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BEHAVIOR OF RECYCLED AGGREGATE CONCRETE BEAMS WITH VARYING SPAN TO DEPTH RATIO

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Abstract: To address sustainable issues in construction, researchers and construction firms are focussing upon utilizing recycled construction material. This present investigation is based on the use of recycled coarse aggregates in reinforced concrete beams. Recycled Coarse Aggregate was replaced by 0%, 50% and 100% of natural coarse aggregates. Shear behaviour of reinforced concrete beams were studied by varying shear span to depth ratios ranging from 1.0 to 4.0. Load carrying capacities of the beams were observed by plotting the load deflection curves.

Keywords: Recycled coarse aggregate, varying span to depth ratio, load carrying capacity.

I. INTRODUCTION

The demand for natural resources in the construction industry has increased exponentially over the past 100 years. This is due to several factors including the fast growth in the world population, the reconstruction which followed the two world wars and the need to replace a significant number of structures that have completed their service life. One of the ways to reduce demand on natural aggregates is to recycle the construction and demolition waste (C&D). The potential use of recycled concrete as coarse aggregates for the production of new concrete has been increased globally. Research has shown that RCA generally has inferior qualities relative to NCA. The effects of using RCA on the shear strength of reinforced concrete beams have been the subject of significant research. The ultimate shearing strength of longitudinally reinforced beams depends on numerous factors like the properties of the concrete, the structural actions acting along with shear (such as bending moments and axial forces), the amount of longitudinal non-pre-stressed and pre-stressed reinforcement and the size of the member. Among them, the properties of concrete are considered as the most influential one. The presence of a cement-aggregate interface within the RCA can reduce the effective size of the aggregate because the shearing crack can pass through this interface. Most of the previous works were done on RC beams with a constant shear span to depth ratio (a/d). This work studies the variation in shear behaviour of RAC beams with different a/d.

II. MATERIAL SPECIFICATIONS

A. Cement

In this study, Birla Gold Cement of grade 53, ordinary Portland cement (OPC) is used for casting. The cement is of uniform color. The various tests were performed as per IS codes and the properties of Portland cement are as follows:

TABLE I
Properties of Cement

Tests	Results
Standard Consistency	32%
Fineness	7%
Specific Gravity	3.15
Initial Setting Time	148 minutes
Final Setting Time	225 minutes

B .Fine Aggregate

Fine aggregate is defined as rock particles with diameter less than 4.75mm, usually called sand. The properties are as follows.

TABLE IV
Properties of Fine Aggregate

Tests	Results
Specific Gravity	2.45
Bulk Density	1.5gm/cm^3
Grading Zone	II
Fineness modulus	2.7
% of Voids	35%
Void Ratio	0.53

C. Coarse Aggregate

In this study coarse aggregate having maximum size of 20mm is used and the properties are as follows.

TABLE V
Properties of Coarse Aggregate

Tests	Results
Specific Gravity	2.77
Bulk Density	1.402gm/cm^3
Void Ratio	0.9
% of Voids	49.8%
Fineness Modulus	7.89
Water absorption	2.58%

D. Recycled Coarse Aggregate

TABLE VI

Properties of Recycled Coarse Aggregate

Tests	Results
Specific Gravity	2.53
Bulk Density	1.371gm/cm^3
% Of Voids	45.71%
Void Ratio	0.84
Water absorption	4.12%

E. Mix Design

Mix design is done as per IS 10262-2009 and IS 456-2000.

TABLE VII
Mix Design of M30 Grade Concrete

Materials	Cement	Fine aggregate	Coarse aggregate	Water (lit.)
Quantity (kg/m^3)	390	690.45	1130.8	179.4
Proportions	1	1.76	2.89	0.46

III TEST SET-UP AND LOADING PROCEDURE:

The beams were tested under two-point loading. The test specimen is placed under the 100 tons UTM machine. Two supports are placed at a distance of 75mm from the ends. The dial gauge is placed at the center of the beam specimen and the reading is noted. The beams were tested by applying load as two-point loading. Marking of cracks obtained due to the application of load is done.

Fig.1 Testing of specimens in UTM

Fig.2 Shear failure of specimen

IV RESULTS

TableVIII

Load and deflections for various mix proportions

MIX	LOAD @ FIRST CRACK (KN)	DEFLECTION (mm)	PEAK LOAD (KN)	DEFLECTION (mm)	ULTIMATE LOAD (KN)	DEFLECTION (mm)
1 R 0	160	1.4	280	2.26	235	2.5
1 R 50	145	1.45	250	1.79	213	2.25
1 R100	120	1.5	230	2.8	195	3.25
2 R 0	105	2.81	155	3.68	131	3.99
2 R 50	100	2.71	134	3.74	113	4.15
2 R100	80	1.97	123	2.92	106	3.25
3 R 0	60	0.46	118	1.38	93	1.49
3 R 50	50	0.42	100	1.07	85	1.5
3 R100	40	0.33	93	1.45	79	1.7
4 R 0	60	1.03	115	2.87	97	3.25
4 R 50	50	1	93.6	2.15	79	2.6
4 R 100	35	0.64	78	2.25	66	2.3

Table IX
Shear parameters for various mix proportions

MIX	Ultimate load (KN)	Shear force (KN)	Average shear capacity (KN/m^2)	Shear capacity@ NA (KN/m^2
1 R 0	235	117.5	9.038462	27.11538
1 R 50	213	106.5	8.192308	24.57692
1 R100	195	97.5	7.5	22.5
2 R 0	131	65.5	5.038462	15.11538
2 R 50	113	56.5	4.346154	13.03846
2 R100	106	53	4.076923	12.23077
3 R 0	93	46.5	3.576923	10.73077
3 R 50	85	42.5	3.269231	9.807692
3 R100	79	39.5	3.038462	9.115385
4 R 0	97	48.5	3.730769	11.19231
4 R 50	79	39.5	3.038462	9.115385
4 R 100	66	33	2.538462	7.615385

Where, 4 R0 , 4 R50 and 4 R100 represents a/d ratio of 4 and RCA of 0% ,50% ,100%
3 R0 ,3 R50 and 3 R100 represents a/d ratio of 3 and RCA of 0% ,50% ,100%
2 R0 , 2 R50 and 2 R100 represents a/d ratio of 2 and RCA of 0% ,50% ,100%
1 R0 , 1 R50 and 1 R100 represents a/d ratio of 1 and RCA of 0% ,50% ,100%

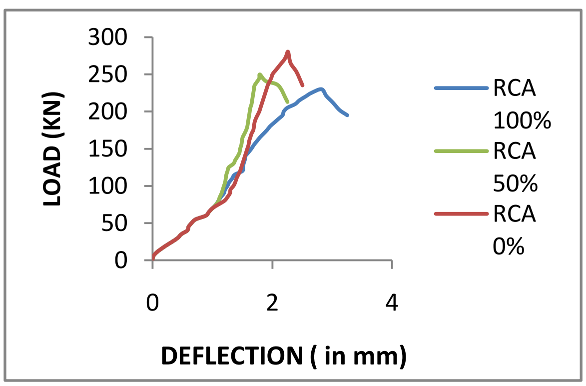

Fig.3 load vs deflection curve for span to depth ratio 1

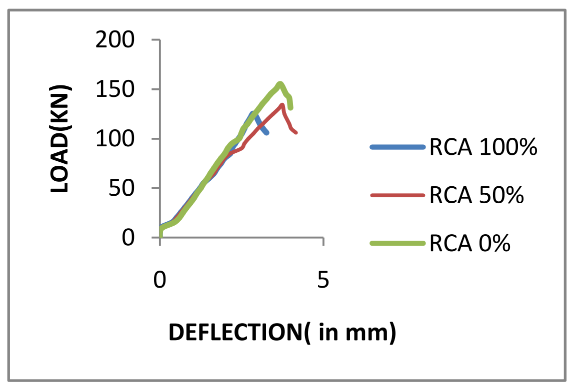

Fig.4 load vs deflection curve for span to depth ratio 2

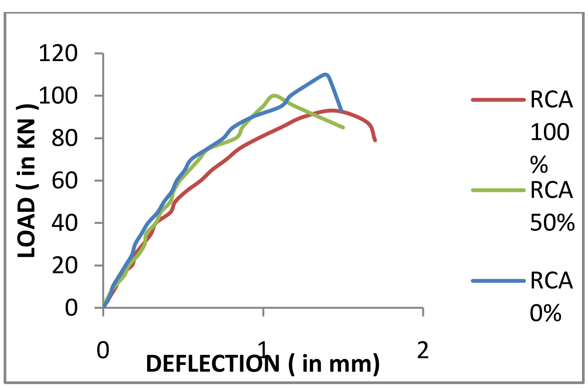

Fig.5 load vs deflection curve for span to depth ratio 3

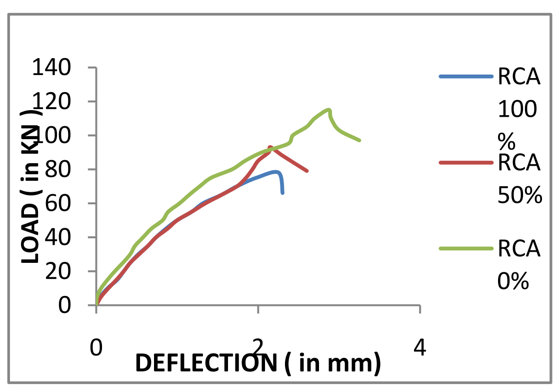

Fig.6 load vs deflection curve for span to depth ratio 4

V CONCLUSIONS

1. In general it is observed that with the decrease in a/d ratio, shear strength of beams decreased.
2. The maximum load for a beam of span to depth ratio 1is obtained at 100% NCA.
3. The maximum deflection for a beam of span to depth ratio 1is obtained at 100% RCA.
4. The maximum load for a beam of span to depth ratio 2 is obtained at 100% NCA.
5. The maximum deflection for a beam of span to depth ratio 2 is obtained at 50% RCA.
6. The maximum load for a beam of span to depth ratio 3 is obtained at 100% NCA.
7. The maximum deflection for a beam of span to depth ratio 3 is obtained at 100% RCA.
8. The maximum load and deflection for a beam of span to depth ratio 4 is obtained at 100% NCA.
9. Out of all beams the maximum load is obtained for a beam of span to depth ratio 1 is at 100% NCA.
10. Out of all beams the maximum deflection is obtained for a beam of span to depth ratio 2 is at 100% RCA.

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