Design and Development of Understructure Platform for Two-Seater Micro Electric Vehicle (MEV)

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Abstract: An understructure platform is also called underbody platform where is a platform that can be divided into three sections which are the rear section that is designed support for the steering system. The mid-section is the main structure of the vehicle that will be a structure protected the battery of the EV and also support the full weight of the passenger and some other components. The rear component is the support for the drivetrain system.

Keywords: platform, understructure.

I. INTRODUCTION

Automotive chassis is an integral part of any vehicle. The chassis supports the body and other parts of the automobile as a framework. Also, the chassis needs to be adequately firm to survive the shock, distortion, vibration, and other stresses. Along with strength, an essential consideration in chassis design for better handling features is to have acceptable bending stiffness. Hence, extreme stress, extreme deflection and equilateral stress, are essential criteria for the chassis design. In this paper, the optimization of the automotive chassis with restrictions of extreme shear stress, equivalent stress and deflection of chassis under maximum load. Chassis is a structural system which can be quickly investigated using the finite element techniques. For weight reduction, a sensitivity study is conducted. Hence, a proper finite element model (FEM) of the chassis is established. FEA is done on the modelled chassis using the Solidwork Simulation.

An EV has to overcome resistances related to the motor itself. Vehicle protection is also extended by using diminishing usual car weight, keeping a low middle of gravity, and warranting that the batteries are mounted away from crash regions. The size and network of the battery modules will be calculated in particular for the Micro-EV so that they may additionally be without problems positioned inside the BBF This final year project is about designing an understructure platform that will be used as the main structure of a contextual designed EV. This EV will be a micro-size EV or micro-urban EV. The EV characteristic itself that has its travel distance depended on the motor size and battery capacity. This study only focusses on the understructure platform. The understructure will be the main structure of Body-on-Frame vehicle type. This BOF vehicle is suitable for a vehicle with being analysed the same system but a different body design. For example, a lorry uses a backbone type of chassis, but for an EV understructure, the structure must be designed strong enough to provide safety to the passenger and also protect the battery itself. The battery was placed in the mid-section to protect the battery from front impact and rear impact. The side structure of the vehicle must be strong enough to protect the vehicle from the side impact. To increase the efficiency of an EV, the vehicle itself must be lighter. The design of the understructure will be minimized without affecting the strength of the structure. The material selection is essential because the weight of the structure will be the most critical criteria affecting EV efficiency.

II. METHODOLOGY

The design process will be using Solid work software, and the final design will be analyzed for structural analysis. The design process of this EV starts with designing the necessary structure to get a desirable design.

Fig. 1. Conceptual design of the EV

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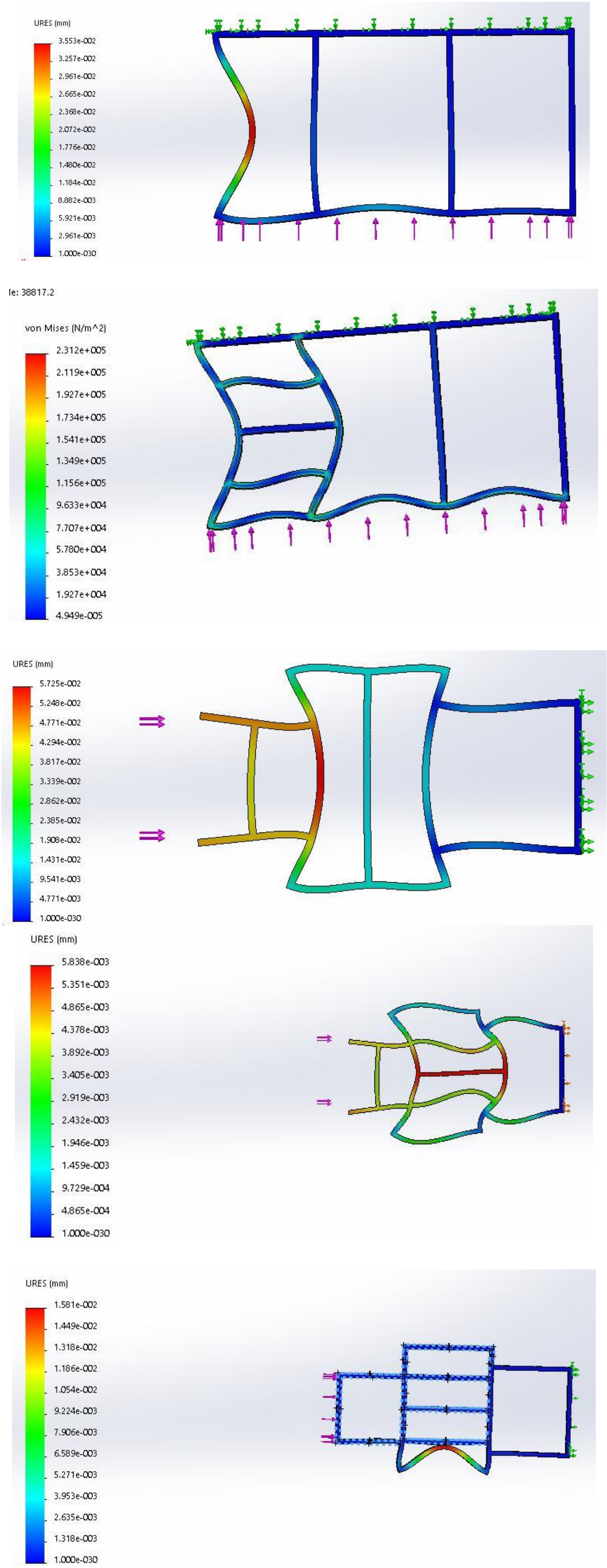
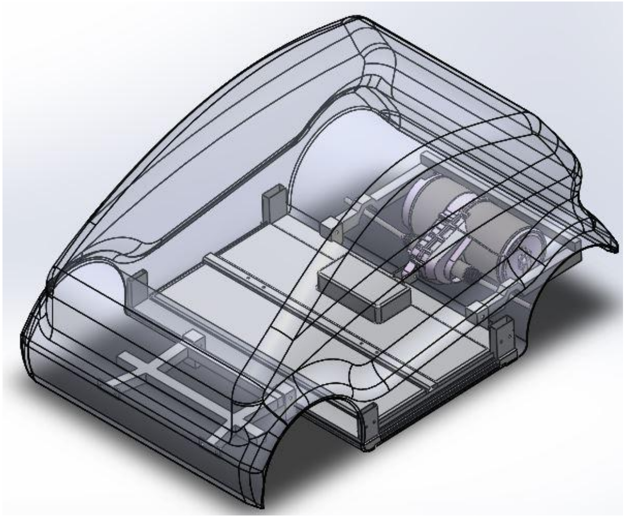
The design process starts with the basic design of the ladder chassis structure to get the suitable design based on static structural Analysis. The size and dimension were based on conceptual design.





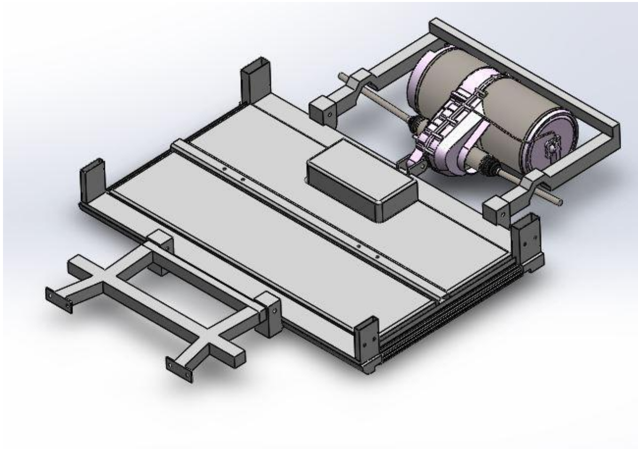


Fig. 2. The design of the understructure platform with the upper body chassis

III. RESULT AND DISCUSSION

A final design has been produced, and the design is analysed for its structural strength. A 1000N of force were applied to the front, side and rear structure for the analysis to determine the maximum stress and strain applied to the structure. The material used for this analysis is Alloy Steel.

Table- I: Properties of the material used for analysis

Elastic modulus	N/m^2	2.10E+11
Poisson's Ratio	N/A	0.28
Shear modulus	N/m^2	7.90E+10
Mass Density	Kg/m^3	7700
Tensile Strength	N/m^2	723825600
Yield Strength	N/m^2	620411000
Thermal expansion coefficient	/K	1.30E-0.5
Thermal conductivity	W/(m.K)	50
Specific heat	J/(kg.K)	460

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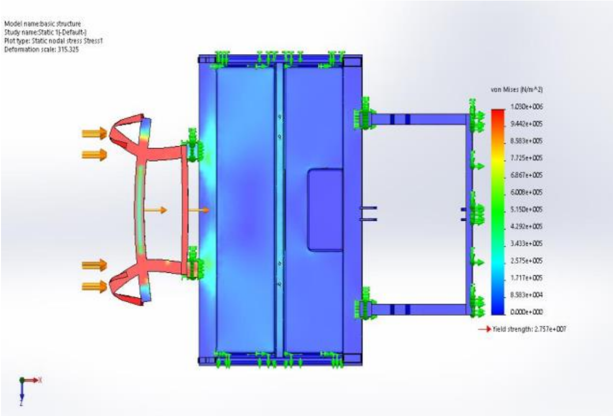

Fig. 3. The effect of force on the front structure

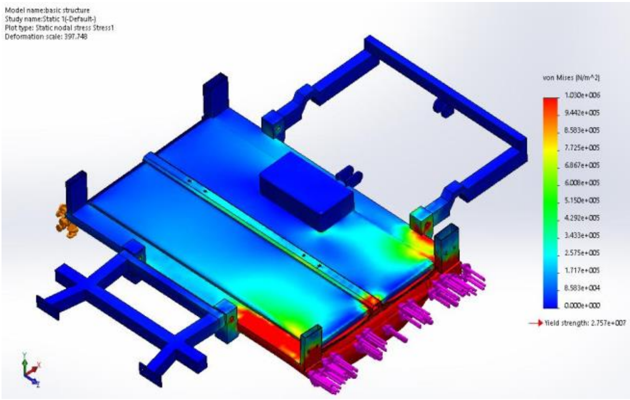

Fig. 4. The side impact deformation

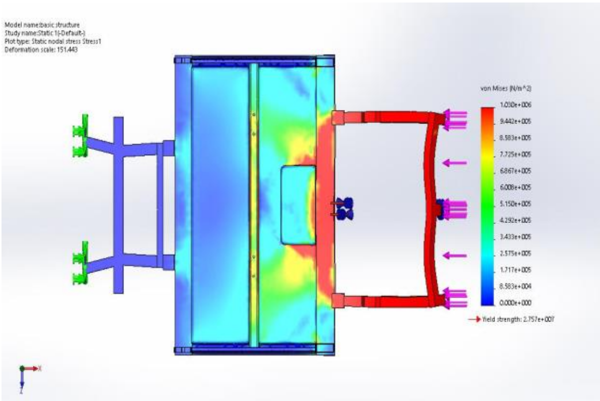

Fig. 5. Rear impact deformation

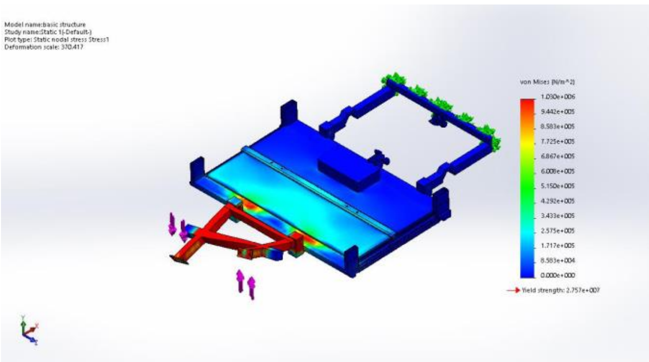

Fig. 6. Front-impact deformation

Based on the result, the maximum stress of the structure is 1.03x106 N/m2, and the yield strength was 2.757x107 N/m^2

Mass properties of a structure
Mass = 5766634.02 grams
Volume = 5530003794.09 mm3
Surface area = 55524789.36 mm2
Center of mass: (millimetres)
X = 1052.55
Y = 1037.49
Z = 671.72

Based on the design study, three materials with 1000N force were applied to the structure, and the results are shown above: Max stress 1.03e+06 N/m2 can be applied to the structure before it starts to deform

Displacement

The displacement of the chassis and position of extreme displacement is revealed in Figure 7. The magnitude of maximum displacement is in millimetre (mm).

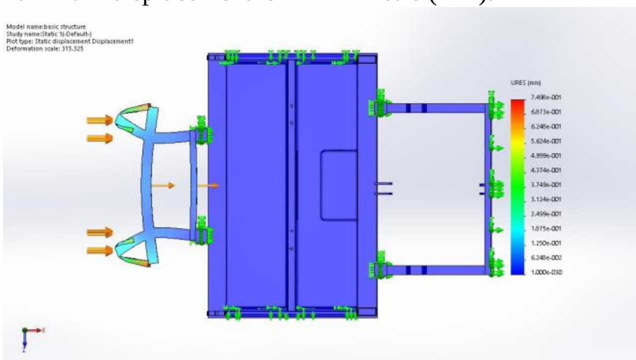

Fig. 7. Maximum displacement 0.7498mm

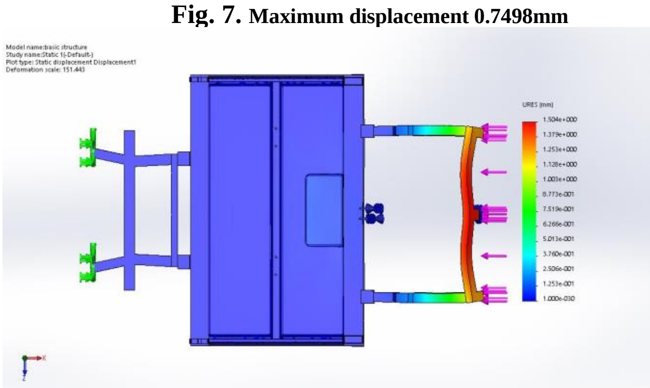

Fig. 8.Maximum displacement of 1.504mm

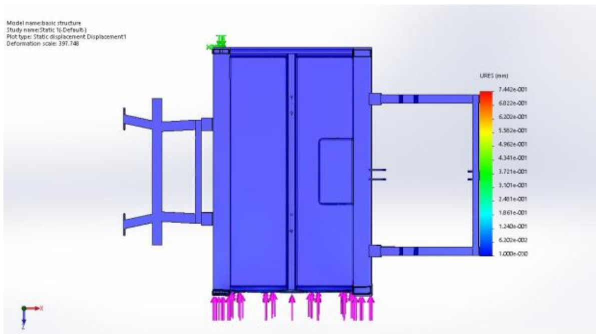

Fig. 9.The maximum displacement of 0.7442mm

Table- II: Properties of the material used for analysis

			Optimal value	Scenario 1	Scenario 2	Scenario 3

Parameter constraint or goal	Format	Unit	Carbon fibre	Pure CP-Ti	Carbon fibre	Alloy Steel
Mass 1	Min	G	85411.3	256803	85411.3	438445
Stress 1	Max	N/m^2	54.217	55.798	54.217	66.603
Displacement 1	Min	Mm	2.50E-07	0.36136	2.50E-07	0.17656
Centre of Mass X1	Min	Mm	1017.8	1017.8	1017.8	1017.8
Centre of Mass Y1	Min	Mm	548.72078	548.72078	548.72078	548.72078
Strain 1	Max	-	0	0.000171	0	0.000102
Minimum factor of Safety 1	Max	-	7.377795	6.631078	7.377795	9.315232
Frequency 1	Min	Hz	1.26E+05	131.79	1.26E+0.5	165.0423

The table above shows the result obtain from the design study with different material. Based on the results we can see that carbon fibre is the most suitable material for the structure this is because as we know that Composite materials demonstrate low von misses stress as associated with structural Alloy-Steel. At the natural frequency at which extreme deformation occurs upon the chassis frame, where the density of the composite material is very low. This helps to lower the weight of chassis frame and contribute to the increased effectiveness of the automobile. The Pure CP-Ti have exposed a bit high deformation compared to steel. This change is due to low stiffness; however, when the thickness of the epoxy glass chassis frame is increased, the deformation lowers. A composite material is expensive compared to other metal used in vehicle chassis frame which leads to new price on the consumer. Wherever the cost is not a factor; composite materials are the best alternative for the automobile and chassis frame. The results of the harmonic investigation give a clear sign that the extreme stress made is in steel and the composite material has the lowest stress-induced.

IV. CONCLUSION

As a conclusion, this project was completed whereby meeting the objectives stated before. Firstly, to construct a 3D design of understructure platform based on the conceptual vehicle design. The new design of the platform was minimised to a smaller size to reduce the weight of the platform without affecting the safety, which is the strength of the structure. The analysis using SolidWorks was to analyse stress distribution using Finite Element Analysis on the understructure platform, where stress concentration area was focused and minimise during the fabrication process in the future. The analysis done is to determine the weak location of the structure, and thus design improvement can be made before the fabrication process starts. This method can avoid problems from happening and can reduce the total waste cost of the structural repair process. According to the result, the selection of the material is essential to increase the efficiency of the electric vehicle.

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