International Journal of Recent Engineering Research and Development (IJRERD)
Volume No. 02 – Issue No. 05, ISSN: 2455-8761
www.ijrerd.com, PP. 41-45

Strength And Deformation Characteristics of Deep Beam Using ANSYS

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Abstract: Reinforced concrete deep beams are widely used structural elements in construction industry. With large growth of construction work in many developing countries, deep beams design and its behavior prediction is a considerable importance. Deep beam often appears in the form of transfer girders in high-rise building, foundation walls, water tanks, shear walls & corbels. Side face reinforcement or skin reinforcement is provided in a beam when the depth of the beam is 750mm or more. The main function of skin reinforcement is to control crack width. By application of finite element method in reinforced concrete deep beams, analytical study was done based on the behaviour of deep beams by considering stress and deformation at various side face reinforcement spacing. Then the relationship between side face reinforcement spacing and deformation was found out.

Keywords: Deep beam, side face reinforcement, skin reinforcement, finite element method

I. INTRODUCTION

RC deep beams had many useful applications in building structures such as transfer girders, wall footings, foundation pile caps, shear walls. The use of deep beams at the lower levels in tall buildings for both residential and commercial purposes has increased rapidly because of their convenience and economical efficiency. Side face reinforcement or skin reinforcement is provided in a beam having depth exceeds 750mm. Skin reinforcement is provided on the sides of deep beams to reduce the formation of flexural crack widths. Side face reinforcement spacing is the most important factor in case of deep beams. Otherwise the crack width will increases to a larger value and will leads to corrosion reduces the beam strength.

The behaviors of deep beams are different from other beams, requiring special consideration in analysis, design and detailing of reinforcement. So special design methods are used for these differences. The stresses in deep beams are studied by using the methods of two dimensional elasticity such as finite element analysis or finite strip method.

II. OBJECTIVES

- The objective was to study the relationship between side face reinforcement spacing and deformation.
- To study the behaviour of deep beam with different side face reinforcement spacing.

III. scope

The scope is to concentrate on the idea to make the deep beam implementation economical by providing more spacing. To workout this idea, finite element analysis needs to be conducted by using ANSYS, taking advantage of the wide range of element types and material models available in this computer program. By studying relationship between stress and deformation occurring corresponds to spacing, better spacing can be suggested and can be make economical than that of conventional ones.

IV. METHODOLOGY

- Modeling using appropriate design software.
- Assigning material properties.
- Selection of suitable elements from ANSYS element library.
- Discretization of the structure using various methods.
- Solving the problem with appropriate loads and boundary conditions.

- Observation and conclusion.

V. NUMERICAL ANALYSIS

A. Details of model

Consider 3 deep beams having dimensions 380 mm x 2100 mm x 4m. The numerical analysis was carried out in simply supported beams with different side face reinforcement spacing. Materials used were M20 grade concrete and Fe415 steel. Reinforcements were provided as per IS Codes. 8 mm diameter bars were provided in side face with different spacing such as 120mm, 170mm, 220mm. Six 16mm diameter bars were provided in the tension side. Deep beams were modeled using CATIA V6. Numerical Analysis was carried out using ANSYS Workbench 15.0.

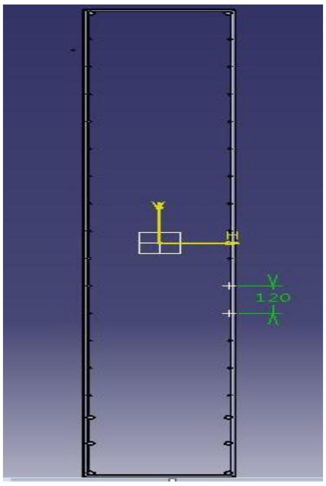

Fig 1: Cross section of deep beam

VI. STASTICAL ANALYSIS OF DEEP BEAM

Statistical analysis is carried out to identify the response of the structure. This analysis is used to determine the stress and deformation of beam. The accuracy of the finite element analysis results highly depends on choosing the appropriate elements to predict the actual behavior of the structure.

A. Material Properties

The material used is steel and concrete. The properties of materials are already available in ANSYS library. The properties are shown in Table 1.

TABLE 1 – MATERIAL PROPERTIES

Sl No	Material	Poisson's ratio	Young's modulus (GPa)	Density (kg/m^3)
1	Concrete	0.2	45	2500
2	Steel	0.3	200	7850

B. Meshing

A free mesh technique can be used for meshing but it would increase both the number of elements and the computational time. Instead, the model was meshed with two objectives: to create a sufficiently fine mesh to model the essential feature of the deformed shape, and to minimize the number of elements to reduce computation time.

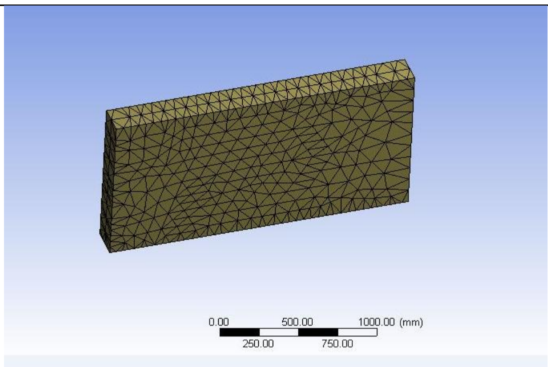

Fig 2: Meshing of the beam

A. Results and Discussion

The stress and deformation of beam having different sideface reinforcement is shown below. Results are shown in table 2.

1. 120mm side-face reinforcement spacing

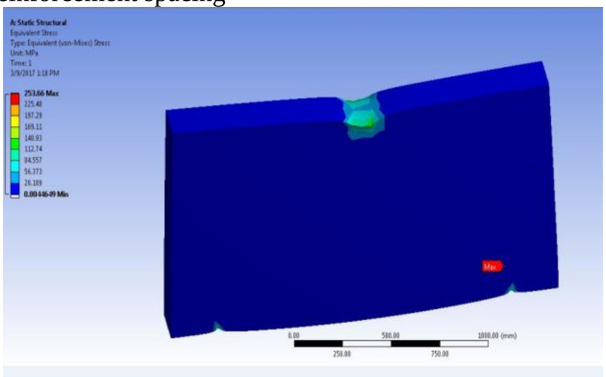

Fig 3: Equivalent stress distribution

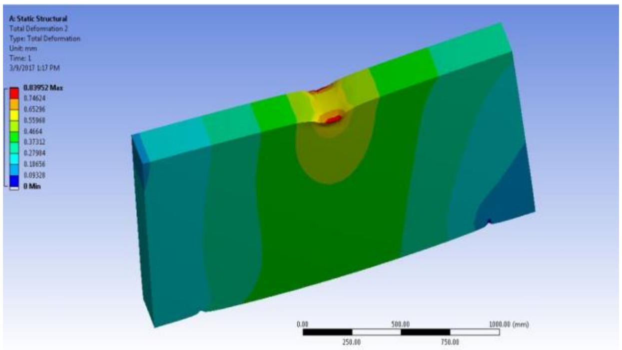

Fig 4: Total deformation

2. 170mm side-face reinforcement spacing

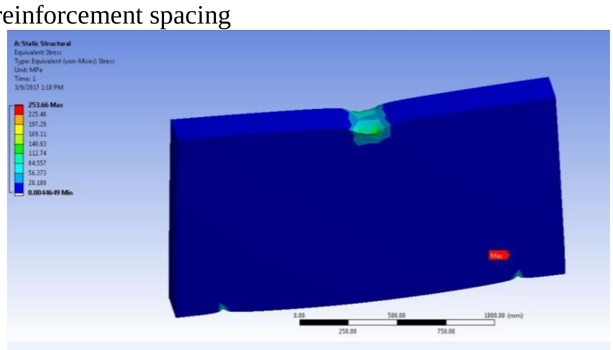

Fig 5: Equivalent stress distribution

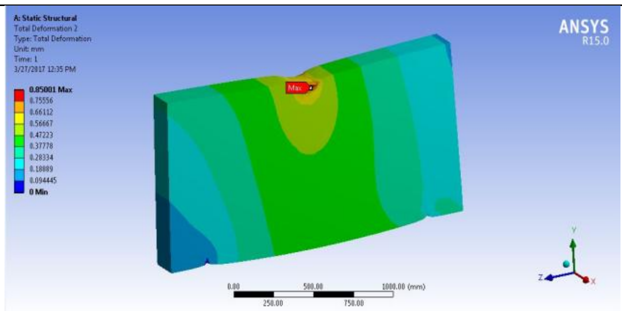

Fig 6: Total deformation

3. 220mm side-face reinforcement spacing

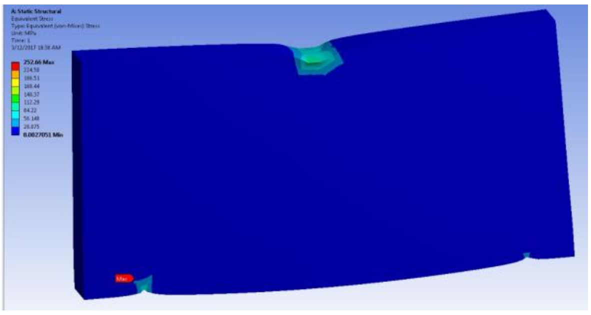

Fig 7: Equivalent stress distribution

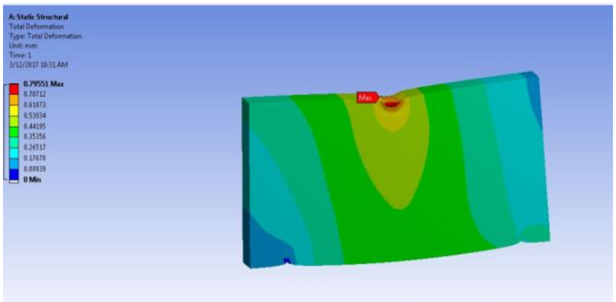

Fig 8: Total deformation

TABLE 2: STRESS AND DEFORMATION OF DEEP BEAM

Spacing	120mm	170mm	220mm
Stress (MPa)	256.96	253.66	252.66
Deformation (mm)	0.889	0.850	0.795

VII. CONCLUSIONS

The ANSYS Finite Element Analysis has been used to understand the behavior of three deep beams with different side face reinforcement Spacing. Following are the findings from this study,

- Change of spacing of side face reinforcement doesn't shows much variation in stress values.
- Spacing does not affect deformation.
- Since stress and deformation have less effect on spacing, more spacing will reduce cost of implementing deep beams.

VIII. FUTURE SCOPE

- Investigation on the use of other reinforcement material instead of steel.
- Calculation of natural frequency and mode shapes of deep beam with different reinforcement material.

ACKNOWLEDGEMENT

We would like to acknowledge **Dr. P. G. Bhaskaran Nair**, P. G Dean, Sree Narayana Institute of Technology, for his valuable suggestions, encouragement, and finding. I thank **God** Almighty for his grace throughout the work

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