Modelling and Analysis of Knuckle Joint by using CREO and ANSYS

In partial fulfillment of the requirements for the degree of

Bachelor of Technology

In

Mechanical Engineering

Submitted By

V.Pavan kalyan - 19B81A0386

P.Sagar - 19B81A0393

M.Sai ram - 19B81A0397

Department of Mechanical Engineering

CVR COLLEGE OF ENGINEERING

(UGC Autonomous Institution)

Affiliated to JNTU Hyderabad

Vastunagar, Mangalpalli (V), Ibrahimpatnam (M),

Ranga Reddy (Dist.), Hyderabad – 501510, Telangana State

(2022-2023)

CVR COLLEGE OF ENGINEERING

(UGC Autonomous Institution)

Affiliated to JNTU Hyderabad

Vastunagar, Mangalpalli (V), Ibrahimpatnam (M),

Ranga Reddy (Dist.), Hyderabad – 501510, Telangana State

CERTIFICATE

This is to certify that the mini-project work topic entitled **'Modelling and Analysis of Knuckle Joint by CREO and ANSYS'** being submitted by **'V.Pavan kalyan(19B81A086),P.Sagar(19B81A0393),M.Sai Ram(19B81A0397)'** for partial fulfillment of the requirement for the award of '**Bachelor of Technology'** in **Mechanical Engineering** discipline.

Mini Project Supervisor **Head of the Department**

CVR COLLEGE OF ENGINEERING

(UGC Autonomous Institution)

Affiliated to JNTU Hyderabad

Vastunagar, Mangalpalli (V), Ibrahimpatnam(M),

Ranga Reddy (Dist.), Hyderabad – 501510, Telangana State

DECLARATION

We "***V.Pavan Kalyan , P.Sagar , M.Sai Ram"*** are students of III year B.Tech IISem in Mechanical Engineering, CVR College of Engineering, Hyderabad, Telangana State,hereby declare that the mini-project work presented in this report titled "*Modeling and Analysis of Knuckle Joint by using CREO and ANSYS*" is the outcome of our bonafide work and is correct to the best of our knowledge and this work has been completed with taking care of engineering ethics

Date:

V.Pavan kalyan -19B81A0386

P.Sagar -19B81A0393

M.Sai Ram -19B81A0397

ACKNOWLEDGEMENT

We are greatly indebted tom **Mr.Neeraj Kumar Jha** (Asst.Prof) my revered guide for his valuable affectionate guidance in the preparation of this project work. He has been a source of great inspiration and encouragement to us. He has been kind enough to devote considerable amount of his valuable time in guiding us at every stage. This is our debut, but we are sure that we will be able to do many more such studies, purely because of his lasting inspiration and guidance. We are highly grateful to him for helping us with necessary information and material. He has not only guided but also endowed us with capacity to guide us in future.

We would like to express heart full thanks to **Dr. M. Venkata Ramana,** Professor and Head of the Department of Mechanical Engineering, who have always been grateful for us to complete our project.

We would like to express heart full thanks to **Dr.Ramamohan Reddy Kasa**,principal, who have always been grateful for us to complete our project **"Modelling and Analysis of Knuckle Joint by using CREO and ANSYS".**

We also thank all the teaching and non – teaching staff members of Department of Mechanical Engineering who have helped us directly or indirectly during the project.

V.Pavan Kalyan	19B81A0386
P.Sagar	19B81A0393
M.Sai Ram	19B81A0397

Abstract

Knuckle joint is used to connect two rods whose axes either coincide or intersect and lie in one plane. It is used to transmit axial tensile force and permits limited angular movement between rods, about the axis of the pin. As the rods are subjects to tensile force, yield strength is the criterion for the selection of material for the rods. The pin is subjected to shear stress and bending stress. Therefore, strength is criterion for material selection for the pin. The objective of this project is to design and analysis the structural deformation, stresses in a Knuckle joint. Here the Knuckle joint is modelled by using Creo and analysis is done by ANSYS workbench.

TABLE OF CONTENTS

1. Introduction

A Knuckle joint is used to connect two rods which are the action of tension forced when a small amount of flexibility or angular moment is necessary . It is basically a tensile joint. However, if the joint is guided,it may support a compressible load . This joint can be readily disconnected for adjustments or repairs.

The knuckle joint assembly consists of the following major components:

1. Single eye
2. Double eye or fork
3. Knuckle pin

The end of one rod is formed into an eye and the end of another rod is formed into fork with an eye in each of the fork leg. The eye is inserted into the fork and after aligning the holes in the eye and fork, the knuckle pin is inserted through them. The knuckle pin has a head at one end and the other end it is secured by a collar and a taper pin or split pin Fig 1 show the knuckle joint with various elements

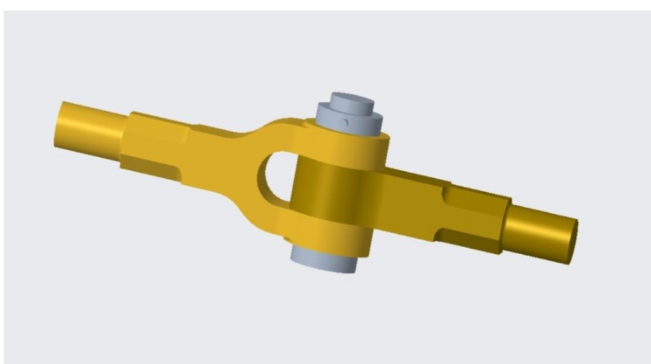


Figure of Knuckle Joint

1.1 Applications of Knuckle joint

1. Tie rod joint of roof truss.
2. Tension link in bridge structure.
3. Link of roller chain.
4. Tie rod joint of jib crane.
5. The Knuckle joint is also used in tractor

1.2 Failure of Knuckle Joint

A Knuckle joint may be failed on the following three modes

->Shear failure of pin(Single shear).

->Crushing of pin against rod.

->Tensile failure of flat end bar

2. Material Selection

There are several materials used for manufacturing of Knuckle joint as S.G iron(ductile iron),white cast iron and grey cast iron. But grey cast iron is mostly used. Structural steel is most demanding material for this application. Therefore, structural steel is used here.

Modulus of Elasticity	20x10^5 N/mm^2
Poison’s Ratio	0.3
Density	7850 kg/m^3
Yield Strength	250MPa
Ultimate Strength	460MPa

2.1 Bill of Material

Parts used in the assembly of Knuckle joint is Provided in the Table given below

Table 2 Parts List

Part No.	Description	Material	Quantity
1	Fork	Structural Steel	1
2	Eye	Structural Steel	1
3	Knuckle Pin	Structural Steel	1
4	Collar	Structural Steel	1
5	Taper pin	Structural Steel	1

3.Analytical Design

Following Data is Provided for the design of Knuckle joint,

P=Land Carried by the rods =12000N

Diameter of Rod =d=25mm

3.1 Design

For Structural Steel,

Tensile Stress($\sigma 1$)=250 Mpa.

Crushing Stress(σck)=250MPa.

Shear stress=(τ)=125MPa

Assuming Factor of Saftey(FoS)=5

Allowable Stresses are,

Allowable Tensile strees[$\sigma 1$]=50MPa,

Crushing stress[σck]=50MPa,

Shear stress=[τ]=25MPa

From Empirical Relationships

1. Outer diameter of the eye
   d2=1.5 x d
   d2=1.5 x 25
   d2=37.5=38mm

2. Diameter of the pin head
   d3=1.5 x d
   d3=1.5 x 25
   d3=37.5=38mm
3. Thickness of the eye
   t1=1.2 x d
   t1=1.2 x 25
   t=30mm
4. Thickness of the Fork
   t1=0.7 x d
   t1=0.7 x 25
   t1=17=17.5mm
5. Thickness of the pin head
   t1=0.4 x d
   t1=0.4 x25
   t1=10mm

3.2 checking whether the design is safe

1. **Checking failure of single Eye in Tension across the slot**
   σt =P/(d2-d1)*t=12000/(50-25)*30
   σt=16N/MM^2<50N/MM^2
   Hence, design is safe in Tension

2.Checking failure of Single Eye in Crushing

σck=P/d1xt = 12000/25x30

σck=16N/mm^2<50N/mm^2

Hence, design is safe in Crushing.

3.Checking failure of single Eye in Shear

τ=P/(d2-d1)xt = 12000/(50-25)x30

τ=16 N/mm^2<50N/mm^2

Hence, design is safe in Shearing.

4.Checking failure of Fork End in Tension

σ1 = P/2x(d2-d1)xt1 = 12000/2(50-25)x17.5

σ1 = 13.71N/mm^2<50N/mm^2

Hence, design is safe in Tension.

5.Checking failure of Fork End in Crushing

σck = P/2xd1xt1 = 12000/2x25x17.5

σck = 13.17 N/mm^2 < 50N/mm^2

Hence, design is safe in Crushing.

6.Checking failure of Fork End in Shear

τ = P/2x(d2-d1)xt1 = 12000/2x(50-25)x17.5

τ = 16N/mm^2 < 50N/mm^2

Hence, design is safe in Shear.

7.Checking failure of Knuckle Pin in Shear

τ = P/2x3.14/4 x d1^2 = 12000/2x3.14x25^2

τ = 12.22<25N/mm^2

Hence, design is safe in shear.

8. Modeling failure of Rod in Tension

$\sigma t = P/(3.14/4)xd^2 = 12000/(3.14/4)x25^2$

$\sigma t = 24.446N/mm2 < 50N/mm2$

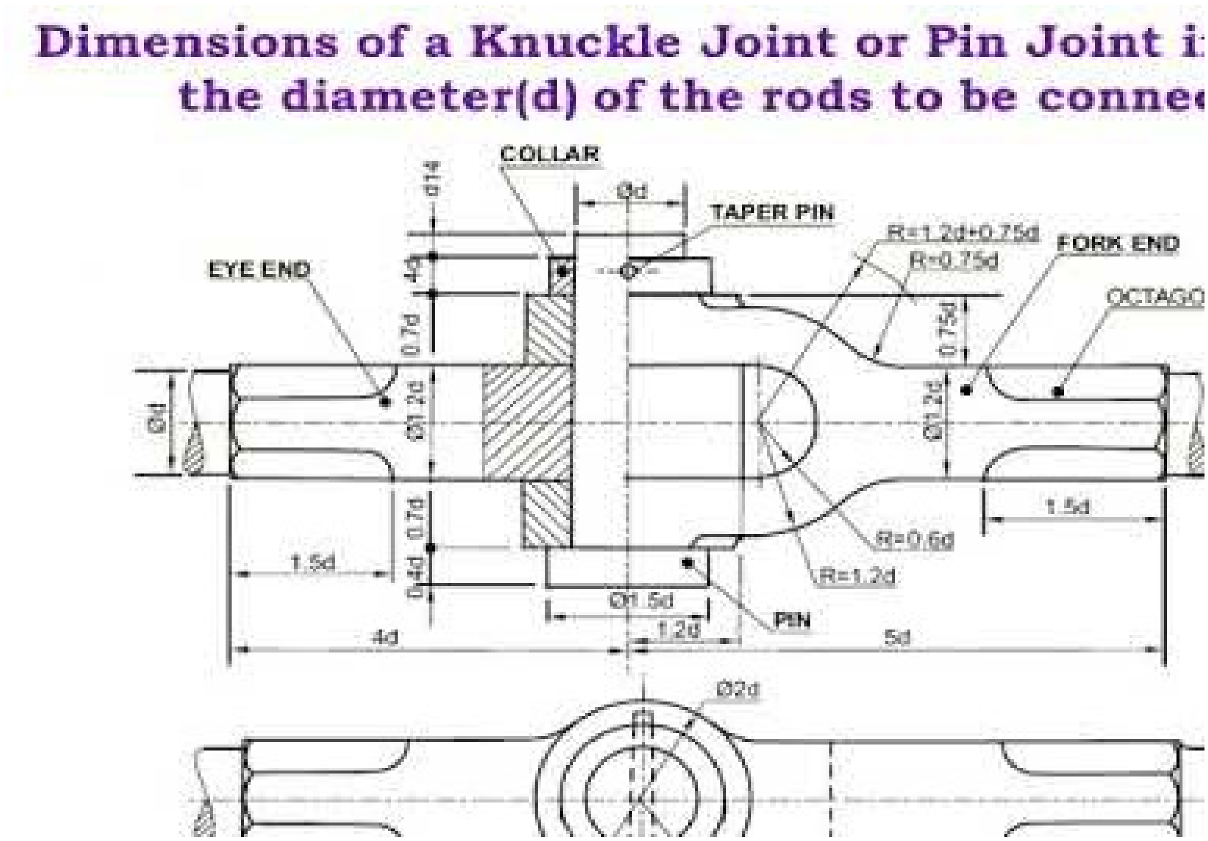
Hence, design is safe in Tension.

Therefore, finally from the above design Table shows the various dimensions of the Designed Knuckle Joint.

Table Parameters

Parameter	Dimensions
Rod Diameter(d)	25mm
Load applied(P)	12000N
Diameter of Knuckle pin(dp)	25mm
Thickness of Single Eye(t)	30mm
Thickness of Fork(t2)	17.5
outer diameter of Eye(d2)	50mm
Thickness of pin Head(t3)	10mm

4..Drafting of Knuckle Joint



4.1 Model of Knuckle joint

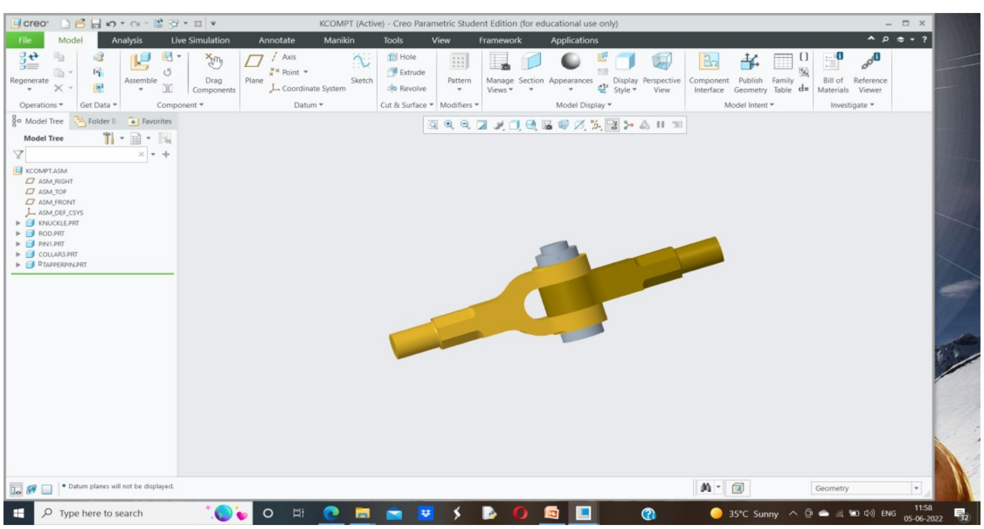
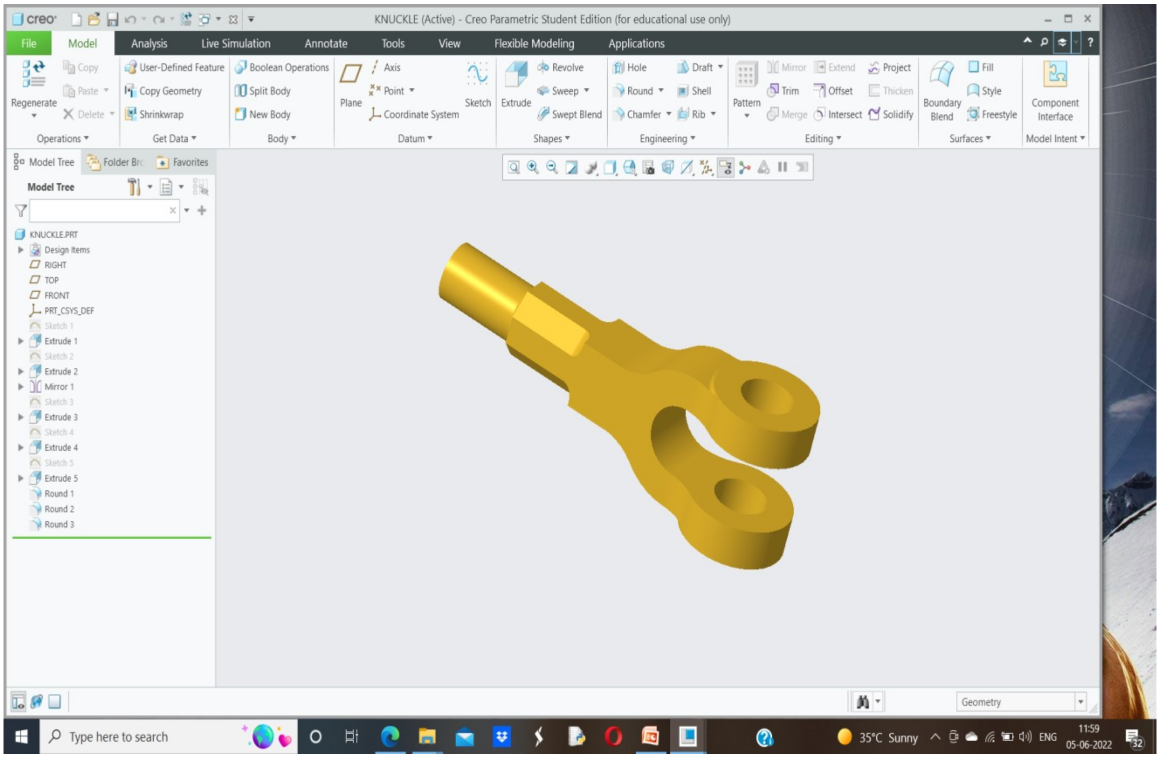
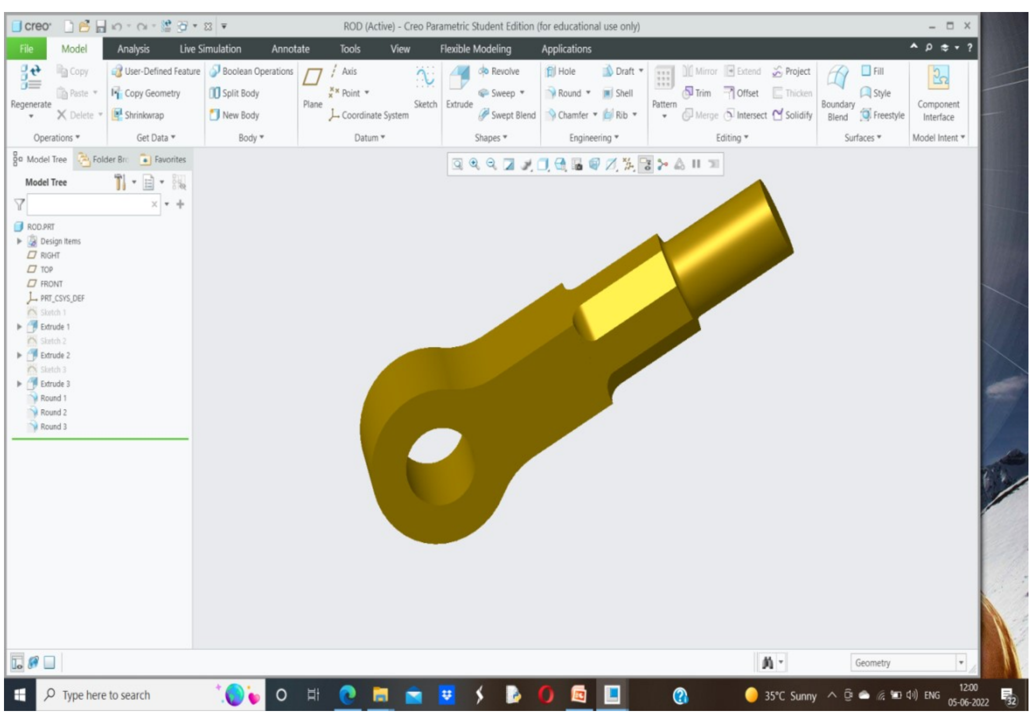


Figure Assembly of Knuckle Joint

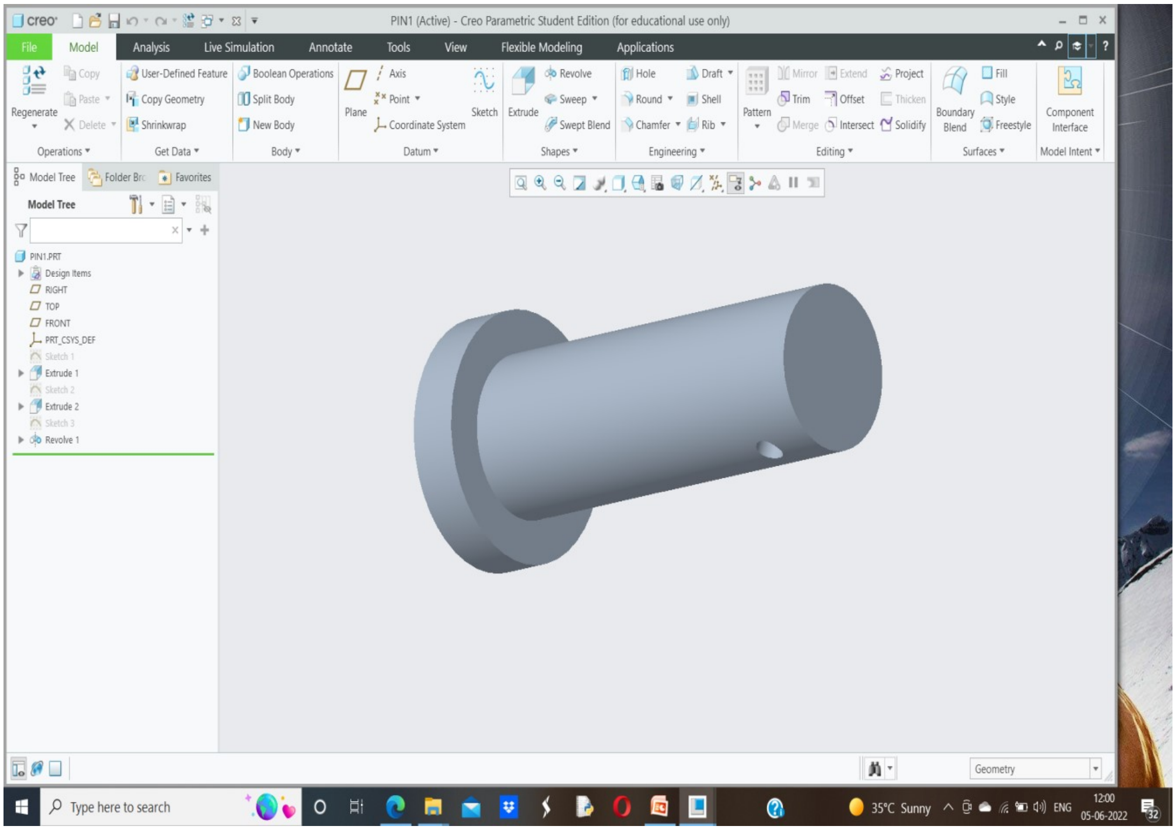
4.2 Modeling of Fork End



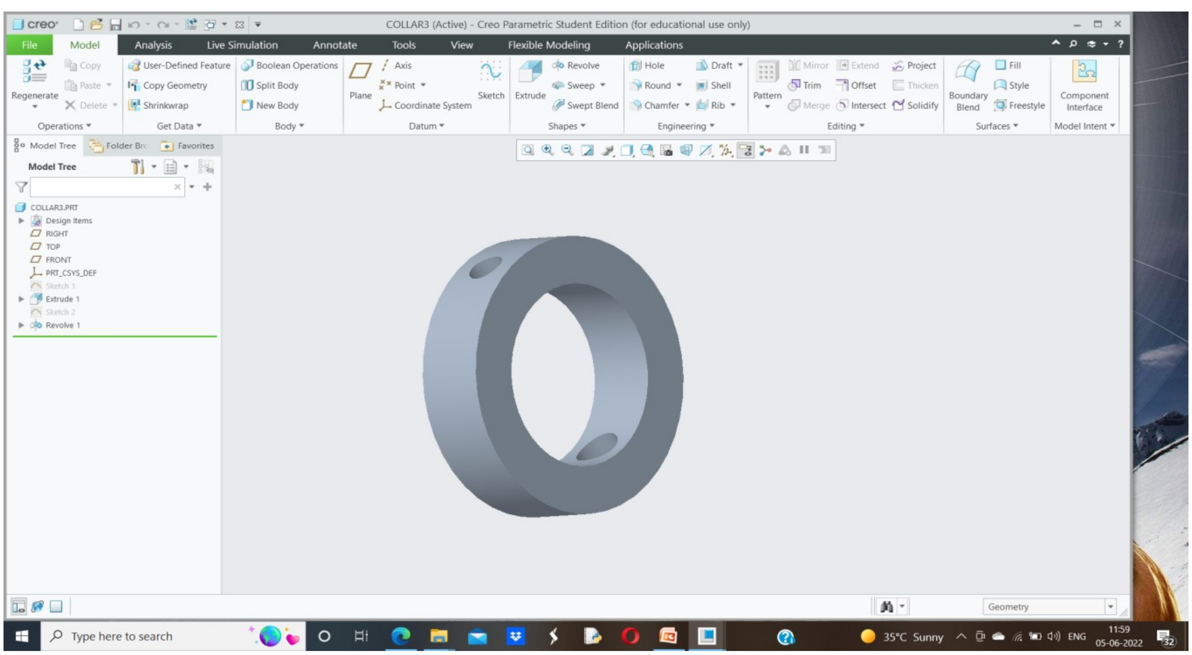
4.3 Modeling of Single End Eye



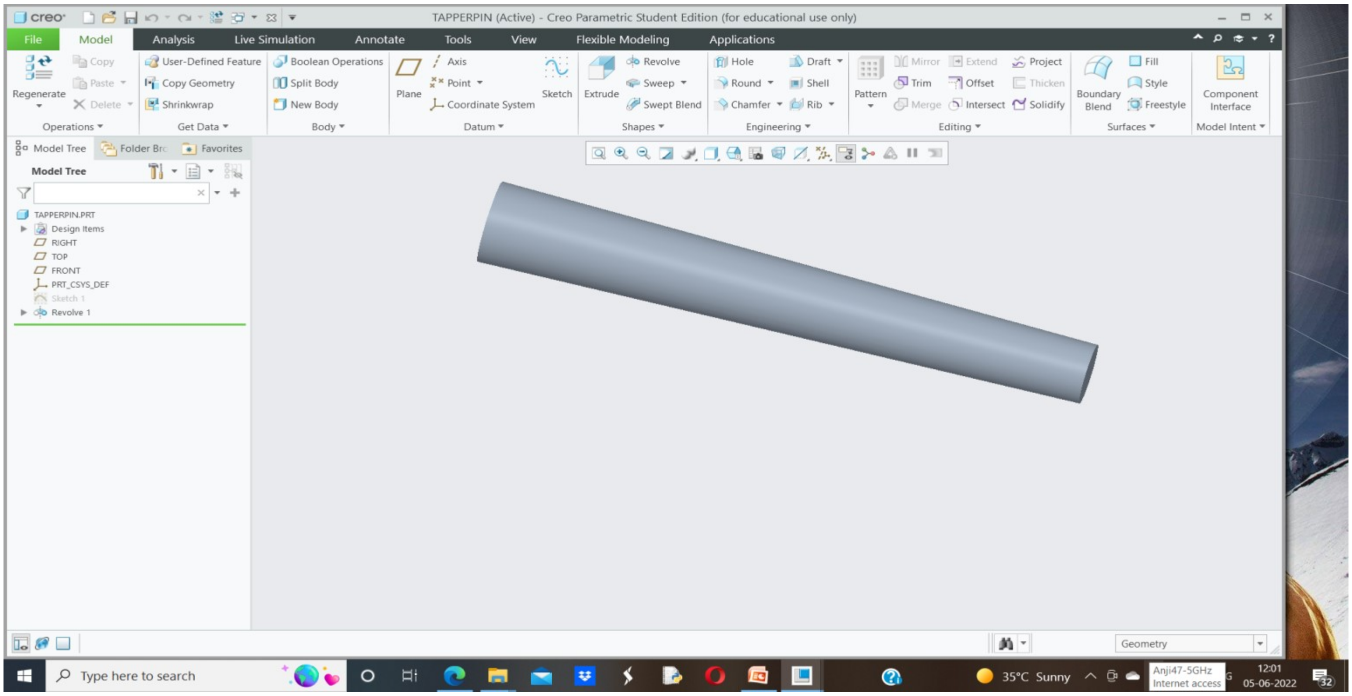
4.4 Modeling of Knuckle Pin



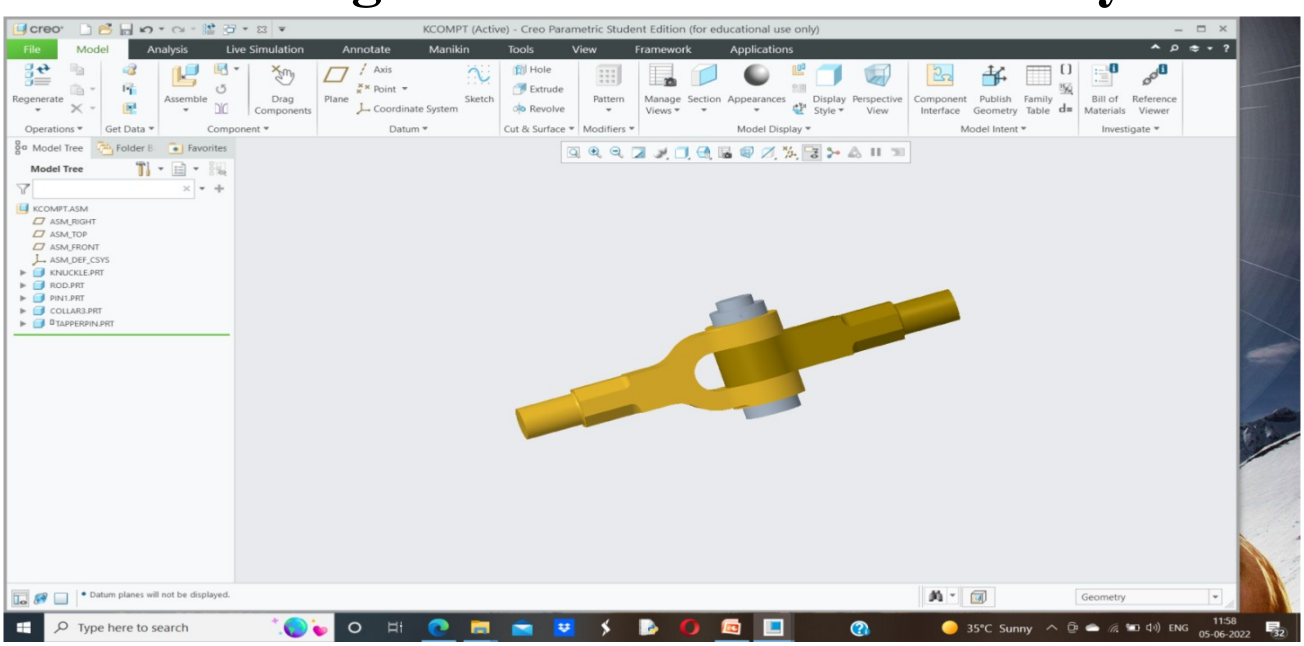
4.5 Modeling of Collar



4.6 Modeling of Tapper Pin



4.7 Modeling of Knuckle Joint Assembly



4.Meshed Model of Knuckle Joint

In oder to carry out the stress analysis, mesh was developed for the Knuckle joint. The tetrahedral elements have been used . The mesh consists of 25714 nodes and 6717 elements and elements size 4mm. The meshing of domains has been show in fig

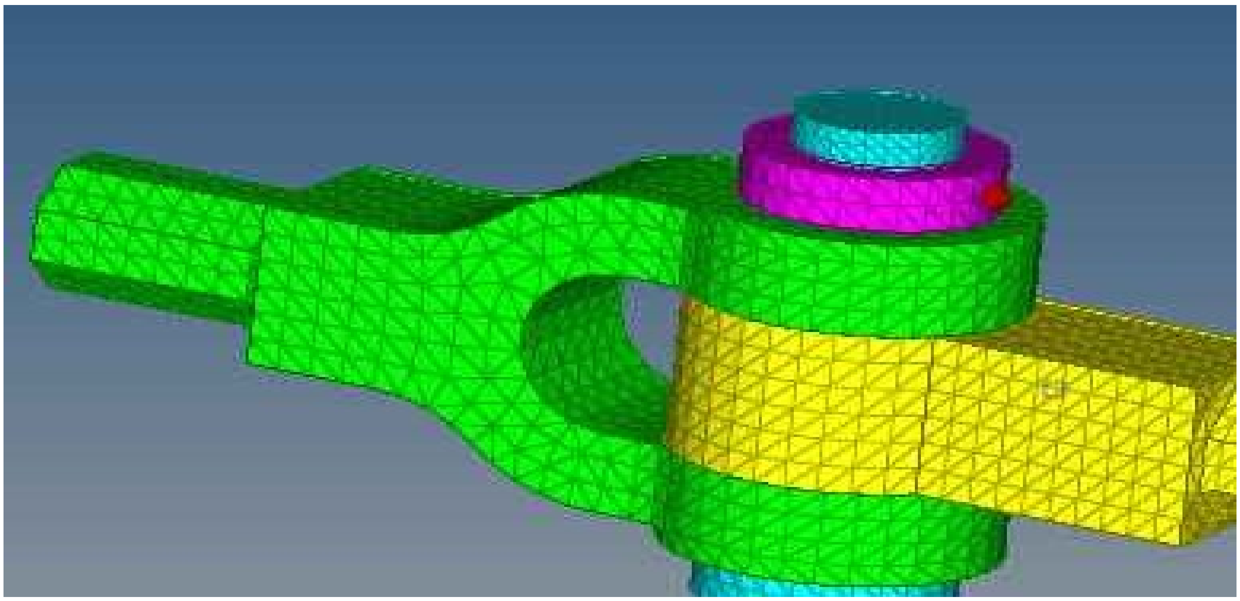
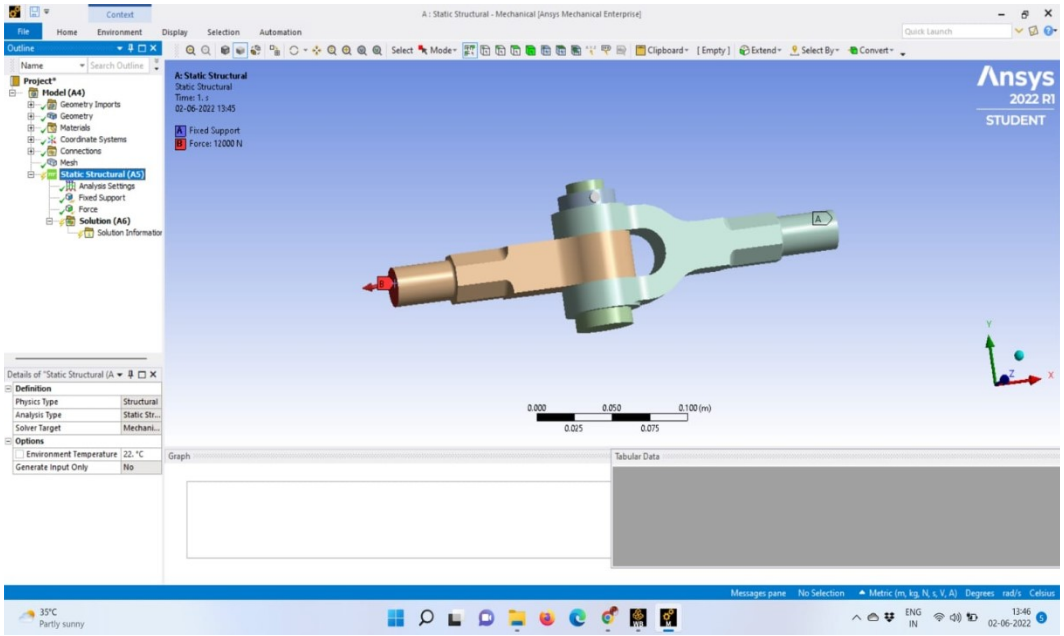


Figure Meshing

Table Mesh details

Mesh type	Coarse Mesh
Element Type	Quad/tetra
Number of Nodes	25714
Number of Elements	6717

6.Boundary Conditions



Boundary Condition :

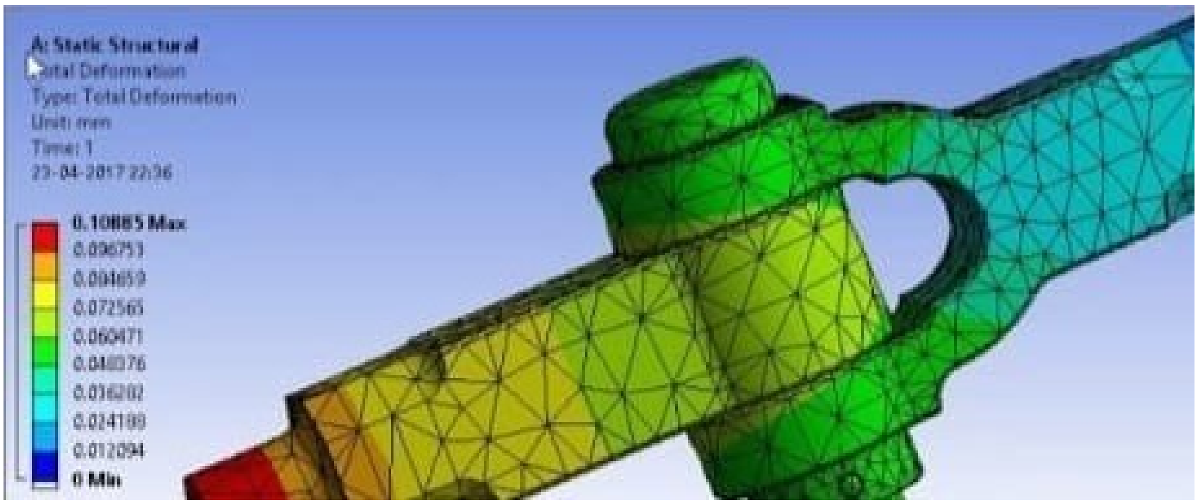
->The axial tensile force of 12000N is applied on the other end.

-> The Knuckle Joint is fixed at the fork End.

7.Results

7.1 Deformation of knuckle Joint:

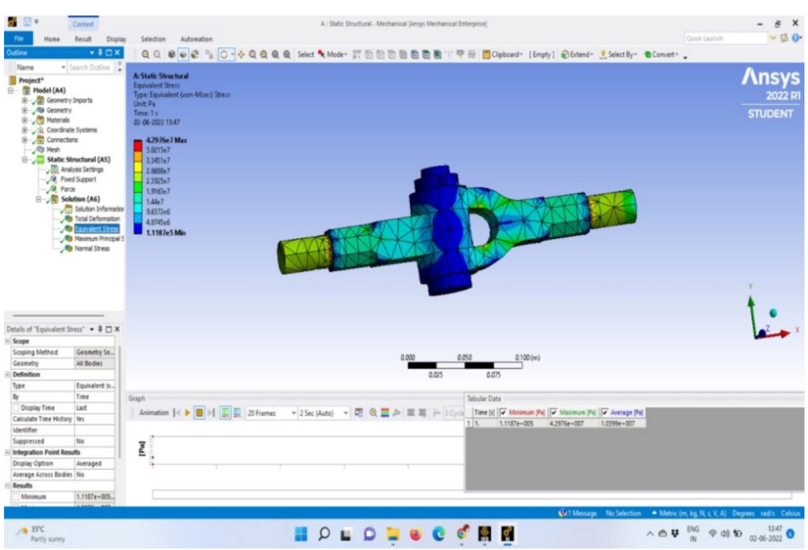
After applying tensile load in the joint it is seen that maximum deformation occurs is 0.073416mm.Fig show the graphical deformation occurred and zones are highlighted in different colours. Red indicates maximum deformation while blue region shows minimum



Deformation of knuckle joint

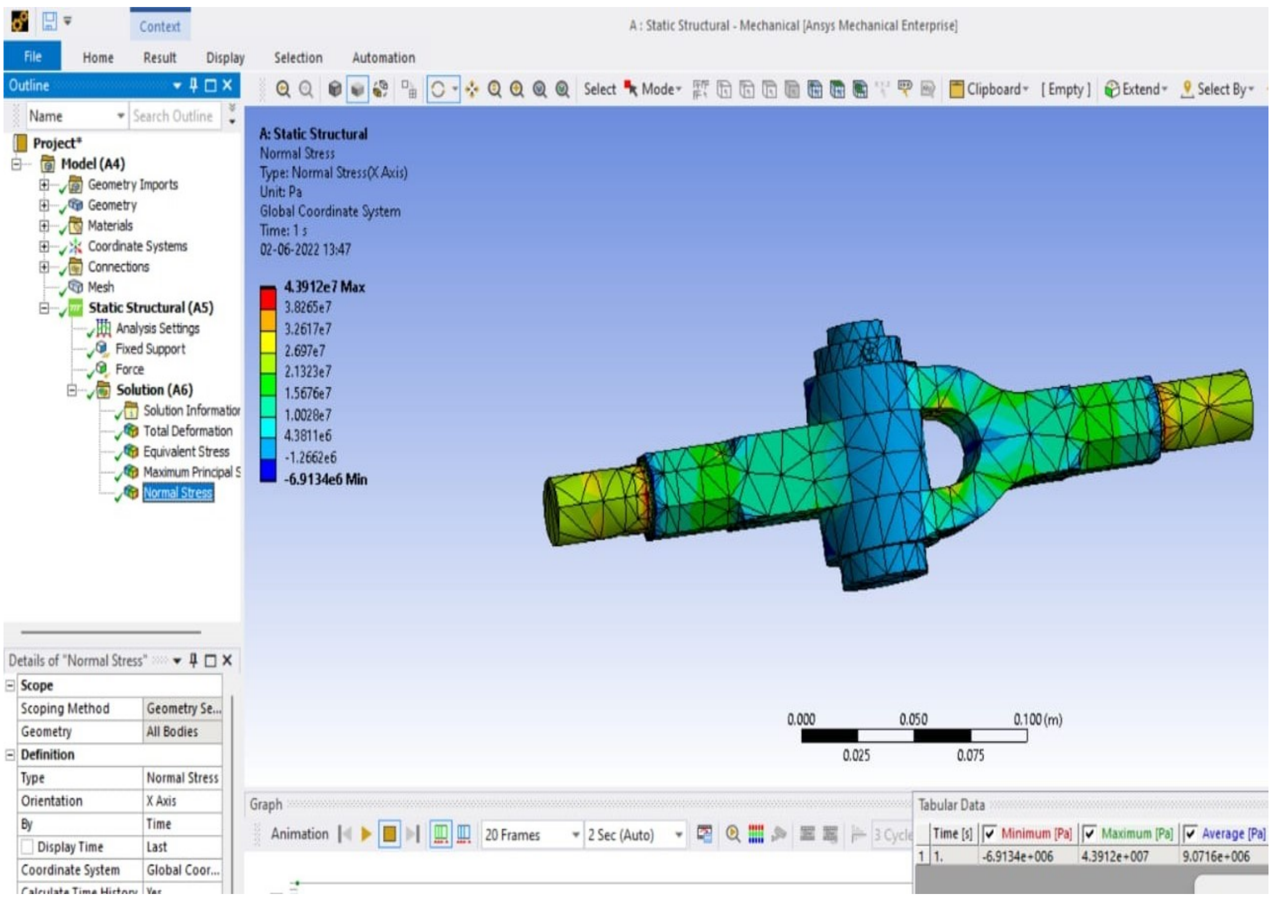
7.2 Equivalent stresses

Fig shows equivalent stresses produced in the Joint . The maximum tends to 41.328MPa while minimum varies to 0.0036292MPa



7.3 Normal Stress

Fig shows equivalent stresses produced in the joint. The maximum tends to 44.1MPa while minimum varies to 6.9MPa



Results from FEA

Parameter	Maximum	Minimum
Deformation	0.0026mm	0mm
Equivalent(von mises)Stress	42.9MPa	0.11MPa
Normal stress on joints	44.1MPa	6.91MPa

8.Conclusion

It is concluded from the above study that using CREO and Ansys Workbench software designs and modelling becomes easier . Here material used for Knuckle Joint is Structural steel because structural steel sustain more Load than other material. From the above results using structural steel as a material for a 25mm diameter Knuckle Joint, the design is safe a 12KN load

9.Reference

[1] Design of Machine Elements by VB Bhandari, ISBN: 978-0-07-068179-8.

[2] K.L.Narayan , P.Kannaiah , V.Venkata Reddy, Machine Drawing, Published by New Age International (P) Ltd., ISBN (13): 978-81-224-2518-5.