CRASH ANALYSIS OF A COMPOSITE CAR BODY

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Abstract: To avoid the crash in automobile during accidents, the strength of structure must be food enough which in return helps in fuel economy by light weight parts. This leads to development of auto industry to meet huge demands. In design field of automobile, light weight & crashworthiness are major aspects to be considered. In this project we will design a Hatch back body of car by using Solid works 2016 software, Crash analysis will be performed in Ansys workbench software by Explicit Dynamic module by using different material for car body and different speed of car body, stresses formed and deformation and areas of deformation of car body will be found after analysis.

1. Introduction

The expectations of the people in the current generation towards automobile are safety, crashworthiness & light weight. Consuming less fossil fuel is the area where public & private sector are focusing in the field of vehicles development to increase safety by reducing weight.

Now-a-day’s car producers focusing more the usage of light-weight parts to consider less weight like aluminum, magnesium, plastics, composites and new varieties of high. Energy steels Most of these substances, restrained power or ductility, in every case rupture is a severe opportunity during the crash occasion. The crash worthiness and light weight analysis can be done by (a) conduction real test on crash. (b) Simulation performing on FE/ANSYS DYNAMICS.

Thacker et. Al [1] performed crash-checking out study on Honda accord in 1997 for simulation by taking car after which, automobile turned into pieces all the way by primary elements, element become check, categorized, fabric find out. Anderson al. [2] has discussed that to growth crash performance in automotive cars it’s far necessary to apply new strategies inclusive of use of energy absorber and materials. Components connected to crash safety ought to transmit or take in energy. The power absorbing functionality of a specific element is an aggregate of geometry and fabric residences. Evans D and Morgan T [3] have studied that as car producers keep emerging as extra competitive with the styling of new cars, bumper system technologies could be required to locate new solutions that match into the reduced package deal spaces at the same time as persevering with to meet the car overall performance and price requirements. It changed into advised to introduce new and innovative
Expanded Polypropylene (EPP) foam technology and strategies. Bautista et al. [4] look into unique effect in which precise cloth by optimizing the beam form through simulation.

Brief studies about car body, car body materials, and light weight composites materials, and impact mechanism is done in this project. By using 3d modeling software solid works 2016 hatch back body of car is modeled and imported to ANSYS Workbench software for crash analysis. Explicit Dynamics module is used from ANSYS software, for study of car crash on different speeds. Three different speeds of car, 50km/hr., 100 km/hr., and 150 km/hr. are selected for crash investigation. Four different light weight high strength materials are selected as the material of car body such as Aluminum alloy, Aluminum metal matrix (KS1275), High strength carbon fiber & Kevlar -49. Analysis is performed on four different speeds on three different speed conditions. Stress, strain deformation due to crash on front surface area of car body due to crash with concrete wall will analyze for suitable material will provide high s/w and can provide the maximum safety to passengers due to crash.

2. Methodology

2.1 Composite Materials
AS Composite materials are extensively standard replacement for conventional materials, this may be chosen for our simulation.

2.2 Method of Analysis
Crash-testing requires some of the look at automobile to be pulverized at some stage in the exams furthermore, is also tedious and uneconomical. One new late sample this is increasing huge incidence is PC recreated crash-trying out. The model in finite element, let us consider, the car as model which is used for simulation before going to actual vehicle test will give genuine performance.

2.3 explicit Dynamic Analysis
For many engineering applications ANSYS explicit dynamic simulations in physical occasions to test in easy.

2.4 express Dynamic Analysis
ANSYS express dynamics engineering simulation solutions square measure good for simulating physical occasions that occur during a pace and will give birth to cloth damage or failure. These types of events square measure frequently exhausting or luxurious to appear at through an experiment. Simulation offers insight and an in-depth info of the essential physics taking space and offers engineers a danger to form vital modifications before their merchandise square measure placed into service, while mistakes in style could also be overpriced.

2.5 Modeling of Car Body
Figure 1. 2D Sketch

Figure 2. Different views of car body

2.6 ANSYS Simulation
ANSYS gives a technology inclusive of geometry managing, meshing and submit-processing. These improvements by myself constitute a primary step in advance in course.

3. Results

Table 1. Result at 50 km/hr.

|                | Al Alloy | KS1275 | Kevlar-49 | H.S.C |
|----------------|----------|--------|-----------|-------|
| Equivalent stress (Map) | 55.898   | 47.434 | 55.228    | 73.922|
| Elastic strain          | 0.0010869 | 0.00096632 | 0.00065421 | 0.00045206 |
| Total deformation (mm)  | 13.897   | 13.897 | 13.897    | 13.894|
| Mass (kg)               | 1209.1   | 1178.6 | 641.668   | 785.73|

Table 2. Result at 100 km/hr.

|                | Al Alloy | KS1275 | Kevlar-49 | H.S.C |
|----------------|----------|--------|-----------|-------|
| Equivalent stress (Map) | 232.01   | 240.07  | 223.77    | 279.69|
| Elastic strain         | 0.0053397 | 0.0048935 | 0.0029251 | 0.0019042 |
| Total deformation (mm) | 27.84    | 27.836  | 27.822    | 27.806|

Table 3. Result at 150 km/hr.

|                | Al Alloy | KS1275 | Kevlar-49 | H.S.C |
|----------------|----------|--------|-----------|-------|
| Equivalent stress (Map) | 535.99   | 565.15  | 510.26    | 590.96|
| Elastic strain           | 0.012307  | 0.011257 | 0.0065808 | 0.0042632 |
| Total deformation (mm)  | 41.89    | 41.864  | 41.806    | 41.762|
Graphs: Different Speed with equivalent Stress

At 50 km/hr.

![Graph showing equivalent stress at 50 km/hr](image1.png)

**Figure 3:** Graph of equivalent stress (map)

It is observed that 50 km/hr. Kevlar-49 is less equivalent stress.

At 100 km/hr.

![Graph showing equivalent stress at 100 km/hr](image2.png)

**Figure 4:** Graph showing the stress at 100 km/hr

It is observed that 100 km/hr. Kevlar-49 is less equivalent stress.

At 150 km/hr.

![Graph showing equivalent stress at 150 km/hr](image3.png)
Figure 5: Graph showing the stress at 150km/hr.

It is observed that 150km/hr. Kevlar-49 is less equivalent stress.

Weight of car body on different materials

Figure 6 Graph showing weight of car body

Hence as the Kevlar-49 is providing high strength to weight ratio, that is high strength on least weight, we can conclude that Kevlar-49 is best material for car body according other three materials, as it can provide max safety and less weight means less fuel consumption too.
4. Conclusion

Brief study about car crash mechanism, different composite materials is done in this project Car hatch back body is design with a rectangular concrete wall by using solid works 2016 software. Part model of hatch back body of car with a wall is saved as IGES (neutral) file and transfer to Ansys workbench 16. Crash analysis is performed by using explicit dynamic module in Ansys workbench. Four different materials such as aluminum alloy, aluminum metal matrix (KS1275), and Kevlar-49 and High strength carbon fiber are used as car body materials and concrete is selected as material for wall.

Crash analysis is performed on three different speeds 50km/hr., 100km/hr. and 150km/hr. Stress, strain, and total deformation are noted tabulated as result after explicit dynamic analysis on car body after crash of the car on concrete wall. Results are noted and tabulated according respective speeds and materials. According 50km/hr. result table, aluminum metal matrix (ks1275) is showing least stress value after that next aluminum alloy and Kevlar showing approx. same stress value. According 100km/hr. result table Kevlar-49 is showing least stress value. And according 150km/hr. also Kevlar-49 is showing least stress value. As the more crashes will occur at high speeds hence Kevlar-49 will provide more safety than other three materials, as it has least stress value compared to other materials. According weight optimization Kevlar-49 showing least weight i.e. 641.668kg which is very less compare to generally used aluminum alloy material.

Hence as the Kevlar-49 is providing high strength to weight ratio, that is high strength on least weight, we can conclude that Kevlar-49 is best material for car body according other three materials, as it can provide max safety and less weight means less fuel consumption too.

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