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Evaluating Properties Of Concrete Beam Below The Neutral Axis By Replacing With Cups

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Abstract: The region below the neutral axis is in tension and the region above neutral axis is in compression. Since concrete is weak in taking up tension, steel reinforcements are provided at the tension zone of the beam. We have responsibility to reduce the effect of the application of concrete materials to environmental impact.

Our assumption to design the R.C.C. beams is the contribution of tensile stress of the concrete is neglected. The flexural capacity (MR) of the beam is influenced only by compressive stresses in the concrete and the tensile stress in the steel reinforcement. Efficient use the concrete materials can be done by replacing the concrete in and near the neutral axis. Different studies were conducted by researchers all overthe world to propose an effective method for replacement of concrete below neutral axis.

***Index Terms* - neutral axis, compression, steel reinforcements, compressive stresses, tensile stress.**

I. INTRODUCTION

While taking the building materials, concrete remains as one of the most important building components all over the world. Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement that hardens over time. It is the second most used substance in the world and is the most widely used building material.

Concrete is the major structural component. With increasing demand and consumption of cement, researchers use the various waste materials to replace the concrete. In recent days the problem faced by the construction industry is the acute shortage of raw materials. Researchers have been investigating many alternative materials to suite the Indian scenario. Rice husk, saw dust, light weight aggregates, copper slag, fly ash, are some of the materials experimented. In simply supported reinforced concrete beam, the neutral axis divides the tension zone and compression zone.

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II. OBJECTIVES OF STUDY

The volume of the concrete in tension zone below the neutral can be reduced using various methods. In this study, the volume of concrete in tension zone has been reduced using cups

- To study the flexural behavior of beams by partial replacement of concrete below neutral axis with cups.

- To compare the effect of replacement of concrete by cups.
- To analyze the material saving for different methods of replacement and make it more economical to construct.
- To propose an effective method for the replacement of concrete below neutral axis for beams and slabs.

III. MATERIALS & PROPERTIES

Materials used for casting concrete specimens consists of Ordinary Portland Cement (OPC) of grade 43 with 28 days compressive strength of 43 MPa, as a binding material provided by Ultratech Cement complying with IS 8112: 2013 (Ordinary Portland Cement 43 Grade- Specifications). Natural washed and uncrushed river sand was used as fine aggregate (FA), and as a coarse aggregate (CA) natural crushed basalt was used in saturated surface dry (SSD) condition. In this study maximum nominal size of aggregates was restricted to 20 mm and it is smaller than the one-fourth of the minimum thickness of the specimen and satisfying the IS 456: 2000 (Plain and Reinforced Concrete - Code of Practice) requirement. The density of materials used in this experiment like fine aggregate and coarse aggregate in SSD condition was 2500 kg/m3 and 2600 kg/m3 respectively. Most of the civil engineering projects in India are constructed in concrete with 28 days design compressive strength of 25

MPa. Hence, concrete mix design was performedfor M25 grade of concrete by considering the water/cement (W/C) ratio 0.45, Cement, fine aggregate and coarse aggregate were mixed in the assistance of distilled water. And local tea serving cups.

Fig.1: Cups

Physical Properties of Cement:

Table.01: Properties of Cement

Sr. No.	Description of test	Requirement as per IS	Results
01	Fineness of cement (residue on IS sieve No.9)	0- 10%	7%
02	Specific gravity	--	3.15
03	Standard consistency of cement	--	35 %
04	Setting time of cement a) Initial setting time b) Final setting time	30 minutes 600 minutes	41 minutes 426 minutes
05	Soundness test of cement (with Le-chatelier's mould)	10.0 mm	3.0 mm

Physical Properties of Fine Aggregates:

Table.02: Properties of Fine Aggregates

Sr. No.	Property	Requirement as per IS	Results
01.	Particle Shape, Size	<4.75 mm	Round, 4.75 mm down
02.	Fineness Modulus	2.2 – 2.6	2.447
03.	Silt Content	3.3 %	3.3 %
04.	Specific Gravity	2.65 – 2.85	2.72
05.	Bulk Density	1200 – 1750 kg/m^3	1723 kg/m^3

Physical Properties of Coarse Aggregates:

Table.03: Properties of Coarse Aggregate

Sr. No	Property	Requirements as per IS	Results
01.	Particle Shape, Size	<20 mm	Angular, 20 mm down
02.	Fineness Modulus	6.0 – 6.9	4.92
03.	Specific Gravity	2.6 – 2.8	2.61
04.	Water absorption	< 5 %	2.835 %
05.	Moisture content	Nil	Nil
06.	Bulk Density	1200 – 1750 kg/m^3	1620 kg/m^3

IV. MIX DESIGN:

Methods of Mix Design of concrete: Available methods of mix design are listed below andmostly they are based onempirical relations.

1. Trial and adjustment method of mix design.
2. British DoE mix design method (Improvement over Road Note No. 4 Method).
3. American Concrete Institute (ACI) mix design method.
4. Indian Standard (IS) method
5. Rapid method for mix design.

Table.04: Mix Design

Sr. No.	W/C	Mixture Proportion		
		Cement	Fine Aggregate	Coarse Aggregate
1.	0.45	1	1.88	2.27

Details of Specimen:

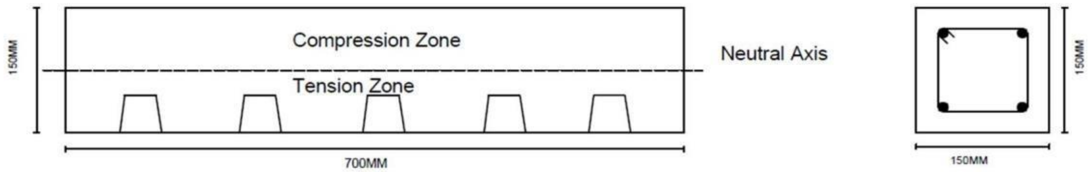


Fig.2: Details of Beam Specimen

Size & Shape of cups:

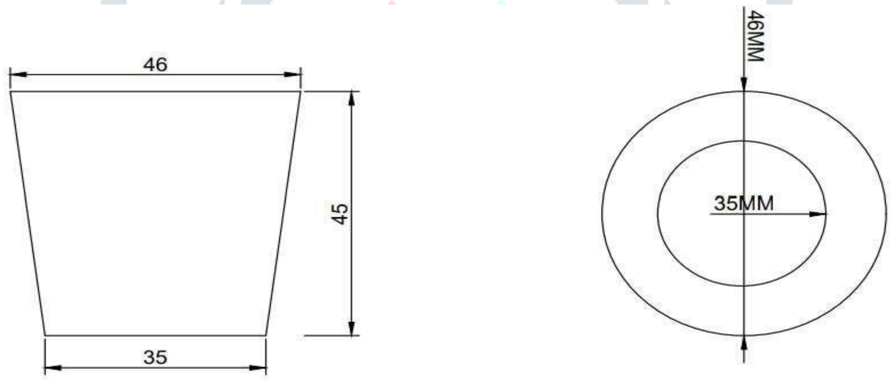


Fig.3: Size of Cups

V. EXPERIMENTAL PROGRAM:

The main objectives of the experimental investigation is to develop the properties of fresh and hardened concrete and the various mechanical properties like compressive strength, flexural strength by conducting suitable laboratory tests on hardened concrete specimens.

VI. Result & Discussion:

Tests on Fresh Concrete:

Table.05: Results of Tests on Fresh Concrete

Tests	Results
1. Slump Cone Test	90mm
2. Compaction Factor Test	0.92

Tests on Hardened Concrete:

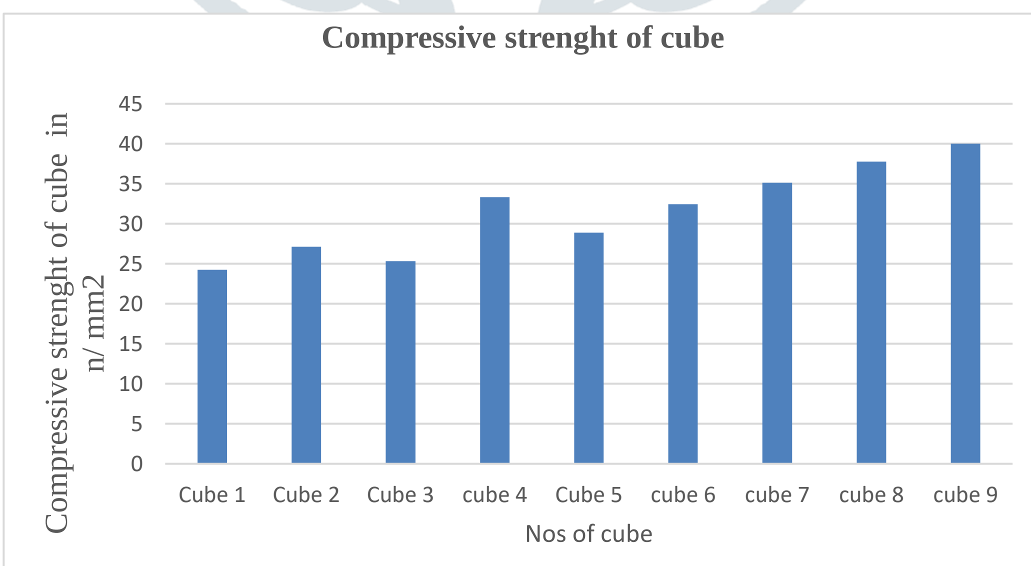
1. **Compressive Strength Test**
2. **Flexural Strength Test**

1. Compressive Strength Test:

Fig.4: Experimental Setup of Compressive Strength Test

Table.06: Results of Compressive Strength Test

M25					
Concrete Cubes					
Sr. No.	**Cube No.**	**Breaking Load(N)**			**Average Compressive Strength(N/mm^2)**
		After 3 Days	**After 7 Days**	**After 28 Days**	
1.	1.	5.5x10^3			25.62
2.	2.	6.1x10^3			
3.	3.	5.7x10^3			
4.	4.		7.5x10^3		31.56
5.	5.		6.5x10^3		
6.	6.		7.3x10^3		
7.	7.			7.9x10^3	37.62
8.	8.			8.5x10^3	
9.	9.			9.0x10^3	



Graph.1: Compressive Strength Test

2. Flexural Strength Test:

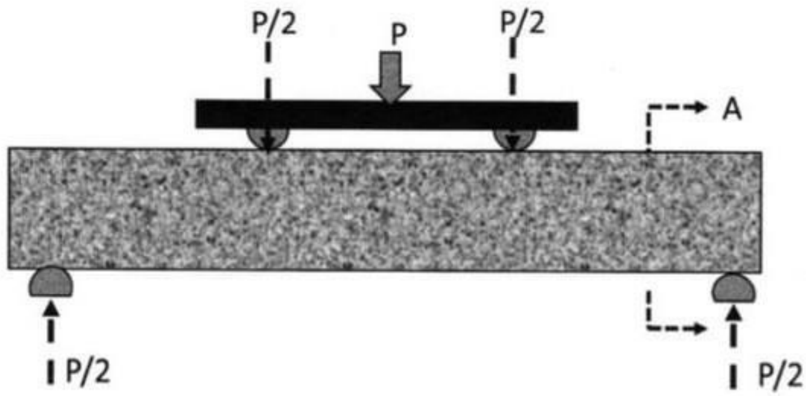
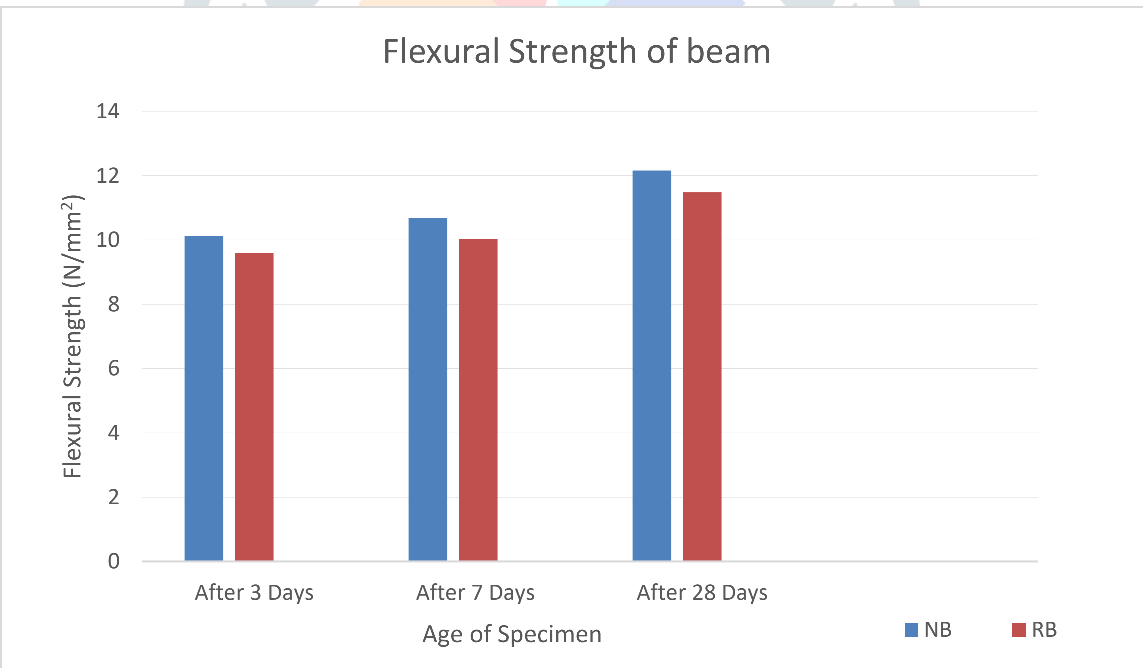


Fig.5: 4 Point Loading on Beam

Fig.6: Experimental Setup of Flexural Strength Test

Table.07: Results of Flexural Strength Test

M25					
RCC Beam Specimen					
Sr. No.	**Specimen**	**Breaking Load(N)**			**Flexural Strength(N/mm^2)**
		After 7 days	**After 14 days**	**After 28 days**	
1.	NB-1	$57x10^3$			10.13
2.	RB-1	$54x10^3$			9.6
3.	NB-2		$65x10^3$		10.68
4.	RB-2		61x103		10.03
5.	NB-3			$72x10^3$	12.16
6.	RB-3			$68x10^3$	11.48



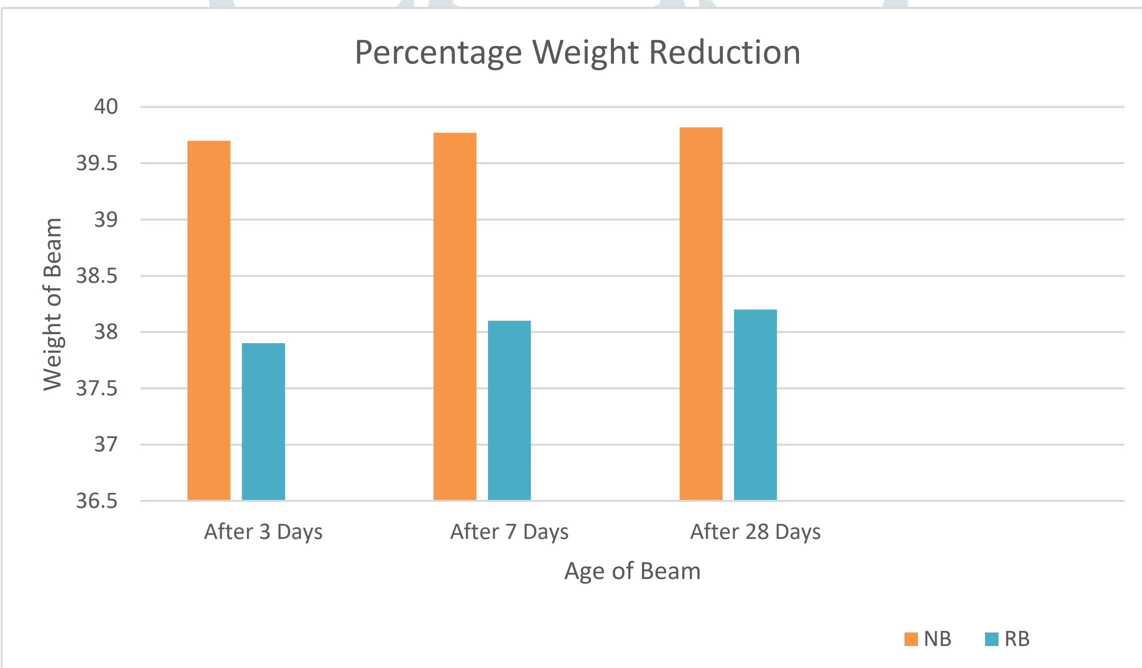
Graph.2: Flexural Strength Test

2. Percentage Weight Reduction in Beam:

As the main objective of this experimental research was to reduce the volume of concrete below neutral axis in beam by replacing with cups. Below table no. 5.3 Shows the reduction in weight of beam after replacing with cups.

Table.08: Percentage Weight Reduction

Percentage Weight Reduction			
Beam	**Weight of Concrete(kg)**	**Difference in Weight of Concrete (kg)**	**Percentage Reduction in Weight**
NB-1	39.700	1.800	4.53%
RB-1	37.900		
NB-2	39.770	1.670	4.19%
RB-2	38.100		
NB-3	39.820	1.630	4.06%
RB-3	38.200		



Graph3: Percentage Weight Reduction

VII. CONCLUSION

1. **Replacing a portion of the concrete below the neutral axis will effectively reduce weight, save resources, and lower construction costs.**
2. **replaced reinforced concrete beams can be used for environmentally friendly and sustainable projects.**
3. **The primary benefits of using cups as a partial substitute in this study are their low cost and attractive appearance.**
4. **The amount of concrete that is replaced determines the economy and weight reduction of beams.**
5. **The longer and deeper the beam is, the more efficient the concrete saving will be.**
6. **When comparing replaced beam (RB) specimens to normal beam (NB) specimens, the flexural strength marginally drops.**
7. **The specimen's weight drops from NB to cups replacing the beam.**

VII. REFERENCES

1.	Basil Tom Jose, Divya Sasi: Comparative Study on Partial Replacement of Concrete below Neutral Axis of Beam Using Seeding Trays and Polythene Balls. IJISET, Vol.5 Issue 4, April 2020
2.	Prof. Bharatesh R., Study on Influence of Concrete Strength in The Tension Zone Using Partial Beam. 41S_BE_1076, 2021
3.	Manish Kumar, Dr. G.P. Khare, Mr. Pukhraj Sahu, Flexural Behavior of RCC Beam With Partially Replaced Concrete Below Neutral Axis. IRJET p-ISSN: 2395-0072
4.	Mohd. Ahmed, Javed Mallick, Mohd. Abul Hasan, A Study of Factors Affecting the Flexural Tensile Strength of Concrete. 2020
5.	Aswathy S. Kumar, Anup Joy, Experimental Study on Partial Replacement of Concrete Below Neutral Axis of Beam. IJERT ISSN: 2278-0181, 2020
6.	B.S. Karthik, Dr. H. Eramma, Madhukkaran Behaviour of Concrete Grade Variation in Tension & Compression Zones of RCC Beam, IJATES, Volume No.02, Issue No. 07, July 2019 ISSN (online): 2348 – 7550
7.	Sujit B. Krishna, Senthil Kumar V., Influence of Concrete Strength in the Tension Zone Using Partial Beam., IRJMETS, e-ISSN: 2582-5208 Volume:04/Issue:02/February-2022
8.	MMA Pratama, B.S. Umniati, AA Permanasari., Effect of Concrete Strength Configuration on the Structural Behaviour of Reinforced Graded Concrete Beam. Journal of Physics Conference Series · March 2021, DOI: 10.1088/1742-6596/1808/1/012017
9.	Sally Jalil, Ali A. Sultan Flexural Strength of RC Beams With Partial Replacement of Concrete With Hooked-Steel Fibre-Reinforced Concrete., Jordan Journal of Civil Engineering, Volume 15, No. 4, 2021
10.	Shi, K.; Zhang, M.; Zhang, T.; Xue, R.; Li, P.; Chen, G. Study on Flexural Performance of Concrete Beams Reinforced by Steel Fiber and Nano–SiO2 Materials. Crystals 2021, 11, 927. https://doi.org/10.3390/cryst11080927