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Numerical Simulation on Reinforced Concrete Beam with Different Cover Size under Two Point Bending Load

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ABSTRACT

Structural analysis is used to assess the behavior of engineering structures under the application of loads. Usually, structural analysis methods include analytical,experimental and numerical methods is used in thisproject, however, only Analytical method is used and the values are taken from literature reference, to get familiar with Finite Element Analysis (FEA) using ANSYS, this is done to acquire practical knowledge about of the effect of the cover. The aim is to identify different failure modes under a range of loading conditions by changing the cover size to get the data of various parameters such as deflection, stress etc. Study of cover helps to observe the stability, reliability and the overall strength of the structural beam. This project attempts made to study the effect of cover on the behavior of reinforced concrete beam. Forthis analytical study, the Reinforced concrete beam specimen of 2000x100x200mm was considered.ANSYS software is a suite of engineering simulation software, based on finite element method, which can solve problems ranging from linear analysis to nonlinear analysis. The Doubly reinforced beams weremodeled by using geometry. In this model,various covers are provided. The beam specimensused in this study were tested under two-point static loading condition until failure of the specimen. From theobtained resultconcluded that the total deformation and directional deformation values are low in 25mm cover compared to other cases but the equivalent stress value is low in 35mm cover size compared to 25mm cover size.

KEYWORDS: *Finite Element Analysis, ANSYS, Concrete Block, Reinforced Concrete Beam*

I. INTRODUCTION

Concrete is one of the important construction materials in the world. Reinforced concrete beam has specific concrete block sizes. By changing the dimension of the concrete block, their properties like strength, stress, deformation, etc vary.For this study, optimum block size has been taken the effect of cover depth on the behavior of RC beams was studied using ANSYS Workbench®. The results obtained from finite element models are in good agreement with the test data. Cover protect against corrosion and weathering effect. Finding the effect of cover depth on behavior of RC beam requires maintaining long lasting life of the reinforced concrete beam. Cover in the reinforcement bars corrode due to bad weathering effect. A cover block is usually a space that is used to lift the rebar in the surface so that the concrete may flow below the reinforcement. While doing

RCC work, it is necessary to infix the steel in the concrete (also known as cover) so that the steel bar doesn't corrode and also provides fire resistance to the steel. If the concrete block is not provided in the structure it will corrode the steel and will result in early failure of the structure. Thus, using concrete cover blocks improves the life of the structure significantly. Concrete cover blocks are frequently used in the construction of hotels, homes, bridges and other structures or projects requiring long lasting life and durability. Concrete and steel bond perfect. Hence it no cracks.The compressive strength is also not less than the environment concrete. These lowis water absorption and it also sustains extreme heat. There is no occur during curing and ensures proper concrete cover block. It also fixes to the reinforcement

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss materials and methods used for simulation. In Section 3 we have the information about finite element simulation. Section 4 shares information about the modeling of the reinforced concrete beam using ANSYS and their simulation . Section 5 tells us about the results and discussion. Section 6 tells us about the future scope and concludes the paper with references.

OBJECTIVES

The aim is to identify different failure modes under a range of loading conditions, by changing the cover size to get the data of various parameters such as deflection, stress etc. Study of cover helps to observe the stability, reliability and the overall strength of the structural beam. It also helps to maintain the bond strength throughout the concrete.

II. MATERIALS AND METHODS

The doubly reinforced beam specimen sizes were of 100mm width and 200mm depth in cross section. Doubly reinforced beam wasof 2000mm in length and it was simply supported over an effective span of 1900 mm. The clear cover of the beam was 25mm. The test specimen was mounted on to a loading frame of 1000kN capacity. The load was applied on two points of 633 mm away from center of the beam towards the support. It was decided to take the section of M30 grade concrete Fe 415 HYSD bar. While calculation, the beam size was chosen, then by drawing its cross section it was understood that with different cover size the property through different cross section of same dimension but different cover size at top and bottom (25mm size remains same along longitude) can be found out. For example: 15mm cover at vertical position and 25mm remains in horizontal position. The standard cover size was fixed as 25mm. The remaining are changed at top and bottom with prior to respective size next two sizes in ascending and descending order chosen for the test. Calculating using basic subtraction and addition cover varied in modeling the beam.

Table 1. Material Properties of a Beam

S. No	Property	Concrete	Steel(Reinforcement and Stirrups)
1.	Density(kg/m^3)	2300	7850
2.	Coefficient of thermal expansion(C^{-1})	1.4E-5	1.2E-5
3.	Young's modulus(Pa)	3E+10	2E+11
4.	Poisons ratio	0.18	0.3
5.	Bulk modulus(Pa)	1.5625E+10	1.6667E +11
6.	Shear modulus(Pa)	1.2712E+10	7.6923E +10
7.	Tensile ultimate strength(Pa)	5E+6	4.6E+8
8.	Compressive ultimate strength(Pa)	4.1E+7	0
9.	Tensile yield strength(Pa)	0	2.5E+8
10.	Compressive yield strength(Pa)	0	2.5E+8
11.	Strength coefficient(Pa)	-	9.2E+8
12.	Strength exponent	-	-0.106
13.	Ductility coefficient	-	0.213
14.	Ductility exponent	-	-0.47
15.	Cyclic strength coefficient(Pa)	-	1E+9
16.	Cyclic strain hardening exponent	-	0.2

III. FINITE ELEMENT SIMULATION

The specimen is of 2000mm length and 100mm breadth, 200mm thick.ANSYS preprocessing consists of geometry and modeling the object. The composite materials are analyzed by explicit conditions in ANSYS Workbench®. The ANSYS explicit dynamics were used to analyses the physical properties of short-duration events for models that undergo transient dynamic forces. In this model meshing have Mesh size-0.5mm, Number of nodes-93639, Number of elements-68449.

Table 2.Dimension of the section

Type of beam	Doubly Reinforced Beam
Length of the beam	2000 mm
Width of the beam	100 mm
Depth of the beam	200 mm
Main Steel bars	Top steel – 2nos # 10 mm, bottom steel – 2nos # 12mm
Stirrups	8mm diameter@125mm c/c spacing
Clear cover	15mm,20mm, 25mm ,30mm,35mm
Section type	Under reinforced
Support conditions	Simply supported beam

IV. MODELLING OF REINFORCED CONCRETE BEAM

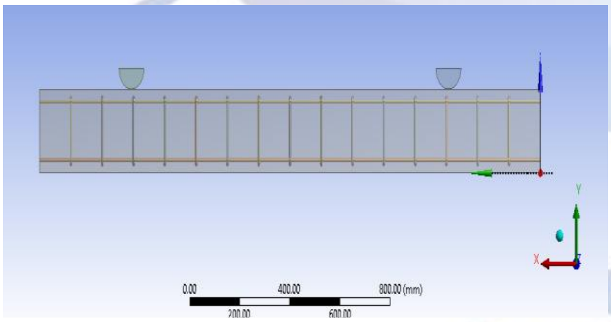

Fig.1 Geometrical construction of Reinforced beam

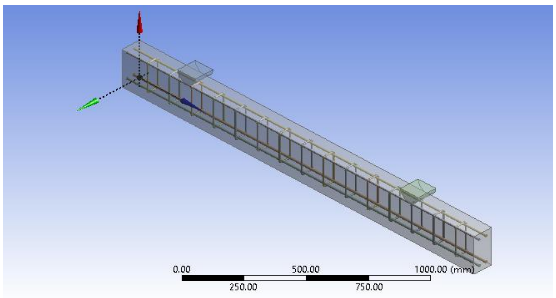

Fig. 2 Longitudinal view of specimen for 25mm

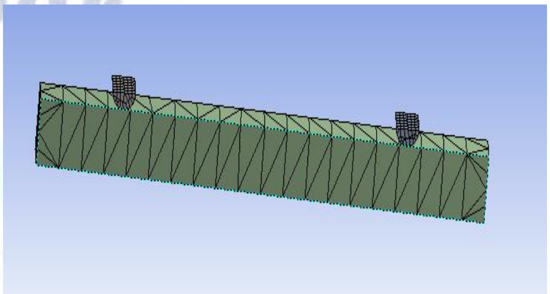

Fig. 3 Mesh model of beam specimen

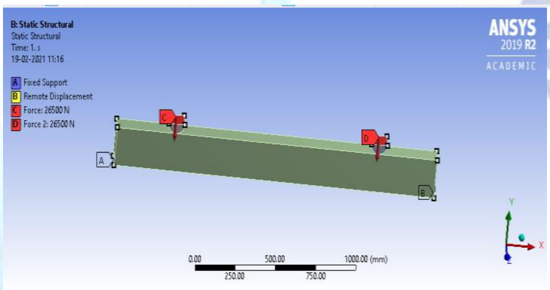

Fig. 4 Boundary conditions

V. RESULTS AND DISCUSSION

The problem was solved using ANSYS. It gave displacements and stress as output. The test properties ofthe steel like first crack, breaking load and deformation are taken from the journal [1],

- The total deformation adds the information about deformation length a material experiences upon the given breaking load.
- Equivalent stress is used when there is a multiracial stress state with multiple stress components acting at the same time in the structure.

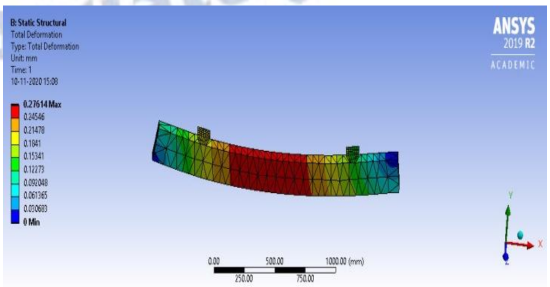

Fig. 5 Total deformation of 15mm cover.

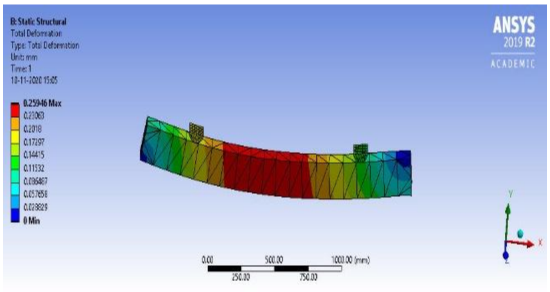

Fig. 6 Total deformation of 20mm cover.

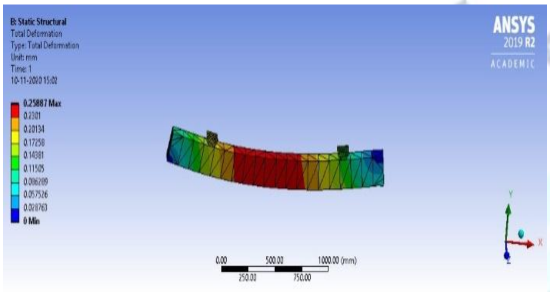

Fig. 7 Total deformation of 25mm cover.

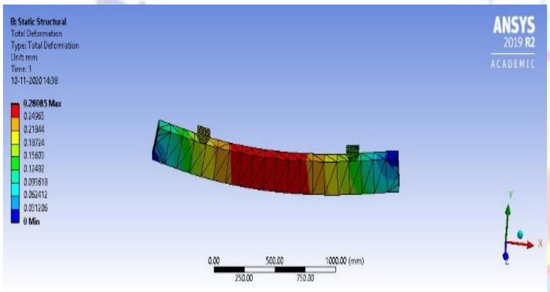

Fig. 8 Total deformation of 30mm cover.

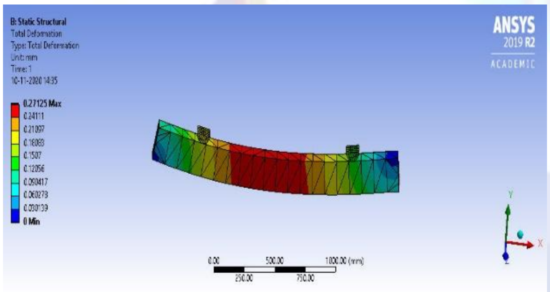

Fig. 9 Total deformation of 35mm cover.

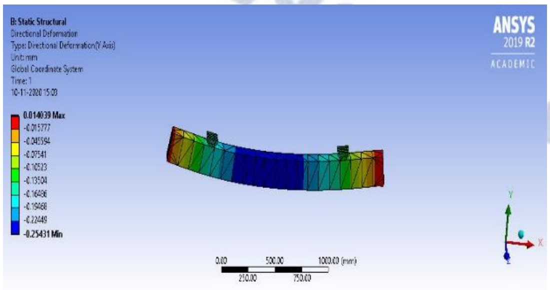

Fig. 10 Directional deformation of 25mm cover.

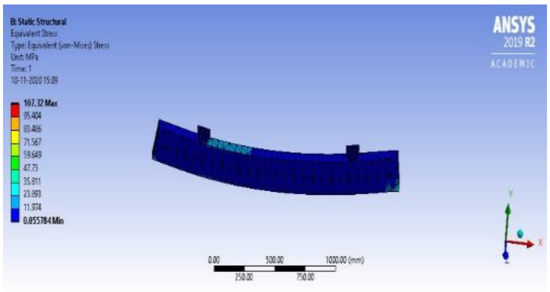

Fig. 11 Stress plot of 15mm cover.

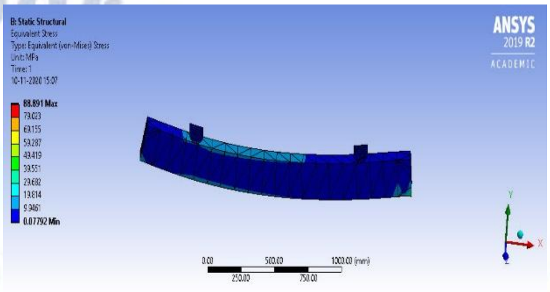

Fig. 12 Stress plot of 20mm cover.

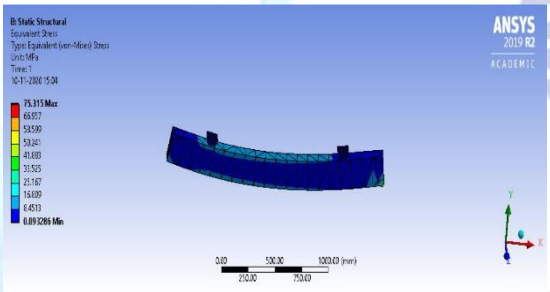

Fig. 13 Stress plot of 25mm cover.

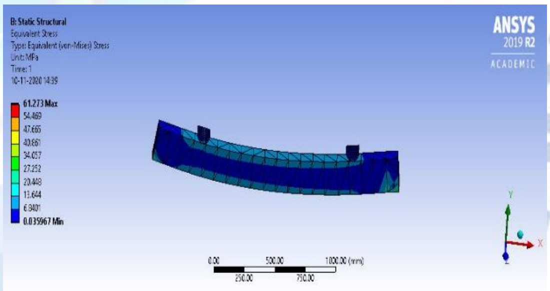

Fig. 14 Stress plot of 30mm cover.

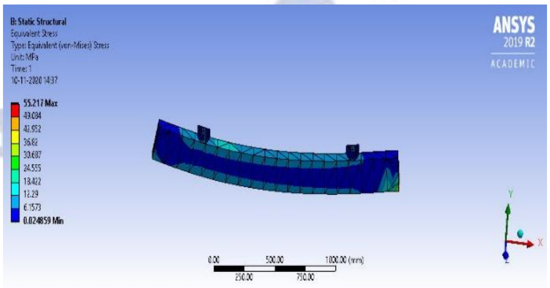

Fig. 15 Stress plot of 35mm cover.

Table 3 Simulation results with different cover size

Cover Size (mm)	Total Deformation (mm)	Directional Deformation (mm)	Equivalent Stress (N/mm^2)
15	0.27614	0.01422	107.32
20	0.25946	0.014167	88.89
25	0.25887	0.014039	75.315
30	0.28085	0.015005	61.273
35	0.27125	0.01462	55.217

VI. FUTURE SCOPE AND CONCLUSION

- The ANSYS simulation results show the total deformation and normal stress in the composite materials. Steel has disadvantages of large deformation, higher weight and low corrosion resistance. These properties can be improved by reinforcing it with composites.

- A Reinforced concrete beam has been solved in the present problem.FEM software helps in solving the beam problem.

- In the above result, it is concluded that total deformation and directional deformation values(refer table 3) are low in 25mm cover compared to other cases but the equivalent stress value (55.217 N/mm^2) is low in 35mm cover size compared to 25mm cover size (75.315 N/mm^2).

- Total deflection and directional deflection results have been analyzed. Equivalent elastic stress results have been referred to understand the behavior of RC beam with varying cover size under the application of two-point loading.

- By comparing the results, the effective value is obtained and the optimum cover size value is found to be 25mm. It also satisfies the IS800:2007 standards (table 6).

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