International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 5 Issue 4|| April 2016 || PP.22-29

Non Linear Analysis of Composite Beam Slab Junction with Shear Connectors using Ansys.16

Bukka R S[1], Shimpale P M[2], Lokhande R M[3]
[1] *((P.G.StudentCivil Engineering department, MGMCOE Nanded)*
[2]*(Associate Professor,Civil Engineering department, MGMCOE Nanded)*
[2] *(Associate Professor,Mathematics department, MGMCOE Nanded)*

ABSTRACT: *Frame finite-element models permit obtaining, at moderate computational cost, significant information on the dynamic response behavior of steel–concrete composite beam frame structures. As an extension of conventional monolithic beam models, composite beams with deformable shear connection were specifically introduced and adopted for the analysis of composite beams, in which the flexible shear connection allows development of partial composite action influencing structural deformation and distribution of stresses. The use of beams with deformable shear connection in the analysis of frame structures raises very specific modeling issues, such as the characterization of the cyclic behavior of the deformable shear connection and the assembly of composite beam elements with conventional beam–column elements. In addition, the effects on the dynamic response of composite beam frame structures of various factors, such as the shear connection boundary conditions and the mass distribution between the two components of the composite beam, are still not clear and deserve more investigation. The object of this paper is to provide deeper insight into the natural vibration properties and nonlinear seismic response behavior of composite beam frame structures and how they are influenced by various modeling assumptions. For this purpose, a materially nonlinear-only finite-element formulation is used for static and dynamic response analyses of steel–concrete frame structures using composite beam elements with deformable shear connection. Realistic uniaxial cyclic constitutive laws are adopted for the steel and concrete materials of the beams and columns and for the shear connection. The resulting finite-element model for a benchmark problem is validated using experimental test results from the literature review.*

KEYWORDS: *ANSYS,Composite Beams, Non Linear Analysis, Shear Connectors*

I. INTRODUCTION

1.1 GENERAL

Composite steel–concrete construction, particularly for multi-storey steel frames, has achieved a high market share in several European countries, the USA, Canada and Australia. This is mainly due to a reduction in construction depth, to savings in steel weight and to rapid construction programmes. Composite action enhances structural efficiency by combining the structural elements to create a single composite section. Composite beam designs provide a significant economy through reduced material, more slender floor depths and faster construction. Moreover, this system is well recognized in terms of the stiffness and strength improvements that can be achieved when compared with non-composite solutions. A fundamental point for the structural behavior and design of composite beams is the level of connection and interaction between the steel section and the concrete slab. The term "full shear connection" relates to the case in which the connection between the components is able to fully resist the forces applied

1.2 TYPICAL ELEMENT OF COMPOSITE BEAM

The elements that make up composite construction are as shown in fig.1.1

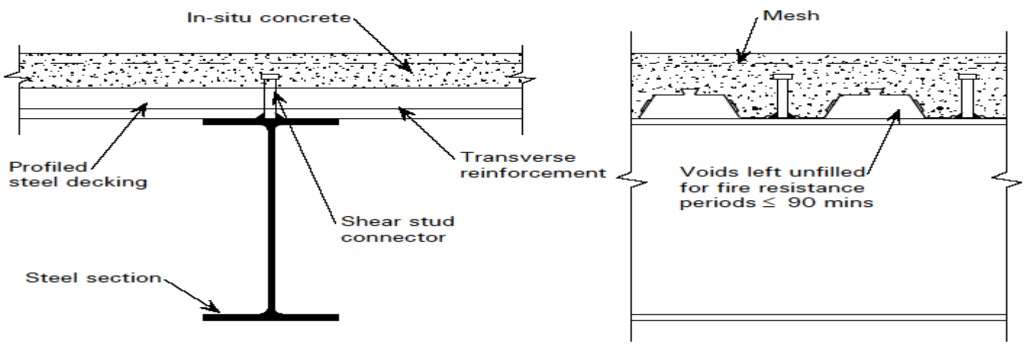


Fig.1.1 Elements of composite beam

II. AIM AND OBJECTIVE

2.1 AIM :Aim of this paper is to check non linear behaviour of composite beam under influence of dynamic loading.

2.2 OBJECTIVE:

1. Studying the effect of the continuation of shear connection beyond the supports of simply supported composite beams.
2. Validation of the FEA model of ANSYS Workbench with experimental result
3. Behaviour of composite beam in cyclic loading and influence of shear connectors.
4. To check dynamic response of Composite beam with different types of shear connectors
5. Investigating the overall structural system behaviour when different concrete compressive strengths are used in the slab and in the associated push-out tests. This situation has often beenobserved in reportedlaboratory studies but has not previously received any systematic study, being important, for instance, for the definition of the load–slip curves used for the shear connectors

III. SYSTEM DEVELOPMENT

ANSYS 16 is useful to finite element simulation for RCC structure ewe use Solid 186 for concrete, link8 for Rebar (Reinforcement), Conta 174 and Targe 173 to define contact between them.

3.1 SOLID186 Element Description

SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behaviour. 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, hyper elasticity, 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

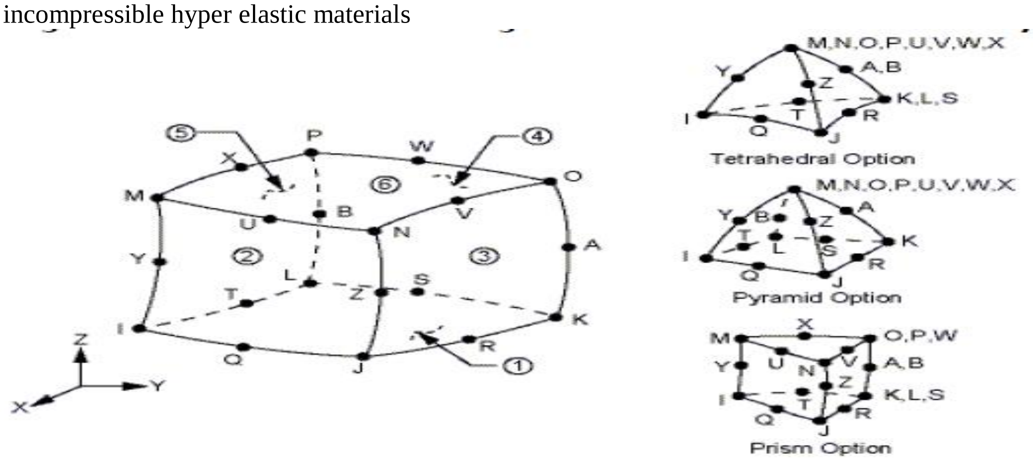


Fig. 3.1

3.2 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. A tension only compression-only element is defined as LINK10

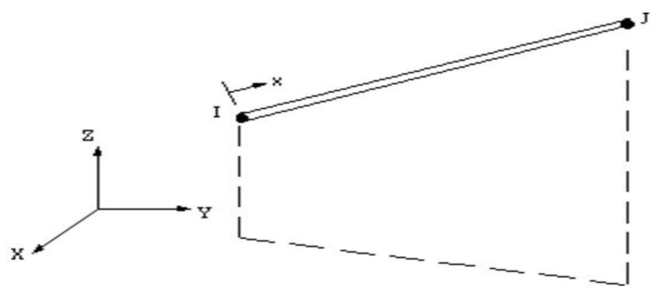


Fig 3.2

3.3 CONTA 174 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).

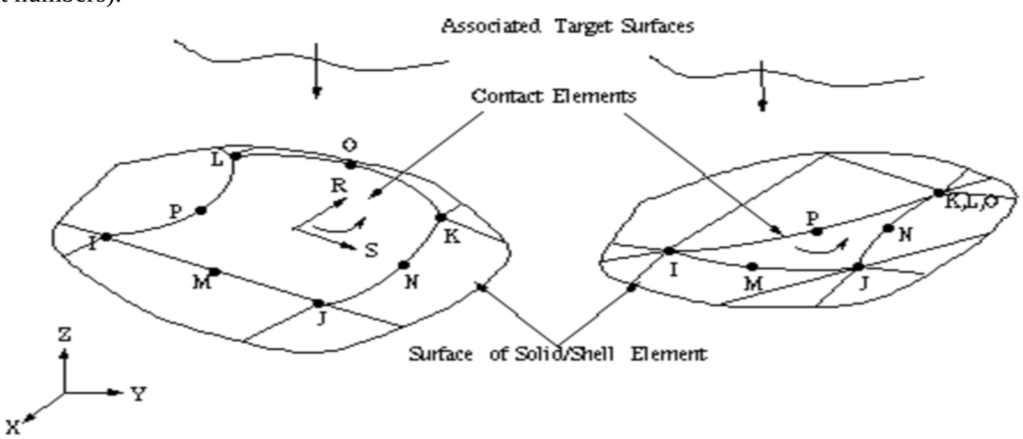


Fig 3.3

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.

IV. PROBLEM STATEMENT :

4.1 CHAPMAN AND BALKRISHNAN's "A3" model:

In this paper a composite beam from literature review is analyzed using finite element analysis tool ANSYS16 the total span of beam 6050 mm thickness of slab is 152 mm & slab is doubly reinforced depth of steel girder is 305mm & flange width is 152mm

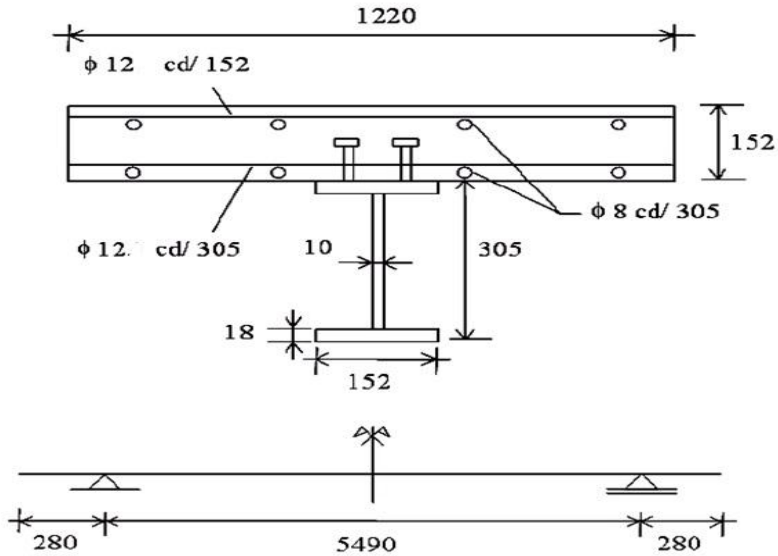


Fig. 4.1 Dimensions of Composite beam model

4.2 MATERIALS PROPERTIES

The characteristics of the "A3" beam of Chapman and Balkrishnan model and the real properties of materials are presented in Table 4.1. It is noteworthy mentioning that this study also considered other configurations for the connectors, as number, height and diameter.Materials properties of composite beam were as follows

Sr.No.	Material	Property	Value
1	Structural steel	Yield stress f_{sy}(MPa)	265
		Ultimate strength f_{su}(MPa)	410
		Young's modulus *Es*(MPa)	205×10^3
		Poisson's ratio μ	0.3
		Ultimate tensile strain e_t	0.25
2	Reinforcing bar	Yield stress f_{sy}(MPa)	250
		Ultimate strengthf_{su} (MPa)	350
		Young's modulus Es(MPa)	200×10^3
		Poisson's ratio μ	0.3
		Ultimate tensile strain e_t	0.25
3	Concrete	Compressive strengthf_{sc}(MPa)	42.5
		Tensile strengthf_{sy}(MPa)	3.553
		Young's modulus E_c(MPa)	32920
		Poisson's ratio μ	0.15
		Ultimate compressive strain e_s	0.045
4	Stud shear connector	Spacing (mm)	110
		Number of rows	2
		Numbers of connectors	68
		Yield stressf_{sy}(MPa)	435
		Ultimate strength f_{su} (MPa)	565
		Young's modulus E_s(MPa)	200×10^3
		Poisson's ratio μ	0.15
		Ultimate strain *e*	0.045

Table No. 4.1 Material properties

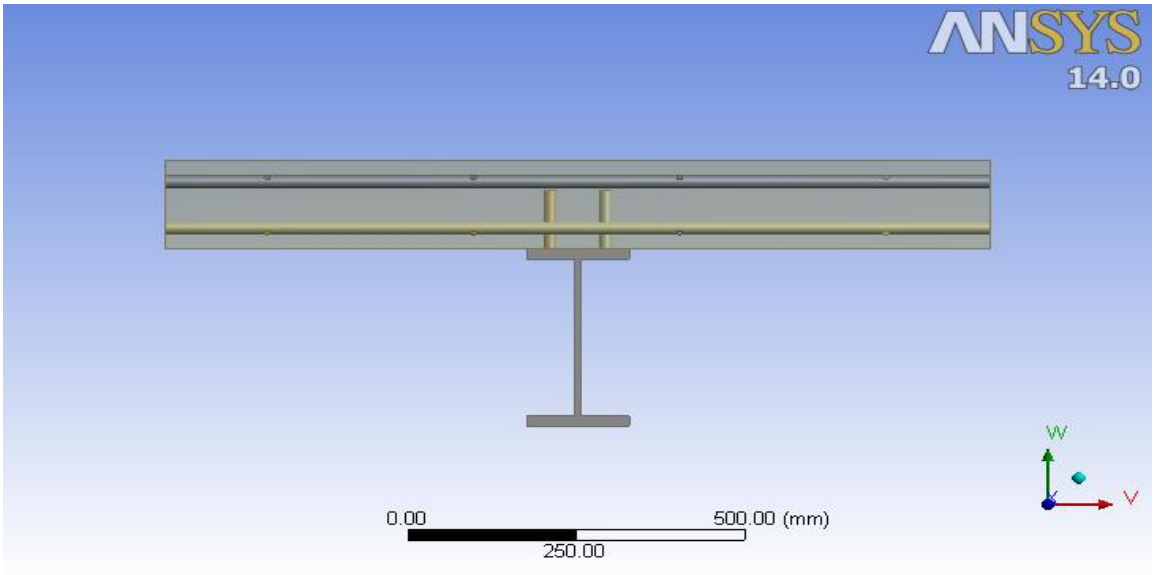


Fig 4.2 Geometry of Chapman/Balkrishnan composite beam model in ANSYS

4.3DISCRETIZATION OF COMPOSITE BEAM IN ANSYS.16

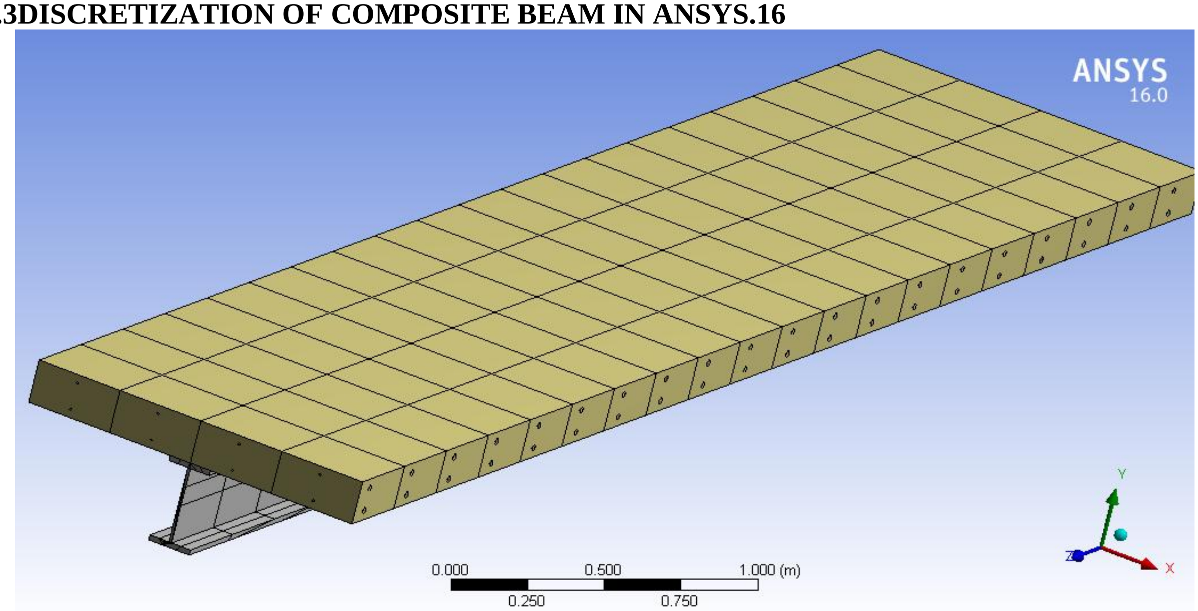


Fig 4.3Finite Element Meshing of composite beam model in ANSYS

In this paper the composite beam having element 11616 and 136969 nodes and each node is having six degree of freedom.

3. Result and discussion:

Graph 5.2shows comparative results of vertical displacements at mid-span with the increment of the applied load. These results refer to the first stage of the simulation and compare well with values experimentally obtained by Chapman and Bal Krishnan Test and presented in this work. The results match up to the linear values and variation of 20% is found in non-linearity

In this paper the composite beam is analyzed in combined bending and shear for linear and non-linear analysis. The influence of shear connector is checked in accordance with EUROCODE-4[3] under which 2 parameters are selected Height and Shape keeping diameter 19 mm constant. For circular connector Φ 19mm, 102 mm height first crack is found at load of 481.54kN.Table No.5.1 and Table No.5.2 shows distinct comparison of rectangular connector and circular connector

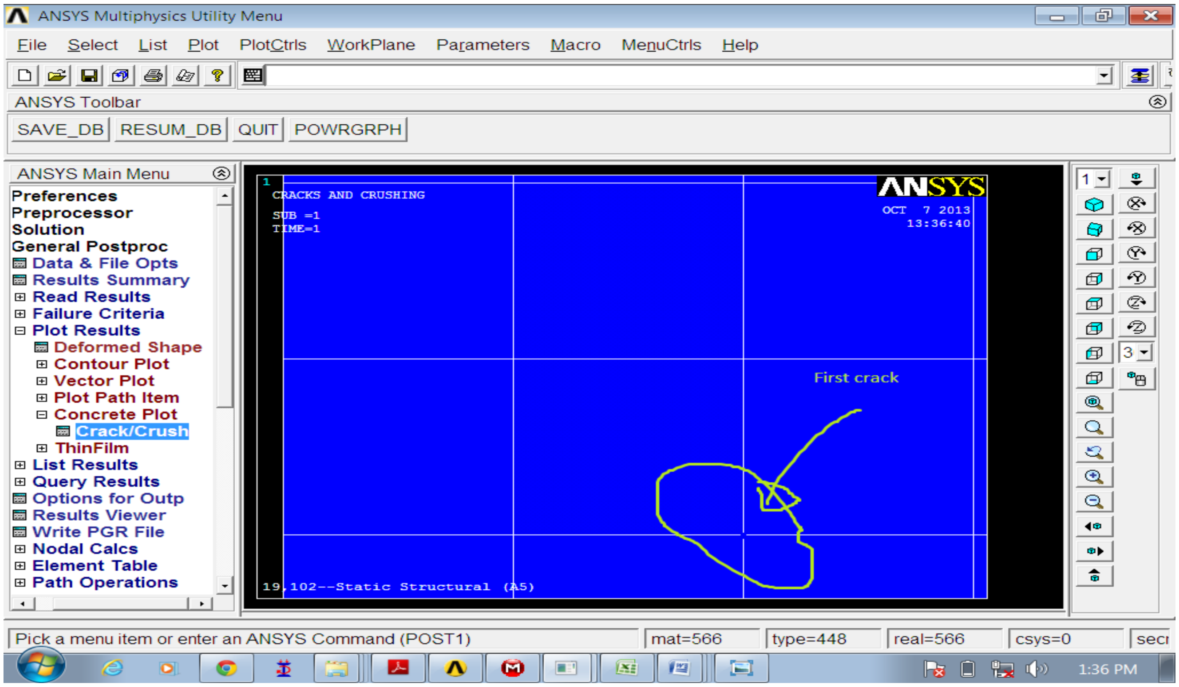


Fig 5.1First Crack at the load of 481.54

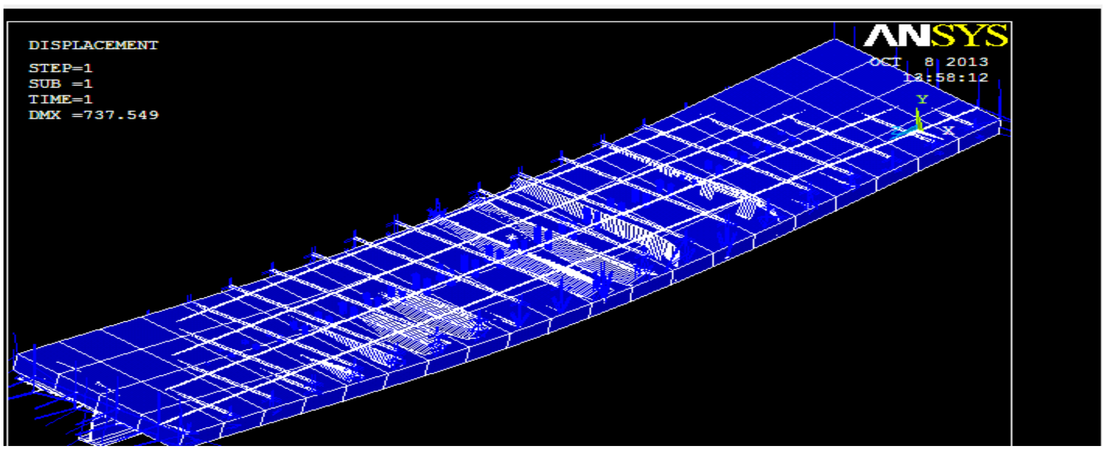


Fig 5.2 Crushing of slab

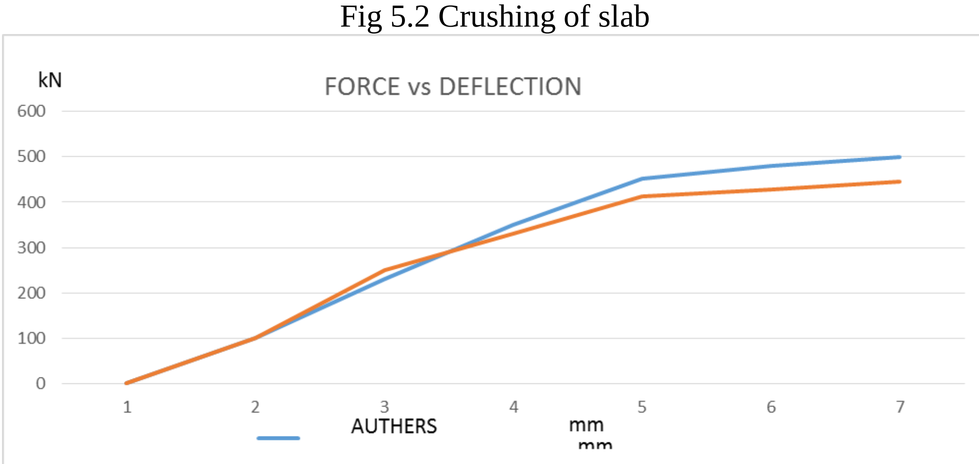


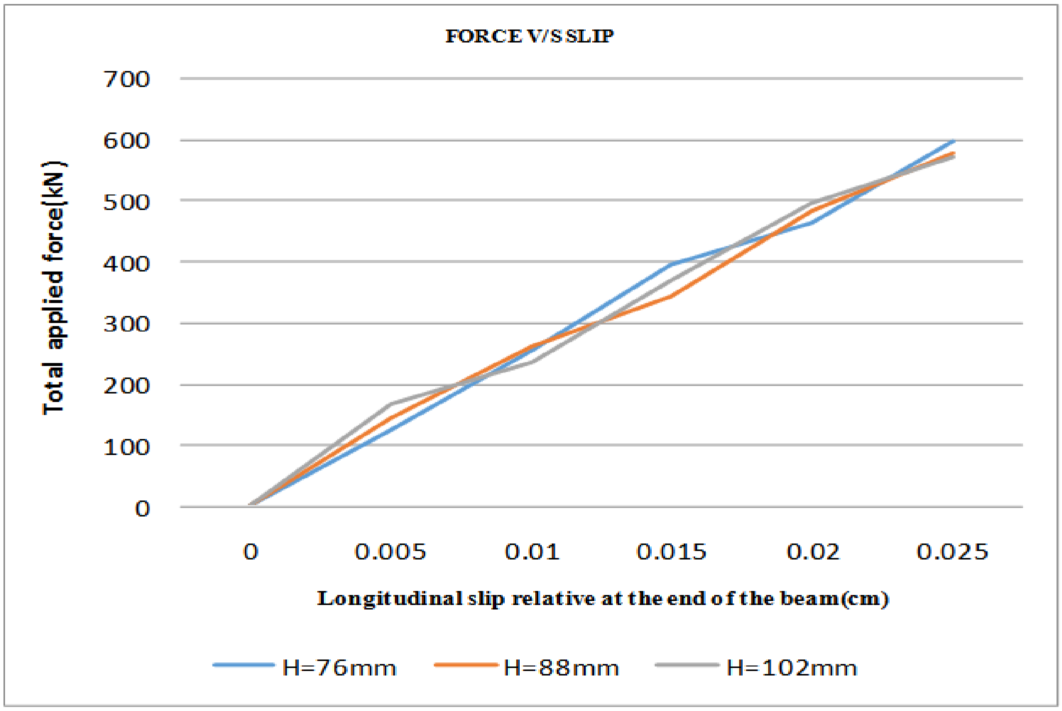
Fig 4.Validation of Composite Beam model with Experimenal results with ANSYS 16

Parameter	□ (mm)	Fmax (kN)	Umax(cm)	dmax (cm)
H=76mm	19	506.9	9.24	0.0188
H=88mm	19	481.3	6.48	0.0143
H=102mm	19	481.4	6.54	0.0149

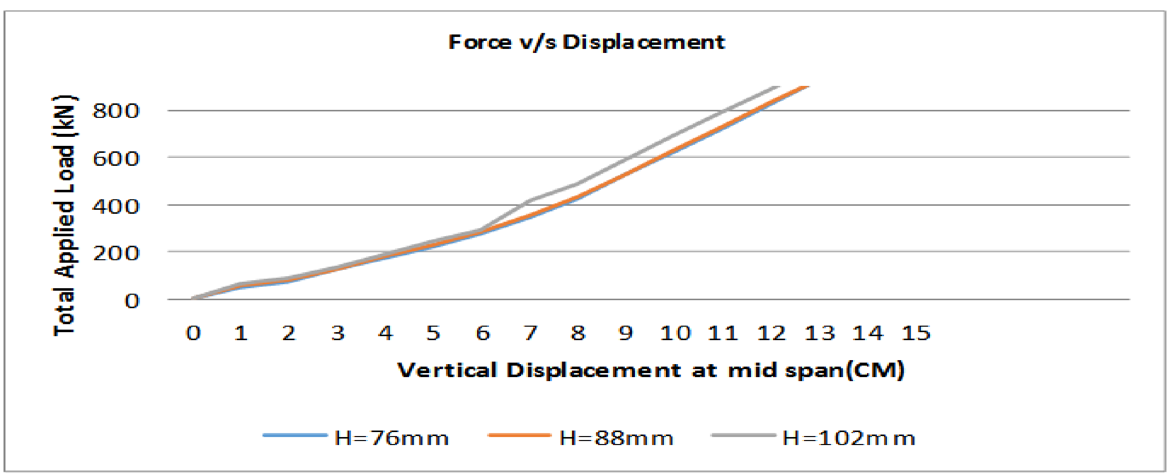
Table No.5.1 Summary of the results considering variations of H with circular connector

Parameter	Φ(mm)	Fmax (kN)	Umax(cm)	dmax (cm)
H=76mm	19	591	6.25	0.009
H=88mm	19	474	3.66	0.00876
H=102mm	19	469	3.41	0.00854

Table No.5.2 Summary of the results considering variations of H with rectangular connector



Graph 5.2



Graph 5.1

IV. CONCLUSION

In this paper author has studied the influence of shear connector for beam slab junction. Non linearity is checked up to first crack only and diffrence between ANSYS results and experimental results are found to be 20%.Further it is observed that shape of cross section of shear connector also matters in behavior of composite beam. The shear connectors having rectangular cross section are found more effective than those with circular cross section for arresting the deflection of composite beam

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