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Experimental Work on the Flexural Behaviour of Infilled Composite Concrete Beams

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Abstract:
Recent researchers of civil engineering mainly focus in the field on replacement of concrete by the help of light weight materials in order to achieve the light weight concrete structures with improved strength and durability simultaneously. In the design part of conventional Reinforced Cement Concrete (RCC) beams as per IS 456-2000, the concrete is used to take care of compression alone not tension. The tensile stresses developed on the beam are purely carried out by reinforcement. Hence the fibres which are subjected to only tensile stresses require some infill material to hold the reinforcement along with the beam but not for the purpose of load carrying since the centre of gravity (CG) of the tensile force is acting at the centre of main reinforcement. In this experimental work an attempt is made to partially replace the concrete present in the tension fibres of normal Reinforced Cement Concrete beams with the help of brick masonry and the bending behavior of such light weight materials Infilled Composite concrete Beams (ICB) is studied by comparing the performance of normal RCC beams. From the test results it is noted that the ICB beams having the maximum deflection of 16.67 mm under the moment of 2.3 kNm which is 2.3 % lesser than the normal RCC beam. By comparing the rate analysis it is noted that the total amount of ICB beams are 11% lesser than the normal RCC beams.

Keywords: *tensile stress, light weight concrete structures, Infilled Composite concrete Beam, Reinforced Cement Concrete beams, tension fibres, Centre of Gravity.*

INTRODUCTION

Based on the results from the previous research work conducted by many researchers [4] it is to be noted that the strength of an infilled beam was about 80% of the conventional reinforced concrete beams. And it was observed that 30% saving in the materials in the economical aspect. The main objective of this project work is to study the behaviour of brick light weight material infilled composite concrete (ICB beams) beam experimentally by comparing the flexural behaviour of infill beam with normal Reinforced Concrete beams (RCC beams).

MATERIALS AND METHODS

a) CEMENT

300 gm of cement is taken. Initially a trial percentage of water (p) is added with cement to make cement paste. This paste is filled in the mould of Vicat apparatus. The surface is made smooth and level. The plunger in the Vicat apparatus is released on the cement paste sample and the scale reading is noted down. As explained in the Table 1 calculation is done and it is found that the standard consistency of the cement is 33%. By using this standard consistency percentage the Initial and Final setting time of cement has been calculated from the same Vicat apparatus.

January-February 2020
ISSN: 0193-4120 Page No. 12581 - 12584

Figure 1 Standard consistency of cement

Observation:

Cement Used = OPC 53
Weight of sample taken = 300gm
% of water added = 0.85 % of p
Standard Consistency = 33 %
The final setting time of cement = 540 min

Table 1 Standard Consistency of cement

Wt of sample in (g)	% of water add	Quantity of water taken (ml)	Depth of penetration of plunger (mm)	
			Top	Bot
300	25	75	22	28
	27	81	17	33
	29	87	21	29
	31	93	37	13
	33	101	43	7

B) AGGREGATES

As per IS 2720 (part 1–sec2): 1980 a sample of about 1 kg for 10 mm to 4.75 mm or 500g if finer than 4.75 mm is taken. From the Sieve analysis experiment as shown in the Figure 2a it is noted that the specific gravity of fine aggregate is 1.98. The specific gravity of fine aggregate noted is 1.98. Similarly for Coarse Aggregate (CA) it is calculated as 1.34. The Sieve analysis of Fine aggregate (FA) has been done and from the test the particle size distribution curve has been drawn as mentioned in Figure.2b.

Figure 2a Sieve Analysis of FA

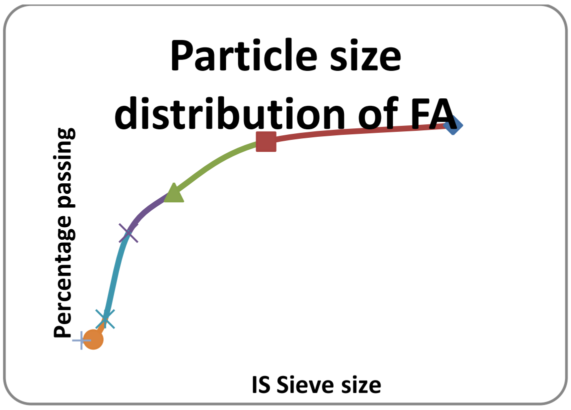

Figure 2b Sieve Analysis of FA

C) BRICK

Five bricks are taken for testing and the bricks are put in an oven at a temperature of 105^{0}C for drying.) Bricks are weighed in a digital weighing machine and it is record as W_1. The bricks are kept in water for 24 hours as shown in the Figure 3. Then they are taken out of water and wiped with a damp cloth for 3 minutes.

Figure 3 Water Absorption of Bricks

The bricks are weight again and recorded as W_2. From the observation as shown in the Table 2, the percentage of water absorbed by the brick = 8.83

January-February 2020
ISSN: 0193-4120 Page No. 12581 - 12584

Table 2 Water Absorption of Bricks

Sl No	Weight W1 (Kg)	Weight W2 (Kg)	Water absorption in %
1	3.680	4.005	8.83

DESIGN OF BEAM

From IS 10262-2009, the mix design of M40 grade concrete has been done and the mix ratio calculated as 1:1.8:1.6 using 0.4 water cement ratio. The beam is designed as a singly reinforced beam as per IS 456-2000. The detailing of the beam is shown in Figure 4.

- Effective depth (d)
  = Total depth -clear cover –dia of stirrups –half the dia. of main bar
  = 150-25-8-(10/2)
  = 112 mm
- Depth below NA (from the centre of main bar)
  d-xu = 112-40
  = 72 mm

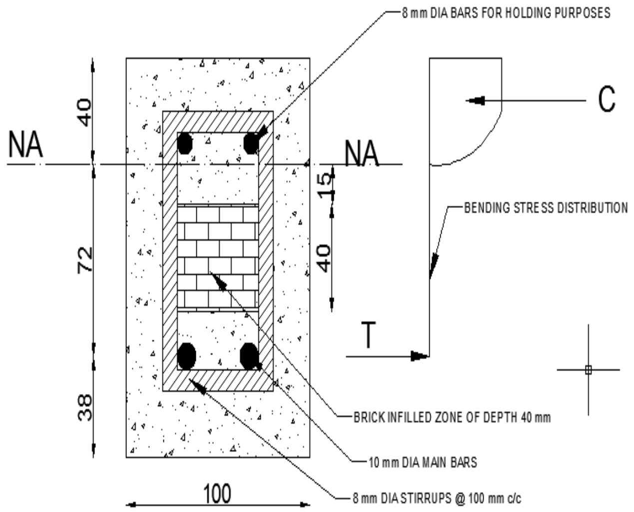

Figure 4 Detailing of ICB beams (All dimensions are in mm)

As per IS 456 the depth of concrete in the tension zone (below the NA in this case) is only for holding the reinforcement since the concrete tensile strength is neglected. Hence in the 72 mm concrete depth (below NA) some portions are infilled with light weight brick materials and the change in bending effect has been studied experimentally. Depth of Infilled zone = 40 mm (@ 15 mm from NA)

RESULTS AND DISCUSSIONS

After 28 days curing the beams are white washed and prepared for flexural test. The beams are marked at the one third of span for load application and at each 1 cm interval the beams are marked to identify the cracks.

Figure 5 Bending test on Beam

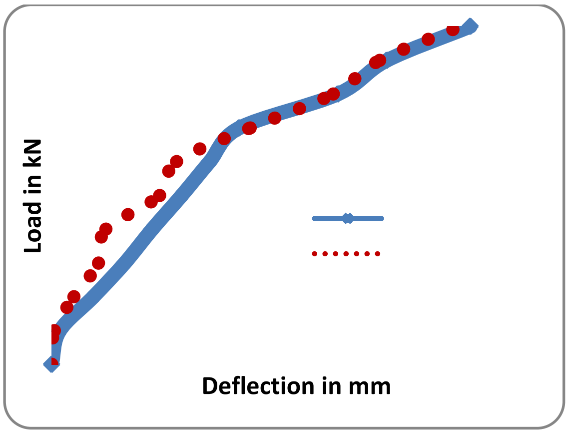

Figure 6 Bending test comparison between RCC and ICB

The spacing of the beams has been arranged and the deflectometers are fixed at the one third of the span and middle portion. The loading plate is arranged in such a way that the two point loads are applied at the spacing of L/3 distance of the span as shown in the Figure 5. A load measuring dial gauge has been placed under the hydraulic jack. The least count of the deflectometer is 0.01mm. The load is applied and for each 1 kN application of load the corresponding deflection has been noted down. By comparing the results of RCC and ICB beams (as shown in Table 3) it is clear that the behaviour of both beams is not significantly varied. The ICB beam behaved almost like RCC beam and in the failure load of 10 kN ICB beam has the maximum deflection of 16.7 mm which is 2.3% lesser than normal RCC beams.

Table 3 Bending test results

Beam	Maximum Load in kN	Maximum Deflection in mm			Max. Moment in kNm
		Right	Middle	Left	
RCC	10	16.2	17.1	16.1	2.3
ICB	10	11.1	16.7	12.2	2.3

CONCLUSION

By replacing the concrete by using brick as an infilled material below the neutral axis (40 mm), the flexural behaviour of ICB has been studied by comparing the bending behaviour of normal RCC beam. From the test results it is noted that the ICB beams having the maximum deflection of 16.67 mm under the maximum moment of 2.3 kNm which is 2.3 % lesser than the normal RCC beam and the behaviour of both RCC and ICB beams are almost similar. By comparing the rate analysis it is clear that the total amount of ICB beams are 11% lesser than the normal RCC beams.

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