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Design and Analysis of airbag System for Two wheeler Vehicle

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ABSTRACT:
Our project"DESIGN AND ANALYSIS OF AIRBAG SYSTEM FOR TWOWHEELER VEHICLE"gives you information about the introduction and how an airbag system can be used in a two wheeler vehicle (bikes). The concept of airbag system is: "To reduce the injuries to a rider when impacting with an opposing vehicle and/or opposing object in frontal collisions by absorbing rider kinetic energy and by reducing rider separation velocity from motorcycle in the forward direction". The material of the bag will be optimized and calculation of force with which rider impacts the airbag is calculated accordingly. This research will include working, construction and installation and problem regarding airbag system in twowheeler vehicle. Some limitations that were there in the deployment of airbag in twowheeler like fixed location with respect to airbag at the point of impact and lack of supporting surfaces. The nature of such collision will be analysed using solidworks(2020) which includes structural and thermal analysis of the designed airbag model and various desired results are obtained as stated in this research paper.

I. INTRODUCTION:

The Airbag system was first introduced in 4-wheelers . This paper gives information about the introduction of the airbag system in the two wheelers(bikes). The concept of this airbag system is "To reduce the injuries to a rider when impacting with an opposing vehicle and/or opposing object in frontal collisions by absorbing rider kinetic energy and by reducing rider separation velocity from motorcycle in the forward direction."With the help of the CRASH sensor, inflator and sense of the collision and the large frequency vibration to open the air bag.

A bike becomes an essential feature for any service class as well as businessman to meet with the stringent demand of hectic lifestyle. Safety of the driver as well as passengers becomes an important feature along with comfort and performance of any two wheeler vehicle. Airbags have even been suggested from the beginning of the motor vehicle safety. It has been used for the protection of mainly head, knees and legs. Rear passenger airbags and side airbags in addition to driver air bag are developed for providing protection in roll- over accidents by shielding the occupants and passengers from side window glass and protecting the head.

The concept of our research paper is this airbag system is beneficial in "reducing the injuries to a rider while affecting with an opposing vehicle as well as restricting object in frontal crashes by absorbing rider kinetic energy and by decreasing rider detachment speed from motorcycle the forward way."

Nowadays the increment in the death rate of India is 20% because of the accidents on the highways hence this invention can help us to reduce the death rate by 7% to 10% since this can be used in the pedestrian and safety department all around the globe".

II. DESIGN OF AIRBAG:

We have designed the airbag by using Solidworks software. The dimensions of the airbag is same as mentioned above. There are numerous commands used while designing it and we have also chosen the material for the airbag. The procedure which we have followed for designing the airbag is as follows:

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1. First step is to select the plane, so we selected the top plane.
2. After selection of the plane next step which we did was to sketch the rectangle which is the base of airbag by using the dimensions which we measured.
3. Then we selected the front plane and drew a straight line, from the centroid the rectangle and perpendicular to it.
4. After that we selected the plane at the top of a line and sketched a random circle of very minute radius (no need to give it any dimension).
5. Then again we selected a plane which touched the straight line (the point which was situated at the right hand side of the front line).
6. Then by using the spline command, we drew the shape of the airbag (that is, curve at the side of airbag) over the selected point.
7. Then similarly select plane on the other side and repeat the above process, that is select plane on the other side of the straight line (point which is situated at the right hand side of the back side of rectangle).
8. Then by using spline command shape was sketched on the other side.
9. Next step was to select the loft command and loft the shape by making it touch the guide curve.
10. Then by using extrude cut command, cut the side which is opposite to the loft shape, by breaking the circle into two parts.
11. Now one side of the body of airbag is ready so next we will use the mirror command and mirror the one side to the other side and complete body will be ready
12. Next step is to select shell command and make it shell by 2.5mm
13. Then lastly use fillet command and use it at the edges and our airbag will be completely sketched.

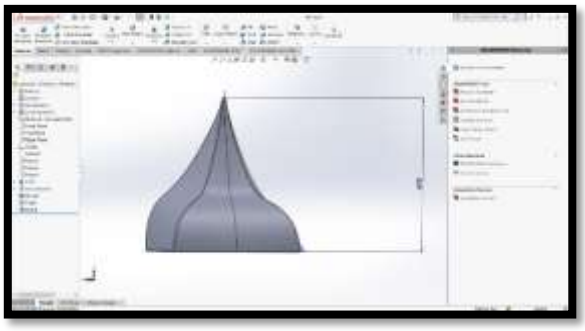
III. DIMENSIONS FOR AIRBAG:

The airbag which we have designed in our project has completely different dimensions as compared to the one which is used in four wheeler vehicles. We have taken the dimensions of the airbag according to the two wheeler classic Royal Enfield model which we have designed by using Solidworks software. There isn't any particular dimension of airbag for two wheeler vehicle, so we read in one of the research paper titled as "Design and Analysis of Air Bag System in Two Wheeler Vehicle System by Mr. Urvish A. Mehta, Prof. Dr. D. M. Patel, that we have to take dimensions of airbag according to our two wheeler model, that is, we have to measure the distance between rider's face, neck and chest area and speedometer for getting the vertical height of the airbag, and we have to measure the width of an average person (we have considered average person's weight = 80kgs and average person's width = 500mm to 600mm and average person's height = 5 feet 8 inches) for getting the dimension of length of an airbag and lastly for getting the dimensions of width of an airbag, we have measured the dimensions of an airbag module, that is, the box or case in which airbag will be fitted. We have designed the airbag module which will be fixed in between the handlebars.

The dimensions which we have measured by taking the above mentioned criteria are:

1. Height of an airbag = 610mm.
2. Length of an airbag = 550mm.
3. Width of an airbag = 320mm.

The dimensions of an airbag will change according to the bike model in which it has to be fixed. These dimensions are solely for the classic Royal Enfield model which we have designed and considered in our project. These dimensions will differ in different two wheeler models.



DIMENSIONS OF AIRBAG

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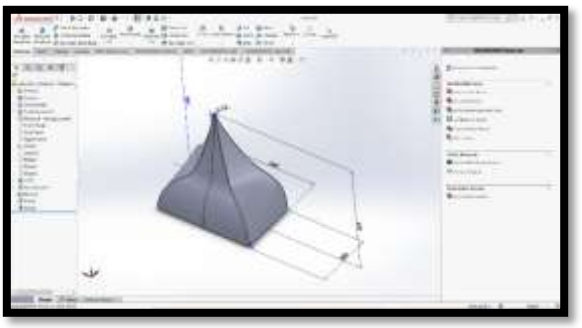
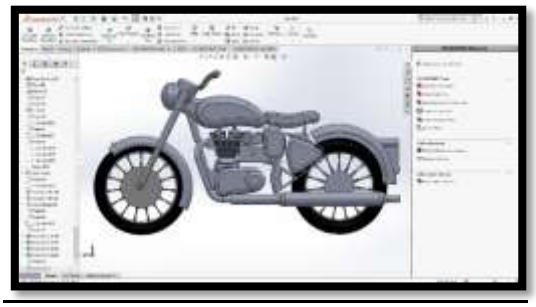


DIMENSIONS OF AIRBAG

IV. DESIGN OF A BIKE MODEL:

1. In an open sketch, click SketchPicture (Sketch toolbar) or click Tools > Sketch Tools > Sketch Picture.
2. In the dialog box, browse to the picture file and click Open.
3. When you insert a picture, the scale tool automatically displays. (The scale tool is a construction line with handles at each end. Use the scale tool to resize the picture).
4. You can also resize the picture in the graphics area by dragging its handles. You can drag the picture without changing its size when the pointer changes to.
5. To use the scale tool:
6. Place the left end of the scale tool at one end of the picture. Zoom to position the scale tool and picture as needed.
7. The pointer changes to Scale Tool Left Pointer.
8. Drag the right end of the scale tool to extend the length of the line. You can also drag the right end to rotate the picture.
9. The pointer changes to Scale Tool Right Pointer.
10. In the Modify dialog box for dimensions, enter a value for the desired measurement and click .
11. The picture and the scale tool resize together.
12. Clear Enable Scale Tool in the Property Manager to remove the construction line from the graphics area.
13. Continue to set properties in the Sketch Picture Property Manager and click.



BIKE MODEL DESIGNED

V. ATTACHING AIRBAG COMPONENTS:

1. We have attached the crash sensors in the front, back and both sides, they can sense the collision from any direction.
2. We have attached a box containing Airbag Control Unit below the seat in the vacant space available.
3. We have attached a Airbag Module near the front tank portion which will contain the airbag unit, inflator and lid.
4. Inflator and lid located inside the airbag module instantaneously emits nitrogen gas to fill the airbag when signaled by the ECU.

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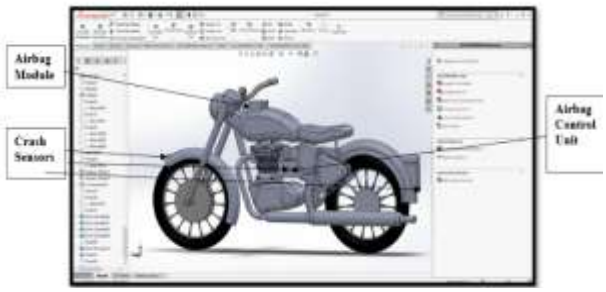


COMPONENTS ATTACHED TO BIKE MODEL

VI. CALCULATION:

Force of impact is the total force exerted on an object during a collision. To derive the impact force equation, you can consider the law of conservation of energy. At the beginning, a moving object possesses kinetic energy that reduces to zero after the collision (object stops). To fulfill the conservation law, the change of kinetic energy must be compensated by the work done by the impact force. We express it with the below impact force equation.

$$F = m * v^2 / (2 * d),$$

Where,
F is the average impact force,
m is the mass of an object,
v is the initial speed of an object,
d is the distance traveled during collision.
m= 90kgs (average person's weight).
v= 60km/hr = 16.667 m/s (average speed of bike).
d= 4cms= 0.04m (research paper).
$F=90*(16.667)^2 / (2 * 0.04)$.
F=312500 N.
F=312 KN.

VII. STRUCTURAL ANALYSIS:

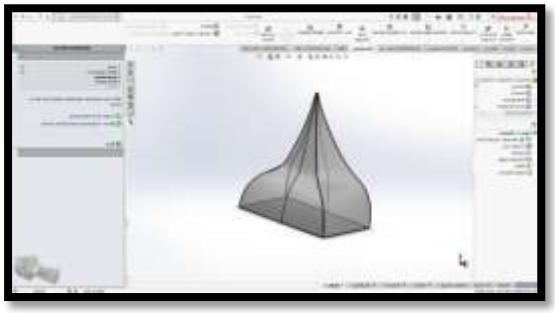
From the perspective of FEA software, each application of FEA requires three steps:
1) Pre-processing of the FEA model, which involves defining the model and then splitting it into finite elements.
2) Solving for desired result.
3) Post-processing for results analysis.

We will follow the above three steps in every exercise. From the perspective of FEA methodology, we can list the following FEA steps:

1. Building the mathematical model.
2. Building the finite element model by discretizing the mathematical model.
3. Solving the finite element model.
4. Analysing the results.

Step 1) Building the model

1. We have constructed the geometry of airbag as discussed in before.



BUILDING THE AIRBAG MODEL

Step 2) Applying the material:

1. We have applied Nylon 6/10 as discussed before.
2. The properties of nylon 6/10 are as follows:

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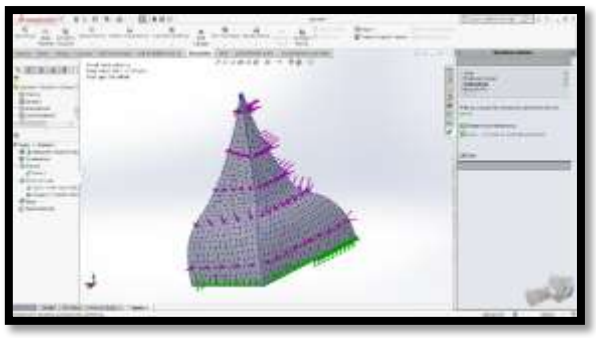
APPLYING MATERIAL TO AIRBAG MODEL

Step 3) Meshing:

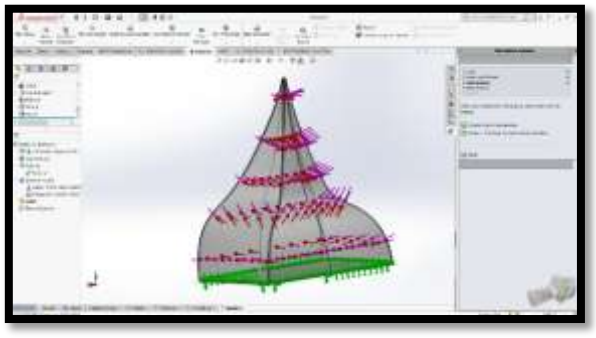
Beam elements are created by meshing curves (wire frame geometry). They are a natural choice for meshing weldments. Assumptions about the stress distribution in two directions of the beam cross section are made. A beam element does not have any physical dimensions in the directions normal to its length. It is possible to think of a beam element as a line with assigned beam cross section properties.Solid mesh (Beam mesh) which is programme generated. Fine Meshing is applied.



MESHING OF AIRBAG

Step 4) Application of forces:
Forces are applied as per our calculations:

1. Magnitude of impact force: 312500 N.
2. Magnitude of internal pressure: 34473 N/m2.



APPLICATION OF FORCES

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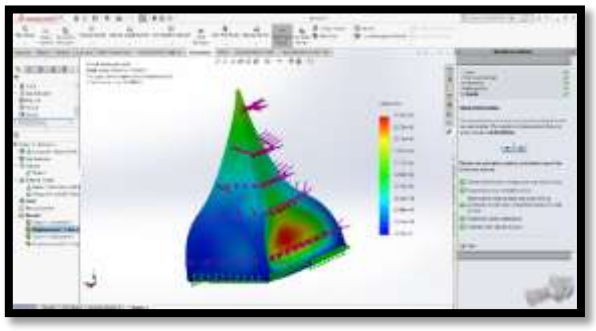
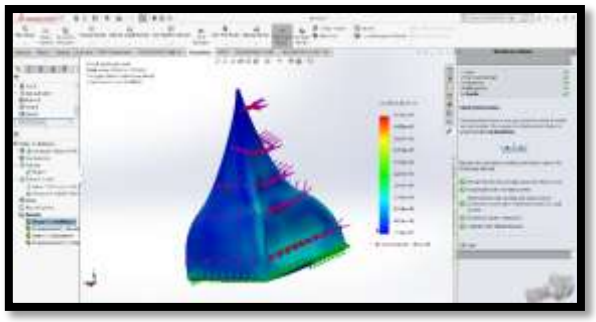
Result obtained:

1. Von mises Stress Obtained: 139 MPa.
2. Displacement Obtained: 0.252403m.



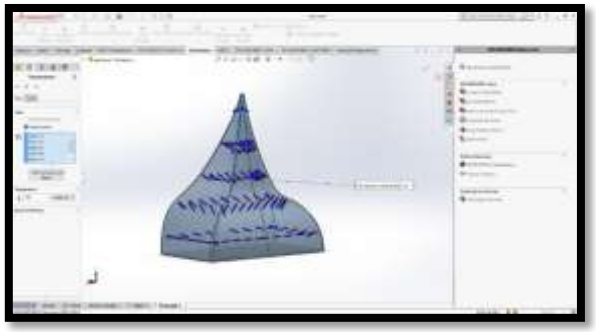
DISPLACEMENT RESULT OBTAINED



VON MISES STRESS RESLUT OBTAINED

VIII. THERMAL ANALYSIS:

1. Temperature inside the airbag is considered: 353K (Temperature of gases inside airbag when it is fully inflated = 353K/80 °C).
2. Uniform temperature variation is applied on the inner surface of airbag.
3. Fixtures are added to the bottom surface of airbag.



TEMPERATURE APPLIED TO AIRBAG

Result Obtained:

1. The above figure shows the temperature distribution of airbag.

2. Blue color shows that temperature variations are within the same limits.

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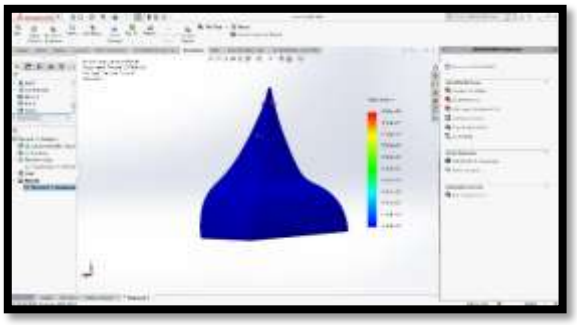

TEMPERATURE RESULT OBTAINED

IX. OUTCOME OF ANALYSIS:

1. The outcome of our analysis is that the displacement obtained from the structural analysis is within the safe limits and airbag will try save the driver from the head injury by proper deployment within the time range and without causing any injury due to airbag.
2. The outcome of thermal analysis is that when airbag is fully inflated the temperature of the inside gases is 353K and when it is uniformly distributed over the airbag the temperature distribution is within safe limits.
3. The yield stress is safe for nylon and it will not cause any distortion to fabric material.
4. The thermal stresses are less and they will not cause any distortion to fabric material.

X. CONCLUSION:

Our research paper shows that installing airbags in two wheeler vehicle will give major safety to the rider and reduce the fatality rate by1-2% which is approximately 5-6 thousand people per year. Our research also proves that airbag dimensions will vary according to the two wheeler model and more than one air bag can also be installed on the bike according to the requirements. Our analysis shows the amount of stress, pressure, force and temperature that will act on an airbag at the time of impact which clearly concludes that an airbag should be fixed right from the bottom to the bike. This system should be installed in two wheeler and should be bought in practical sense.

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