MAJOR PROJECT PRESENTATION

ON

DESIGN AND STRUCTURAL ANALYSIS OF LEAF SPRING

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(AUTONOMOUS)

CONTENTS

OBJECTIVE

- The objective is to reduce cost, weight that is capable of carrying given static external forces without failure.
- In this project we will be replacing steel leaf spring by composite material of Glass Epoxy and analyze it with same loading condition for stresses and deflection.

ABSTRACT

Leaf spring is a simple form of suspension spring used to absorb vibrations induced during the motion of a vehicle. The automobile industry has shown increased interest in the replacement of steel leaf spring (AISI 5160) with composite leaf spring (E-glass/Epoxy) due to high strength to weight ratio, higher stiffness, high impact energy absorption and lesser stresses. This research is aimed to investigate the suitability of natural and synthetic fiber reinforced hybrid composite material in automobile leaf spring application. By using natural fibers efforts have been made to reduce the cost and weight of leaf spring. And this work an attempt is made to develop a natural and synthetic fiber enforced hybrid composite material with optimum properties so that it can replace the existing synthetic fiber reinforced composite material and automobile leaf spring.

Jute and E-glass woven roving mats are used as reinforcements and epoxy resin LY556 is used as the matrix material. The CAD models of Leaf spring are prepared in CATIA V5 and imported in static structural analysis work bench of Ansys 14.5 where ignite element analysis (FEA) is performed. The design constraints are stresses and deflections. This study gives a comparative analysis between steel leaf spring and Jute/E glass reinforced Epoxy leaf spring. The hybrid composite leaf spring is found to have lesser weight, lesser cost, lesser stresses and higher stiffness.

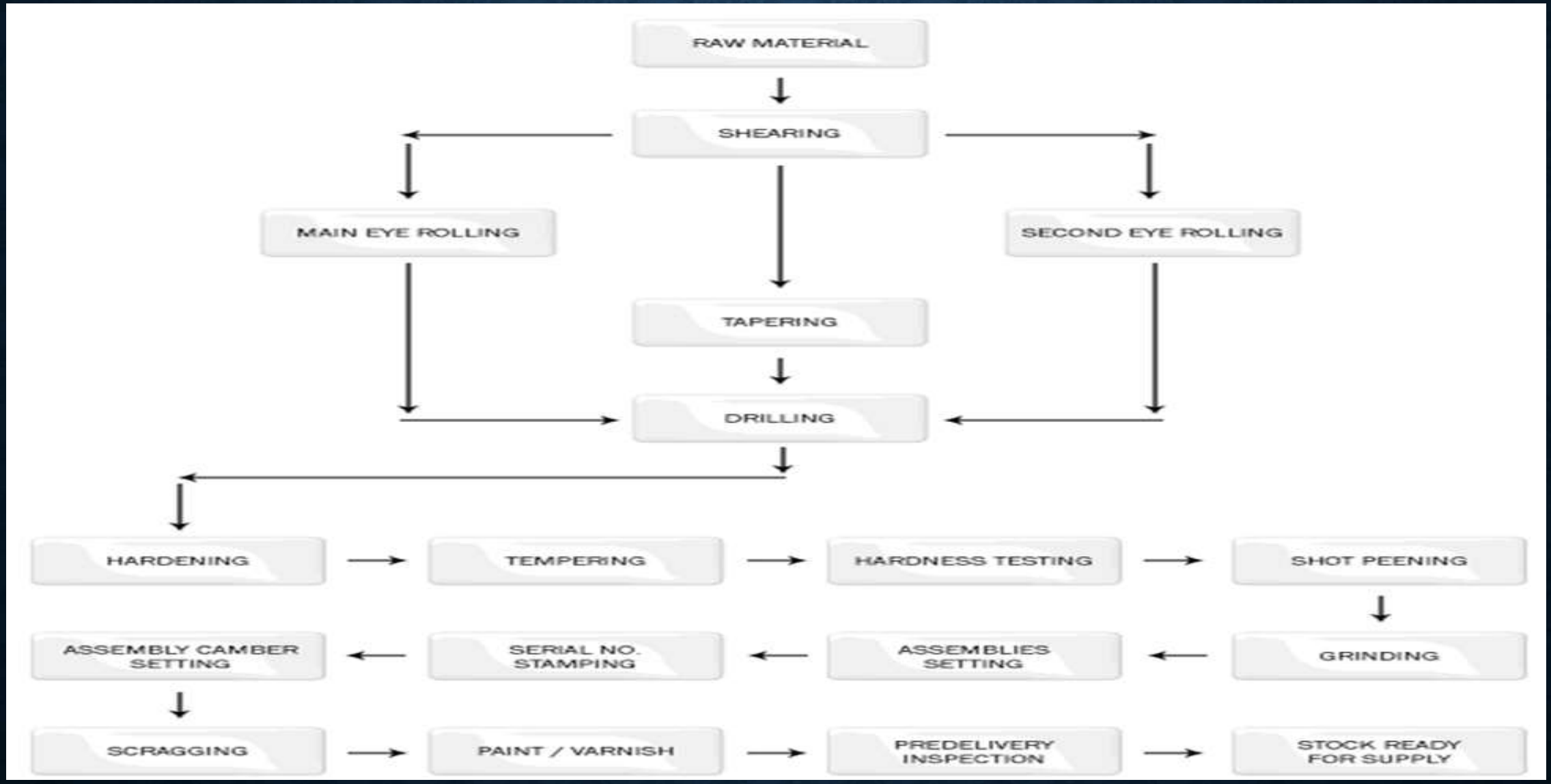
INVENTION OF LEAF SPRING

- Leaf spring was invented by Obadiah Elliot of London in 18th century.
- He simply piled one steel plate on top of another, pinned them together and shackled each end to a carriage, it was the first ever leaf spring used on a vehicle.
- Originally called as laminated or carriage spring,and sometimes referred to as a semi-elliptical spring or cart spring.
- The leaf spring is named after the leaf because it is very similar to adding many leafs on top of each other.

- A Leaf spring is a simple type of suspension spring commonly used in heavy duty vehicles.
- The advantages of leaf spring over helical spring is that the ends of the spring be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing device.

FUNCTION OF LEAF SPRING

- The main function of leaf springs is to provide comfort to the passengers by minimizing the vertical vibration caused by the nonuniformity of road geometry.

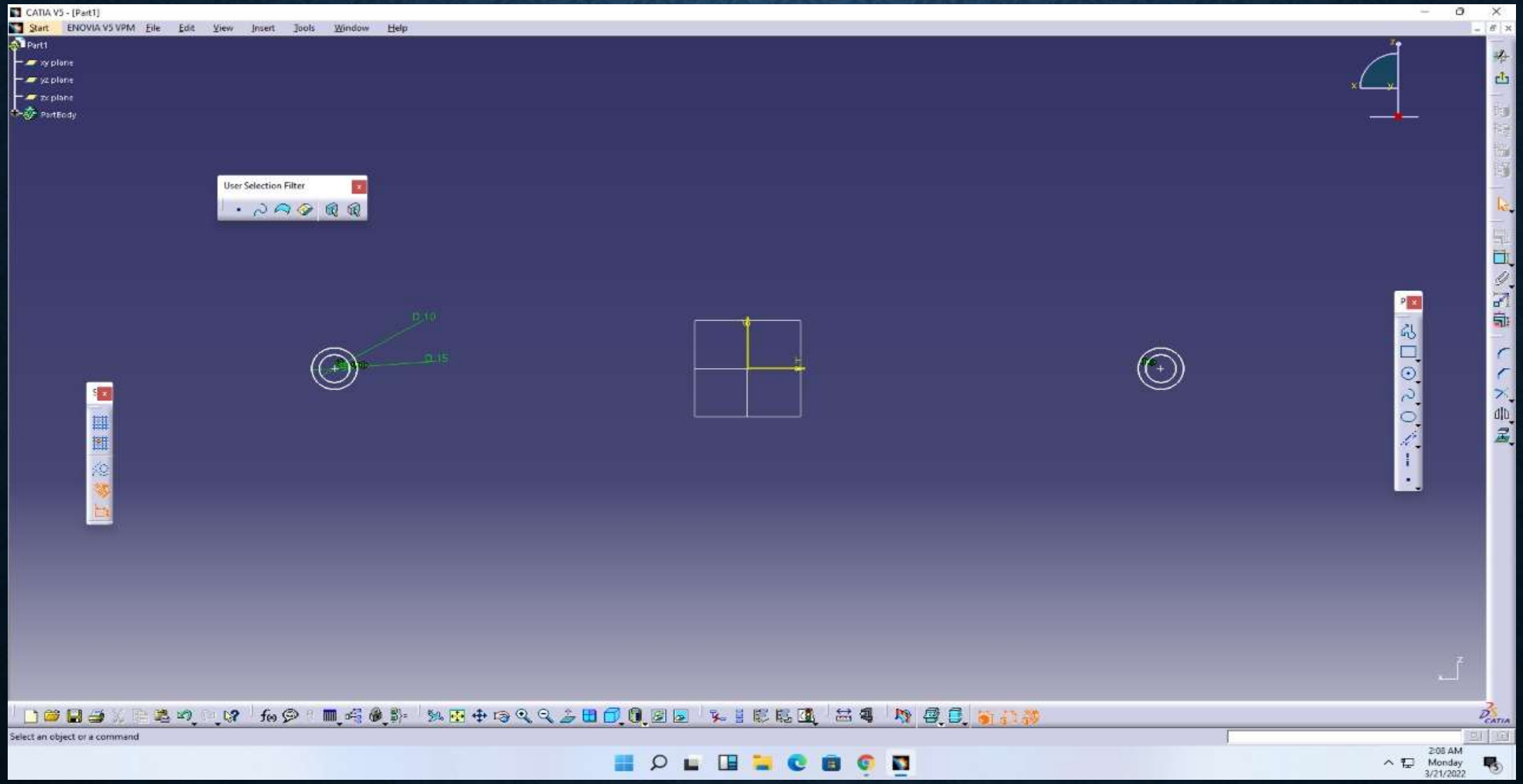


Flow chart Manufacturing Process of Leaf Spring

METHODOLOGY

- Present work is related to the comparative study of “55 Si 7 steel and composite leaf spring” Component details.
- The component details is studied and prepared 3-D model in CATIA V5 software.
- The component is studied for the operation required to convey the different types of loads on it. Design the component in the required shape and dimensions and analyzed.
- Design calculations are carried for the component leaf spring with the help of material properties which are specified by the previous research.
- Analysis work is carried by importing 3-D model into Ansys software. A FEM model of leaf spring, only one leaf is created by using Ansys processor. The material properties loads and boundary conditions are also specified in the Ansys Processor.
- Analysis work is done by applying loads on the leaf spring then the results such as stress, strain, total deformation are obtained.
- The results are compared with material properties of the material used for the component. Then we find that results obtained by using FEM are within the material properties. There we find that the component can withstand for given loads during operation.

DESIGN PROCEDURE



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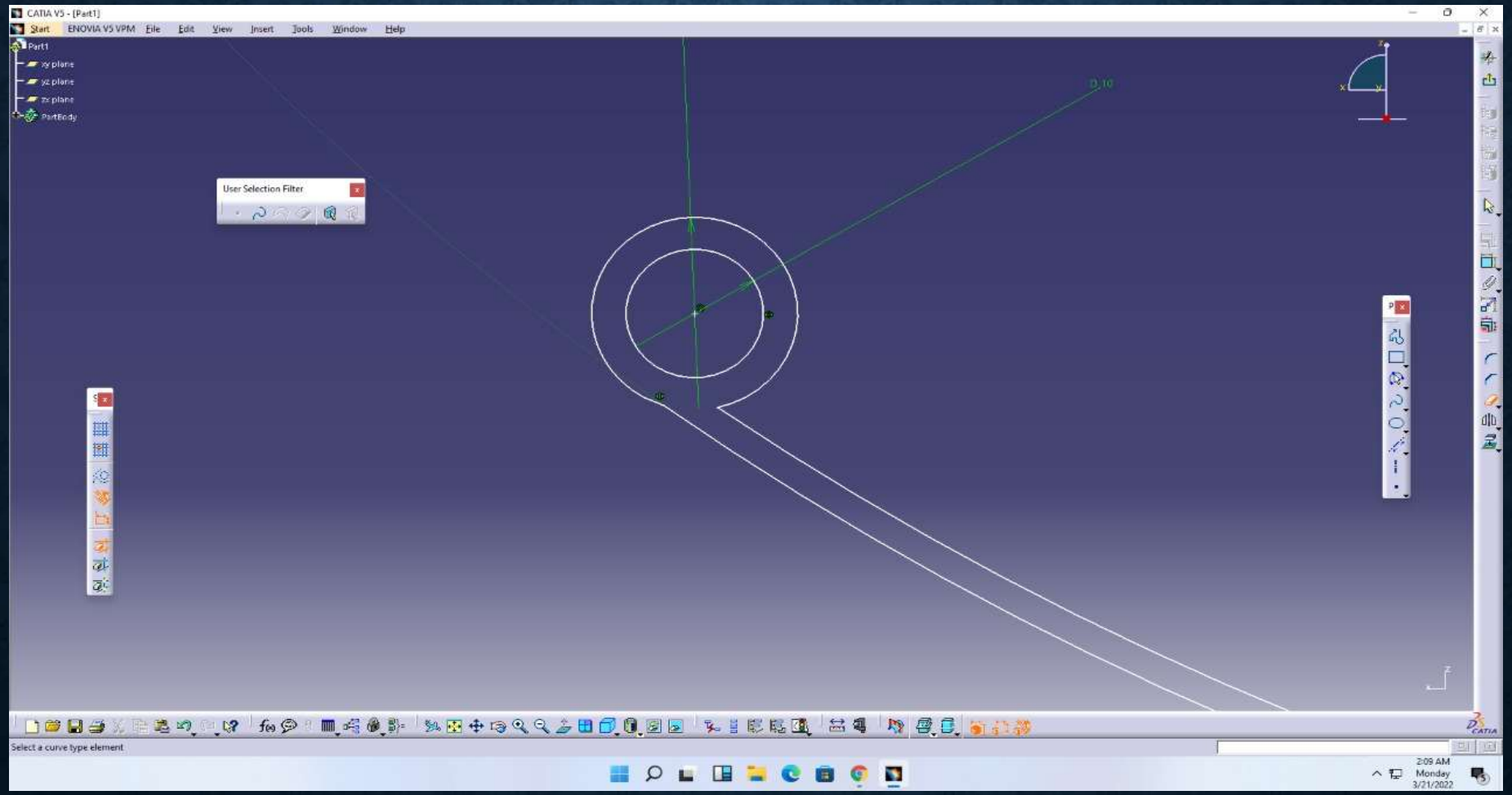
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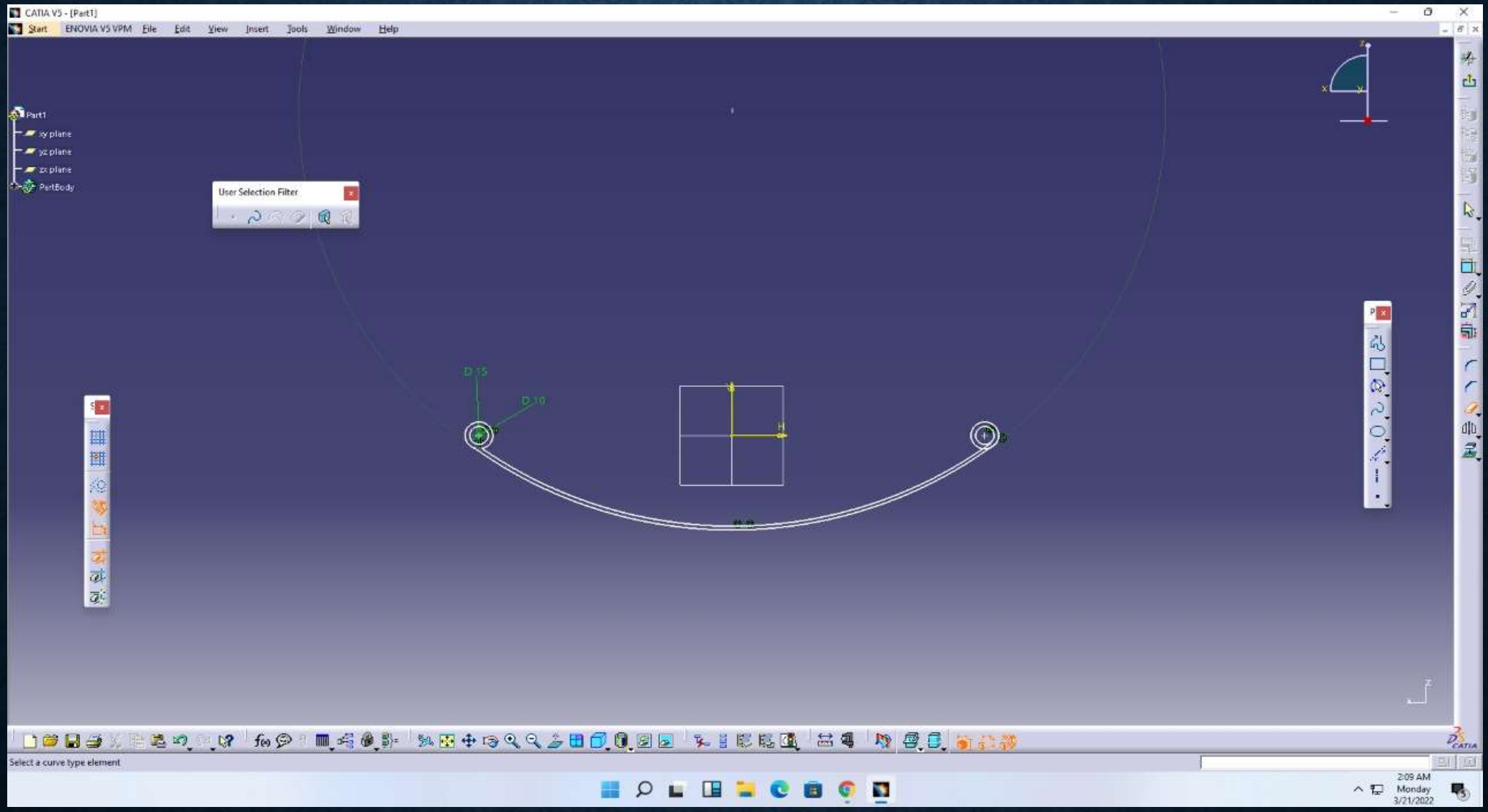
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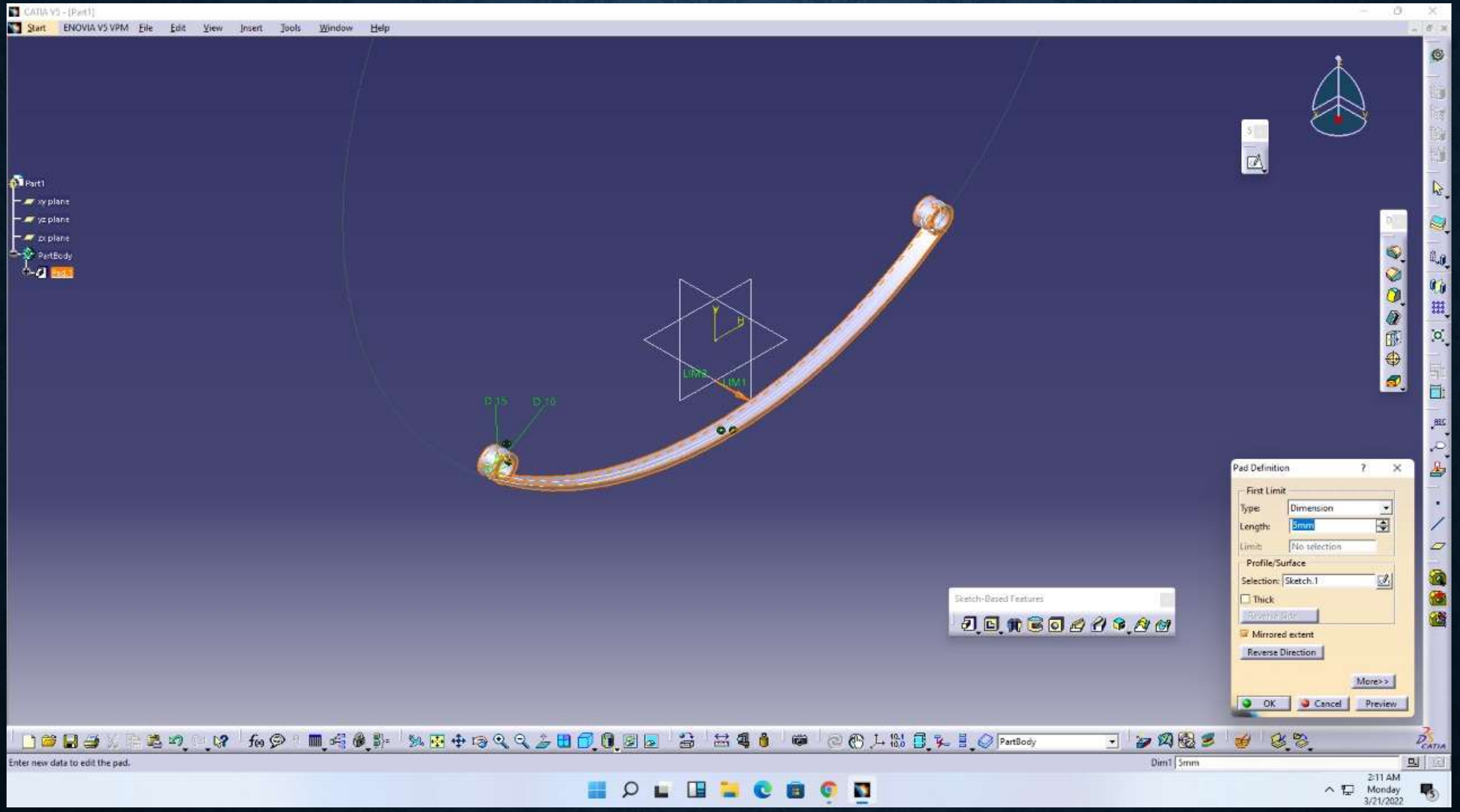
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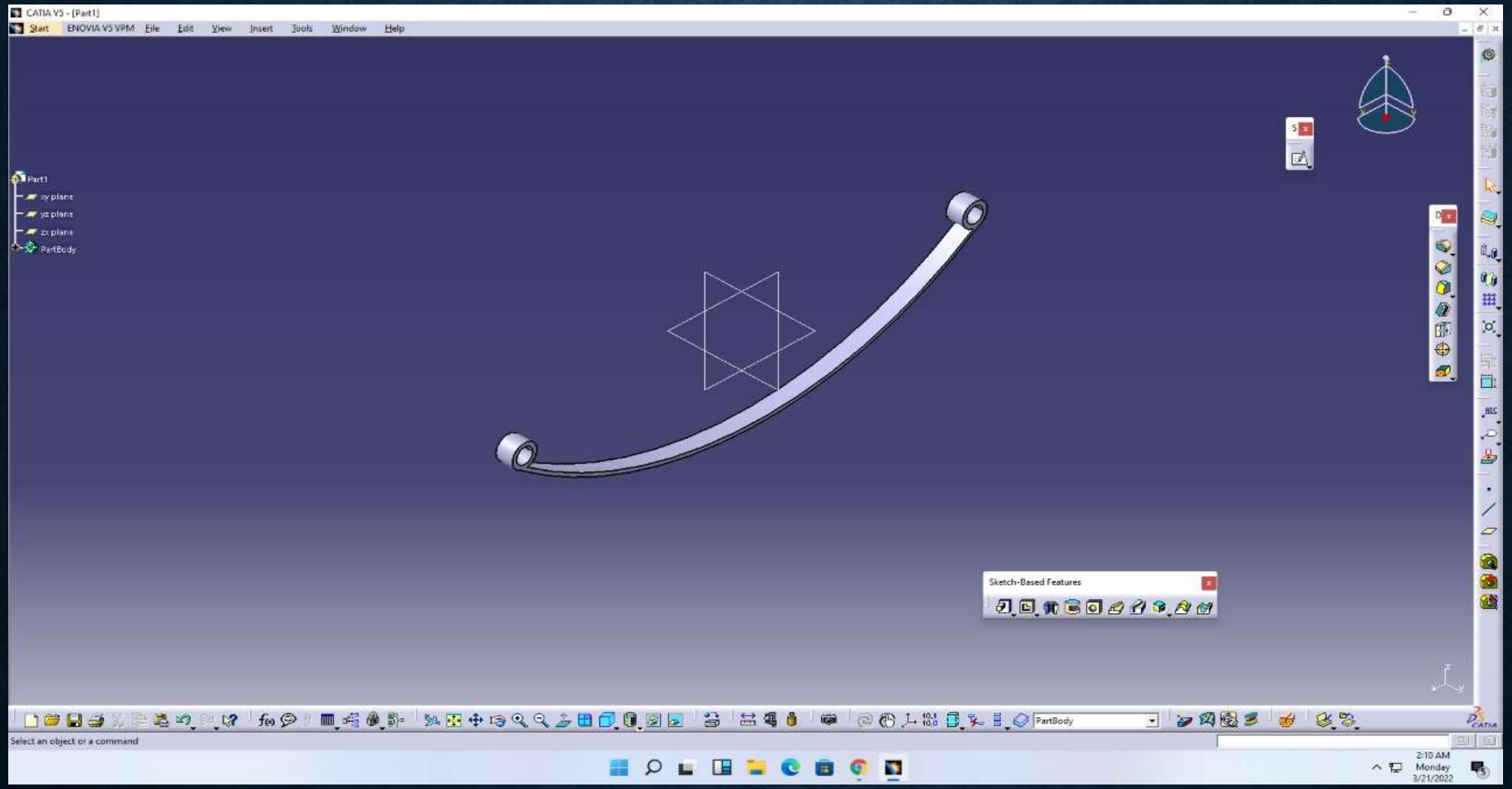
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. THE CAD MODELS OF LEAF SPRING ARE PREPARED IN CATIA V5 AND IMPORTED IN STATIC STRUCTURAL ANALYSIS WORK BENCH OF ANSYS 14.5 WHERE ELEMENT ANALYSIS IS PERFORMED. THE DESIGN CONSTRAINTS ARE STRESSES AND DEFLECTIONS

ANSYS INTRODUCTION

- About ANSYS

- Historically, finite element modelling tools were only capable of solving the simplest engineering problems which tended to reduce the problem to a manageable size and scope. These early FEA tools could generally solve steady-state, linear problems in two dimensions. The factors that forced these simplifications were the lack of efficient computational techniques and the computing power to model more complex real-life problems.

The ANSYS philosophy can be summarized as one that aims to simulate a complete real-life engineering problem. The simulation usually begins by using a three dimensional CAD model to construct a finite element mesh followed by imposing loads and boundary conditions and then computing the solution to the finite element problem.

- There are two types of materials employed in this study:
- 1. Steel
- 2. Jute/E-Glass/Epoxy
- 55Si7 is the most popular grade of spring steel being used in automobile leaf spring.

CHEMICAL COMPOSITION

GRADE	C	Si	Mn	S	P	Cr	V
55 Si7	0.55-0.6	1.50-1.80	0.70.1.00	0.045 Max	0.045 Max	-	-

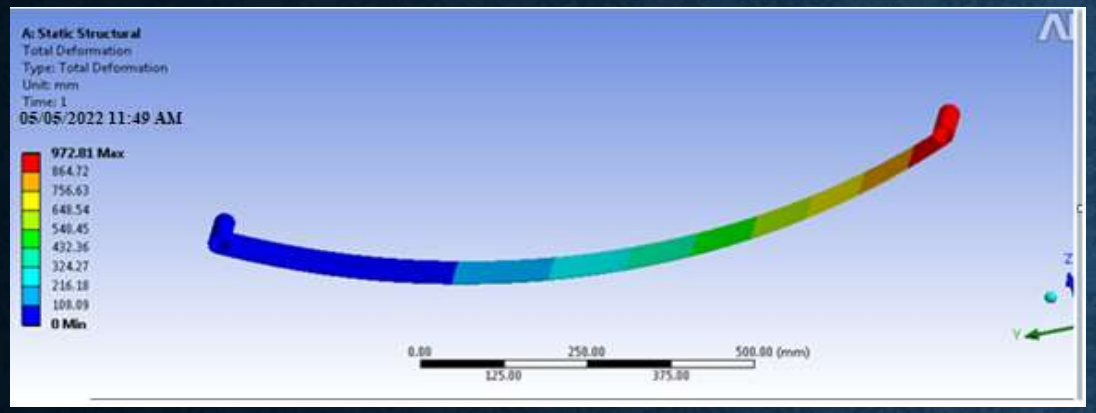
Design Parameters Of Steel Leaf Spring.

Total Length Of Leaf Spring (Eye to Eye)	1100 mm
Arc Height At Axle Seat	170 mm
Thickness Of Leaf Spring	6 mm
Width Of Leaf Spring	56 mm
Outer Diameter Of Eye	50 mm
Inner Diameter Of Eye	44 mm

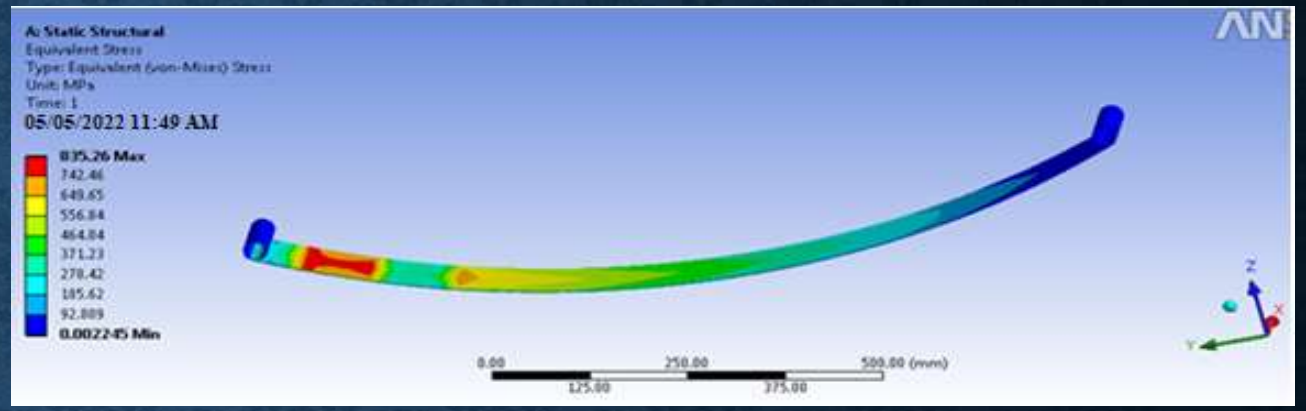
Design Parameters of Composite Leaf Spring.

Total Length Of Leaf Spring (Eye to Eye)		965 mm
Arc Height At Axle Seat		125 mm
Thickness	At Centre	60 mm
	At Ends	10 mm
Width	At Centre	30 mm
	At Ends	45 mm

STATIC STRUCTURAL ANALYSIS FOR (55 Si 7) STEEL LEAF SPRING



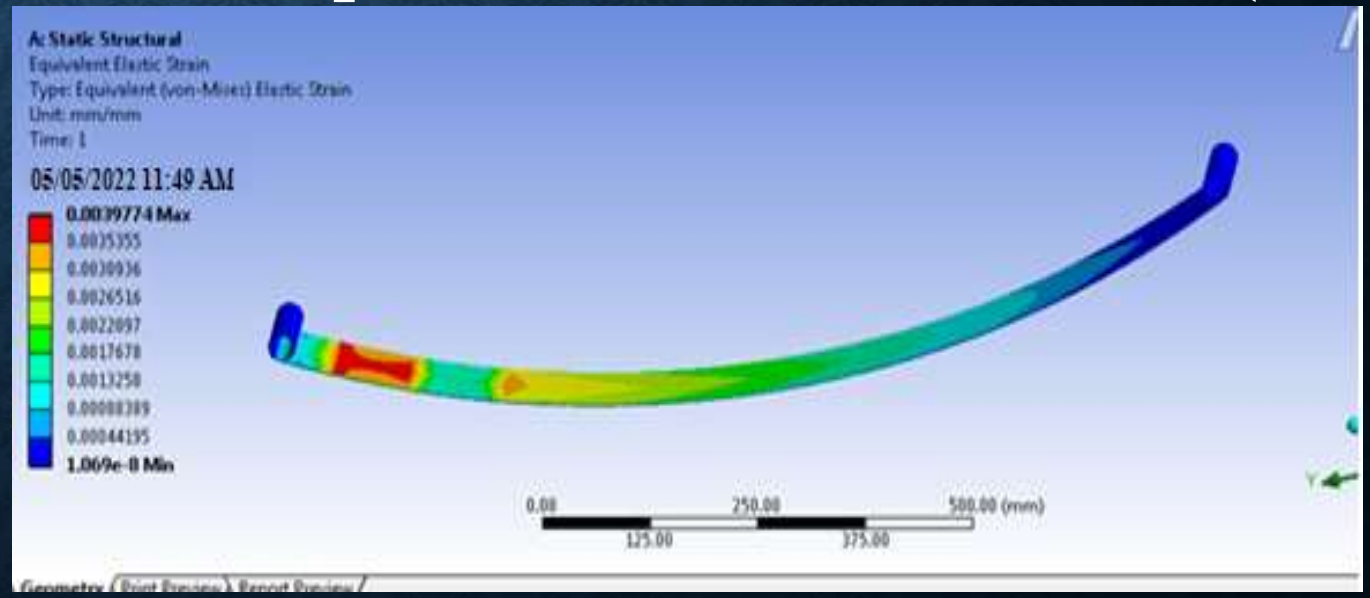
Total deformation 2500(N)



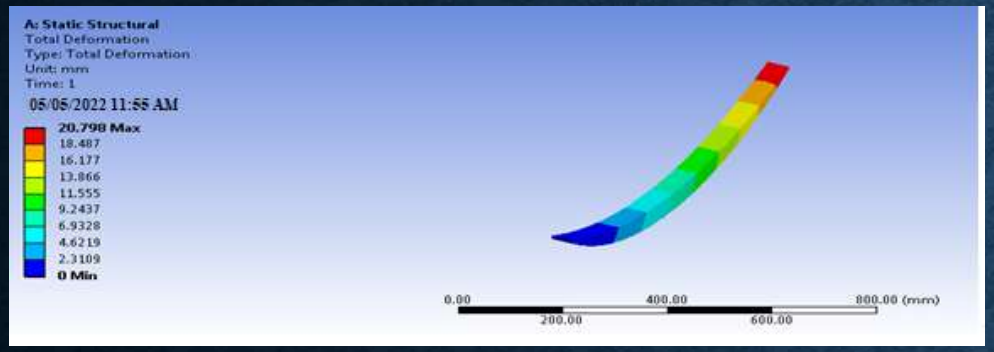
Equivalent Stress 2500(N

Equivalent Elastic Strain

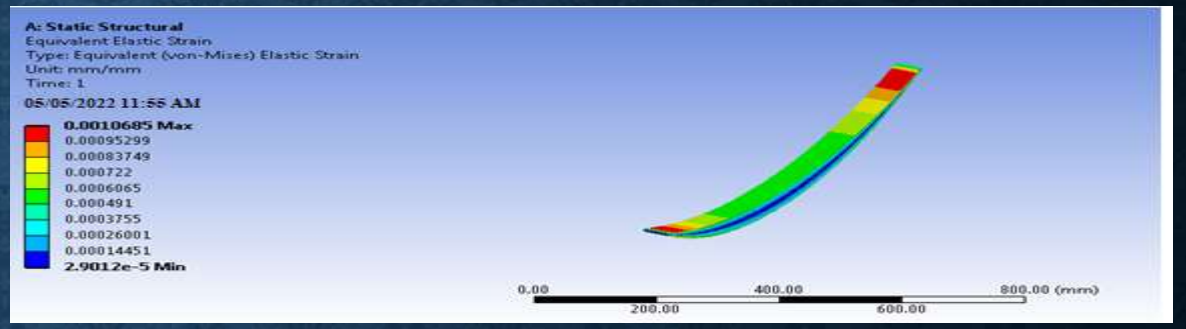
2500(N)



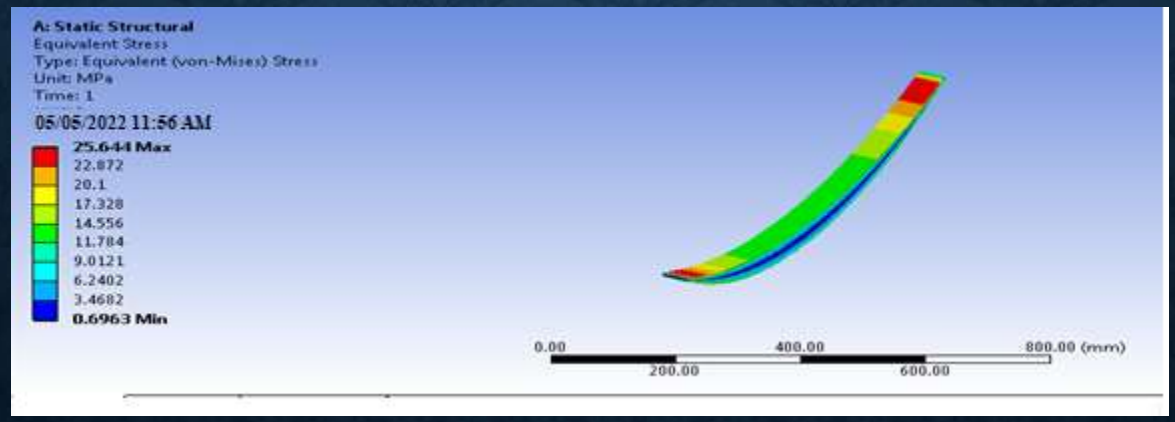
STATIC STRUCTURAL ANALYSIS FOR E-GLASS/EPOXY LEAF SPRING



Total deformation 2500(N).



Equivalent Elastic Strain 2500(N).

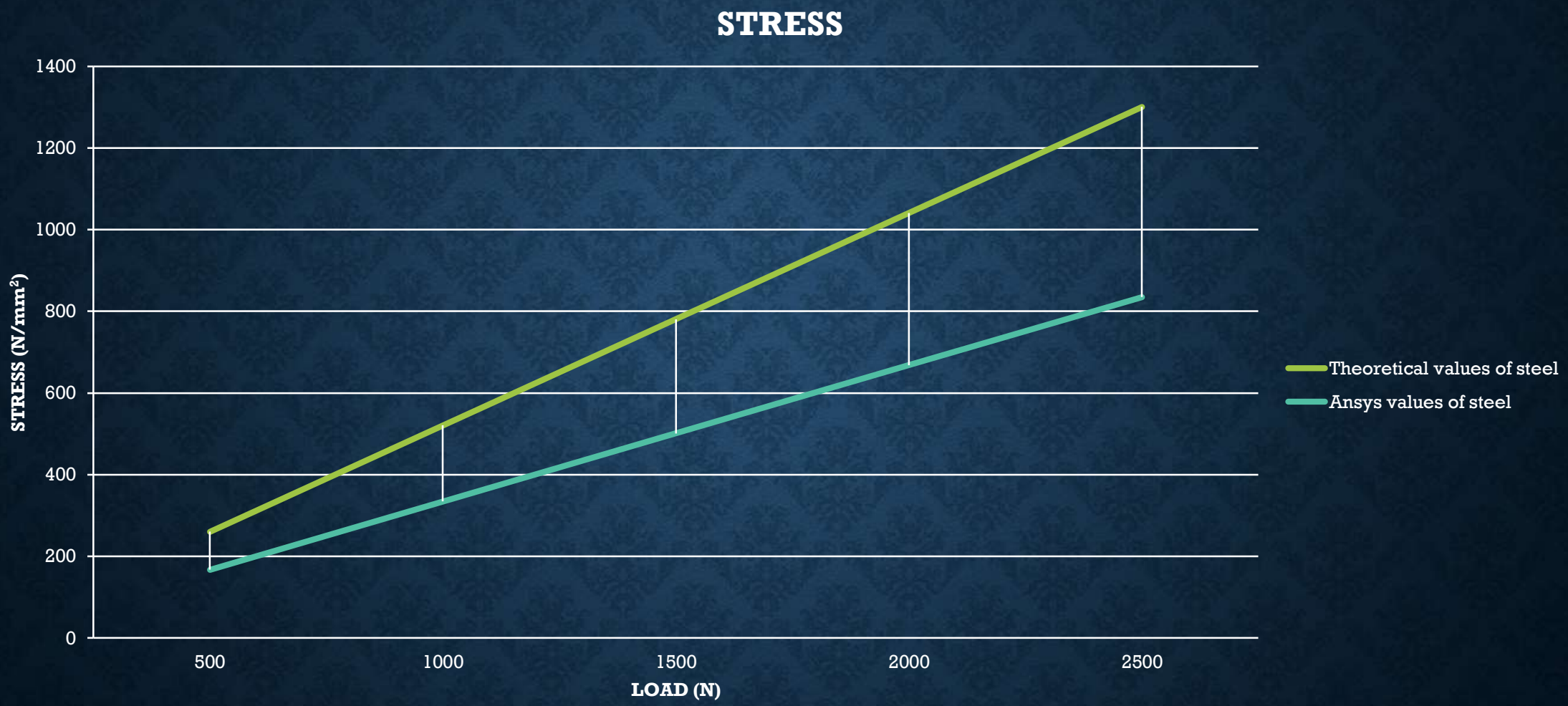


Equivalent Stress 2500(N).

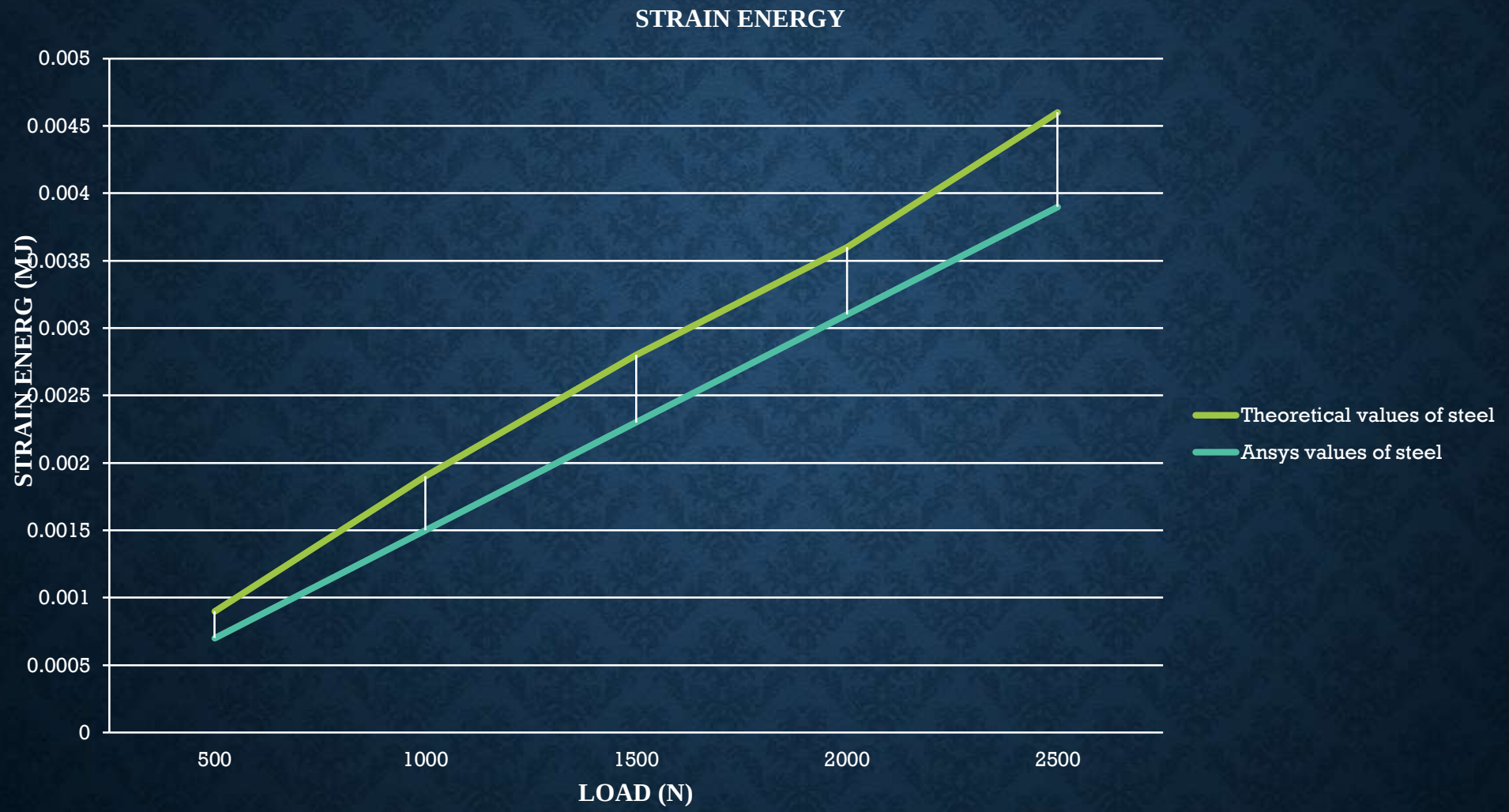
COMPARISON OF 55 SI 7 STEELS WITH THEORETICAL AND SIMULATION RESULTS

	Total deformation (mm)		Stress (N/mm^2)		Strain energy (MJ)	
LOAD (N)	Theoretical values of steel	Ansys values of steel	Theoretical values of steel	Ansys values of steel	Theoretical values of steel	Ansys values of steel
500	238.75	194.56	260.23	167.05	0.0009	0.0007
1000	477.50	389.12	520.46	334.11	0.0019	0.0015
1500	716.25	583.68	780.699	501.16	0.0028	0.0023
2000	955.00	778.25	1040.93	668.21	0.0036	0.0031

GRAPH -1 Load Vs Deformation



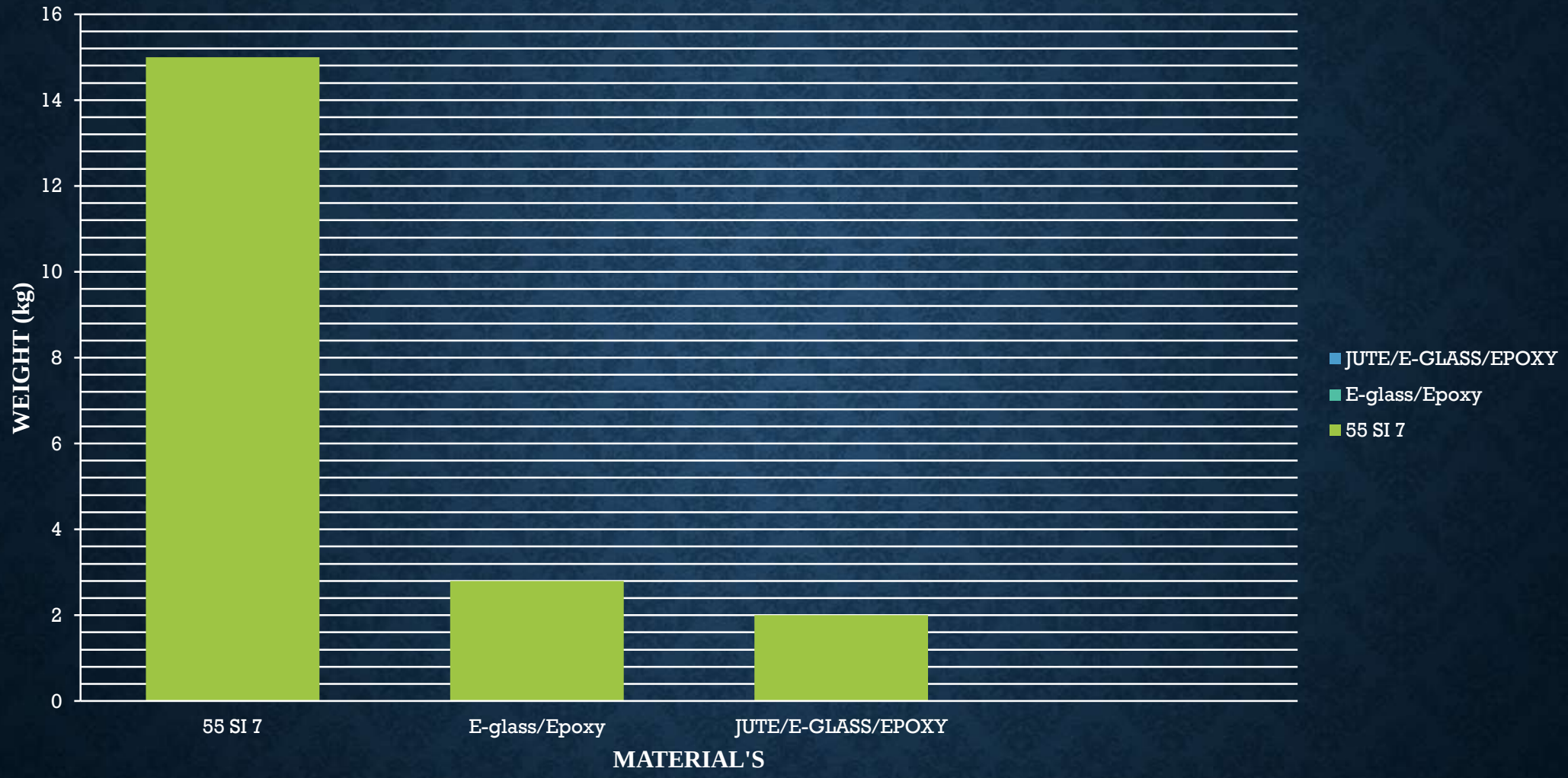
GRAPH -2 indicates Load Vs Stress



GRAPH -3 Load Vs Strain energy

COMPARISON OF WEIGHTS

Bar- Chart drawn for the comparison of weight of both steel and composite leaf springs. The bar chart below shows the comparisons in leaf spring weight (Kg) in case of steel and composite material. From this comparison of bar chart it is easily observed that the weight reduction in leaf spring. For steel leaf spring weight is 15kg and for composite leaf springs it is 2 & 2.8 kg.



GRAPH -4 indicates Weight Vs Material

CONCLUSION

The 3-D modeling of both steel and composite leaf spring is done and analyzed A comparative study has been made between composite and steel leaf spring with respect to Deflection , strain energy and stresses. From the results.

1.This research work provides optimum values for design variables (leaf spring thickness and width) of hybrid composite leaf spring by using finite element Analysis.

2.Weight can be reduced by 55% if steel leaf spring is replaced by Jute/E-Glass/Epoxy hybrid composite leaf spring. Weight reduction reduces the fuel consumption of the vehicle.

3.At various loading conditions, hybrid composite leaf spring is found to have lesser stresses and deflections as compared to conventional steel leaf spring.

4.Jute/E-glass/Epoxy hybrid composite has higher elastic strain energy storage capacity than steel because it has lower young's modulus and lower density as compared.Hence hybrid composite leaf spring can absorb more energy which leads to good comfortable riding.

5. Jute/E-glass/Epoxy hybrid composite leaf spring is found to be more economical as the cost of jute fiber is very much less and it is abundantly available in nature.

REFERENCES

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3. Shishay and Amare Gebremeskel, "Design, Simulation, and Prototyping of Single Composite Leaf Spring for Light Weight Vehicle".Global Journal of Researches in Engineering Mechanical and Mechanics Engineering Volume 12