ANALYTICAL BEHAVIOUR OF RC DEEP BEAM WITH WEB OPENING IN FEA

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Abstract - *Deep beams are having small values of span to depth ratios. The presence of web openings in such beams is frequently required to provide accessibility such as doors and windows or to accommodate essential services such as ventilating and air conditioning ducts. Enlargement of such openings due to architectural/mechanical requirements and/or a change in the building's function would reduce the element's shear capacity, thus rendering a severe safety hazard. Two circular openings, one in each shear span, are placed symmetrically about the mid-point of the beam. External and Internal strengthening different methods are used to determine in structural response of RC deep beams with openings was primarily dependent on the degree of the interruption of the natural load path. Externally bonded FRP and steel plate are shear strengthening around the openings was found very effective in upgrading the shear strength of RC deep beams and internally strengthened by truss in different types to gain shear strength. Finite element modeling of RC deep beams containing openings strengthened with various methods is studied using ANSYS 16.1 and result compared with conventional method.*

*Key Words***:** ANSYS, deep beam, external & internal strengthening method, FRP, steel plate, truss.

1. INTRODUCTION

Analytically evaluate the influence of circular openings in reinforced concrete deep beams with low shear span-to-depth ratio. According to IS-456 (2000) Clause 29, simply supported beam it acts as deep beam when the ratio of its effective span (L) to overall depth (D) is less than 2.0 and that for continuous beam when the ratio is less than 2.5. The effective span is defined as the centre to centre distance between the supports or 1.15 times the clear span whichever is less.

Web openings are created within the deep beams to pass for utilities such as electronic cables, air-conditioning ducts. Thus we can reduce the area needed for the inclusion of these utilities and increase the useful space within the structure. There are several methods for analysis of deep beams. Among those methods strut and tie model design is considered as most efficient and economical.

Non strengthening method as conventional deep beam with web opening is analysed to evaluate the result as reference for strengthening method and compared with maximum shear strength.

1.1 Strengthening method

The presence of an opening in the web of a reinforced concrete beam leads to many problems in the beam behavior such as reduction in the beam stiffness, excessive cracking, excessive deflection and reduction in the beam strength. When an Internal strengthening methods are, truss method and hybrid method used to ensure the beam strength due to reinforced in different types.

In an external strengthening method, before failure of deep beam with web opening to increase the strength of beam by externally bonded by FRP and steel plate. In this condition we have to improve the shear strength of deep beam containing holes for wrapping FRP and steel plate to overcome the failure of deep beams.

1.2 Objectives

The main objectives of this study are:

- To attain high strength deep beam with web opening.
- To investigate different methods to determine in increase of deep beam with web opening.
- To analyze the deflection of beam using ANSYS 16.1.
- To analyze the externally bonded materials to gain the shear strength of deep beam with web opening.
- To analyze the internal strengthening methods to attain high strength.
- To determine the most strengthening method to increase the strength of deep beam in economically.

2. MODELING AND ANALYSIS

2.1Material properties and elements used in the modeling

| Material	Linear Isotropic properties	
	Modulus of elasticity	Poisson's ratio
Concrete	19365	0.15
Steel	20000	0.3
FRP	7788	0.3
Steel Plate	210000	0.27

2.2 Modelling

Simply supported beam is considered having and overall length of 1200 mm with effective length of 900 mm. Size of the beam is 150 x 460 mm. In this conventional deep beam with web opening is anlysed in ANSYS 16.1.
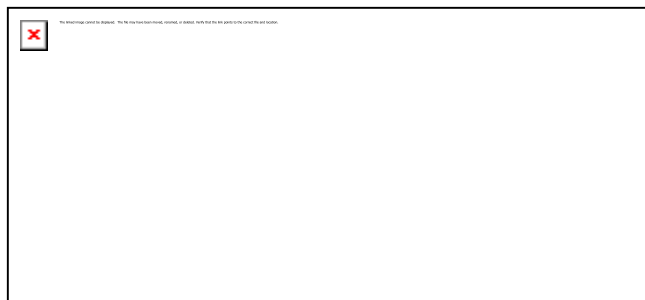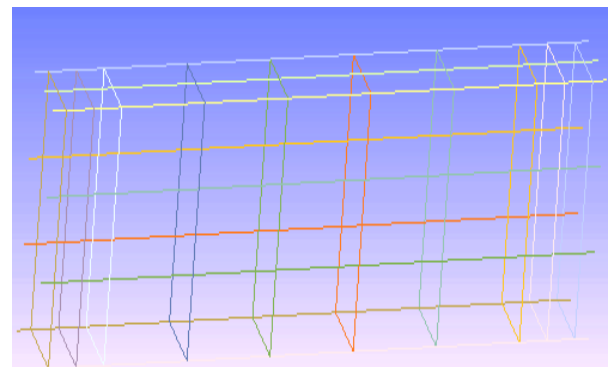

Reinforcement

2.3 Meshing and reinforcement

Single point loading is applied at the midpoint of the beam. To get the accuracy of results mesh size considered as 25 mm as edge length.
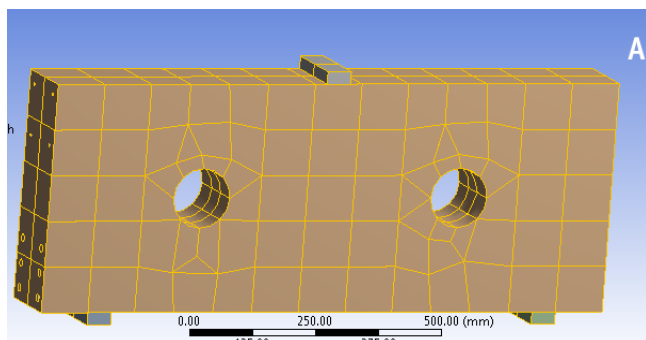
Beam model and meshing

Reinforcement

2.4Analysis using ANSYS software

Analytical investigation is to be validated using ANSYS Software. For that, geometry is selected and modeling is done. Different beams are modeled by using the properties obtained from the analytical study. Mesh generation is done, and deflection corresponding to each load is to be determined for all models.

3. RESULT & DISCUSSIONS

3.1 Comparison of conventional method with external strengthening method

Method	material used	Type	Concentrated load		Strength in %
			Deflection	Load(KN)	
Conventional method	(without strengthening)reference		2.5032	120	
External strengthening method	FRP	flexural & shear zone	2.5	170	40
		Shear zone	2.5	120	0
	Steel plate	flexural & shear zone	2.5	330	175
		shear zone	2.5	122	1.67

3.2comparison of deflection in various loads by external strengthening methods
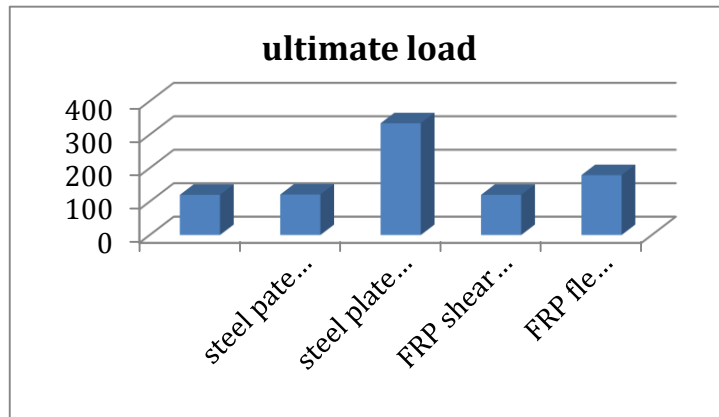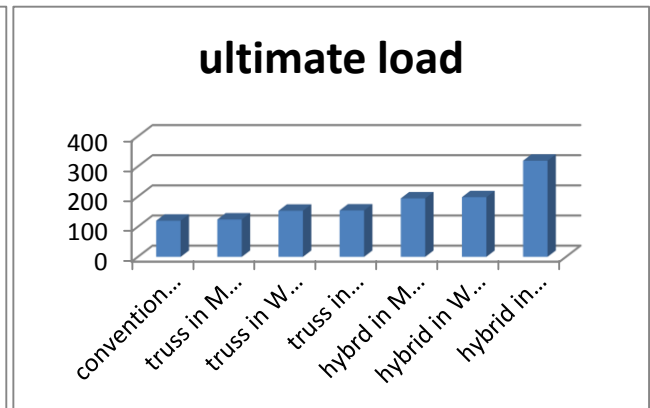

It shows the deflection and load analysis of deep beam with web opening in external strengthening method compared with non-strengthening method.

In this method steel plate has high load carrying capacity as well as shear strength in deep beam containing web opening.

3.3 Comparison of conventional method with internal strengthening method

Method	material used		Type	Concentrated load		Strength in %
				deflection	Load(KN)	
Conventional method	(without strengthening) reference			2.5032	120	
Internal strengthening method	Truss type		M type	2.5	124	3.3
			W type	2.5	153	27.5
			Both M & W type	2.5	154	30
	Hybrid type		M type	2.5	194	60
			W type	2.5	198	70
			Both M & W type	2.5	208	70

3.4 comparison of deflection in various loads by internal strengthening method.

`It shows deflection and load analysis of internal strengthening method compared with non-strengthening method.

Maximum load carrying capacity of deep beam with internal strengthening method are discussed on the figure.in this method has high strength of beams are increasing compared to conventional method.

4. CONCLUSION

The present analytical study is done on the shear behavior of reinforced concrete deep beams containing openings strengthened by different materials reinforced concrete (RC) deep beams containing openings weak in shear having same reinforcement detailing are tested under concentrated point loading. From the calculated strength values, the following conclusions are given:

- Carried out analytical study using ANSYS 16.1 software for the prediction of the shear strength of RC deep beams web opening.
- Compared the strengthening methods values with conventional method value obtained using ANSYS 16.1 software.
- The ultimate load carrying capacity of all the strengthen beams is higher when compared to the conventional deep Beam.
- Initial shear cracks appear at higher loads in case of strengthened beams.
- In case of external strengthening methods, steel plate shows high strength in deep beam with web opening compared to other external methods.
- In case of internal strengthening method, hybrid truss increasing the strength of deep beam.
- In all cases the strengthening method of deep beam in increases when compared to without strengthening method.

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