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MODELLING AND ANALYSIS OF I .C ENGINE CONNECTING ROD

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Abstract

The key aim of this project is to investigate the varying stress involved for a forged steel connecting rod. This study deals with two things, namely design and stress analysis of the connecting rod. Design of connecting rod will be discussed in the first part of the study like Measuring dimensions of forged steel connecting rods and drawing the 2D profiles and converting it to 3D parts after which assembling the parts of the connecting rod and also Part file is converted to IGES file by using Solid Edge V20 software. Secondly the connecting rod tension analysis contains the following steps like importing the IGES file to Ansys Workbench Simulation Environment, meshing the connecting rod at different element size in different surface areas, applying the constraints and loads in suitable surface area of the connecting rod and Solving for the variable stresses involved in forged steel material based connecting rods.

Keywords – *Ansys, Connecting rod, Finite Element Analysis, Stress analysis, Solid Edge Version 20.*

I. Introduction

The connecting rod of the car engine attaches the reciprocating piston to the spinning crankshaft and transmits the piston thrust to the crankshaft. Every vehicle using an internal combustion engine needs at least one connecting rod, depending on the number of engine cylinders. Usually, the connecting rods are created by welding either wrought steel or by powdered metal. The process of forging produces blow-hole-free which give them an advantage over cast rods. Powder metallic blank prices are high, and processed blanks have the advantage of being similar to net formed. Forging of forged steel, the stock is cheap, and the method of producing the hard component. Bringing the part under tight tolerance to final dimensions results in high machining expenditure, since the blank usually contains more excess material. Metal matrix composites widely used in automobile and aerospace applications [1-35] This paper presents the comparative study of analysis of connecting rod through static Fem

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method and by quasi dynamic Fem method for variable stresses and it is clear that there is a difference in stresses at these analysis. [36-45] They stated that connecting rod was simulated in Solid Works software, meshed in ANSYS software and critical loads were exerted on it finally stress analysis was done and also the maximum tensile and pressure stress acted on the pin end of the rod of connecting rod. The first part of the work was to examine and equate the tensile, compressive and fatigue resistance of forged steel connecting rods with those of the connecting rods cast with iron. The second element was to analyze for varying stress involved in connecting rod through static stress method. For the current study, finite element modeling techniques is used for the investigation.

II. Designing connecting rod using Solid Edge

Solid Edge Version 20, a powerful 3D CAD software application Version 20 also enhances the industry-leading capability of Solid Edge for 2D/3D hybrid design with increased familiarity for AutoCAD users, a new ability to create 3D parts from 2D assembly layouts and a new and unique "Zero D" capability that allows you to define the product structure before any geometry is committed to paper. Solid Edge Mold Tooling is also being enhanced to now facilitate the design of unlimited size multi-core, multi-cavity plastic injection molds, with a variety of international standard or custom mold bases. Solid Edge has separate environments to create parts, build assemblies and make drawings. Every environment is autonomous. For example, in the Draft environment all the commands you need to create a drawing are in. The environments are tightly integrated, making the completion of your designs easy to move among them.

2.1 Part environment

The Modelling environment for the Solid Edge component helps to create solid 3D models with true features. The process of part modelling begins with a base feature, such as a block or cylinder that builds on with part features to create a part model. Part characteristics include protrusions and cut-outs (extruded, rotated, swept, and lofted), holes, ribs, thin-walled solids, rounds, angles of draft and chamfers. The program keeps track of building features, modifies the function but hides them from view when working on other parts of the design and even applies your own construction geometry, such as extruded, lofted, and swept surfaces, intersection curves, planned curves, and intersection points.

2.2 Smart Step

Smart Step controls the flow of each function command- a ribbon bar which guides each step of creating a feature. For example, after creating a rib, its profile can be quickly modified or its thickness changed.

2.3 Intelligent Sketching

Intelligent Sketch helps draw 2D profiles with precision for use in the design of applications and offers immediate feedback on relationships between the drawing elements and other profile elements or edges of the pieces. Use Intelligent Sketch to make elements horizontal or vertical, or to make one element parallel or perpendicular, or to connect a profile element to a part edge.

2.4 Solid edge window

This window includes the draw tool bar, modify tool bar, feature tool bar, etc. Figure 1 show the windows in solid edge software and creation of 2D and 3D models of connecting rod are shown in Figure 2 and 3.

2.5 Edge bar

Edge bar consists of types of commands used to draw the three dimensional part of connecting rod as shown in Figure 4.

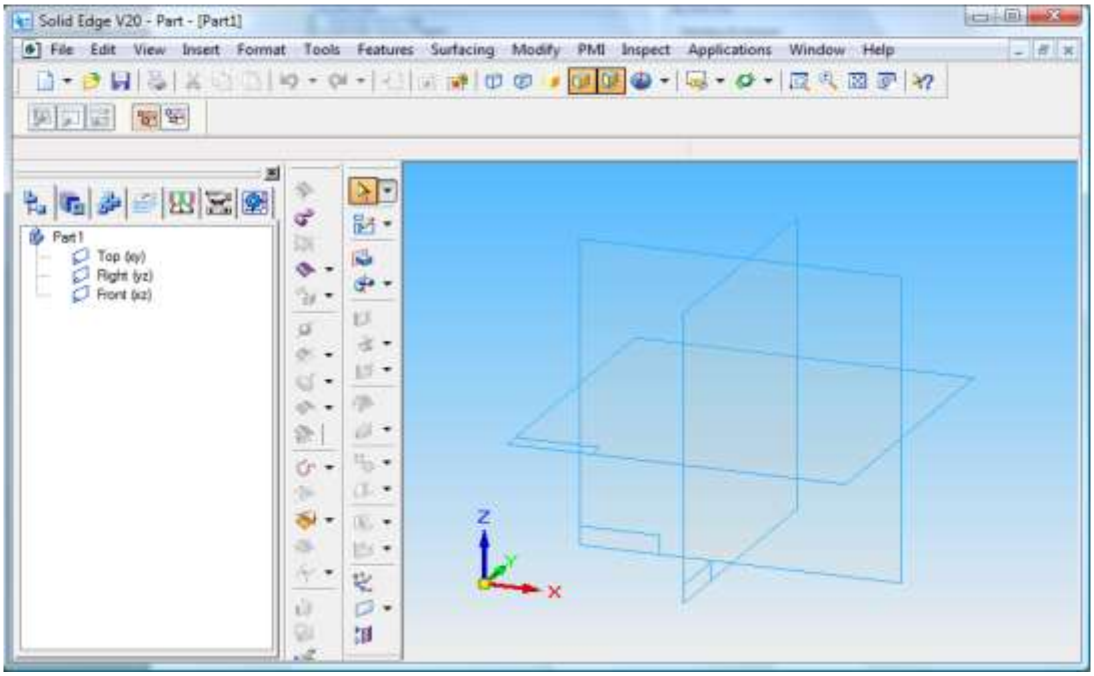

Fig. 1 Shows solid edge window.

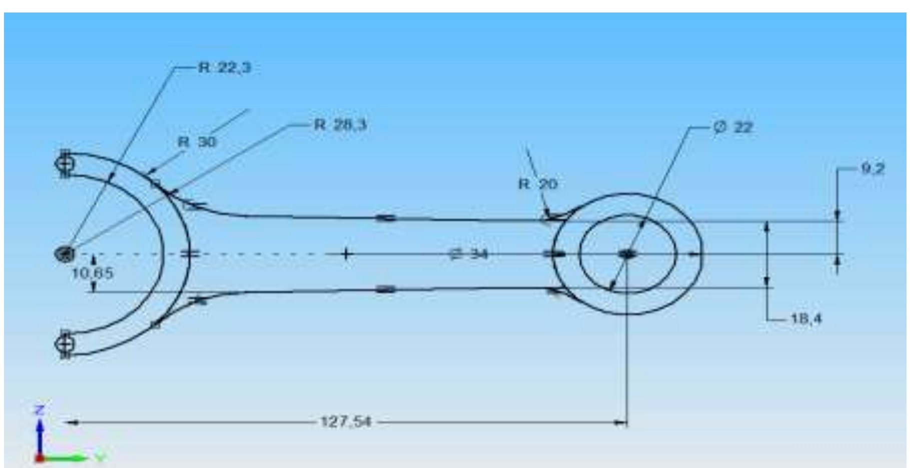

Fig. 2 Shows 2D Profile of connecting rod.

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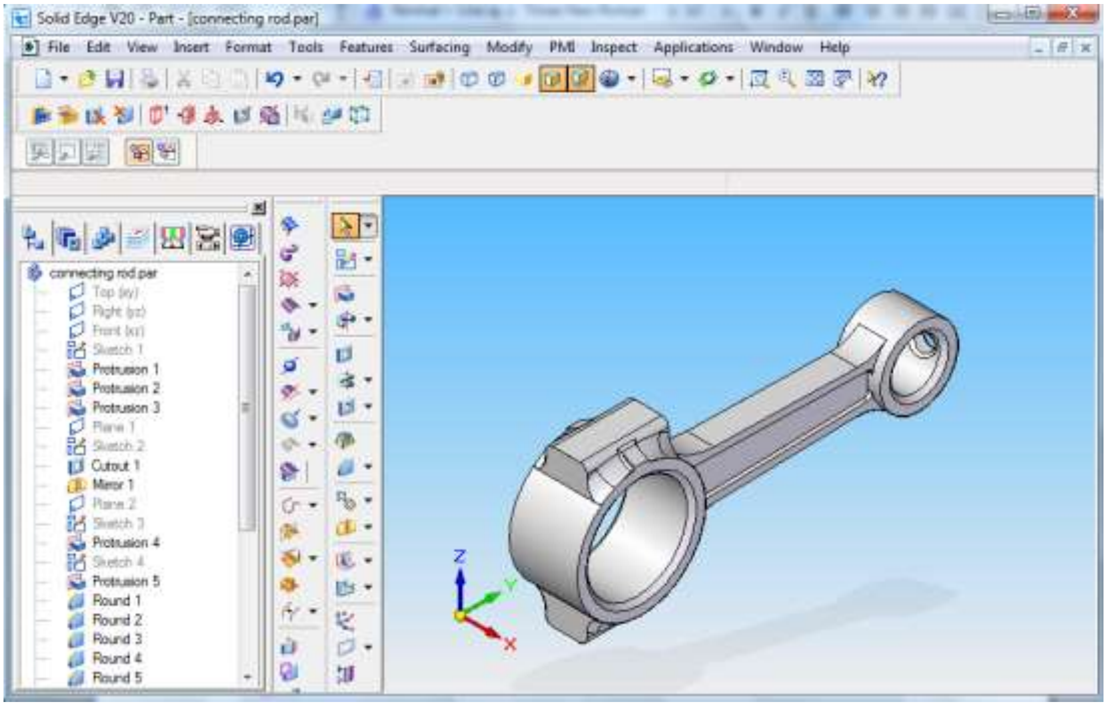

Fig. 3 Shows 3D Part of connecting rod.

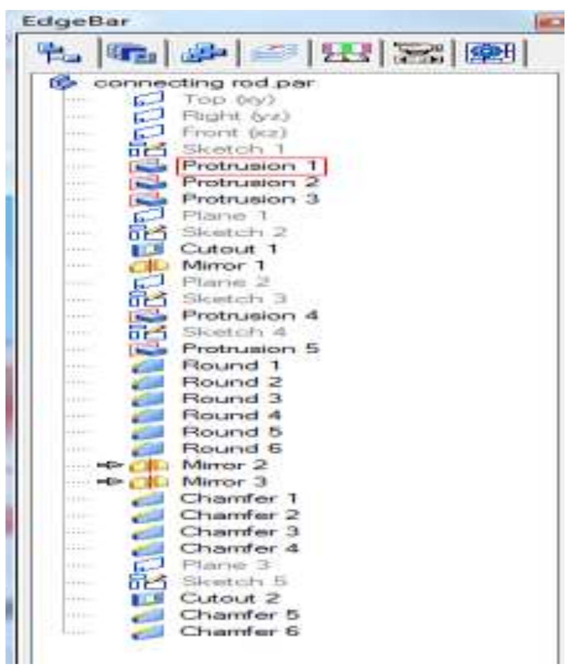

Fig. 4 Shows Edge bar with commands.

III. Constraints and procedure for Finite element analysis

The fully sketched connecting rod is shown in figure 5 and is imported to Ansys 12.

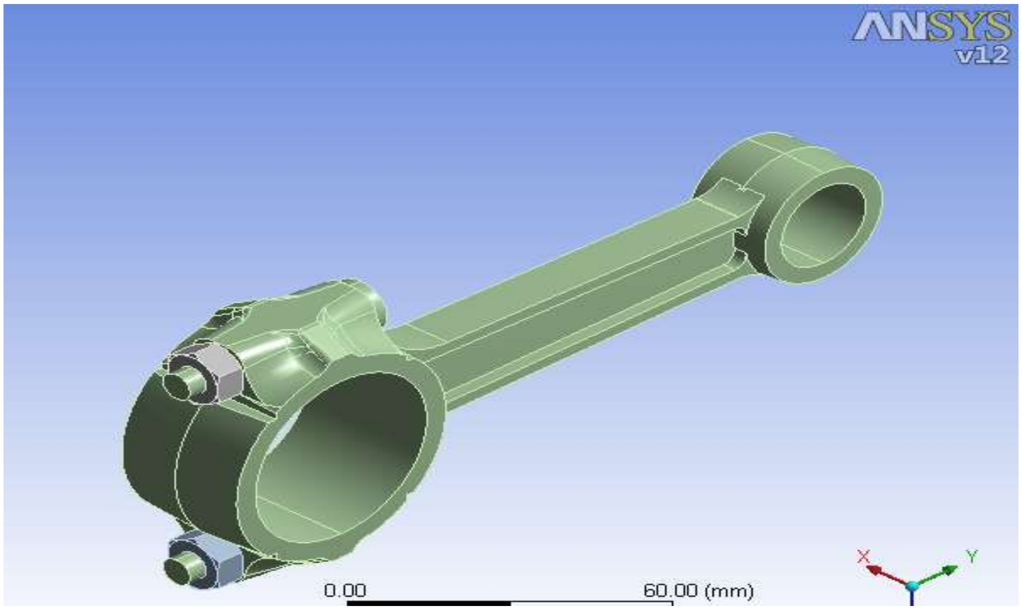

Fig. 5 Shows Complete image of connecting rod.

Table 1 and 2 gives the geometric properties and parts specification, Table 3 shows about Units used while Table 4 shows Connection and coordination system and Table 5 Mesh used in Ansys for performing analysis.

Table 1 Geometric property.

Definition		Properties and statics		Preferences	
Object name	Geometry	Volume	58729mm3	Import solid bodies	Yes
State	Fully defined	Mass	4.5938e-004t	Parameter processing	Yes
Source	User	Scale factor value	1	CAD associativity	Yes

Type	Design modeler	Bodies	3	Import using instances	Yes
Length unit	Millimeter	Elements	5127	Analysis type	3-D
Element control	Program control	Nodes	9885	Mixed import resolution	None
Display style	Part colour	Mesh metric	None	Material properties transfer	No

Table 2 Parts specification of geometry.

Definition		Properties			
Object name	Solid	Volume	728.32 mm3		57272mm3
State	Meshed	Mass	5.6969e-006t		4.4799e-004
Visible	Yes	Length X	2.0651e-007mm	-1.41632e-007mm	-1.7579e-003mm
Transparency	1	Length Y	-21.053mm		32.033mm
Suppressed	No	Length Z	-27.1mm	27.1mm	3.1632e-002mm
Reference temperature	By environment	Moment of inertia Ip1	1.0587e-004t mm2		1.3275t mm2
Thermal strain effects	Yes	Moment of inertia Ip2	1.6832e-004t mm2		0.17118t mm2
Assignment	Forged steel	Moment of inertia Ip3	1.0586e-004t mm2		1.1957t mm2
Nodes	1426	Elements	712		3703

Table 3 Shows Units used.

Unit System	Metric (mm, t, N, s, mV, mA) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Table 4 Shows Connection and coordination system.

Coordinate system		**Connections**	
Object name	Global coordinate system	Tolerance type	Slider
State	Fully defined	Tolerance slider	0
Type	Cartesian	Tolerance value	0.47671 mm
Origin X	0 mm	Fixed joint	Yes
Origin Y	0 mm	Priority	Include all
Origin Z	0 mm	Face	Yes
X axis	[1.0.0.]	Face/edge	No
Y axis	[0.1.0.]	Revolute joints	Yes
Z axis	[0.0.1.]	Transparency	Yes

Table 5 Shows Mesh used in Ansys.

Mesh		Analysis	
Object Name	Mesh	Object name	Static structural
State	Solved	State	Solved
Physics Preference	Mechanical	Physics type	Structural
Element Size	Default	Analysis type	Static structural
Initial Size Seed	Active Assembly	Environment temperature	22° C
Smoothing	Medium	Suppressed	No
Transition	Fast	Magnitude	26700 N (ramped)
Span Angle Center	Coarse	Direction	Defined

Table 6 Shows Material data for forged steel

Materials data			
Density	7.822e-009t mm3	Ductility coefficient	0.67
Tensile yield strength	625	Ductility exponent	-0.597
Young’s modulus	221	Cyclic strength	1159
Poisson’s ratio	0.3	Cyclic strain hardening	0.128
Strength coefficient	1124	Ultimate tensile strength	827

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Figure 6-8 shows the meshing of connecting rod with application of load and force for performing analysis.

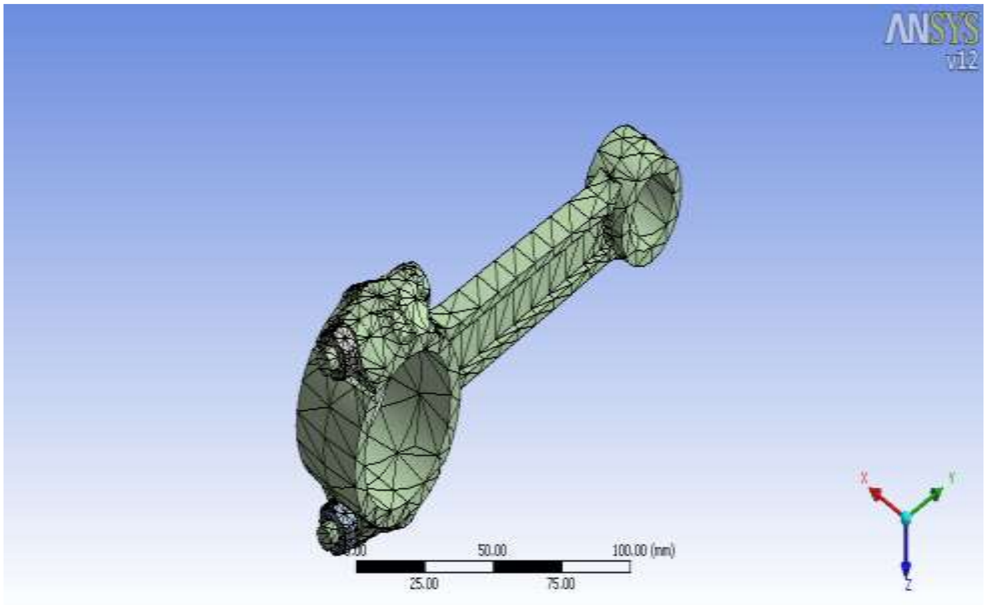

Fig.6 Shows Meshed connecting rod.

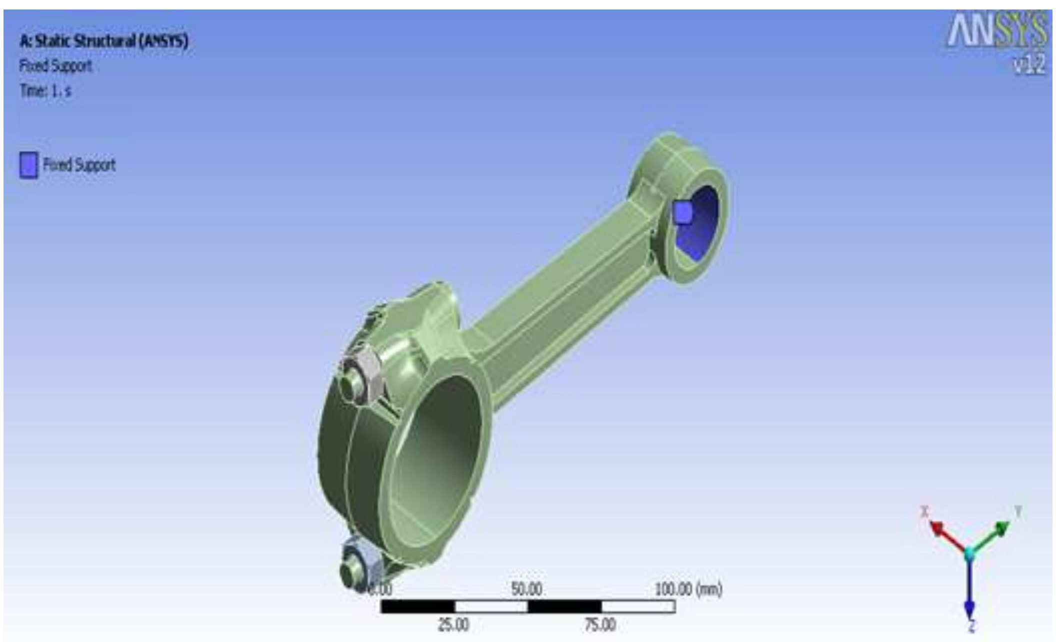

Fig.7 Shows Fixed support image.

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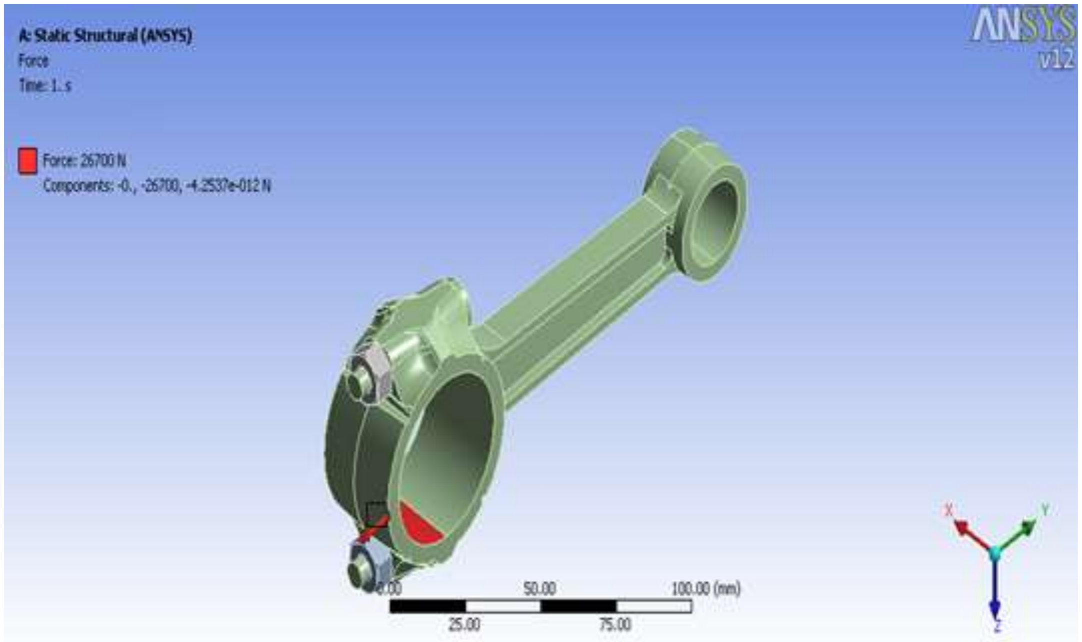

Fig 8 Shows Application of Force for analysis.

IV. Results and Discussion

Table 7 Shows Solutions and results.

Solution and results					
Minimum	-5.7886 mm	0.39957 MPa	-213.49 MPa	-216.7 MPa	0. mm
Maximum	20.972 mm	1467.2 MPa	1036. MPa	320.87 MPa	321.41 mm
Time	1. s				
Load Step	1				
Iteration Number	1				

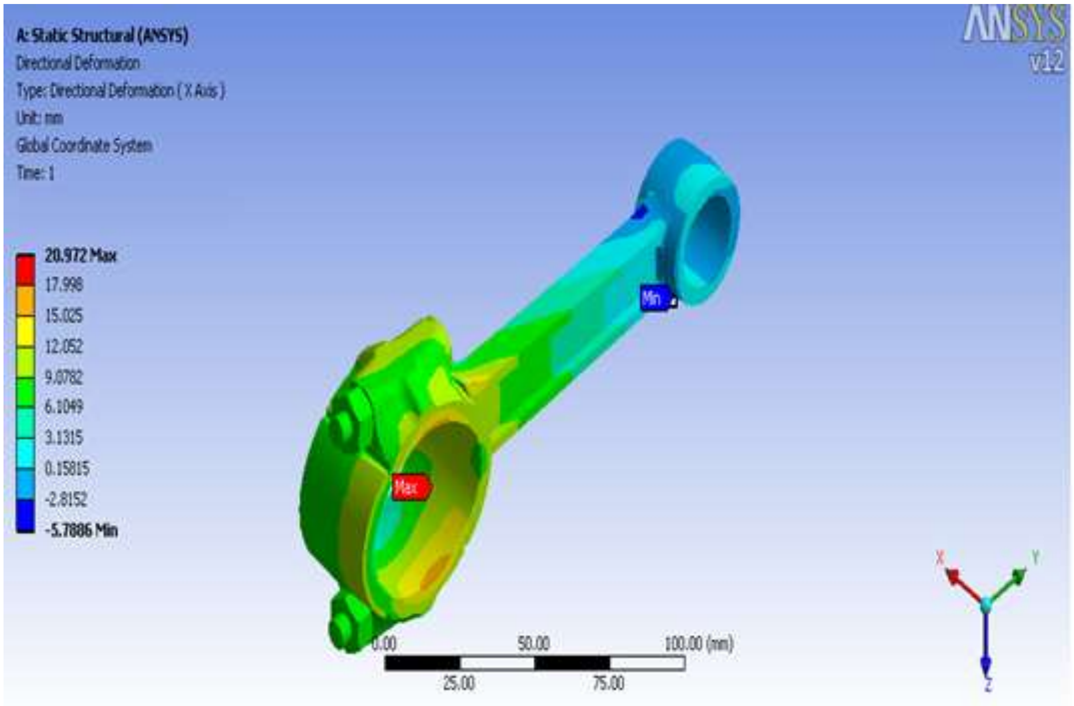

Fig.9 Shows Directional deformation image.

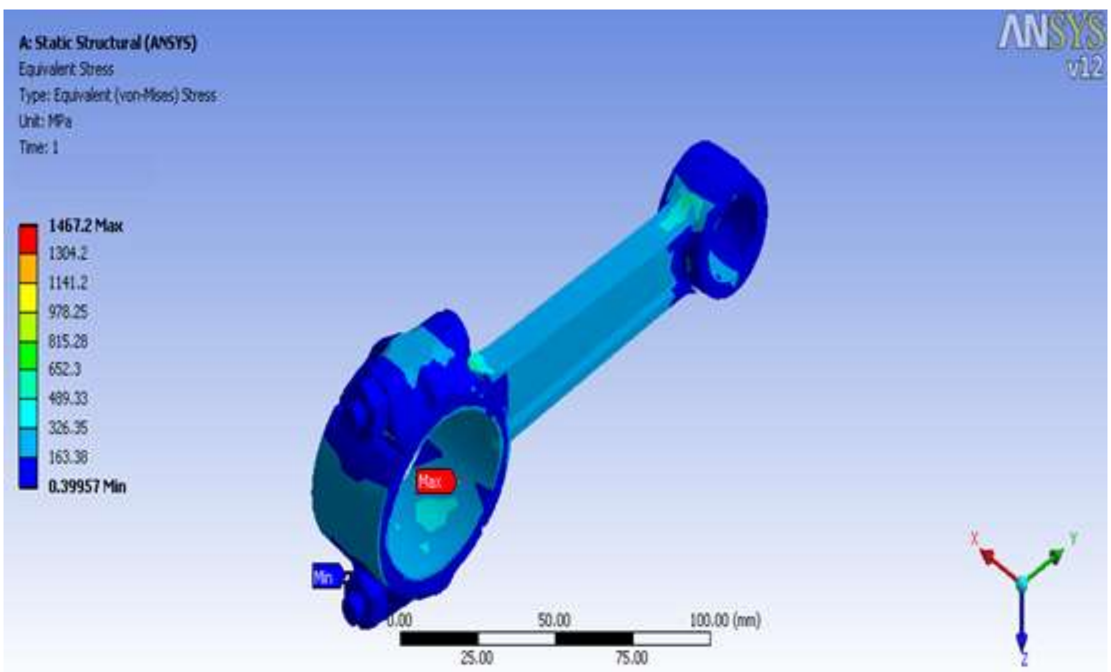

Fig.10 Application of equivalent stress.

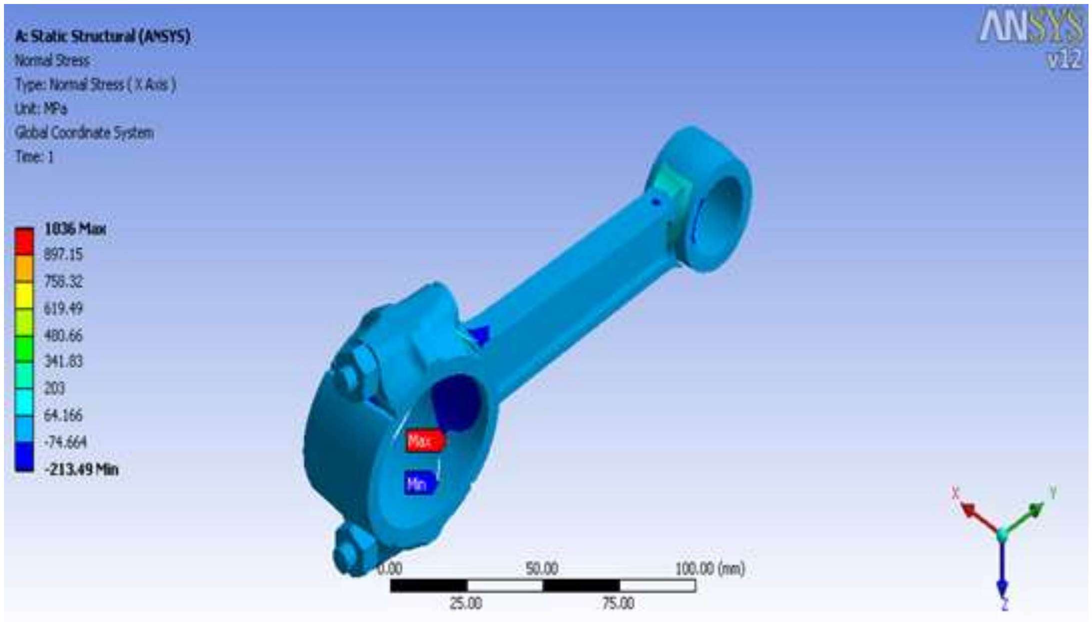

Fig.11 Application of normal stress.

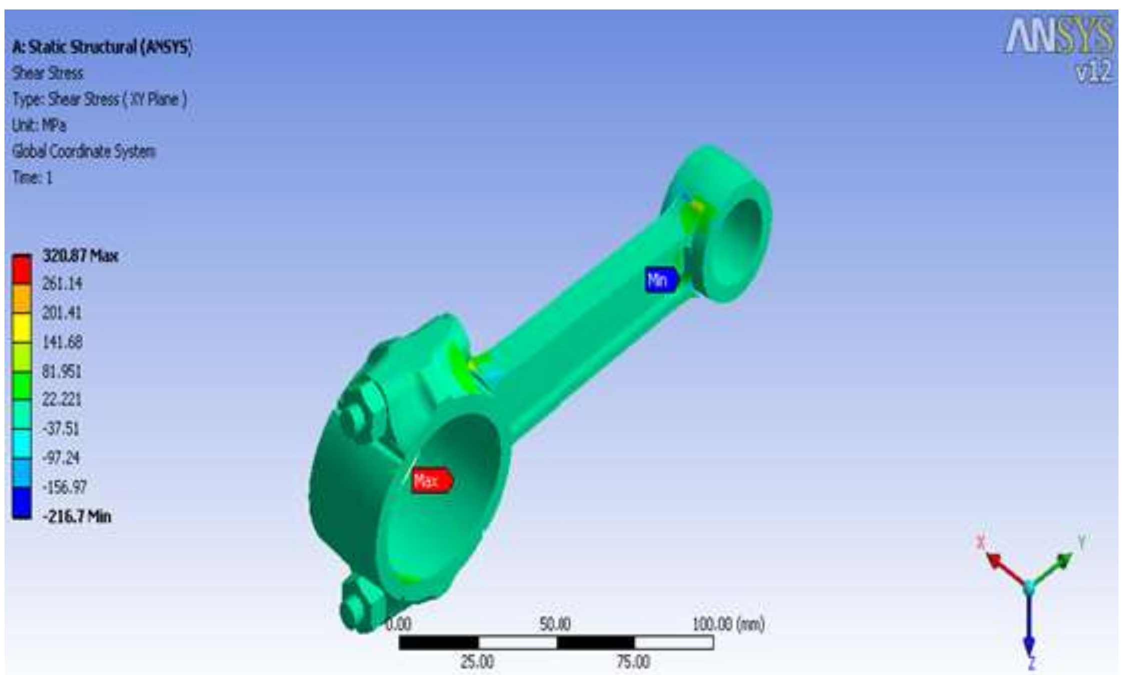

Fig.12 Application of shear stress.

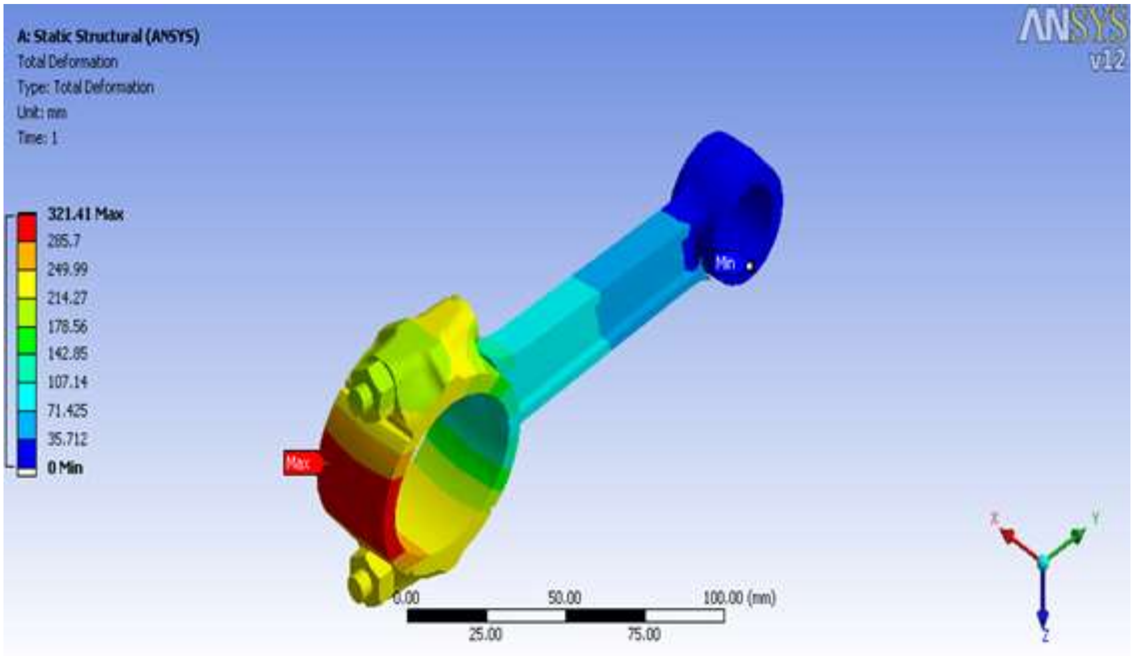

Fig.13 Total deformation image.

V. Conclusions

Thus finite element analysis makes us to apply the required examination in the design and made us to review the effect that made due to applied force and stress for the analysis. The entire test like shear force, normal force, and equivalent stress will shows the deformation that took placed. The complete image of connecting rod along with various analysis results are shown in the figure 5-13. The changes made can be revised and that gives the effective design of the connecting rod in the reduced weight. Thus we conclude that the finite element analysis will gives us the overall view of design and make the examination more quick and accurate.

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