MODELLING DESIGN OF KNUCKLE JOINT IN CREO PARAMETRIC

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ABSTRACT:

A knuckle joint is used to connect two rods under tensile load. This joint permits angular misalignment of the rods and may take compressive load if it is guided. These joints are used for different types of connections e.g. tie rods tension links in bridge structure. In this, one of the rods has an eye at the rod end and the other one is forked with eyes at both the legs. A pin is inserted through the rod end eye and fork-end eyes and is secured by a collar and a split pin. Screwed connections often play an important part in the transmission of load through machine assemblies. In large circuit breakers they are subjected intermittently to high impulsive loads transmitted through largescale linkages.

The paper reports on knuckle joint used in power transmission with designing carried out using 3D modelling software CREO 8 PARAMETRIC.

1. INTRODUCTION:

In mechanical & automobile domain the joints play very crucial role, depending upon the application the joints are used may be temporary or permanent. For power transmission or motion transfer application we generally uses temporary joints like screwed joint, cotter joint, sleeve cotter joint, universal joint or knuckle joint. The Knuckle joint is a type of joint which is used in steering system in between the steering rod and pinion of the steering gear, as the line of the action/axis of both the mechanical parts are intersecting and lies in different planes, so it is the only joint that we can employ here In order to gain the maximum productivity for the plant, the manufacturing technology must not be stiff, it must have an option of customizability of manufacturing system to gain the agility. For this a term FMS, i.e., Flexible Manufacturing System is used in order to gain the advantage over simple manufacturing system. FMS consists of a group of a processing work stations interconnected by means of an automated material handling and storage system and controlled by integrated computer controlled system. FMS is an arrangement of machines interconnected by a transport system which is accurate, rapid and automatic. The manufacturing plant is located in Gwalior which is a new and developing industry, having a small set up of six milling centers, two turning centers, one drill and a hacksaw machine, with a total employee staff of twenty-five. A small scale industry is manufacturing knuckle joint for automotive applications for his clients in batch production of fifty pieces. A mechanical joint is a part of machine which are used to connect the other mechanical part or mechanism. Mechanical joints may be temporary or permanent. Most types are designed to be disassembling when required.

Types of Mechanical Joints:

1. Knuckle Joints	2. Turnbuckle Joints	3. Pin Joints
4. Cotter Joints	5. Bolted joints	6. Screw Joints
7. Welded Joints		

2. LITERATURE SURVEY:

Number of investigations has been done on finite element analysis of knuckle joint and its components. Saurav Das, Vishvendra Bartaria, Prashant Pandey calculated the stresses in knuckle joint using analytical method. It was observed that on changing the pin diameter the load carrying capacity of the pin increases [2]. Dinesh Shinde and Kanak Kalita performed FE analysis of knuckle joint pin used in tractor trailer. Analysis was performed on pin under acceleration and declaration condition using newton's second law. It was observed the intensity of von misses stress is maximum in case of deceleration [3]. NishantVibhavSexena and Dr. Rohit Rajvaidya performed the study and analysis of knuckle joint with the replacement of material by Teflon. It was observed parts made of composite materials are economical to produce and facilitate cost reduction as compared to metal parts [4].

3. KNUCKLE JOINT:

Knuckle joint is a joint between two parts allowing movement in one plane only. It is a kind of hinged joint between two rods, often like a ball and socket joint. There are many situations where two parts of machines are required to be restrained, for example two rods may be joined coaxially and when these rods are pulled apart they should not separate i.e. should not have relative motion and continue to transmit force. Similarly if a cylindrical part is fitted on another cylinder (the internal surface of one contacting the external surface of the other) then there should be no slip along the circle of contact. Such situations of no slip or no displacements are achieved through placing a third part or two parts at the jointing regions. Such parts create positive interference with the jointing parts and thus prevent any relative motion and thus help transmit the force.

One should remember that the rivets in a riveted joint had exactly the same role as it prevents the slipping of one plate over the other (in lap joint) and moving away of one plate from other (in butt joint). The rivets provided positive interference against the relative motion of the plate. Knuckle joint is another promising joint to join rods and carry axial force. It is named so because of its freedom to move or rotate around the pin which joins two rods. A knuckle joint is understood to be a hinged joint in which projection in one part enters the recess of the other part and two are held together by passing a pin through coaxial holes in two parts. This joint cannot sustain compressive force because of possible rotation about the pin. There are most common in steering and drive train applications where it needs to move something but also need to allow for offset angles.

A knuckle joint is used when two or more rods subjected to tensile and compressive forces are fastened together such that their axes are not in alignment but meet in a point. This type of joint allows a small angular movement of one rod relative to another. The joint can be easily connected and disconnected. Knuckle joint is found in valve rods, braced girders, links of suspension chains, elevator chains, etc.

The figure of a knuckle joint and its parts are shown below. The knuckle joint assembly consists of following major components: 1. Single eye. 2. Double eye or fork. 3. Knuckle pin. 4. Collar. And 5. Tapper pin.

The end of one of the rods is forged in the form of a fork while the end of the other rod has an eye, which can be inserted in the jaws of the fork. A cylindrical pin is passed through the holes in the forks and the eye. The pin is secured in position by a taper pin, split pin or a thin nut screwed up to shoulder on the end of the pin. The ends of the rods are made octagonal for good hard grip. A knuckle joint is used to connect the two rods which are under the tensile load, when there is requirement of small amount of flexibility or angular moment is necessary. There is always axial or linear line of action of load.

Fig 1: Single Eye

Fig 2: Double Eye or Fork

Fig 3: Knuckle Pin

Fig 4: Collar

Fig 5: Taper Pin

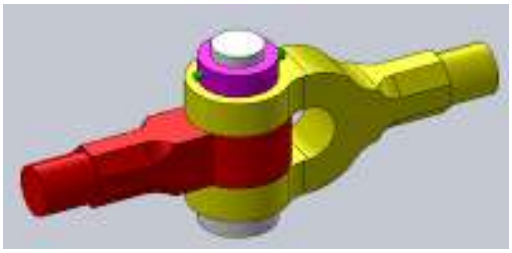


Figure 6: Knuckle joint

At one end of the rod the single eye is formed and double eye is formed at the other end of the rod. Both, single and double eye are connected by a pin inserted through eye. The pin has a head at one end and at other end there is a taper pin or split pin. For gripping purpose the ends of the rod are of octagonal forms. Now, when the two eyes are pulled apart, the pin holds them together. The solid rod portion of the joint in this case is much stronger than the portion through which the pin passes. The knuckle joint is used in many applications such as wiper, tie rod joint of roof truss, tension link in bridge structure, link of roller chain, in tractor, elevators chains, valve rods, wire line tool-string etc.

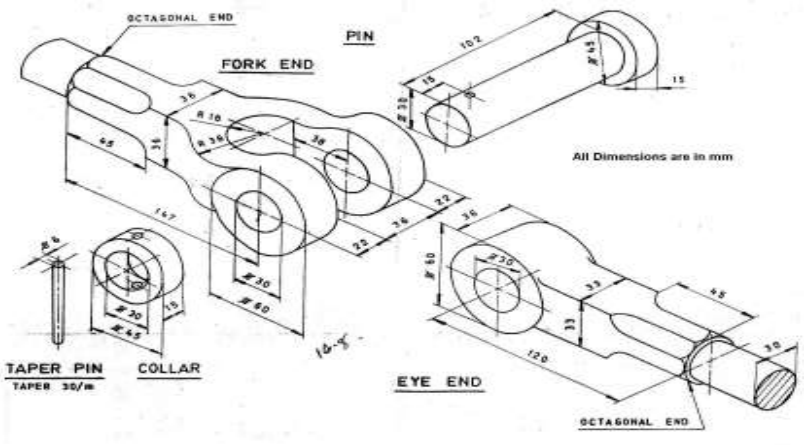


Fig 7A: Knuckle Joint Parts with dimensions- CAD Model

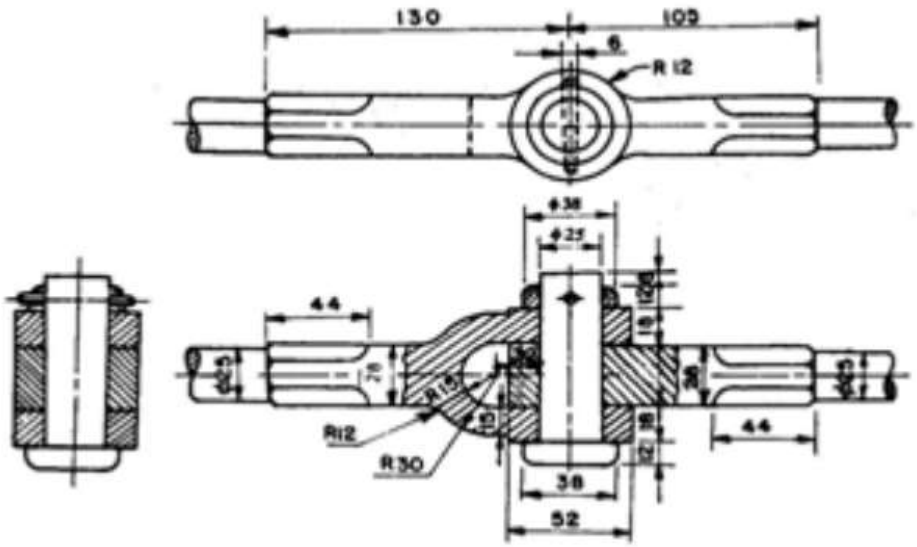


Fig 7B: Knuckle Joint Parts with dimensions- Assemble Model

3.1. APPLICATIONS OF KNUCKLE JOINT

Knuckle joints are used most often when two or more rods subjected to tensile and compressive forces are fastened together, their axes are not in alignments but meet in a point, the joint allows a small angular moment of one rod relative to another and it can be easily connected and disconnected.

Knuckle joints find a wide variety of applications. They are used in:

1. Bicycle chains	2.Tractors	3.Trusses
4. Automobile wipers	5.Cranes	6.Chain straps of watches
7. Earth movers'	8.Robotic joints	9.Structural members

In general, the materials used for making knuckle joint are Stainless Steel, Grey cast Iron, Teflon, etc.

A knuckle joint may be failed on the following three modes:

1. Shear failure of pin (single shear).

2. Crushing of pin against rod.

3. Tensile failure of flat end bar.

The failure mechanism of knuckle joint has been studied by several investigators. Russell [5] have studied the failure of a knuckle joint of a universal coupling system. It was mentioned that torsional overload of the knuckle joint is the major cause of failure. Another study reported that shear failure due to tensional loading is the normal failure mechanism in many engineering components. However, in many cases it was reported that wear of material due to severe friction leading to delimitation wear.

4. CREO Parametric

CREO Parametric is the essential tool for 3D CAD. It is state-of-the-art software, which promotes best practices in design and maintains your industry standards. Answer your pressing design challenges with CREO Parametric, with its fully-fledged powerful yet flexible 3D CAD abilities. The software has capabilities to accommodate multi-CAD data, electromechanical design and make alterations late in the design process. CREO Parametric is widely used for 3D CAD, CAID, CAM, and CAE solutions, decrease design timescales and also to optimize product development processes to implement remarkable designs. As CREO Parametric integrates easily with all other CREO apps, there is no longer risk wasting time translating data across platforms and eliminate costly data transfer errors. Instead, the potential of moving seamlessly between 2D and 3D design information without impacting on the original design structure is an added benefit. This provides unparalleled scope to achieve essential productivity gains as part of product development.

Creating a geometry model in CREO Parametric can be described in brief as follows:

Open CREO Parametric: Launch CREO Parametric on the computer.
Start a New Part: Create a new part file to begin the design.
Sketching: Use the sketching tools to create 2D profiles of the components (pin, beams, etc.).
Apply dimensions and constraints to define the geometry accurately.
Extrude: Extrude the 2D profiles to create the 3D solid geometry.
Additional features such as fillets and chamfers can be applied as needed.
Assembly: Create an assembly to represent how different components fit together.

Given below is the step by step process to create components and preparation of assembly models of a knuckle joint:

PREREQUISITE:

Open the Creo Parametric 8.0.0 either using the desktop icon or using the program menu.

Set the working directory as per your choice.

Create a “New” file for part modelling.

Set the units to millimetre newton second by using the menu Setup-Units mm-Ns.

PROCEDURE:

PART MODELLING:

Part No: 1- FORK:

The first feature of the fork is created by producing the cross section of the fork as shown the figure. The command are as follows:

Feature – 1

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview
By choose the right and top as the reference.
Sketching is done as per the given shape and dimensioning is done asper the requirement.
Exit the sketcher by click the TICK mark.
As the elements have been defined. OK is given after seeing the preview.

Feature –2

Revolve tool >Placement>Define>Select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview
A required profile is drawn as per the dimensions.
Exit the sketcher by clicking the TICK mark.
Give angle of rotation.
As all the elements have been defined, OK is given after seeing the preview

Feature–3

Mirror tool>select the feature be mirror>select the plane>done.

Feature–4

Solid>cut>Revolve>done>both sides>done>Plane (rod end of the fork)>default.
An octagon profile is drawn as per the given dimensions.
Then exit the sketcher by giving “TICK” mark.
As all the elements have been defined. OK is given after seeing the preview.

Feature–5

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview>
An extrusion shaft is drawn at the end of the fork.

Part No: 2- EYE:

The first feature of the eye is created by producing the cross section of the eye as shown the figure. The command are as follows.

Feature–1

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview>
By choose the right and top as the reference.
Sketching is done as per the given shape and dimensioning is done asper the requirement.
Exit the sketcher by click the TICK mark.
As the elements have been defined. OK is given after seeing the preview.

Feature-2

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview>
By choose the right and top as the reference.
Sketching is done as per the given shape and dimensioning is done asper the requirement.
Exit the sketcher by click the TICK mark.
As the elements have been defined. OK is given after seeing the preview.

Feature–3

Revolve tool >Placement>Define>Select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview>
A required profile is drawn as per the dimensions.
Exit the sketcher by clicking the TICK mark.
Give angle of rotation.
As all the elements have been defined. OK is given after seeing the preview.

Feature–4

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview>
An extrusion shaft is drawn at the end of the fork.

Part No: 3- KNUCKLE PIN:

The first feature of the pin is created by producing the cross section of the pin as shown the figure. The command are as follows.

Feature – 1

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview
A required profile is drawn as per the dimensions.
Exit the sketcher by clicking the TICK mark.
Give angle of rotation.
As all the elements have been defined. OK is given after seeing the preview.

Part No: 4- COLLAR:

The first feature of the collar is created by producing the cross section of the collar as shown the figure. The command are as follows.

Feature – 1

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview
A required profile is drawn as per the dimensions.
Exit the sketcher by clicking the TICK mark.
Give angle of rotation.
As all the elements have been defined. OK is given after seeing the preview.

Part No: 5- TAPER PIN:

The first feature of the taper pin is created by producing the cross section of the collar as shown the figure. The command are as follows.

Feature – 1

Extrude tool>placement>Define>select>required plane>sketch>Draw profile>give options>Enter value depth (or) select surface, symmetric>preview
A required profile is drawn as per the dimensions.
Exit the sketcher by clicking the TICK mark.
Give angle of rotation.
As all the elements have been defined. OK is given after seeing the preview.

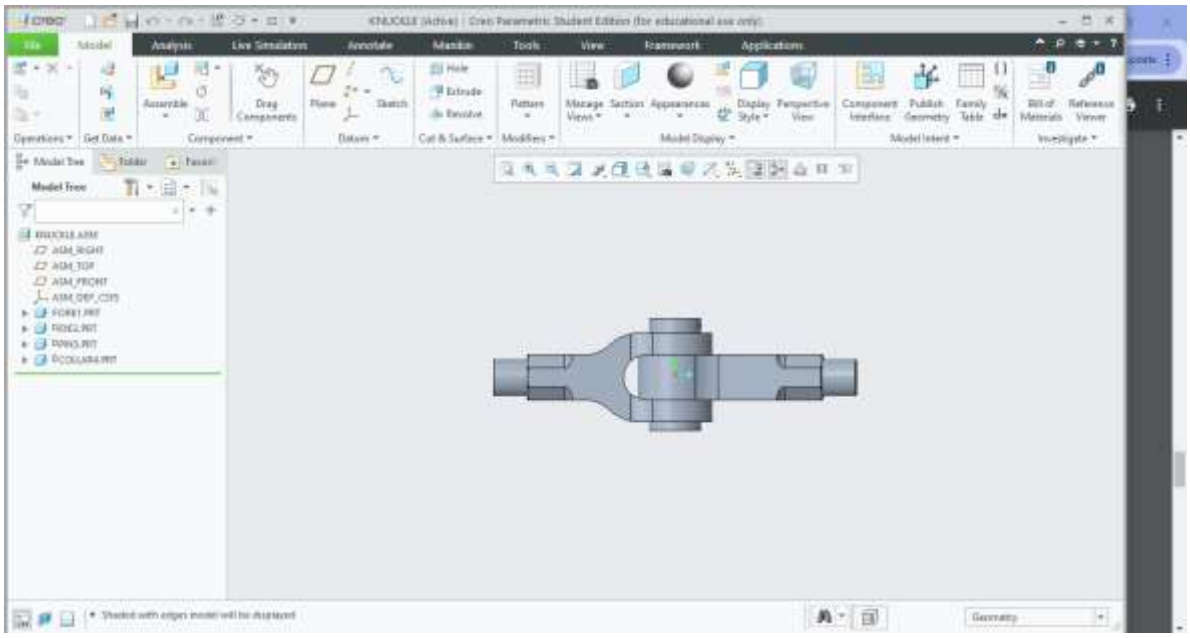
ASSEMBLY:

Assembling of the parts is carried out in a separate file. The KNUCKLE Body is first fixed using the plane constraints. The general command sequences are:

Command >Assemble>select the component that is to be assemble>Select the constraints that is to be created between the parts and chose appropriates surfaces as per the requirements of the constraints.

The part are assembled as per the following order

Fork (set as default)	Eye (Align, Mate)	Pin (Mate, Align)
Collar (Align, Mate)	Taper pin (Align, Default)	



CONCLUSION:

Thus creation of drawing 3D model and preparation of assembly models of Knuckle joint was carried out successfully in CREO 8 Parametric software with appropriate dimension values.

5. REFERENCE

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[2] Saurav Das, Vishvendra Bartaria, Prashant Panday, “Analysis of Knuckle Joint of 30C8 Steel For Automobile Engineering”, IJERT, Vol. 3, January 2014.

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[5] Russell G. Altherr, “Coupler knuckle pin protector structure and stress reliever”, 8449 Moraine Ave. Munster,Ind. 46321 on 15th Feb. 1994