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Design and Fabrication of Seat Belt Assisted Hand Brake Lever

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Abstract: *In India, 15 to 30 percent accident are occurs while driving cars, due to not wearing a seat belt. By wearing seat belt 45% of risk of death or life losses can be avoided and 50% risk of serious injury can be avoided. In this project we have designed the mechanism which is used to operate hand brake using seat belt assist. Means if we wear the seat belt then only handbrake is released otherwise handbrake is remain operated. Here we have use limit switch, when we press the limit switch then it sends it output to microcontroller. Where we have relay which is operated through battery. We have use two relays which allow clockwise and anticlockwise rotation of wiper motor which activates or release brake.*

Keywords: Seat Belt Assist Handbrake, Limit Switch, Wiper Motor, Microcontroller, etc.

I. INTRODUCTION

As we know the main function of brake is to decelerate or to stop the vehicle. Hand brake is used when we park the car, it is also called parking brake, this mechanism is used to keep the vehicle securely motionless when parked. There is a need of project due to some following reasons:

1. Save Lives: - Among drivers and front seat passengers seat belt reduces the risk of death by 45% and cut the risk of serious injury by 50%.
2. Prevent Injuries: - Wearing a seat belt can reduce the severity or reduce risk of type of injury such as
   a. Head injuries
   b. Spinal cord injuries
   c. Broken bones/ fractures
3. Keep passenger from projection: - Means if we wearing the seat belt helps passenger stay in place when inertia in inevitable
4. Airbags can't work alone: - The forces on airbags can seriously injury or even kill you if you are not wearing seat belt.
5. "You will avoid traffic ticket" you wear seat belt

Seat belt keeps us sage from injuries and projection during curve road. In this project we are going to design a seat belt assisted hand brake lever. It is efficient system with low cost. The main purpose of system is driver's safety and reduction of manual effort.

II. COMPONENTS & MATERIAL SELECTION

The major components that are employed in the fabrication of the Seat belt assisted Hand break lever system are as follows.

- Motor
- Control unit
- Wheel arrangement
- Frame
- Seat belt assist
- Braking system
- IR sensor/Limit switch

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III. MATERIAL SELECTION

Mild Steel

Material selection for the supporting member and frame is mild steel. Mild steel materials have good strength compare to the other and also easily available in market.

It is also having advantages like:

- Low cost
- Min Rupee 34/kg
- Weldable
- Ductile
- Recyclable

Allowable bending stress = Tensile yield strength / factor of safety
Where Syt = yield stress = 210 MPa = 210 N/mm²
Where factor of safety = 2
So σall= 210/2 = 105 MPa = 105 N/mm²

IV. DESIGN CONSIDERATION AND CALCULATIONS

Base Frame Design

In our working prototype to support the wheel, we required to design the frame.

So, we choose L shaped frame having dimensions 25*25*3. As it is easily available in market.

Also, for L-shaped we require to use electrical welding but if we use hollow rectangular section we need to use gas welding.

As we know mild steel having high weight so using L-shaped frame over hollow rectangular section frame reduces the weight of prototype.

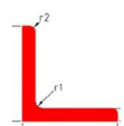


Figure: L-angle Bar Dimensions

- $\frac{M}{I}=\frac{\sigma b}{y}$ ……………………..(1)
- Bending moment(M)=force *perpendicular distance
- M=4*450*9.8
- Bending moment(M)=17640 Nmm
- I=$\frac{(b(d^3))}{12}$
- I=$\frac{(25(25^3))}{12}$
- I=32552.08mm^4
- Y=$\frac{25}{2}$
- Y=12.50
- Using above value of Y in eq (1)
- $\frac{17640}{32552.08}=\frac{\sigma b}{12.5}$
- Therefore,
- σ_b=6.77 Nmm
- 6.77<105
- Hence design is safe.

V. BEARING SELECTION

- Bearing is nothing but mechanical element which locates two machine parts relative to each other and permits a relative motion between them.
- It is required to provide end support to shaft.
- Here we are using rolling contact bearing.
- We are using bearing of designation 6202 in which –
- 6 denotes single row deep groove ball bearing
- 2 denotes light series
- 2 indicates bore diameter of 15mm.

Table: Bearing Table from Design Data Book

Shaft and housing diameters
Deep groove ball bearings
6200 series

Bearing	bearing bore diameter (mm)	shaft diameter (in.) max.	min.	bearing outside diameter (mm)	housing diameter (in.) max.	min.
6200	10	0.3939	0.3936	30	1.1816	1.1811
6201	12	0.4726	0.4723	32	1.2604	1.2598
6202	15	0.5908	0.5905	35	1.3786	1.3780
6203	17	0.6695	0.6692	40	1.5754	1.5748
6204	20	0.7878	0.7875	47	1.8510	1.8504
6205	25	0.9847	0.9844	52	2.0479	2.0472
6206	30	1.1815	1.1812	62	2.4416	2.4409
6207	35	1.3785	1.3781	72	2.8353	2.8346
6208	40	1.5753	1.5749	80	3.1503	3.1496
6209	45	1.7722	1.7718	85	3.3474	3.3465
6210	50	1.9690	1.9686	90	3.5442	3.5433
6211	55	2.1660	2.1655	100	3.9379	3.9370
6212	60	2.3628	2.3623	110	4.3316	4.3307
6213	65	2.5597	2.5592	120	4.7253	4.7244
6214	70	2.7565	2.7560	125	4.9223	4.9213

VI. DESIGN OF SHAFT

- $\frac{M}{I} = \frac{\sigma b}{y}$ **…………………….(1)**
- Bending moment=force*perpendicular distance
- $I = \frac{\pi}{64} * d^4$
- Bending moment=4*9.81*450/2=8829Nmm
- For diameter 15mm,
- $I = \frac{\pi}{64} * d^4$
- $I = \frac{\pi}{64} * 15^{4=2485.7}$
- Therefore,
- $\frac{8829}{2485.7} = \frac{\sigma b}{7.5}$
- σ_b=8.87*7.5=26.63Nmm
- 26.63Nmm <105 Nmm
- Therefore, design is safe.

Motor Selection

- Consider weight applied by the human=2kg
- So, the force applied is equal to = 2x9.81 newton.
- F= 19.62 N
- Hence, the torque required = 19.62x 600 = 11772 N-mm=11.77N-m
- So, we have considered the 12v 11Amp wiper motor which has 19 N-m torques.

VII. CATIA PART MODEL

Seat Belt Assist

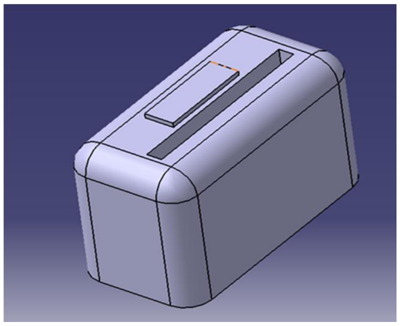


Figure: Seat Belt Assist

Motor

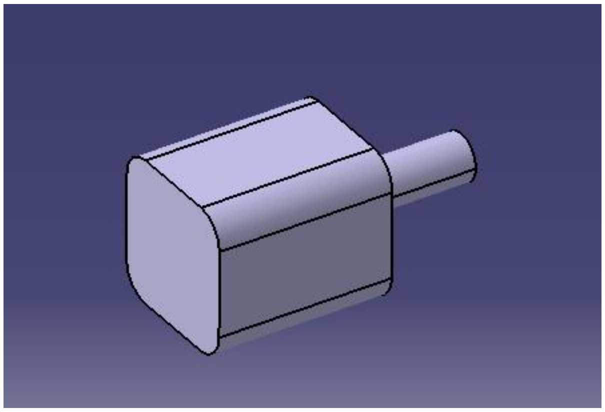


Figure: Motor

Wheel:

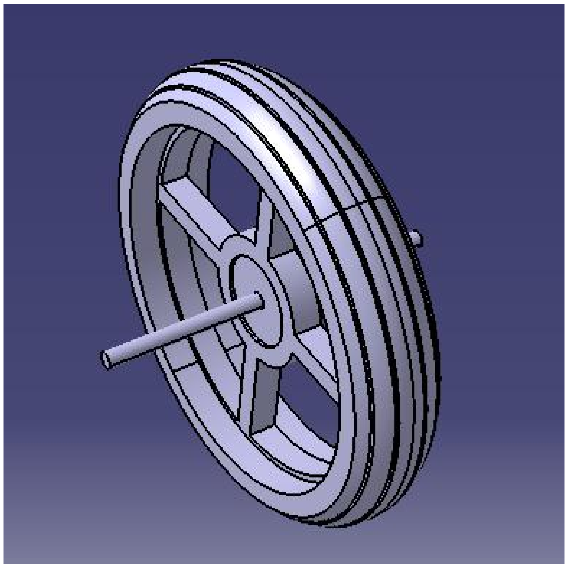


Figure: Wheel

Shaft:

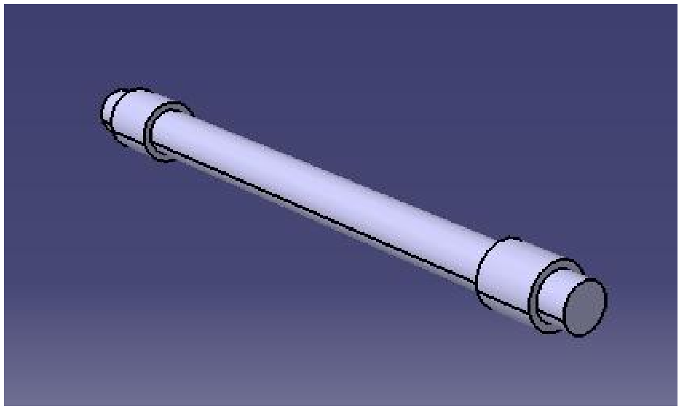


Figure: Shaft

VIII. ASSEMBLED MODEL

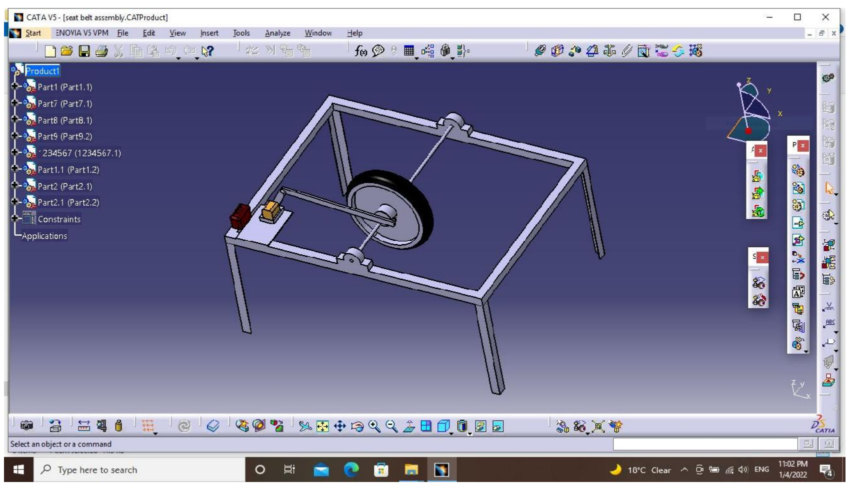
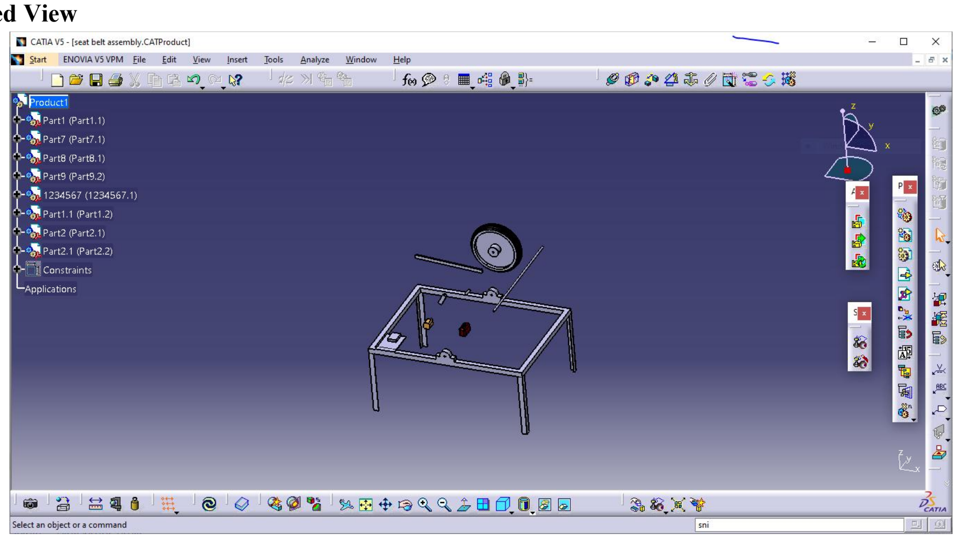


Figure: Catia Assembly

Exploded View



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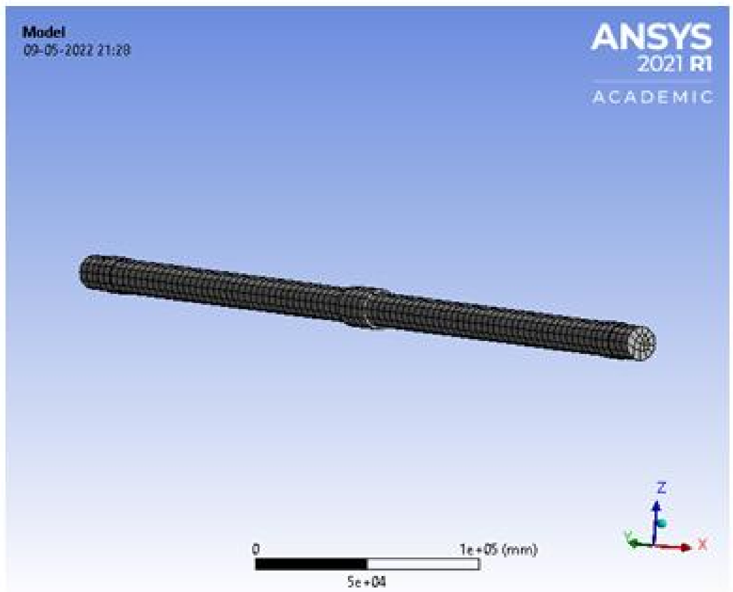

We have done the analysis of shaft as it is the weaker part in our prototype.
Steps to be follow during analysis of shaft:
For structural analysis of shaft, we have used ansys workbench 2021 R

- Step1 – We have imported CAD model in ansys workbench.
- Step 2 – We have assigned mild steel properties to the shaft
- Step 3 - We have performed meshing operation on shaft
- Step 4 – We have applied fixed support at the end of shaft

IX. ANALYSIS REPORT

Units

Unit System	Metric Radians rad/s Celsius
Angle	Radians
Rotational Velocity	rad/s
Temperature	Celsius

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Mesh

Objects Name	*Body Sizing's*	*Multi Zone*
Geometry	1 Body	
Types	Element Size	
Element Size	5000.0 in mm	
Method		Multi Zone
Mapped Mesh method		Hexa mesh

Force

X Component	0. N
Y Component	0. N
Z Component	30. N

Stress

	Minimum In MPA	Maximums In MPA	Average In MPA
1.	2.0641e-010	5.2744e-006	9.1486e-007

Deformation

	Minimum In mm	Maximum In mm	Average In mm
1.	0.	1.9556e-005	8.8879e-006

STRAIN

Minimum IN [mm/mm]	Maximum IN[mm/mm]	Average IN [mm/mm]
2.8492e-015	2.6377e-011	4.74e-012

Material

Mild steel

Density = 7.87e-009 tonne mm^-3

Coefficient of Thermal Expansion = 1.2e-005 C^-1

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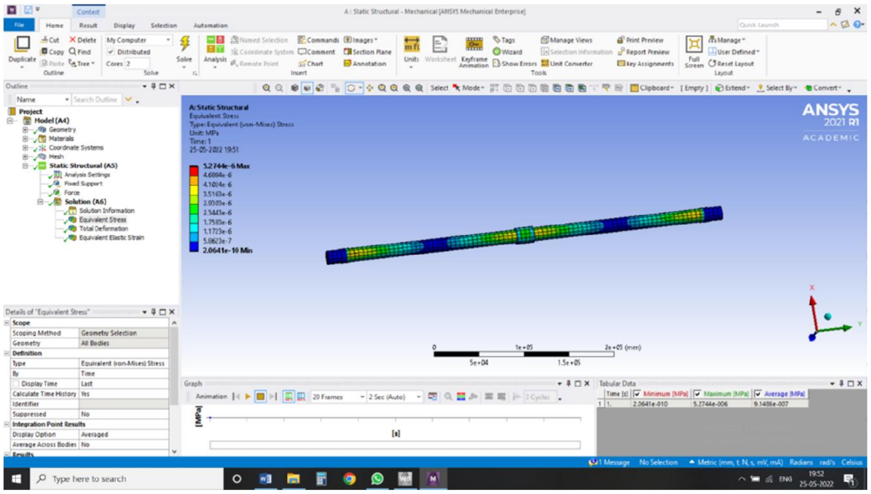
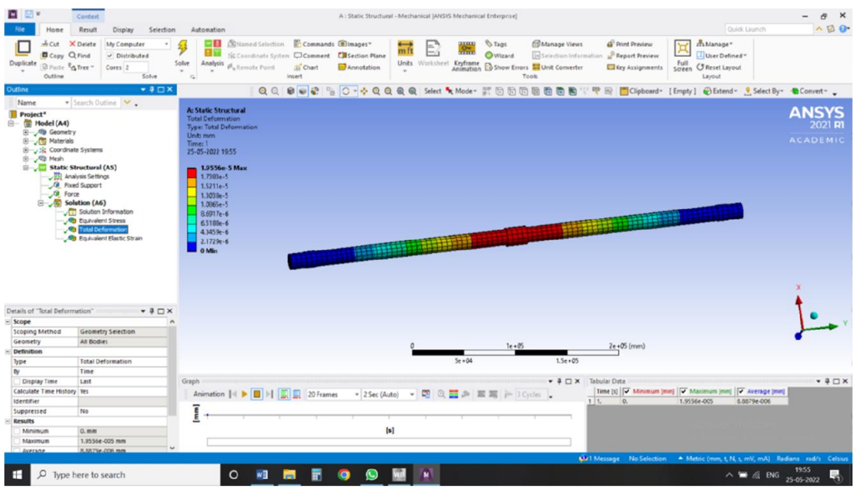
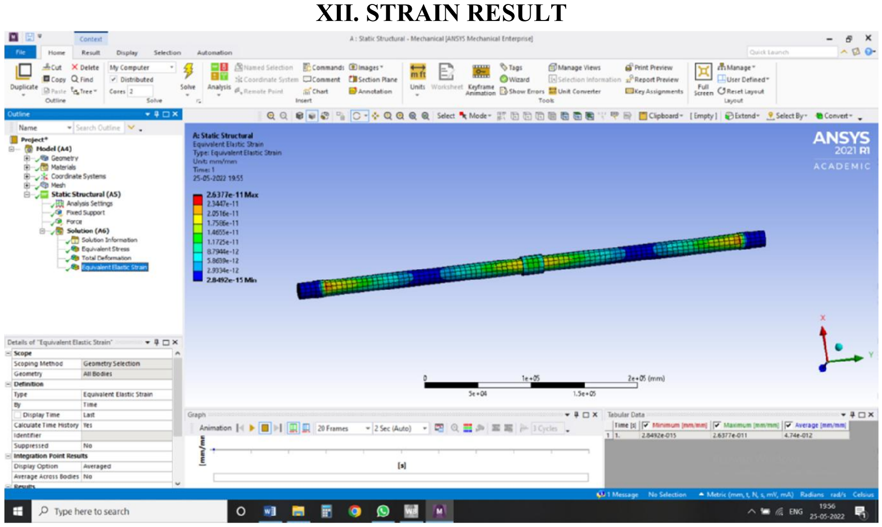
X. STRESS RESULT



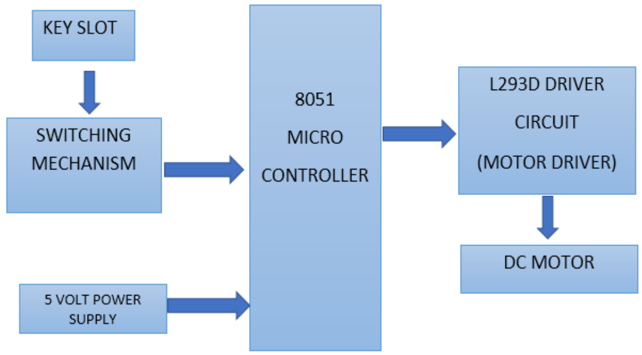
XI. DEFORMATION RESULT



XII. STRAIN RESULT

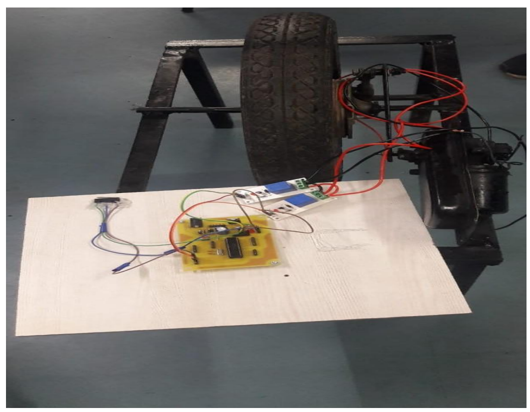


XIII. CONTROL UNIT



AUTOMATIC HAND BRAKE RELEASE ELECTRONIC CONTROL UNIT (ECU)

XIV. FINAL PROTOTYPE



XV. CONCLUSION

We successfully completed literature survey on the project and finalized the problem statement and objective of our project. Then we completed the CAD part model of project using CATIA V5R21 software. We have also completed the analysis part and the manufacturing part then we have completed the coding part and embedded it in atmega328 microcontroller and conclude with final working prototype.

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