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Modeling and Simulation of Frontal Crash Between Heavyweight and Lightweight Vehicles

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Abstract: This represent on the simulation of a frontal collision between a light and heavy weight vehicle by using ANSYS software. The study is focusing on the deformation and crashworthiness behaviour of frontal crash impact of both vehicles. The material for the vehicles is aluminium alloy and structural steel. Based on the result generated by the simulation, the maximum deformation occurs on lightweight vehicles compared with heavyweight vehicle. The maximum equivalent stress generated by the collision between both vehicles. The maximum stress occurred on the car body where it shows the force exerted on car is higher compare to the lorry body. Therefore, after the collision the car will face large damage as compared to heavyweight vehicle or lorry. The lightweight vehicle faced the most damage compare the other. Besides, the stress generated on the car body was the highest.

Keywords: Deformation, ANSYS, Lightweight, Heavyweight, Vehicles, Stress

1. Introduction

This study is concern about the deformation of frontal crush between light and heavy weight vehicle. The important aspects of the vehicles interaction and collision involve many parameters such as the weight, size, speed of vehicle and so forth. Numerical analysis on the deformation of vehicles after collision will be carried out by using software ANSYS in which the vehicles is designed with their necessary specifications and the collision between two vehicles will be carried out and examined to understand more on the deformation of the two vehicles [1,2].

In this investigation, the preliminary stage of it is related to the creation of vehicles geometry model based on the normal and standard size of specific chosen vehicles. It is important to understand and observe on the total damage between two vehicles as well as other dynamic responses aspect relatives to the collision. The information that is vital during collision between two vehicles are the vehicle impact , damage, inertia and other aspect like driver and passenger injury and so forth. Large energy involves when it relates with vehicle collision [3, 4, 5] It is believed that through these kind of analysis and observation,it may provide possible ways

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to reduce impact between two vehicles, develop better brakes and understand how these situations can provide better and safer in the sense of lesser damage to the vehicle and the people driving the vehicle.

2. Materials and Methods

Figure 1 shows the flow chart of research methodology. The material properties of vehicular bodies are aluminium alloy and structural steel (Table 1). To elaborate the results of the deformation of vehicles by frontal crash simulation that have been chosen, an engineering software is used which is named as ANSYS.

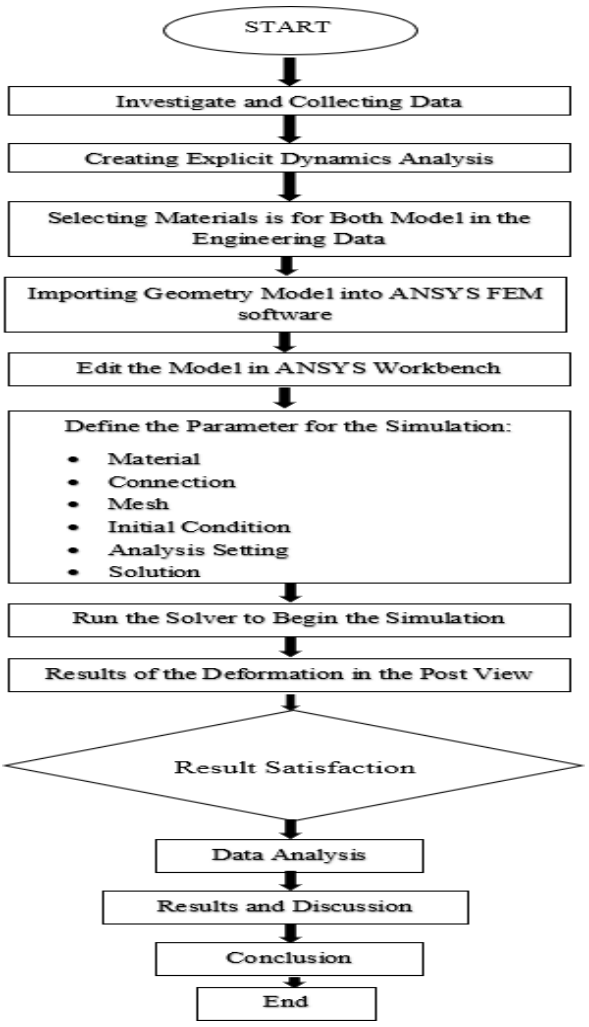

Figure 1: Flow chart of research methodology

Table 1: The material properties of vehicle body

Properties/Parameters	Material	
	Aluminium Alloy	Structural Steel
Young's Modulus, E	69 GPa	200GPa
Poisson's Ratio, v	0.33	0.30

The shape or geometry model was designed by using ANSYS Explicit (Dynamic) with a fixed dimension of Length × Width × Thickness. Figure 2 shows the dimensions and size of both lorry and car.

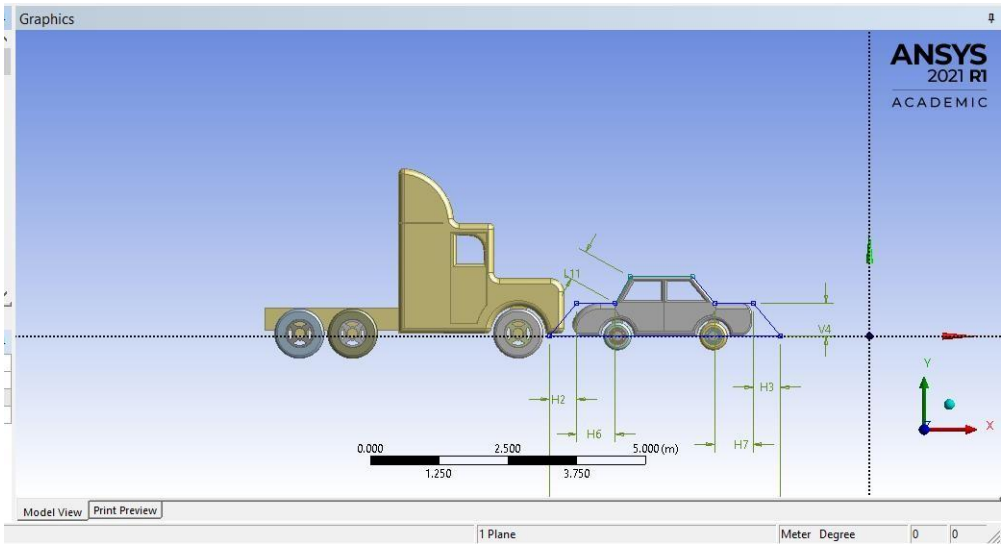

Figure 2: Geometry model of the vehicles

3. Results and Discussion

The interaction and impact between heavyweight vehicle and lightweight vehicle are discuss and assessed in further detail through the simulation between both of the vehicles. Among the parameters analyzed are total deformation, equivalent stress and elastic strain. Due to mass of the heavyweight is more than lightweight vehicle there are minor damage to the heavyweight vehicle compared to lightweight vehicle. Vehicle speed also play a major role in contributing n large vehicle damage [6.7]. The maximum total deformation occurred on carbody. Therefore, the lightweight vehicle faced the most damage compare the other.

3.1. Total Deformation

The collision between lightweight vehicle and heavyweight occur at the speed of 45 km/h as shown in Figure 3. When both of the vehicles collide between one to each other at low speed impact, both of the vehicles undergoing less damage after collision in form of small bends and dents. Among both of vehicles, light weight vehicle exhibit more damage effect rather than heavyweight vehicle. The result of the deformation at minimum speed was obtained from the ANSYS after simulation.

Figure 4 shows the graph of total deformation against time. Basically the speed of the vehicles will influence on the level of deformation and damage of vehicles itself.

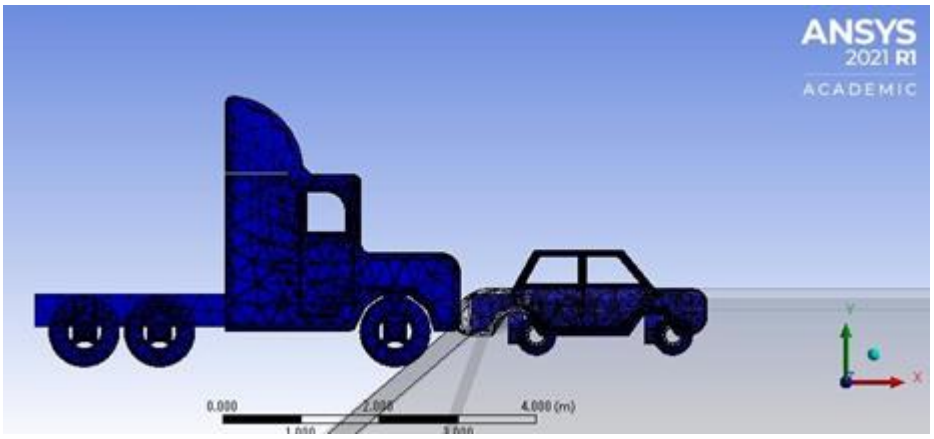

Figure 3: Total Deformation

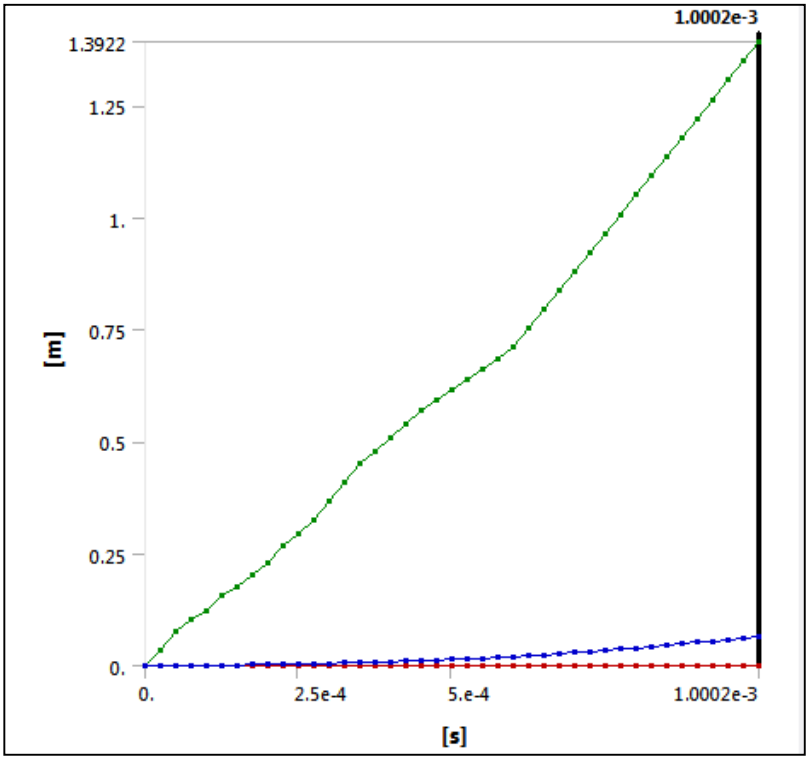

Figure 4: Vehicles total deformation against time

3.2. Equivalent Stress

The maximum equivalent stress generated by the collision of two vehicles and no stress generated before the impact of both vehicles. The maximum stress occurred on the car body where it shows the force exerted on car is higher compare to the lorry body. Therefore, after the collision the car will face large damage as compared to heavyweight vehicle or lorry. Figure 5 shows the graph of equivalent stress against time.

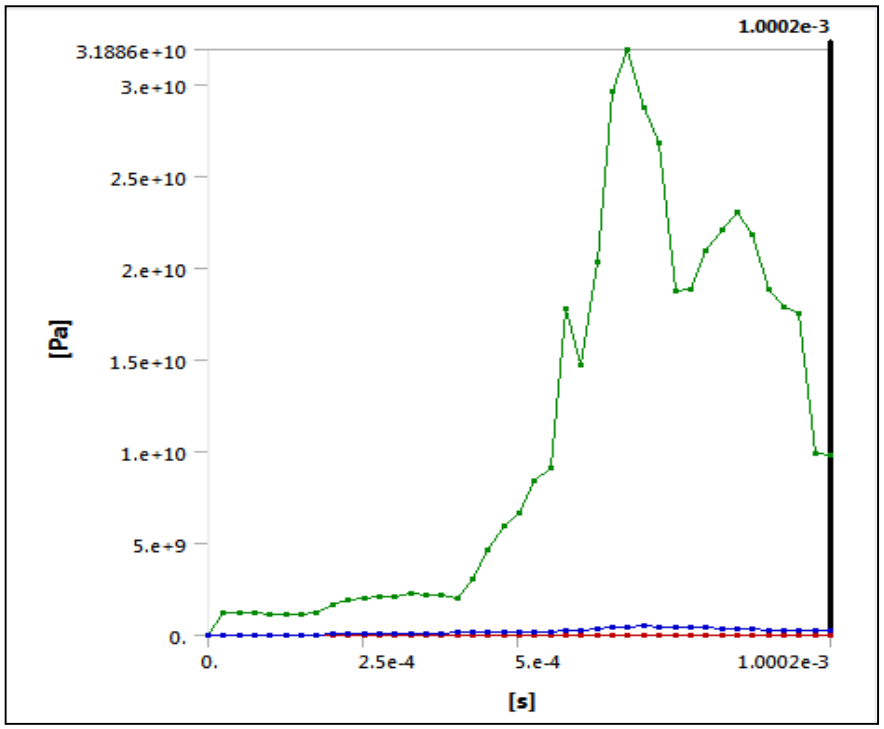

Figure 5: Vehicles equivalent stress against time

3.3. Elastic Strain

Elastic strain can be defined as the limit of the object which will rebound and will come back toits original shape after the removal of the load. When any object is subjected to an external large load,it faces lots of deformation. When the heavy weight and light weight vehicles are colliding at low speed impact, the deformation faced by both of vehicles will be recoverable due to the elastic strain presented at the moment.

4. Conclusion

The simulation of frontal crash impact between heavyweight and lightweight vehicle at low and medium speed is done using ANSYS Explicit finite element method. The purpose for the simulation is to analyze on the deformation and crashworthiness behavior of frontal crash impact of both vehicles. Lorry and car model are designed and representing the heavyweight and lightweight vehicles. The vehicles speeds are set to medium and low speed for the simulation process. The speed and mass of vehicles play a major role in generating large deformation and leads to vehicle damage occurrence when it exceed an elastic limit of collided materials. The maximum total deformation occurred on car body. Therefore, the lightweight vehicle face the most damage compare to the other. Further investigation on its damage profile and results output need for further study as some of its finding exhibit uncertain value as compared to reasonable finding. It can be concluded that the car body is experiencing larger deformation and damage effect as compared to body of lorry.

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