An Experimental Investigation Was Conducted to Analyze the Flexural Behavior of Reinforced Concrete Beams with Hollow Sections in the Tension Zone

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Abstract- In reinforced cement concrete beam, the region below the neutral axis is in tension and above neutral axis is in compression. Concrete materials is a dominant material for construction due to its various advantages such as workability, low cost and fire resistance as well as its low maintenance cost when compared to the other material. It is formed from a hardened mixture of cement, fine aggregate, coarse aggregate, water and some admixture according to the requirrement. Massive exploration of the natural resources for producing concrete is affected by the environment condition and global warming. We have a responsibility to reduce the effect of the application of concrete materials to environmental impact. According to the natural behaviour of the concrete, it is strong in compression and weak in tension. Our assumption,the contribution of tensile stress of the concrete is neglected in the design of reinforced concrete beams. The flexural capacity of the beam is influenced only by the compression stresses of concrete and the tensile stress of the steel reinforcement. Efficient use the concrete materials can be done by replacing the concrete in and near the neutral axis. In this study explores on flexural behaviour of reinforced concrete beam with hollow section in tension zone . It also presents to find out flexural behaviour by using Polyvinyl chloride pipes of various diameters like 1/2 inch and 3/4 inch .

Keywords: Flexural strength, Performance of concrete, Polyvinyl chloride pipe, Replacement of concrete in tension zone

I. INTRODUCTION

A beam is a two dimensional structuralmember which resist transverse loading by means of bending or flexural stresses. Concrete is most widely used material in any structure because of its ease in production, casting and strength. But concrete is weak in tension. To overcome this weakness, concrete is generally reinforced with steel, known as reinforced concrete. When a beam is loaded there are two zones is to be considered i.e. tension zone and compression zone. Since concrete is quite weak in tension (having tensile strength 1/10 of its compressive strength generally) in general design of Reinforced cement concrete beam, it is assumed that all compressive stress is taken by concrete in compression zone above the neutral axis and all tensile stress are taken by the steel only. In this paper an experimental and analytical study on hollow beamis done by inserting Polyvinyl chloride pipe in tension zone at various depths and with different size.

II. OBJECTIVE

1. To conduct a study on introducing a newmethod by replacing some amount of the concrete below the neutral axis by creating hollow section using Polyvinyl chloride pipes without affecting the geometry of the section.
2. To analyze and compare the cracking pattern
3. To study hollow beam with conventional M_{25} grade concrete.

III. METHODOLOGY

In this project the methodology consist of
1. Reviewing the literature
2. Selecting the grade of concrete
3. Design the mix design by using the basic material test in the laboratory.
4. Using the obtained mix design reinforced concrete solid beam and reinforced concrete with hollow

section in tension zone is casted.
5. Flexural strength test is carried for both specimen and their effects were studied
6. Experimental analysis is carried out by using the ANSYS software.

IV. MATERIALS DETAIL

The locally available Portland pozzolana cement, fine aggregate, coarse aggregate, water are used for preparation of concrete. The maximum size of aggregates is 20 mm.

CEMENT:

Cement is a binder, a substance that sets and hardens and can bind other materials together by means of its properties. Portland pozzolana cement,is a type of cement that is manufactured by grinding Portland cement clinker and pozzolana or by uniformly blending fine pozzolana and Portland cement. The properties of Portland pozzolana cement are as follows:

Initial & final setting time:

- Initial setting time – 30 minutes (half anhour).
- Final setting time – 600 minutes (10 hours).

FINE AGGREGATE:

Aggregates which are passing through4.75mm sieve are known as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity. Locally available manufactured sand is used as fine aggregate. The most important thing to be considered is that fineaggregates should be free from coagulated lumps.

COARSE AGGREGATE:

Crushed stone is normally used as coarse aggregate. It should be hard, strong, dense, durable, clean and free from clay or loamy admixtures orquarry refuse or vegetable matter. The aggregatesshould be cubical or round shape and should granular or crystalline or smooth, non- powdery surface. Coarse aggregates containing flat, elongated or flaky pieces or mica should be rejected. Aggregates which are retained in 4.75mm sieve is called as coarse aggregate. Broken stone from the quarry of size 20 mm confirming to IS:383-1970 was used as coarse aggregate. The specific gravity of 20 mm coarse aggregate ranges from 2.6 to 2.8. Also, the water absorption of 20 mm aggregate ranges from 0.1% to 2%.

WATER:

Fresh, clean and portable water was used for mixing and curing the concrete as per IS:456-2000 in the experiment and as well as in the construction. Water is the important constituent in concrete. It chemically reacts with cement to give an desirable properties of cement. Mixing water is the quantity of water that comes in contact with cement, impacts slump of concrete and is used to determine the water to cement ratio.

POLYVINYL CHLORIDE PVC:

Polyvinyl Chloride (PVC) is one of the mostwidely used polymers in the world, PVC is a very durable and long-lasting material which can beused in a variety of applications, either rigid or flexible.

V. MATERIAL TEST

Table 1 : Material Test

TEST	MATERIALS	VALUES OBTAINED
Specific Gravity	Fine aggregate	2.4
Specific Gravity	Coarse aggregate	2.66
Specific Gravity	Cement	3.15
Water absorption	Coarse aggregate	0.5%

VI. MIX DESIGN

Table 2: Mix Design Proportions

Water (l/m3)	191.58
Cement (Kg/m3)	425.733
Fine aggregate (Kg/m3)	593.184
Coarse aggregate (Kg/m3)	1119.43
Mix proportion	1: 1.39:2.7

Mechanical properties of concrete:

Test for compressive strength of concrete cubesTable 3: Compression Strength Table

No of days	No of cylinders	Average compressive strength (N/mm^2)
7th day	3	20.5
14th day	3	30
28th day	3	33.3

VII. EXPERIMENTAL INVESTIGATION

Specimen details

The solid reinforced concrete beam andreinforced concrete beam with hollow section in thetension zone beam of size 700mm *150mm *150mm were casted .Specimen details are given in table 3

Table 3: Specimen details

BEAM NOTATION	SPECIMEN DETAIL	DIMENSION
RC - SB	Reinforced concrete solid beam	700mm *150mm *150mm
HB1andHB2	Reinforced concrete with hollow section in tension zone	700mm *150mm *150mm

Casting of beam specimen :

The beam were casted with M25 mix concrete and compaction was given with the help ofdamping rod. The surface of beam were finished to get a level surface after concreting. The specimencasted were demoulded after 24 hours and thensubjected to curing for 7 days,14 days and 28 days. Testing of specimen:

The beam specimen were tested under the loading equipment. Draw grids on beam at an interval of 5cm to note the propagation of cracks. Paste the electrical strain gauge to the surfaceof the beam at the required places. Make the loading setup, note the initial reading of dial gauge. Connect the electrical strain gauge load and LVDT with data logger. Observe the grid pattern which is drawn on the vertical surface of beam in longitudinal direction carefully for any cracks after each load increment. Identify the first crack and its width is to be measured at the level of steel using the microscope. For each load increment identify the cracks on the specimen and the width of first crack is to be measured at the same level. At the failure of the ultimate load carrying capacity of the beam is noted.

VIII. RESULT AND DISCUSSIONS

Load vs deflection character :

The load versus deflection characteristics ofthe beam were drawn. The deflection is plotted alongthe X axis corresponding to the load in the Y axis .The load is taken in KN and the deflection in mm .The load deflection characteristics of beam for 28th day are compared in the figure

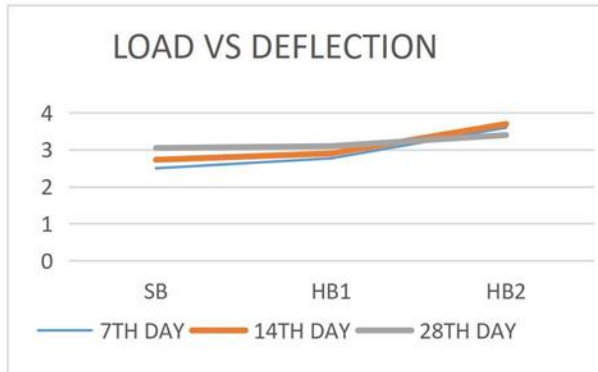


Fig 1: comparison of load Vs deflection curves

Ultimate load carrying capacity of the beam:

The ultimate load taken by the beam were observed during the experiment. The ultimate load is observed and beyond this load the beam takes no load and that failure is occurred. The below table shows the ultimate load and the initial crack load. The chart shows the comparison of the ultimate load

Fig 2. Comparison of the ultimate load

Analyzing Parameters	Ultimate load (KN) at 7th day	Ultimate load (KN) at 14th day	Ultimate load (KN) at 28th day
RC -SB	65	67	69
RC -HB1	64	65.5	68
RC -HB2	58	64	67.5

Table4 : Ultimate load table

Flexural strength test :

The beam tested for flexural test wasconducted the following result were obtained .

Table5: Flexural strength details

S.No	MIX	7 Days	14 Days	28 Days
1	Solid beam	4.89	5.4	5.9
2	HB 1	4.77	5.2	5.8
3	HB 2	4.66	5.45	5.9

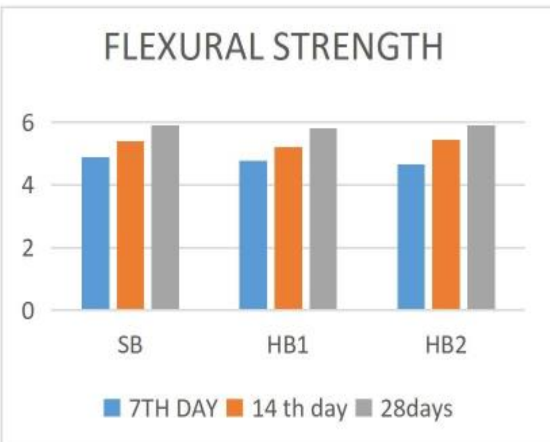
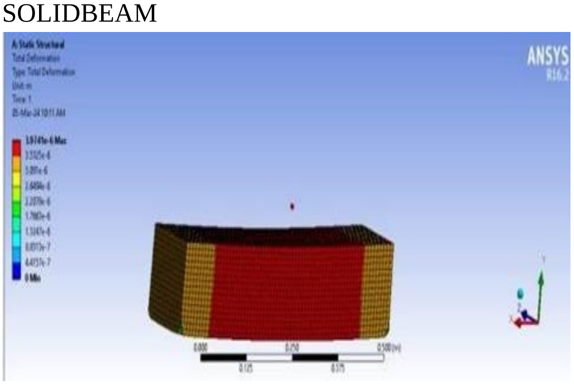


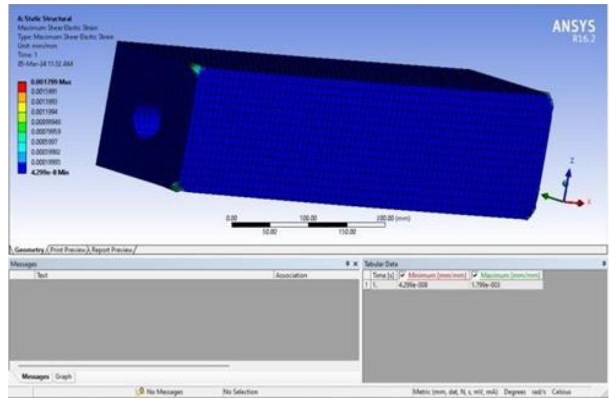
Fig 3. Comparison of the flexural strength

FLEXURAL STRENGTH RESULT BY USING ANSYS SOFTWARE

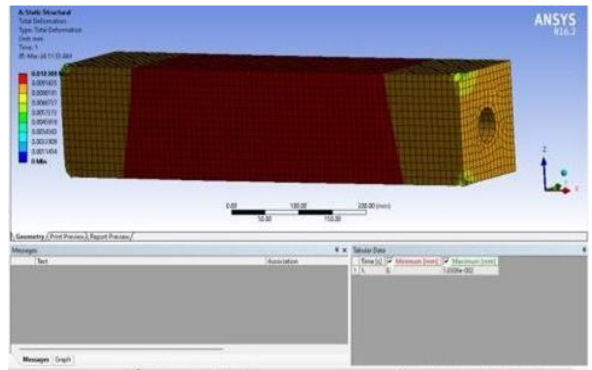
1. FLEXURAL STRENGTH RESULT FOR SOLIDBEAM



2. FLEXURAL STENGTH RESULT FOR RC-HB1



3. FLEXURAL STRENGTH RESULT FOR RCHB2



IX. CONCLUSION

1. Flexural behaviour of reinforced concrete beam with a hollow section in the tension zone is same asthat of an solid reinforced concrete beam
2. It has been observed that it doesn't require additional time and labour
3. The concrete saving is increases with the varying diameter of the hollow section the tension zone
4. Reinforced cement concrete with hollow section in the tension reduces the concrete as well as reducethe emission of carbon dioxide produce due to the cement.

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