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Modelling of car bumper developed by polymer composite material

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ABSTRACT

The current research work is based on the study of FEM modelling of car bumper using polymer matrix hybrid composites consisting E-glass and jute fiber reinforced thermoset polymer. Both fibers are in form of chopped fibers with random orientation. The work is mainly focused on replacing exiting car bumper material which is pure plastic with polymer composites. This replacement will reduce plastic content to some extent. Simulation results of car bumper model have been obtained in terms of tensile strength and nodal displacement with the application of load on car bumper.

Keywords: Epoxy, hybrid composites, FEM, natural fibers.

1. INTRODUCTION

Polymer composites have replaced many conventional materials in different applications such as automobile and aerospace industry. Various components like bumper, door panel, head liner etc. have been attempted with polymer composites. Among polymer composites, glass fibers, natural fibers and combination of both have been reinforced with either thermoset or thermoplastic polymer [1].

Belingardi et al. [2] reported that an aggressive lightweight design can be achieved using reinforced composite materials, which can reduce the weight by up to 30-50%. John and Alex [3] in their study investigated the factors that affect the selection of bumper material. The results of this paper reports commonly used materials for automotive bumper and to get an overview on the material which would be the optimized composite for automotive bumper.

Rimy and Faieza [4] in their article showed that by using fibre reinforced polymer composites as a bumper material, the bumper impact of collision can be reduced by replicating the simulated bumper as similar as possible. Study conducted by Ramakrishna and Hamada [5] stated that the energy absorption capability of the composite materials offers a unique combination of reduced weight and improved crashworthiness of the vehicle structures.A good design of car bumper must provide safety for passengers and should have low weight.

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II SIMULATION

Software Used: **NX CAD NASTRAIN 10.0** NX CAD Simulation enables to carry out structural simulation on parts and assemblies with FEM. Structural simulation covers a wide range of FEM problems- from the performance of a part under constant load to the stress analysis of a moving assembly under dynamic loading, all of which can be determined using NX CAD Simulation tools.

2.1 Bumper model

First, model of car bumper has been created and then bumper design has been imported to NX CAD environment. Thickness and material properties have been inserted into software environment. E-Glass fibre has been added from custom library. The model is shown in figure 1.

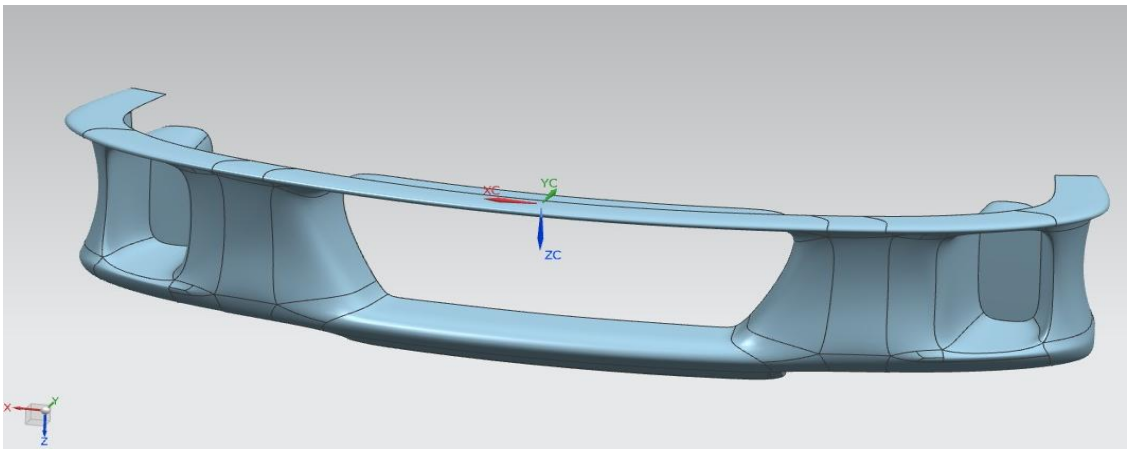

Figure 1. Car bumper model.

Modelling has been performed for epoxy and polyester. From library, "SHELL181 (3) type triangular element has been chosen. Subdivision meshing method has been selected. The element size was kept constant as 5mm. The element is shown in figure 2.

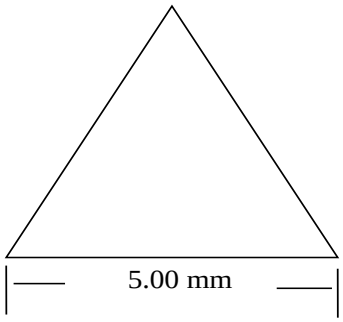

Figure 2. Element geometry.

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Boundary conditions have applied to carry out tensile test on bumper model. Meshed model is shown in figure 3. Red dots represents the application of Load on the bumper whereas blue dots represents fixed part. Force used in the model is 200 Newton.

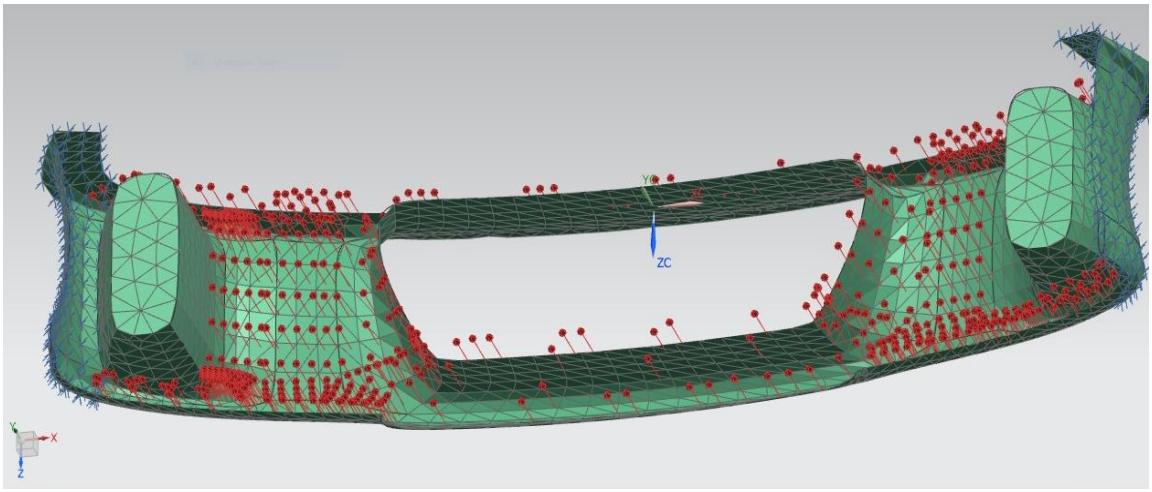

Figure 3. Meshing of car bumper.

III RESULT AND DISCUSSION

3.1 Tensile Strength Test on Epoxy Material

A tensile test was carried out on the bumper model and a force of 200 Newton is applied. The maximum displacement obtained from the results is 0.398 mm as shown in figure 4.

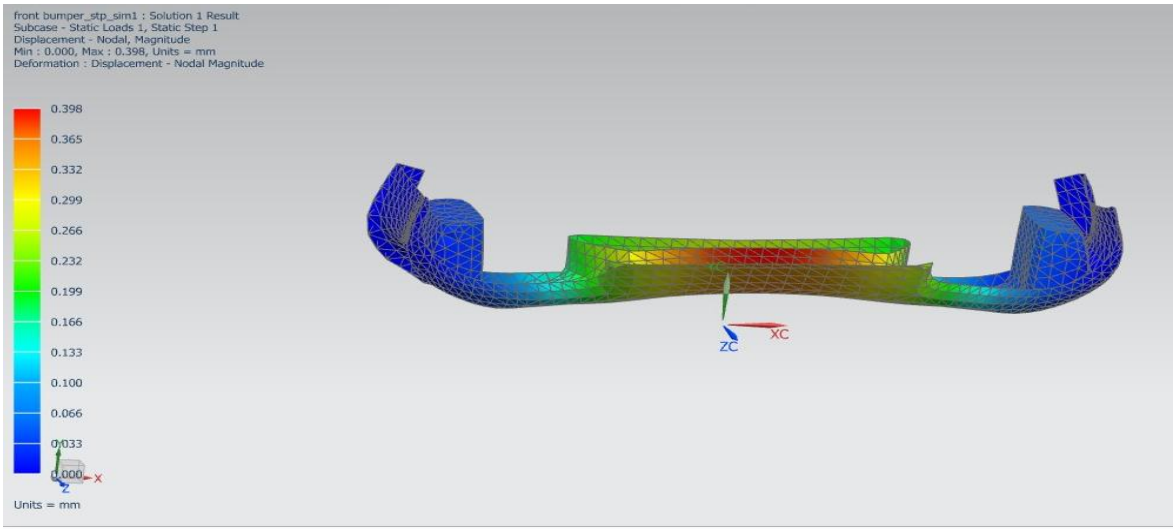

Figure 4. Simulation of epoxy based car bumper model under tensile testing.

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3.1.1 Nodal Displacement Graph of Epoxy Material

Figure 5 shows the displacement of different nodes of car bumper made up of epoxy material on application of force amounting 200 newton.

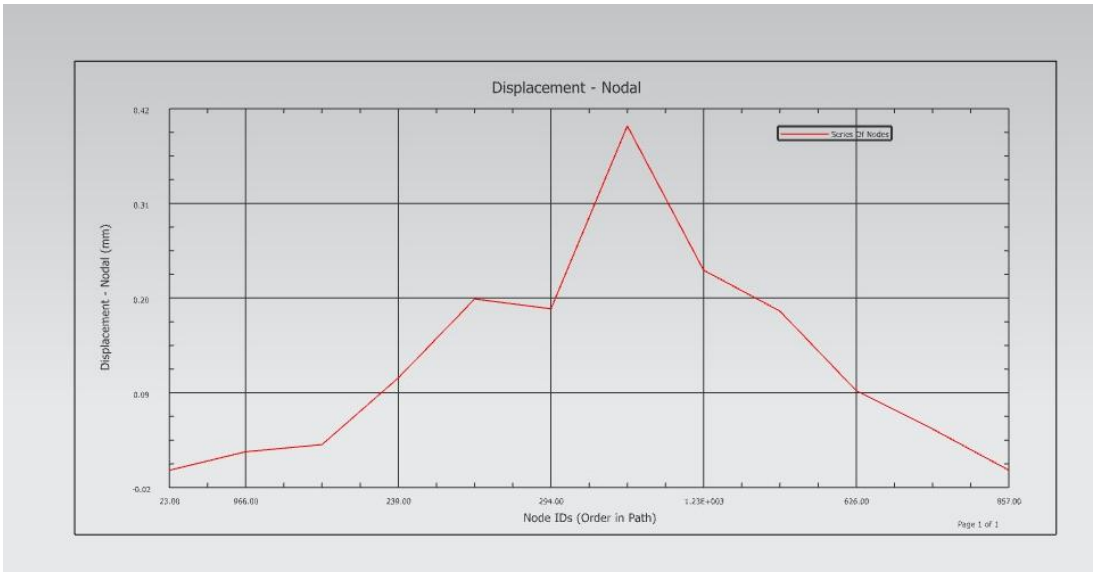

Figure 5. Nodal displacement of car bumper model.

3.2 Tensile Strength Test on Polyester Material

A tensile test was carried out on the design and a force of 200 Newton is applied. The maximum displacement obtained from the results is 0.419 mm as shown in figure 6.

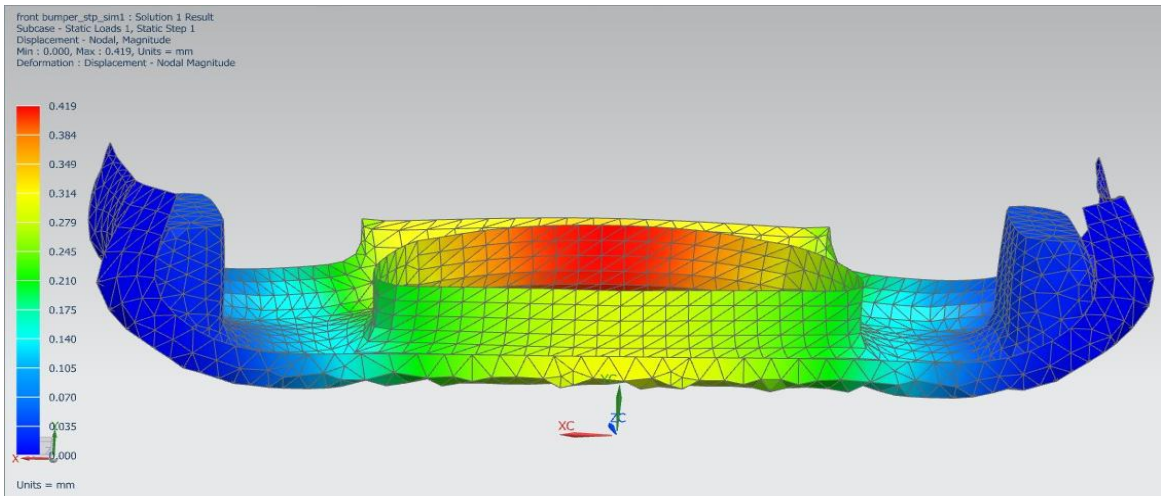

Figure 6. Simulation of polyester based car bumper model under tensile testing.

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3.2.1 Nodal Displacement Graph of Polyester Material

Figure 7 shows the displacement of different nodes of car bumper made up of polyester material on application of force amounting 200 newton.

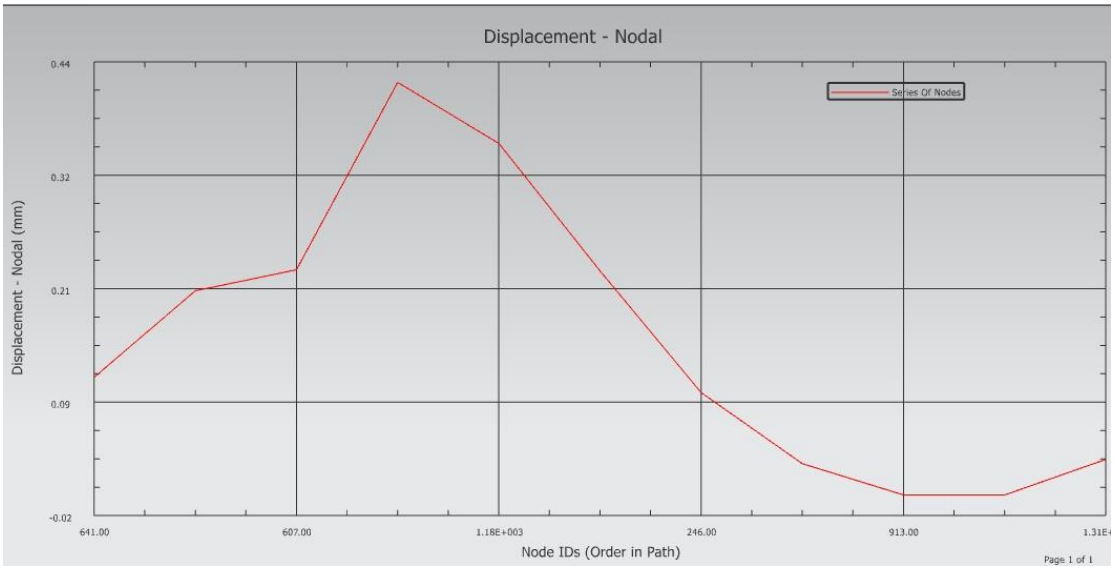

Figure 7. Nodal displacement of car bumper model

3.3Tensile Strength Test on Urea Formaldehyde Material

A tensile test was carried out on the design and a force of 200 Newton is applied. The maximum displacement obtained from the results is 31.44 mm as shown in figure 8.

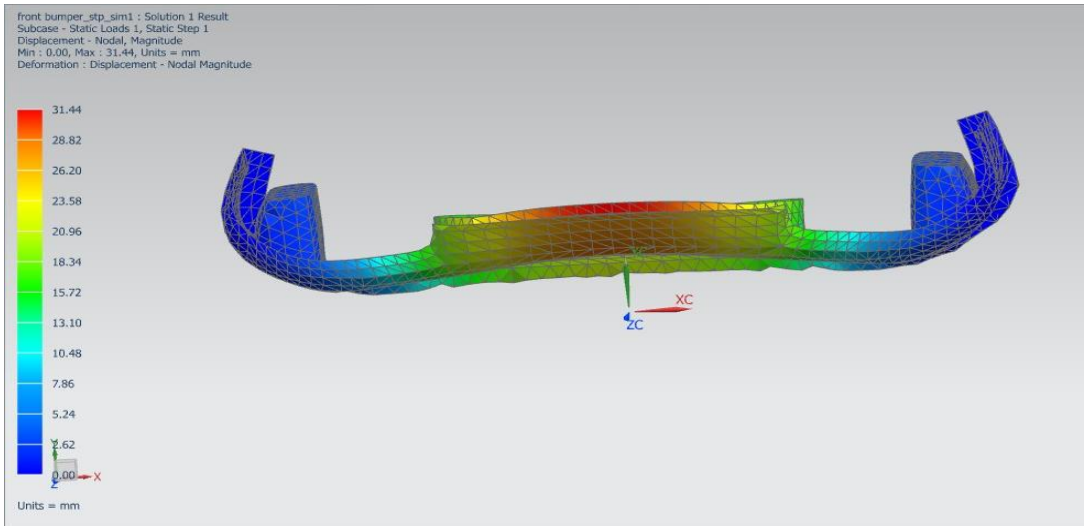

Figure 8. Simulation of urea formaldehyde based car bumper model under tensile testing.

3.3.1 Nodal Displacement Graph of Urea Formaldehyde Material

The graph shows the displacement of different nodes of car bumper made up of urea formaldehyde material on application of force amounting 200 newton.

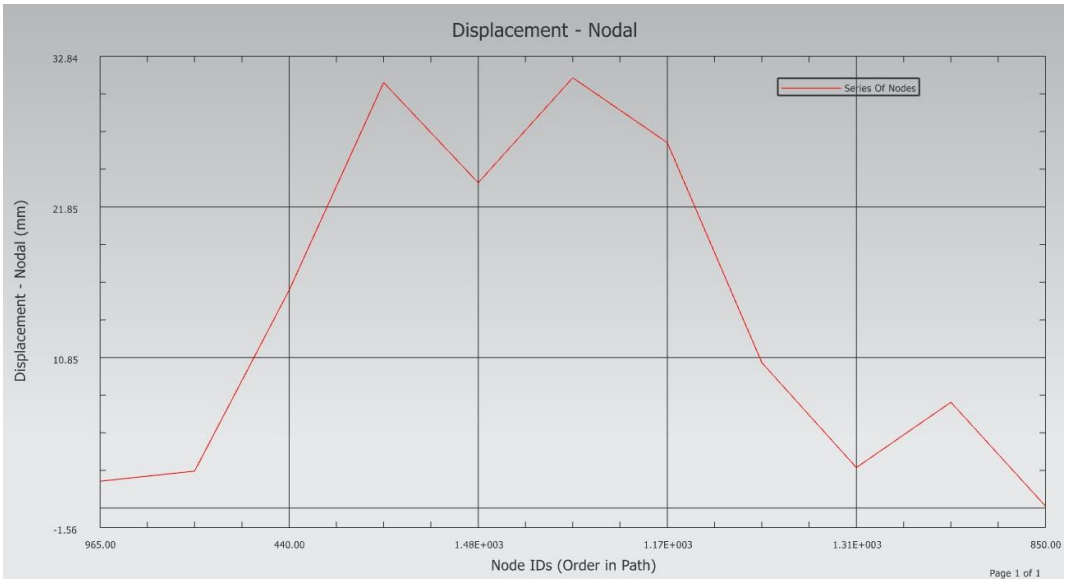

Figure 9. Nodal displacement of car bumper model.

IV CONCLUSION

Car bumper model has been created and simulated for three different polymers. Based on the simulation results best polymer has been selected as matrix material in polymer composites to be used as car bumper material.

Simulation results show that epoxy polymer has shown minimum displacement under the application of load whereas Urea Formaldehyde polymer has shown fairly long displacement under same loading conditions.

It can be concluded that Urea Formaldehyde can't be used as car bumper material in any form. Epoxy polymer is suitable to be used as matrix material in polymer composites which can be used as alternative car bumper material.

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