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# Design and Analysis of 150CC IC Engine Connecting ROD

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## ABSTRACT

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 CREO. 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 CREO and analysis is done in ANSYS.

**Keywords :** CREO, ANSYS, ROD, RIM, VARTM, BMC, ETC, LFTP

## I. INTRODUCTION

In a reciprocating engine, the connecting rod connects the piston to the crank or crankshaft. In modern automotive internal, the connecting rods are most usually made of steel for production engines, but can be made of aluminum (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. They are not rigidly fixed at either end, so that the angle between the connecting rod and the piston can change as the rod moves up and down and rotates around the crankshaft. Condors', especially in racing engines, may be called "billet" rods, if they are machined out of a solid billet of metal, rather than being cast. 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 big end connects to the bearing journal on the crank throw, running on replaceable bearing shells accessible via the con rod bolts which hold the bearing "cap" onto the big end; typically there is a pinhole bored through the bearing and the big end of the con rod so that pressurized lubricating motor squirts out onto the thrust side of the cylinder wall to lubricate the travel of the pistons and piston rings.

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 con 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 con rod/piston assemblies to the same weight and Magnafluxing 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 bolts to 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. Therefore, the big end "caps" are not interchangeable between con rods, and when rebuilding an engine, care must be taken to ensure that the caps of the different con rods are not mixed up. Both the con rod and its bearing cap are usually embossed with the corresponding position number in the engine block.

Recent engines such as the Ford 4.6 liter engine and the Chrysler 2.0 liter 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 from the 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 to 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 connecting 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.

In modern automotive internal combustion engine, the connecting rods are most usually made of steel for production engine. But can be made of aluminum or titanium for high performance of engines of cast iron for application such as motor scooters. They are not rigidly

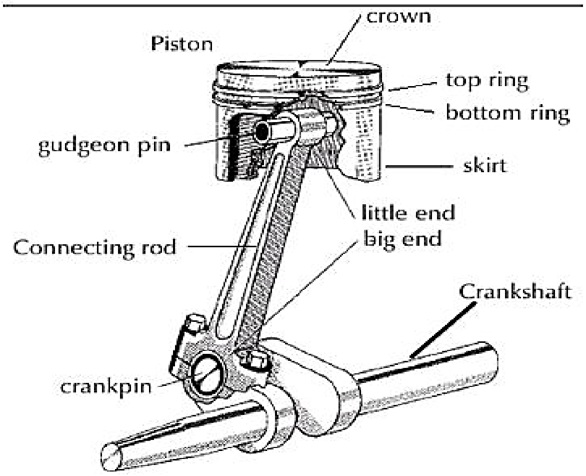



**Figure 1.** Schematic diagram of connecting rod.

**CONNECTING ROD**

Connecting rod is a member connecting piston and crankshaft and is a medium for converting the reciprocating motion to rotary motion. In four stroke engines during the compression and power stroke the connecting rod is subject to high compressive load. In suction stroke it undergoes high tensile stresses. In case of two-stroke engine the connecting rod is only subject to compressive load. Connecting rod length is usually about 4 to 5 times of the crank radius. They are I beam sections of fine-grained, fully killed alloy steel forging. Connecting rods are having a fine-drilled hole from the big end to the small end for transporting oil for lubrication at small end bearing and piston pin and for cooling of piston.

The connecting rod assembly consists of**:**

(i) Connecting rod, (ii) Connecting rod cap (iii) Piston pin bushing (iv) Bearing Shell upper (v) Bearing Shell lower (vi) Connecting rod bolts and nuts.

**Composition**

Carbon 0.43
Manganese 0.75%
Phosphorous 0.025% Max.
Sulphur 0.025% Max.
Silicon 0.20 %
Nickel 0.40 %
Chromium 0.40 - 0.60%
Molybdenum 0.15 - 0.25%
Boron 0.5% Min.

# II. METHODOLOGY AND MATERIAL

### Methods Generally Used For Manufacturing The Connecting Rod

**Forging Vs Casting**

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

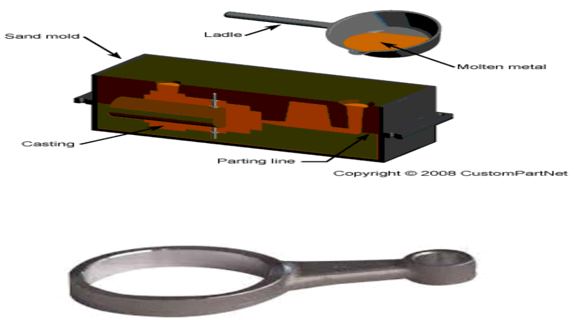



**Figure 2.** Sand Cast Connecting Rods

### Wrought Forged Connecting Rods

It is unclear when the first wrought forged connecting rod was produced but the wrought forged connecting rod has long been the "standard" for the automotive industry. Plain carbon steel forgings were the initial material of choice. Since a finished connecting rod cannot be formed in one blow, the forging dies for connecting rods have several impressions, each step moving progressively toward the final shape. The metal billet, or starting material, is transferred from one impression to another between successive blows. Figure 6 shows a set of forging dies and the main steps in forging a connecting rod. Often, the cap part and lower rod part are forged separately, or forged slightly oblong and sawed in two pieces. After the part has been forged it must be heat treated to reach the desired properties and then straightened after the heat treating operation.

To ensure proper weight and balance of the finished rod, the rod is forged with extra weight in the form of balancing pads on both ends of the rod These balancing pads are then machined during 10 the finishing operation to obtain a well balanced connecting rod. The rod and cap are finish machined using several operations including broaching, milling, boring, honing, fringing and other finishing steps. A substantial quantity of metal is removed to get the final dimensions and finish. The quantity of metal removed during the machining process is typically around 25-30% of the drop forged roughstock cap and rod. This estimate does not include the flash that is trimmed immediately after the forging operation.

**Figure 3.** Powder Forged Connecting Rods

In the 1970s, the connecting rod appeared as one of the powder forged technology's target applications. The powder forging process, as can be seen in Figure 7, is an extension of the conventional press and sinter powder metallurgy (P/M) process. A porous preform is densified by hot forging with a single blow. The forging is performed in heated, totally enclosed dies, and virtually no flash is generated.

## HIGH PRESSURE DIE CASTING OPTIMIZATION OF A CONNECTING ROD

Connecting rods connect the pistons to the crank shaft in automotive engines and are vital components of the engine. Connecting rods are traditionally produced in ferrous metals by forging or die casting. The Abor foundry, long time suppliers of connecting rods to the automotive industry, engaged EnginSoft to carry out a multi-objective engineering simulation study of the connecting rods manufacturing process in aluminum (EN AB46100 or AlSi11Cu2(Fe)) using the high pressure die casting method of production. The study results were implemented to produce a lower cost connecting rod that maintains the same high-quality standards required by their customer.

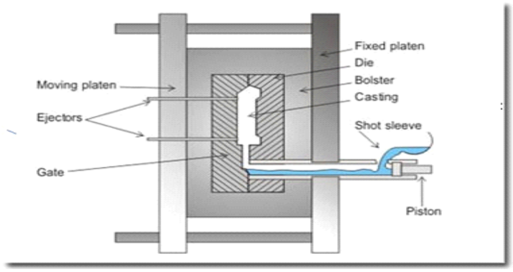



**Figure 4.** Manufacturing process for composite materials products

**Reaction injection molding (RIM):** injects a rapid-cure resin and a catalyst into the mold in two separate streams. Mixing and the resulting chemical reaction occur in the mold instead of in a dispensing head. Automotive industry suppliers combine structural RIM (SRIM) with rapid preforming methods to fabricate structural parts that don't require a Class A finish. Programmable robots have become a common means to spray a chopped fiberglass/binder combination onto a vacuum-equipped preform screen or mold. Robotic sprayup can be directed to control fiber orientation. A related technology, dry fiber placement, combines stitched preforms and RTM. Fiber volumes of up to 68 percent are possible, and automated controls ensure low voids and consistent preform reproduction, without the need for trimming.

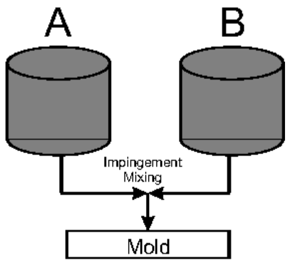



**Figure 5.** Injection Moulding

**Vacuum-assisted resin transfer molding *(VARTM):*** refers to a variety of related processes that represent the fastest-growing new molding technology. The salient difference between VARTM-type processes and RTM is that in VARTM,
resin is drawn into a preform through use of a vacuum only, rather than pumped in under pressure. VARTM does not require high heat or pressure. For that reason, VARTM operates with low-cost tooling, making it possible to inexpensively produce large, complex parts in one shot.

In the VARTM process, fiber reinforcements are placed in a one-sided mold, and a cover (typically a plastic bagging film) is placed over the top to form a vacuum-tight seal. The resin typically enters the structure through strategically placed ports and feed lines, termed a "manifold." It is drawn by vacuum through the reinforcements by means of a series of designed-in channels that facilitate wet out of the fibers. Fiber content in the finished part can run as high as 70 percent. Current applications include marine, ground transportation and infrastructure parts. A twist on the VARTM process is the use of *two* bags, termed double-bag infusion, which uses one vacuum pump attached to the inner bag to extract volatiles and entrapped air, and a second vacuum pump on the outer bag to compact the laminate. This method has been employed by The Boeing Co. (Chicago, Ill.) and NASA, as well as small fabricating firms, to produce aerospace-quality laminates without an autoclave.

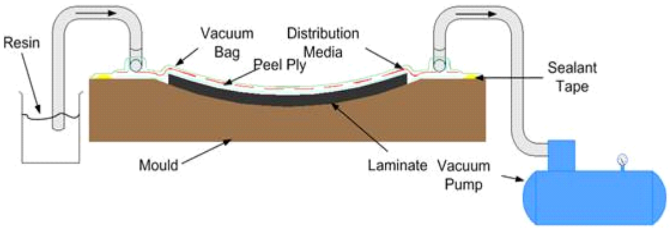



**Figure 6.** Vacuum Moulding

**Resin film infusion (RFI):** is a hybrid process in which a dry preform is placed in a mold on top of a layer, or interleaved with multiple layers, of high-viscosity resin film. Under applied heat, vacuum and pressure, the resin liquefies and is drawn into the preform, resulting in uniform resin distribution, even with high-viscosity, toughened resins, because of the short flow distance

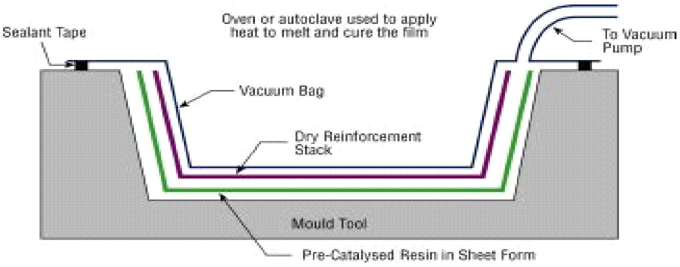



**Figure 7.** Resin film infusion

**Injection molding**: It is a fast, high-volume, low-pressure, closed process using, most commonly, filled thermoplastics, such as nylon with chopped glass fiber. In the past 20 years, however, automated injection molding of BMC has taken over some markets previously held by thermoplastic and metal casting manufacturers. For example, the first-ever BMC-based electronic throttle control (ETC) valves (previously molded only from die-cast aluminum) debuted on engines in the BMW *Mini* and the Peugeot *207*, taking advantage of dimensional stability offered by a specially-formulated BMC supplied by TetraDUR GmbH (Hamburg, Germany), a subsidiary of Bulk Molding Compounds Inc. (BMCI, West Chicago, Ill.,).

In the BMC injection molding process, a ram- or screw-type plunger forces a metered shot of material through a heated barrel and injects it (at 5,000 to 12,000 psi) into a closed, heated mold. In the mold, the liquefied BMC flows easily along runner channels and into the closed mold. After cure and ejection, parts need only minimal finishing. Injection speeds are typically one to five seconds, and as many as 2,000 small parts can be produced per hour in some multiple-cavity molds.

Parts with thick cross-sections can be compression molded or transfer molded with BMC. Transfer molding is a closed-mold process wherein a measured charge of BMC is placed in a pot with runners that lead to the mold cavities. A plunger forces the material into the cavities, where the product cures under heat and pressure.

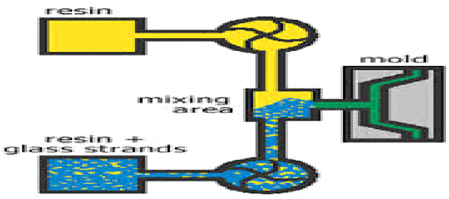



**Figure 8.** Injection Moulding

**Fiberglass spray lay-up process**

It is very different from the hand lay-up process. The difference comes from the application of the fiber and resin material to the mould. Spray-up is an open-molding composites fabrication process where resin and reinforcements are sprayed onto a reusable mould. The resin and glass may be applied separately or simultaneously "chopped" in a combined stream from a chopper gun. Workers roll out the spray-up to compact the laminate. Wood, foam, or other core material may then be added, and a secondary spray-up layer embeds the core between the laminates. The part is then cured, cooled, and removed from the mould.

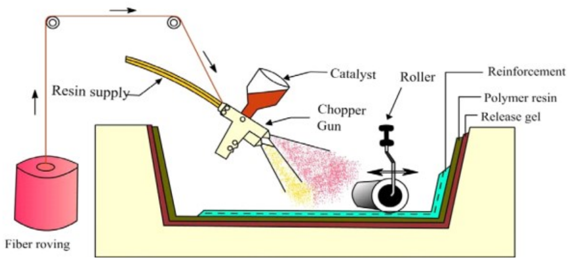



**Figure 9.** Resin Transfer Molding

RTM is a vacuum-assisted, closed-mold, resin transfer process with a flexible solid counter tool for the B-side surface compression. This process yields increased laminate compression, a high glass-to-resin ratio, and outstanding strength-to-weight characteristics. RTM parts have two finished surfaces.

Reinforcement mat or woven roving is placed in the mold, which is then closed and clamped. Catalyzed, low-viscosity resin is pumped in under pressure, displacing the air and venting it at the edges, until the mold is filled. Molds for this low-pressure system are usually made from composite or nickel shell-faced composite construction.Suitable for medium volume production of larger components, resin transfer molding is usually considered an intermediate process between the relatively slow spray-up with lower tooling costs and the faster compression molding methods with higher tooling costs.

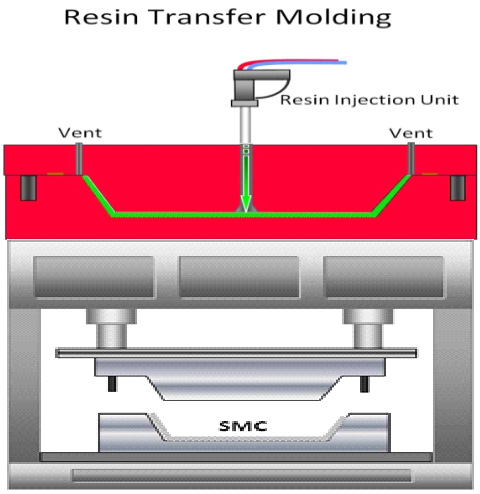



**Figure 10.** Compression molding

Compression molding is often associated with SMC and BMC materials. In actuality, compression molding process is independent of the material type and is the most common choice for high-volume composite parts made from BMC, SMC, liquid composite (preform), GMT or LFTP.

The high-pressure molding process produces high strength, complex parts in a wide variety of sizes. Matched metal molds are mounted in a hydraulic or mechanical molding press. The material charge of choice is placed by robotics or hand in the open mold, the heated mold halves are closed, and pressure up to 2,000psi is applied. Cycle time, depending on part size and thickness, ranges from one to five minutes. Features such as ribs, bosses, inserts and attachments can be molded in.

Compression-molded composites are characterized by net size and shape, two excellent finished surfaces, and outstanding part-to-part repeatability. Trimming and finishing costs are minimal.

**Autoclave Molding**

Autoclave molding is a modification of pressure-bag and vacuum-bag molding. This advanced composite process produces denser, void free moldings because higher heat and pressure are used for curing. It is widely used in the aerospace industry to fabricate high strength/weight ratio parts from preimpregnated high strength fibers for aircraft, spacecraft and missiles. Autoclaves are essentially heated pressure vessels usually equipped with vacuum systems into which the bagged lay-up on the mold is taken for the cure cycle. Curing pressures are generally in the range of 50 to 100 psi and cure cycles normally involve many hours. The method accommodates higher temperature matrix resins such as epoxies, having higher properties than conventional resins. Autoclave size limits part size.

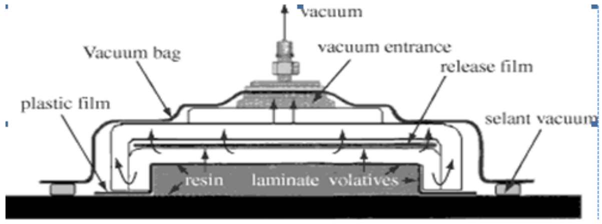



**Figure 10.** Autoclave Molding

**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.

## III. 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.

The automobile engine connecting rod is a high volume production, critical component. It connects reciprocating piston to rotating crankshaft, transmitting the thrust of the piston to the crankshaft. Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine. Connecting rods for automotive applications are typically manufactured by forging from either wrought steel or powdered metal. They could also be cast. However, castings could have blow-holes which are detrimental from durability and fatigue points of view. The fact that forgings produce blow-hole-free and better rods gives them an advantage over cast rods. Between the forging processes, powder forged or drop forged, each process has its own pros and cons. Powder metal manufactured blanks have the advantage of being near net shape, reducing material waste. However, the cost of the blank is high due to the high material cost and sophisticated manufacturing techniques.

With steel forging, the material is inexpensive and the rough part manufacturing process is cost effective. Bringing the part to final dimensions under tight tolerance results in high expenditure for machining, as the blank usually contains more excess material. The first aspect was to investigate and compare fatigue strength of steel forged connecting rods with that of the powder forged connecting rods. The second aspect was to 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.

**HOW TO MANUFACTURING PROCESS**

Connecting rods are mostly used in variety of engines such as, in-line engines, V engines, opposed cylinder engines, radial engines and oppose-piston engines. A connecting rod consists of a pin-end, a shank, and a Pin-end and crank-end pin holes at the upper and lower both ends are machined to permit accurate fitting of bearings. These holes must be parallel. The upper end of the connecting rod is attached to the piston by the piston pin. If the piston pin is locked in the piston pin bosses in the piston and the connecting rod, the upper hole of the connecting rod will have a solid bearing of bronze or other same material. As the lower end of the connecting rod rotate with the crankshaft, the upper end is forced to turn back and forth on the piston pin. Although this crusade is rebuff, the bearing bushing is essential because of the high pressure and temperatures. The lower hole in the connecting rod is crack to permit it to be fixed around the crankshaft. The bottom part is made of the same material as the rod and is attached by two bolts. The surface that tolerate on the crankshaft is generally a bearing material in the form of a distinct crack shell. The two parts of the bearing are maintaining in the rod and cap by dowel pins, forecasts, or short brass screws. Split bearings may be of the accuracy or semi accuracy type.

The connecting rod in I.C. engines are subjected to high cyclic loads comprised of dynamic tensile and compressive load. 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 the rotary motion of the crank. It consists of a long shank small end and a big end. The cross section of the shank may be rectangular, circular, tubular, I-section or H-section. Commonly the circular section is used for low speed engine while I-section is preferred for high speed engine. Stress analysis of connection rod by finite element method using ANSYS 16.2 work bench software. And analyzed that the stress induced in the piston end of the connecting rod are greater than the stresses induced at the crank end. So that piston end more fractures compare to crank end.

## IV. EXPERIMENTAL WORK AND USED SOFTWARE

**Figure 11.** Design of Connecting Rod used in I.C Engine

## V. OBJECTIVE

1. Study of connecting rod.
2. Geometry design through CAD Tool solid work.
3. Stress analysis through ANSYS.

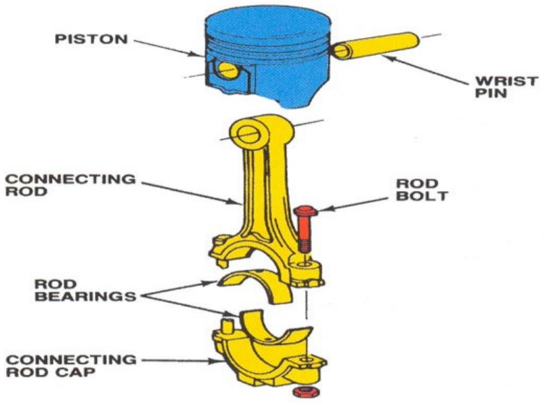



**Figure 12.** Parts of Connecting Rod

### INTRODUCTION TO CAD

**Computer-aided design** (**CAD**) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term **CADD** (for Computer Aided Design and Drafting) is also used.

Its use in designing electronic systems is known as electronic design automation, or **EDA**. In mechanical design it is known as mechanical design automation (**MDA**) or **computer-aided drafting** (**CAD**), which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions. CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

### INTRODUCTION TO CREO

PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule-based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself.

The name was changed in 2010 from Pro/ENGINEER Wildfire to CREO. It was announced by the company who developed it, Parametric Technology Company (PTC), during the launch of its suite of design products that includes applications such as assembly modeling, 2D orthographic views for technical drawing, finite element analysis and more.

PTC CREO says it can offer a more efficient design experience than other modeling software because of its unique features including the integration of parametric and direct modeling in one platform. The complete suite of applications spans the spectrum of product development, giving designers options to use in each step of the process. The software also has a more user friendly interface that provides a better experience for designers. It also has collaborative capacities that make it easy to share designs and make changes.

There are countless benefits to using PTC CREO. We'll take a look at them in this two-part series. First up, the biggest advantage is increased productivity because of its efficient and flexible design capabilities. It was designed to be easier to use and have features that allow for design processes to move more quickly, making a designer's productivity level increase.

Part of the reason productivity can be increased is because the package offers tools for all phases of development, from the beginning stages to the hands-on creation and manufacturing. Late stage changes are common in the design process, but PTC CREO can handle it. Changes can be made that are reflected in other parts of the process.

The collaborative capability of the software also makes it easier and faster to use. One of the reasons it can process information more quickly is because of the interface between MCAD and ECAD designs. Designs can be altered and highlighted between the electrical and mechanical designers working on the project.

The time saved by using PTC CREO isn't the only advantage. It has many ways of saving costs. For instance, the cost of creating a new product can be lowered because the development process is shortened due to the automation of the generation of associative manufacturing and service deliverables.

PTC also offers comprehensive training on how to use the software. This can save businesses by eliminating the need to hire new employees. Their training program is available online and in-person, but materials are available to access anytime.

A unique feature is that the software is available in 10 languages. PTC knows they have people from all over the world using their software, so they offer it in multiple languages so nearly anyone who wants to use it is able to do so.

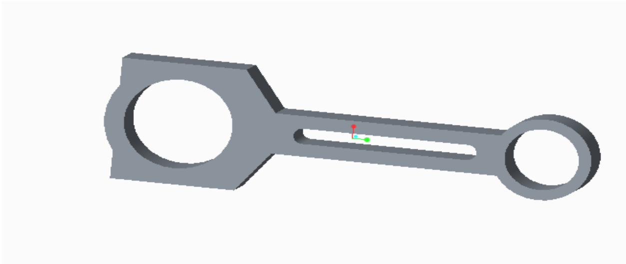


**Figure 13.** 3D MODEL(ORIGINAL)

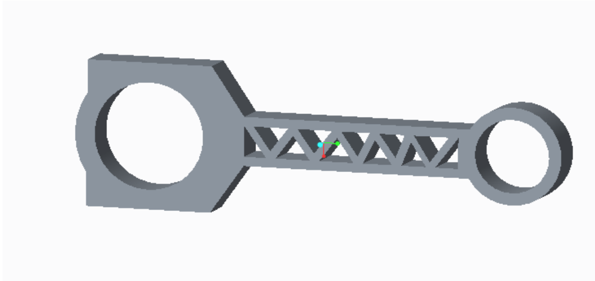


**Figure 14.** 3D MODEL(MODIFIED)

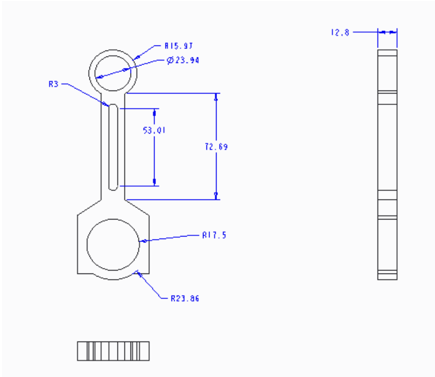



**Figure 15.** 2D MODEL (ORIGINAL)

## INTRODUCTION TO ANSYS

### Structural Analysis

ANSYS Autodyn is computer simulation tool for simulating the response of materials to short duration severe loadings from impact, high pressure or explosions.

### ANSYS Mechanical

ANSYS Mechanical is a finite element analysis tool for structural analysis, including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behavior, and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS Mechanical also includes thermal analysis and coupled-physics capabilities involving acoustics, piezoelectric, thermal–structural and thermo-electric analysis.

### Fluid Dynamics

ANSYS Fluent, CFD, CFX, FENSAP-ICE and related software are Computational Fluid Dynamics software tools used by engineers for design and analysis. These tools can simulate fluid flows in a virtual environment — for example, the fluid dynamics of ship hulls; gas turbine engines (including the compressors, combustion chamber, turbines and afterburners); aircraft aerodynamics; pumps, fans, HVAC systems, mixing vessels, hydro cyclones, vacuum cleaners, etc.

**STATIC ANALYSIS OF DIESEL ENGINE CONNECTING ROD**

**MATERIALS USED: FORGED STEEL**

**Young's modulus = 205000mpa**

**Poisson's ratio = 0.3**

**Density = 7850kg/mm$^3$**

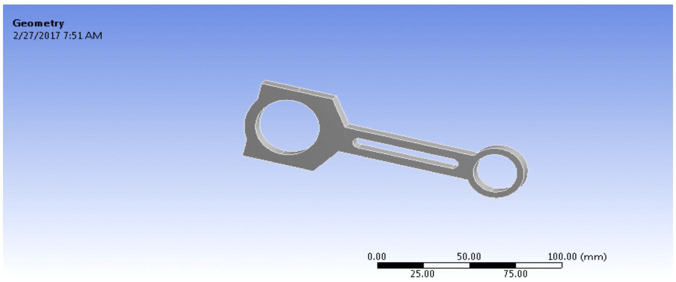
**Save Creo Model as .iges format**

→→Ansys → Workbench→ Select analysis system → static structural →double click

→→Select geometry → right click → import geometry → select browse →open part → ok

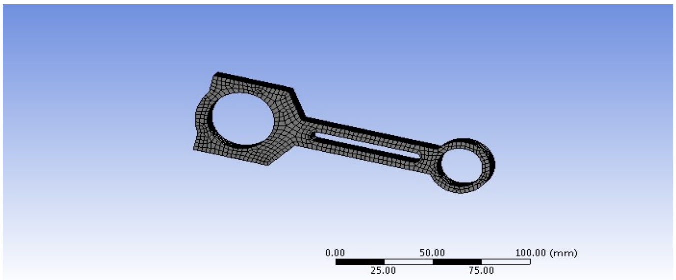
→→ Select mesh on work bench → right click →edit

Double click on geometry → select MSBR → edit material →



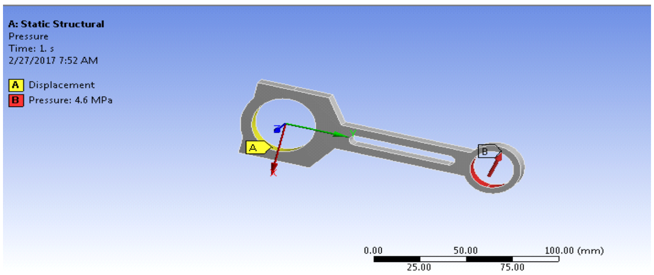

Material selection

Select mesh on left side part tree → right click → generate mesh →



Mesh Generation

Select static structural right click → insert → select rotational velocity and fixed support → Select displacement → select required area → click on apply → put X,Y,Z component zero →




Static Structural Analysis

Select force → select required area → click on apply → enter rotational velocity

Select solution right click → solve →

Solution right click → insert → deformation → total →

Solution right click → insert → strain → equivalent (von-mises) →

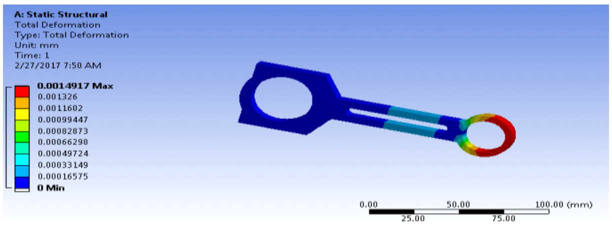
Solution right click → insert → stress → equivalent (von-mises) →

Right click on deformation → evaluate all result

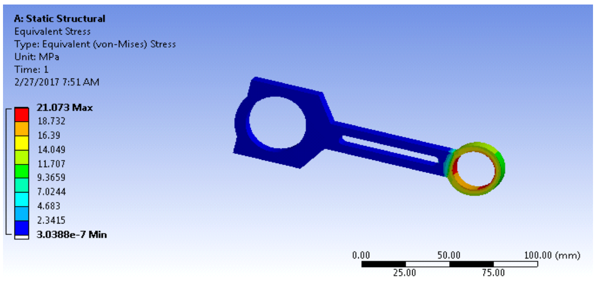
## VI. RESULTS AND DISCUSSIONS

Designed model is analyzed at different levels at different loads and stresses. Finally got the results as deformation in different levels. These are as follows

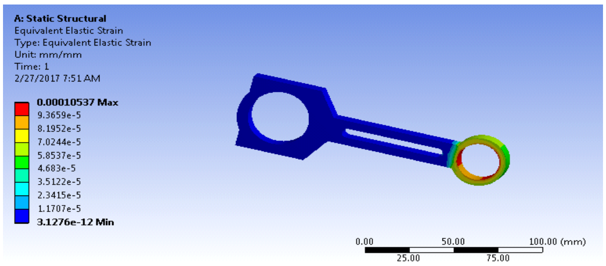
**ORIGINAL MODEL AT PRESSURE-4.6MPA**




Total Deformation at Pressure-4.6mpa

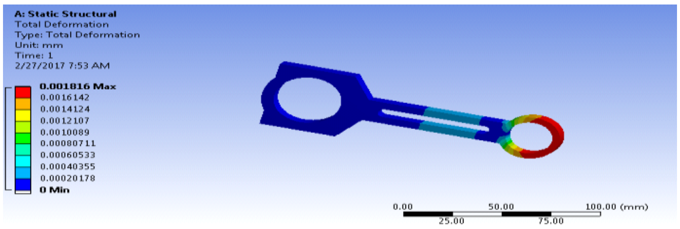



Stress at Pressure-4.6mpa

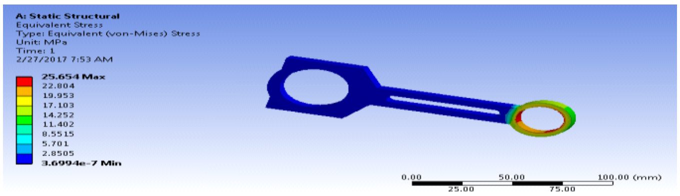



Strain at Pressure-4.6mp

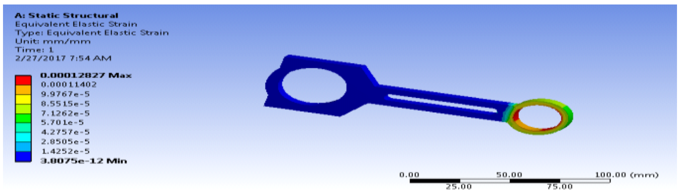
## ORIGINAL MODEL AT PRESSURE-5.6MPA




Total Deformation at Pressure-5.6mpa

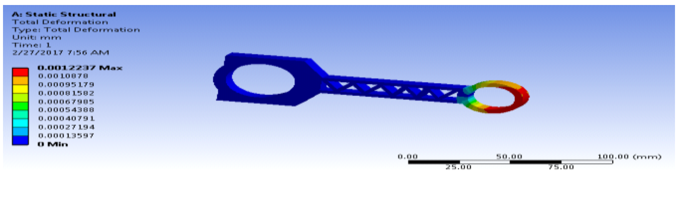


Stress at Pressure-5.6mpa

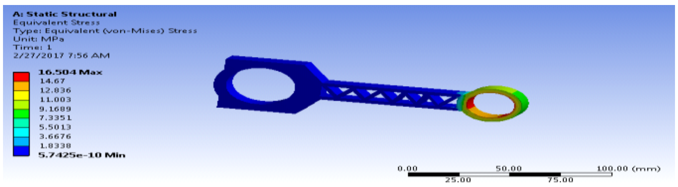


Strain at Pressure-5.6mpa

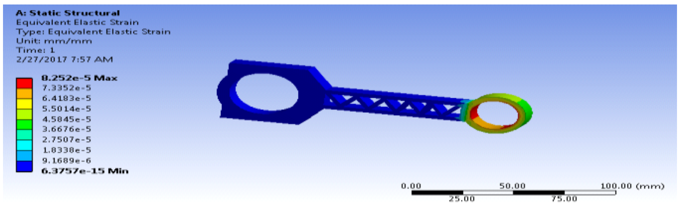
## MODIFIED MODEL: AT PRESSURE-4.6MPA



Total Deformation at Pressure-4.6mpa

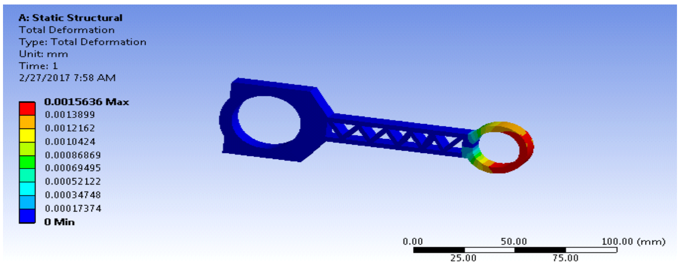


Stress at Pressure-4.6mpa

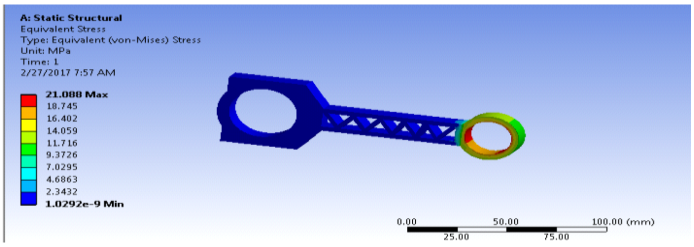


Strain at Pressure-4.6mpa

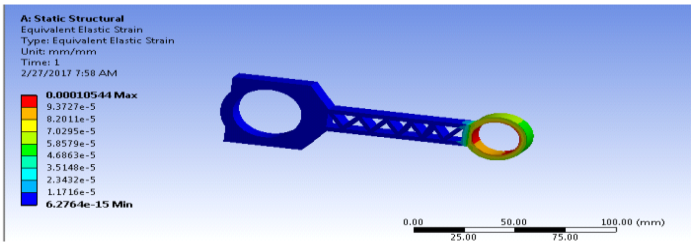
## MODIFIED MODEL AT PRESSURE-5.6MP




Total Deformation at Pressure-5.6mp



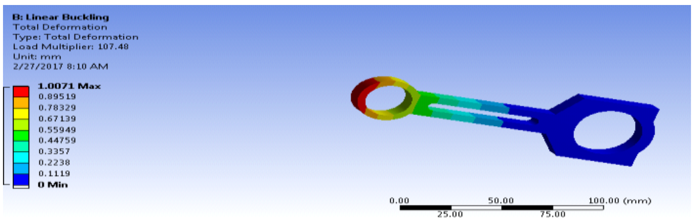

Stress at Pressure-5.6mp



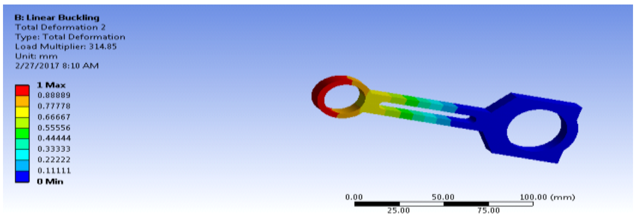

Strain at Pressure-5.6mp

## BUCKLING ANALYSIS OF DIESEL ENGINE CONNECTING ROD

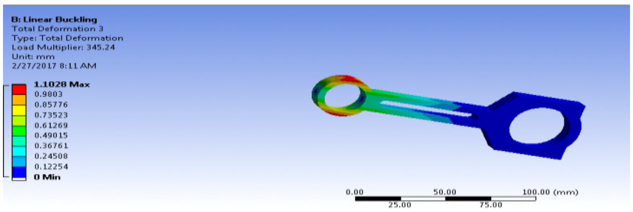
### Original Model: At Pressure-4.6mpa



Total Deformation 1: at Pressure-4.6mpa

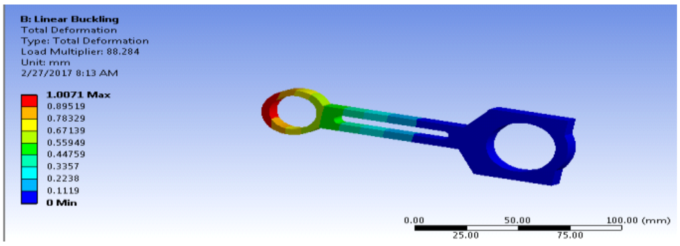


Total Defrmation2: At Pressure-4.6mpa

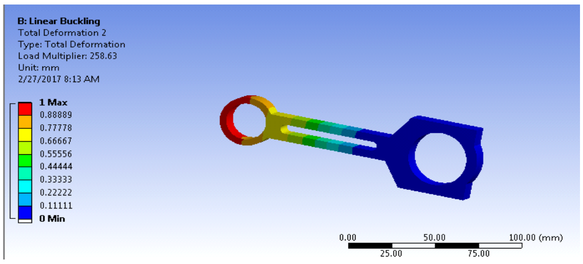


Total Defrmation3: At Pressure-4.6mpa

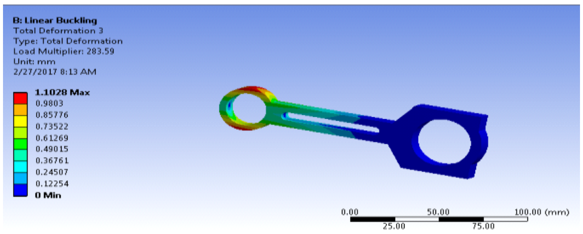
**Original Model: At Pressure-5.6mpa**



Total Defrmation1: At Pressure-5.6mpa

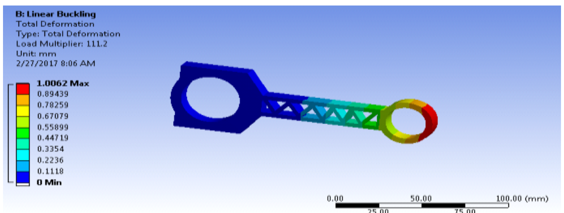


Total Deformation 2: At Pressure-5.6mpa

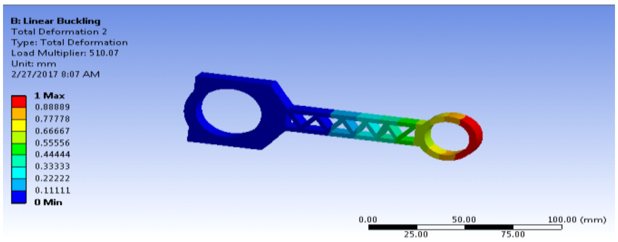


Total Deformation 3: At Pressure-5.6mpa

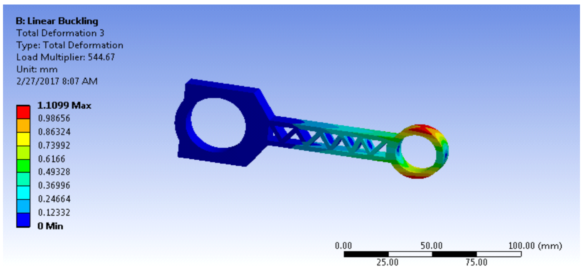
**MODIFIED MODEL: AT PRESSURE-4.6MPA**



Total Deformation 1: At Pressure-4.6mpa

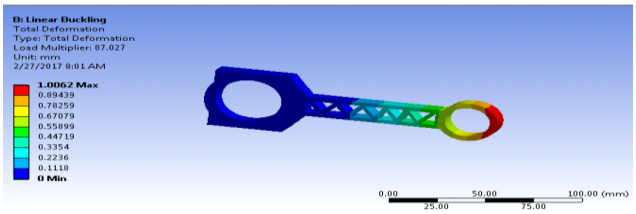


Total Deformation 2: At Pressure-4.6mpa

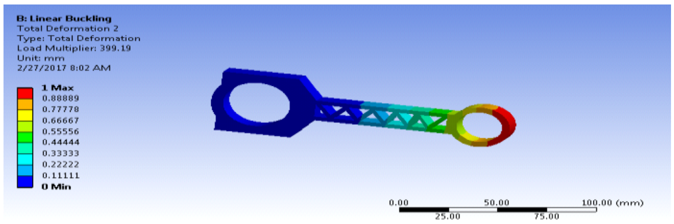


Total Deformation 3: At Pressure-4.6mpa

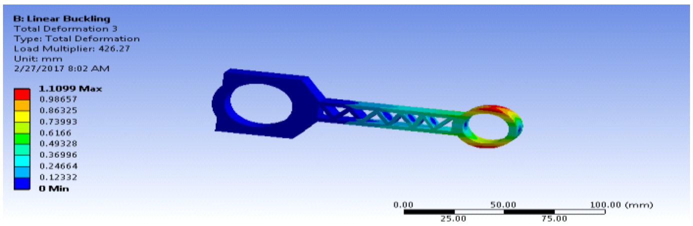
**MODIFIED MODEL: AT PRESSURE-5.6MPA**



Total Deformation 1: At Pressure-5.6mpa



Total Deformation 2: At Pressure-5.6mpa



Total Deformation 3: At Pressure-5.6mpa

**Table 1.** STATIC ANALYSIS RESULTS

| **Geometry** | **At pressure($N/mm^2$)** | **Deformation (mm)** | **Stress ($N/m^2$)** | **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 |

**Table 2.** BUCKLING ANALYSIS RESULTS

| Geometry | At pressure ($N/mm^2$) | Load 1 | Deformation 1 | Load 2 | Deformation 2 | Load 3 | Deformation 3 |
|---|---|---|---|---|---|---|---|
| **Original** | **4.6** | 107.48 | 1.0071 | 314.85 | 1 | 345.24 | 1.1028 |
| | **5.6** | 88.284 | 1.0071 | 258.63 | 1 | 283.59 | 1.1028 |
| **Modified** | **4.6** | 111.2 | 1.0062 | 510.07 | 1 | 544.67 | 1.1099 |
| | **5.6** | 87.027 | 1.0062 | 399.19 | 1 | 426.27 | 1.1099 |

## VII. CONCLUSION

1. 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.
2. 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.
3. 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.
4. So it can be conclude the connecting rod modified model is better.

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