Design and Analysis of Failure Strength of Composite I-Beam

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Abstract
Most of the chemical industries, the steel is coated with Polyurethane (PU) on steel sample which is found that some chemical reaction and rusted in acidic bath solution so there is very big problem in industry. The above problem is reduced by using the reinforced epoxy glass fiber composite material. In this investigation the results revealed that, Araldite 2015 have used in this composite material the maximum stress at web-flange junction (WFJ) is 10.797MPa which indicate that maximum stress as compared to Huntsman Araldite, the maximum stress value of 10.363MPa, which is improved the failure strength on the web-flange junction. The numerical analysis results clearly indicate that the emersion of the reinforced epoxy glass fibre in the acidic bath solution for a certain period for no any reaction with acidic bath and improving the behaviour of the specimen.

***Keywords:** Acidic bath, Composite, Polyurethane, Reinforced epoxy glass fiber, Web-flange junction*

INTRODUCTION

Rolled Steel Joist (RSJ), W-beam (for "wide flange"), Universal Beam (UB, H-beam, is also known as I-beam with an I- or H-shaped cross-section. The "I" beam flanges are horizontal elements, and the web is the vertical element. The flanges counterattacks mostly in the bending moment and the web counterattacks shear forces practiced by the beam. The Beam theories are very efficient in the form of both shear force and bending moment in I-shaped segment with the plane of the web. Alternatively, the cross-section has an inefficient in carrying torsion and reduced capacity in the transverse direction, for which mostly have considered the hollow structural sections for improving the failure strength.

Two standard I-beam sections are designed as follows:

1. Plate girder, made by welding (or sometimes riveting or bolting) plates.
2. Rolled I-beam, made by extrusion, cold rolling, hot rolling (contingent on material).

Potter et al. studied that the use of adhesive bonding in advanced composite structures which offers the potential for considerable weight and cost saving compared to the use of mechanical fasteners. Conversely, the ability to design and analyses like structures and in their production to appropriate eminence quality standards are developed [1]. Experimental tests were accomplished that to examine the effect of bending moments and axial compression loads on composite I-beams. The effect of the aspect ratio on the first crushing load, the energy absorption and the initial crushing bending moments have also been studied. Woven fabric glass fiber was used as the fiber material while the matrix was of an epoxy resin and hardener mixture. Even though, the fabrication process for the composite I-beams have been done with great care in this project, some thickness variations have been found even along the same model [2].

In this paper analyses the effect of restraints on elastic lateral buckling (no any deformation) of tracks loaded at the flange of bottom, and shows the which one to be excused for in design of the strength [3]. Most prone of stainless steel to fighting the corrosion, which was predictable of this purpose type of steel reason for its chemical composition? These corrosion specimens had excessive damage in strain and strength, along with the major weight defeat. Pitting was also most prevalent on these samples [4]. At that time this beam is used in acid factory the material of beam is steel with PU coating such as high elasticity, high chemical resistance, ultraviolet durability, and good transparency. In the field of engineering PU has been widely used in various domains, like tires, high-performance sealants, wheels, hard plastic parts seals, gaskets and automotive suspension bushes. In spite of, the PU is not suitable abrasive wear resistance properties. PU specimens submerged in the 1 M HCl chemical solutions for various time-periods, in which the effect of weight of the PU has become a more substantial with longer involvement. The involvement of the PU in the chemical permits the immersion of water molecules so that the quantity of riveted water in the PU rises with improved immersion period, subsequent in dissimilar weight losses of the PU with altered immersion periods through evaporation of the engrossed water. On the other hand, the reduced weight of the PU with longer immersion time should be correlated to the lowered thermal stability of the polymer because the polymer structure can be degraded by the prolonged immersion in the highly acidic solution [5].

Geometry of I Beam

Figure 1 show that the geometry of I-beam is taken from ISMB 80 standard for using the sample of stirrer mounting mechanism. The height of the I-beam is 80 mm, the width of flange is 50 mm and thickness of the web and flange is 5 mm.

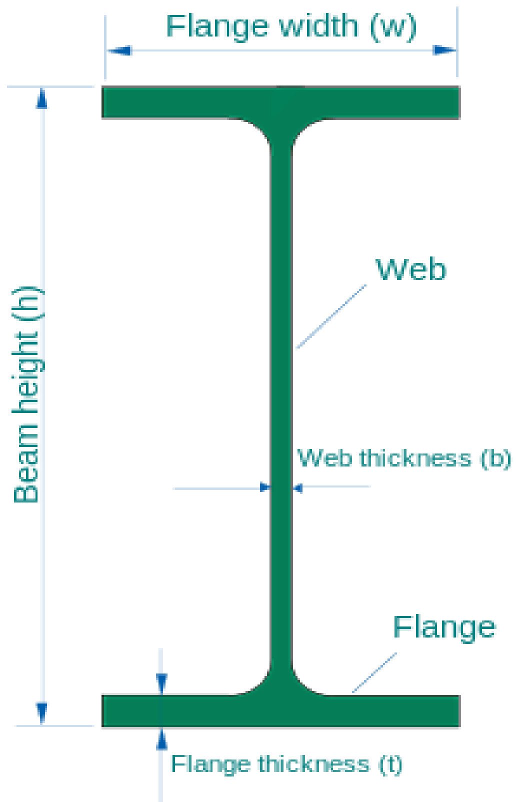

Figure 1: *Geometry of I Beam.*

Problem Statement

- In I beam structure web resists shear forces while the flanges resist most of the bending moment experienced by the beam.
- Most of times failure occurs at joining section of web and flange.
- So the complete bonding between these two is very essential part.
- Currently using steel beam with PU coating has shorter life of span due to chemical reaction with acid used and further it gets rusted.
- Here we are going to study and improve the bonding of the joint section.

Objectives

- To design the structural I beam by using reinforced epoxy glass fibercomposite materials.
- To calculate the stress and force of composite I beam at web-flange junction using FE analysis.
- To improve the failure strength of I beam which is used to adhesive at WFJ.

MODELLING USING ANSYS

Following Step are used in ANSYS

To solve any ANSYS problem mainly following steps are used. These steps are common in all ANSYS problem except material properties and type of analysis used.

Preliminary Decisions

a) Analysis type
b) Model
c) Element type

Pre-processing

a) Material
b) Create or import the model geometry
c) Mesh the geometry

Solution

a) Apply loads
b) Solve

Post Processing

a) Review results
b) Check the validity of the solution

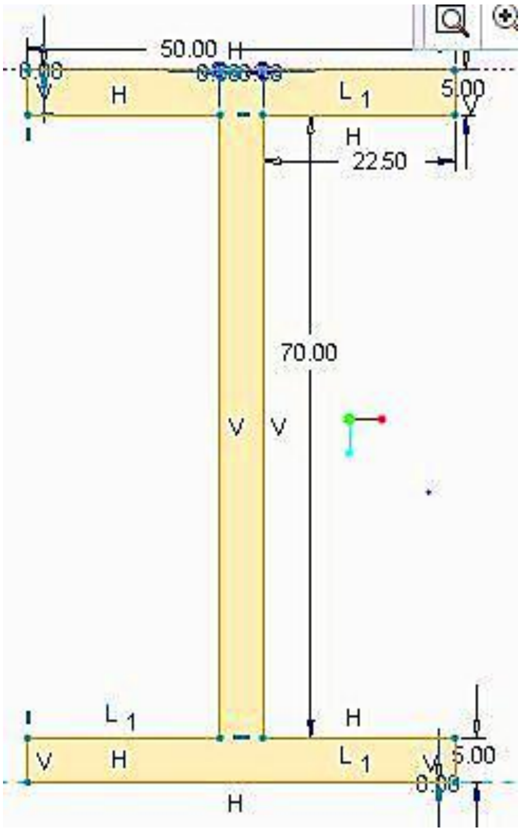

Figure 2: *Creo Design of I Beam.*

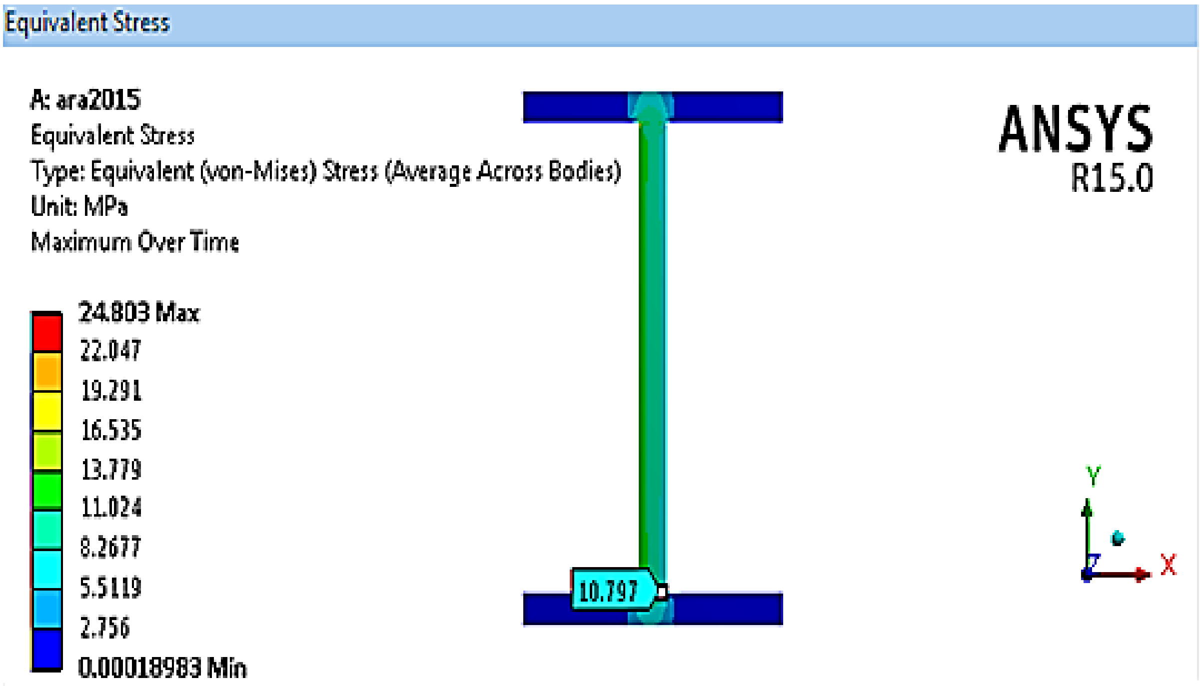

Figure 3: *Von-Mises Stress of araldite 2015.*

Maximum stress at the bonding area of flange and web junction is 10.797 MPa and it can be seen in above Figure 3. This clearly indicates as time increases stress on junction point increases and it has taken 10.797 MPa stress and then failed.

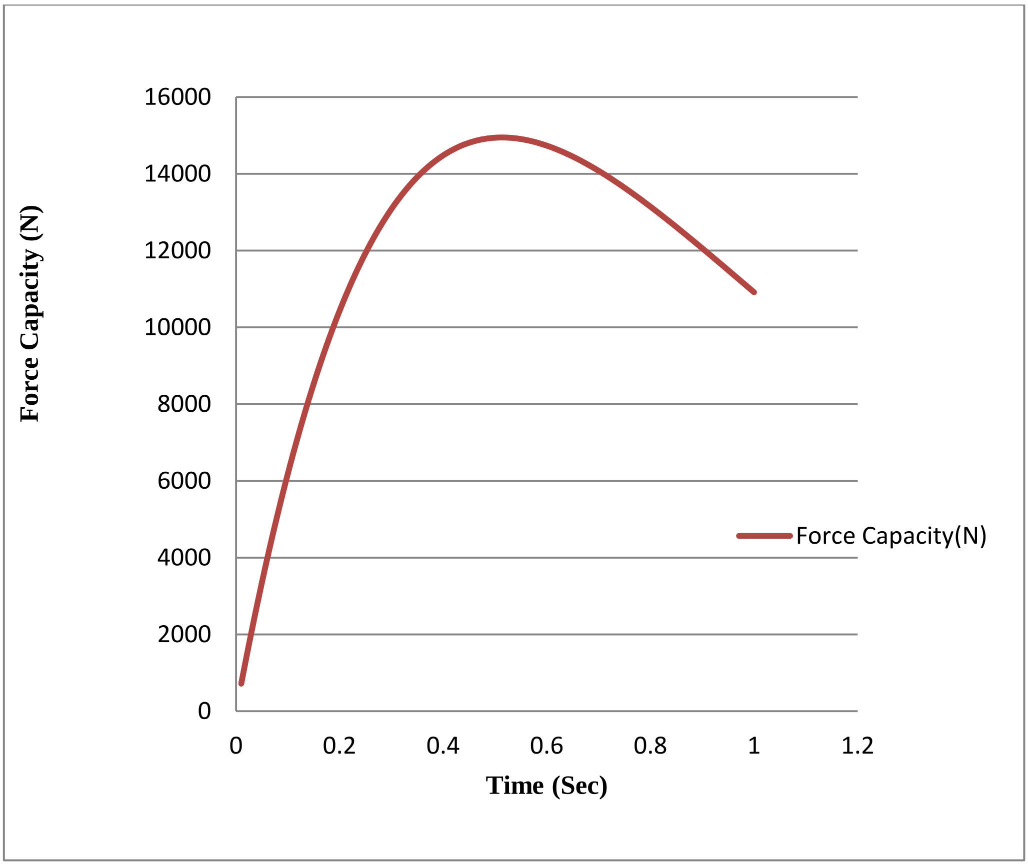

Figure 4: *Force Capacity of I-Beam with Araldite 2015 Adhesive.*

By using this adhesive when we done FEA of I-Beam component we got following graph of time Vs force capacity shown in Figure 4. In the graph time is taken on x-axis and force capacity is taken on y-axis. This component has taken maximum force of 14945 N.

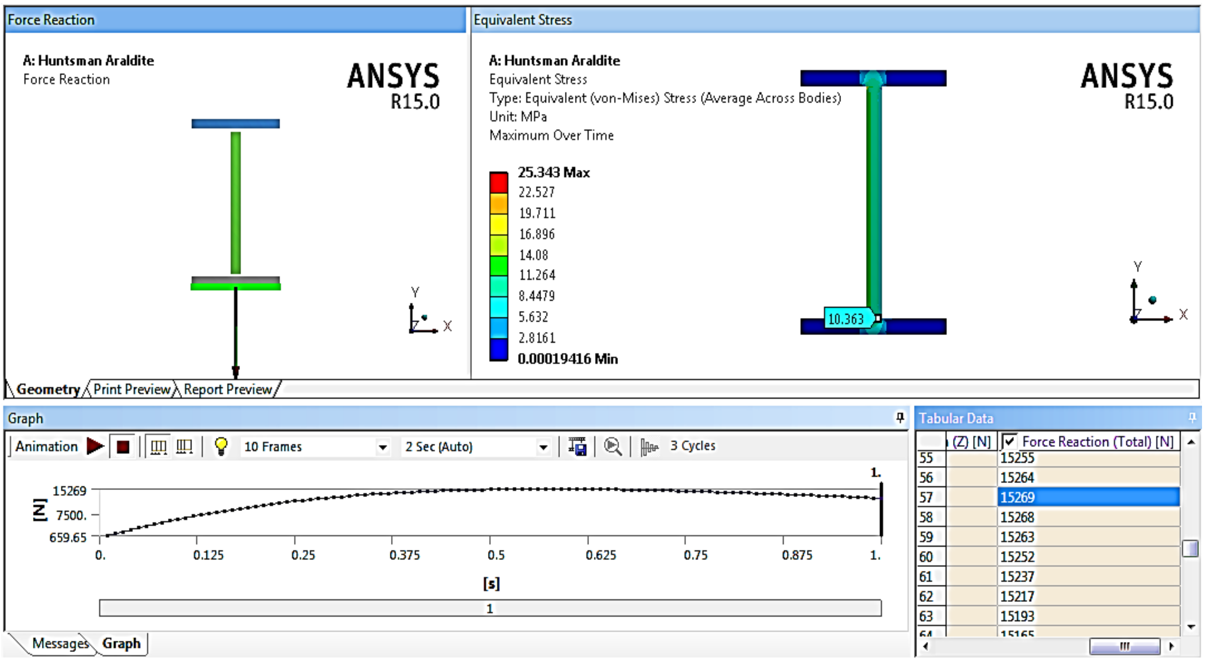

Figure 5: *Von-Mises Stress Huntsman Araldite Adhesive.*

Figure 5 shows a time Vs load curve, time is taken on x- axis and force is on y-axis. The force reaction, Upper flange of beam is fixed and pulling load is applied along y-axis on flange, as load increases with time one step reached where the beam taken 15269 N load and failed. Max principal stress at the bonding area of web-flange junction (WFJ) for specimen is 10.363 MPa. The I-Beam specimen which clearly indicates that the time increases, stress on junction point also increased and it has taken 10.363 MPa stress and then failed.

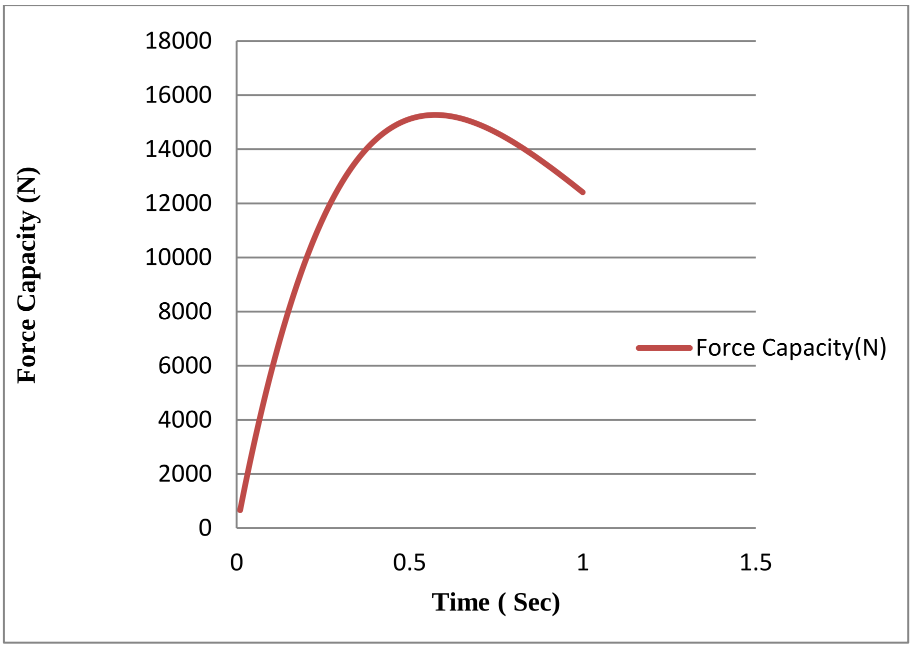

***Figure 6:** Force Capacity of I-Beam with Huntsman Araldite Adhesive.*

By using this adhesive when we solved FEA of I-Beam component we got following graph of time Vs force capacity shown in Figure 6. In the graph time is taken on x-axis and force capacity is taken on y-axis. This component has taken max force of 15269 N.

PROPERTIES OF MATERIAL

***Table 1:** Properties of Glass Fiber-Reinforcement Materials.*

Fiber Property	Glass Fibers
Diameter (µm)	8-14
Density (kg/m^3)	2560
Longitudinal Modulus of Elasticity (GPa)	76
Transverse Modulus of Elasticity (GPa)	76
Tensile Strength (GPa)	1.4-2.5
Elongation at Fracture (%)	1.8-3.3

***Table 2:** Properties of Epoxy Matrix Materials.*

Matrix Property	Epoxy
Density (kg/m^3)	1100-1400
Modulus of Elasticity (GPa)	3-6
Tensile Strength (GPa)	0.035-0.10
Compressive Strength (GPa)	0.1-0.2
Elongation at Fracture (%)	1-6

RESULTS AND DISCUSSION

***Table 3:** Max Stress Sustained by I-Beams at Joint.*

Specimen No.	I-Beam with Adhesive	Stress (MPa)
1st	Araldite 2015	10.797
2nd	Huntsman Araldite	10.363

From above result Table 3 it is observed that, I-Beam with Araldite 2015 has offered max stress as compared to Huntsman Araldite. It is clear that 2nd I-Beam specimen with Huntsman Araldite as adhesive has taken minimum stress 10.363 MPa.

***Table 4:** Maximum Force Carrying Capacity of I-Beams Specimens.*

Specimen No.	I-Beam with adhesive	Force (N)
1st	Araldite 2015	14945
2nd	Huntsman Araldite	15269

It is observed from above result Table 4, I-Beam with Huntsman Araldite has maximum force carrying capacity as compared to Araldite 2015 specimen. It is clear that 2nd I-Beam specimen with Huntsman Araldite adhesive has taken maximum force as compared to Araldite 2015 specimen. I-Beam specimen with Huntsman Araldite has taken force of 15269 N, whereas the specimen with araldite 2015 has taken force of 14945 N. It means Specimen of Huntsman Araldite is stronger than specimen of araldite 2015.

CONCLUSION

1. Composite I-Beam will be best option in chemical industries because there is no chemical reaction with acidic bath.
2. Also, its main advantage is low weight as compared to steel.
3. The sample of Huntsman Araldite is tougher than sample of araldite 2015. Because its force carrying capacity is more.

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