Design of Con-Rod with the Help of ANSYS_WORKBENCH Software

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Abstract— Con-rod essentially connects piston to the crank-shaft even as transmitting strength It can be manufactured from metal or any alloy. Our assignment ambitions on the calculations of deformation strain and stress of the con-rod with widespread dimensions of an inventory and examine the layout the usage of design software known as ANSYS_WORKBENCH. Also it includes calculation of elements including stress, strain, component of protection deformation whilst contemplating the distinction in weight and layout.

Keywords: Con-Rod, Piston Rod, Aluminium Alloy, RPM - Revolution per Minute, FEA - Finite Element Analysis

I. Introduction

A. Con-rod transfers power to the crank shaft to generate some rotational power.

Materials Selected:-Steel and Al. This steel is desired because of its mild weight and price. The desire of the steel used additionally relies upon at the sort of requirement and preference metals which includes Al alloy is light-weight and additionally price much less in comparison to different substances like Brass Copper which can be more potent however a whole lot costlier.
Types of Beams:-
A con-rod is of following types:-
1) I-beam
2) H-beam

I-beam is each mild weight and sturdy however the sort of fabric used limits its capability to address load. Whereas in H-beam can manage a whole lot extra pressure without bending. So they're utilised in excessive power engines.

B. Beam Types:

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C. Design Process:

SPACE_CLAIM&ANSYS_WORKBENCH is used in designing process. Using SPACE_CLAIM&ANSYS_WORKBENCH layout is for the con-rod in the given dimensions. For analysing the layout created its miles import in to ANSYS for similarly evaluation of the important thing elements which includes equivalent stress, strain energy and total stress.

II. Literature Review

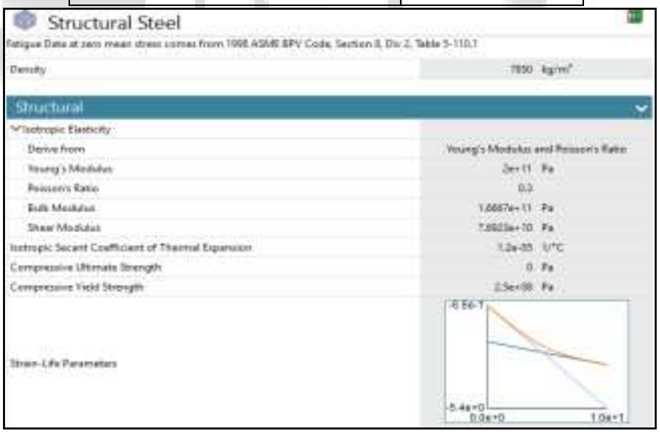
The evaluation turned into finished and we were given the Strong and susceptible factors of the layout upon which upgrades may be executed. Other substances may be used to examine with Al-alloy and in addition weight and value discount may be executed to optimise the layout. The layout much like current ones and lots studies wishes to be executed to make a floor breaking layout this is very green in comparison to current ones. The regions of the layout which buckle maximum beneath earth strain want require extra interest to gain a extra green layout.

III. Scope

Adjustments with inside the layout of con-rod may be made similar to deciding on some other segment apart from the I-segment. Further evaluation is viable through deciding on one of a kind substance for the con-rod. Analysis of weight loss and fee evaluation may be completed. Maximum strain awareness on the fillet of crank and piston give up may be decreased through including or getting rid of cloth from the con-rod. Obstacles of con-rod additionally allows in lowering the strain stage and will increase energy of the con-rod. Dynamic evaluation of con-rod may be completed and different elements of failure may be considered.

A. Structural steel

Compressive Yield Strength	2.50 e+8 Pa
Poisson Ratio	0.3
Bulk modulus	1.667 e+11 Pa
Young modulus	2e+11 Pa
Shear modulus	7.693 e+10 Pa



B. Properties of Al are

– Al has good appearance and good anodising.
– It has excellent for my ability and weldability.

Al is good resistance of corrosion and rusting
It has wear resistance and it is also non toxic in nature
Al have high strength (can be change also)
It is also non magnetic in nature
The melting point of pure Al is 660 degree Celsius
And the melting point of Al alloy is ranges from 480 degree Celsius to 660 degree Celsius
Pure Al appearance has a silver white metal with minute traces of blue colour on it.
Al alloy is lighter than most metals.
Al alloy have good electrical and thermal conductivities

Al alloys are also highly reflective to the both heat and light

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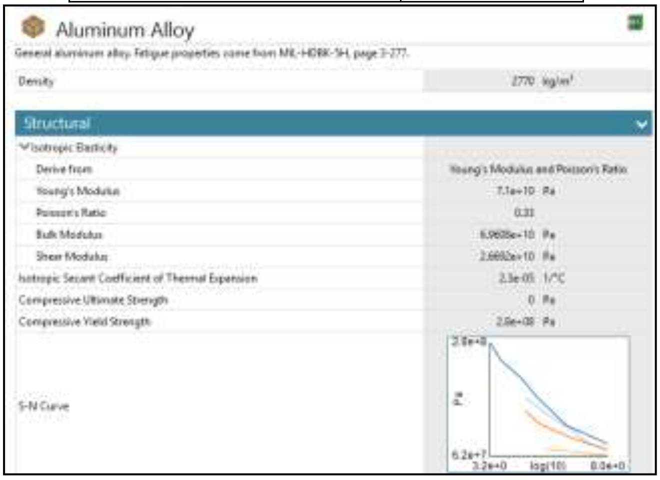


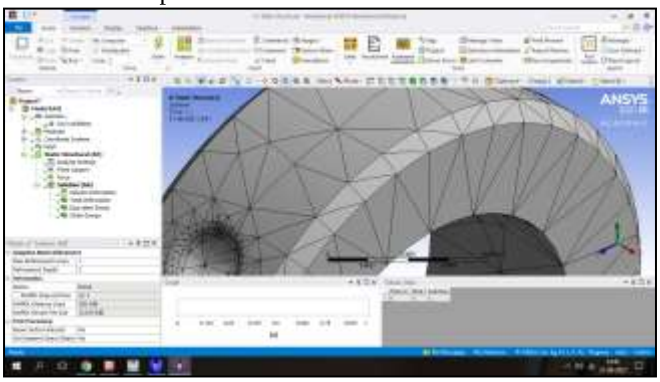
C. *Structural Steel*

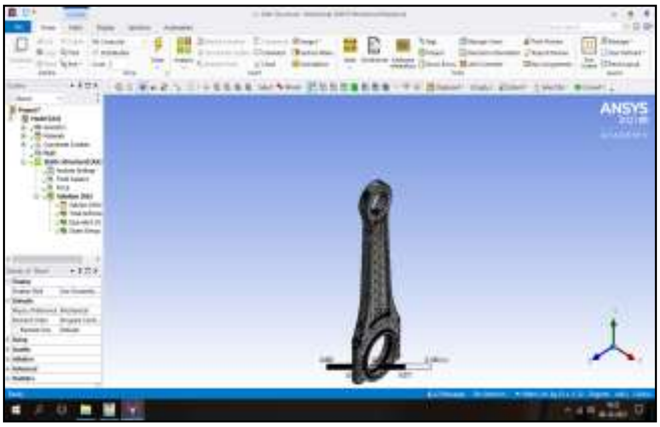
- Structural steel is an alloy of iron and carbon.
- With the increase in the percentage of carbon the strength hardness and brittleness of Steel increases but the ductility decreases
- Steel is formed by the pig iron and it has 0.15 to 2 percentage of carbon content in.
- Steel is good in both tension and compression so it is more preferred than cast iron and wrought iron.

D. *Meshing:-*

Meshing is one of the most vital steps in acting an accurate simulation the use of FEA. A mesh is made up of factors which contain nodes (coordinate places in area that may variety through element kind) that represent the form of the geometry.

Meshing is the way of turning abnormal shapes into more recognizable volumes known as “elements.” earlier than you begin meshing, you need to first add a geometry or CAD version into, as an example, Ansys Mechanical to begin the simulation procedure





IV. CALCULATIONS

A. *Con-Rod Force Calculation*

Given data:

1) Bore * Stroke = 67*62.4 (mm)
2) Displacement = 220 cc =220*10^3mm
3) Volume of cylinder = 220000mm^3
4) RPM of engine = 8500
5) Angular velocity (ω) = 890.11 rad/s
6) Mass of reciprocating parts ,(Mr)= 0.5 kg
7) Density of Petrol = 737.22*10^-9 kg/mm^3 @ T= 288.85K
8) Molecular weight, M = 114.228 g/mol =0.114228kg/mol
9) Density of petrol = 737.22*10^-9 kg/mm^3 @ T=288.85K
10) Molecular weight, M=114.228g/mol =0.114228 kg/mol
11) Gas constant,R = 8.314 J/mol-K

B. *Pressure Calculation:*

PV =mRT

Here, m= mass of the fuel

R_{sp}= specific gas constant

= R/M , M= molecular weight

=8.3143/0.114228 =72.78J/kg

R_{sp} = 72.78J/kgK

m = density * volume

=737.228*10^-9*220000

m= 0.1622kg

P = m*R_{sp}*T/V

= 0.1622*72.78*288.85/0.00022

= 15,499693.73

~15.49MPa

Pressure force on piston= (F_l)

$F_l = \pi*(D/4)^2 * P$

Here, D = bore diameter = 67mm

$= 3.14/4 *(67)^2 * 15.449$

F_l = 54,612.3N

ϴ=0°

$F_l = m*r*\omega^2 *(\cos(\Theta)+\cos(2*\Theta)/n)^{1/2}$

= 0.5*890.11^2*31.2[1+1/4]

Here r = radius of crank

= stroke length/2

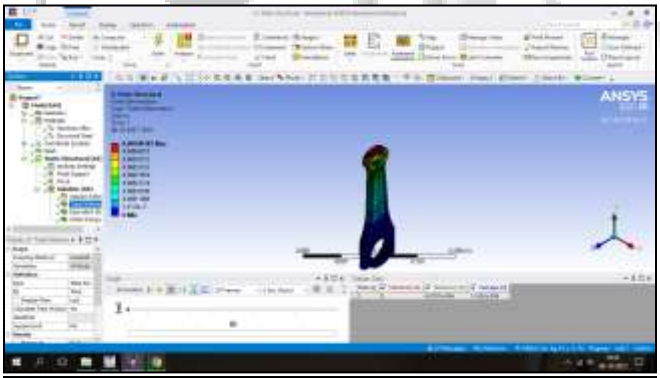
= 62.4/2

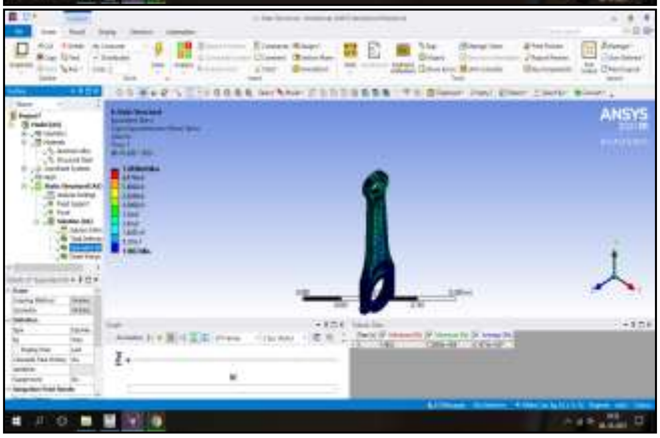
= 31.2mm

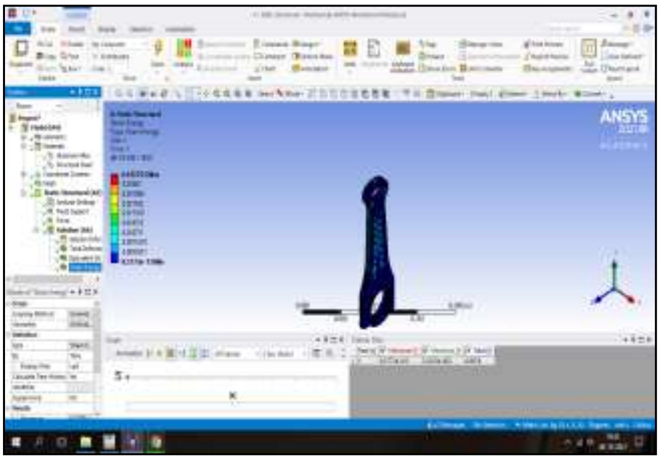
n= length of crank / radius of crank = 4
Therefore;
$F_I = 15,499N$
Net force on piston = F_1-F_I
= 54,612-15,499
= 39,113N
For Ɵ=60°,
$F_I = m*r*w^2[\cos Ɵ° + \cos 2Ɵ°/ n]^{1/2}$
$F_I = 0.5*31.2*890.112\ [0.5-0.5/4]$
F_I= 4,634N
Hence,
net force acting on piston will be ,
Fp = F_l-F_I
Fp = 49,978N
For 0 ° crank angle case,
F_p = 39,113N
For 60 ° crank angle case,
Fp = F_l-F_i
Fp = 49,978N
Force on con-rod,
$Fc = Fp/(1-\sin^2Ɵ)/n^2)^{1/2}$
Fc 0 ° crank angle ,
$Fc = 39,113 / (1-0/16)^{1/2}$
= 39,113N
$(Fc)_{0°}$ = 39,113N
For 60 ° crank angle ,
$Fc = 49,978/(1-(\sin 60°/4)^2)^{1/2}$
= 51,192.2N
$(Fc)_{60°}$ = 51,192.2N

V. ANALYSIS OF MATERIALS

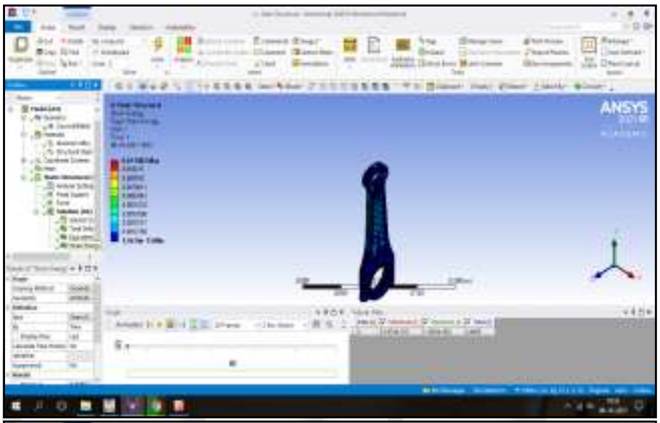
A. *AL ROD*

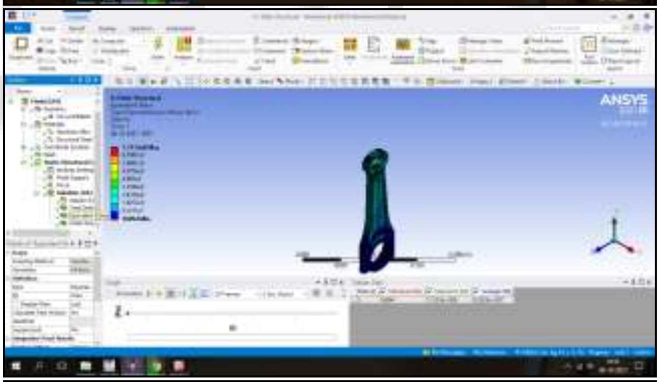


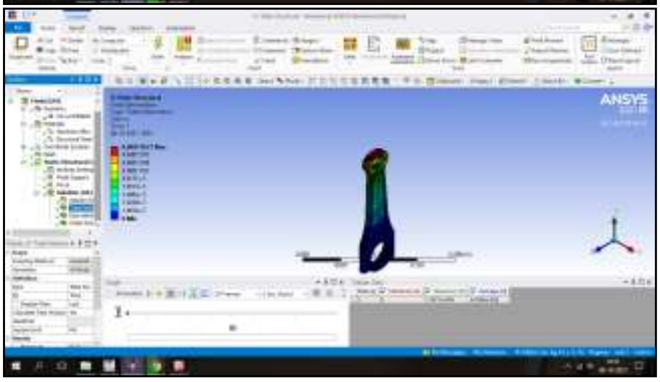




B. *Structural Steel*







VI. DESIGN OF CON-ROD

Considering I beam:
Length of stroke = 62.4mm
Section of con-rod
1) T=t= flange thickness and web

2) $A=11t^2$
3) H= 5t= height of section
4) B= 4t= width of section
5) Ixx/Iyy= 3.2
6) Kxx= radius of gyration about x- axis
   Kxx^2= Ixx/A, Kxx = 1.78t
7) Length of rod (L) = Stroke length*2
   =2*62.4=124.8mm

A. *Buckling load calculations*

W_B=Buckling load
= F_1*FOS (FOS = 5 to 6)
=54612.3N*6
= 327673.8N
Al Alloy
Yield strength= 280N/mm^2
Structural steel
Yield strength= 250N/mm^2

Dimensions	For Al in mm	For steel in mm
T =t	10.5	10.94
W= 4t	42	43.76
H= 5t	52.5	54.7
A= 11t^2	115.5	1316.52
H1= 0.85H= height at small end	44.625	46.52
H2= 0.2H= height at big End	63	65.676

Small End (for pin)		Large End (for crack)	
F=	d_p*l_p*B_{p1}	F	l_c*d_c*B_{p2}
l_p=	1.5d_p	l_c	1.5d_c
B_{p1}=	1.5MPa	B_{P2}	10MPa
F=	54612 N	F	54612 N
d_p=	9.26mm	d_c	60.34mm
l_p=	73.89mm	l_c	90.5mm

VII. RESULT

Materials	Al	Stainless Steel
Equivalent Stress (Pa) Max Min	 7.28e8 13902	 7.313e8 16094
Total Deformation (m) Max Min	 0.00049787 0	 0.000176 0
Strain Energy (J) Max Min	 0.03225 9.237e-13	 0.0114 3.617e-13

VIII. CONCLUSION

1) Solid modelling of con-rod became made in ANSYS Workbench in step with layout system used and evaluation below the impact of stress, accomplished using ANSYS_Workbench.
2) For similarly optimisation of dynamic evaluation of con-rod required. After dynamic load situations, detailed evaluation will be required. It will supply extra correct consequences than existing.
3) Strain energy is more in Al, it means that it can resist more impact load.
4) Al alloy con-rod is having extra deformation than Stainless steel.
   So, Al con-rod indicates extra shaky behaviour.
5) Minimum and Maximum Von_Mises stress are minimal in con-rod of Al alloy.

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