DESIGN AND EVALUATION OF COMPOSITE CAR FRONT SUBFRAME RAILS AND CRASH INJURY RESPONSE BY CARBON STEEL AND ALLOY STEEL HARDROX

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Abstract

Today, every car manufacturer prioritizes occupant safety. New standards are being established for occupant safety in various crash scenarios such as frontal head-on collisions, angle impacts, side impacts, rear impacts, and rollover. In today's world, fuel consumption is also a serious issue that must be addressed. With these constraints in mind, a lighter and stronger composite material than steel is used in car front rail. Using this material would aid in increasing fuel efficiency without jeopardizing vehicle safety. The traditional material used for car front subframe rails, steel, is replaced in this project with composite materials Carbon steel and Alloy steel hardox. CATIA V5 is used to create a 3D model of the subframe rail. For all materials, an impact analysis is performed in ANSYS14.0 to compare displacements and stresses at different speeds of 80 km/hr, 100 km/hr, and 120 km/hr.

***IndexTerms*: Angle impacts, side impacts, rear impacts and rollovers, composite material, conventional material, Carbon steel and Alloy steel hardox.**

I. Introduction

The automotive industry has had a long relationship with composites. They save a lot of weight compared to monolithic structural materials, but more importantly, if properly designed, they are the ideal engineering material for the wide range of tasks that can be tailored to them. At the lower end of the scale, high-volume (200,000 exemplars per year) commercial vehicles, which use randomly oriented glass fibers as sheet molding compounds (SMCs) or performs embedded in rapid-curing polyester resins for RTM-type processes. Low-volume Formula 1 or IndyCar racing vehicles (1–30 exemplars per year) that use fighter-jet technologies like vacuum-bag, autoclave high modulus, and high strength carbon/epoxy prepregs are at the top of the scale. Closer to the lower end, the relatively high volume and relatively high end sport vehicles (5000–20,000 per year) that use fiberglass mats with selective unidirectional reinforcements in thermoplastic or lower grade thermo set resins for semi-automated processes find their collocation Closer to the top, lower volume and higher end (50–500 per year) sport-luxury vehicles, such as the Lamborghini Murcielago, are now turning to continuous fiber, high grade epoxy composite materials derived from the aerospace industry to meet their high performance requirements. Except for the doors and roof structure, the Murcielago (Fig. 1) has an entirely carbon/ epoxy body (bumpers, fenders, hood, etc.). The use of composites in this application saves 75 lb (34 kg) in weight. The Murcielago's composite body is how it looks over its tubular steel frame and steel.

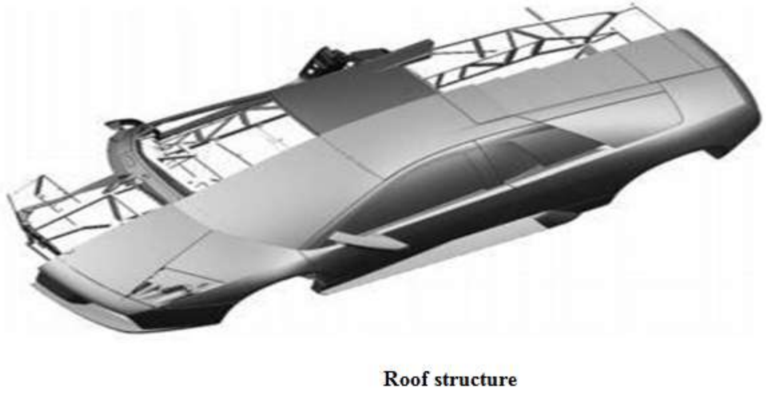


Fig.1 Roof Structure

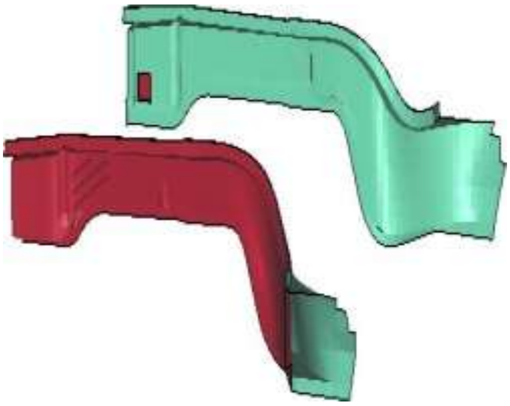


Fig.2 Car Front Sub frame Rails

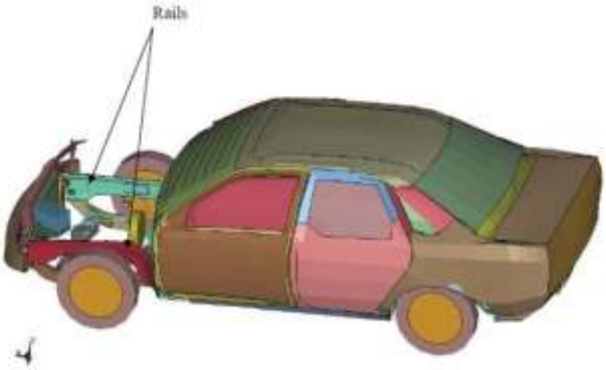


Fig.3 **Rails in the Car**

Because of the strong localized damage that occurs beneath the loading roller in three-point bend tests, a modified version of the test, the four-point bending test, is frequently used, as in this study. While material systems with the best mechanical properties are desirable, they may fall short of other fundamental engineering requirements such as reliable pseudo-isotropic behavior, ease of manufacturing (drape-ability) and joining, resistance to environmental degradation, and surface finish, forcing designers to make constant compromises. A surface must meet certain criteria for inclusions, voids, roughness, and tolerances in order to be classified as Class A. This type of certification is a set of procedures that affects not only the final product, but also the mathematical model, materials, and molding tools.

II. Design of Composite Car Front Subframe Rails

Modeling Of Chassis Using CAD System:

There are several compelling reasons to support mechanical design with a CAD system:
In order to increase productivity.
In order to improve the mechanical design quality.
To a set of design guidelines.
To compile a database of manufacturing information.
To eliminate inaccuracies in drawings caused by hand-copying and irregularities between drawings.

It is a document that contains the production specifications for a part. Part drawings are typically drawn to get a clear idea of the model that will be produced. CATIA V5 R20 is used to create the part drawing for the entire frame, which includes all views. The components created in the part module are imported into the assembly module using the ‘insert components' command, and then mated together to form the required assembly. The following are the various assembly views and the drawing generated in CATIA V5 R20.

ANSYS Mechanical is a finite element analysis tool for linear, nonlinear, and dynamic structural analysis. For a wide range of mechanical design problems, this computer simulation product provides finite elements to model behavior, as well as material models and equation solvers.

Thermal analysis and coupled-physics capabilities involving acoustics, piezoelectric, thermal–structural, and thermo-electric analysis are also included in ANSYS Mechanical.

ANSYS provides a comprehensive software suite that spans the entire range of physics, allowing designers to access virtually any field of engineering simulation. ANSYS is trusted by companies all over the world to provide the best value for their engineering simulation software investment. ANSYS 14.0 was used to conduct the analysis.

2.1 Software Overview:

ANSYS is designed to be user-friendly and as simple as possible, so that the user is kept as far away from the stressful side of programming as possible. The ansys software allows us to apply any type of load to any type of component and see the resulting stresses and strains at all points of the solid component. It also shows how much weight a solid component can support. The stresses and strains acting in that model were identified by analyzing the given solid model diagram, which was drawn using catia.

2.2 Overview of Ansys Work Bench

Ansys Workbench combines the power of our core product solvers with the project workflow management tools that are required. Analyses are built as systems in ansys workbench, and they can be combined into projects. The project is guided by a schematic workflow that manages the system connections. You can interact with applications that are native to ansys workbench from the schematic, and you can launch applications that are data in targeted with ansys workbench from the schematic, so the interface stays separate but the data from the application communicates with the native ansys workbench data Native workspaces include project schematic engineering data and design exploration, data integrated application include the mechanical application.

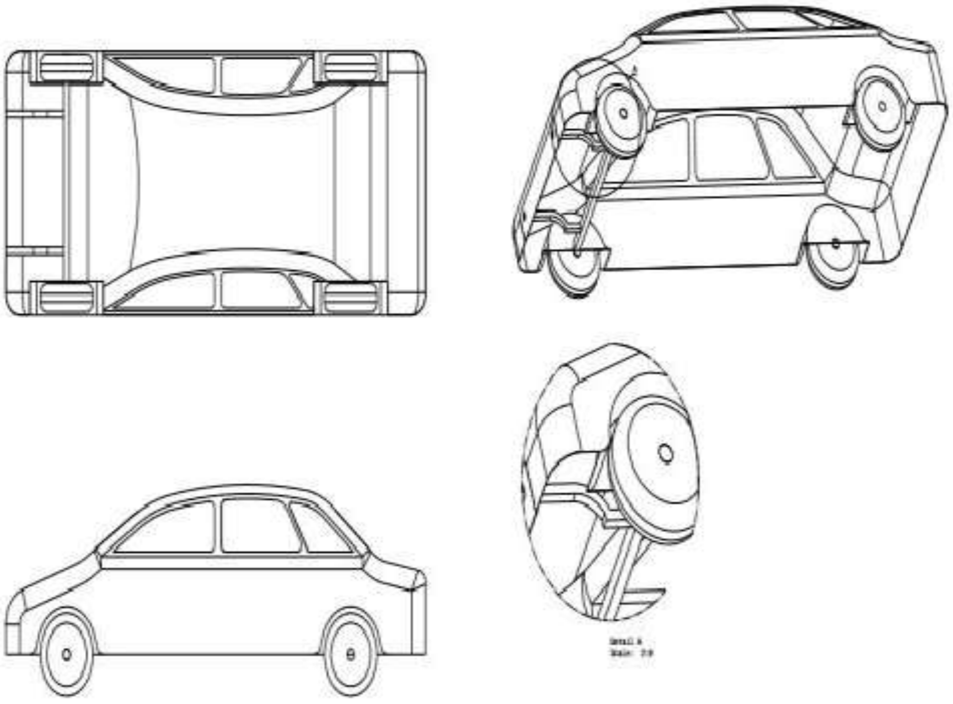
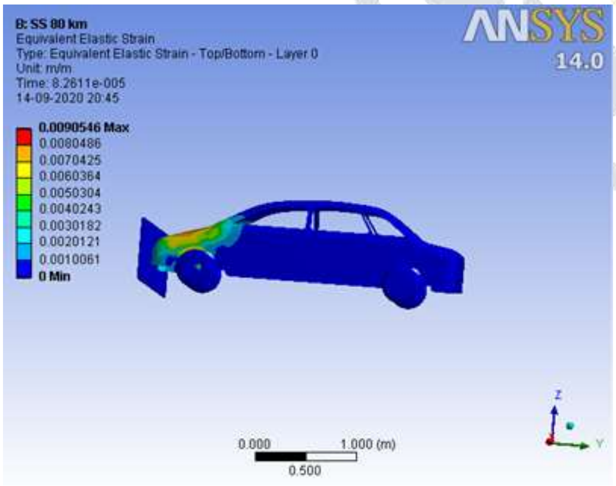


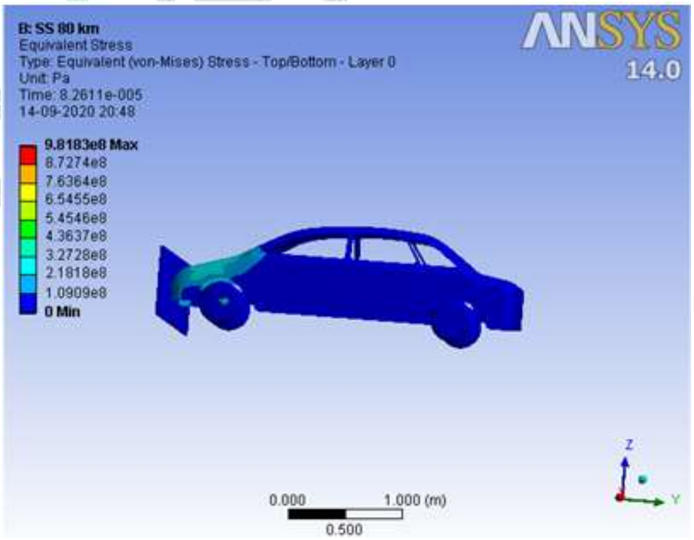
Fig.4Sub-frame Structure

III. Results and discussion



B: SS 80 km
Equivalent Elastic Strain
Type: Equivalent Elastic Strain - Top/Bottom - Layer 0
Unit: m/m
Time: 8.2611e-005
14-09-2020 20:45

Fig.5 Equivalent Elastic Strain



B: SS 80 km
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom - Layer 0
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Fig.6 Equivalent Stress

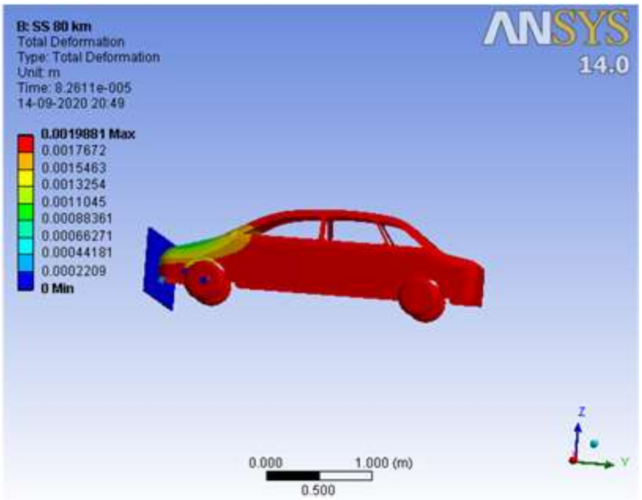


Fig.7 Total Deformation

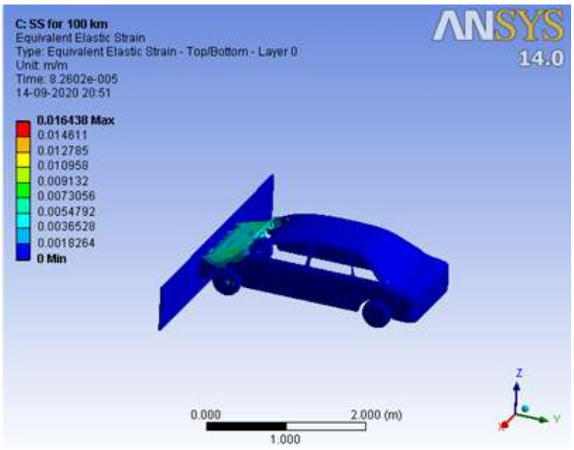


Fig.8 Equivalent Elastic Strain

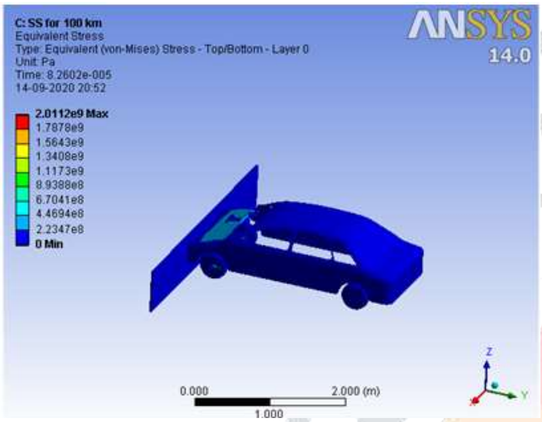


Fig.9 Equivalent Stress

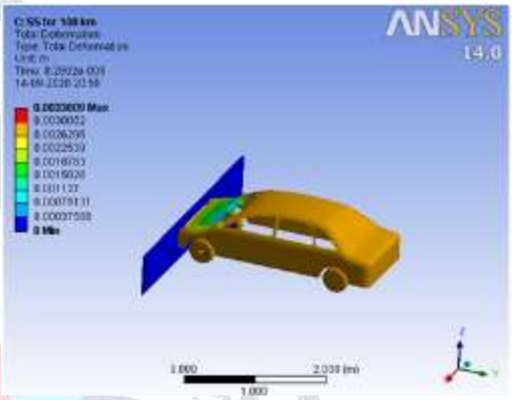


Fig.10 Total Deformation

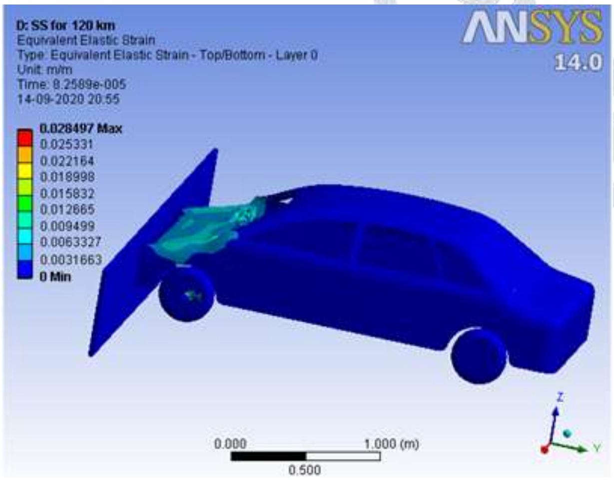


Fig.11 Equivalent Elastic Strain

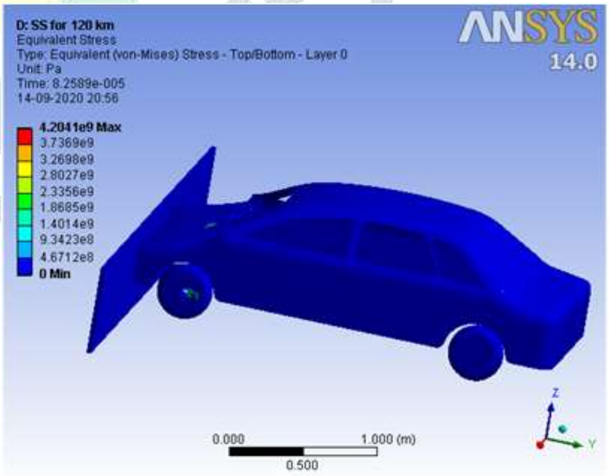


Fig.12 Equivalent Stress

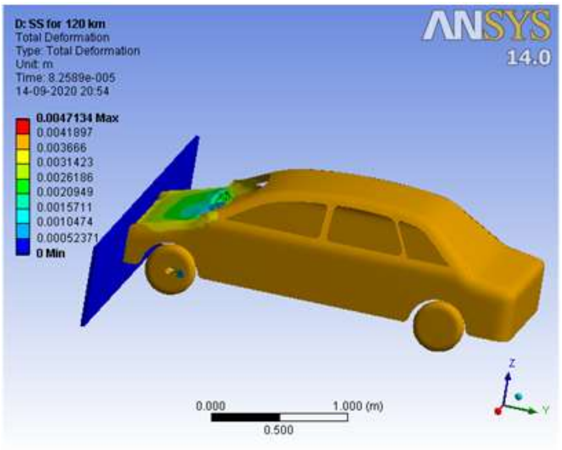


Fig.13 Total Deformation

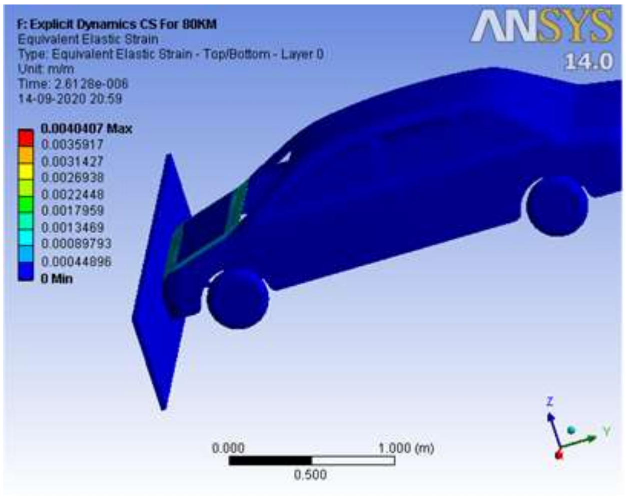


Fig.14 Equivalent Elastic Strain

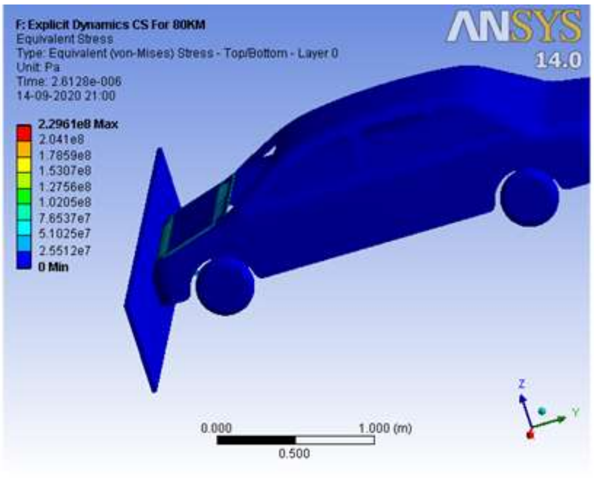


Fig.15 Equivalent Stress

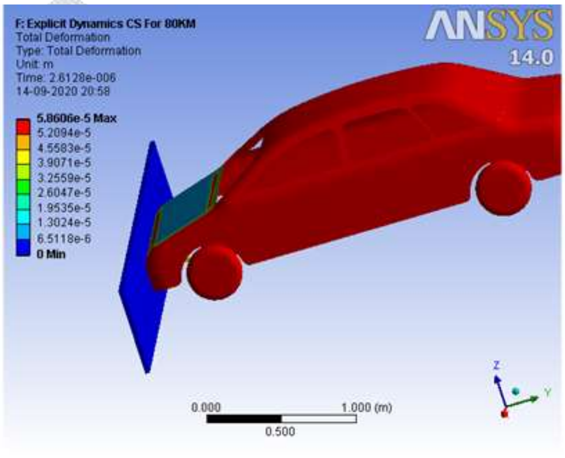


Fig.16 Total Deformation

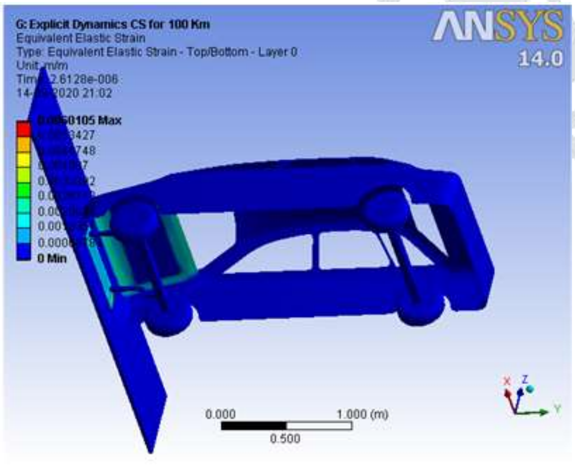


Fig.17 Equivalent Strain

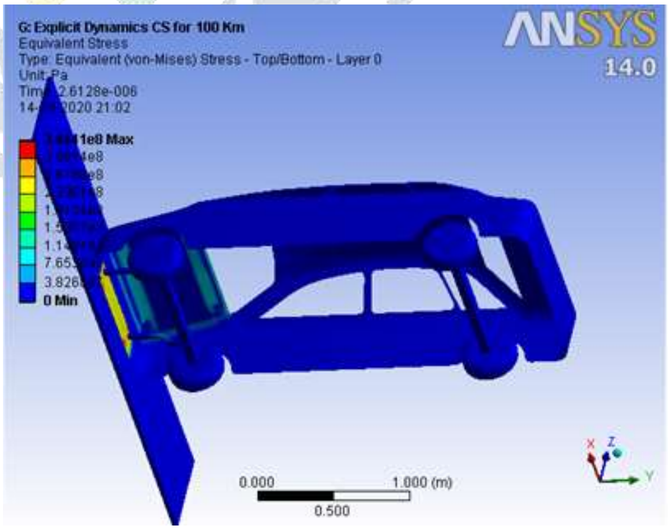


Fig.18 Equivalent Stress

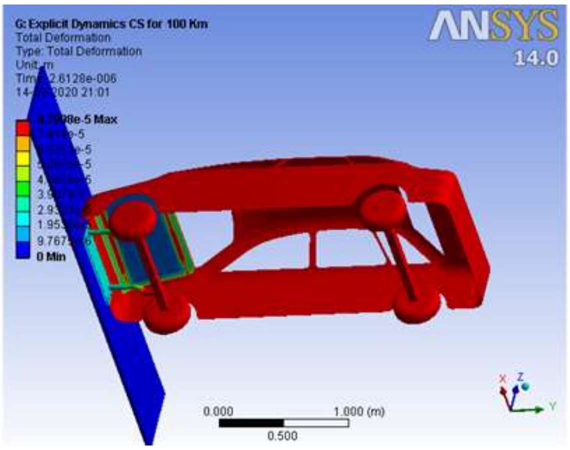


Fig.19 Total Deformation

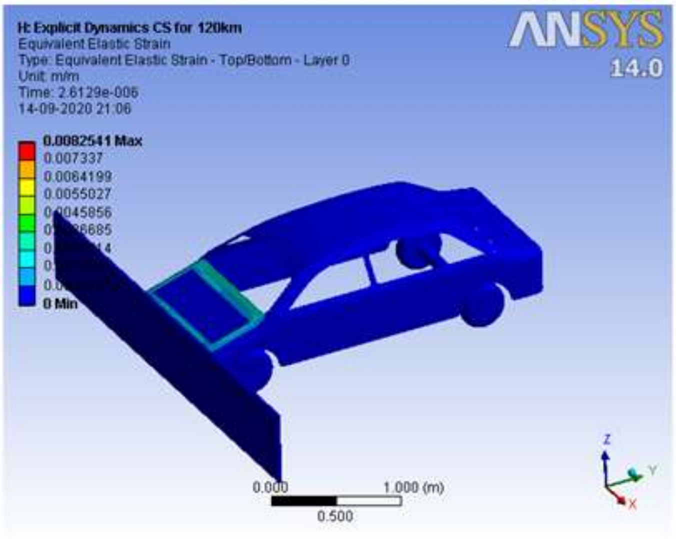


Fig.20 Equivalent Elastic Strain

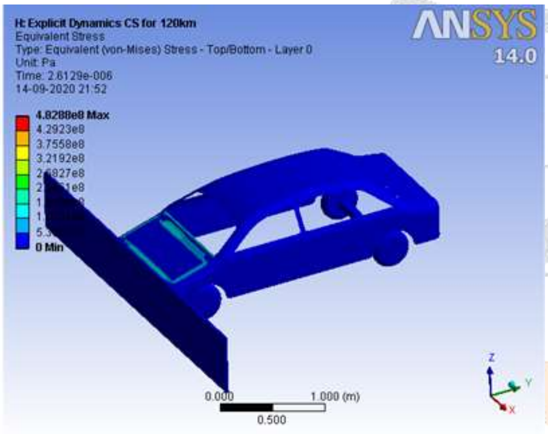


Fig.21 Equivalent Stress

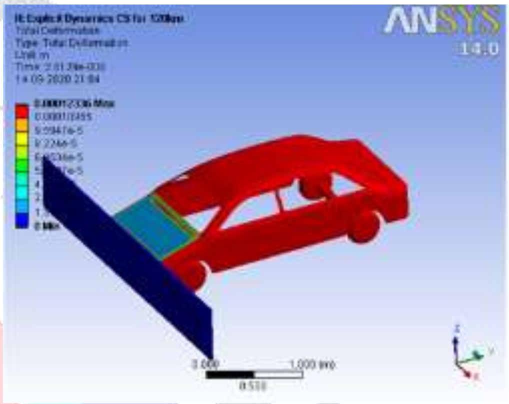


Fig.22 Total Deformation

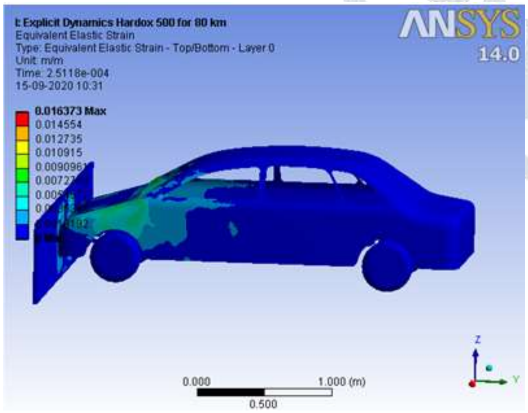


Fig.23 Equivalent Elastic Strain

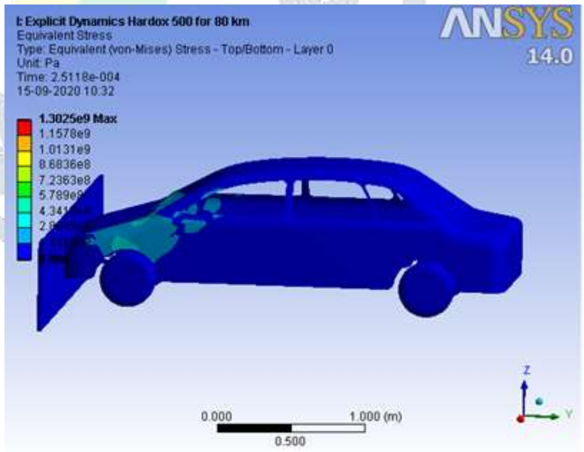
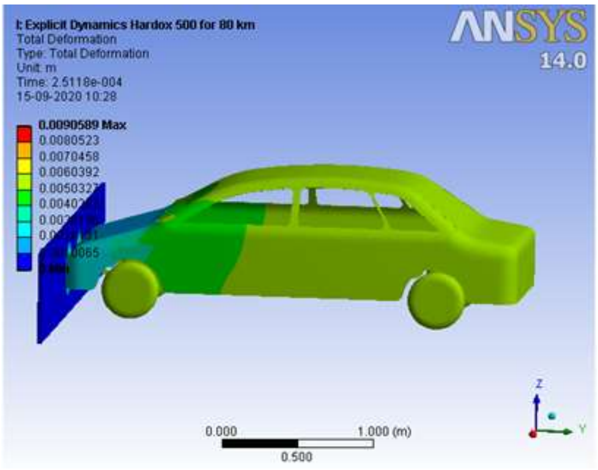


Fig.24 Equivalent Stress



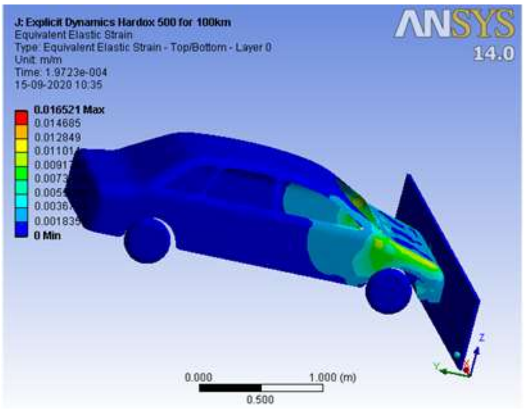
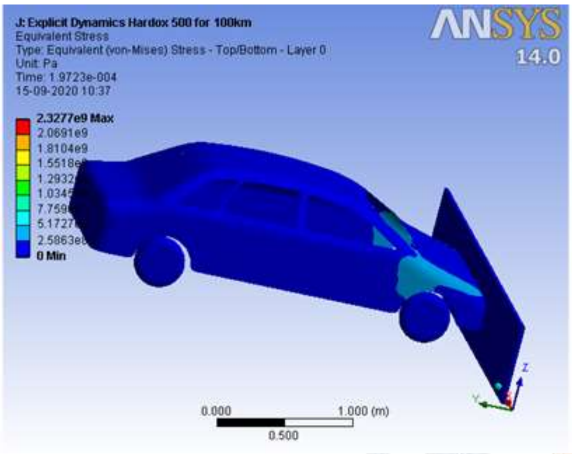


Fig.25 Total Deformation

Fig.26 Equivalent Elastic Strain



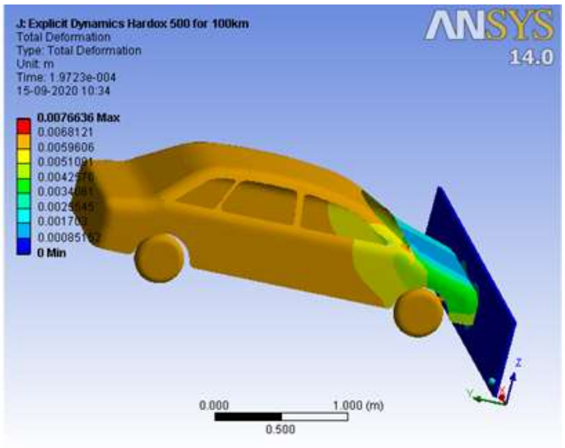
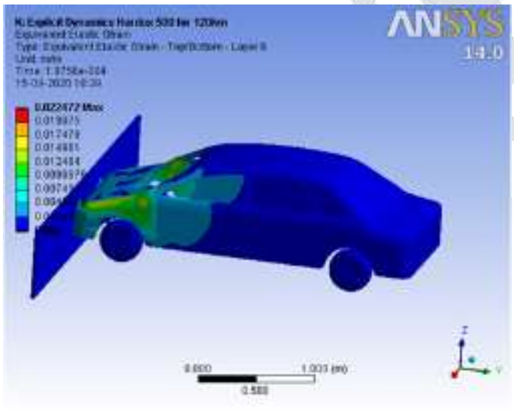


Fig.27 Equivalent Stress

Fig.28 Total Deformation



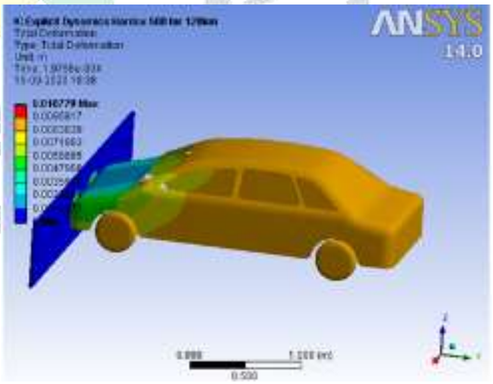


Fig.29 Equivalent Elastic Strain

Fig.30 Total Deformation

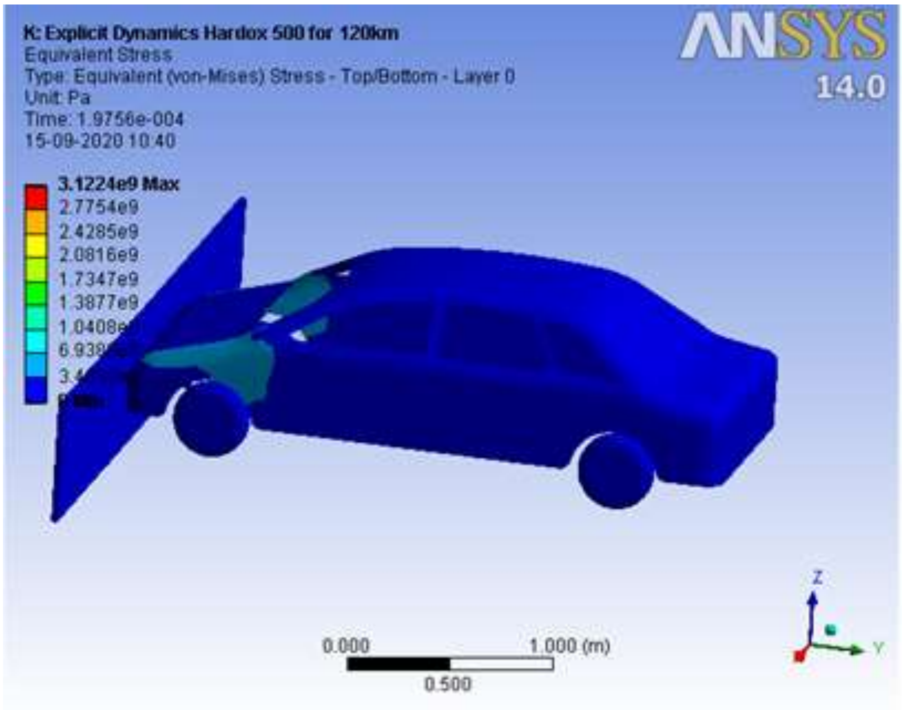


Fig.31 Equivalent Stress

IV. Conclusion

In this project, the traditional material used for front subframe rails in cars, steel, is replaced with carbon steel and alloy steel hardox 500 composite materials. CATIA V5 is used to create a 3D model of the subframe rail. For all materials, an impact analysis is performed in ANSYS 14.0 to compare displacements and stresses at different speeds of 80km/hr, 100km/hr, and 120km/hr. The stress values are less for Carbon Steel, but the variation of stress values is not as great for Alloy steel hardox 500, and the displacement values are less for Carbon Steel, according to the impact analysis results. As the speed is increased, the displacement and stress values significantly raise. As a result, it can be concluded that carbohydrate usage is beneficial.

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