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# Finite Element Analysis of Seat Belt Buckle Assembly

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**Abstract -** Seat belts are most important component of a Car assembly. This component is designed to prevent passenger movement towards the dashboard if there is any accident. So it is very important to study the concepts and important terminology related to the seat belt assembly .In the present paper the aim is to construct a specific seat belt buckle assembly using modeling software. An attempt is made to analyze the seat belt buckle assembly for Total Deformation and Von Mises Stress using finite element analysis. Also to study the effect of various parameters a parametric analysis is carried out for seat belt buckle assembly by varying the thickness and load. The obtained results are tabulated for comparison. From the comparison table it is found that thickness decreases the total deformation and stress levels increases the maximum deformation is 0.00125 mm which is negligible. The ultimate strength of the buckle is 300 Mpa but the maximum stress levels achieved are 25 Mpa to 35 Mpa which is negligible.

***Key Words***: **Total Deformation, Von Mises Stress, finite element analysis**

## 1. INTRODUCTION

A safety belt is a vehicle wellbeing gadget intended to secure the person of a vehicle against hurtful development that may come during a crash or a sudden stop. A safety belt capacities to decrease the probability of death or genuine damage in a car accident by reducing the force of secondary impacts with interior strike dangers, by keeping person situated accurately for most extreme of the airbag (if prepared) and by keeping person being ejected from the vehicle in a crash or if the vehicle rolls over[1]. A 2-point belt joins at its two endpoints, and was invented in the mid1900s by Jack Swearingen of Louisville, Kentucky [1]. A lap belt is a tie that goes over the waist. This was the most generally introduced type of belt before enactment requiring 3-point belts, and is basically found in older cars [1]. A "sash" or shoulder saddle is a strap that goes diagonally over the vehicle occupant's detachable shoulder and is buckled inboard of his or her lap. The shoulder harness may attach to the lap belt tongue, or it might have a tongue and buckle totally isolate from those of the lap belt [1].In the present study we have considered to construct a specific seat belt buckle assembly using modeling software. To analyze seat belt buckle assembly for Total Deformation and Von Mises Stress using FEA. To study the effect of various parameters a parametric analysis is carried out for seat belt buckle assembly by varying the thickness

## 2. METHODOLOGY

Based on the dimensions selection of steel material sections after collecting of all details .CAD geometry generated using solid edge software. The geometry is exported in the form of neutral file from solid corner software. After the meshing the elements are checked for the following element quality. After Discretization, boundary and loading conditions are applied on the structure and the analysis is conducted for three loading conditions.

In this analysis 5 cases are considered to analyze the seat buckle i.e.

Case1: 8 mm Thickness Notch – Loading conditions are 63.5 N, 100 N, 200N, 250N, and 350N.

Case 2: 7 mm Thickness Notch – Loading conditions are 63.5 N, 100 N, 200N, 250N, 300N and 350N.

Case 3: 6 mm Thickness Notch – Loading conditions are 63.5 N, 100 N, 200N, 250N, 300N and 350N.

Case 4: 5 mm Thickness Notch – Loading conditions are 63.5 N, 100 N, 200N, 250N, 300N and 350N.

Case 5: 4 mm Thickness Notch – Loading conditions are 63.5 N, 100 N, 200N, 250N, 300N and 350N.

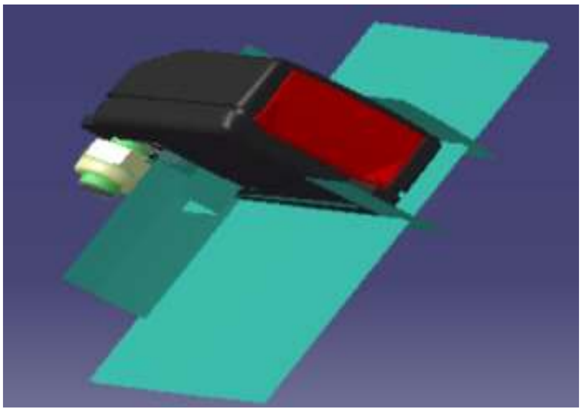

Fig. 1: 3D Model of Seat Belt

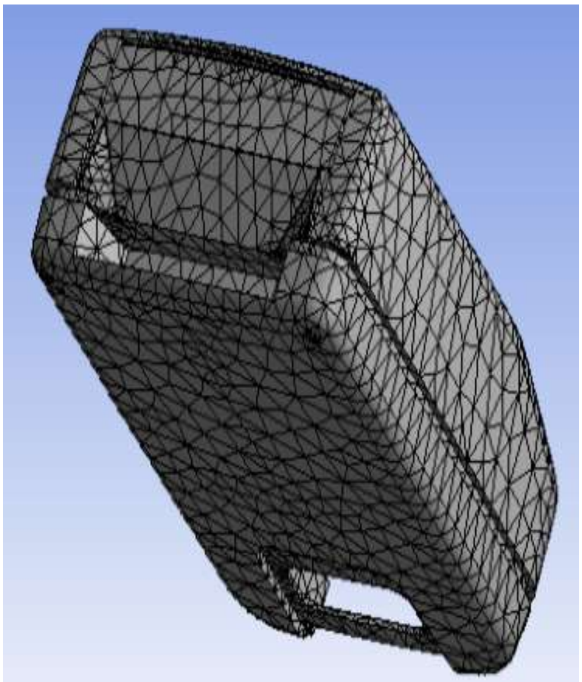

Fig. 2: 3D Mesh of Seat Buckle

## 3. RESULTS AND DISCUSSION

In the present analysis for 5 cases Total Deformation and Von Misses Stress tabulated and then comparison is made how the deformation and stresses are varying.

For 8 mm thickness notch and for 63.5 N and 100 N load the total deformation and stress is as shown below.

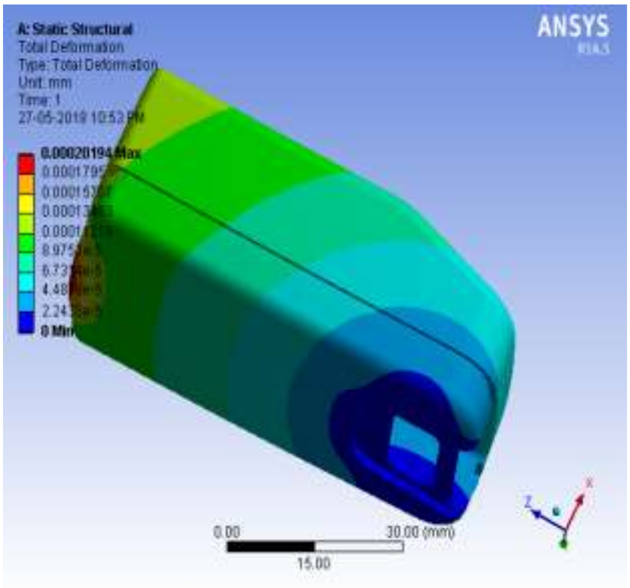


Fig.3: Total Deformation for Case 1 and for load 63.5 N.

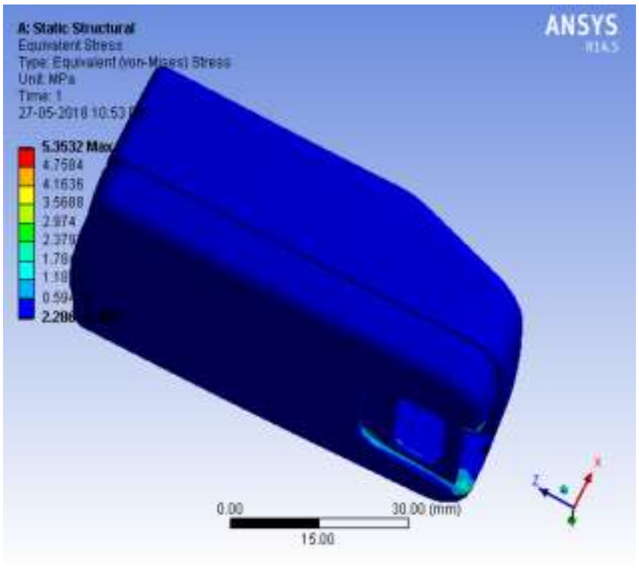


Fig. 4: Von Misses Stress for Case 1 and for load 63.5 N.

In the above Figure no 3 and 4 shows the results of Total Deformation and Von-Misses Stress developed in buckle assembly. The maximum Total Deformation is 0.00020194 and maximum Von-Misses Stresses developed is 5.3532 for a load of 63.5N.

Table 1: Total Deformation for all the cases

| Thickness | 63.5N | 100N | 200N | 250N | 350N |
|---|---|---|---|---|---|
| 8 mm | 0.0002 | 0.0003 | 0.0006 | 0.0007 | 0.0009 |
| 7 mm | 0.00022 | 0.00034 | 0.0006 | 0.0008 | 0.0011 |
| 6 mm | 0.00025 | 0.00038 | 0.00064 | 0.00085 | 0.00112 |
| 5 mm | 0.00028 | 0.00041 | 0.0007 | 0.00080 | 0.00120 |
| 4 mm | 0.00031 | 0.00043 | 0.00076 | 0.0009 | 0.00125 |

Table 1: Von Misses Stress for all the cases

| Thickness | 63.5N | 100N | 200N | 250N | 350N |
|---|---|---|---|---|---|
| 8 mm | 5.35 | 8.43 | 16.86 | 21.07 | 25.29 |
| 7 mm | 5.90 | 9.27 | 17.71 | 21.91 | 30.34 |
| 6 mm | 6.74 | 10.12 | 18.55 | 22.70 | 31.92 |
| 5 mm | 7.58 | 10.95 | 19.4 | 23.60 | 32.035 |
| 4 mm | 8.261 | 11.80 | 20.23 | 24.44 | 32.87 |

## 4. CONCLUSION

The seat buckle of the car plays a major role in safety of the passenger. The manufacturing cost of any seat buckle is important to reduce the material invested in the product keeping the stress and deformation levels under control. Here in this project an attempt is made to analyze the buckle by varying notch thickness from 8mm to 4mm as per the choice of plate thickness. The study shows that as the thickness decreases the total deformation and stress levels increases the maximum deformation is 0.00125mm which is negligible. The ultimate strength of the buckle is 300mpa but the maximum stress levels achieved are 25mpa to 35mpa which is negligible. Hence the study depicts that the optimum design of the buckle can be achieved at lower thickness and hence the material wastage can be reduced.

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