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Finite Element Modeling of RCC voided Beam and it's comparison with conventional RCC beam

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ABSTRACT : *In the construction of modern buildings, a network of pipes and ducts is necessary to accommodate essential services like water supply, sewage, air-conditioning, electricity, telephone, and computer network. Usually, these pipes and ducts are placed underneath the beam soffit and, for aesthetic reasons, are covered by a suspended ceiling, thus creating a dead space. The provision of transverse openings in floor beams to facilitate the passage of utility pipes and service ducts results not only in a more systematic layout of pipes and ducts, it also translates into substantial economic savings in the construction of a multi-storey building.*
KEYWORDS *– ANSYS, Beam (Reinforced Concrete), Serviceability, Structural design, voided beam.*

I. Introduction

Usually pipes and ducts are placed underneath the beam soffit which is necessary to accommodate essential services like water supply, sewage, air-conditioning, electricity, telephone, and computer network. Passing these ducts through transverse openings in the floor beams leads to a reduction in the dead space and results in a more compact design. For small buildings, the savings thus achieved may not be significant, but for multistory buildings, any saving in story height multiplied by the number of stories can represent a substantial saving in total height, length of air-conditioning and electrical ducts, plumbing risers, walls and partition surfaces, and overall load on the foundation.

It is obvious that inclusion of openings in beams alters the simple beam behavior to a more complex one. Due to abrupt changes in the sectional configuration, opening corners are subject to high stress concentration that may lead to cracking unacceptable from aesthetic and durability viewpoints. The reduced stiffness of the beam may also give rise to excessive deflection under service load and result in a considerable redistribution of internal forces and moments in a continuous beam. Unless special reinforcement is provided in sufficient quantity with proper detailing, the strength and serviceability of such a beam may be seriously affected.

In extensive experimental study, Many Researchers considered openings of circular, rectangular, diamond, triangular, trapezoidal and even irregular shapes. However, circular and rectangular openings are the most common ones in practice. When the size of opening is concerned, many researchers use the terms *small* and *large* without any definition or clear-cut demarcation line. From a survey of available literature, it has been noted that the essence of such classification lies in the structural response of the beam. When the opening is small enough to maintain the beam-type behavior or, in other words, if the usual beam theory applies, then the opening may be termed as small opening. In contrast, large openings are those that prevent beam-type behavior to develop. Thus, beams with small and large openings need separate treatments in design.

II. System Development

ANSYS is useful to final element simulations for RCC structure we use SOLID 186 for Concrete, LINK 8 for Rebar (Reinforcement),CONTA 174 And TARGE 173 to define contact between them. Following are the elements are used for the simulation of RCC beam.

2.1 SOLID186 Element Description:

SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyper elastic materials.

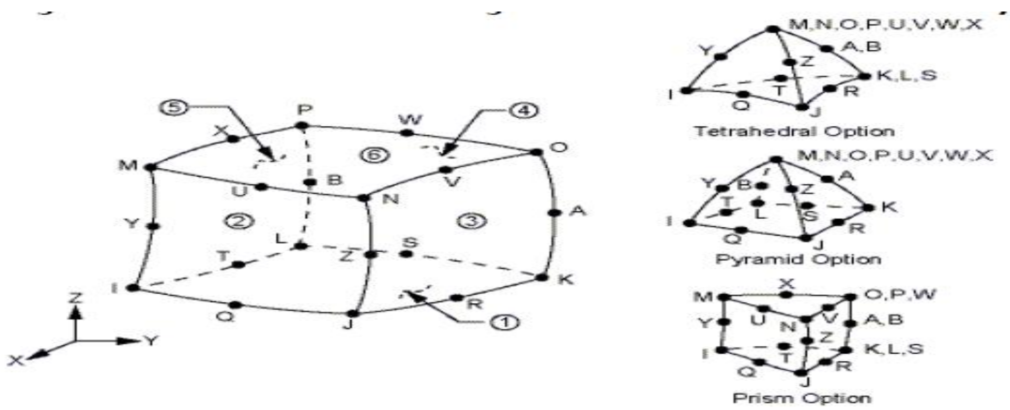


Fig. 1

2.2 LINK8 3-D Spar:

LINK8 is a spar which may be used in a variety of engineering applications. Depending upon the application, the element may be thought of as a truss element, a cable element, a link element, a spring element, etc. The three-dimensional spar element is a uniaxial tension-compression element with three degrees of freedom at each node: translations in the nodal x, y, and z directions. As in a pin-jointed structure, no bending of the element is considered. Plasticity, creep, swelling, stress stiffening, and large deflection capabilities are included. See Section 14.8 in the ANSYS Theory Reference for more details about this element. A tension only compression-only element is defined as LINK10.

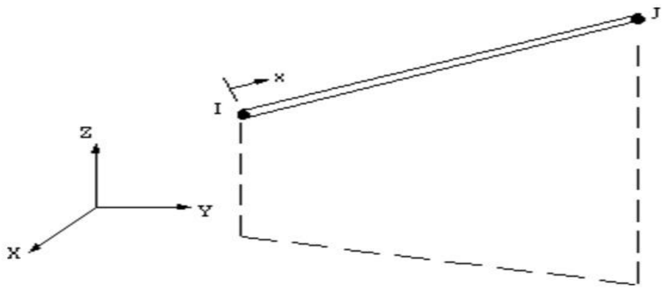


Fig. 2

2.3 CONTA174 and TARGE170:

The 3-D contact surface elements (CONTA173 and CONTA174) are associated with the 3-D target segment elements (TARGE170) via a shared real constant set. ANSYS looks for contact only between surfaces with the same real constant set. For either rigid-flexible or flexible-flexible contact, one of the deformable surfaces must be represented by a contact surface.

If more than one target surface will make contact with the same boundary of solid elements, you must define several contact elements that share the same geometry but relate to separate targets (targets which have different real constant numbers), or you must combine two target surfaces into one (targets that share the same real constant numbers).

Real constant R1 is used only to define the radius if the associated target shape (TARGE170) is a cylinder, cone, or sphere. Real constant R2 is used to define the radius of a cone end at the second node.

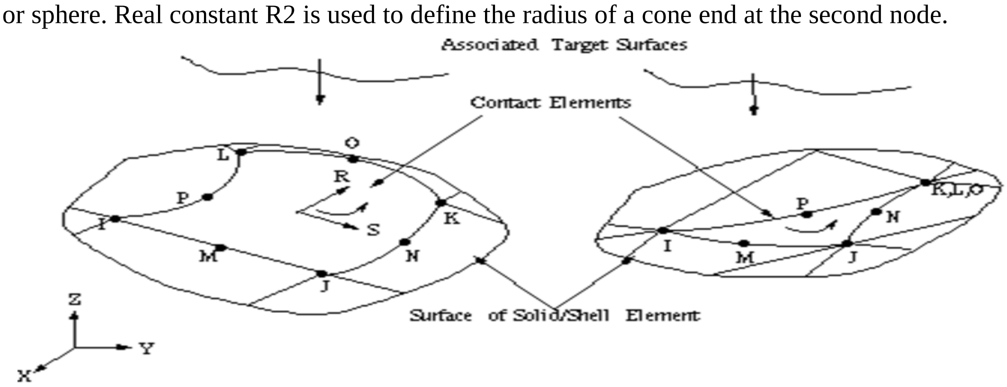


Fig. 3

a. Analysis of Ultimate Strength:

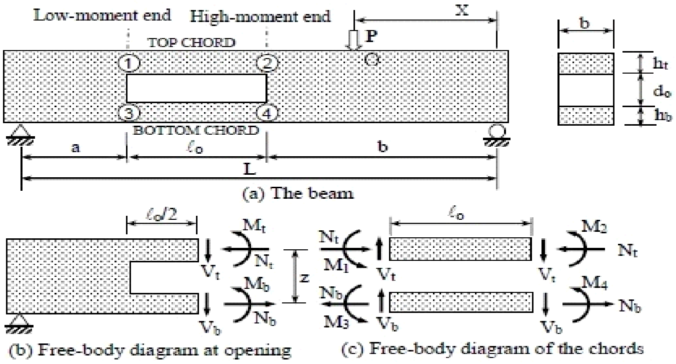


Fig. 4, Beam with a large opening under bending and shear.

III. Problem Statement

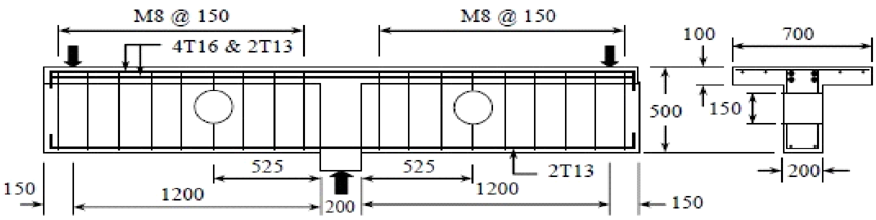


Fig. 5, Reinforcement details of beams

The RCC beam of 2900 mm span is experimentally casted by Mansur et al in 1999, all the specifications and loading pattern is mention in fig. 5.

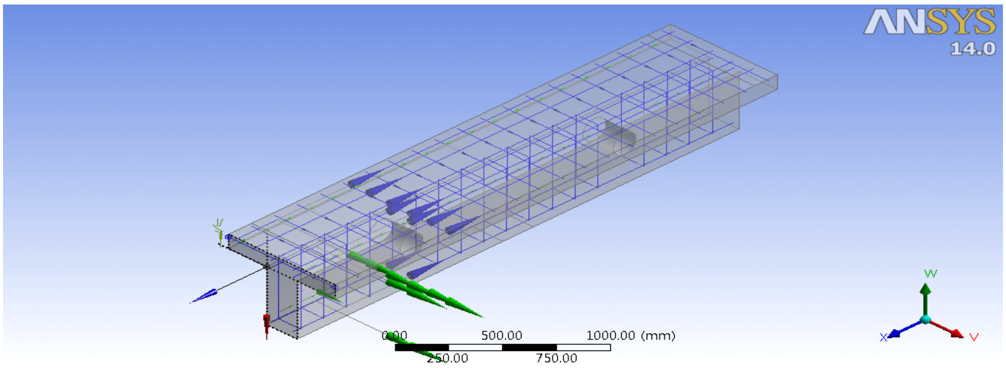


Fig. 6

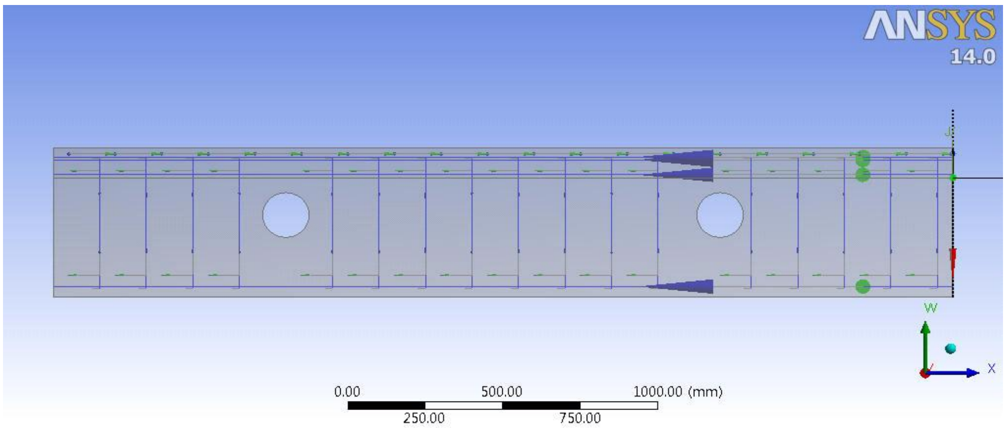


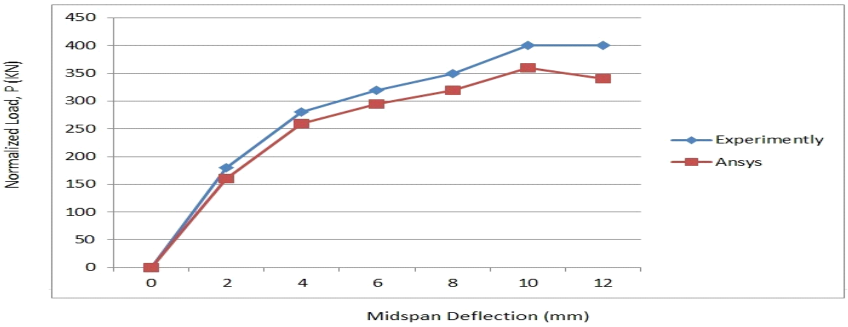
Fig. 7

3.1 Material Properties :

Grade of steel 415 MPA and Grade of Concrete M30, cylindrical compressive strength of concrete 30.8 MPA, assume service load is equal to ultimate load of beam / 1.7.

IV. Performance of Analysis:

The experimental test results are validated with finite element analysis model using Ansys WORKBENCH 14. The errors are founds to be 20 % in given simulations.



Graph 1

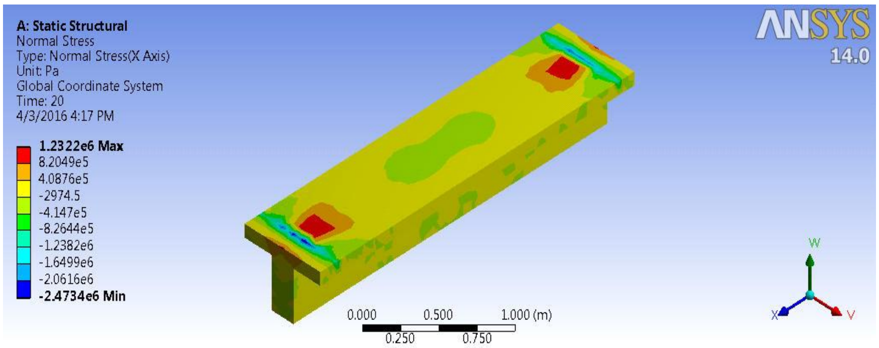


Fig. 8, Max. normal stress occurred at l/4 due to voids

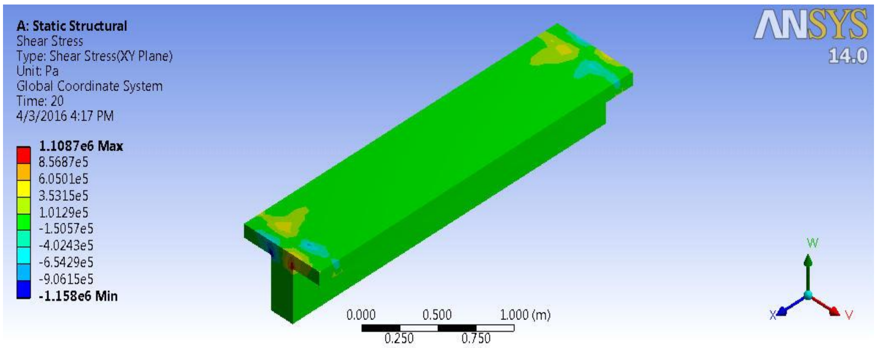


Fig. 9, Max. shear stress developed at slab beam connection

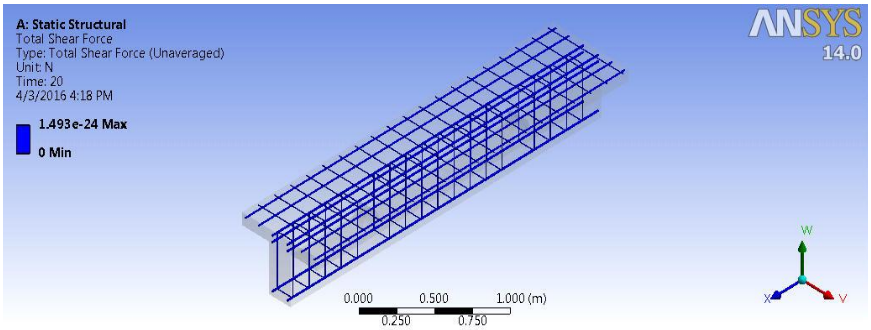


Fig. 10, Total shear force

The Maximum mid span deflection of beam with circular opening, large rectangular opening and conventional RCC beam is plotted in Graph 1. It was observed that mid span deflection, normal stress, shear stress is comparatively less in conventional RCC beam. In RCC beam with circular opening first crack occurred at 269 KN and assume service load was 275 KN which is nearly same.

V. Conclusion

- This paper brief above comparison of RCC conventional beam with RCC beam having transverse web opening subjected to combined bending and shear.
- In various construction, ducts are provided for different utilities, due to duct deflection, deformation, normal stress, shear stress increase due to voids additional reinforcement and its design are need to be provided in IS codes, in later stage of project type of openings are studied (Circular and rectangular openings.).
- Maximun normal stress are observed near opening of beam hence additional transversed shear reinforcement required to reduce normal stress.

References

[1] ANSYS. ANSYS User's Manual Revision 14, ANSYS.
[2] IS 1893 - Part 1, Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, India, 2002.
[3] IS 456, Indian Standard Plain and Reinforced Concrete Code of Practice, Bureau of Indian Standards, New Delhi, India, 2000.
[4] Mansur, M.A., Design of Reinforced concrete beams with web openings. proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006), 5 - 6 September 2006, Kaula Lumpur, Malaysia.