Comparative Study for Static Analysis of Connecting Rod for Different Materials.

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***Abstract*-Themain objective of paper is comparative study of connecting rod for three material i.e. for steel, titanium and aluminum. It deals with static analysis of connecting rod and crosscheck failure by FEM. An appropriate CAD model of connecting rod was designed in Solidworks, after that FEA was carried out in ANSYS WORKBENCH to determine maximum Von mises stresses acting on it.**

***Keywords*— Connectingrod, FEA, Ansys Workbench, Static analysis.**

I. Introduction

Automobile engine connecting rod is the critical component in internal combustion engine which connects reciprocating piston and connecting rod. Connecting rods for automotive applications are mainly manufactured by forging from either wrought steel or powdered metal. They can also be cast. However, castings could produce blow-holes which are inimical from durability and fatigue points of view. Connecting rod is subjected to forces generated by mass & fuel combustion which results in axial load and bending stresses. A connecting rod must withstand for transmitting axial tension, axial compression, and bending stress occurred due to the thrust and pull of the piston and by centrifugal force. In this paper finally, the comparison is made between the connecting rod made by three different material that are steel, titanium and aluminum.

II. Simulation Methodology

Simulation methodology contains design of connecting rod, modelling, meshing and boundary conditions.

2.1 Design of connecting rod: Design of various parts of connecting rod such as connecting rod shank, big end, small end, bolts for cap, cap of big end is done as per standard design procedure.

TABLE 1 INPUT PARAMETER FOR CONNECTING ROD

Parameters	Dimensions
Diameter of piston	95 mm
Weight of reciprocating parts	1.6 kg
Length of connecting rod	200 mm
Stroke	62.5 mm
Speed	1500-2500rpm
Compression ratio	4:1
Maximum explosion pressure	2.5MPa

OUTPUTS OF THE DESIGN: Outputs obtained are the dimensions of connecting rod required for modelling it on solidworks software.

TABLE 2. DIMENSIONS OF CONNECTING ROD

Dimensions	Values (mm)
Web thickness t	3
Width of flange B	12
Height of I section H	15
Diameter of pin end	24
Length of pin end	32
Diameter of crank end	64
Length of crank end	34
No of bolts	2
Size of bolts	M14 X 1.5

2.2 Modelling: Connecting rod was modelled using Solidworks software which is shown in Figure 1. It was then imported to Design modeller of ANSYS Workbench.

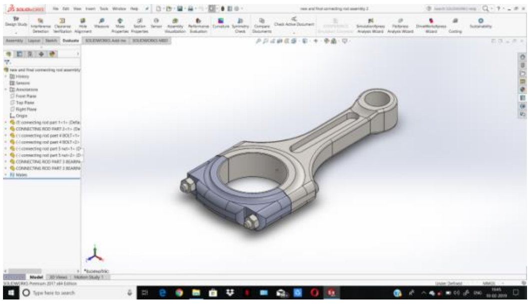

Fig. 1 Modelling of Connecting Rod

2.3 Meshing: Element used is 10 node Tetrahedron named Solid187. First convergence was checked by finding deformation against different element size. This resulted in a mesh with 299379 elements and 773220 nodes. Figure 2 shown below is meshed model of connecting rod.

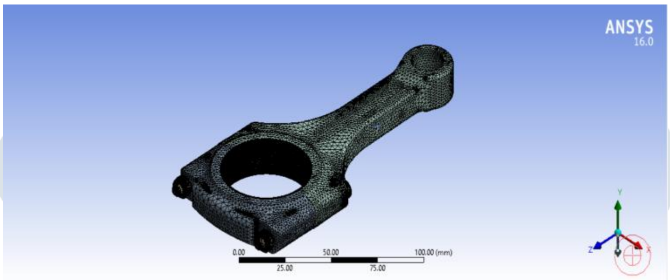

Fig2: Mesh model of connecting rod

2.4 Boundary Condition: By using the expressions from force analysis of connecting rod tensile and compressive loads acting on the connecting rod were obtained in the analysis carried out, the axial load was 10000 N in both tension and compression. For both tensile and compressive loads FEA was conducted.

CONNECTING ROD END LOADING	CRANK END	PISTON PIN END
COMPRESSIVE LOADING	10000N	RERSTRAINED
TENSILE LOADING	10000N	RESTRAINED

2.5 Stress Observations: Equivalent stress and deformation in connecting rod were obtained in both tensile as well as compressive loading condition using static structural analysis in ANSYS workbench. Factor of safety was calculated based on ratio of allowable stress to maximum stress. In case of compressive loading at crank end, due to stress concentration maximum stress occurred at oil hole and at pin end maximum stress is occurred on the pin end. In case of tensile loading at crank end maximum stress is occurred at oil hole and at pin end stress distribution for Structural steel.

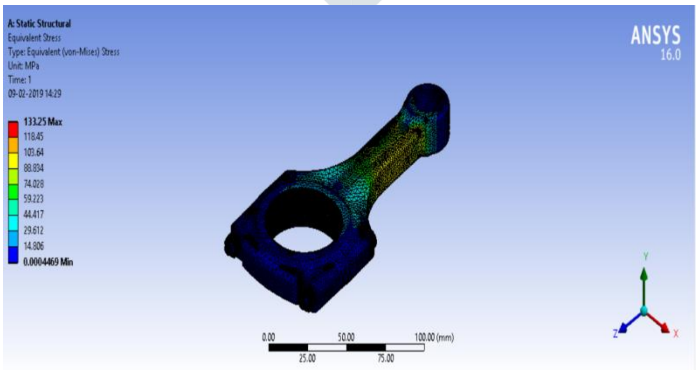

Fig3: Von misses Stress for Structural Steel for compression.

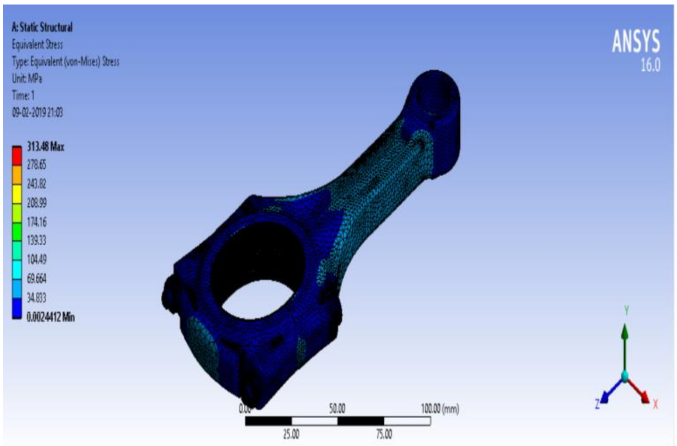

Fig 4: Von misses Stress for Aluminum for tensile.

III. Comparison

Mechanical Property	Structural Steel	Aluminium	Titanium
Density(kg/m^3)	7800	2710	4430
Tensile Yield Strength (MPa)	470	450	850
Ultimate Tensile Strength (MPa)	745	550	950
Young's Modulus (GPa)	200	68.32	113.8
Poisson's Ratio	0.26	0.34	0.342
Mass (Gram)	650	712	
Cost (per Kg)	Rs. 35	Rs. 325	Rs. 1500

IV. RESULTS

MATERIAL	STRUCTURAL STEEL	ALUMINIUM
MAXIMUM DEFORMATION(mm)	0.0868	0.153
VON MISES (MPa)	133.25	94
FACTOR OF SAFETY	3.53	4.78

MATERIAL	STRUCTURAL STEEL	ALUMINIUM
MAXIMUM DEFORMATION(mm)	0.07646	0.175
VON MISES (MPa)	319.18	313.48
FACTOR OF SAFETY	1.47	1.44

For compressive loading of aluminium the maximum deformation (0.153mm) occurs at big end i.e. crankshaft end. The factor of safety for compressive loading of Aluminium is 4.78.For compressive loading of structural steel the maximum deformation (0.0868mm) occurs at big end i.e. crankshaft end.

The factor of safety for compressive loading of structural steel is 3.53.For Tensile loading of aluminum the maximum deformation (0.175mm) occurs at big end i.e. crankshaft end.

The factor of safety for Tensile loading of Aluminum is 1.44.For Tensile loading of structural steel the maximum deformation (0.07646mm) occurs at big end i.e. crankshaft end. The factor of safety for tensile loading of structural steel is 1.47.

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