DESIGN AND ANALYSIS OF CONNECTING ROD USING ALUMINIUM FLY ASH

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Abstract-**Connecting rod is the intermediate member in piston and connecting rod. The primary function is push in gudgeon pin to pull in crank pin, its converting reciprocating motion of piston into rotary motion of crank shaft. Currently existing connecting rod is Aluminum alloy 7068 T6,T6511.Intially to design connecting rod and then analysis,model is drawn by usingSolidworks2014 software and then analysis carried out by using ANSYS version 15.0.The model of connecting rod is drafted from calculation.Aluminum fly ash. The best combination of parameter like von misses stress,strain, deformation, factor of safety and reducing weight for two wheeler done in ANSYS software.Its has more factor of safety,reduce weight and stress,more stiffer than other material like aluminium alloy 7068 T6,T6511.With fatigue analysis to determined the life time of connecting rod.**

I.INTRODUCTION

In a reciprocating piston engine, the connecting rod connects the piston to the crank or crankshaft. In modern automotive internal combustion engines, the connecting rods are most usually made of steel for production engines, but can be made of aluminium (for lightness and the ability to absorb high impact at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high performance engines, or of cast iron for applications such as motor scooters. The small end attaches to the piston pin, gudgeon pin (the usual British term) or wrist pin, which is currently most often press fit into the con rod but can swivel in the piston, a "floating wrist pin" design. The connecting rod is under tremendous stress from the reciprocating load represented by the piston, actually stretching and being compressed with every rotation, and the load increases to the third power with increasing engine speed. Failure of a connecting rod, usually called "throwing a rod" is one of the most common causes of catastrophic engine failure in cars, frequently putting the broken rod through the side of the crankcase and thereby rendering the engine irreparable; it can result from fatigue near a physical defect in the rod, lubrication failure in a bearing due to faulty maintenance or from failure of the rod bolts from a defect, improper tightening, or re-use of already used (stressed) bolts where not recommended. Despite their frequent occurrence on televised competitive automobile events, such failures are quite rare on production cars during normal daily driving. This is because production auto parts have a much larger factor of safety, and often more systematic quality control. When building a high performance engine, great attention is paid to the connecting rods, eliminating stress risers by such techniques as grinding the edges of the rod to a smooth radius, shot peening to induce compressive surface stresses (to prevent crack initiation), balancing all connecting rod/piston assemblies to the same weight and Magnafluxings to reveal otherwise invisible small cracks which would cause the rod to fail under stress. In addition, great care is taken to torque the con rod boltsto the exact value specified; often these bolts must be replaced rather than reused. The big end of the rod is fabricated as a unit and cut or cracked in two to establish precision fit around the big end bearing shell. Recent engines such as the Ford 4.6 litre engine and the Chrysler 2.0 litre engine have connecting rods made using powder metallurgy, which allows more precise control of size and weight with less machining and less excess mass to be machined off for balancing. The cap is then separated fromthe rod by a fracturing process, which results in an uneven mating surface due to the grain of the powdered metal. This ensures that upon reassembly, the cap will be perfectly positioned with respect the rod, compared to the minor misalignments, which can occur if the mating surfaces are both flat. A major source of engine wear is the sideways force exerted on the piston through the con rod by the crankshaft, which typically wears the cylinder into an oval cross-section rather than circular, making it impossible for piston rings to correctly seal against the cylinder walls. Geometrically, it can be seen that longer connecting rods will reduce the amount of this sideways force, and therefore lead to longer engine life. However, for a given engine block, the sum of the length of the con rod plus the piston stroke is a fixed number, determined by the fixed distance between the crankshaft axis and the top of the cylinder block where the cylinder head fastens; thus, for a given cylinder block longer stroke, giving greater engine displacement and power, requires a shorter connecting rod (or a piston with smaller compression height), resulting in accelerated cylinder wear.he diffuser, the fluid is decelerated and as a result the dynamic pressure drop is converted into static pressure rise, thus increasing the static pressure further. The vapour from the diffuser enters the volute casing where further conversion of velocity into static pressure takes place due to the divergent shape of the volute. Finally, the pressurized fluid leaves the compressor from the volute casing.

2.SPECIFICATION OF THE PROBLEM

The objective of the present work is to design and analysis of connecting rod made of Aluminum fly ash. Aluminum alloy 7068 T6,T6511materials are used to design the connecting rod. In this project the material (Al alloy) of connecting rod replaced withAluminum alloy 7068 T6, T6511. Connecting rod was created in SOLID WORK 2014. Model is imported in ANSYS 15.0 for analysis.After analysis a comparison is made between existing steel connecting rod. Aluminum fly ash in terms of weight, factor of safety, stiffens deformation and stress.The objective of the present work is to design and analysis of connecting rod made of Aluminum fly ash. Aluminum alloy 7068 T6,T6511materials are used to design the connecting rod. In this project the material (Al alloy) of connecting rod replaced with Aluminum alloy 7068 T6, T6511. Connecting rod was created in SOLID WORK 2014. Model is imported in ANSYS 15.0 for analysis.After analysis a comparison is made between existing steel connecting rod. Aluminum fly ash in terms of weight, factor of safety, stiffness, deformation and stress.

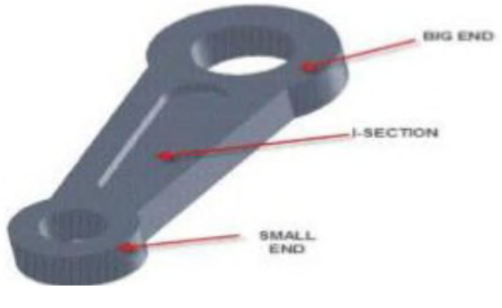


Fig 1.Schematic diagram of connecting rod.

3.DESIGN FOR CONNECTING ROD.

A connecting rod is a machine member which is subjected to alternating direct compressive and tensile forces. Since the compressive forces are much higher than the tensile force, therefore the cross-section of the connecting rod is designed as a strut and the rankine formula is used. A connecting rod subjected to an axial load W may buckle with x-axis as neutral axis in the plane of motion of the connecting rod,{or}y-axis is a neutral axis. The connecting rod is considered like both ends hinged for buckling about x-axis and both ends are fixed for buckling about y-axis. A connecting rod should be equally strong in buckling about either axis, according to rankine formulae.

In order to have a connecting rod equally strong in buckling about both the axis.This shows that the connecting rod is four times strong in buckling about y-axis than about-axis.

If > 4, Then buckling will occur about y-axis and if < 4, then buckling will occur about x-axis .In Actual practice is kept slightly less than 4. It is usually taken between 3 and 3.5 and the Connecting rod is designed for buckling about x-axis. The design will always be satisfactory for buckling about y-axis. The most suitable section for the connecting rod is I-section with the proportions shown it.

Area of cross section = 2 [4t x t] +3t.
Moment of inertia bout x-axis = $1/12[4\{5\}^3-3\{3\}^3]$ =11
Moment of inertia about x-axis = $(2x1/12)x\ t\ x\ \{4t\}^3+(1/12)\{3t\}t^3$
=[419/12]x[12/131] =3.2

Since the value I lies between 3 and 3.5 m therefore I section chosen is correct.

3.1.pressure calculation in 150cc in Suzuki engine.

Engine type air coolend 4 stroke,Bore x stroke(mm)=57x58.6

Displacement =150 cc

Max power =13.8 bhp @ 8500 rpm

Max torque =13.4 Nm @ 600 rpm

Compression ratio = 9.34

Density of petrol C8H18 = 737.243 Kg/lit

Temperture = 60^{o}F

=288.845^{o}K

Mass = Density x volume

=737.22 x 149.5

= 0.13 kg

Molecular weight of the petrol 114.28 g/mole from gas

Equation, PV= Mrt R

= 8.3143/114228

= 72.76 P

= (0.11 X 72.786 X 288.85)/149.5

P = 15.5 Mpa

4.DESIGN CALCULATION FOR EXISTING CONNECTING ROD

Thickness of flange & web of the section = t

Width of section B =4t

The standard dimension of I – SECTION

Height of section H =5t

Area of section A = 2(4t x t)+3t x t

$A = 11\ t^2$

Moment of inertia about y axis = (2 x 1/12) x t x{4 t}^{3} + (1/12){3t}t^3

= [419/12] x [12/131]

= 3.2 m

Length of connecting rod(L) = 2 time the stroke

L = 117.2 mm

Buckling load = maximum gas force x F O S

= 37663 N

Compressive yield stress = 415 Mpa

Width of the section B = 4 x t = 4×3.2

= 12.8mm

Height of the section H = 5 x t = 5×3.2

= 16mm

Area A= 11

Thickness t = A x t^2

=11×3.2×3.2

= 112.64mm^2

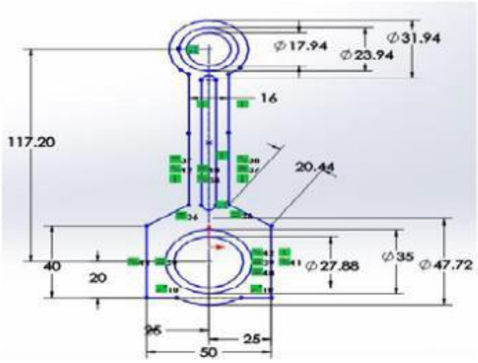
Height in big end (crank edge) H_2 = 1.1H to 1.25H

= 1.1×16

H_2=17.6mm

Height in small end (piston edge)H_1 = 0.9H to 0.75H = 0.9×16

H_1 =12mm



Stroke length (l) =117.2mm

Diameter of piston (D)=57mm

P=15.5N/ mm2

Radius of the crank(r) =stroke length/2

=58.6/2

=29.3 mm

Max force on piston due to pressure (F_l)=π /4xDxP

=π/4 × 57×15.469

F_l=39473.16 N

Maximum angular speed = [2π×8500]/60

=768 rad/sec

Ratio of the length of connecting rod to the radius of crank (N)= l/r =112/ (29.3)

= 3.8

Maximum Inertia force of reciprocating parts = Mr x r x (1+1/n)

= 0.11x(768) x (0.0293) x [1+ (1/3.8)]

= 2376.2643N

Inner diameter of the small end =6277.167/12.5×1.5

= 17.94 mm

Design bearing pressure for small end =12.5 to 15.4N/mm^2

Length of the piston pin = (1.5to 2) mm

Outer diameter of the small end = 17.94 + [2×2] + [2×5]

= 31.94mm

Where,

Thickness of the bush = 2 to 5 mm

Marginal thickness = 5 to 15 mm,

Inner diameter of the big end = 6277.167/10.8×1.0

=23.88 mm

Where,

Design bearing pressure for big end =10.8 to 12.6 N/mm^2

Length of the crank pin = (1.0 to 1.25),

Root diameter of the bolt = (2×6277.167x π×56.667)

= 4mm

Outer diameter of the big end = 23.88+2×2+2×4+2×5

= 47.72mm

Where,

Thickness of the bush = 2 to 5 mm

Marginal thickness = 5 to 15 mm

Nominal diameter of bolt = 1.2 ×root diameter of the bolt

= 1.2×4

= 4.8mm

Table 1. Design Parameters in connecting rod

S.no	Parameters(mm)
1	Thickness of the connecting rod (t) = 3.2
2	Width of the section (B = 4t) = 12.8
3	Height of the section(H = 5t) = 16
4	Height at the big end = (1.1 to 1.125)H = 17
5	Height at the small end = 0.9H to 0.75H = 14
6	Inner diameter of the small end = 17.94
7	Outer diameter of the small end = 31.94
8	Inner diameter of the big end= 23.88
9	Outer diameter of the big end= 47.72

5.ANALYSIS OF THE CONNECTING ROD

Modified Connecting Rod (Aluminum fly ash)

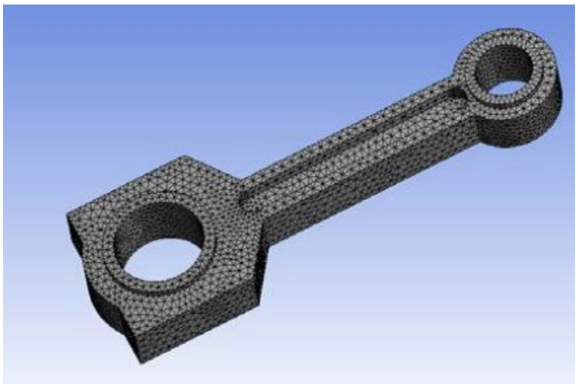


Fig 3.1: Meshing of Connecting Rod

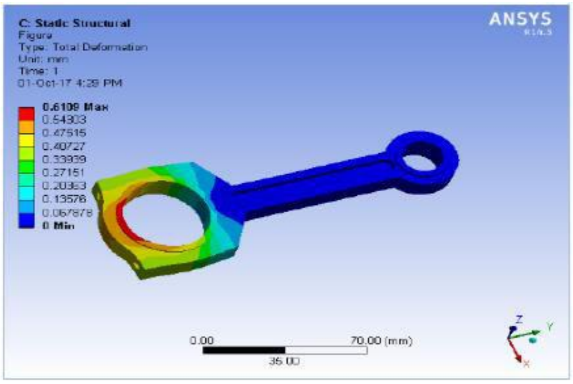


Fig 3.2: Total Deformation

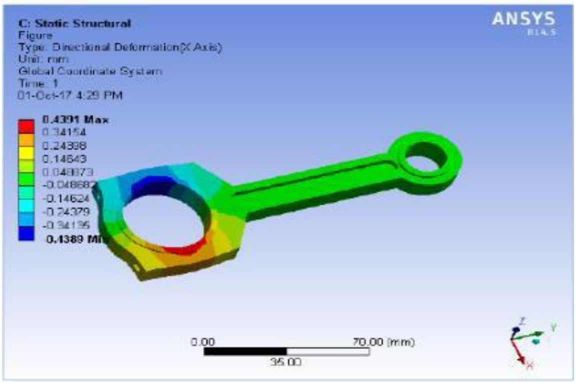


Fig 3.3: Directional Deformation X-axis

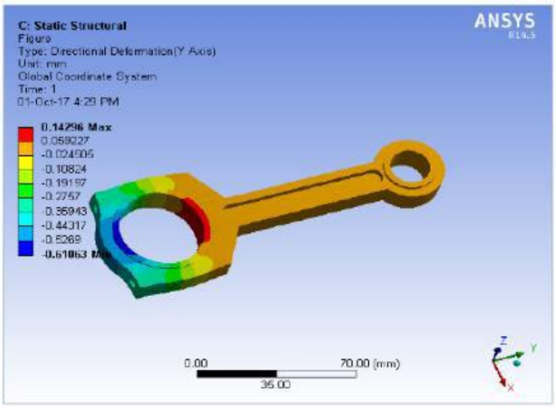


Fig3.4:Directional Deformation Y-axis

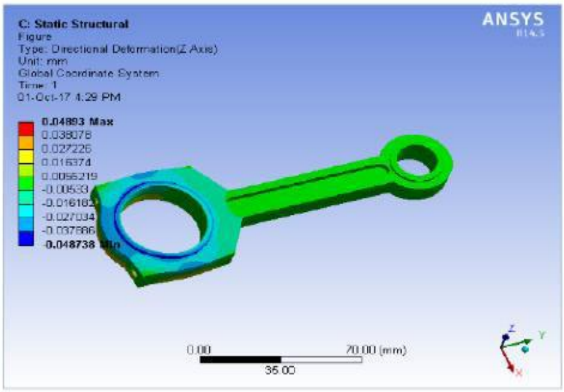


Fig 3.5: Directional Deformation z-axis

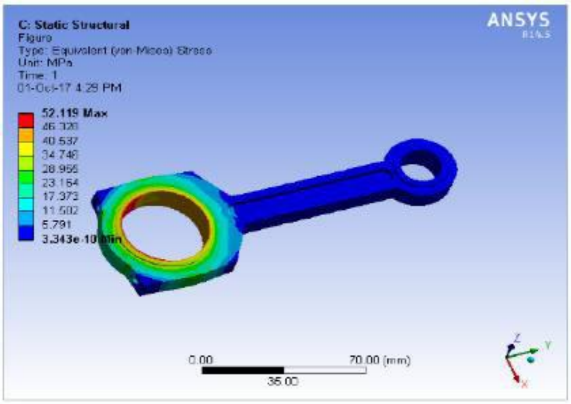


Fig 3.6: Equivalent stress

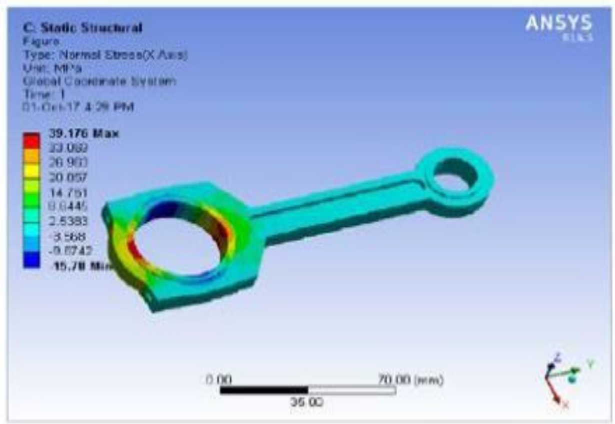


Fig 3.7: Normal Stress X-axis

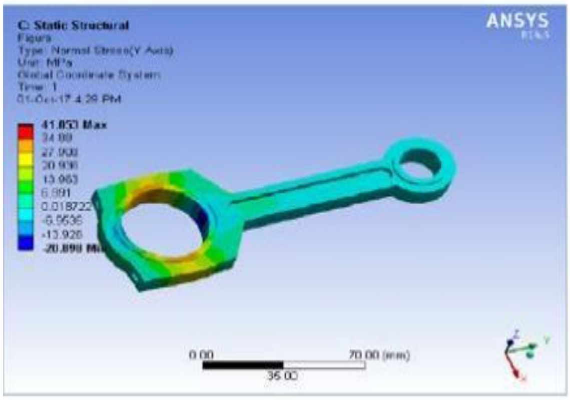


Fig 3.8: Normal Stress Y-axis

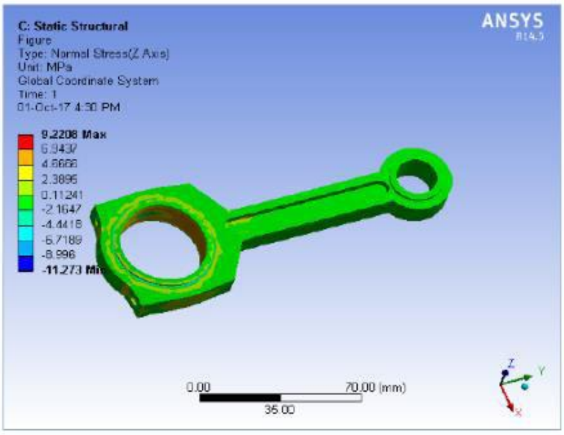


Fig 3.9: Normal Stress Zaxis

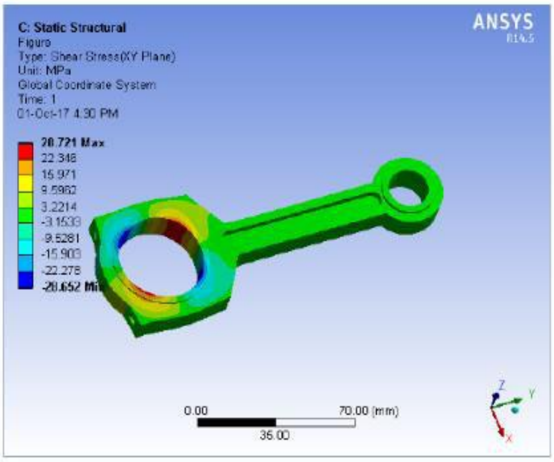


Fig 3.10: Shear Stress XY plane

s.no	Types	Aluminum fly ash		Stresses and Deformation of Aluminum Alloy 7068 T6,T6511	
		Max (Mpa)	Min (Mpa)	Max (Mpa)	Min (Mpa)
1	Equivalent stress	52.119	$3.343\ E^{-10}$	25.142	0.093156
2	Normal stress (X-axis)	39.176	-15.78	35.934	-34.953
3	Normal stress (Y-axis)	41.853	-20.898	13.913	-45.953
4	Normal stress (z-axis)	9.2208	-11.273	9.9224	-9.4259
5	Shear stress(XY plane)	28.721	-28.652	14.152	-14.914
6	Shear stress(yz plane)	11.369	-10.985	6.4729	-7.2802
7	Shear stress(Xz plane)	5.9874	-5.5638	6.2828	-6.2138
8	Total deformation(mm)	0.6109 mm	0	0.0044016 mm	0
9	Directional deformation(x-axis)	0.4391 mm	-0.4389 mm	0.00082689 mm	-0.00083117 mm
10	Directional deformation(y-axis)	0.14296 mm	-0.61063 mm	0.0044014 mm	$-1.9783e^{-7}$ mm
11	Directional deformation(Z-axis)	0.04893 mm	-0.048738 mm	0.0001689 mm	-0.00017897 mm

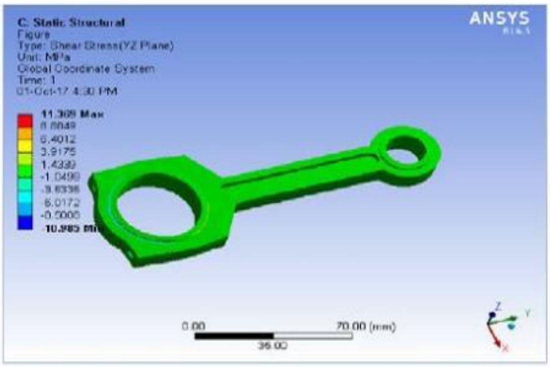


Fig 3.11: Shear Stress YZ

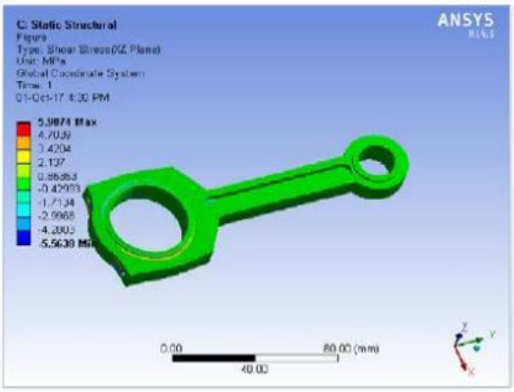


Fig 3.12: Shear Stress XZ

8.CONCLUSION

Conclusion and future scope of Solid modeling of the connecting rod is produce drawing specification and analysis under the effect for tensile and compressive load, pressure is done by ANSYS Workbench. In the present design and analysis of connecting rod using aluminum alloy 7068 T6,T6511 have been done with the help of SOLID WORK and ANSYS 15.0. Here Analysis is done for the Normal stress as well as Shear stress in x-y plane. From modeling and simulation, Solid work is good for Analysis, but ANSYS is better than other software. Here we can find minimum stresses among all loading conditions, were at crank end cap as well as piston end. So the material can be reduced from those portions, thereby reducing material cost.

Analysis result comparition for Aluminum fly ash Stresses andDeformation of Aluminum Alloy.

Dynamic load condition, once again finite element analysis will have to be perform. It will give more accurate results than existing results.

9.REFERENCES

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