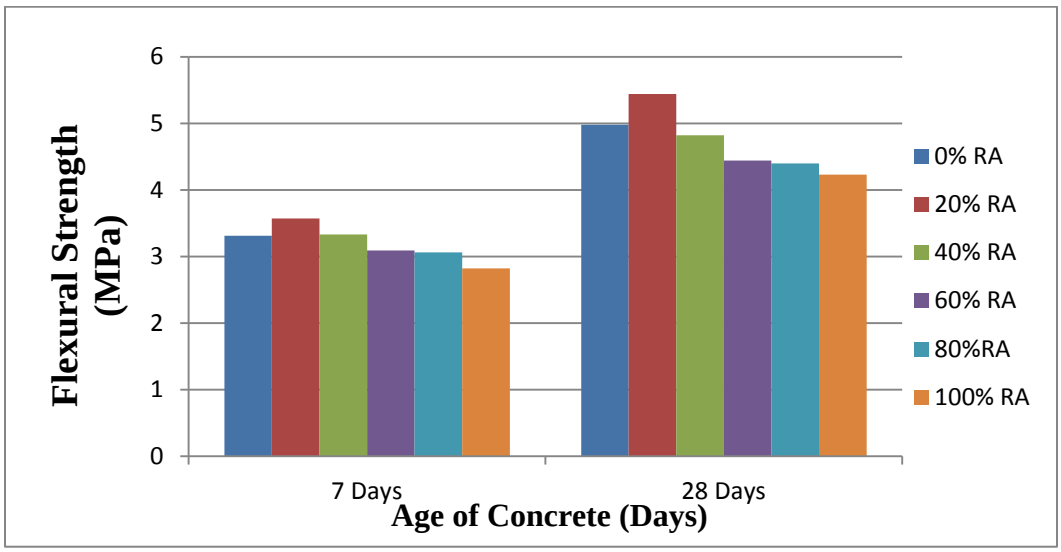
3.2 Testing of Concrete:

3.2.1 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 6.4, are considered for discussions

Table 6.4: Variation of flexural strength with age

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



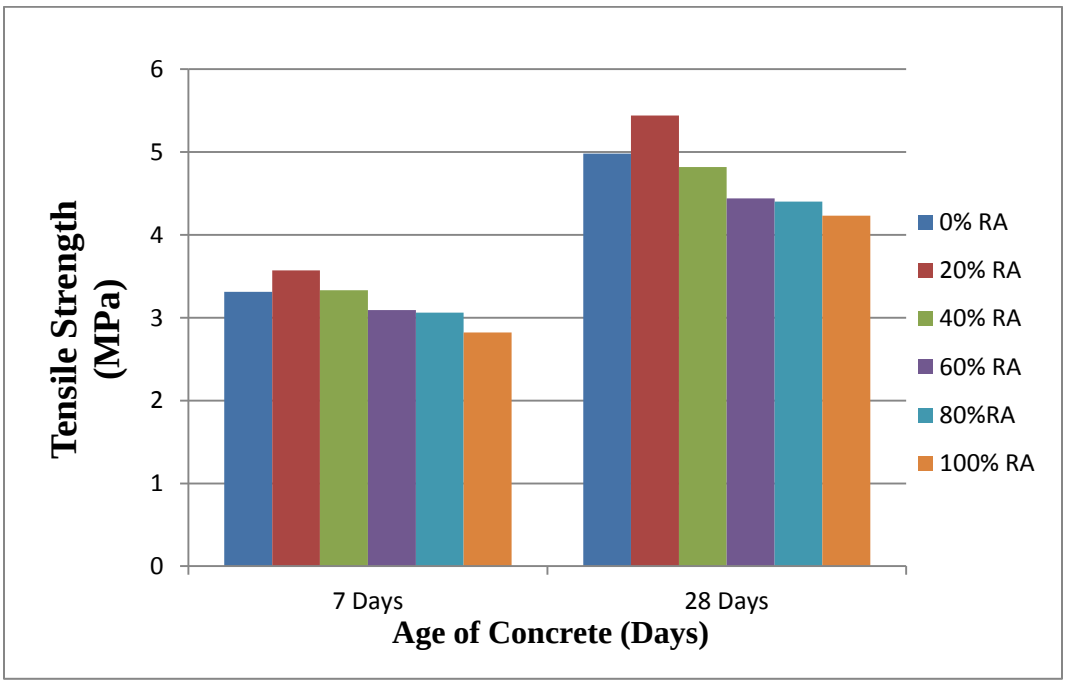
Graph 1: Variation in Flexural Strength with increasing % of Recycled Aggregate

3.3.2 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 6.5, are considered for discussions.

Table 6.5: Variation of Split Tensile strength with age

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

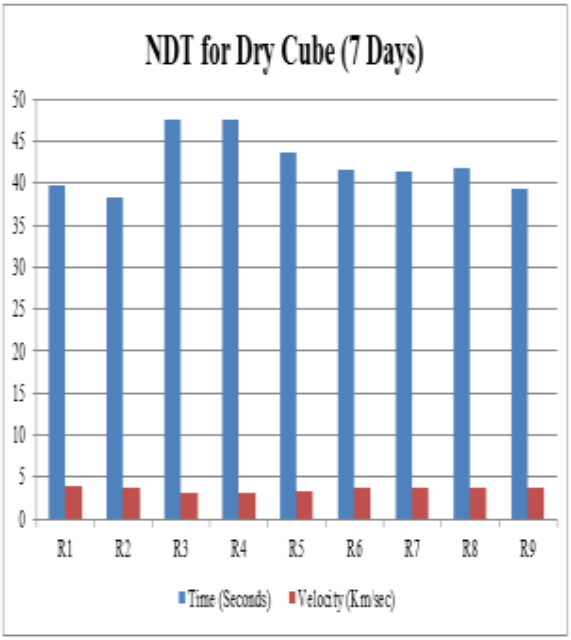


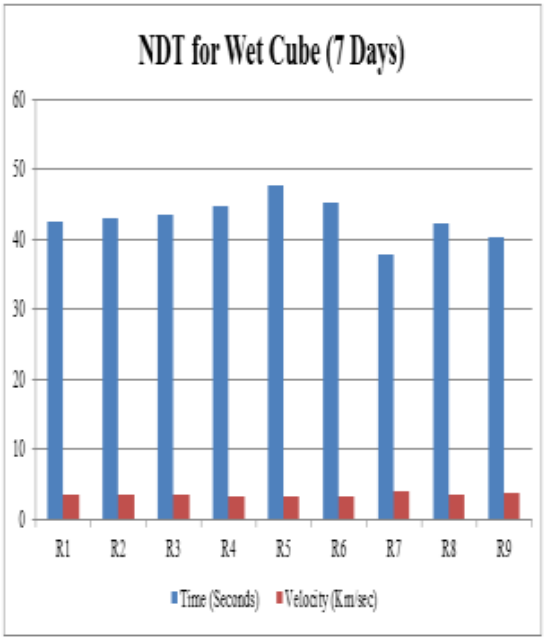
Graph 2: Variation in Tensile Strength with increasing % of Recycled Aggregate

3.3.3 Result Analysis of Ultrasonic Pulse Velocity(UPV): Since after doing the partition of M45 cube, has been cured for 7 days and 28 days, following results has been drawn shown in table below along with its graphical representation:-

Table 2: NDT of Cube for 7 days

Reading No.	Type of Specimen	Type of Transmission	Path Length (mm)	Dry (8.7 KG)		Wet (8.75 KG)	
				Time	Velocity	Time	Velocity
R1	CUBE (150mm x 150 mm x 150 mm) Grade M 45	Direct	150	39.8	3.88	42.5	3.54
R2		Direct	150	38.3	3.82	43	3.45
R3		Direct	150	47.6	3.15	43.4	3.46
R4		Direct	150	47.5	3.18	44.6	3.31
R5		Direct	150	43.7	3.4	47.7	3.12
R6		Direct	150	41.6	3.68	45.3	3.28
R7		Direct	150	41.3	3.63	37.8	3.94
R8		Direct	150	41.9	3.7	42.2	3.47
R9		Direct	150	39.4	3.72	40.3	3.71
		Average Velocity			3.96		3.47



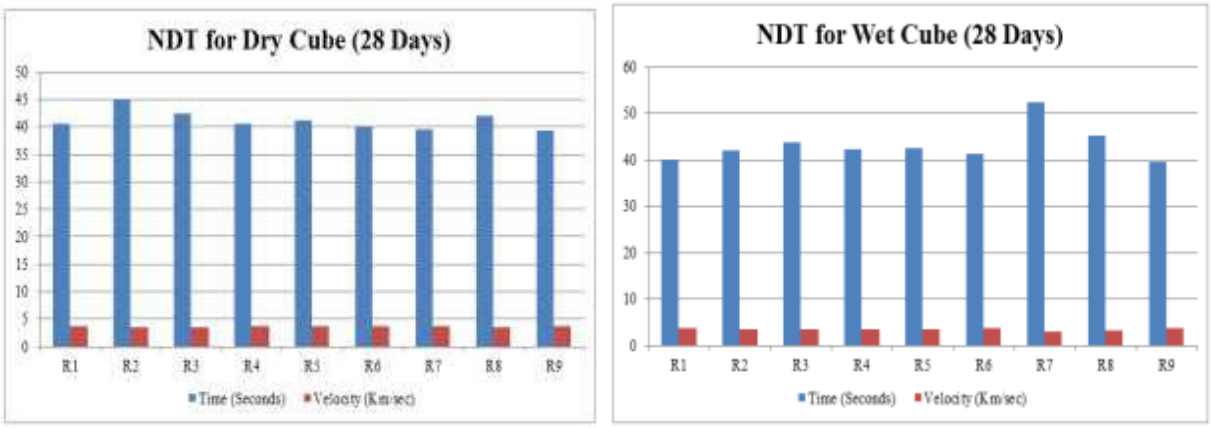


Graph 3: NDT of Dry and Wet Cube (7 days)

Table 2: NDT of Cube for 7 days

Reading No.	Type of Specimen	Type of Transmission	Path Length (mm)	Dry (8.7 KG)		Wet (8.75 KG)	
				Time	Velocity	Time	Velocity
R1	CUBE (150mm x 150 mm x 150 mm)	Direct	150	40.5	3.72	40	3.72
R2		Direct	150	44.8	3.42	42.1	3.58
R3		Direct	150	42.5	3.52	43.7	3.43

R4	Grade M 45	Direct	150	40.5	3.69	42.3	3.55
R5		Direct	150	41.2	3.64	42.5	3.51
R6		Direct	150	39.9	3.75	41.3	3.63
R7		Direct	150	39.5	3.75	52.4	3.88
R8		Direct	150	42	3.52	45.2	3.32
R9		Direct	150	39.4	3.8	39.6	3.77
		Average Velocity			4.06		3.48



Graph 4: NDT of Dry and Wet Cube (28 days)

4. CONCLUSIONS

Based on experimental observations, following conclusions can be drawn

1. Maximum split tensile strength was observed when recycled aggregate replacement is about 20%.
2. Maximum flexural strength was observed when recycled aggregate replacement is about 20%.
3. Before testing, it is observed that there is increase in weight of concrete specimen when it has been cured under water for 7 and 28 days.
4. A different test result value has seen when the specimen is parted to detect the exact position location of probe used
5. The wet results have been drawn after removing the specimen from curing tank, wipe water out by a cloth and then NDT test has performed and after then, it has placed in oven to maintain and remove the moisture, than after dry test has performed
6. Variation in result obtained when thickness of specimen changes along with distance of probe in our case, thickness is 15 cm

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