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Modelling and Static Analysis of Car Chassis with Different Materials



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Abstract:

This project concerns on the assessment on making design an analysis of the car chassis will fit all aspects and concepts according to the rules of Eco Marathon Challenge. The objective of this paper to design and analyze of car chassis and to avoid any possibilities of failure of structure and thus to provide enough supporting member to make the region stronger in term of deformation, Finite element analysis enables to predict the region that tends to fail due to loading. Besides that, need to utilize the feature of CAE software named as FEMPRO to get the distribution of stress and strain on the chassis, both component as well as the material costing. The main objective is to study the effect of load that applied in term of driver weight, the car body and the equipment.

I. INTRODUCTION

Air pollution can be considered as one of the main hazard to the health of human being. The air pollution is due to the increasing number of vehicle use by human. The lack of the source of the petrol makes the price increase by time to time. The emission from the vehicle makes the environment faces the air pollution that in critical level.Many steps need to reduce the number of the vehicle in other side to reduce the price of the petrol. The big number of vehicles in each country makes the prevention to reduce the number of vehicle difficult. So, the other prevention is increase the efficiency of the vehicle's engine. When the engine at the efficient level, the emission is at the low level and the most important is the usage of petrol is low. The prevention is reducing the weight of the body and chassis of each vehicle.This project focused to reduce the usage of petrol by design and analysis the chassis to reduce the weight of the chassis of vehicle. At the same time, the global usage of the petrol also reduced.

Type of Chassis:

Chassis is considered to be one of the significant structures of an automobile. Itis usually made of a steel frame, which holds the body and motor of an automotive vehicle. To be precise, car chassis or automobile chassis is a skeletal frame which bolts various mechanical parts like engine, tires, brakes, steering and axle assemblies. Chassis usually made of light a metal or composite plastic which provides strength needed for supporting vehicle components and load into it. Here I listed several different types of automotive chassis which include ladder chassis, backbone chassis, monocoque chassis and tubular space frame chassis (Wakeham, 2009).Ladder chassis is considered to be one of the oldest forms of automotive chassis or automobile chassis that is still been used by most of the SUVs till today. It is also resembles a shape of a ladder which having two longitudinal rails inter linked by several lateral and cross braces. The lateral and cross members provide rigidity to the structure (Wakeham, 2009).

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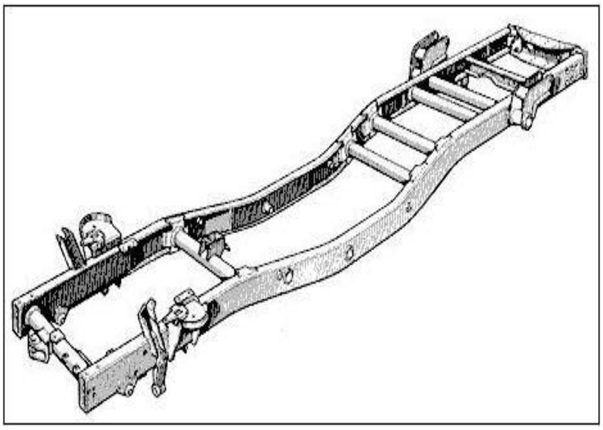


Figure 1: Ladder chassis

The other type of chassis is backbone chassis which has a rectangular tube like backbone and simple in structure. It usually made up of glass fiber that is used for joining front and rear axle together and responsible for most of the mechanical strength of the framework. The space within the structure is used for positioning the drive shaft in case a rear-wheel drive. Furthermore, the drive train, engine and suspensions are all connected to each of the ends of the chassis. This type of chassis is strong enough to provide support smaller sports car besides it is easy to make and cost effective (Wakeham, 2009).

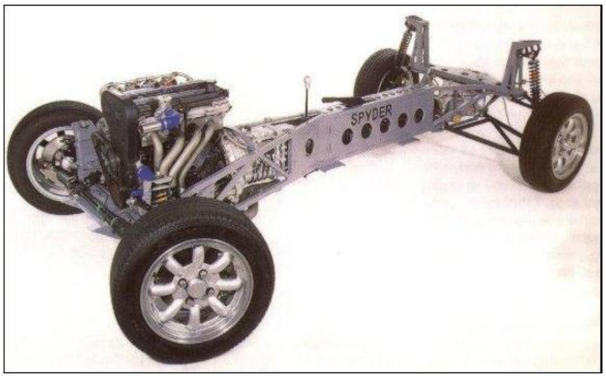


Figure 2: Backbone chassis

As for monocoque chassis, most modern cars nowadays use this type of chassis.Amonocoque chassis is a single piece of framework that gives shape to the car. A one-piece chassis is built by welding several pieces together. It is different from the ladder and backbone chassis as unlike them incorporated with the body in a single piece, where as the former only support the stress members.

The demanding of a monocoque chassis highly increased since it is cost effective and suitable for robotized production (Christopher, 2004).

Figure 3: Monocoque chassis

Figure 4: Spaceframe chassis

II. MATERIALS

Different chassis materials can reduce the weight of the vehicle, improving the vehicle power to weight ratio. Material selection can also provide advantages by reducing member deflection, increasing chassis strength and can determine the amount of reinforcement required.

Material Mechanical Concept:

Many materials display linear elastic behavior, defined by a linear stress-strain relationship, as shown in the figure up to point 2, in which deformations are completely recoverable upon removal of the load that is, a specimen loaded elastically in tension elongates, but it returns to its original shape and size when unloaded.

A plastically deformed specimen not returns to its original size and shape when unloaded. Note that there is elastic recovery of a portion of the deformation.For many applications, plastic deformation is unacceptable, and is used as the design limitation. After the yield point, ductile metals undergo a period of strain hardening, in which the stress increases again with increasing strain, and they begin to neck, as the cross-sectional area of the specimen decreases due to plastic flow. In a sufficiently ductile material, when necking becomes substantial, it causes a reversal of the engineering stress-strain curve (curve A); this is because the engineering stress is calculated assuming the original cross-sectional area before necking. The reversal point is the maximum stress on the engineering stress-strain curve, and the engineering stress coordinate of this point is the tensile ultimate strength, given by point 1.

The ultimate tensile strength is not used in the design of ductile static members because design practices dictate the use of the yield stress. It is, however, used for quality control, because of the ease of testing. It is also used to roughly determine material types for unknown samples. In Figure 5 shows the stress vs. strain curve of a ductile material, at point number one (1) is the ultimate tensile strength, refer to the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross section starts to significantly contract. At point number two (2) is yield strength, explained that the boundary between elastic region and plastic region.

At the point number three (3) is point for the proportional limit stress, at this point explained that the amount of stress increasing proportional to the increasing of strain. Fracture occurred at the point number four (4). Fracture is the local separation of an object or material into two, or more, pieces under the action of stress. Lastly at point number five (5)is the offset strain (typically 0.2), this offset use in order to find the yield strength of material.

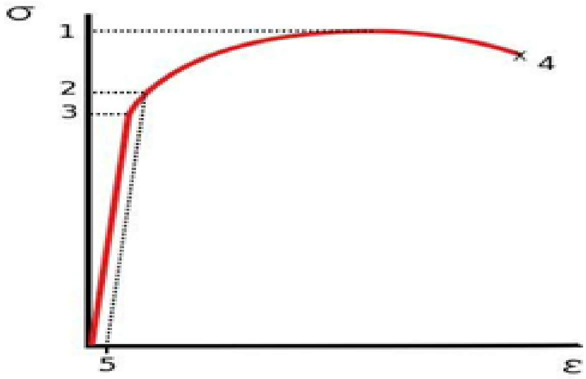


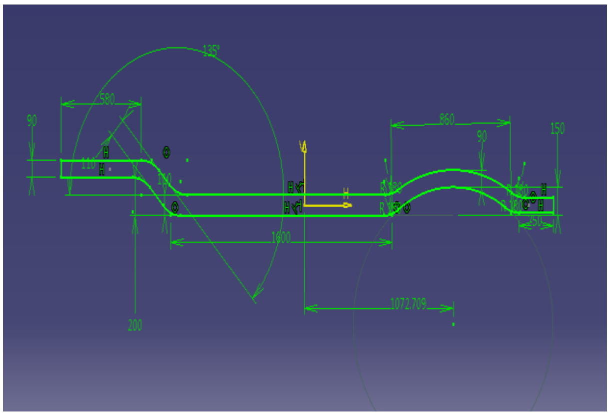
Figure 5: Stress vs. strain curve of ductile material

III. FINITE ELEMENT ANALYSIS (FEA) USING ALGOR

Finite Element Analysis (FEA) was first developed by R. Courant in 1943, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement.

A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition (Widas, 1997).

Modelling of Car Chasis



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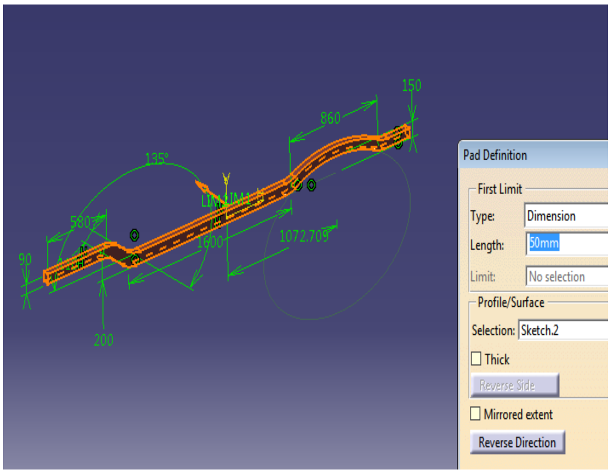
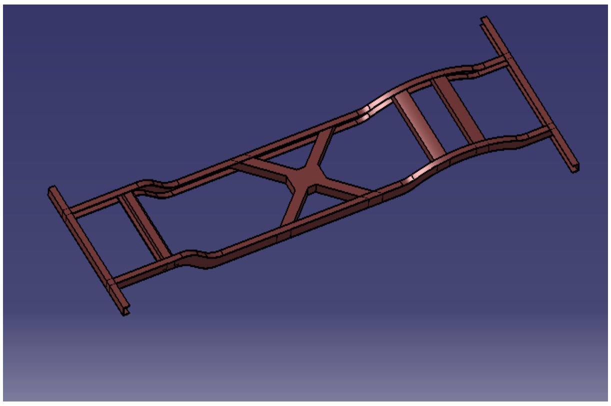
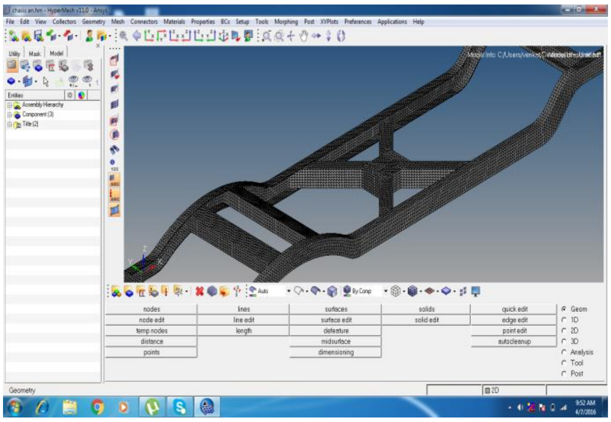
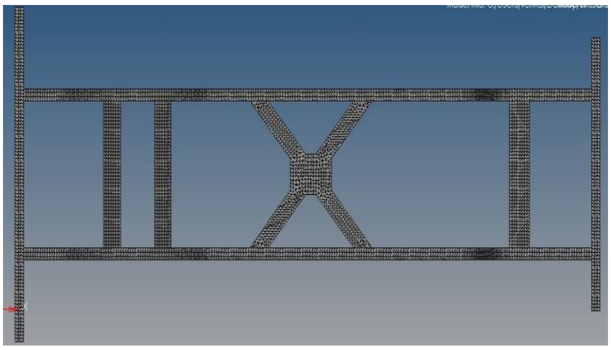
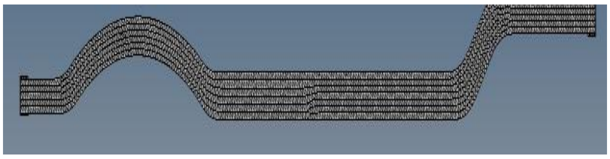


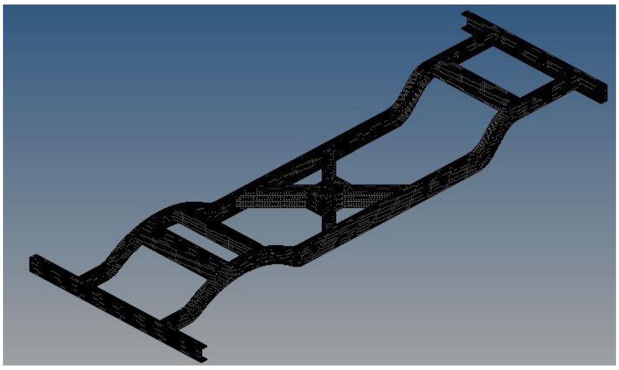


Mesh:

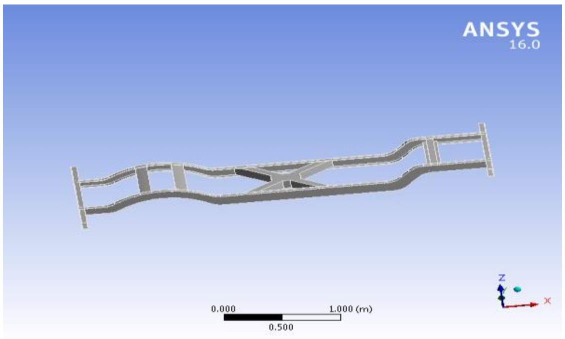




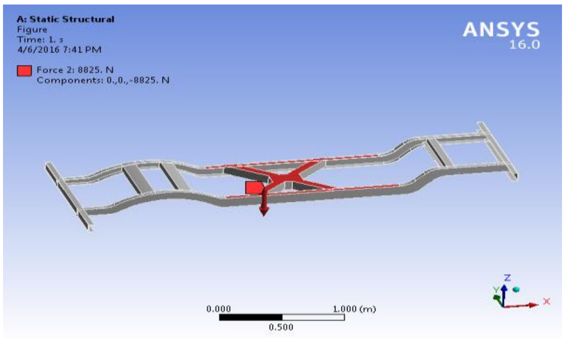


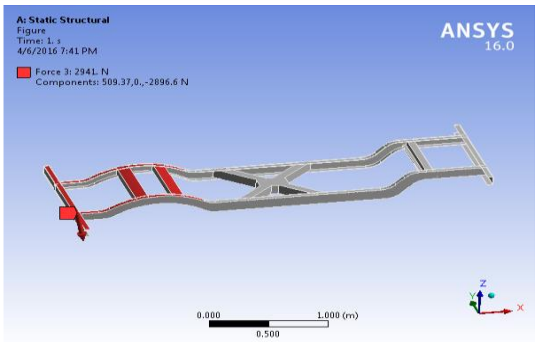


Analysis of Car Chasis Magnesium Alloy



Applied Load:





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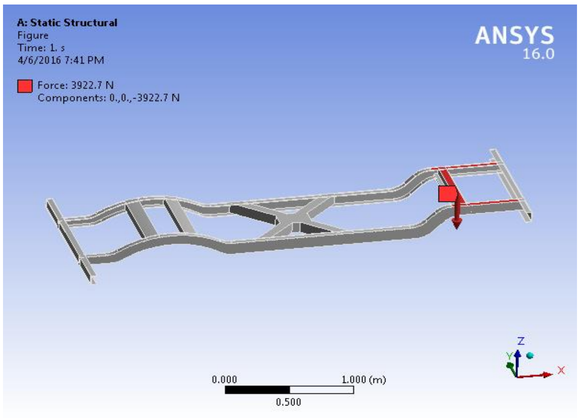
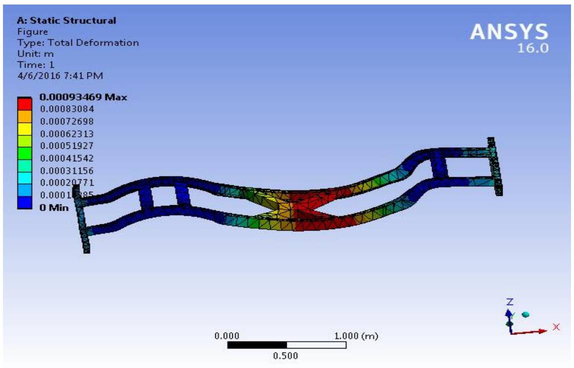
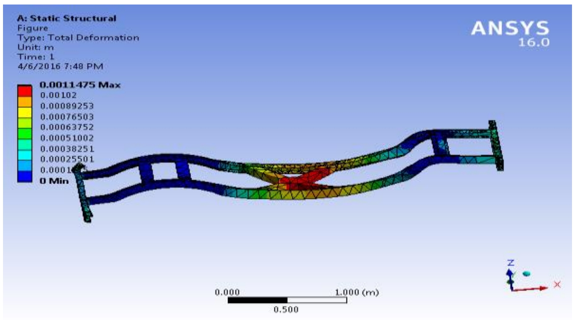


Total Deformation:

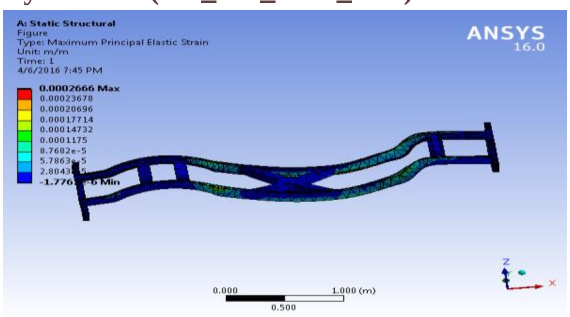
Cast Iron



Magnesium Alloy



Epoxy Carbon (UD_230_GPA_Wet)



CONCLUSION

To observe the all results and to compare the polymeric composite heavy vehicle chassis and heavy vehiclechassis with respect to weight, stiffness and N strength.By employing a polymeric composite heavy vehicle chassis for the same load carrying capacity, there is a reduction in weight of 73%~80%,natural frequency of polymeric composite heavy vehicle chassisare 32%~54% higher than steel chassisand 66~78% stiffer than the chassis.

Present used material for chassis. Polymeric composites Carbon/Epoxy, for chassis material are considered in this paper. Based on the results, it was inferred that carbon/epoxy polymeric composite heavy vehicle chassis SECTION chassis has superior strength and stiffness and lesser in weight compared to and other polymeric composite materials and other cross sections considered in this investigation. From the results, it is observed that the polymeric composite heavy vehicle chassis is lighter and more economical than the conventional chassis with similar design specifications.

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