Design, Analysis and Shape Optimization of Connecting Rod Considering Fatigue Life

[1] Kandhikanti Madhu [2]Dr, V Suresh, [3]Ayub Ashwak [4] Meruga Mahesh Babu

[1]STUDENT (M TECH), [2,] Professor, [3,4]Assistant Professor
Mechanical engineering Department,
HOLY MARY INSTITUTE OF TECHNOLOGY & SCIENCE Hyderabad India

Abstract: **The plug rod plays an important function as media player between piston assembly crankshaft whole assembly engines. It transforms the mutual action piston and rotates the crank; throughout its lifespan it faces often several tensile and compressive loads. Connecting rods are usually produced carbon steel and aluminum alloys are being used in connecting rods these last few days. This study substitutes connecting rod with aluminum and also outlines modeling link rod, as well as thermal analysis. Strong program for Catia modeling is used to create the 3-D solid rod attachment model. The connecting rod is evaluated by Ansys tools. The project's key goal is to examine thermal stresses rod connecting through various materials same geometry.**

Index Terms: **rod relation, ANSYS, thermal analysis.**

I. 1. INTRODUCTION TO DIESEL ENGINE

The diesel interior burning motor varies from gas controlled Otto cycle by utilizing exceedingly packed, hot air to light fuel instead utilizing start plug (pressure start as opposed to start). Just air is carried to ignition chamber at first in authentic diesel engine. In the vicinity between 15:1 and 22:1 air is then compacted to pressure amount that gives the weight of about (around 200 psi) oil engine. The air warmed up to 1022°F (150°C). This intensity is very high. The fuel is instantly injected into packed air in burning chamber about maximum point pressure stroke. There may be (usually toroidal) gap at top cylinder, or prechamber dependent on the engine plane. Owing to the blast effect in barrel, weights inside chamber increase heap is added on cylinder, thereby shifting to associated bar, which may justify the deceit of the interface bar.

1.1 ROD HISTORY LINKING

Any vehicle which uses an internal burning engine needs not less than one pole interface based on the number of barrels in the engine. Bars are routinely rendered by fashioning of either steel or polished metal in association with automobile applications. They could even be thrown away. Castings may, however, have blown openings unfavorable from the viewpoints of solidity and vulnerability. The way that blow-gap shapes and stronger bars have room over cast poles.

1.2 CONNECTING ROD INTRODUCTION: -

The related pole is core path from cylinder to the cell. Its basic ability is to push and pull from cylindrical stick to pivot and thus turn into revolving motion wrench through reacting movement cylinders. It has long shank, short end, wide end. Cross section shank can rectangular, oval, I or H segment. For majority roundabout section, low speed engines are used while fast I segments are favored. The small end related bar is usually rendered phosphorus bronze is sealed. It interacts with the cylinders through cylindrical stick methods. Usually, the large end associated bar (in two halves) is made up to install conveniently on padlock jar. The top separated into two high jolts is locked to enormous end. The covers immense end are constructed thin sheet white metal steel, metal or bronze (around 0.75 mms). The wearing massive end is taken into account by adding thin metal bands (so-called shims) roughly 0.04 mm thick from top to settled section corresponding bar. At least one strip is removed and tried up when wear occurs. The related poles are typically created by drops and should be acceptable consistency, firmness and low weight. Most content used to interface poles varies from gentle carbon steels to amalgam steels. The carbon steel has an extrem rigidity of roughly 650 MPa of 0.35% carbon. The extreme Elasticity is at 750 MPa when legitimately heated and 0.45% carbon carbon steel. These steels are used to attach mechanical engine bars. The composite steels have an intense elasticity of around 1050 MPa and are used for air motor bars.

1.3 SMALL END BEARING

In spite of the fact that the gudgeon stick and little end bearing straightforwardly respond against the burning burden they are never the less made apparently littler in width than wrench stick and enormous end bearing. The distinction in estimate is basically to oblige the little end of the associating pole with the cylinder however can be defended by little end be ring a profiting from the much lessened state of the aggregate responding and turning idleness powers made by the con pole and cylinder. Where a completely skimming kind of gudgeon stick is utilized, a different bearing shrub is squeezed into the eye of the con bar , its length being, for example, as far as possible the most extreme bearing weight of 62Mpa. Since the bearing is hard to grease up successfully on account of its swaying instead of rotational movement it must procedures a high level of strength. It is for the most part of composite development and contains steel backing fixed with a hard lead bronze combination. The get together attack of the gudgeon stick in the little end bramble has a tendency to be basic since an excess of freedom can deliver little end tapping

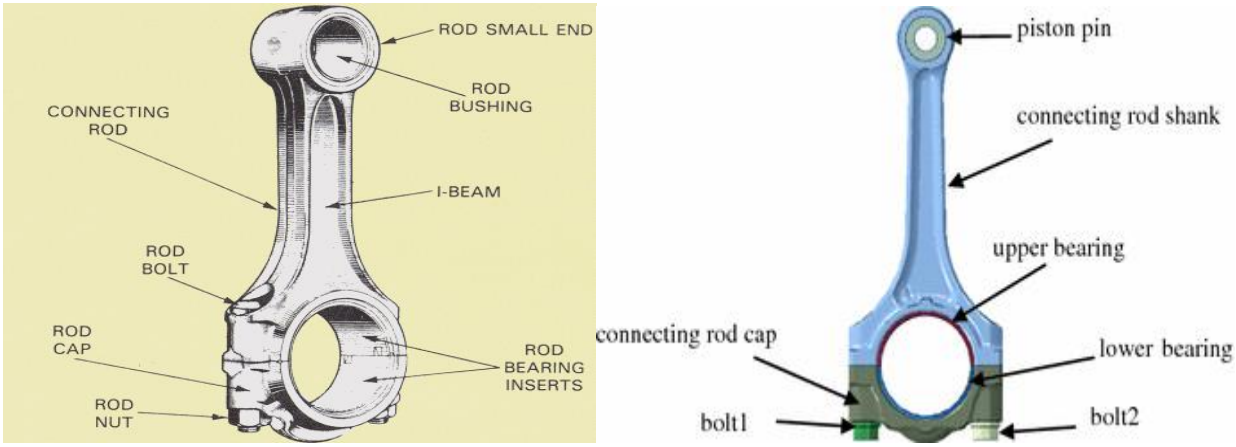


fig-1

commotion. Too little freedom when frosty can bring about the cylinder bearing shook by the rakish movement of the interfacing pole, thereby causing a transitory cylinder thumping clamor.

1.4 BIG END BEARING

They are composite development and comprise of a preformed thin steel support or shell to which is fortified at least one thin layers of moderately delicate bearing material. Thin divider course have a few imperative specialized points of interest, including a much enhanced weakness protection, a more minimal establishment and better appropriateness to large scale manufacturing necessities. Weariness protection concerns the capacity of the bearing to with stand fluctuating burdens at genuinely high temperatures and is the absolute most essential property expected of a heading. It is accomplished in the thin divider bearing on the grounds that there is less disfigurement occurring in the significantly slenderer layer of bearing material.

1.5 FORCES ACTING ON CONNECTING ROD: -

There are unlike powers operating on linking rod:

1. Piston power attributable to gas friction and reciprocal sections inertia.
2. Force attributable to twisting powers connecting rod or inertia.
3. Power since piston rings piston are friction,
4. The power piston pin padlock bearing friction.

II. INTRODUCTION TO CATIA

The CATIA is multi-stage business programming suite developed by the French Assault systems organisation, CATIA (Computer Assisted Three-dimensional Interactive Application). The Assault Systems Lifecycle Management Programming Suite is the cornerstone of CATIA written on C++.

CATIA is vying for Siemens NX, Pro/E, Autodesk Inventor, Strong Edge and several others in the CAD/CAM/CAE display case.

- **MECHANICAL ENGINEERING:**

3D pieces are allowed, from 3D depicts, metal sheets, composites and composite components, to sense of mechanical congregations, created, manufactured produced. It gives tools for finishing object descriptions, including utilitarian resistors, also defines cinematics.

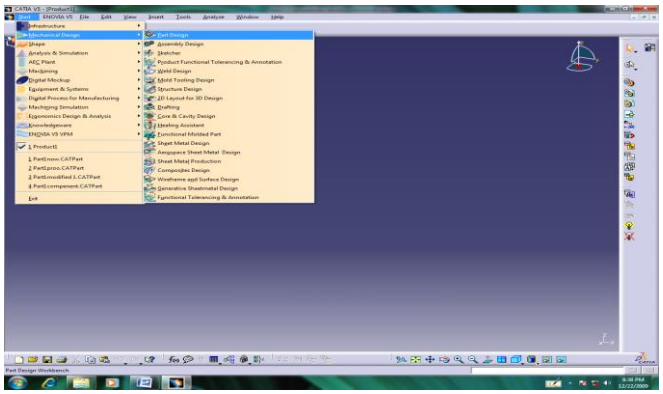
- **EQUIPMENT DESIGN:**

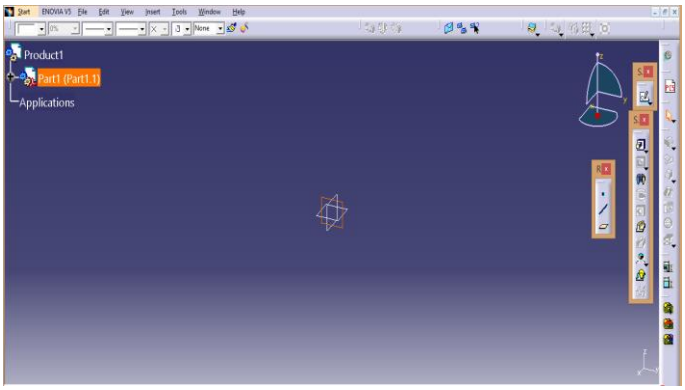
CATIA promotes the construction of mechanical, electric and transported systems, such as liquid and HVAC frames, as well as the distance between production and assembly papers.

- **STARTING CATIA**

In order that CATIA starts, there may be an icon on working field, or you may need to scan base computer windows taskbar in start menu. This software needs some time for piling, but rest confident that startups are done until device resembles a CATIA software default.

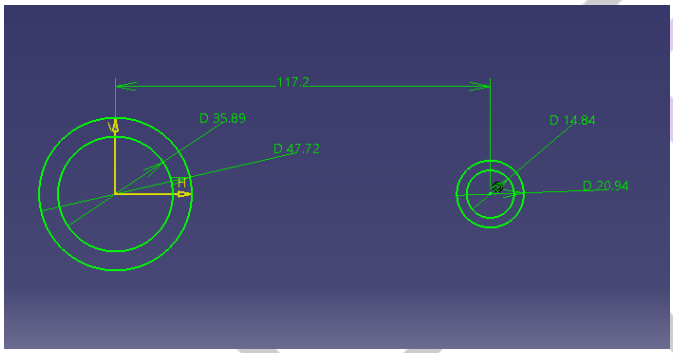
CATIA includes specific components that can carry out number of activities. The simple window and CATIA modules shown in the figure:



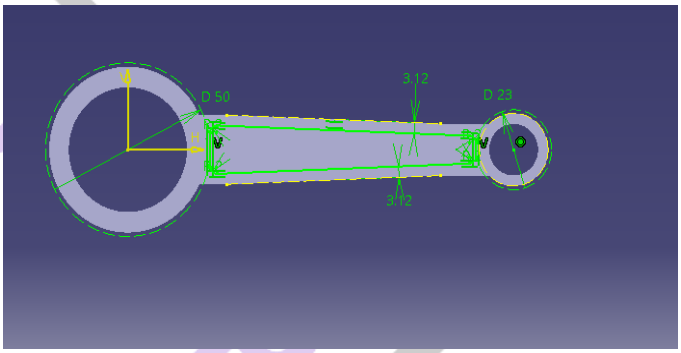


DESIGN PROCEDURE

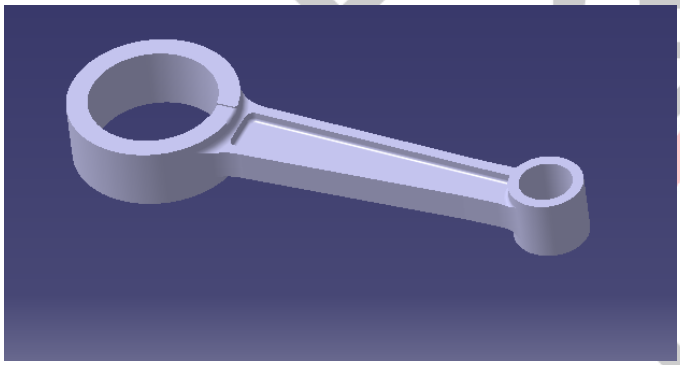
After selecting component contour map, three planes XY, YZ and ZX are displayed below picture screen. The XY styles speak to best bottom, Yz plane to front or back, ZX plane to right or left edge. Select ZX-plan and choose your screen-like skipper in these three designs.



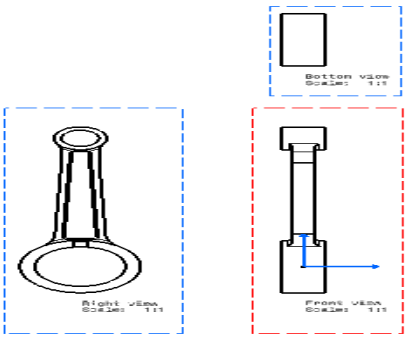
Sketch drawing:



Apply pad option:



Final product:



Drafting:

III. ANSYS
INTRODUCTION

ANSYS is program kit with general purpose FEA study. Finite element analysis is a computational means of deconstruction to very specific (user-designated) bits recognized as components complex structure. The program uses resolves equations that control and describe behavior of these components, including description of how method operates in its entirety. These data may then be shown in tabulated or graphic ways. This method analysis is commonly used to develop refine device that is much too difficult to evaluate manually. Systems that would fit in this group, regardless of their geometry, size or calculations, are too complicated.
In the Department of Mechanical Engineering, ANSYS is the standard FEA teaching tool in several classrooms. ANSYS is also used in areas of structural engineering, electrical engineering and physical and chemical engineering.
ANSYS is inexpensive way to investigate product or method output in simulated world. Digital prototyping is this form of product growth.
Users will iterate different situations using simulated prototyping techniques in order to refine software even before development begins. Which causes danger level expense of improper designs to be minimized. The multi-faceted existence of ANSYS often offers an insight into impact design on product's whole comportamiento, including electromagnetic, thermal, mechanical etc.

III.1 Generic Steps to solving any Problem in ANSYS:

You have describe (1) solution area, (2) physical model, (3) limit conditions and (4) physical properties, like solving every problem analytically. The dilemma is answered conclusions are presented. The only distinction in numerical methods is step in development of mesh. This is the phase through which complicated model is separated into small components, which can be overcome in otherwise challenging scenario. Here is much more detailed summary processes in terms.

III.1.1 Geometry construction

Create - or three-dimensional version modeled and evaluated object using the ANSYS work plane coordinates method.

III.1.2 Define properties of substance

When the piece resides, identify library materials required for modeling object or mission. This involves mechanical and thermal characteristics.

III.1.3 Render Mesh

ANSYS understands the composition component at this stage. Now describe how to split modeling framework in finite bits.

III.1.4 Tons of Application

After finishing the device, the last task load machine with restrictions physical loads or boundary constraints.

III.1.5 Solution achieved

It's actually a phase, since ANSYS wants to consider what situation the problem needs to be solved inside (state, transient... etc.).

III.1.6 results

After solution is found, ANSYS findings are displayed in several different formats, including charts, graphs and contour plots. There are several choices to choose from.

III.2 ANSYS SPECIFE SPECIFICALITIES

III. 2.1 Structural

Maybe more common application is the Structural Study, which includes bridges and houses, naval systems, air transport mechanical structures mechanical sections, like pistons, engine components and instruments, vessels' mountings, air freight and machinery.

• **Static measurement –** used for calculating displacement, voltage, etc. Static loading conditions. ANSYS may used to evaluate both linear nonlinear static analyses. Plasticity, intensification of stress, broad deflection, high stress, hyper elasticity, contact and creep may lead to non-linearities.

• **Transient dynamic analysis -** Used to evaluate structure's reaction to loads that are random in time. All nonlinearities mentioned above are permitted under static analysis

• **Hopper Analysis –** Used for measuring hopper loads and to decide the hopper mode shape. Buckling is possible both linear (Eigen value) and nonlinear.

In addition to analytical forms mentioned above, numerous special features, including fracture dynamics, composite material analysis, fatigue, p-Method and beam analyses, are also usable.

***NOTE:** These forms of analyzes should not preclude one another. For eg, thermal or adiabatic laminar testing may be done. A compressible or incompressible turbulent study may be.

IV. Results and descusion

IV.1 ANALYSIS OF RESULTS

In this section, the outcomes acquired for the examination of connecting rod for the first profile and transient investigation. And furthermore clarified the charts plotted by looking at those outcomes.

Geometry:

- If in design software kit, geometry component you wish to study was already known, importing part into ansys is usually more effective than re-creating it.
- The theories about usage of shell and line bodies are important to understand:
- The thickness gradients temperature are not taken into consideration for shell bodies. For tiny structures, shell body can be used considered to be the same on the surface top and bottom.
- There would also be surface difference in temperature, not from the thickness but is not directly modelled.

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	E:\catia\conecting rod\1.igs
Type	Iges
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	17.72 mm
Length Y	151.53 mm
Length Z	47.72 mm

Geometry

Object Name	*Mesh*
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Solver Preference	Mechanical APDL
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Fine
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium

Mesh

Mesh

The half component of the piston model is enough for study because symmetry. In the presence complex angled surfaces inner cavity, the piston form is irregular. General deliberate, intelligent automatic. It provides most reliable, effective mesh solutions for multiphysics. With simple mouse press, x well fit mesh can be produced for particular study for all sections model. The specialist consumer who wants to change it will provide full controls on options used to monitor mesh. The parallel computing capacity is used to dynamically minimize waiting period for mesh creation. The automated routing system for mapping is used.

Two-style meshing is open meshing and mapping. We used free meshing here because traction gear was irregular in form. We can't carry out mapped meshing for irregular forms. So here we did free meshing default mesh size i.e. the 6th mesh traction gear statistic is illustrated below.

Transient

Transient dynamic analysis is method use evaluate response structure to behavior some general time-dependent loads. The analysis is also named time history analysis. This method study used evaluate period varieties displacements, stresses forces in a system, reacts to some mixture of static, transient and harmonic loads. You may run transient test with fluid arrangement or static assembly in mechanical application. A transient, nonlinear or linear structural analysis can be. Nonlinearities of all forms are tolerated large deformations, plasticity, contact, hyper elasticity, etc. An additional mode overlay device solution to conduct linear transient structural analysis is given in ANSYS Workbench. You must split the load-to-time curve into necessary load steps for defining certain loads. Each "corner" on the load time curve may be one loading phase, evaluating for a second and showing performance.

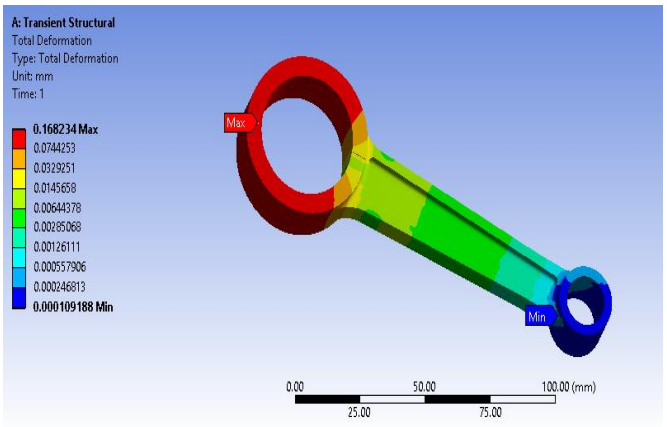
The rotational speed is: 62,882 rad/s is used for traction gear showed below and 2 forces i.e. Force 1: 1200 N Force 2: 1200 N with frictionless supports for transient structural analysis. Traction gear under transient structural analysis is shown below. Analysis

Object Name	*Transient (A5)*
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Transient
Solver Target	Mechanical APDL
Options	
Environment Temperature	22. °C
Generate Input Only	No

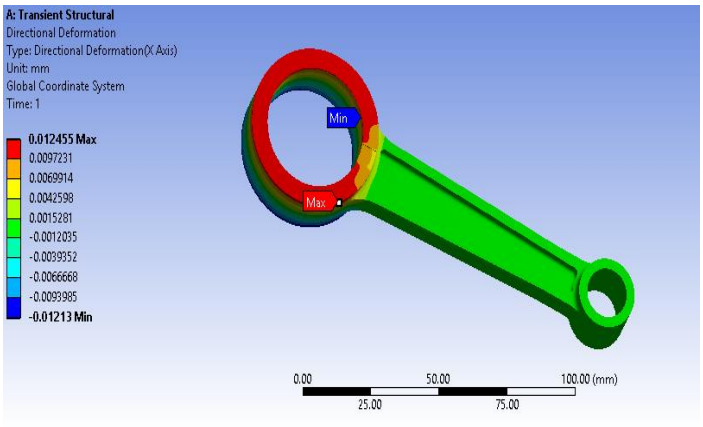
Initial Conditions

Object Name	*Initial Conditions*
State	Fully Defined

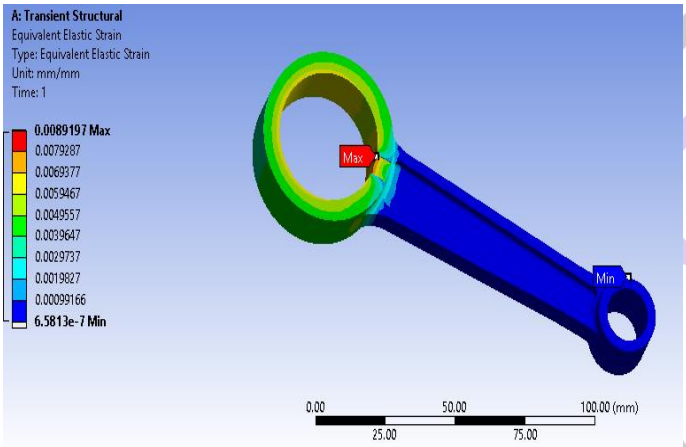
Loads



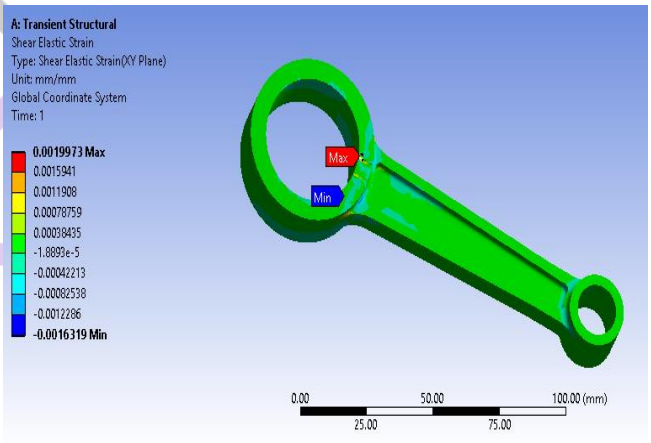
Total Deformation



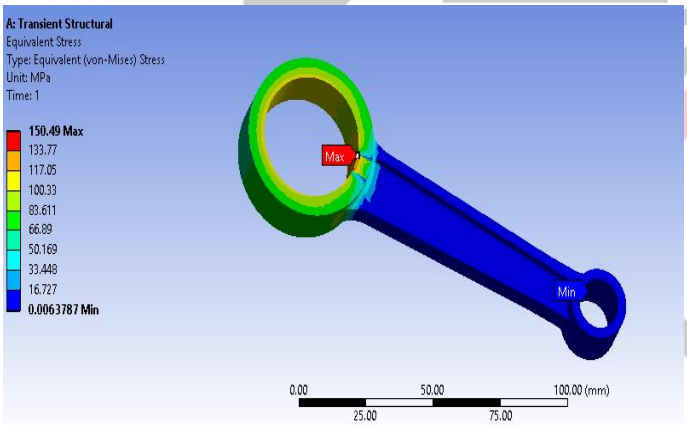
Directional Deformation



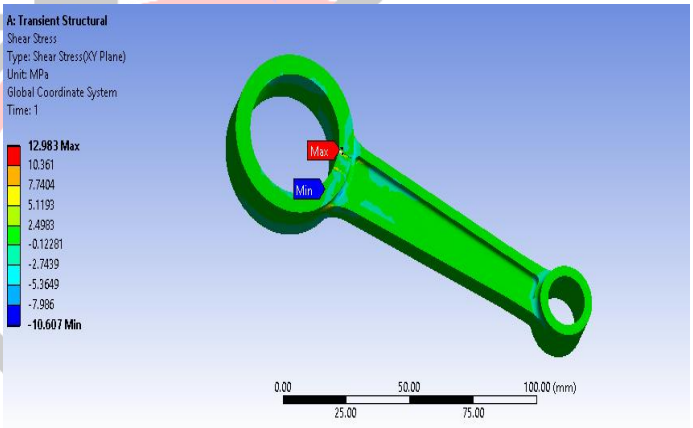
Equivalent Elastic Strain



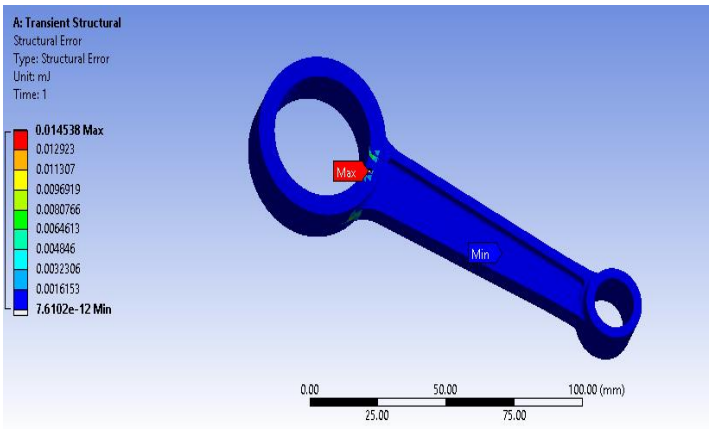
Shear Elastic Strain



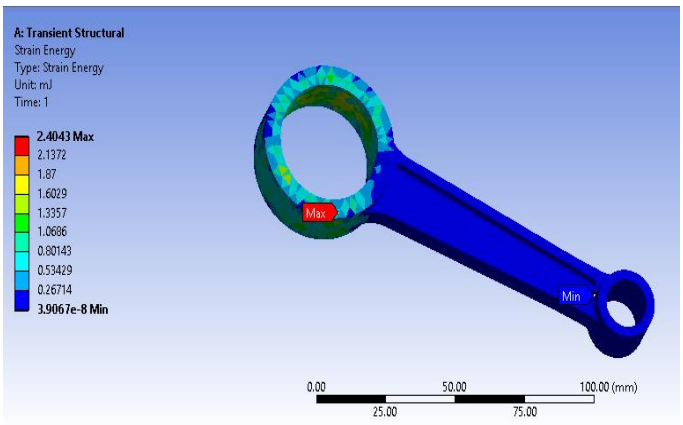
Equivalent Stress



Shear Stress



Structural Error



Strain Energy

V. Results and comparison:

- **forged steel**

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Shear Elastic Strain*	*Equivalent Stress*
Minimum	2.8963e-004 mm	-4.977e-002 mm	1.374e-006 mm/mm	-1.2779e-003 mm/mm	0.20516 MPa
Maximum	0.62799 mm	4.7053e-002 mm	5.3023e-003 mm/mm	1.1801e-003 mm/mm	1060.1 MPa

aluminium silcon carbide

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Shear Elastic Strain*	*Equivalent Stress*	*Shear Stress*
Minimum	2.9785e-004 mm	-2.369e-003 mm	7.4254e-008 mm/mm	-1.846e-004 mm/mm	6.4033e-003 MPa	-10.65 MPa
Maximum	1.8282e-002 mm	3.8955e-004 mm	1.012e-003 mm/mm	2.258e-004 mm/mm	151.56 MPa	13.027 MPa

AL203

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Shear Elastic Strain*	*Equivalent Stress*	*Shear Stress*	*Structural Error*	*Strain Energy*
State	Solved							
Results								
Minimum	1.092e-004 mm	-1.213e-002 mm	6.5813e-007 mm/mm	-1.6319e-003 mm/mm	6.3787e-003 MPa	-10.607 MPa	7.6104e-012 mJ	3.9067e-008 mJ
Maximum	0.16823 mm	1.2455e-002 mm	8.9197e-003 mm/mm	1.9973e-003 mm/mm	150.49 MPa	12.983 MPa	1.4538e-002 mJ	2.4043 mJ

The project benefits from ansys applications with correct setup, complex analytical loads derived from initial measurements rod connection value even rod specification formulas and results.

* The importance of bend in AL203 smaller than the current content
* Two other chemicals relative to two other materials are less painful for AL203.
* Gross strain equal for AL203 materials is more compared to two other materials.
* TERRICAL Overall Pressure, Stress Strength and best in structural error is more comparable with current materials AL203 in shear elastic strain.
* The Equivalent Tension, Shear Elastic Strain relative to current aluminum alloy is more,

VI. CONCLUSION

In this thesis, Titanium TIC and AL203 are substituted by a shattered connecting rod constructed of cast steel. The components are modified so that when Titanium TIC and AL203 are used, the weight connecting rod is smaller than Cast Steel. The connecting rod has a catia model, forces measured. TitaniumTIC and AL203 materials are tested on the connector rod after the test findings have been validated.

- We have modified some its parameters and reduced tension level in Al203 to maximize stress connecting rod.
- A fragile and solid attachment rod segment is tested and potential changes have been developed.
- We have fixed some errors in reference data by measuring and evaluating connected rod.
- There is also comparison with potential safety factor is less than safety feature (factor of safety obtained in ansys).
- In the current configuration we did not create big improvement.

The outcome reached by almost identical to findings reference paper and any improvements to this result are not really good

REFERENCES

1. D. Gopinath and Ch. V. Sushma / Materials Today: Proceedings 2 (2015) 2291 – 2299, Design and Optimization of Four Wheeler Connecting Rod Using Finite Element Analysis,
2. Dongkai Jia ,Ke Wu,Shi Wu, Yuntong Jia, Chao Liang (2011) International Conference on Electronic & Mechanical Engineering and Information Technology,
3. The Manufacturing Engineering Society International Conference, MESIC 2015 Procedia Engineering 132 (2015) 313 – 318 J.P. Fuertes et al. / Procedia Engineering 132 (2015) 313 – 318.
4 .Journal of Materials Engineering and Performance (Submitted April 7, 2015; in revised form July 29, 2016) Isa Metin O¨zkara and Murat Baydog˘an, (2016) Optimization of Thixoforging Parameters for C70S6 Steel Connecting Rods.
5. Mohammed Mohsin Ali Ha , Mohamed Haneef Analysis of Fatigue Stresses on Connecting Rod Subjected to Concentrated Loads At The Big End.