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# MODELLING AND ANALYSIS OF CONNECTING ROD USING 4340 ALLOY STEEL AND AlSiC-9

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## ABSTRACT

Connecting rod is the intermediate link between the piston and the crank. And is responsible to transmit the push and pull from the piston pin to crank pin, thus converting the reciprocating motion of the piston to rotary motion of the crank. Generally connecting rods are manufactured using 4340 alloy steel. In this work connecting rod is replaced by AlSiC-9. And it also describes the modelling of connecting rod in Pro-e and analysis of connecting rod using ansys (mechanical APDL 14.5).

FEA analysis was carried out by considering two materials. The von mises stress obtained from ANSYS software. Compared to the former material the new material found to have less in weight. It resulted in reduction of 61.6560% of weight.

**KEYWORDS:** Connecting rod, 4340 alloy steel, Pro-e, ANSYS

## INTRODUCTION

Connecting Rods are used in all varieties of automobile engines. Acting as an intermediate link between the piston and the crank of an engine of an automobile. It is responsible to transmit the reciprocating motion of the piston to rotary motion of the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. While the one end, small end of the connecting rod is connected to the piston of the engine by the means of piston pin, the other end, the bigger end being connected to the crank with lower end big end bearing by generally two bolts. Generally connecting rods are being made up of 4340 alloy steel. Forces generated on the connected rod are generally by weight and combustion of fuel inside cylinder acts upon piston. Pro/ENGINEER Wildfire 4.0 software is used for modelling of the connecting rod model and ANSYS 14.5 is used for analysis. ANSYS being an analysis system which stands for "Advanced Numerical System Simulation". It is an CAE software, which has many capabilities, ranging from simple static analysis to complex non-linear, dynamic analysis, thermal analysis, transient state analysis, etc. By Pro/ENGINEER Wildfire 4.0 software, the geometric shape for the model is described, and then the ANSYS program is used for meshing the geometry for nodes and elements. In order to obtain the desirable results at each and every point of the model, the fine meshing is done which also results in accurate results output. Loads and boundary constrains in the ANSYS can be applied on the surfaces. Finally the results calculation is done by the ANSYS software and the desired output results can be achieved.

## THEORITICAL CALCULATION

### 2.1 LML FREEDOM 110CC SPECIFICATIONS

Engine type = air cooled, 4 stroke
Engine displacement = 109.15cc
Number of cylinders = 1
Maximum power = 8.5 bhp@7550rpm
Bore x Stroke = 53.0 x 49.5 mm
Fuel type = petrol
Compression ratio = 9.5:1
Mechanical efficiency = 80%

### 2.2 PRESSURE CALCULATION

Mechanical efficiency = 80%

$= \frac{80}{100}$

$= 0.8$

Brake power = 8.5 hp

$= 8.5 \times 746$

$= 6341$ watts

Indicated power $= \frac{Brake\ power}{Mechanical\ efficiency}$

$= \frac{6341}{0.8}$

$= 7926.25$ watts

$$I.P = \frac{p \times L \times A \times n}{60}$$

Where,

I.P = Indicated Power in watts
P = Indicated mean effective pressure in $N/mm^2$
D = cylinder bore in mm
= 53.0 mm
A = crossectional area of cylinder in $mm^2$

$= \frac{\pi D^2}{4}$

$= \frac{\pi(53.0)^2}{4}$

$= 2206.183441\ mm^2$

L = length of stroke in metres

$= 49.50$ mm

$= \frac{49.50}{1000}$

$= 0.0495$ m

N = speed of the engine in rpm

n = number of working strokes per minute

= N, for two stroke engine

$= \frac{N}{2}$, for four stroke engine

$= \frac{7550}{2}$

$= 3775$ rpm

$I.P = \frac{p \times L \times A \times n}{60}$

$7926.25 = \frac{p \times 0.0495 \times 2206.183441 \times 3775}{60}$

$= p \times 6870.882554$

$p = \frac{7926.25}{6870.882554}$

$= 1.1536\ N/mm^2$

The maximum gas pressure ($P_{max}$) is 9 to 10 times the indicated mean effective pressure (p).

$P_{max} = 10 \times p$

$= 10 \times 1.1536$

$= 11.536\ N/mm^2$

## MATERIALS AND METHODOLOGY

### 3.1 MATERIALS

The materials chosen for analysis of the connecting rod here are 4340 alloy steel and AlSiC-9. These materials where tested using ANSYS software for the stress. The material properties are shown in the table below

Table 3.1 Comparision of mechanical properties

| Mechanical properties | 4340 alloy steel | AlSiC-9 |
|---|---|---|
| Density(Kg/mm$^3$) | 0.00000785 | 0.00000301 |
| Modulus of elasticity (Mpa) | 210000 | 192000 |
| Tensile strength, Ultimate (Mpa) | 745 | 550 |
| Poisson's ratio | 0.3 | 0.242 |

### 3.2 MODELLING OF CONNECTING ROD USING PRO-E

Connecting rod of a LML freedom (110cc) is selected and its dimensions are measured. According the dimensions obtained the model of the connecting rod is developed in the Pro/ENGINEER Wildfire 4.0. Model of the connecting rod developed of this study as shown in figures below

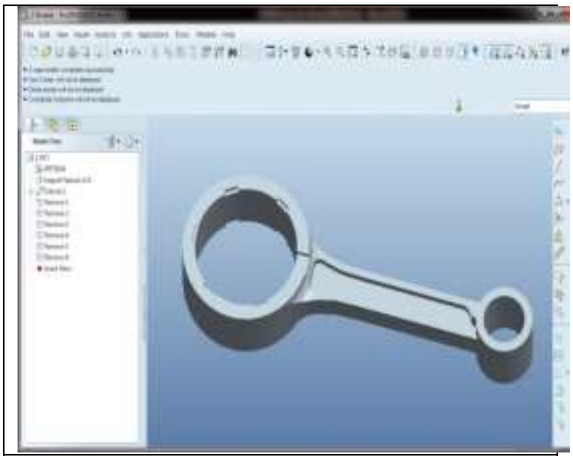

Fig 3.1 connecting rod model in pro-e

### 3.3 FINITE ELEMENT ANALYSIS USING ANSYS

The analysis of connecting rod model is carried out using ANSYS (mechanical APDL 14.5) software. First the model file prepared in ProE, is exported to ANSYS software as an IGES files as shown in figure


Fig 3.2 imported iges file into ansys


Fig 3.3 meshed model of connecting rod

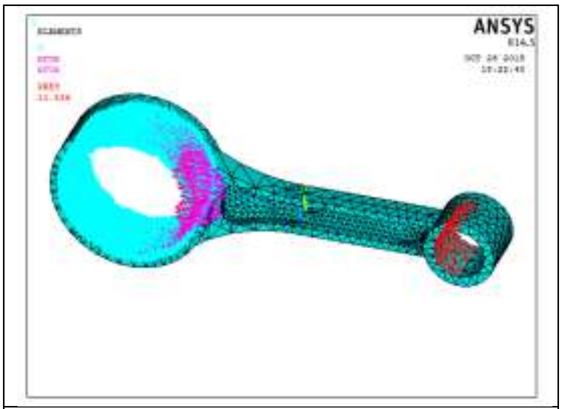

Fig 3.4 constraints and compressive load applied

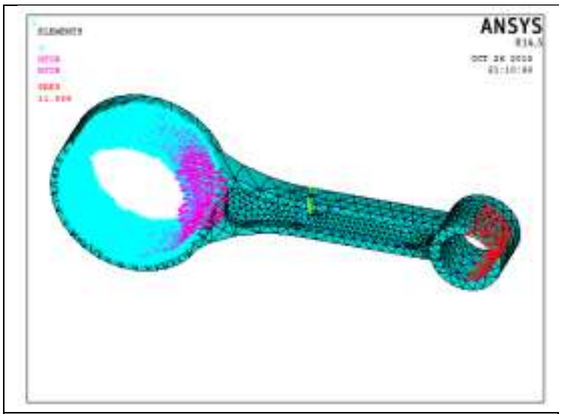

Fig 3.5 constraints and tensile load applied

## RESULTS AND DISCUSSIONS

The static analysis of connecting rod model was conducted for different materials.

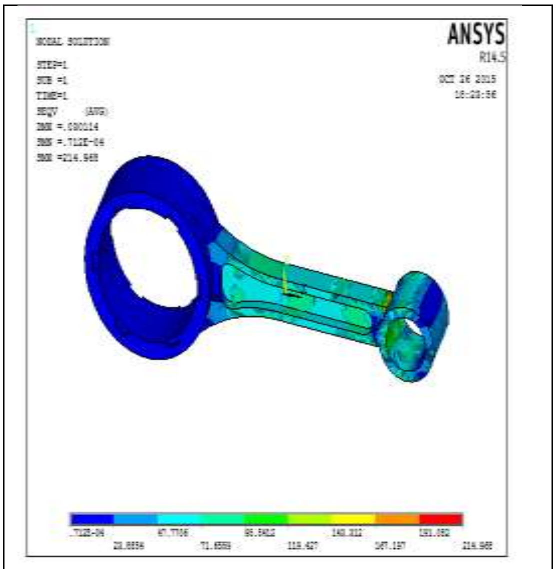

Fig 4.1 Compressive von mises stress in 4340 alloy steel

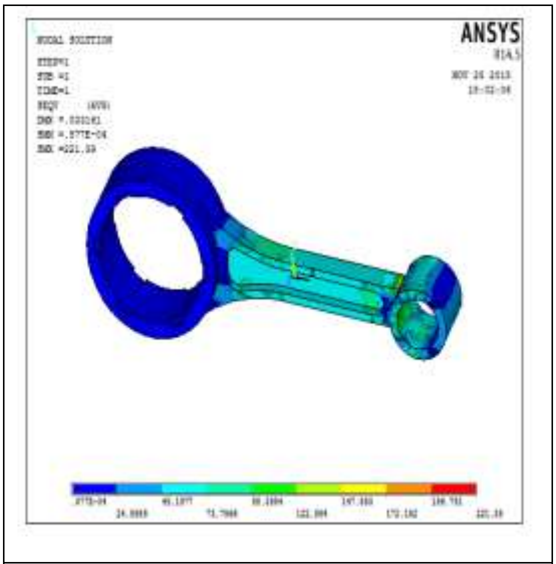

Fig 4.2 Compressive von mises stress in AlSiC-9

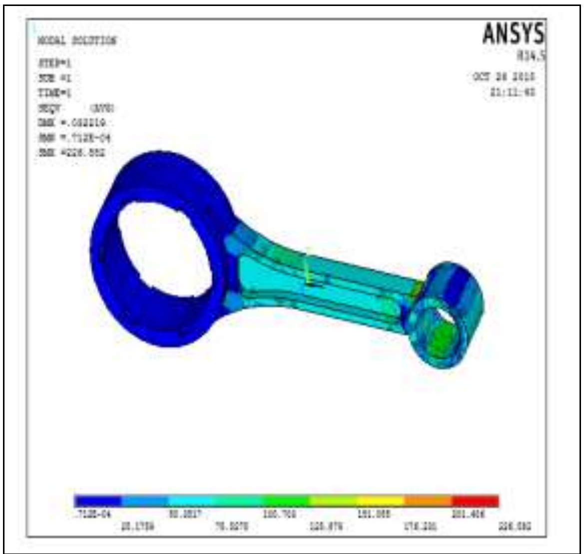

Fig 4.3 Tensile von mises stress in 4340 alloy steel

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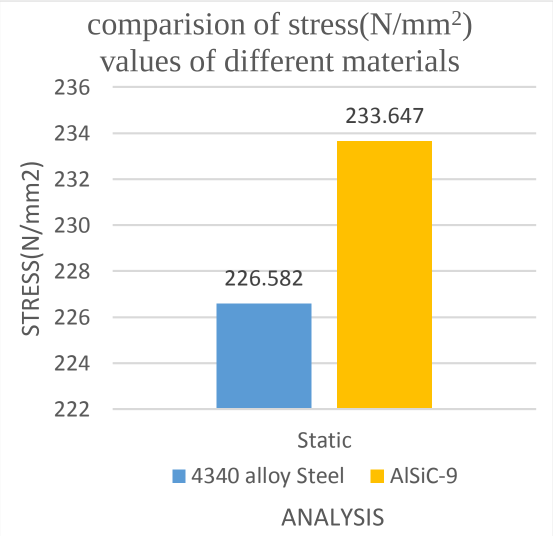
Table 4.1 Comparision of Von mises stress

| | 4340 alloy steel | AlSiC-9 |
|---|---|---|
| Von mises stress ($N/mm^2$) (Compressive load) | 214.968 | 221.39 |
| Von misses stress($N/mm^2$) (Tensile load) | 226.582 | 233.647 |

From the table the stresses produced in AlSiC-9 are 2.9% greater than 4340 alloy steel in compressive load and in tensile load it is 3.0% only.

According to the values obtained in experimentation, We Plot the graphs for 4340 alloy steel & AlSiC-9 as shown following




**Graph 4.1 (Tensile) von mises stress vs analysis**

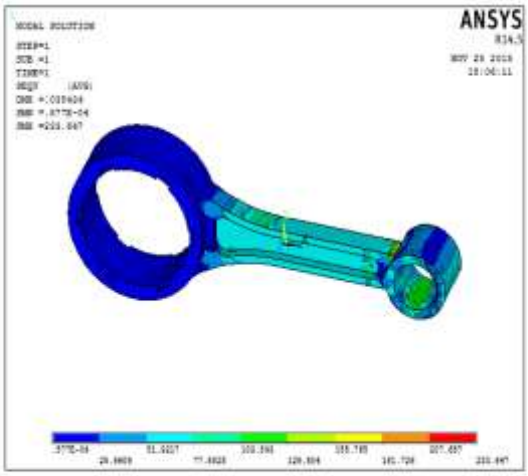
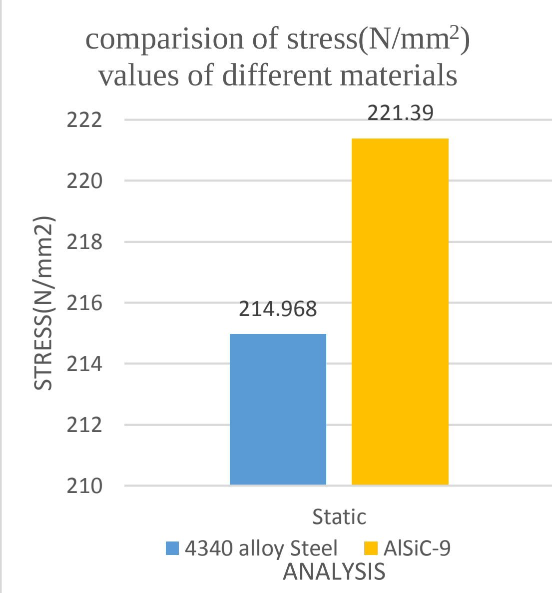



Fig 4.4 Tensile Von mises stress in AlSiC-9




**Graph 4.2 (compressive) von mises Stress vs analysis**

### 3.2 PERCENTAGE REDUCTION IN WEIGHT

**A) For 4340 alloy steel**

Weight ($W_1$)

$= m \times g$

$= d \times v \times g$

$= 0.00000785 \times 14448.7 \times 9810$

$= 1112.6727$ N

**B) For AlSiC-9**

Weight ($W_2$)

$= 0.00000301 \times 14448.7 \times 9810$

$= 426.6426$ N

% reduction in weight between 4340 alloy steel and AlSiC-9

$$= \frac{W1 - W2}{W1} \times 100$$

$$= \frac{1112.6727 - 426.6426}{1112.6727} \times 100$$

= 61.6560 %

## CONCLUSIONS

- Weight can be reduced by changing the material of the current 4340 alloy steel connecting rod to AlSiC-9.
- The optimised connecting rod is 61.6560% lighter than the current connecting rod.

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|---|---|
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