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"USE OF RECYCLED AGGREGATES AS BUILDING MATERIAL"

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ABSTRACT

For better understanding the behavior of concrete using RCA some tests are performed like permeability tests, rapid chloride permeability test, Acid attack test and salt action test for durability testing and for flexural test crack patterns, patterns of load vs deflection and the deflection of Reinforced concrete beams with two point loading system is done. Result show that Recycled coarse aggregate and natural coarse aggregate have similar workability. The flexural strength of RCA is less than the NCA. The permeability and chloride permeability of the RCA is also more than that of the NCA. For high dosage of acid percentage change in weight for RCA was more than that of NCA. Increase in weight for NCA concrete and RCA concrete was approximately same for salt attack test.

Keyword:- Rc Beam, Flexure, RCA, NCA, Strength etc.

1. INTRODUCTION

The safety of our environment and ecosystem can only result in our safety and protection of the future generation. Construction materials play a major role in our lives, because we spend much of our time in buildings , houses or other structures. Protection of natural resources and environment is the most important thing before any development program. Aggregates are used in the production of concrete production which impacts properties and workability.

Fig. 1 Recycled coarse aggregate (20mm and 12.5mm respectively)

Applications of Recycled Aggregates

The recycled concrete aggregate made up of aggregate parts shielded with concrete mortar from the fall of old structure. As per the past theory work and after0 the investigation of previous examination the most widely recognized use of RCA is the utilization in concrete sub-base in Roads development, bank security and dikes at the spot of regular coarse aggregate. After the cautiously destruction of a structure the end of contaminants should be possible by screening and air partition and the size additionally be diminished in a smasher to aggregate sizes.

Objectives

The objective of this research is to perform the tests on flexural properties of the concrete that is made by natural coarse aggregate and try to make a concrete using the fully replaced natural aggregate by the process of recycle of the coarse aggregates that can provide the proper durability which is suitable for application in structural concrete. The scopes of this project are as follows:

To create structural concrete using recycled coarse aggregate

- To study the effects of the recycled aggregate in the process of the replacement of the natural coarse aggregates.
- To study effect of RCA on compressive and spilt tensile strength.

2. LITERATURE SURVEY

K. UshaNandhini et al. (2016) found that the control concrete have lesser deflection than 100% of RCA used in RC beams It was seen that it acquires 3.75% higher deflection and 13.7% higher strain in the tension zone of the beam. It further occupies more cracks. The RA obtained from good quality concrete imparts good.

N. Kisku et al. (2017) claimed that if a concrete is made with recycled aggregate or adding suitable proportion of admixture to recycled aggregate concrete mix and proper surface treated recycled aggregate then several properties such as mechanical properties, durability, toughness, hardness etc. can be improved. Here number of mixing type method that shows improvement in the properties of the RAC.

OzgurCakir et al. (2014) contemplated the improvement in properties when silica exhaust joined in concrete blend plan which further improves the nature of recycled aggregate concrete. This RCA made by joining of silica exhaust in the concrete secures a decrease in early age compressive quality of recycled aggregate concretes. The examination demonstrated a superior mechanical performance than the regular aggregate concrete.

Shi-Cong Kou et al. (2013) focused on recycled aggregates concrete with the utilization of fly debris as concrete substitution in legitimate extent for a long time in open air presentation conditions or in water. The quality increase is over 65% for concrete blend Containing hundred rates recycled coarse aggregate between 28 days and 5 years. The Concrete blend with 100% recycled concrete aggregates has higher rigidity and expanding carbonation coefficient then typical coarse aggregates. The investigation likewise proposed that in the recycled aggregate concrete blends half recycled aggregate can use at the spot of normal aggregates in ideal blend extents and at the spot of standard Portland concrete the 25% fly debris can be utilized.

Ivan S. Ignjatovic et al. (2013) examined that compressive quality and functionality of recycled coarse aggregate and characteristic coarse aggregate have same worth. The conduct of RAC radiates is relying just upon the material properties of both RAC and equal NAC. RAC radiates when contrasted with NAC radiates made of concrete with a similar water- concrete proportion have 10 % lower splitting burden with recycled coarse aggregate up to 100 %.

Wenguiliet al. (2012) made a correlation between recycled aggregate concrete and ordinary concrete in the wake of considering the mechanical property, durability and the structural performance of recycled aggregate concrete for around 10 years (1996-2011). It was seen that the concrete network interfacial zone of recycled aggregate concrete had free and permeable hydrates and recycled aggregate concrete had bring down the mechanical properties, for example, compressive quality, elasticity, and shear quality.

3. METHODOLOGY

MATERIAL PROPERTIES

Cement

Cement is a dry powdery material formed by calcining lime and clay and then mixing it with water to make mortar or sand, gravel, and water to make concrete. It's a substance used to hold things together.

Sand

Sand is a granular combination of tiny rock grains and granular elements that is primarily defined by size, being finer than gravel but coarser than silt. And they come in sizes ranging from 0.06 mm to 2 mm. Silt is defined as particles bigger than 0.0078125 mm but less than 0.0625 mm. Sand is formed by erosion, shattered pebbles, and rock weathering, and is transported by waves and rivers.

Aggregate

Aggregate is the component of a composite material that resists compressive load and gives the composite material bulk. It is mostly utilised in the building industry. Sand, gravel, crushed stone, slag, and recycled aggregates are examples of inert materials. For the effective filling, the aggregate in a composite should be significantly smaller than the completed object and available in a variety of sizes.

Concrete

Concrete is a mixture formed by correctly mixing aggregates (such as sand, gravel, stone, or brick flakes), water, additives, or a binder (such as cement or lime). The blend's composition determines the product's strength and quality. Concrete is a crucial and practical material. Cement and water start to react and unite to form durable structure when all the ingredients—cement, clay, and water—are thoroughly combined.

Test of Concrete

Slump Cone Test
Compressive Strength of Concrete
Flexural Test
Split Tensile Test
Rebound Hammer
Durability Test by Rapid Chloride Permeability Test (RCPT)

Mix formation

Table: 3.1 Quantity of Materials

Material	Cement (kg)	FA (kg)	RCA 20 mm (kg)	RCA 12.5 mm (kg)	Water (kg)	Super plasticizer (Litre)
Quantity for 1 m3	450.66	643.52	796.52	341.37	202.51	4.6

4. RESULT & DISCUSSION

Table 4.1 Chloride Ion Penetrability

Charges Passed (coulomb)	Chloride Ion Based Penetrability
> 4000	High
2,000 - 4,000	Moderate
1,000 -2,000	Low
100 - 1,000	Very Low
<100	Negligible

Table 4.2 Chloride Ion Penetrability of NCA & RCA Mix

Specimen	Charged Passed (coulomb)	Chloride Ion Based Penetrability
NCA mix (28 days)	581	Very Low
RCA mix (28 days)	798	Very Low
NCA mix (56 days)	501	Very Low
RCA mix (56 days)	846	Very Low

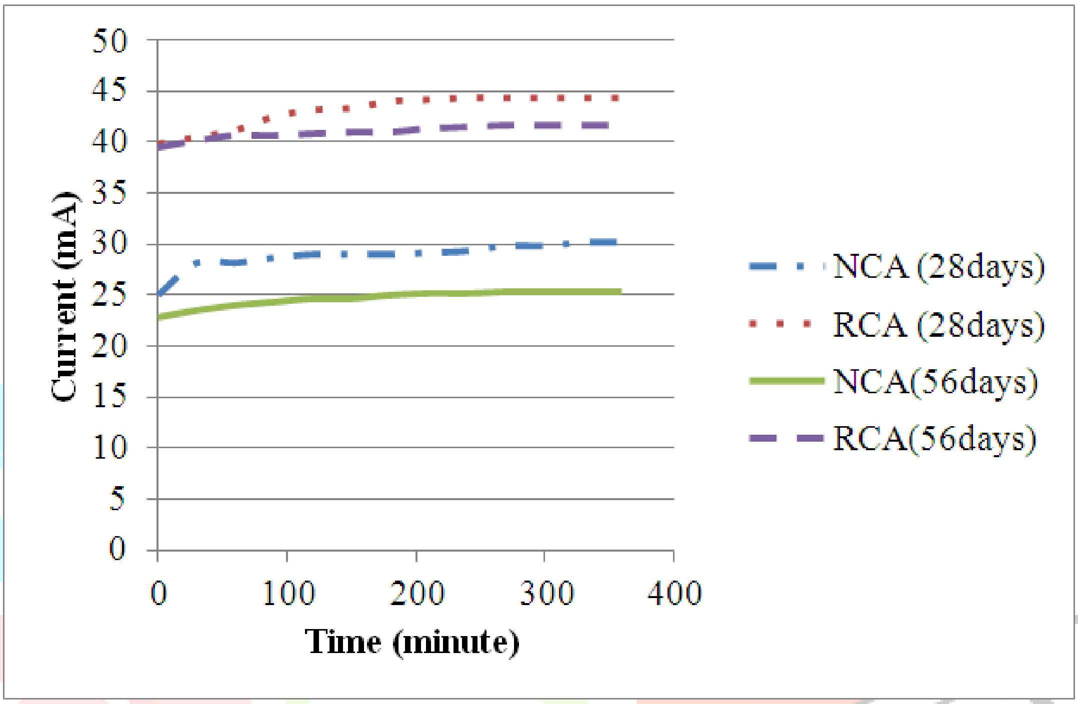

Fig. 4.1 Results of the Rapid Chloride Based Permeability

Fig. 4.2 Rapid Chloride Based Permeability Test Setup

Table 4.3 Change in Weight for Acid Dosage of 2.5%

Specimen	nitial weight (in grams)	Weight after 1 cycle (in grams)	Veight loss in %
NCA-1	3880	3854	0.67
NCA-2	3882	3851	0.79
RCA-1	3692	3653	1.05
RCA-2	3680	3642	1.03
Specimen	Initial weight (in grams)	ght after 2 cycle (in grams)	Veight loss n %
NCA-1	3880	3741	3.58
NCA-2	3882	3779	2.65
RCA-1	3692	3547	3.95
RCA-2	3680	3536	3.91
Specimen	Initial weight (in grams)	Weight after 3 cycle (in grams)	Weight loss in %
NCA-1	3880.	3677	5.23
NCA-2	3882	3672	5.33
RCA-1	3692	3456	6.39
RCA-2	3680	3442	6.47
Specimen	Initial weight (in grams)	Weight after 4 cycle (in grams)	Weight loss in %
NCA-1	3880	3603	7.13
NCA-2	3882	3399	7.29
RCA-1	3692	3391	8.15
RCA-2	3680	3385	8.02

Table 4.4 Change in Weight for Acid Dosage of 5%

Specimen	Initial weight (in grams)	Weight after 1 cycle (in grams)	Weight loss in %
NCA-3	3850	3798	1.35
NCA-4	3876	3826	1.28
RCA-3	3666	3587	2.15
RCA-4	3677	3603	2.01
Specimen	Initial weight (in grams)	Weight after 2 cycle (in grams)	Weight loss in %
NCA-3	3850	3705	3.76
NCA-4	3876	3729	3.79
RCA-3	3666	3460	5.61
RCA-4	3677	3475	5.49
Specimen	Initial weight (in grams)	Weight after 3 cycle (in grams)	Weight loss in %
NCA-3	3850	3592	6.70
NCA-4	3876	3618	6.65
RCA-3	3666	3328	9.21
RCA-4	3677	3342	9.11

Specimen	Initial weight (in grams)	Weight after 4 cycle (in grams)	Weight loss in %
NCA-3	3850	3449	10.4
NCA-4	3876	3480	10.2
RCA-3	3666	3181	13.2
RCA-4	3667	3220	12.4

Table 4.5 Change in Weight for Acid Dosage of 10%

Specimen	Initial weight (in g)	Weight after 1 cycle (in g)	Weight loss in %
NCA-5	3882	3808	1.91
NCA-6	3887	3836	1.31
RCA-5	3756	3650	2.82
RCA-6	3668	3567	2.75
Specimen	Initial weight (in g)	Weight after 2 cycle (in g)	Weight loss in %
NCA-5	3882	3618	6.80
NCA-6	3887	3633	6.54
RCA-5	3756	3395	9.61
RCA-6	3668	3320	9.48
Specimen	Initial weight (in grams)	Weight after 3 cycle (in grams)	Weight loss in %
NCA-5	3882	3392	12.62
NCA-6	3887	3383	12.96
RCA-5	3756	3132	16.61
RCA-6	3668	3031	17.36
Specimen	Initial weight (in grams)	Weight after 4 cycle (in grams)	Weight loss in %
NCA-5	3882	3096	20.24
NCA-6	3887	3086	20.60
RCA-5	3756	2891	23.03
RCA-6	3668	2803	23.58

Fig. 4.3 Specimen at different cycles for 5% of dosage of acid

Table 4.6 Change in Weight for Salt Dosage of 2.5%

No. of cycle	Increase in weight in NCA (%)	Increase in weight in RCA (%)
1	0.11	0.11
2	0.24	0.27
3	0.37	0.39
4	0.61	0.68

Table 4.7 Change in Weight for Salt Dosage of 5%

No. of cycle	Increase in weight in NCA (%)	Increase in weight in RCA (%)
1	0.36	0.36
2	1.10	1.16
3	1.70	1.82
4	1.82	1.87

Table 4.8 Change in Weight for Salt Dosage of 10%

No. of cycle	Increase in weight in NCA (%)	Increase in weight in RCA (%)
1	0.64	0.61
2	1.95	2.0
3	2.11	2.18
4	2.50	2.54

Fig. 4.4 Specimen after 4 cycles at 5% dosage of salt

Table 4.9 Flexure Strength of Beams for Cover 40mm

S. No.	Group	Beam	Load at first crack (kN)	Ultimate load (kN)
1	A	NCA1 C-40	23.5	43.0
2		NCA2 C-40	24	43.5
3	B	RCA1 C-40	17.7	36.1
4		RCA2 C-40	20.1	37.1

Table 4.10 Flexure Strength of Beams for Cover 25mm

S. No.	Group	Beam	Load at first crack (kN)	Ultimate load (kN)
5	C	NCA1 C-30	25.8	43. 0
6		NCA2 C-30	27.9	43.80
7	D	RCA1 C-30	21.6	36. 9
8		RCA2 C-30	22.7	38. 5

Table 4.11 Deflection of beams for cover 40 mm

Beams	Deflection at the first of the crack (mm)	Ultimate Based deflection (mm)
NCA1 C-40	1.99	13.40
NCA2 C-40	1.74	13.5
RCA1 C-40	1.31	9.24
RCA2 C-40	1.12	10.56

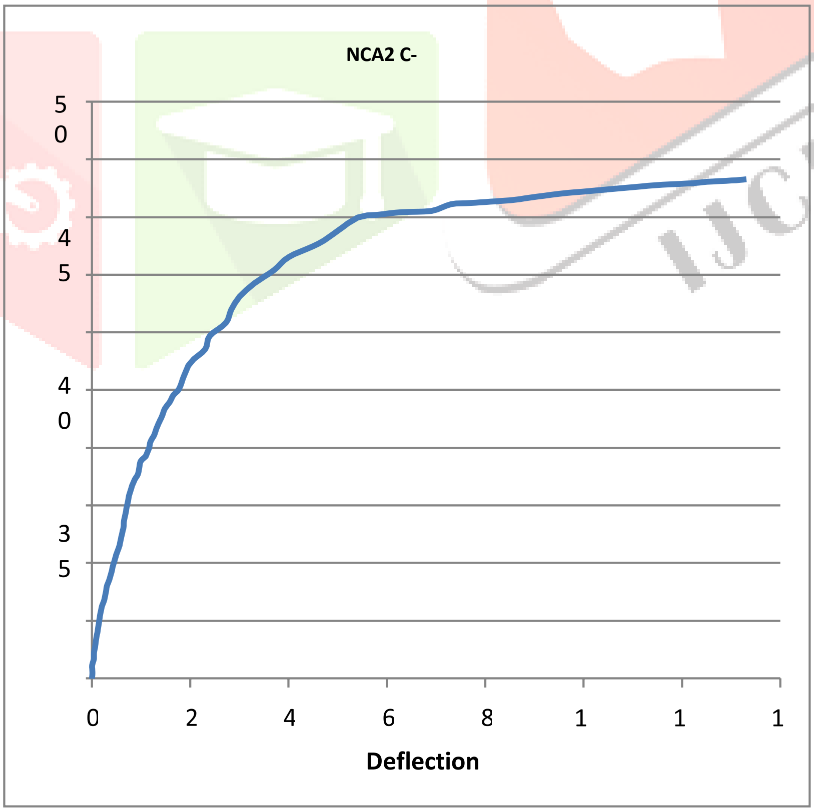

Fig. 4.5: The Load - Deflection Based Curve for NCA2 C-40

Table 6.14 Deflection of Beams for 25 mm cover

Beam	Deflection at the first of the crack (mm)	Ultimate Based deflection (mm)
NCA1 C-30	2.72	13.67
NCA2 C-30	2.92	14.22
RCA1 C-30	1.28	9.01
RCA2 C-30	1.51	9.73

CONCLUSION

1. Physical properties of recycled aggregate is lower than that of natural aggregate but these are within the permissible range for application
2. The RCA concrete has almost same work ability as that of NCA concrete for same mix designs.
3. The rate of absorption of water in Recycled aggregate concrete is 14% higher than that of Normal aggregate concrete due to presence of more voids.
4. If we replace all the natural aggregate with recycled ones then 13 % decrease in flexural strength occurs.
5. Deflection at the centre of the RCA beam is about 20-25% less than that of NCA beams due to low elasticity
6. The load carrying capacity of 40mm cover beam is same as that of 30mm cover beams.
7. Increase in cycles (**1 to 4)** was also increasing rate of loss of weight for acid attack test. In initial stages, the rate was lower than that of later stages.
8. For high dosage of salt more percentage increase in weight of concrete was observed. Increase in weight for NCA concrete and RCA concrete was almost same i.e. **0.76%** for 2.5% dosage, **1.85%** for 5% dosage, **2.50%** for 10%dosage.
   After increase in cycles rate of increment in weight of specimen was found to be very less.

REFERENCE

1. Nandhini, K. Usha, S. Jayakumar and S.Kothandaraman, "Flexural Strength Properties of Recycled Aggregate Concrete", *International Journal of Application or Innovation in Engineering & Management*, 6-11, 2016.
2. Ozgur, C. and Omer OzkanSofyanh, "Influence of silica fume on mechanical and physical properties of recycled aggregate concrete", *Housing and building research center Journal*, 124-140, 2014.
3. Kisku, N., H.Joshi, M.Ansari, S.K.Panda, Sanket Nayak Sekhar and Chandra Dutta, "A critical review and assessment for usage of recycled aggregate as sustainable construction material", *Construction and Building Materials*, 721- 740, 2017.
4. Xiao Jianzhuang, Wengui Li, Yuhui Fan and Xiao Huang, "An over view of study on recycled aggregate concrete in China", *Construction and Building Materials*, 364– 383, 2013.
5. Kou, S. C. and C. S. Poon, "Long-term mechanical and durability properties of recycled aggregate concrete prepared with the incorporation of fly ash", *Cement & Concrete Composites*, 123-135, 2013.
6. Ignjatovic, Ivan S., Snezˇana B. Marinkovic, ZoranM. Misˇkovic and Aleksandar R. Savic, "Flexural behavior of reinforced recycled aggregate concrete beams under short-term loading", *Materials and Structures*, 1045-1059, 2013.
7. Kwan Wai, H., Mahyuddin Ramli, Kenn Jhun Kam and Mohd. Zailan Sulieman, "Influence of the amount of recycled coarse aggregate in concrete design and durability properties", *Construction and Building Materials*, 565–573, 2013.
8. Corinal desi Valeria, "Mechanical and elastic behaviour of concretes made of recycled-concrete coarse aggregates", *Construction and Building Materials*, 1616– 1620, 2010.

Sami Tabsh, W. and Akmal S. Abdelfata, "Influence of recycled concrete aggregates on strength properties of concrete", *Construction and Building Materials*, 1163–1167, 2009.