Frequency Analysis 0f Complex Composite Beam By Using Finite Element And Ansys workbench 14.0

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ABSTRACT

Complex composite beam is one of the most common structural members that have been considered in design. This paper is intended to provide tools that ensure better designing options for composite beam of simply supported beam. In this Paper an analytical method & FEM approach calculating total deformation at different frequency of complex composite beam.

The results show the strength of composite simply supported beam.

Keywords:- *Composite Beam , Finite Element Analysis, Ansys workbench 14.0*

Introduction:

Two and three layer beams contain of the relationship of layers having the similar or dissimilar thickness and length made of the same or altered material, attached together by suitable mechanical devices or adhesive joints. Typically the resulting complex mechanical elements show enhanced performances in both global toughness and strength compared to those obtained by the sum of individual layers without connection. A perfect connection would permit the complete transmission of the stresses between the layers, Connections exhibit usually finite stiffness so this relative displacements between the layers can happen both in the longitudinal and transverse directions (respectively, slips and uplifts). Moreover, that creates inter layer stress, a further decline of the stiffness of the assembly and, as a significance of the universal stiffness and asset of the complex beam could be induced important to a early failure as soon as the layer is still flexible under loading conditions. For the optimal design of such structural elements. The analysis of the special effects of the interfacial nature on the mechanical reaction of composite beams is formerly of great importance .The problems of two layer beams with deficient linking have been the object of a large numbers of studies in works.

Analyzed steel–concrete beams with mechanical shear connectors the first half-done composite achievement theory was suggested by Newark. His theory is based on assumptions that no improves among the layers are possible and flat section remain plane through the loading procedure. The connection was preserved as a continuous circulation of longitudinal spring categorized by a linearly elastic constitutive law. The layer was demonstrated as linearly elastic Euler-Bernoulli beams .Since this pioneering work, other models were offered which differ in one or more assumptions and numerical examples considered only few mechanisms deal with three-layer beams, perfect assembly in the crosswise direction and a linear elastic law for the joining in the longitudinal direction they commonly accept flexible layers. On the other hand, new indications show that, similarly for reasonable levels of slips, combine exhibition nonlinear nature consistent to a procedure of open-minded de bonding. In a lots work the nonlinear interface behavior is full in account. However, most of it deal with explicit problems & employ numerical events of solution. Here is a absence of analytical answers with general cogency that can be working to examine the impact of interfacial nonlinearity the reaction of complex composite beams. In order to fill this gap, even simplified models which provide explicit analytical solutions are preferable to numerical finite element analyses.

They are generally lighter and stiffer than other structural materials composite material is widely used in aerospace, defense, maritime, vehicle, and many other engineering. A composite material consists of some layers of a composite muddle consisting of ground and more than material . Each layer may have similar or dissimilar material properties with different mechanical properties. It is important to know the dynamic and buckling features of such constructions exposed to dynamic loads in complex composite environmental condition. Composite metal materials are generate in many mishmashes and forms, the design engineer most considers many designs substitutes.

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Objective of Research

1- To obtain total deformation of the complex composite beam by Ansys 14.0
2- To comparative study of analytical and ansys workbench.
3- To analyzed the mode analysis of complex composite beam.

LITERATURE REVIEW

G.Fabbrocino, G.Manfredi, E.Cosenza (2008) Studied the structural behaviour of steel – concrete composite beams depends on the interaction between the steel beam and the concrete slab analyzing the connection largely influences the global behaviour of the beam and its modeling was a key issue in the analysis of these structures. An effective model requires the introduction of an explicit relationship between slip and interaction force given by each connecto and proposed the structural behavior of composite beams subjected to sagging moment due to short term loads.

T.H.Ooijvaar, R.Akkerman (2010) Studied of 16 layer unidirectional carbon fiber reinforced T Beam analyzed forced irrational setup including a laser vibrometer system obtained dynamic behavior of the beam and the modal strain energy damage Index algorithm was applied using the bending and torsion modes. Special attention was paid to the effect of the number of measurement points required to detect and localize the delamination accurately.

Jun Deng et al.(2011) Presented on stress analysis of steel beams reinforced with a bonded CFRP (Carbon Fiber Reinforced Polymers) Plate. The analysis included the analytical solution to calculate the stresses in the reinforced beam under mechanical as well as thermal loads. The solution had been extended by a numerical procedure to CFRP plates with tapered ends, which can significantly reduce the stress concentration. Finite element analysis was employed to validate the analytical results, and a parametric study was carried out to show how the maximum stresses had been influenced by the dimensions and the material properties of the adhesive and the adherents.

Uttam Kumar Chakravartyet al.(2014) Investigated on the modeling of composite beam cross-sections. Theoretical models were available for simple composite beam cross-sections but computational technique, such as finite element analysis (FEA), was considered for complex composite beam cross-sections. It was found that variational asymptotic beam sectional analysis (VABS) and boundary element method (BEM) were very popular and computationally efficient models for composite beam cross-sectional analysis.

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Method and methodology

the finite element method is used to simulate the response of a complex composite simply supported beam. To validate the model, ANSYS 14 is used to solve examples. A two layer symmetric simply supported complex beam with a different loading condition.The problem first solve the analytically and then with finite element method.

Analytical analysis of composite beam:-

The following equations are used to calculate the elasticproperties of an angle ply lamina in which continuous fibers are aligned at an angle ɵ with the positive x direction.

$$\frac{1}{E_{11}} = \frac{\cos^4\theta}{E_X} + \frac{\sin^4\theta}{E_Y} + \frac{1}{4}\left(\frac{1}{G_{XY}} - \frac{2\vartheta_{xy}}{E_x}\right)\sin^2 2\theta$$

$$\frac{1}{E_{22}} = \frac{\sin^4\theta}{E_X} + \frac{\cos^4\theta}{E_Y} + \frac{1}{4}\left(\frac{1}{G_{XY}} - \frac{2\vartheta_{xy}}{E_x}\right)\sin^2 2\theta$$

$$\frac{1}{G_{12}} = \frac{1}{E_X} + \frac{2\vartheta_{xy}}{E_X} + \frac{1}{E_Y}\left(\frac{1}{E_X} + \frac{2\vartheta_{12}}{E_x} + \frac{1}{E_Y} - \frac{1}{G_{XY}}\right)\cos^2 2\theta$$

Elemental Stiffness Matrix:-

$$Q = \begin{bmatrix} Q_{11} & Q_{12} & Q_{16} \\ Q_{21} & Q_{22} & Q_{26} \\ Q_{61} & Q_{62} & Q_{66} \end{bmatrix}$$

$$Q_{11} = \frac{E_{11}}{1-\vartheta_{12}\ \vartheta_{21}}$$

$$Q_{22} = \frac{E_{22}}{1-\vartheta_{12}\ \vartheta_{21}}$$

$$Q_{12} = \frac{v_{12}\ E_{22}}{1-\vartheta_{12}\ \vartheta_{21}}$$

$$Q_{66} = G_{12}$$

$\overline{Q}$ **Matrix**

Using trigonometric identities, Tsai and Pagano have shown that the Elements in the $\overline{Q}$ matrix can be written as,

$$\overline{Q} = \begin{bmatrix} \overline{Q}_{11} & \overline{Q}_{12} & \overline{Q}_{16} \\ \overline{Q}_{21} & \overline{Q}_{22} & \overline{Q}_{26} \\ \overline{Q}_{31} & \overline{Q}_{32} & \overline{Q}_{66} \end{bmatrix}$$

where

$$\overline{Q}_{11} = \overline{Q}_{11}\cos^4\theta + 2(Q_{12} + 2Q_{66})\sin^2\theta\cos^2\theta + Q_{22}\sin^4\theta$$

$$\overline{Q}_{12} = (Q_{11} + Q_{22} - 4Q_{66})\sin^4\theta\cos^2\theta + Q_{12}(\sin^4\theta + \cos^4\theta)$$

$$\overline{Q}_{22} = Q_{11}\sin^4\theta + 2(Q_{12} + 2Q_{66})\sin^4\theta\cos^2\theta + Q_{22}\cos^4\theta$$

$$\overline{Q}_{16} = (Q_{12} - Q_{12} - 2Q_{66})\sin\theta\ \cos^3\theta + (Q_{12} - Q_{22} + 2Q_{66})\sin^3\theta\cos\theta$$

$$\overline{Q}_{26} = (Q_{11} - Q_{12} - 2Q_{66})\sin^3\theta\ \cos\theta + (Q_{12} - Q_{22} + 2Q_{66})\sin\theta\cos^3\theta$$

$$\overline{Q}_{66} = (Q_{11} + Q_{22} - 2Q_{12} - 2Q_{66})\sin^2\theta\ \cos^2\theta + Q_{66}(\sin^4\theta + \cos^4\theta)$$

Stress & strain of complex composite beam using Axial stiffness.

Consider a load, P acting at the centroid, such that the equivalent axial stiffness is,
Therefore,

$$P = \overline{N}_x = \overline{EA}\varepsilon_X^C$$

Constitutive Equation of Composite Beam:-

The stress- strain relations for general complex composite beam can be written as,

$$\begin{bmatrix} \sigma_x \\ \sigma_y \\ \sigma_{xy} \end{bmatrix} = [\overline{Q}] \begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix}$$

$[\overline{Q}]$ represents the stiffness matrix for the Complex composite beam.

The stresses in the K^{th} ply at a distance of Z_k from the reference plane in terms of strains and Complex composite beam can be expressed as,

$$\begin{bmatrix} \sigma_x \\ \sigma_y \\ \sigma_{xy} \end{bmatrix} = \begin{bmatrix} \overline{Q_{11}} & \overline{Q_{12}} & \overline{Q_{16}} \\ \overline{Q_{21}} & \overline{Q_{22}} & \overline{Q_{26}} \\ \overline{Q_{31}} & \overline{Q_{32}} & \overline{Q_{66}} \end{bmatrix} \begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix}$$

Where,

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} \varepsilon_x^0 \\ \varepsilon_y^0 \\ \gamma_{xy}^0 \end{bmatrix} + z_k \begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix}$$

$$\begin{bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{bmatrix} = \begin{bmatrix} \overline{Q_{11}} & \overline{Q_{12}} & \overline{Q_{16}} \\ \overline{Q_{21}} & \overline{Q_{22}} & \overline{Q_{26}} \\ \overline{Q_{31}} & \overline{Q_{32}} & \overline{Q_{66}} \end{bmatrix} \left\{ \begin{pmatrix} \varepsilon_x^0 \\ \varepsilon_y^0 \\ \varepsilon_{xy}^0 \end{pmatrix} + z_k \begin{pmatrix} k_x \\ k_y \\ k_{xy} \end{pmatrix} \right\}$$

The strains in the complex composite beam vary linearly through the thickness whereas the stresses vary discontinuously. This is due to the different material properties of the layer resulting from different fiber orientation.

Computing Axial stiffness for composite Beam.

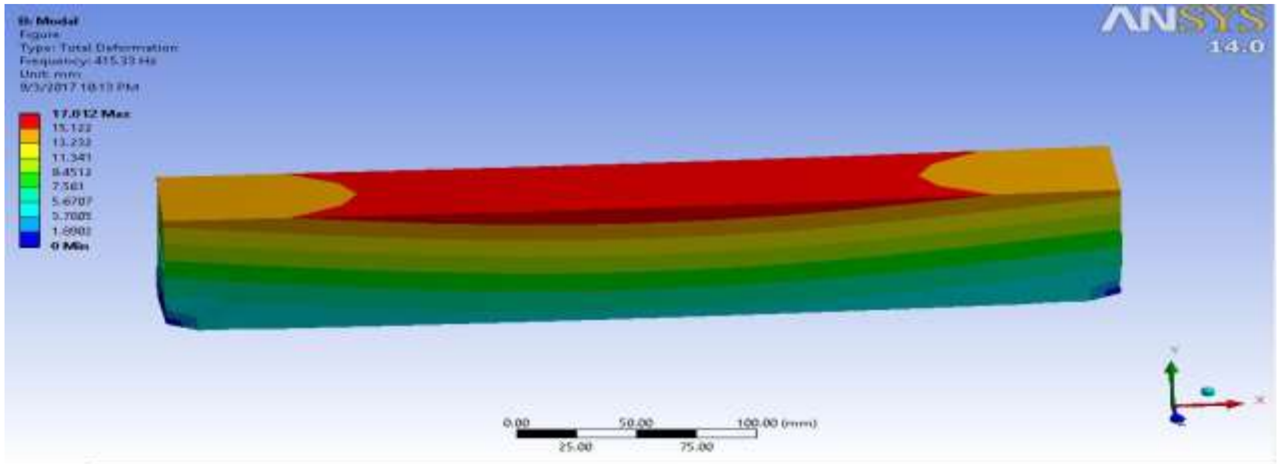
$$(EA)_{BEAM} = \frac{d_{11}}{a_{11}d_{11} - b_{11}^2}$$

Results-

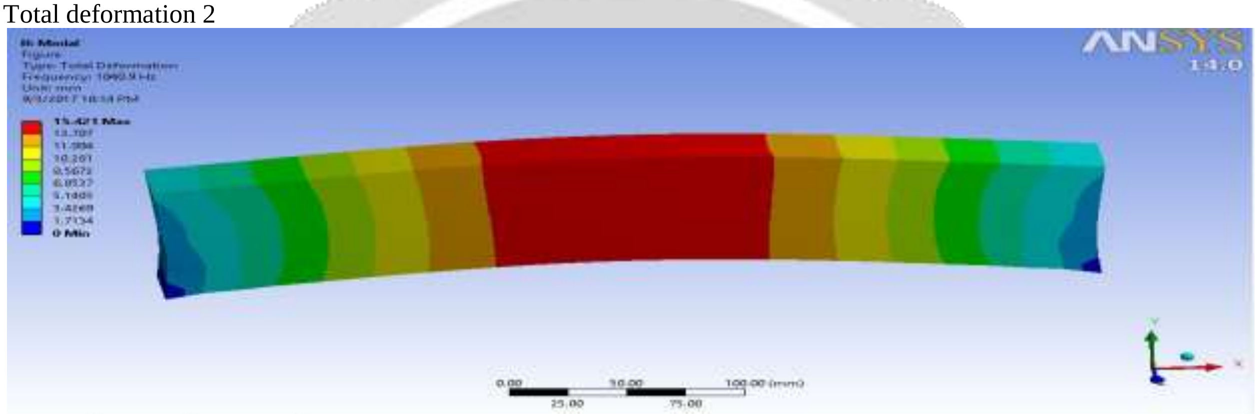
Model (A4, B4) > Modal (B5) > Solution (B6) > Results

Object Name	*Total Deformation*	*Total Deformation 2*	*Total Deformation 3*	*Total Deformation 4*	*Total Deformation 5*
State	Solved				
Scope					
Scoping Method	Geometry Selection				
Geometry	All Bodies				
Definition					
Type	Total Deformation				
Mode	1.	2.	3.	4.	5.
Identifier					
Suppressed	No				
Results					
Minimum	0. mm				
Maximum	17.012 mm	15.421 mm	30.429 mm	13.239 mm	22.029 mm
Minimum Occurs On	Part 2				
Maximum Occurs On	Part 1		Part 2		Part 1
Information					
Reported Frequency	415.33 Hz	1040.9 Hz	1128.5 Hz	1185.2 Hz	1262.9 Hz

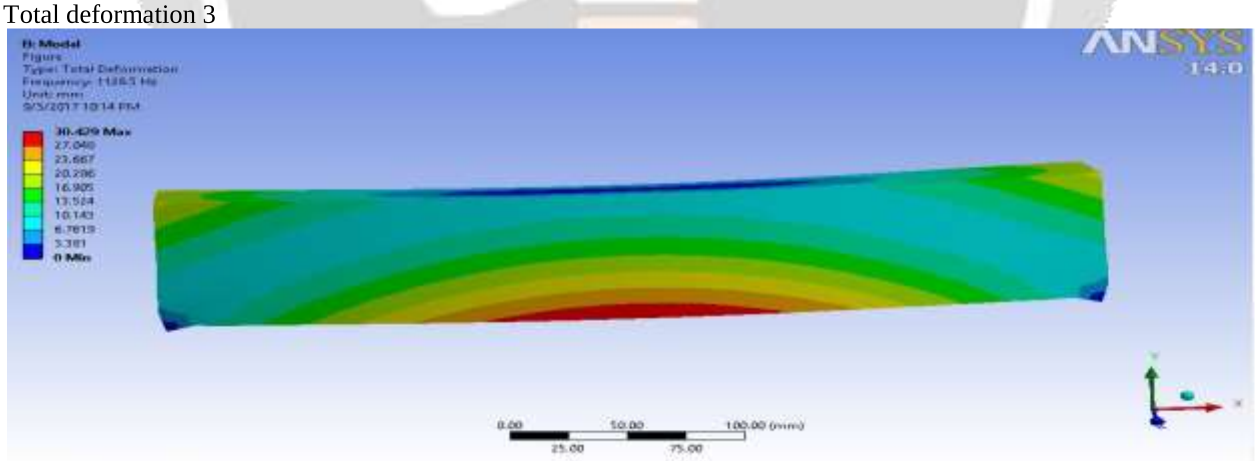
Total deformation 1



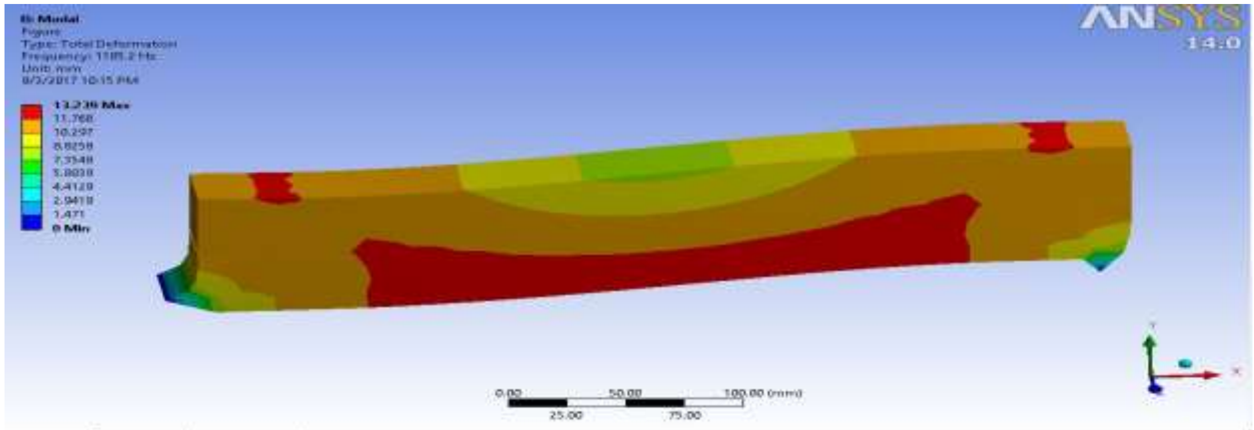
Total deformation 2



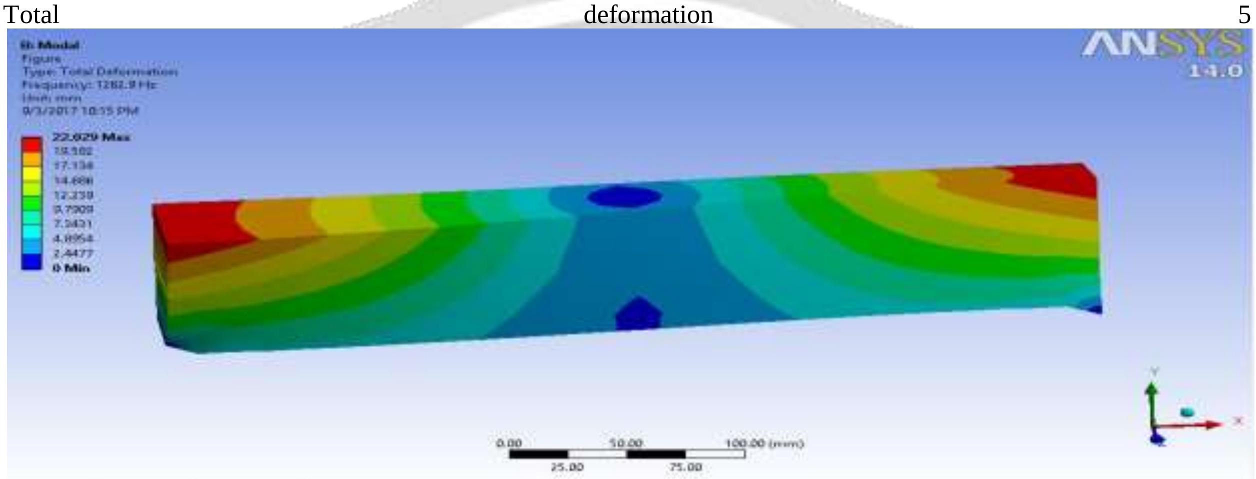
Total deformation 3



Total deformation 4



Total deformation 5



Conclusion

Two dimensional FEM model was developed to study the effects in behaviour of composite beam subjected to various vertical loads. The concrete damage plasticity model and Gattesco nonlinear steel beam model were used to predict the highly nonlinear behaviours of structure. Explicit solver was used due to the complex contact interactions and material nonlinearities. The following conclusions could have been made in this study.

1. The FEM model was analyzed with various levels of low-velocity impacts in combined axes. The results of the FEM model with various speeds were analysed in basis of element distortion and static state prediction. Best agreement was observed with optimum values of velocities 0.5 mm/s and 1.0mm/s in the applications of vertical and axial tensile loadings respectively.
2. The comparison of the failure modes and ultimate limit state values between FEM model and experiment was brought that the FEM model is reliable. Therefore, this FEM model is applicable for the analysis in underlying mechanisms governing the behaviours of various levels of axial tensile loads on the negative moment region of steel-concrete composite beam. Finally, this FEM model is suggested for the design analysis in postponing the failure of structure subjected to biaxial forces through locally strengthening with stiffness wherever necessary.

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