Analysis Of Electric Car Front Chassis In Crash Test Using Fea Software

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***Abstract*— One of the important components of electric cars is the chassis which is a component of the vehicle whose main function is to frame to withstand the burden of vehicles and impact loads during a collision so that it can protect passengers. The properties of the electric car chassis and body is simulated using software based on full-frontal fixed barrier method where collision or collision with wall rigid barrier or rigid wall is applied. In this model, the car is crashed to rigid wall with various speed namely 30 km/h, 45km/h, 60 km/h and 100 km/h. From model analysis and result it can be concluded that the model with the initial design in this study is still in poor condition in modeling, because it is not safe which still has a value of SF < 1 causing damage to the chassis. The resulting stress is greater because the speed given is also getting bigger. The result of deflection is greater when the load or force that occurs is also getting bigger. The FOS in the drop test is not safe to operate because it has an SF value <1, while in the static test it has an SF value> 1.**

Keywords*— *Electric Car, Simulation Chassis, Full frontal fixed barrier, Stress, Strain, Displacement, Factor of safety

1. INTRODUCTION

One of the focuses in this research is the chassis on electric car that generally have several key components, namely: chassis, frame, body, suspension, motor, and auxiliary equipment of electric motors. The chassis is the most important part of the stability of a vehicle, as all components related to the stability are attached to the chassis. Some of them are suspension, wheels, steering system, braking system, and place to put machinery [1].

Therefore, there needs to be a test of vehicles, especially electric cars. One of the tests conducted was crash test at various speed. This test serves to measure the ability of the chassis of the car so that it is safe for the passengers when something is unwanted. In its testing using one of the software is Solidworks. This paper explain cassis characteristic of crash test at various speed by modelling.

2. METHODOLOGY

To perform an analysis of the characteristics of an electric car body at crash condition, it is carried out by numerical analysis with modeling using Solidwork software. In this analysis, the car model uses the actual conditions and sizes which include dimensions, materials, shapes and loads.

A. Model

A Model is an object used in this study with simple modeling using Solidworks [2,3,4]. The model developed is based on actual condition. A jeep based electric car is used as the model. Shape, dimension and load of the car is described in Figure 1, Figure 2 and Figure 3. software. The sizes used are the results of check in the field but some parts are not suitable due to difficulty in making the model because of frequent errors in the case of meshing. So in simple modeling, some small and thin dimensional sections can affect the results to be displayed.

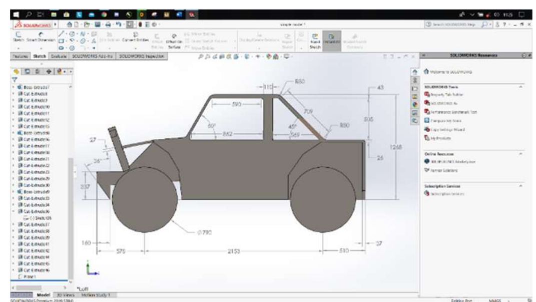

Fig 1. Side-View of Simple Model

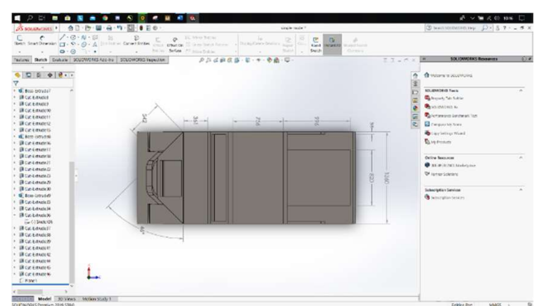

Fig 2. Up-View of Simple Model

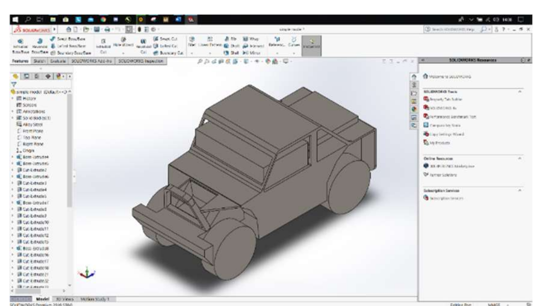

Fig 3. Isometric of the model

B. Material Properties

The electric car have been analyzed is made from alloy steel that described in Table 1 below

TABLE 1. MATERIAL PROPERTIES

Name	Alloy Steel
Model type	Linear Elastic Isotropic
Default failure criterion	Max von Mises Stress
Yield strength	6.20422e+008 N/m^2
Tensile strength	7.23826e+008 N/m^2
Elastic modulus	2.1e+011 N/m^2
Poisson's ratio	0.28
Mass density	7700 kg/m^3
Shear modulus	7.9e+010 N/m^2
Thermal expansion coefficient	1.3e-005 /Kelvin

C. Boundary Condition of Simulation

Boundary condition applied to this model of electric cars in general is, the first condition of the car was styled and drove in a horizontal direction, in which case the car is crashed with a rigid wall, the second condition of gravity force commonly used at 9.81 m/s, the third condition of the car is run at different speeds of 30, 45, 60, 100 $^{Km}/_{h}$. The boundary condition of the analysis is described in Figure 4, Figure 5 and Figure 6 And Figure 7.

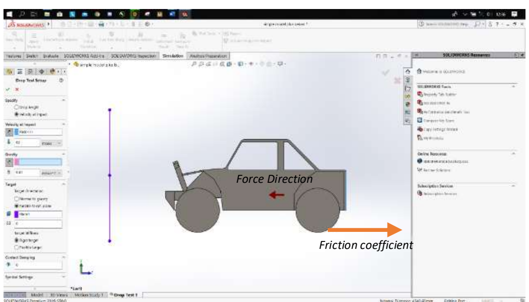

Fig 4. Speed in the horizontal direction

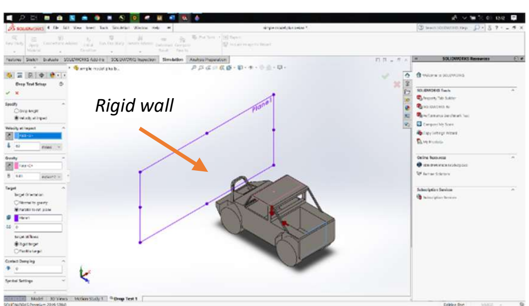

Fig 5. Rigid wall

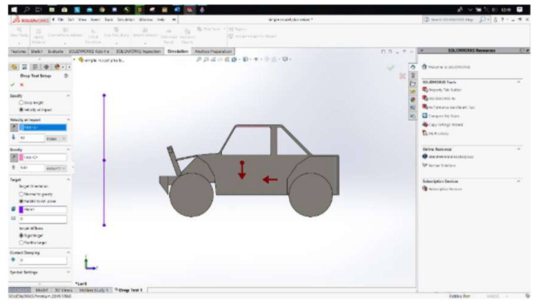

Fig 6. Gravity Force car Direction

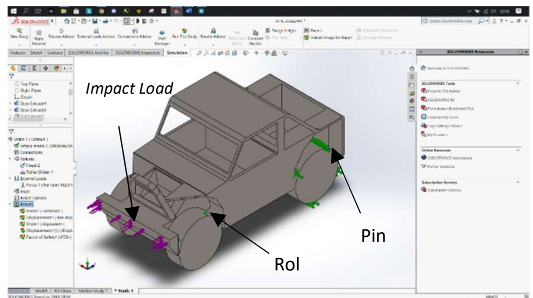

Fig 7. FOD model for static test

3. Model Calculation

Model calculation is based on Full frontal fixed barrier Method [5]. This method is a method used in one of the analyses on crashworthiness, which is a method in the analysis of collision or collision with wall rigid barrier or rigid wall. The walls used are rigid walls that cannot be deflected. The speed of permit on this method is 0-48 km/h, at the standard FMVSS 208. So that with the collision occurs maximum speed reaches a range of 53 km/h, but the speed is included in low speed [6].

In this study used this method against the collision that occurred, but the speed took a little bit with this method. The speeds taken on this method are 30, 45 km/h, and 60, 100 km/h are used as required calculation data.

4. RESULTS AND DISCUSSION

Simulation results When the car is crashed into a wall with various speeds is shown in Figure 7 to Figure 14 below. In this paper the simulation results are represented by displacement and stress figure.

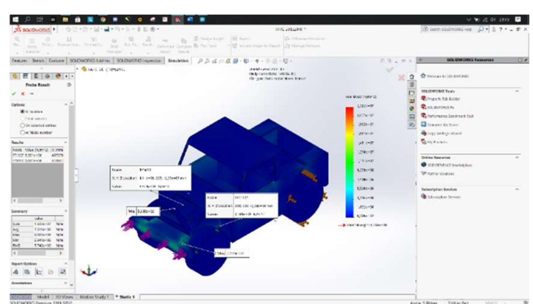

Fig 7. Stress at 30 Km/h

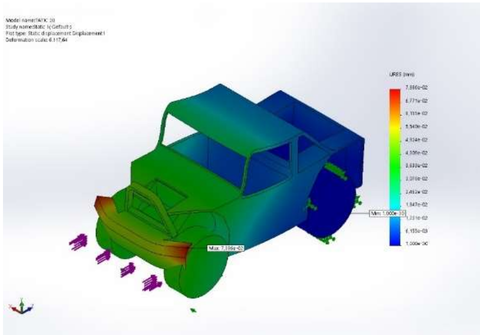

Fig 8. Displacement at 30 Km/h

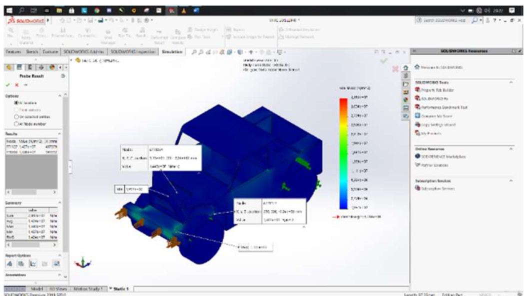

Fig 9. Stress at 45 Km/h

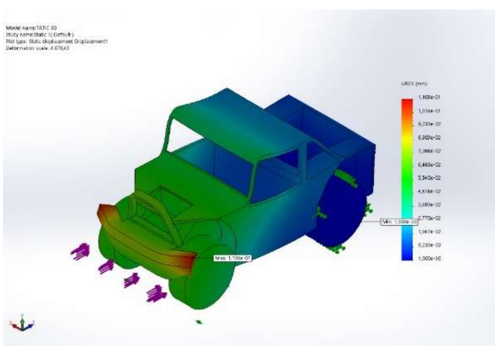

Fig 10. Displacement at 45 Km/h

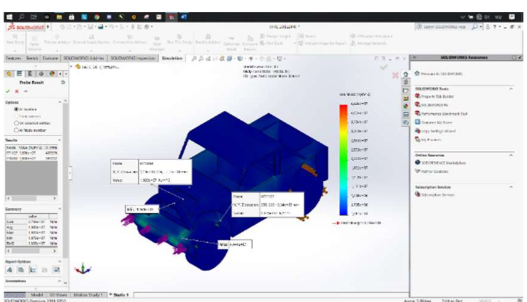

Fig 11. Stress at 60 Km/h

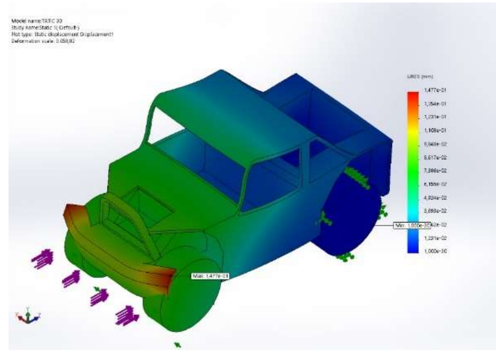

Fig 12. Displacement at 60 Km/h

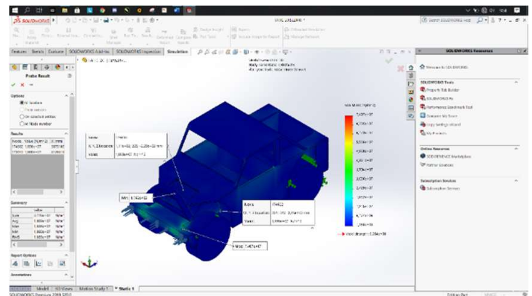

Fig 13. Stress at 100 Km/h

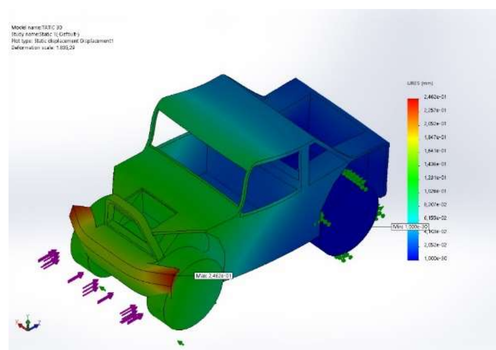

Fig14. Displacement at 100 Km/h

From the simulation results where the car was crashed into a rigid wall, it can be seen that the stress and deflection have the same pattern at various speeds. It appears that the highest stress occurs on the bumper. Meanwhile, the highest deflection also occurs in the bumper. However, what is quite interesting is that the position of the roof also occurs deflection at a speed of 30 km / h, 45 km / h, 60 km / h and 100 km / h. This is because there is a critical point that causes the roof to be very badly damaged, namely the roof supporting pillars or pillars. This should be a concern in the design of this type of electric car.

Numerically and graphically the simulation results can be seen in Table 2 and graphs in the Figure 15 and Figure 16.

TABLE 2. SIMULATED DATA ON MODELS

NO	Velocity $^{Km}/_{h}$	Stress Max Model x10⁸ $(^{N}/_{m^2})$	Deflection Max Model (mm)	Strain Max Model x10⁻²	SF *(Safety Factor)*
1	30	39,36	21,04	0,8504	0,1576219
2	45	61,61	31,38	1,286	0,1006979
3	60	85,24	41,65	1,716	0,0727827
4	100	146,7	68,47	2,702	0,0422904

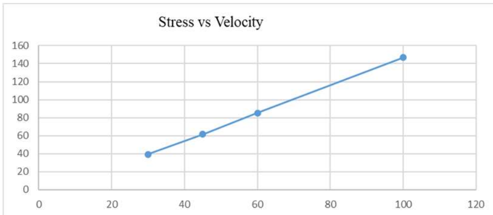

Fig 15. Stress Diagram vs Speed on model

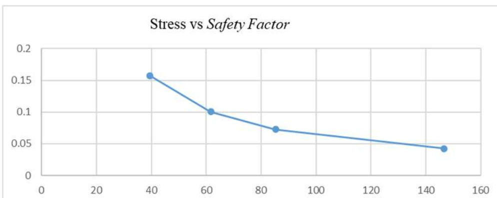

Fig 16. Stress Diagram vs. safety factor on model

In the stress diagram vs the speed that has been shown can be concluded that the stress that occurs increasingly on the model that is carried out the test, then the safety of the model used will also decrease according to the large stress that occurs at the time of the collision occurs. So it can be concluded that the stress that occurs in the body is directly proportional to the speed given.

Based on the results obtained, the stress diagram vs safety factor shows the relationship between the stress occurring against the safety factor. In the stress diagram vs. safety factor that has been described can be concluded that the stress that occurs increasingly on the model that is carried out the test, then the safety of the model used will also decrease according to the large stress that occurs at the time of collision occurs. So it can be concluded that the stress that occurs in an object is inversely proportional to the safety factor produced.

5. CONCLUSIONS

From model analysis and result it can be concluded that the model with the initial design in this study is still in poor condition in modeling, because it is not safe which still has a value of SF < 1 causing damage to the chassis. The resulting stress is greater because the speed given is also getting bigger. The result of deflection is greater when the load or force that occurs is also getting bigger.The safety factor model in the drop test simulation has a greater strain than the simulation in the static test. The FOS in the drop test is not safe to operate because it has an SF value <1, while in the static test it has an SF value> 1. This is because the modeling is not good enough that it causes a very large difference in the FOS value.

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