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A Study on Frontal Deformation of Lightweight Vehicle Due to Different Load Impact

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Abstract: The frontal impact incidents especially involving vehicle crash on the road is frequently occur anywhere since vehicles are play an important role as a facility used to bring peoples or product to their required destination. The evaluation of the crash and impact characteristics of lightweight vehicle at varying impact force is something crucial since it involves safety of the human and also durability of the vehicles structures. The study is focused on the determination of the frontal area deformation of a lightweight vehicle impact test with different force. The vehicle's force is split into five distinct categories: lowest, low, medium, high and highest. The advancements in computer technology leads to the opportunity to conduct nondestructive analysis and test through the application of free or commercialize software such as GiD Pre and Post Processors, Solidworks and so forth. In this research, Solidworks is used to analyze the impact force of frontal lightweight vehicle at various category of impact test. The impact test at 500N force is 2.31e + 07 N/m^2, 6.94 + 07 N/m^2 m at 1500N force, 1.16e+ 08 N/m^2 at 2500N force, 1.62e+ 08 N/m^2 at 3500N force and 2.08e+ 08 N/m2 at 4500N force. It is shows that the effect of higher force may leads to higher risk to the occupant since it can cause greater deformation and damage of the frontal vehicle.

Keywords: Lightweight Vehicle, Impact Test, Solid Work

1. Introduction

Automobiles are wheeled vehicles powered by internal combustion engines. It's a vehicle produced by the automobile industry. Most cars are powered by internal combustion engines that run on gasoline or diesel. In response to environmental concerns and growing oil prices, hybrid engines, plug-in electric vehicles, and hydrogen vehicles have been created to improve the engine [1].

As the principal form of human transportation, safety must always be a top priority. Car bodies reduce the severity of collisions and make vehicles more aesthetically pleasing and practical. The degree of human overloading and the amount of space required for car crew survivability both affect car crash

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outcomes and survivors. When harder automobile body sections hit a solid barrier during collision, human overloading depends on deformation zone components' ability to absorb kinetic energy [2].

Lightweight vehicle tested impact may be conducted by using several FEM software such as Abaqus, Ansys and so forth. Road user safety is a top priority in road transport. Concrete road dividers cause accidents and deaths. Concrete road dividers reduce the effect of light vehicle collisions, increasing safety. Newly built concrete road barriers can absorb crash energy without breaking. Lightweight vehicle accidents with concrete road dividers must be reduced. The most significant reason to use steel is due to its high strength, penetrability, welding, coloring and cost[3].

Traveling vehicles accelerate from low to high speeds. Vehicles moving at different speeds can cause varied deformation and impact forces when colliding with a static object. When a fast moving vehicle collides with a static item, such as the concrete road divider in this case, the impact is high. If a car collides with a concrete road divider, the residual impact forces are absorbed by the vehicle's components. As a result, the passengers are at a significant danger of injury or death in this circumstance. When the car hits from the front, the safety belt can protect the person inside. But the safety belt only stops the upper torso and upper thigh from moving forward. The neck and head parts can still move forward[4].

2. Materials and Methods

The necessity for automobile body materials that have high strength, the capacity to absorb impact energy after a collision, low body weight, and the ability to be maintained According to the findings of the research, using steel as the material for the automobile may have both advantages and disadvantages; nevertheless, the most important reasons to use steel are due to its high strength, penetrability, welding, and coloring capabilities, as well as its cost.

2.1 Materials

The vehicle was fabricated using plain carbon steel in its most basic form. The material characteristics of the materials used in the analysis. The total deformation is the overall deformation caused by stresses operating on the model and can be estimated by determining the vector sum of the system's directional displacements. To be determined is the degree of frontal car deformation, which comprises the bumper and contact area. After the vehicle's front end impacted with the concrete barrier separating the traffic lanes, the system was able to analyze the deformation induced by the collision.

2.2 Methods

Methods of mathematical modelling of blow are able to substitute experimental research methods because the final results are nearly as precise as the actual test. The usage of simulation and computational models is ubiquitous in the design of engineered systems, since they play a crucial role in simulations and modelling while preliminary impact load towards frontal vehicle structure may be implemented using Solidworks software. Researchers and industrial teams rely on this computer system to design energy-efficient automobiles and aircraft, as well as effective communication networks and supply chain models.

3. Results and Discussion

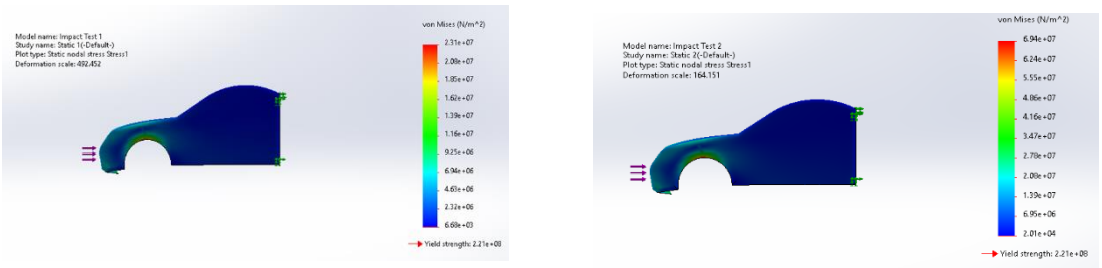
According to the software's data, a total of 17,816 elements have been created for the complete model. The total number of vehicle components is 10,282. The lower size of the element, 0.005 metres, is used to represent the vehicle's frontal area, which comprises the bumper and the contact area. This is done to increase the number of mesh details on the vehicle's front face. The size of the element is defined as 1,2 metres across all other vehicle surfaces. If coarse meshing was applied to the other sides of the

vehicle and the number of accessible meshes was decreased, the amount of time spent by the CPU may be shortened.

3.1 Analysis on Total Deformation Result

The maximum value of impact test in Figure 1(a) over time occurs at a force of 500N and has a value of 2.31e+07 Nm-^{2}. As can be seen in Figure 1 (b), the maximum impact test that can occur over the course of time occurs at a force of 1500N and the value of 6.94e+07 Nm-^{2}. Figure 2 illustrates that the maximum impact test that can occur over a period of time is 1.16e+08 Nm-^{2} when the impact force is 2500N. For the maximum value of impact test in Figure 3 over time occurs at a force of 3500N and has a value of 1.62e+08 Nm-^{2}. Last one based on Figure 4 illustrates that the maximum impact test that can occur over a period of time is 2.08e+08 Nm-^{2} when the impact force is 4500N.

The maximum impact test over time is increasing when the force of the vehicle is increase. The high force of the vehicle makes the internal energy increase thus the impact test at the frontal part more severe. This showed the effect of high force when impact with rigid objects showed high risk to the occupant because the internal energy is high at that point.



(a) (b)

Figure 1: Frontal impact test; (a) at 500N, (b). at 1500N

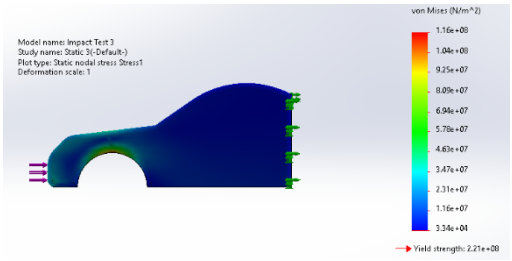


Figure 2: Frontal impact test at 2500N

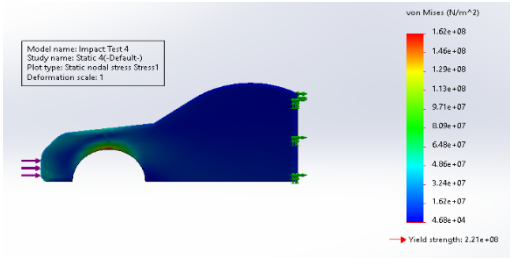


Figure 3 : Frontal impact test at 3500N

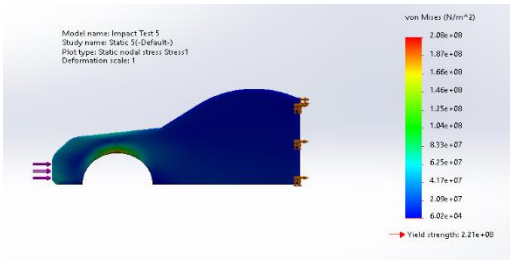


Figure 4: Frontal impact test at 4500N

4. Conclusion

The aims of the study are accomplished completely by the time one reaches the conclusion of the report. Using the SolidWorks software, the geometry of a model was produced. The material was put to the model after the deformation that occurred on the frontal area of the car that was also constructed using the Solid Works software. For the construction of the lightweight vehicle, plain carbon steel was chosen as the material. When there is an increase in the total internal energy, there is likewise an increase in the equivalent strain. The simple carbon steel's yield due to strain was shown by all of the equivalent stress graphs to be larger than its yield strength.

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