Design & Analysis of Fork Pin & Its Assembly in Hydraulic Cylinder

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Abstract *— The traditional fork pin which connects with the next part in hydraulic cylinder with the help of bolt and nut. But, main problem occurs, when motion is transferred through the existing pin, the nut could be loose and may get detached from the assembly. Because of this problem, the assembly may get disassembled and may damage to other parts. So in this review paper, our main aim is to replace traditional nut & screw with modern fork pin with high strength to withstand desired motions considering sudden starting and reducing the assembly weight and its cost. In these days some of the places, where this fork pins are used, but it is having less strength, and meshing problems. So having said that, with the use of CREO modeling and ANSYs software we will carry a throughout analysis of fork pin with its assembly of existing design and the modified fork pin assembly analysis, mating & meshing criterions along with comparison of results with the practical conditions to achieve* maximum strength with minimum weight & cost.

Keywords— Fork pin, CREO, ANSYs, Meshing, Assembly, Strength, Stresses

I. Introduction

A mechanical joint is a part of a machine which is used to connect another mechanical part or mechanism. Mechanical joints may be temporary or permanent. Most types are designed for assembling & disassembling when required. A fork joint is used to connect the two fork ends 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.

The fork joint shafts consist of following major components:

1) The snap-on spring pin fork pin which is easily mounted and dismantled. It is therefore particularly suitable for applications where the articulated connection needs to be loosened often.
2) Double eye or fork pin with side mount ring can be fitted and dismantled without tools, i.e. by hand.
3) The pin with safety clip requires a tool for dismantling (e.g. a screw driver). It is therefore better secured.

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 modes of failure are:

1) Shear failure of pin (single shear).
2) Crushing of pin against rod.
3) Tensile failure of flat end bar.

Fig 1.1: Modern fork pins

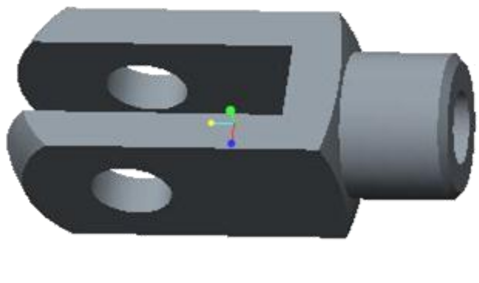

Fig 1.2: Fork

Applications of these particular forks are in the hydraulic cylinders, motor suspension clutches, fork compasses and in the bicycle telescopic fork.

II. Literature survey

Sourav Das, Vishvendra Bartaria, Prashant Pandey[1] , ''Analysis of knuckle joint of 30C8 steel for automobile application'',This review paper gives a brief study to calculate the stresses in fork joint replacing knuckle joint using analytical method. Further study in this direction can make by using various directions of the pin and the capacity to withstand loads. Another important thing that this paper serves is this guides us to do modeling and ansys analysis of fork pin with different material comaparisions and mating conditions.

Geng-Sheng Wang [2],''Computational Method for Evaluating the Fatigue Life of Mechanical Joints'', this research paper gives the throughout design structure of failure and damage of mechanical joints i.e fastners which is useful to carry the stress analysis of fork pin. As fastners are the most fatigue critical & having high stress concentration ,they conceives multiple parameters involved in the fastner design (i.e fork pin here) requires fatigue tests that often prolong the assembly . This will be helpful to maximize strength and minimizing weight criteria & costs along with strategies determined nowadays based on the modern computational techniques and the advanced crack growth models to analyse fatigue crack initiation and propagation even when friction, contact, interference fitting, fretting, and plasticity are involved. With a probabilistic solution, effects of multiple site damage and environmental attacks may also be addressed for various joints using conventional as well as advanced fastener systems.

D. Croccolo, R. Cuppini and N. Vincenzi [3], ‘’The design and the optimization of the Fork-pin compression joints in front Motorbike Suspensions.’’ ,This paper gives us the hint not to compromise with the friction criteria which can highly influence the design during mating conditions and as the motion passes through the hydraulic cylinder. This will affect the assembly due to sudden startings and motion deliveries as it disassembles the counter parts or may damage the assembly, so having said that the compression fit joints will correlate with starting friction co-efficient and mean pressure on the fork due to pin and sudden motions as well as environmental constraints considering axial force.

Dario Croccolo, Rossano Cuppini and Filippo Berto [4], ’’ Fatigue limit prediction of a compression fork-pin coupling of a front Motorbike suspension under fully reversed bending load’’. This research paper gives the futher idea about the previous concept including the bending load. In my case of fork pin, due to excessive forces or due to sudden motions passing through the pin causes bending on the pin, this may damnge the assembly. So this concept strikes us to consider the bending criterion of pin along with shear, tensile and crushing failures. As the pin is the core part in this assembly which we are going to replace with traditional screw and nuts.

William Lewis, Bruce Field and John Weir [5], ‘’Assessing quality of ideas in conceptual Mechanical design’’, This paper upgrade us to find upgraded design model with high performance with the use of conceptual design. A recurring theme in engineering design is the need to upgrade the performance of existing systems. Furthermore, this paper is concerned with the evaluation of skills exercised by designers when trying to solve “improvement” problems with attention focused on their creative effort during the conceptual design phase. Systematic analysis of their responses required the development of new research tools, firstly for assessing the quality of the design concepts proposed, and secondly for modeling the processes of ideation and argument used by each designers and guiding us to use new research tools for high performance of design.

III. MODELLING AND ANALYSIS OF EXISTING DESIGN

A. Existing concept with screw & nut assembly

-Generation of existing model of screw nut assembly for hydraulic cylinder.

- Software used :CREO
- Tools used: Modelling, Assembly.

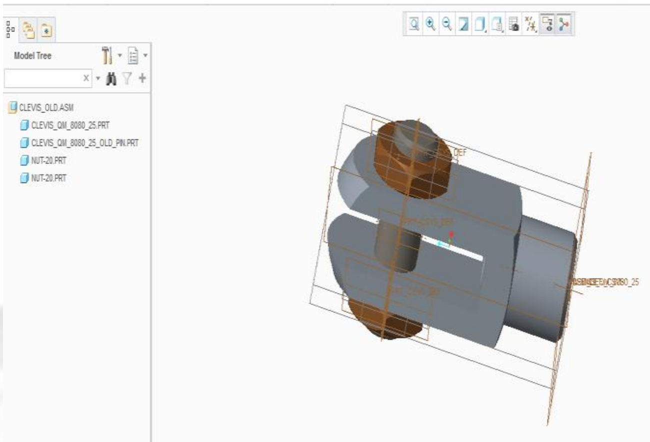

Fig 3.1: CREO modelling of screw

B. Analysis of Existing Assembly

-Stress analysis of existing concept (screw and nut assembly in fork) for the further comparison analysis with pin.

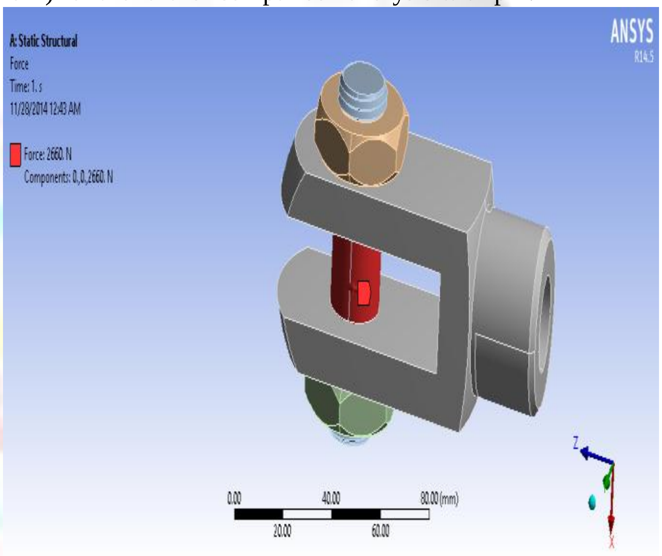

Fig 3.2: ANSYs analysis of screw nut fork assembly (Loading)

Material Data:

- Structural Steel

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

TABLE 1: Structural Steel > Constants

Compressive Ultimate Strength MPa
0

TABLE 2: Structural Steel > Compressive Ultimate Strength

Compressive Yield Strength MPa
250

TABLE 3: Structural Steel > Compressive Yield Strength

Tensile Yield Strength MPa
250

TABLE 4: Structural Steel > Tensile Yield Strength

Tensile Ultimate Strength MPa
460

TABLE 5: Structural Steel > Tensile Ultimate Strength

Reference Temperature C
22

TABLE 6: Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

IV. Conclusion

Any fastner design/mechanical joint design is the analysis of tensile, crushing, shear and bendling stress on assembly parts along with friction, fatigue, life and reliability analysis considering conceptual design concept. So from these papers, all the design criterions related to fork pin will be checked to run this research followed by literatures and refrenced books, journals. Furthermore, this research will conceive some meshing aspects (discretization) and comparative analytical results by changing materials to minimize weight and cost of structure.

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