Effect of Tetmeth Bisphen Carbonate and Ethylene Isophthalate blend on Steel Bridge Girder

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ABSTRACT

A blend is a mixture of more than one component. The density and mechanical properties obtained for different compositions of the Tetmeth Bisphen Carbonate (TBiC) and Ethylene Isophthalate (EI) blend were calculated. The results were used to compare the stress distribution, structural deformation and Mass in the Girder of Steel Bridge. A decrease in the displacement is observed when the mass fraction of Tetmeth Bisphen Carbonate is decreased in the blend. The Mass of the structure also decreased from 142.23 kg to 116.53 kg. Stress induced in the composite structure is less than steel structure.

1. INTRODUCTION

Blends or composites are materials containing more than one components. The components do not lose their identity in the mixture. They combine and contribute to the property of the blend thereby improving the quality of the material. Development of a single material with the desired property involves significant research and time. A blend saves time to develop a new material thereby reducing the cost of development of products with desired properties. Polymer blends can be nano material modified polymers [1], biodegradable polymers- natural fiber composites [2], fire retardant/fire proof materials [3,4], lightweight composite materials having high strength for transportation industries [5], glass fiber reinforced polymers, latex polymer cementitious composites [6] etc. Blends are preferred due to their high values of mechanical properties per unit weight. They can replace conventional metals and alloys.

Steel Bridge is communicator when any obstacle is there between two regions like rivers, hill etc., In this, there is main component Girder of Steel as Material which can withstand the loads on the bridge. Hence it is mainly focused on this study as base. Depending on the composite materials behavior on the Girder, one can take decision on type of material to be used for construction Bridge with Displacement Criteria, Von Mises Stress Criteria and Also Mass of Structure Criteria. This study presents a detailed comparison of Girder of Steel Bridge with composite material for I shaped cross section.

2. MATERIALS & METHODS

Synthia module of Materials studio of Biovia software (Dassault Systems of France)" was used to obtain density and mechanical properties of a blend of Tetmeth Bisphen Carbonate and Ethylene Isophthalate. Catia module of 3D Experience is used for Modeling the girder beam of a Bridge Structure. The mechanical properties were fed corresponding to conventional metal and composite. The constant parameter of the study is the span of girder which is 5m and I- cross section of Steel bridge. The Variable parameter is Conventional material and Composite Material. The I girder beam is subjected to a uniformly distributed load and the stress induced, Mass of the Structure and structural deformation were studied using Simulia. The figure below shows the Finite Element Model of the Girder of the Steel Bridge.

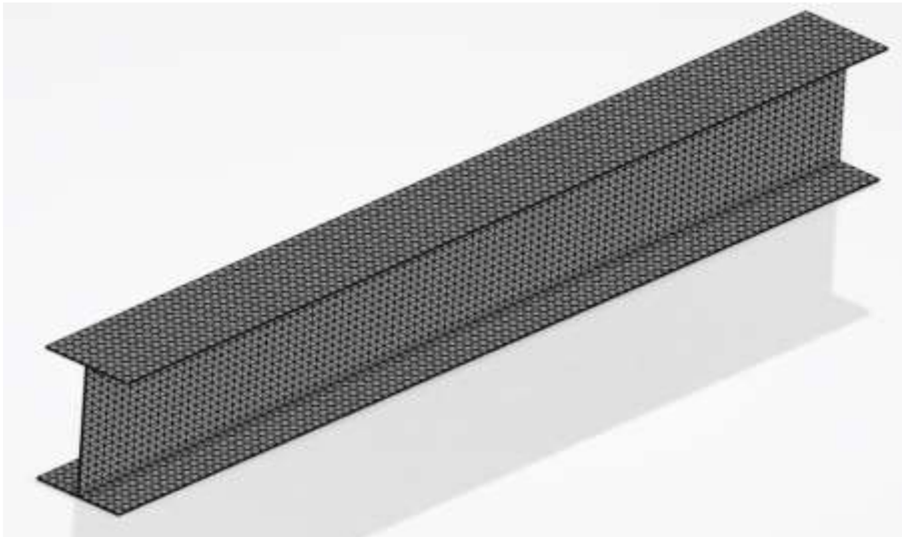

Figure 1: I Girder Beam of a Steel Bridge Structure

Table 1 shows the material properties of Steel 1035 grade and the composite blends of TBiC and Ethylene Isophthalate at various compositions used for the simulation.

Table 1. Properties of the materials of Steel and Composite

Property	Conventional material: Steel 1035	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =1:0	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0.66:0.33	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0.33.:0.66	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0:1
Density	7600 kg/m^3	1079 kg/m^3	1148 kg/m^3	1227 kg/m^3	1317 kg/m^3
Young's modulus	207GPa	284 GPa	266 GPa	248 GPa	229 GPa
Poissions Ratio	0.3	0.375	0.387	0.397	0.41

The I girder beam of Steel Bridge is subjected to Uniformly distributed live load of 10kN/m. The Variational Stress and the Displacement plot for various material compositions are presented below.

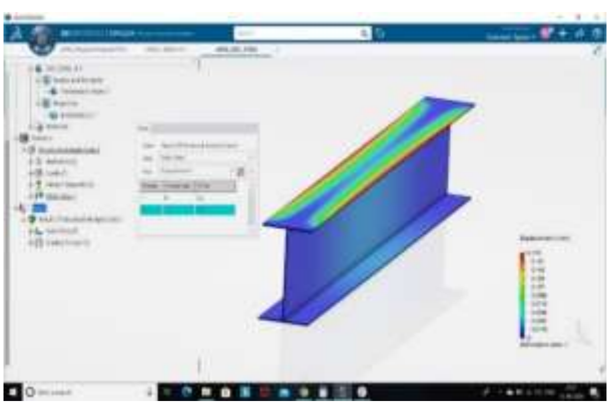

Fig 2: Displacement Plot for Steel (1035)

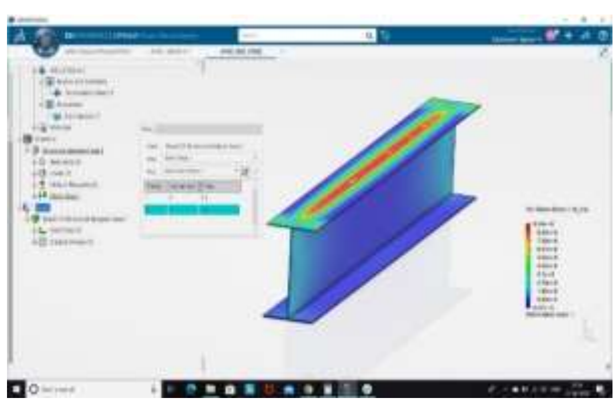

Fig 3: Von Mises Stress Plot for Steel (1035)

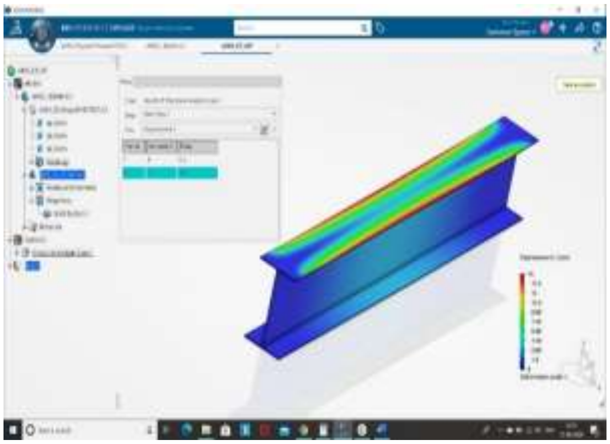

Fig 4: Displacement Plot for 0% EI

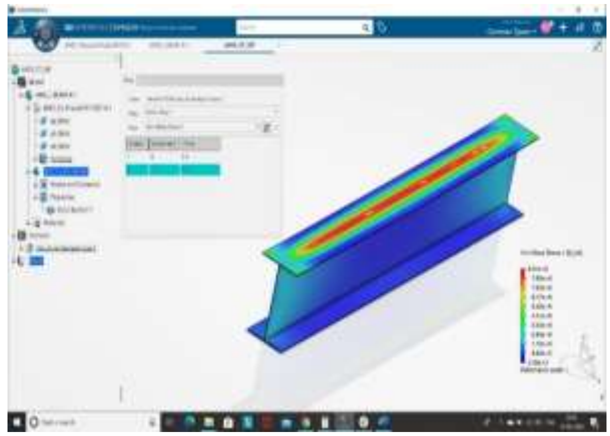

Fig 5: Von Mises Stress Plot for 0% EI

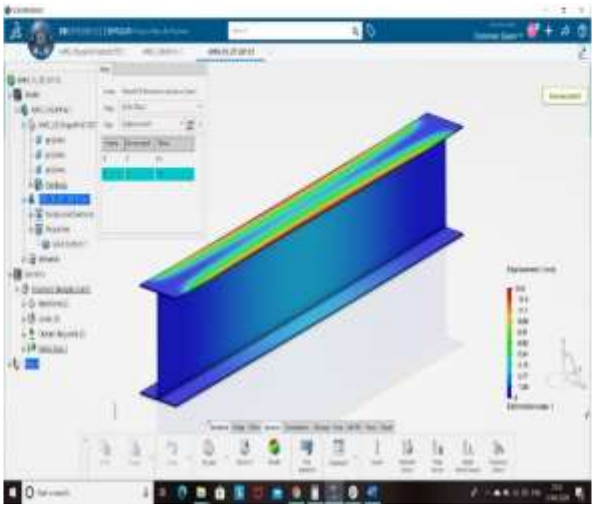

Fig 6: Displacement Plot for 33% EI

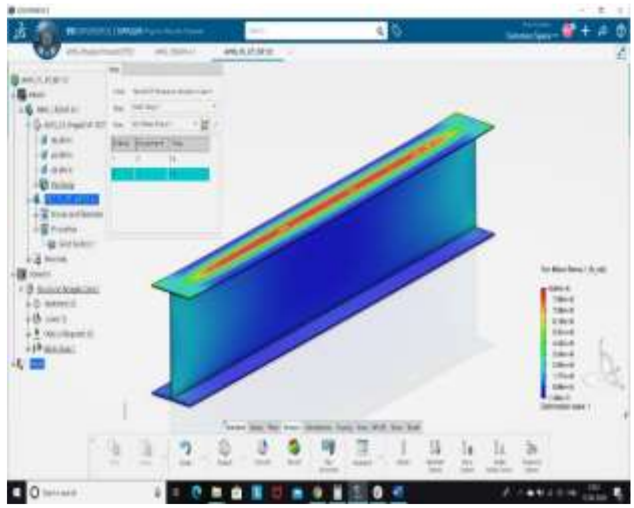

Fig 7: Von Mises Stress Plot for 33% EI

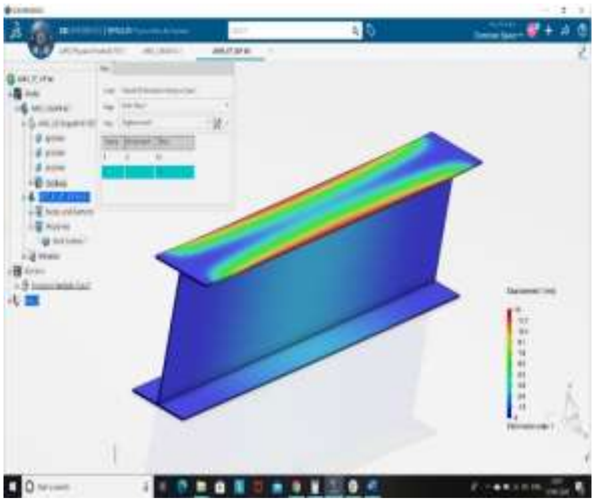

Fig 8: Displacement Plot for 66% EI

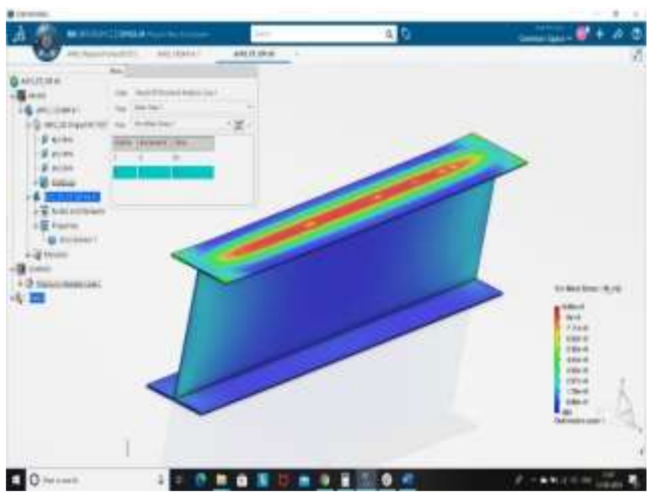

Fig 9: Von Mises Stress Plot for 66% EI

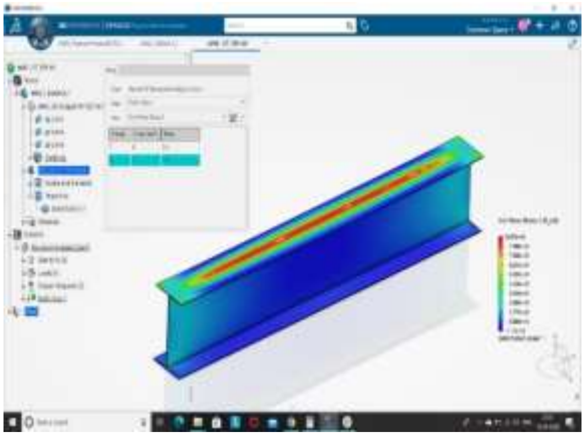

Fig 10: Von Mises Stress Plot for 100% EI

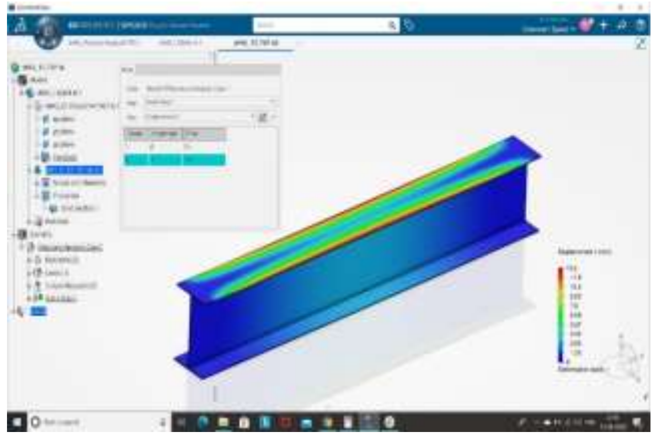

Fig 11: Displacement Plot for 100% EI

Comparison of stress distribution and structural deformation for the different materials has been presented in Table 2.

Table 2. Comparison of effect of different materials

Property	Conventional material: Steel 1035	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =1:0	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0.66:0.33	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0.33.:0.66	Tetmeth Bisphen Carbonate and Ethylene Isophthalate =0:1
Von Mises Stress (N/m^2)	9.24 e+006	8.81 e+006	8.84 e+006	8.88 e+006	8.93 e+006
Structural deformation (mm)	0.17 mm	15 mm	13.8 mm	13 mm	12.3 mm
Mass of the structure (Kg)	847.8 kg	142.23 kg	132.51 kg	123.98 kg	116.53 kg

The study shows that the Mass of the Structure drastically reduced from 847.8Kg for steel to 142.23 Kg for 0% of EI and further to 116.53Kg at 100% EI. The deformation of the girder is found to be 0.17mm for Steel where as for the composites it varied from 15mm at 0% EI to 12.3mm at 100% EI. Vonmises stress for steel is found to be 9.24e6 N/m^2 whereas for the composite it varied between 8.81e6N/m^2 at 0% EI to 8.93e6 N/m^2 at 100% EI.

Displacement is getting reduced when the material composition of Tetmeth Bisphen Carbonate is decreasing from 15 mm to 12.3 mm which will be a good sign for the structure and also Mass is also decreasing from 142.23 kg to 116.53 kg.
Von Mises Stresses is increasing with decreasing in Tetmeth Bisphen Carbonate in combination with Tetmeth Bisphen Carbonate (TBiC) and Ethylene Isophthalate (EI).

4. CONCLUSIONS

This work presents the use of composite material predicted using Synthia module of Materials Studio as a substitute for a conventional Steel I girder Beam of a Steel Bridge. The results show that composite with various mass fractions of Ethylene Isophthalate (EI) has shown a better performance than Steel in terms of stress induced, Mass of the structure and Structural deformation. However, if the deformation of the structure is less than the permissible deformation of the girder, the composite material can be considered for the application.

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