Weight Optimization of Single Girder of EOT Crane By Using Different Types of Cores of Sandwich Structure

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ABSTRACT

Abstract- Sandwich panels with high modulus/high strength skin material and low density/low modulus core material have higher stiffness-to-weight ratio than monolithic panels. This construction has often used in light weight applications such as aircrafts, marine applications, and wind turbine blades. Almost all industrial equipment falls in the category of heavy weight material of I beam section. Hence it is essential to study and optimize the weight and strength in various composite structures. The structural analysis of sandwich panels with C40 face sheets and core is done using ANSYS work bench. Bending stress and deflection is compared with I beam section in analytically. The models of the I Section web core, X(cross) core, and Vf core sandwich structures are done in CATIA V5R20 and weight is analyzed. The aim of thiswork is reduce the weight, deformation and increase the strength. Deformation compared the experimentally by using Universal Testing Machine with analytically as well as summarized the proposed technique for reduction in weight, which will help to investigate the various aspects of weight reduction and strength improvement of various cores i.e. Web core, X core, and Vf core.

Key Word: Sandwich structure, Universal Testing Machine, Electronic Overhead Transfer Machine.

INTRODUCTION

Material handling is a vital component of any manufacturing system and the material handling industry is consequently active, dynamic, and competitive. A crane is a mechanical hoisting contrivance equipped with a rope drum, wire rope and sheaves that are utilized both to hoist and lower materials and to move them horizontally.

Almost all industrial equipment falls in the category of heavy weight material of I beam section. Due to high weight, the deflection of I beam is high.Hence it is essential to study and optimize the weight and strength in various composite structures.Hence we can design different types of cores like web,Vf& X of sandwich structure & after the design numerical, analytical& experimental results of web,Vf& X section are compare with the I-section.

To accomplish this, the following specific objectives are outlined-

1.Numerically determine the bending stress and deflection for sandwich structures.

2.Generate models of sandwich structures (I, web, X, Vf core) by using CATIA.

3.Determine the stress and deflection of sandwich structures by using ANSYS.

4.Compare Analytical and Numerical result of stress and deflection of sandwich structures.

5.Determine the deflection of sandwich structures by using Universal Testing Machine.

6.Check the experimental and ANSYS result of deflection.

7.Compare the ANSYS result of sandwich structure.

8.Selections of sandwich structure low weight, small deformation of the x, Vf, Web core.

2. LITERATURE REVIEW

Extensive work has been carried out on the sandwich structure various static models. The purpose of this literature review is to go through the main topics of interest.

[1]Penttikujala Three cases can be relegated for the collapse modes. For astronomically immense loading areas and for diminutive core plate thicknesses, elastic buckling of core plate is the dominating collapse mode. For thicker plates, core yielding and buckling are causing the failure. With shorter load heights the panel geometry has more diminutive effect and the core plate thickness and the yield vigor dominates the collapse deportment. The third type of collapse mode occurs when the face plate is thin. This can cause face plate buckling afore the collapse of the core plate. The buckling of face plates under compression can be analyzed with standard modes available. The vigor under local load is more problematic. Nar formulations give the most reliable estimate for the ultimate vigor level under local loading, the precision being typically within the region of 10-15% with plate thickness thicker than 1.0 mm and load height higher than 60mm. Finnish recommendations for thin steel structures B6 gives typically 40-60 % more minute values than the quantified figures except for the lowest plate thicknesses and load height, when the precision of B6 is better than 5%. This is explicated by the fact that B6 is developed for point load applications on thin steel corrugated cores. The Roberts formulations developed for tenuous girders give about 50-60 % too high ultimate vigor estimates for sandwich panels with corrugated cores.

[2] **PenttiKujala** Laser welding is used in preaparation of ofmetalic sandwich panels ,when analysis is done then found that it has excellent properties with weight optimization in more application.

[3] JeomKeePaika, Anil K. Thayamballi, Gyu Sung Kim In this study of strength properties of honeycomb sandwich panel which have Al as main material.

[4]KujalaPentti and KlanacAlan When laser welding is used in steel sandwich panel then weight is reduceupto the 30-50%campairing with the conventional steel structure.

[5]Devendra B. Sonawane In rectangular composite structure the equipollent stress as well as weight is additionally reduced compare to Rectangular steel structure. In rectangular composite structure equipollent stress decreases by around 10% and weight is decreases by around 20% as compare Rectangular steel structure.AndIn circular core composite structure equipollent stress decreases by around 62% and weight is decreases by around 30% as compare circular core steel structure.

[6]Gopi Krishna Bagadi Sandwich composite with high bending stiffness with overall low density. This construction has often used in lightweight applications such as aircrafts, marine applications, wind turbine blades and industries. Sandwich structure composite face thickness doubled then total deformation decreases 80 % and equivalent stress decreases 75 %. Sandwich structure composite core thickness doubled then total deformation decreases 15 % and equivalent stress decreases 3 %. Sandwich structure composite faces between distances .

III.METHODOLOGY

Design Procedure

A) Cross section area

A= (2 × Area of flange) + (Area of web +275)

B) Volume of girder section

V= Area × Span

Mass density = $\frac{Weight}{Volume}$

$\rho = \frac{W}{V}$

2. Total force

F= (Total Weight of crane + Weight of girder + Lifting capacity)

3 Maximum bending moment

$Mb_{max} = \frac{wl^2}{8}$

4 Bending stress

$6_b = \frac{M}{Z}$

5 Maximum deflection

$Y = \frac{5W\,L^3}{384EI}$

6 Checking factor of safety for Design

Factor of safety = $\frac{\sigma_{all}}{\sigma_b}$

Table1.Design Parameter

	I-Section	X-Core	Web-Core	Vf-Core
Cross section Area(mm^2)	5380	4910.136	4705.5	4989.16
Total Weight(N)	25094.71	24877.893	24783.45	24969.68
Maximum Bending Moment(Nm)	18821.0325	18651.48	18587.59	18727.26
Bending StressN/mm^2	50.948	47.3980	43.69	52.876
Maximum Deflection(mm)	1.65	1.011	0.901	1.4226
Checking Factor of Safety for Design	3.17	3.4	3.7	3.06

IV.PREPARING THE3-D MODEL

I section beam,X-core, Web core &Vf-core is modeled in CATIA. Then the geometry is saved in STP format and imported to ANSYS workbench. In ANSYS Workbench the STP format is imported and geometry will show three contact pairs. Materials properties are given to the geometry. Now mesh the geometry as optimum meshing size, convergence study optimum mesh size is selected and structural analysis is done by fixing the geometry at both end part of the span of the beam and pressure is applied at top face of the plate. Now by solving the structure the deflection and von misses stress are noted.

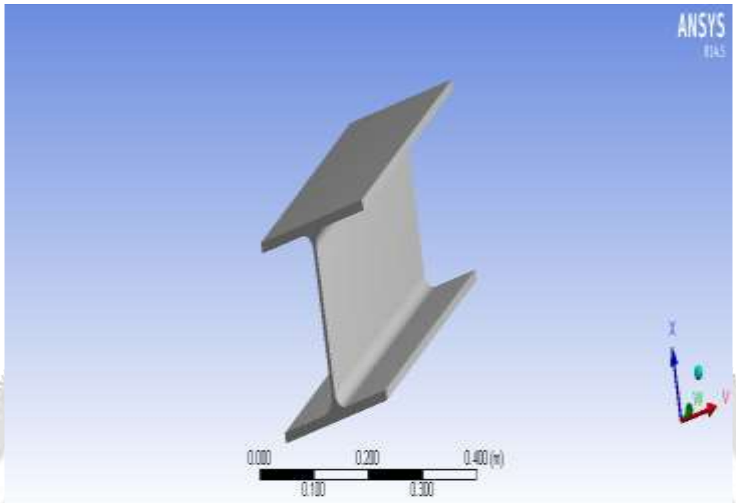

Fig.1.3-D Model of I section

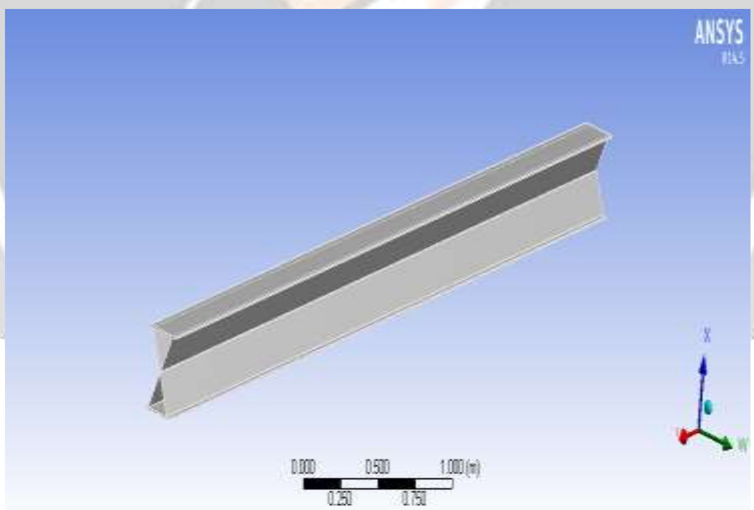

Fig.2.3-D Model of X section

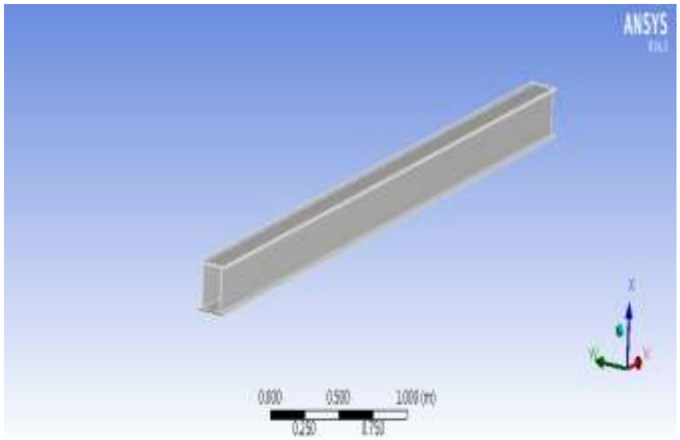

Fig.3.3-D Model of Web section

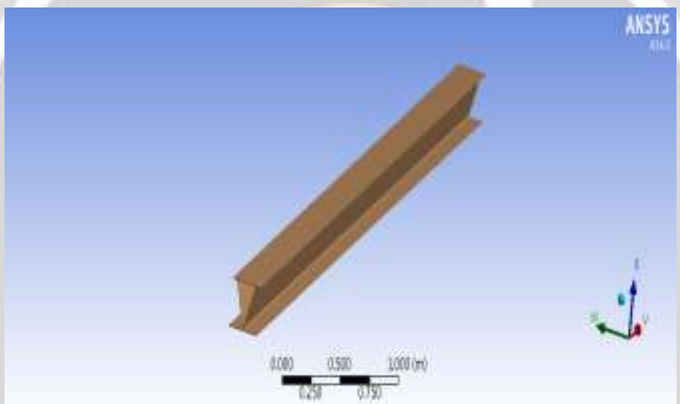

Fig.4.3-D Model of Vf section

V.MESHING

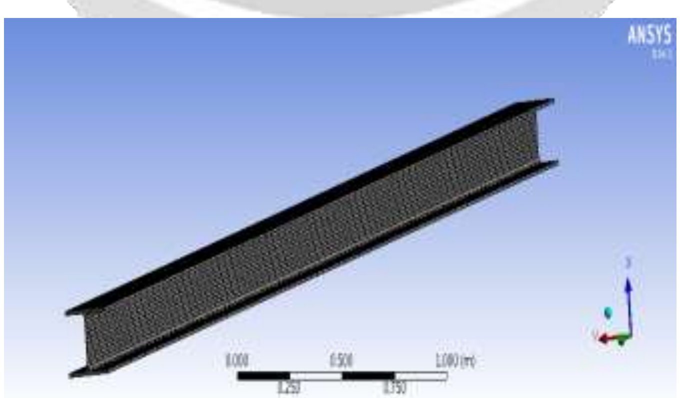

Fig.5.Meshing of I section

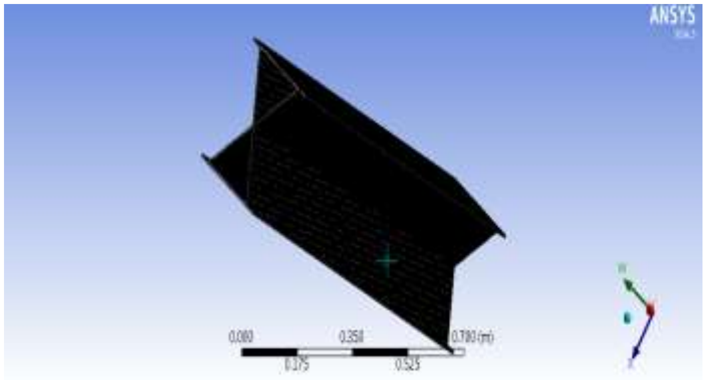

Fig.6.Meshing of X section

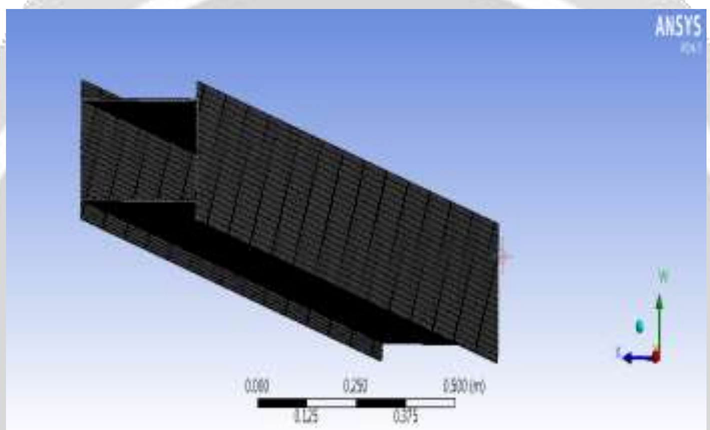

Fig.7.Meshing of Web section

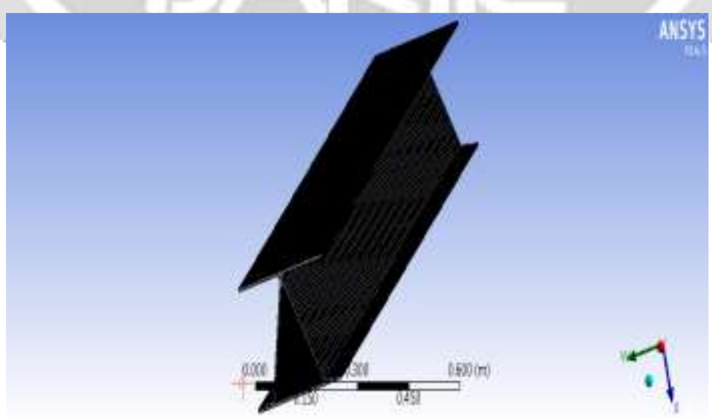

Fig.8.Meshing of Vfsection

VI.TOTAL DEFORMATION

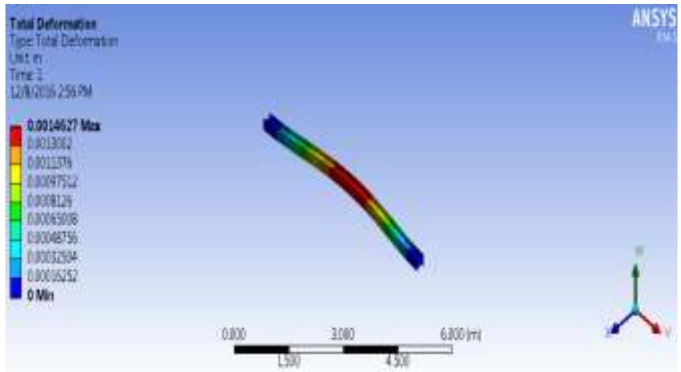

Fig.9.Deformation of I section

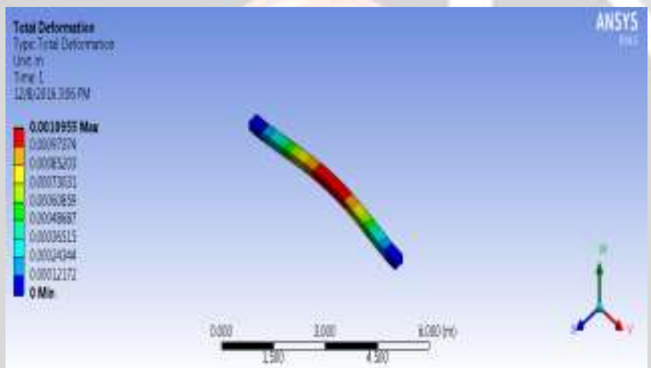

Fig.10.Deformation of X section

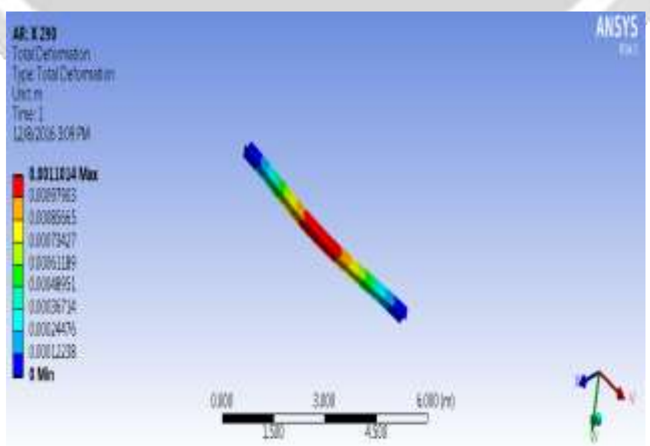

Fig.11.Deformation of Websection

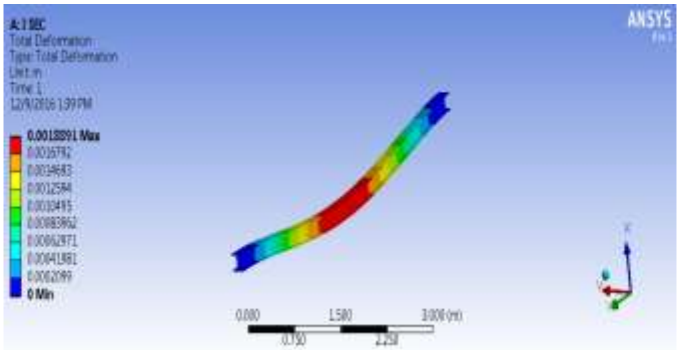

Fig.12.Deformation of Vfsection

VII.EQUIVALENT (VON MISSES) STRESS OF SECTION

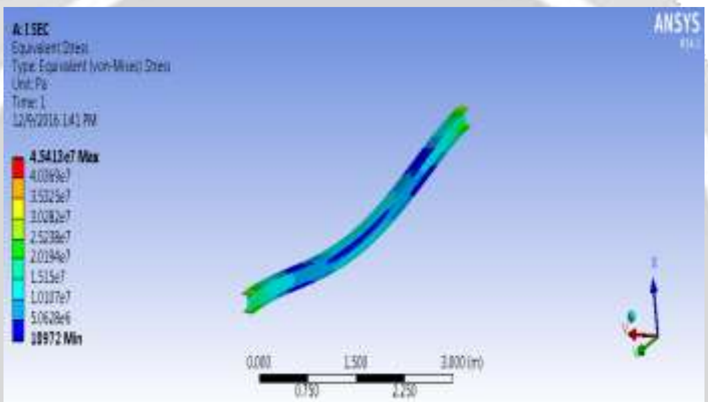

Fig.13.Equivalent stress of I Section

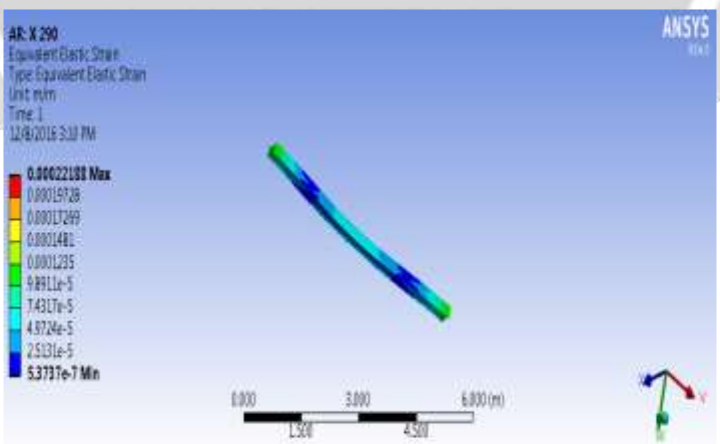

Fig.14.Equivalent stress of X Section

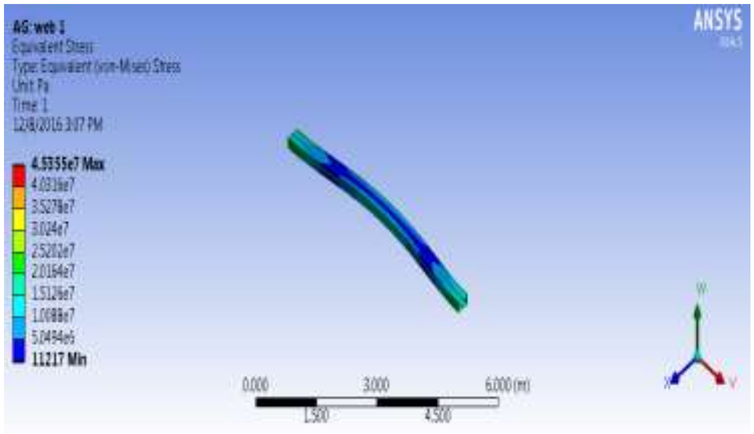

Fig.15.Equivalent stress of Web Section

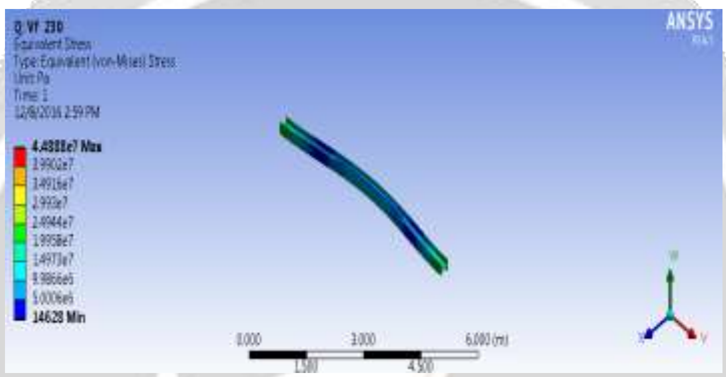

Fig.16.Equivalent stress of Vf Section

Table2.Ansys and theoretical result of sandwich structure

sandwich structure	**ANSYS workbench**		**Theoretical**		**Self Weight (kg)**
	Deflection (mm)	Stress (MPa)	Deflection (mm)	Stress (MPa)	
I section	1.8891	45.413	1.6595	50.948	253
X core	1.1014	44.819	1.011	47.948	230.57
Vf core	1.4627	44.888	1.4226	52.76	240.33
Web core	1.0955	45.355	0.901	43.69	221.34

VIII.CONCLUSION

1.The deflection and self weight of Web core sandwich structure is small as compare to the X core and Vf core sandwich structure.

2.In sandwich structure the weight of web core sandwich sandwich structure is 221.34 kg is small as compare to the Vf core and X core sandwich structure.

3.The deflection of web core sandwich structure is 1.0955 mm is also small as compare to I section, Vf core sandwich structure, and X core sandwich structure.

4.Then web core sandwich structure is optimum sandwich structure.

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