

Design and Analysis of Automobile Body Frame to Reduce the Force Distribution on Accidents

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ABSTRACT: This project is based on the idea how to minimize the force distribution over the automobile bodies during the sudden traffic collision. The automobile body structure reacts while on accidents based on the newton's third law, while the force is distributed in the action, each and every part inside the automobile have the reaction for it. Because of that, the body is collapsed and cursed. This is a new concept made in the modification on the frame structure. Elastic materials are used to reduce the damage. While assembling the car parts, the elastic materials are used between the two parts. This helps to reduce the force distribution on the body. The software used for this modification and analyzing is Creo parametric Software 3.0 and Ansys Explicit Dynamics Analysis.

KEYWORDS: Traffic Collision, Automobile car frame, Creo 3.0, Ansys Explicit dynamic Analysis 15.0.

I. INTRODUCTION

An accident is an undesirable incidental and unplanned event that could have prevented had circumstances leading up to the accident been recognized, and acted upon, prior to its occurrence. Most scientists who study unintentional injury avoid using the term "accident" and focus on factors that increase risk of severe injury and that reduce injury incidence and severity.

II. VEHICLE CRASH ANALYSIS

Vehicle crash analysis has historically been the postmortem physical test that caused engineers and manufacturers to launch a flurry of product modifications and redesign, engineering change orders, and even the eventual demise of a car model. One need only think of the Ford Pinto or Chevy Corvair as examples of models that were designed, manufactured, and sold long before the automotive industry knew how unsafe some of their cars really were. In the early 60's a number of analysis codes were developed to assist engineering in the a priori investigation of designs to better predict when a given part or assembly would fail in real life. However little was done until the mid-70's when Dr. John O. Hallquist developed the first analysis code that attempted to analyze the impact between two bodies. This early FEM has matured into a widely used crash analysis tool that today catches many design flaws long before the first prototype is ever realized. Today, the correct use of this tool is credited with saving millions in development costs, reducing untold numbers of vehicle recalls and ultimately saving unnumbered lives by empowering engineers with the ability to virtually crash their design until they arrive at an optimally safe survival cell for the occupants.

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In this paper, automobile car frame structure is focused. During the accidents there is a crush of the body causes the high deformation. Because of that, lives, money and time losses occurs. The automobile frame structure plays a role while considering the safety. We considering the design by the modification of frame assembly. The elastic material is used between the two components during the assembly. The force is caused during the accidents on the car frame structure results the crush. This is due to the Newton's third law of each and every action have opposite reaction for it. When the force is distributed over the automobile car body frame, every components inside the car have opposite reaction to minimize the force distribution. Because of that the body is entirely caused to collapse. This study is explain through the FEM analysis.



Fig 1: Car Body Frame Assembled explode view

III. MAIN OBJECTIVE OF THIS PROJECT

The accidents can't reduce but keeping safety can prevent the lives from traffic collision. To reduce the accidents the car body frame is consider as modification in this project. Elastic material is used in the frame assembly of the vehicle. At the joints of the two frame parts the material is applied. This method is helps to reduce the Traffic Collision damages. The elastic materials are used in the car body frame is easily replaceable. It leads to develop the future modification on all automobiles and space vehicle bodies.

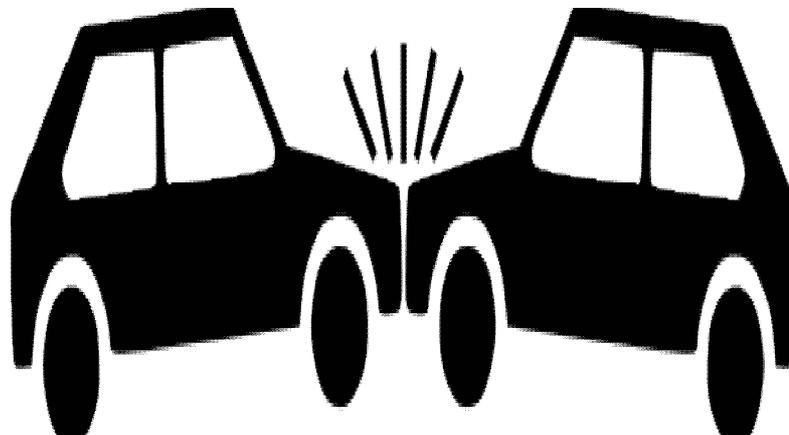


Fig 2: Clip Art about the vehicle crash

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Equation of Motion (EOM)

Underdamped system ($1 > \zeta > 0$)

$$\ddot{\alpha} + 2\zeta\omega_e\dot{\alpha} + \omega_e^2\alpha = 0 \tag{Eq.1}$$

Where $\zeta = c/2m\omega_e$ and $\omega_e = \sqrt{\frac{k}{m}}$

Transient responses of the underdamped system are:

$$\alpha(t) = v_0 e^{-\zeta\omega_e t} / \sqrt{1 - \zeta^2} \sin(\sqrt{1 - \zeta^2} \omega_e t) \tag{Eq.2}$$

Displacement dynamic crush

$$\dot{\alpha}(t) = v_0 e^{-\zeta\omega_e t} [\cos(\sqrt{1 - \zeta^2} \omega_e t) - \frac{\zeta}{\sqrt{1 - \zeta^2}} \sin(\sqrt{1 - \zeta^2} \omega_e t)] \tag{Eq.3}$$

Velocity

$$\ddot{\alpha}(t) = v_0 \omega_e e^{-\zeta\omega_e t} [-2\zeta \cos(\sqrt{1 - \zeta^2} \omega_e t) - \frac{2\zeta^2 - 1}{\sqrt{1 - \zeta^2}} \sin(\sqrt{1 - \zeta^2} \omega_e t)] \tag{Eq.4}$$

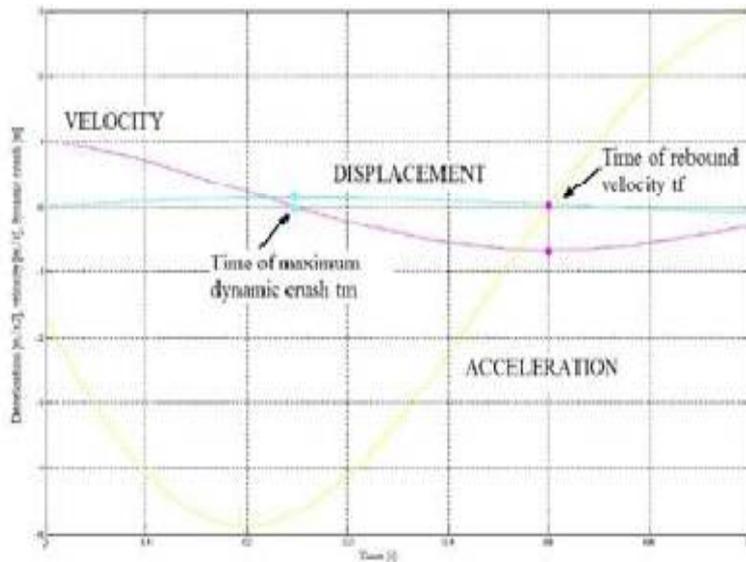


Fig 3: Relationship between t_m, t_f and Acceleration, Velocity, Displacement

At t_m the corresponding velocity is zero and the dynamic crush reaches its maximum value. At t_f the corresponding. $t_f=0.5s$ and $t_m=0.25s$

We can simplify the equation by substituting

$$\sin(\sqrt{1 - \zeta^2} \omega_e t) = 2\zeta \sqrt{1 - \zeta^2} \tag{Eq.5}$$

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EOM for vehicle

$$\ddot{x}_v = -\frac{F}{M} = -ESW \quad \text{Eq.6}$$

$$\dot{x}_v = v_0 - ESW_t \quad \text{Eq.7}$$

$$x_v = v_0 t - \frac{1}{2} ESW_t^2 \quad \text{Eq.8}$$

IV. PARAMETRIC 3D MODELING

Automobile car body frame is designed using the creo 3.0 parametric design tool. Two types of the model is designed, model without the elastic material and model with the elastic material. Crashed cylindrical wall is designed to check the dynamic analysis. The material used for the car body frame is Aluminum and for the cylindrical wall is structural steel.

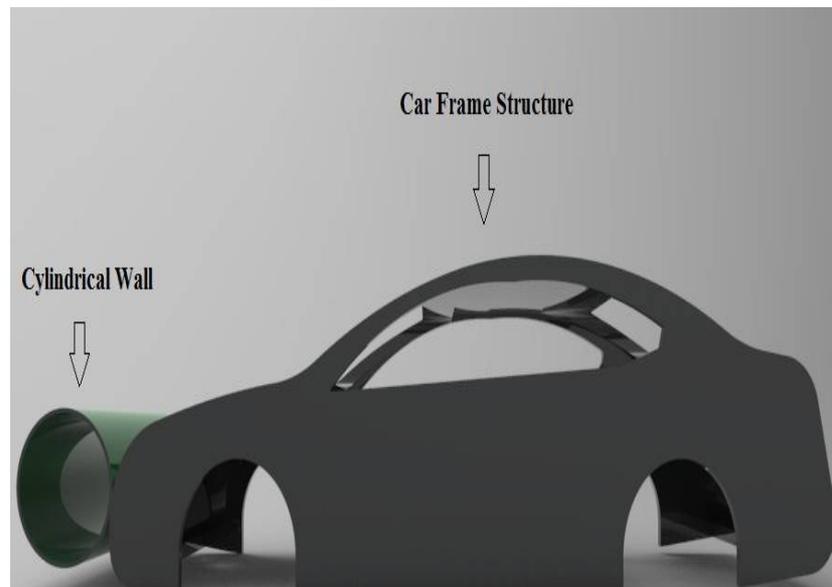


Fig 4: Car body Frame and cylindrical wall 3D modelling

V. ELASTIC MATERIAL PROPERTY

The elastic material is actually have the explicit property, so if the force is applied on the materials, it reflects as the opposite reactions. The concept is based on the Newton's Law.

Mooney-Revin Rubber (Coefficients fitted to experimental data from Treloar, L.R.G., Stress strain data for vulcanized rubber under various types of deformation, Transactions of the Faraday Society, vol. 40, pp.59-70 (1944).

Density	1000	Kg m ⁻³
Material Constant C10	1.5e+005	Pa
Material Constant C01	15000	Pa
Incompressibility parameter D1	1.212e-009	Pa ⁻¹

TABLE 1: Mooney-Revlin Rubber parameter

VI. FINITE ELEMENT ANALYSIS

The dynamic analysis is calculated through the computer based method. Ansys explicit Dynamic 15.0 is used to analysis of the model. There are two types are models, model without the elastic material and model with the elastic material is done. Total deformation, Equivalent stain and stress isThe design is done through the standard parametric modelling software Creo 3.0 and imported to the Ansys. By this way, the flexible modelling is possible for the further changes of the model calculated. Time frame is done for totally 9 seconds. The velocity of the vehicle crashing the cylindrical wall is 50 m/s.

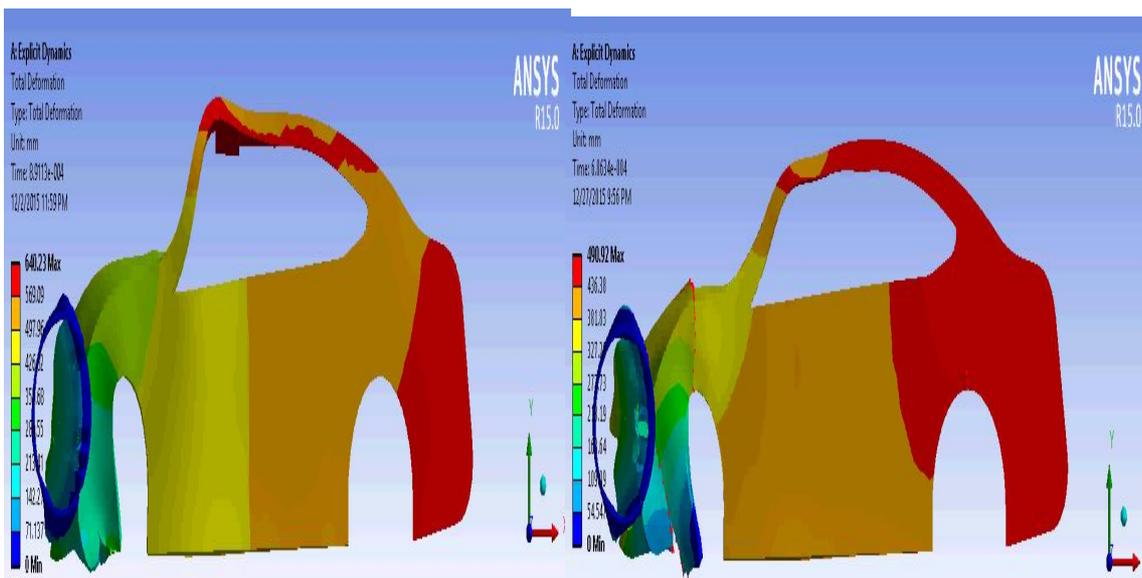


Fig 5: Total Deformation for model without elastic material

Fig 6: Total Deformation for model with elastic material

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The finite element analysis for the car body frame model is shown in the fig 5 and 6. By comparing the two results, it shows that our modified model have the less deformation compared to the model without modification. The flow chart for the model is shown in the fig 7. The blue line indicates the model without the elastic material and the yellow line indicates the model with the elastic material.

This is a concept analyzing project for the future scope in automobile development of advancement. Detailed study and justification can be better result in realistic.

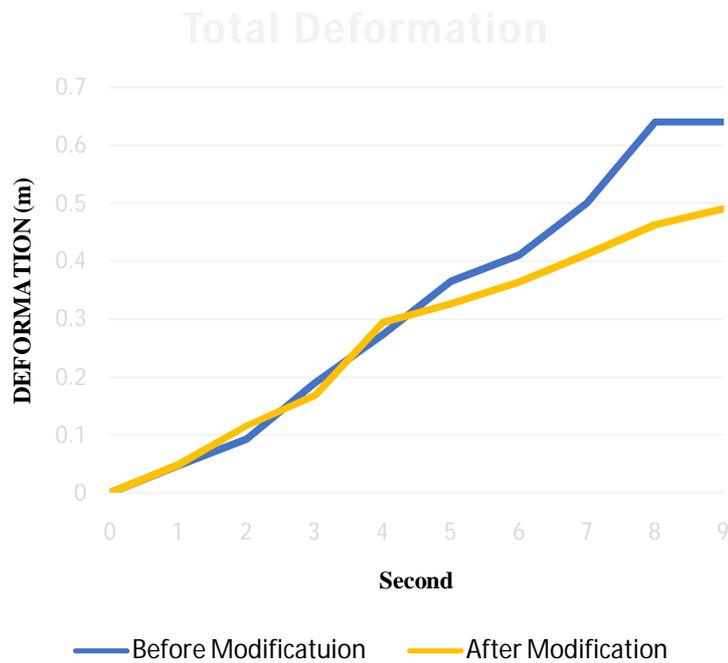


Fig 7: Flow Chart for Total Deformation

VII. RESULT

SL.N0	Calculated Solutions	Before Modification	After modification
1	Total deformation (mm)	640.23	490.92
2	Equivalent Strain (mm)	0.82337	1.5105
3	Equivalent Stress	1.3074e05	7.4230e04

TABLE 2: Calculated Results

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Thus the results are calculated from the finite element method. This gives the future approach to the modification on the car frame structure. The rubbers are modified to easily replaceable. For the higher end automobiles have a high price for the safety system. If this method is implemented, may it cause to better efficient way for the drivers. The mainly concentrated solution in this paper is to controlling the force is distributed on the sudden collision.

VIII. CONCLUSION

This paper is the concept for the future modification during the manufacturing of car body frame. Every action have the opposite reaction for it, according to the Newton's third law. The car body frame is assembled with the many number of parts, during accident the force is distributed from one end to other, by considering law each and every part that are assembled have opposite reaction at the nodes to minimize the force. This makes to entire body collapsed. So the modification is done by fitting the explicit rubber material between the joints. It results to low deformation on the body. We done it through the FEM Solver. For the future concepts, the analysis is carried out to justify it in practice method.

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