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DESIGN AND ANALYSIS OF CONNECTING ROD

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A B S T R A C T

The connecting rod is the intermediate member between the piston and the crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin and thus convert the reciprocating motion of the piston into rotary motion of the crank.In our project we design a connecting rod for a four stroke single cylinder engine for two different materials Carbon Steel and Aluminum alloy. Both the designs are modeled in 3D modeling software CATIA.Structural analysis is done on the connecting rod to verify the strength of the connecting rod original and modified model by using two materials Aluminum alloy by applying the pressure developed in the engine. Modal analysis is done to determine the natural frequencies when loads are applied.The analysis is done to verify the better material for connecting rod to reduce the cost.Modeling is done in CATIA and analysis is done in ANSYS.

Key words: Connecting Rod, Aluminium Alloy, Forged Steel, Ansys Workbench, etc.

I INTRODUCTION

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 con 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,

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giving greater engine displacement and power, requires a shorter connecting rod (or a piston with

FUNCTION OF CONNECTING ROD

The connecting rod is the intermediate member between the piston and the Connecting Rod. Its primary function the push and pull from the piston pin to the crank pin and thus converts the reciprocating motion of the piston into rotary motion of the crank. 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.

MATERIALS USED FOR CONNECTING ROD

Steel is normally used for construction of automobile connecting rods because of its strength, durability, and lower cost. However, steel with its high mass density exerts excessive stresses on the crankshaft of a high-speed engine. This in turn requires a heavier crankshaft for carrying the loads and, therefore, the maximum RPM of the engine is limited. Additionally, higher inertia loads, such as those caused by steel connecting rods and heavier crankshafts reduces the acceleration or declaration rates of engine speed. Therefore, light alloy metals such as aluminum and titanium are currently being used in high-speed engine connecting rods to circumvent the above-mentioned problems. Titanium has better mechanical properties than aluminum, at the expense of higher density and cost. This higher density and cost have made aluminum connecting rods more popular and attractive. However, they suffer from relatively low strength and fatigue life.

optimize the weight and manufacturing cost of the steel forged connecting rod. The first aspect of this research program has been dealt with in a master's thesis entitled "Fatigue Behavior and Life predictions of Forged Steel and PM Connecting Rods. This current thesis deals with the second aspect of the study, the optimization part. Due to its large volume production, it is only logical that optimization of the connecting rod for its weight or volume will result in large-scale savings. It can also achieve the objective of reducing the weight of the engine component, thus reducing inertia loads, reducing engine weight and improving engine performance and fuel economy.

COMPOSITE MATERIALS

A composite is a material that is formed by combining two or more materials to achieve some superior properties. Almost all the materials which we see around us are composites. Some of them like woods, bones, stones, etc. are natural composites, as they are either grown in nature or developed

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by natural processes. Feasibility studies were carried out, since early seventies, to explore the possibilities of using composites in the exterior body panels, frameworks/chassis, bumpers, drive shafts, suspension systems, wheels, steering wheel columns and instrument panels of automotive vehicles. Ford Motor Co. experimented with the design and development of a composite rear floor pan for an Escort model using three different composites: a vinyl-ester-based SMC and XMC and a glass fibre reinforced prolypropylene sheet material. Analytical studies, static and dynamic tests, durability tests and noise tests demonstrated the feasibility of design and development of a highly curved composite automotive part. A composite GM heavy truck frame, developed by the Convair Division of General Dynamics in 1979, using graphite and Kevlar fibres (2:1 by parts) and epoxy resin (32% by wt) not only performed satisfactorily but reduce the weight by 62% in comparison to steel for the same strength and stiffness. The hybrid glass/carbon fibre composite drive shafts, introduced around 1982 in Mazdas, provided more weight savings, lower maintenance cost, reduced level of noise and vibration and higher efficiency compared to their metal counterparts. The more recent pickup truck GMT-400 (1988 model) carries a composite driveshaft that is pultruded around a 0.2cm thick and 10cm diameter aluminium tube. The composite driver shaft is 60% lighter than the original steel shaft and possesses superior dampening and torsional properties.

Chevrolet Corvette models carry filament wound composite leaf springs (monoleaf) in both rear suspension (1081) and front suspension (1984). These springs were later introduced during 1985 on the GM Chevrolet Astro van and Safari van. Fibre glass reinforced polypropylene bumper beams were introduced on Chevrolet Corvette Ford and GM passenger cars (1987 models). Other important applications of composites were the rear axle for Volkswagen Auto-2000, Filament wound steering wheels for Audi models and composite wheels of Pontiac sports cars. Composites are recognized as the most appropriate materials for the corrosion resistant, lightweight, fast and fuel efficient modern automobiles, for which aerodynamics constitute the primary design considerations.

METHODS GENERALLY USED FOR MANUFACTURING THE CONNECTING ROD

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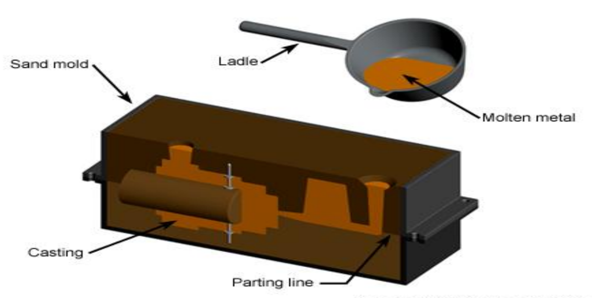
Forging Vs Casting

- **Forging**
  - Total processes approximate 16
  - Dimensional consistency and accuracy
  - Reduce mass by 10%
  - Consume less energy
  - Provides longer tool life
  - smoother running in the engine
  - Less cost for > 20,000 pieces
  - High production rate
  - Less time consumes
  - Reduce cost about 25%
  - It performed at low temperature
- **Casting**
  - Total processes approximate 36
  - Less accuracy
  - More time consuming
  - Required high temperature for melting
  - Low production rate
  - Defects such as pin hole, shrinkage, porosity, Rough surface etc.
  - high cost for >20,000 pieces
  - More waste of materials
  - More labor cost
  - Machining process
  - Low strength

Sand Cast Connecting Rods

Starting with the 1962 Buick V-6 engine, General Motor's Central Foundry, produced 50 million cast pearlitic malleable iron connecting rods for use in 11 different engines, ranging up to 428 cubic inches in displacement. The design was modified slightly from the existing forging designs due to different REQUIREMENTS of the crosssection. Specifically, the I-beam cross section was increased and more generous radii was given to the end of the connecting rod that fits around the crankshaft. These modifications can be seen in Figure 4. These connecting rods were cast in green sand molds, annealed at 1750oF for 18 hours and air cooled. After air cooling they were reheated a second time at 1600oF, quenched in oil to form a martensitic microstructure and then tempered for 3 to 4 hours at 1150-1180oF. The reported properties for this part were: a 100 ksi minimum tensile strength, 80 ksi yield strength, and 2% elongation.



LITERATURE SURVEY

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Design and Analysis of Connecting Rod using Different Materials

The connecting rod is the intermediate member between the piston and the Crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin, thus converting the reciprocating motion of the piston into rotary motion of the crank. This thesis describes designing and Analysis of connecting rod. Currently, existing connecting rod is manufactured by using Forged steel. In this, drawing is drafted from the calculations. A parametric model of Connecting rod is modeled using NX 10 software and to that model, analysis is carried out by using ANSYS Workbench Software. Finite element analysis of connecting rod is done by considering the materials, such as Titanium Alloy, Beryllium Alloy – 25, Magnesium Alloy and Aluminum 360. The best combination of parameters like Von misses Stress and strain, Deformation, Factor of safety and weight reduction for two wheeler piston were done in ANSYS software. Aluminium Alloy has more factor of safety, reduce the weight, reduce the stress and stiffer than other material like Forged Steel. With Fatigue analysis we can determine the lifetime of the connecting rod.

METHODOLOGY

ADVANTAGES OF CATIA PARAMETRIC SOFTWARE

1. Optimized for model-based enterprises
2. Increased engineer productivity
3. Better enabled concept design
4. Increased engineering capabilities
5. Increased manufacturing capabilities
6. Better simulation
7. Design capabilities for additive manufacturing

CATIA parametric modules:

- Sketcher
- Part modeling
- Assembly
- Drafting

3D MODEL

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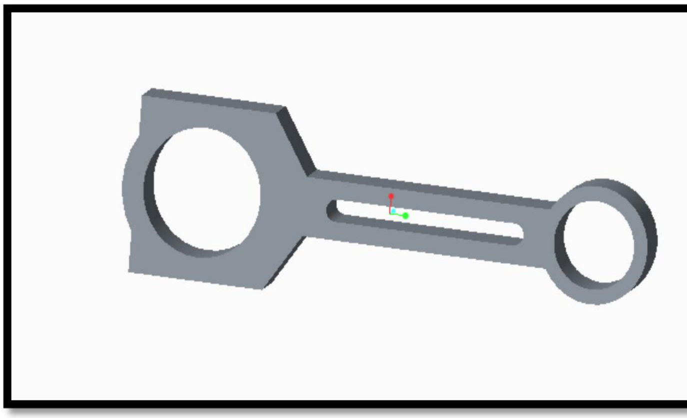
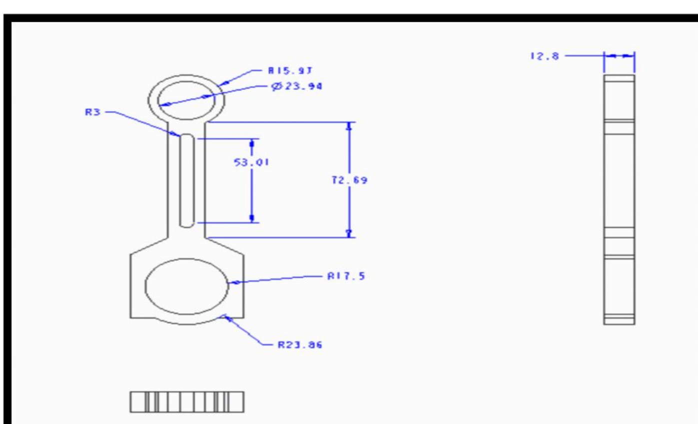


2d model



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STATIC ANALYSIS OF DIESEL ENGINE CONNECTING ROD

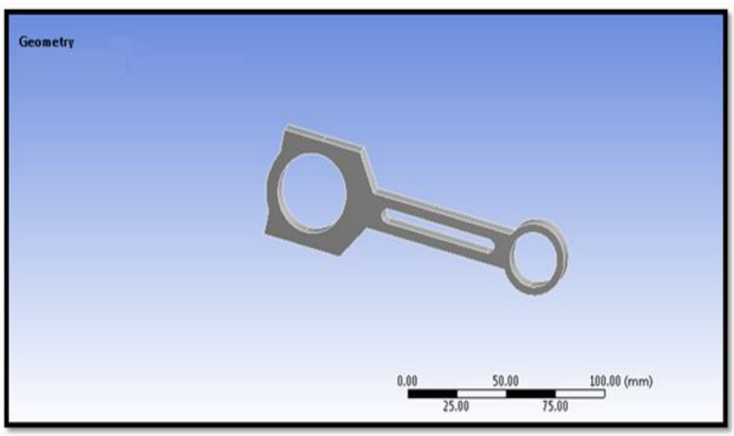
Materials used

forged steel

Young's modulus	=	**205000mpa**
Poisson's ratio	=	**0.3**
Density	=	**7850kg/mm^3**

ORIGINAL MODEL

Import geometry



Meshing

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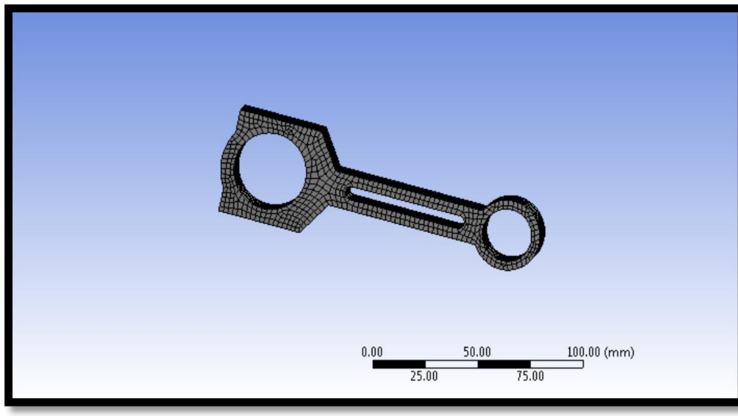
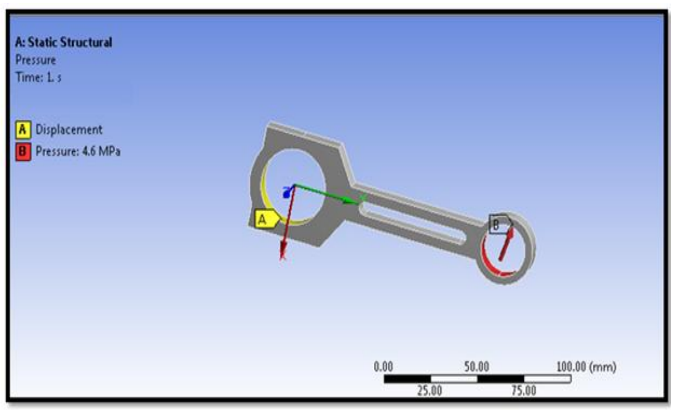
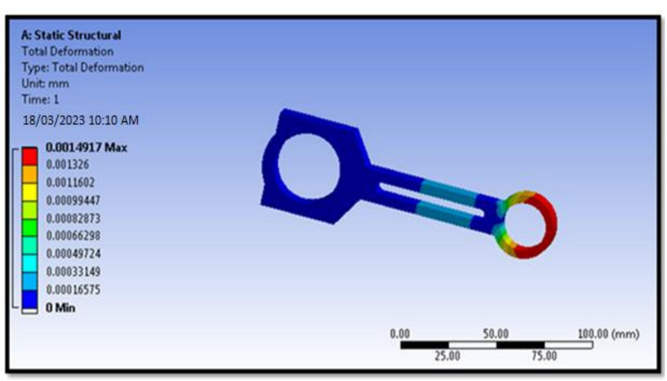


Boundary conditions



AT PRESSURE-4.6MPA

TOTAL DEFORMATION



STRESS

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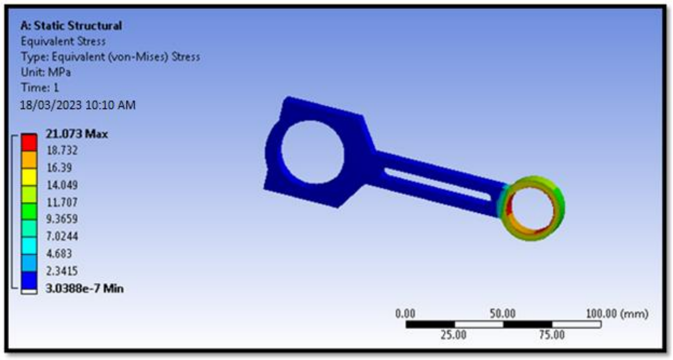
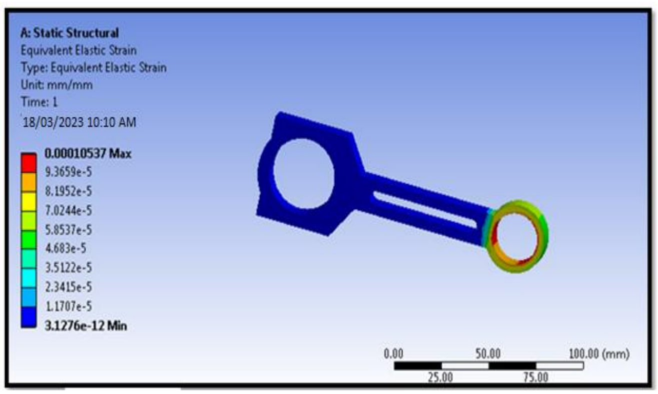
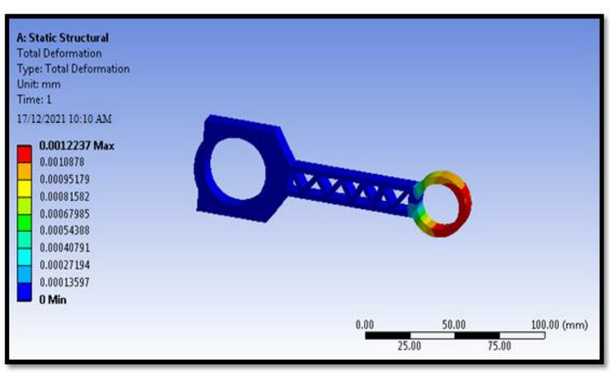


STRAIN



MODIFIED MODEL

TOTAL DEFORMATION



STRESS

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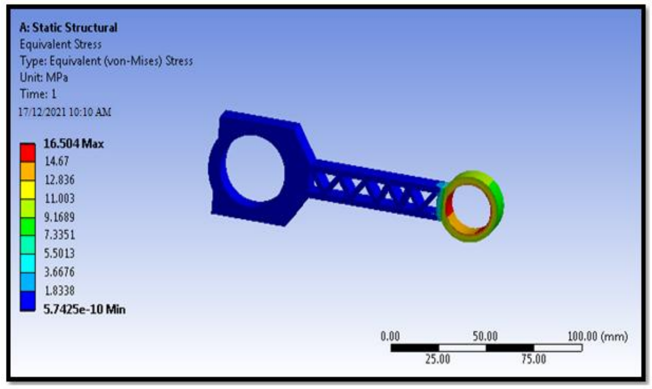

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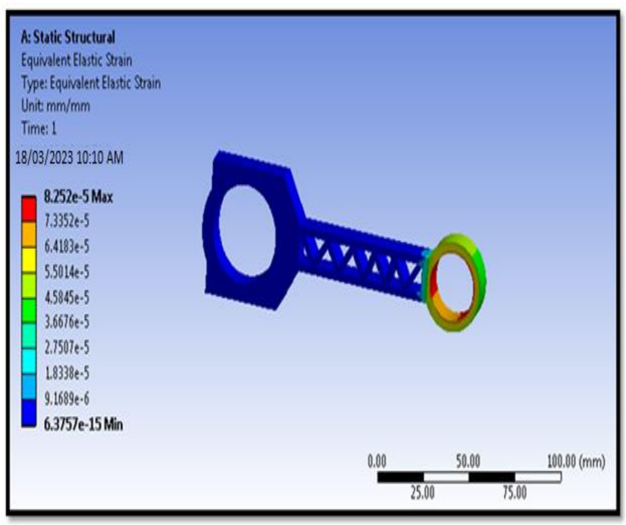

RESULT TABLES

STATIC ANALYSIS RESULTS

Geometry	At pressure(N/mm^2)	Deformation (mm)	Stress (N/mm^2)	Strain
Original	**4.6**	0.0014917	21.073	0.00010537
	5.6	0.001816	25.654	0.00012877
Modified	**4.6**	0.0012237	16.504	8.252e-5
	5.6	0.0015636	21.088	0.00010544

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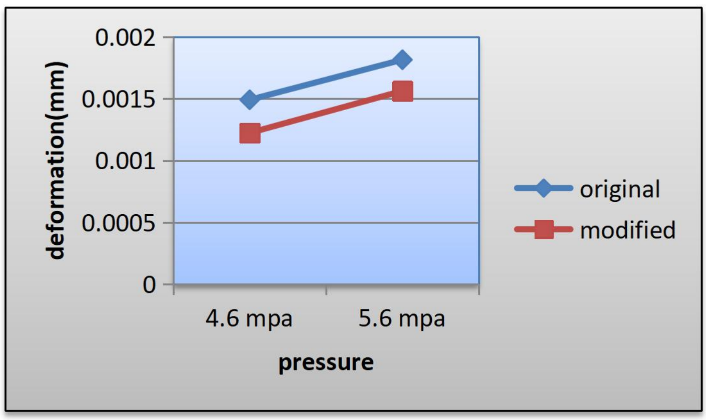
GRAPHS

DEFORMATION



CONCLUSION

Structural analysis is done on the connecting rod to verify the strength of the connecting rod original and modified model by using two materials Carbon Steel and Aluminum alloy by applying the pressure developed in the engine. Modal analysis is done to determine the natural frequencies when loads are applied.

By observing the static analysis the stress and deformation values are increased by increasing the load acting on the connecting rod. And the stress values are decreases the modified model of the connecting rod.By observing the buckling analysis the deformation values are increased by increasing the load acting on the connecting rod. And the deformation values are decreases the modified model of the connecting rod.So it can be concluding the connecting rod modified model is better.

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