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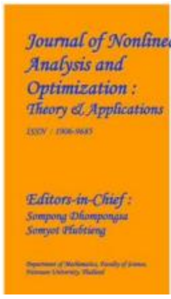

THERMAL ANALYSIS AND MODELING OF CONNECTING ROD USING DIFFERENT MATERIALS

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ABSTRACT

The connecting rod is the intermediate member between the piston and the Crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin, thus converting the reciprocating motion of the piston into rotary motion of the crank. This thesis describes designing and Analysis of connecting rod. Currently, existing connecting rod is manufactured by using Forged steel. In this, drawing is drafted from the calculations. A parametric model of Connecting rod is modeled using CATIA V5 R20 software and to that model, analysis is carried out by using ANSYS Workbench Software. Finite element analysis of connecting rod is done by considering the materials, such as Titanium Alloy, Beryllium Alloy – 25, Magnesium Alloy and Aluminum 360. The best combination of parameters like Von misses Stress and strain, Deformation, Factor of safety and weight reduction for two wheeler piston were done in ANSYS software. Aluminium Alloy has more factor of safety, reduce the weight, reduce the stress and stiffer than other material like Forged Steel. With Fatigue analysis we can determine the lifetime of the connecting rod.

Keywords: forging and cnc lathe machines, connecting rod, and parametric feature.

1. INTRODUCTION TO DIESEL ENGINE

The diesel interior burning motor varies from the gas controlled Otto cycle by utilizing exceedingly packed, hot air to light the fuel instead of utilizing a start plug (pressure start as opposed to start).

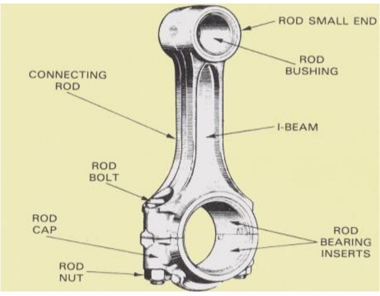
In the genuine diesel motor, just air is at first brought into the ignition chamber. The air is then compacted with a pressure proportion normally in the vicinity of 15:1 and 22:1 bringing about 40-bar (4.0 MPa; 580 psi) weight contrasted with 8 to 14 bars (0.80 to 1.4 MPa) (around 200 psi) in the petroleum motor. This high pressure warms the air to 550 °C (1,022 °F). At about the highest point of the pressure stroke, fuel is infused straightforwardly into the packed air in the burning chamber. This might be into a (commonly toroidal) void in the highest point of the cylinder or a pre-chamber contingent on the plan of the motor. Because of the blast impact in the barrel causes a bring up in weights inside the chamber, which applies a heap on the cylinder, that thusly exchange to the associating bar, which may cause an explanation behind disappointment of interfacing pole.

1.2 CONNECTING ROD BACKGROUND

Each vehicle that uses an inside burning motor requires no less than one interfacing pole contingent on the quantity of barrels in the motor.

Associating bars for car applications are regularly produced by fashioning from either created steel or powdered metal. They could likewise be thrown. Be that as it may, castings could have blow-openings which are unfavorable from sturdiness and weakness perspectives. The way that forgings deliver blow-gap free and better bars gives them leeway over cast poles.

1.3 CONNECTING ROD INTRODUCTION:-



The associating pole is the middle of the road part between the cylinder and the crankshaft. Its essential capacity is to transmit the push and draw from the cylinder stick to the crankpin and in this way change over the responding movement of the cylinder into rotating movement of the wrench. It comprises of a long shank, a little end and a major end. The cross - area of shank might be rectangular, round, I-segment tubular-segment or H-segment.

For the most part roundabout segment is utilized for low speed motors while I-segment is favored for fast. The little end of the associating bar is normally made as an eye and is given a hedge of phosphor bronze .It is interfacing with the cylinder by methods for a cylinder stick.

The huge end of the associating bar is typically made part (in two halves)so that it can be mounted effortlessly on the crankpin bearing shells . The split top is secured to the huge end with two top jolts. The bearing shells of the huge end are made of steel, metal or bronze with a thin coating (around 0.75mm)of white metal.

The wear of the enormous end, bearing is took into consideration by embeddings thin metallic strips (known as shims) around 0.04mm thick between the top and the settled portion of the associating bar. As the wear happens, at least one strips are evacuated and the trued up.

The associating poles are normally made by drop producing procedure and it ought to have satisfactory quality, firmness and least weight. The material for the most part utilized for interfacing poles shifts from gentle carbon steels to amalgam steels. The carbon steel having 0.35 percent carbon has an extreme rigidity of around 650 MPa.

1.6 FORCES ACTING ON THE CONNECTING ROD:-

The various forces acting on the connecting rod are as follows:

1. Force on the piston due to gas pressure and inertia of the reciprocating parts.

2. Force due to inertia of the connecting rod or inertia bending forces.

3. Force due to friction of the piston rings and of the piston, and

4. Force due to friction of the piston pin bearing and the crankpin bearing.

We shall now derive the expressions for the forces acting on a vertical engine, as discussed below.

2. LITERATURE REVIEW

The interfacing bar is subjected to a perplexing condition of stacking. It experiences high cyclic heaps of the request of 108 to 109 cycles, which extend from high compressive loads because of ignition, to high ductile loads because of latency. Thusly, toughness of this part is of basic significance. Because of these elements, the interfacing bar has been the theme of research for various angles, for example, creation innovation, materials, execution reenactment, exhaustion, and so on. For the present examination, it was important to explore limited component demonstrating methods, enhancement strategies, improvements underway innovation, new materials, weariness displaying, and producing cost investigation. This concise writing study audits some of these viewpoints.

- Isa Metin O¨zkara and Murat Baydog˘ an, (2016)Optimization of Thixoforging Parameters for C70S6 Steel Connecting Rods A microalloyed steel, C70S6, with a solidification interval of 1390-1479 C, was thixoforged in the semisolid state in a closed die at temperatures in the range 1400-1475 C to form a 1/7 scaled-down model of a passenger vehicle connecting rod. Die design and an optimized thixoforging temperature eliminated the excessive flash and other problems during forging. Tension test samples from connecting rods thixo forged at the optimum temperature of 1440 C exhibited nearly the same hardness, yield strength, and ultimate tensile strength as conventional hot forged samples but ductility decreased by about 45% due to grain boundary ferrite network formed during cooling from the thixoforging temperature. Thus, C70S6-grade steel can be thixoforged at 1440 C to form flash-free connecting rods. This conclusion was also validated using FEA analysis.

3. CATIA

DESIGN OF CONNECTING ROD

According to rankine formulae

A = Cross-sectional area of the connecting rod,

l = Length of the connecting rod,

σ_c = Compressive yield stress,

W_B = Buckling load,

I_{xx} and I_{yy} = Moment of inertia of the section about X-axis and Y-axis respectively

k_{xx} and k_{yy} = Radius of gyration of the section about X-axis and Y-axis respectively

W_B about x-axis $= \frac{[\sigma c \times A]}{1+a[\frac{L}{Kxx}]^2} = \frac{[\sigma c \times A]}{1+a[\frac{l}{Kxx}]^2}$

$[\therefore for\ both\ ends\ hinged\ L=l]$

W_B about y-axis $= \frac{[\sigma c \times A]}{1+a[\frac{L}{Kyy}]^2} = \frac{[\sigma c \times A]}{1+a[\frac{l}{2Kyy}]^2}$

$[\therefore for\ both\ ends\ fixed\ L=l/2]$

L = Equivalent length of the connecting rod, and

a = Constant

= 1 / 7500, for mild steel

= 1 / 9000, for wrought iron

= 1 / 1600, for cast iron

In order to have a connecting rod equally strong in buck

nust be equal. i.e.

$$\frac{[\sigma c \times A]}{1+a[\frac{L}{Kxx}]^2} = \frac{[\sigma c \times A]}{1+a[\frac{l}{2Kyy}]^2}$$

$$[\frac{L}{Kxx}]^2 = [\frac{l}{2Kyy}]^2$$

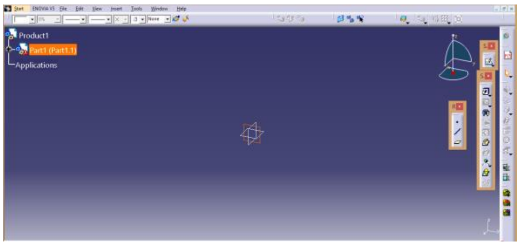
$$K^2xx = 4K^2yy \quad [or] \quad I\,xx = 4Iyy \quad [\therefore I = A \times K^2]$$

1. INTRODUCTION TO CATIA:

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-stage CAD/CAM/CAE business programming suite created by the French organization Assault Systems. Written in the C++ programming dialect, CATIA is the foundation of the Assault Systems item lifecycle administration programming suite.

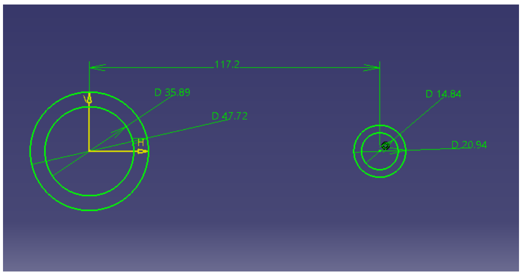
CATIA contends in the CAD/CAM/CAE showcase with Siemens NX, Pro/E, Autodesk Inventor, and Solid Edge and numerous others.

Sketch of the Model:

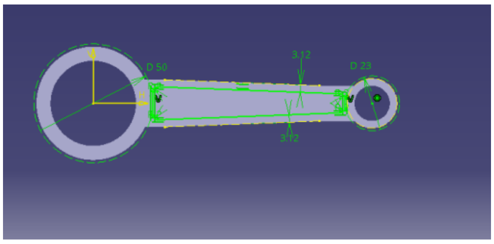


Subsequent to choosing the part outline module screen is as demonstrated is underneath figure in the screen there will be three planes XY, YZ and ZX planes. The XY designs speak to best or base view, the YZ plane speak to front or back view and ZX plane speak to right side or left side view. In that three designs select ZX-plane and select sketcher your screen resembles.

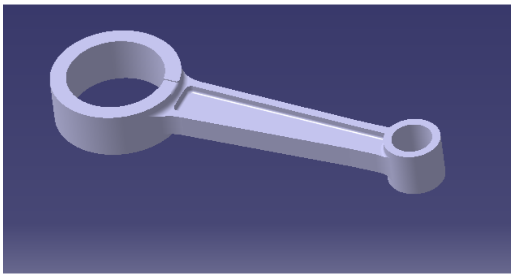
Sketch drawing:



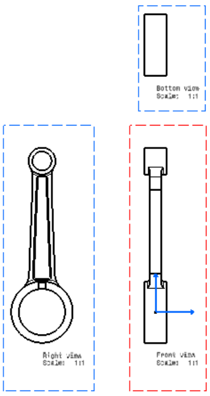
Apply pad option:



Final product:



Drafting:

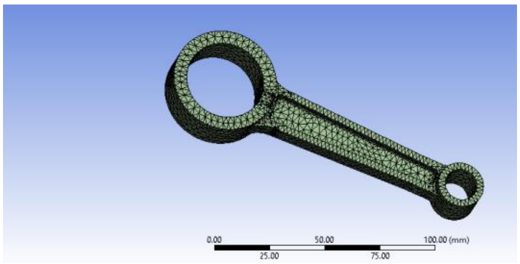


5.1 ANALYSIS OF RESULTS

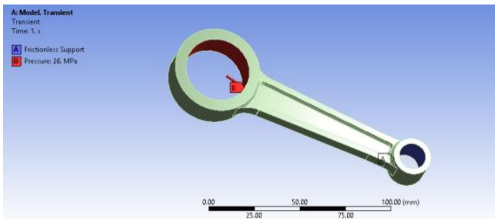
In this section, the outcomes acquired for the examination of connecting rod for the first profile and transient investigation. And furthermore clarified the charts plotted by looking at those outcomes.

- **Forged steel**

Mesh



Transient



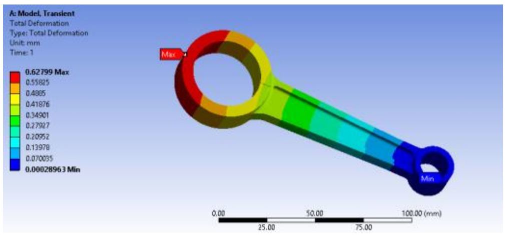
Loads

Object Name	*Frictionless Support*	*Pressure*	*Thermal Condition*
Geometry	2 Faces		1 Body
Magnitude		26. MPa step applied)	400. °C step applied)

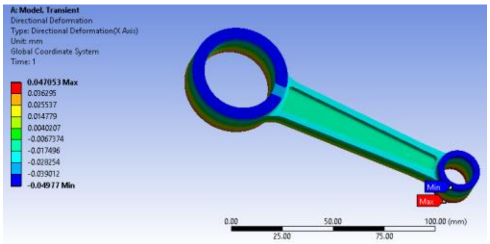
Results

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	-2779e-003 mm/mm	0.20516 MPa
Maximum	0.6279 9 mm	4.7053e 002 mm	5.3023e -003 mm/mm	1.180 le-003 mm/mm	1060.1 MPa

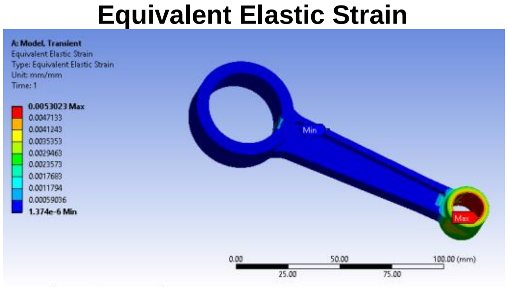
Total Deformation



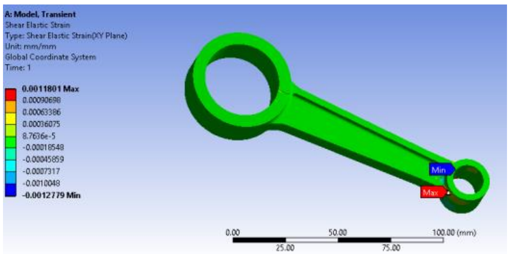
Directional Deformation



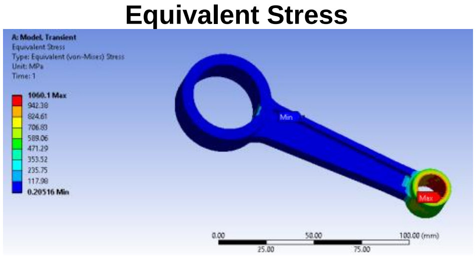
Equivalent Elastic Strain



Shear Elastic Strain



Equivalent Stress



Material results:

- al203

TABLE 13
Results

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	-.213e-002 mm	6.5813e-007 mm/mm	-.6319e-003 mm/mm	6.3737e-003 MPa	-0.607 MPa	7.6104e-012 mJ	3.967e-008 mJ
Maximum	0.16823 mm	1.2455e-002 mm	8.9197e-003 mm/mm	1.973e-003 mm/mm	150.49 MPa	12.83 MPa	1.4538e-002 mJ	2.4043 mJ
Information								
Time	1. s							

FIGURE 3
Total Deformation

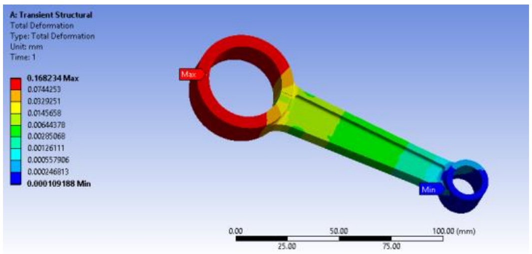


FIGURE 4
Directional Deformation

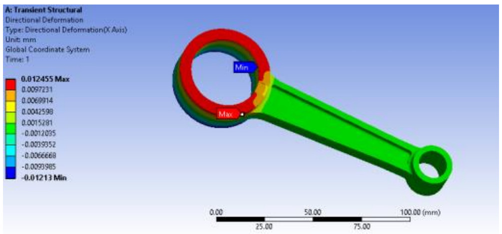


FIGURE 5
Equivalent Elastic Strain

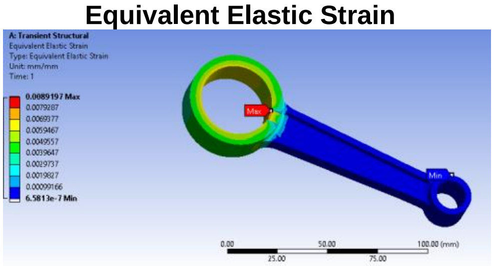


FIGURE 6
Shear Elastic Strain

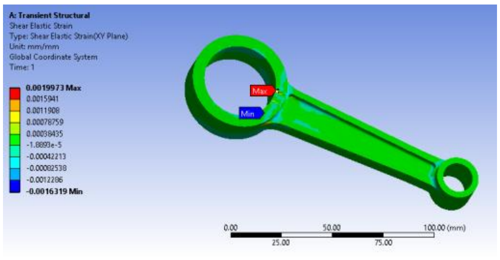
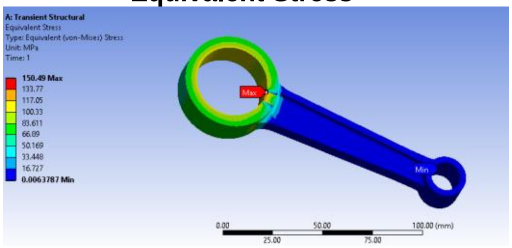


FIGURE 7
Equivalent Stress



Shear Stress

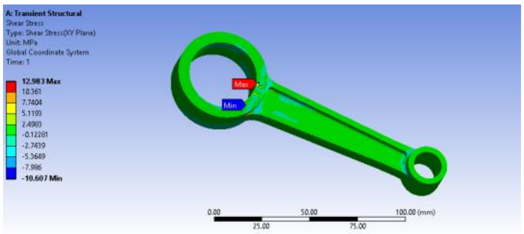


FIGURE 9
Structural Error

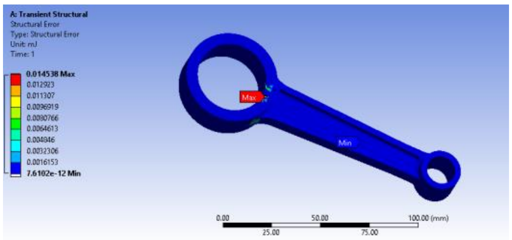
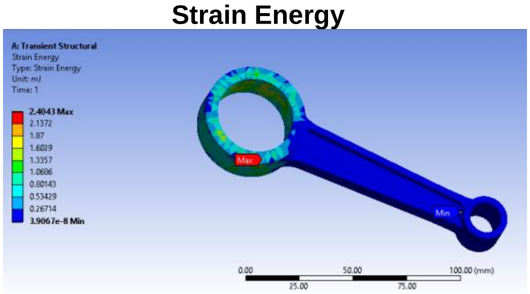
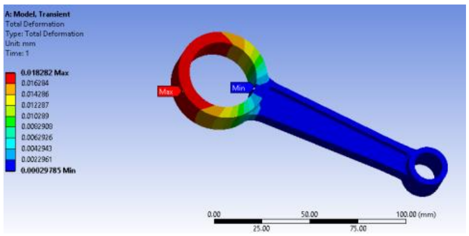


FIGURE 10
Strain Energy

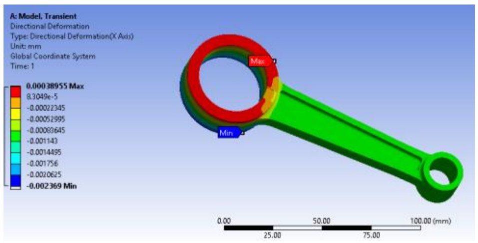


Objec Name	*Total Deform ation*	*Directi onal eforma tion*	*Equiv alent Elastic Strain*	*She ar lastic Strain*	*Equiv alent Stress*	*She ar tress*
Minim um	2.978 5e-004 mm	- .369e-03 mm	7.425 4e-008 mm/mm	- .846e -004 mm/m m	6.403 3e-003 MPa	- 0.65 MPa
Maxi mum	1.828 2e-002 mm	3.895 5e-004 mm	1.012 e-003 mm/mm	2.25 8e-004 mm/m m	151.5 5 MPa	13. 027 MPa

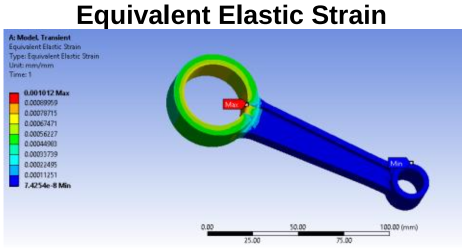
Total Deformation



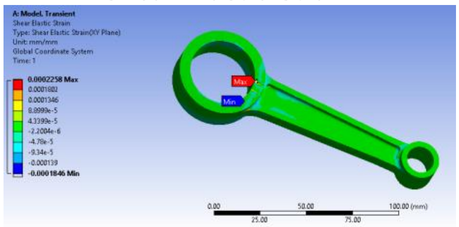
Directional Deformation



Equivalent Elastic Strain



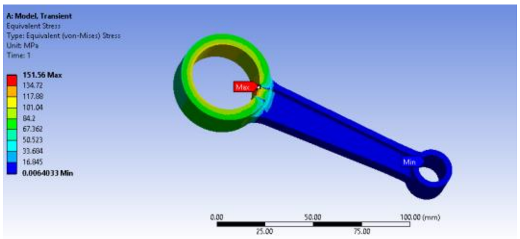
Shear Elastic Strain



Equivalent Stress

- Material Data
  - aluminium silcon carbide

Results



Results and comparison:

- **forged steel**

Object Name	*Total ›eformati on*	*Direction al ›eformatio n*	*Equivale ıt Elastic Strain*	*Shear Elastic Strain*	*Equivale ıt Stress*
Minimu m	2.8963e 004 mm	-4.977e- 002 mm	1.374e- 006 mm/mm	- .2779e- 003 ım/mm	0.20516 MPa
Maximu m	0.62799 mm	4.7053e- 002 mm	5.3023e- 003 mm/mm	1.1801 e-003 ım/mm	1060.1 MPa

aluminium silcon carbide

Object Name	*Total eformati on*	*Directio nal ›eformati on*	*Equival ıt Elastic Strain*	*Shea r ›lastic Strain*	*Equival ıt Stress*	*Shea Stress*
Minim um	2.9785 004 mm	-2.369e- 003 mm	7.4254e -008 nm/mm	- .846e- 004 ım/m m	6.4033e 003 MPa	- 0.65 MPa
Maxim um	1.8282 002 mm	3.8955e 004 mm	1.012e- 003 nm/mm	2.258 ‑004 ım/m m	151.56 MPa	13.0 27 MPa

AL203

Obje ct Name	*Total ›eform ation*	*Direct ional eforma tion*	*Equiv alent ›lastic Strain*	*Shea r lastic train*	*Equiv alent Stress*	*She ar ress*	*Struc tural Error*	*Strai n nergy*
Mini mum	1.092 ‑004 mm	- .213e- 02 mm	6.581 e-007 m/mm	- 6319 -003 ım/m m	6.378 e-003 MPa	- 0.60 7 ΛPa	7.610 e-012 mJ	3.90 57e- 08 mJ
Maxi mum	0.168 3 mm	1.245 ›e-002 mm	8.919 e-003 m/mm	1.99 73e- 003 ım/m m	150.4 MPa	12. 983 ΛPa	1.453 e-002 mJ	2.40 3 mJ

From this project results are obtained from ansys software with accurate design and dynamic analysis and loads are taken from original connecting rod values and design measurements also taken connecting rod design formulas and above results are observing

- ∗ Deformation value is less in AL203comparing with existing material

- ∗ Equivalent Stress are least in AL203 materials comparing with other two materials
- ∗ Equivalent Total Strain is more in AL203 materials comparing with other two materials
- ∗ Comparing with existing material AL203 materials is more in Shear Elastic Strain, Equivalent Total Strain, Stress Intensity, and better in structural error.
- ∗ Comparing with existing material aluminum alloy is more in Equivalent Stress, Shear Elastic Strain,

CONCLUSION

In this thesis, a broken connecting rod made of forged steel is replaced Titanium TIC and AL203. The materials are changed so that the weight of the connecting rod is less when Titanium TIC and AL203 are used than Forged Steel. The connecting rod is modeled in catia, forces are calculated. Analysis is done on the connecting rod using materials Titanium TIC and AL203 After validating the analysis results,

- In order to optimize the stress of connecting rod we have changed some of its parameters and the stress level get reduced in Al203

- A weak and strong section of connecting rod is verified and possible modifications have been done to correct it.
- Some of the mistakes in reference data is being corrected by us through calculation and analysis of connecting rod.
- A comparison is also made between theoretical factor of safety which is less than working factor of safety (factor of safety obtained in ansys).
- We could not bring a major change in the existing design.
- The result obtained by us is nearly equal to the reference paper result and any change in this result is not very much favorable.

Reference:

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