# Design and Analysis of Oil Pump for Improving its Efficiency in I. C. Engine

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***Abstract***— Increasing the efficiency of Engine parts and reduction in development time with good accuracy are the challenges in the Automotive Industry. The aim of this project is to modify the Oil pump available in the Tata motors and analyze it to increase the efficiency of I. C. Engine. For any engines, various systems are involved for the safe and reliable operation, in that oil system plays a vital role for the engine lubrication. Oil pump is the most significant equipment as a part of engine oil system. The main function of oil pump in the engine is to supply lubricating oil to various rotating and sliding parts of an engine in order to prevent the wear and tear, excessive heat generated during the engine operation. The oil pump works on the principle of geo rotor (similar to internal gear arrangement) which is a positive displacement pump. The oil pump develops required pressure greater than the bearing chamber pressure and flow for maintaining the bearing temperature in the engine. The oil pump geo rotor is driven by the engine power through the gear box and quill shaft connected to oil pump driven shaft.

In this research we designed the geo rotor with standard measurements by using CATIA software. Also analysis should be done by taking different materials of Von-mises Stress, Strain& Total Deformation

**Keywords— Oil pump, internal gear pump, Optimization design, Engine Lubrication, Engine cooling, Von-mises Stress & Strain Analysis**

## INTRODUCTION

The oil pump in an internal combustion engine circulates engine oil under pressure to the rotating bearings, the sliding pistons and the camshaft of the engine. This lubricates the bearings, allows the use of higher-capacity fluid bearings and also assists in cooling the engine. To avoid the need for priming, the pump is always mounted low-down, either submerged or around the level of the oil in the sump. A short pick-up pipe with a simple wire-mesh strainer reaches to the bottom of the sump. For simplicity and reliability, mechanical pumps are used, driven by mechanical gear trains from the crankshaft

At 3,000 rpm, the pistons inside your engine are moving up and down violently, the crankshaft is spinning swiftly, and the rocker arms are rapidly doing the two-step with each respective valve. But whether your engine is just idling in drive or at full throttle, it takes a good lubrication system to keep everything from turning into molten metal. To prevent this unsavory transformation, oil is directed to all of the metal contacting surfaces by a full-pressure lubrication system comprised of an oil pan, an oil pump.

The oiling system addresses the need to properly lubricate an engine when it's running. Properly lubricating an engine not only reduces friction between moving parts but is also the main method by which heat is removed from pistons, bearings, and shafts. Failing to properly lubricate an engine will result in engine failure. The oil pump forces the motor oil through the passages in the engine to properly distribute oil to different engine components.

In a common oiling system, oil is drawn out of the oil sump through a wire mesh strainer that removes some of the larger pieces of debris from the oil. The flow made by the oil pump allows the oil to be distributed around the engine. In this system, oil flows through an oil filter and sometimes an oil cooler, before going through the engine's oil passages and being dispersed to lubricate pistons, rings, springs, valve stems, and more

### Causes of oil pump failure:

i. Dirt or foreign materials in the assembly of Oil pump.

ii. Metal particles remaining while assembly at supplier end.

iii. Dirt or metal chips entering while transit.

iv. Metal particles with size more than 0.1 mm is major contributor in oil pump failure.

v. Low discharge of oil at outlet at specified pressure conditions.

vi. Relief valve doesn't open at peak pressures.

Figure 1.1: Causes of oil pump failure

**ISHIKAWA FOR OIL PUMP FAILURE:**

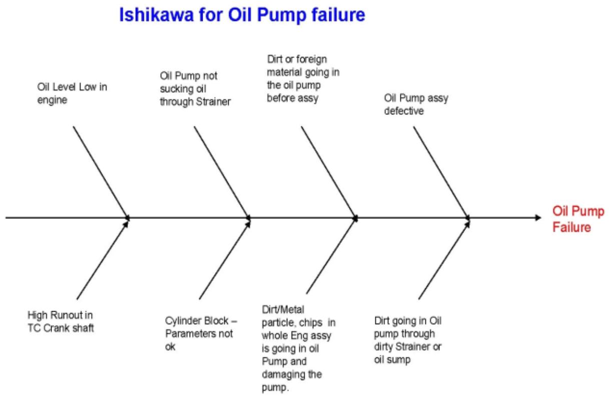



Figure 1.2: Ishikawa for Oil Pump Failure

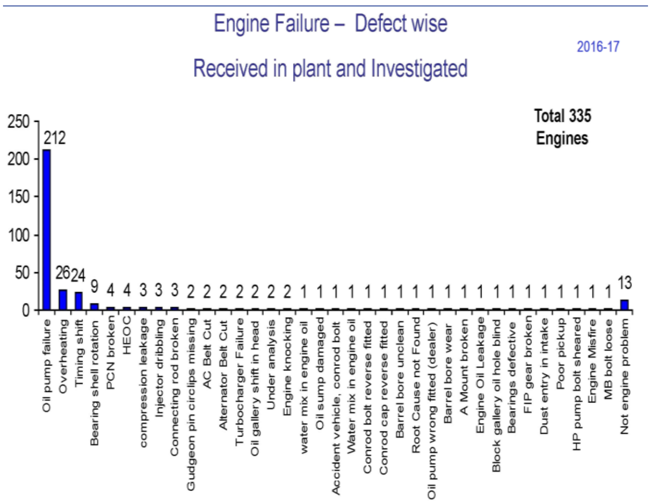



Figure 1.3: Engine Failure- Defect wise

**DESIGN OF GEROTOR**

Geo-rotor was designed using CATIA software with the specified dimensions:

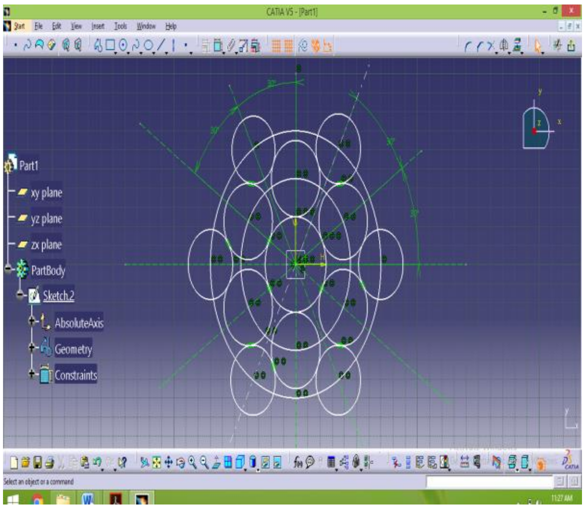



Figure 1.4: (a) 2-D Model of Inner Rotor

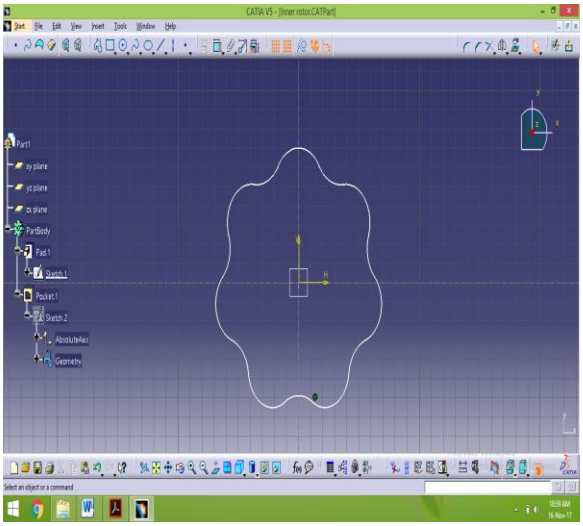


Figure 1.4 (b): 2-D Model of Rotor

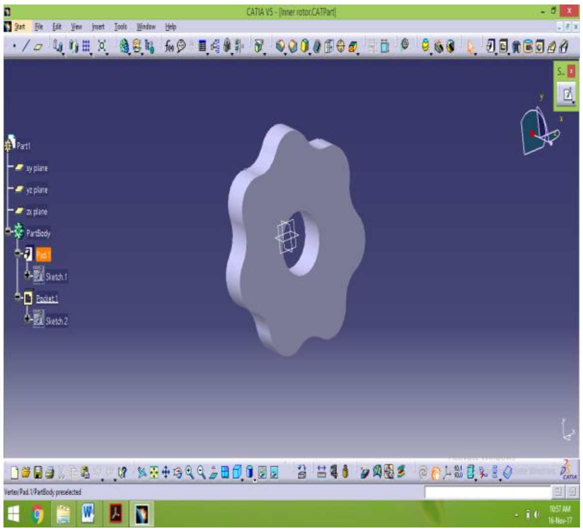


Figure 1.5: 3-D Model of Rotor

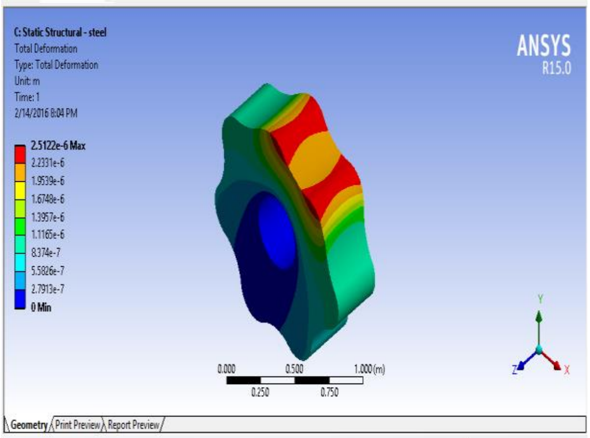
## STRUCTURAL ANALYSIS

### STRUCTURAL ANALYSIS OF STEEL

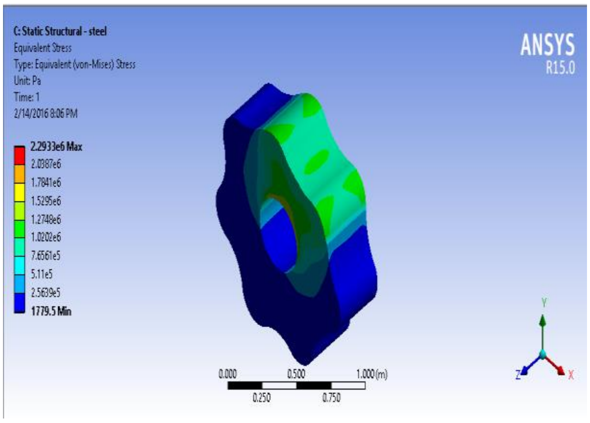
The diagrams shows the structural analysis of steel-

| | TOTAL DEFORMATION | VONMISES STRESS | VONMISES STRAIN |
|---|---|---|---|
| MAXIMUM | 2.5122e-6 m | 2.2933e6 pa | 1.1467e-5 |
| MINIMUM | 0 | 1779.5 pa | 1.3185e-8 |

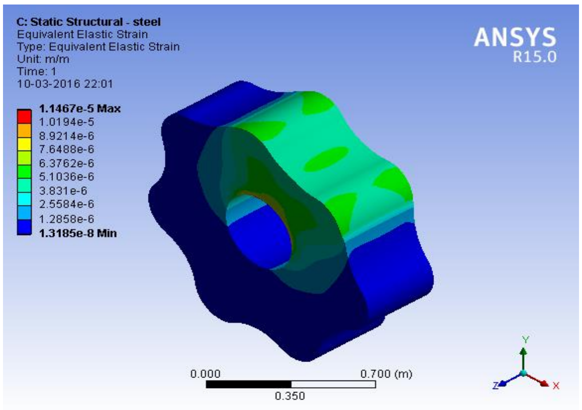
### TOTAL DEFORMATION OF STEEL




### EQUIVALENT STRESS VALUES ON STEEL




### EQUIVALENT STRAIN VALUES ON STEEL

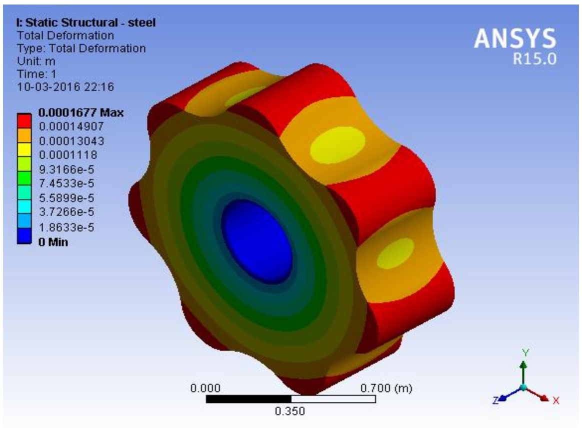



## THERMO STRUCTURAL ANALYSIS OF STEEL

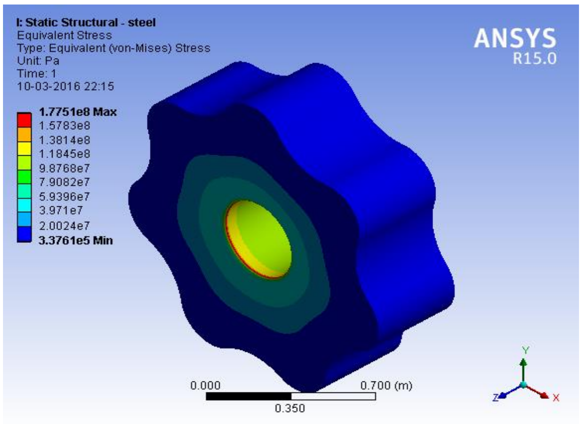
The diagrams shows the thermo structural analysis of steel

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 0.0001677 m | 1.7751e8 pa | MAXIMUM |
| MINIMUM | 0 | 3.3761e5 pa | MINIMUM |

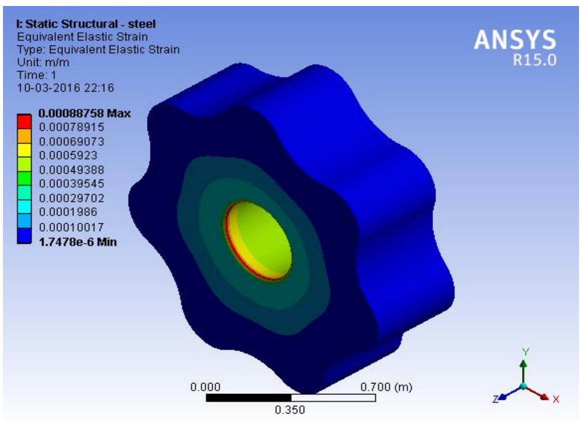
### TOTAL DEFORMATION OF STEEL




### EQUIVALENT STRESS VALUES ON STEEL




### EQUIVALENT STRAIN VALUES ON STEEL

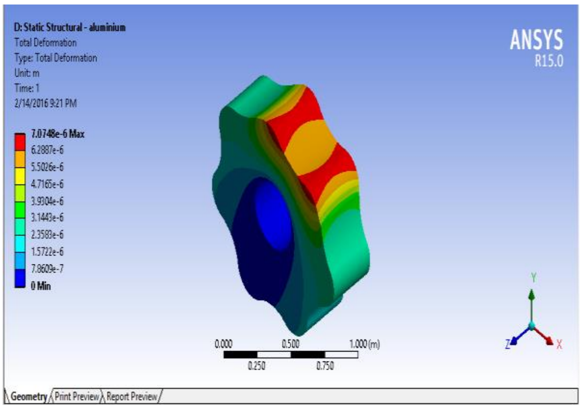


### STRUCTURAL ANALYSIS OF ALUMINIUM

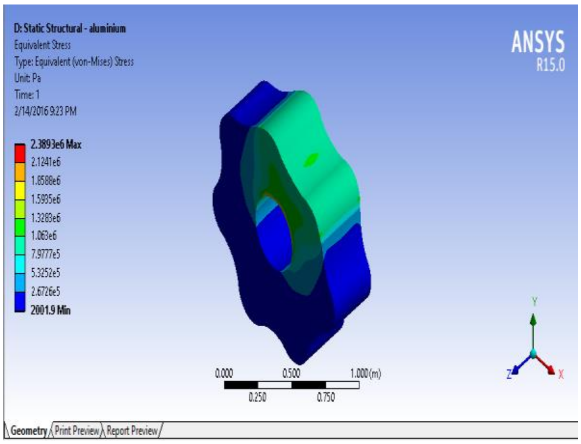
The diagrams shows the structural analysis of aluminium

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 7.0748e-6 m | 2.3893e6 pa | MAXIMUM |
| MINIMUM | 0 | 2001.9 pa | MINIMUM |

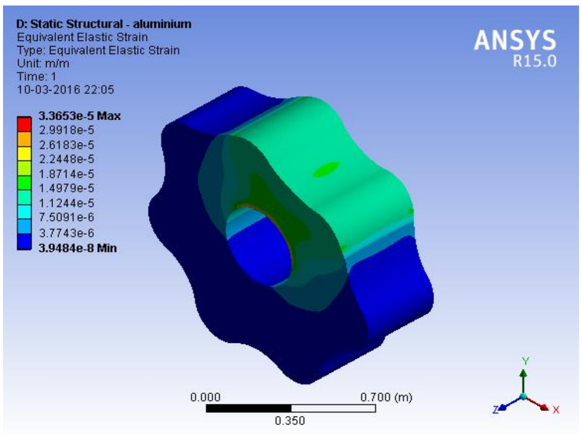
### TOTAL DEFORMATION OF ALUMINIUM




### EQUIVALENT STRESS VALUES ON ALUMINIUM




### EQUIVALENT STRAIN VALUES ON ALUMINIUM

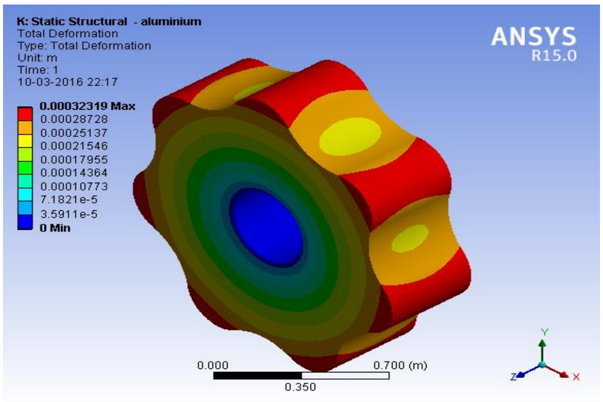



### THERMO STRUCTURAL ANALYSIS OF ALUMINIUM

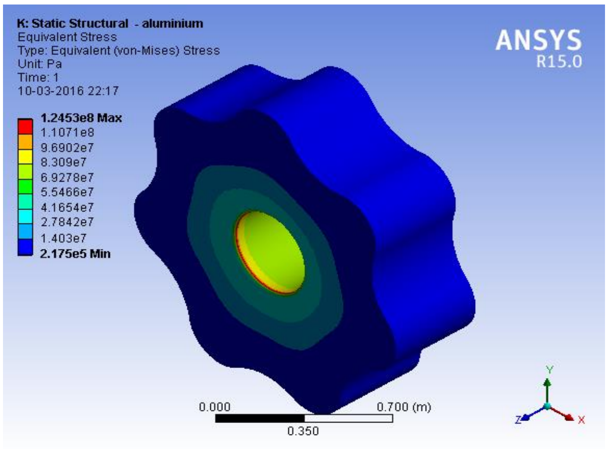
The diagrams shows the thermo structural analysis of aluminium

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 0.00032319 m | 1.2453e8 pa | MAXIMUM |
| MINIMUM | 0 | 2.175e5 pa | MINIMUM |

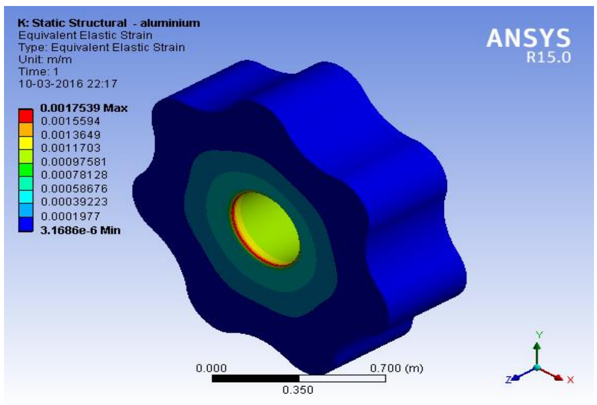
### TOTAL DEFORMATION OF ALUMINIUM




### EQUIVALENT STRESS VALUES ON ALUMINIUM




### EQUIVALENT STRAIN VALUES ON ALUMINIUM



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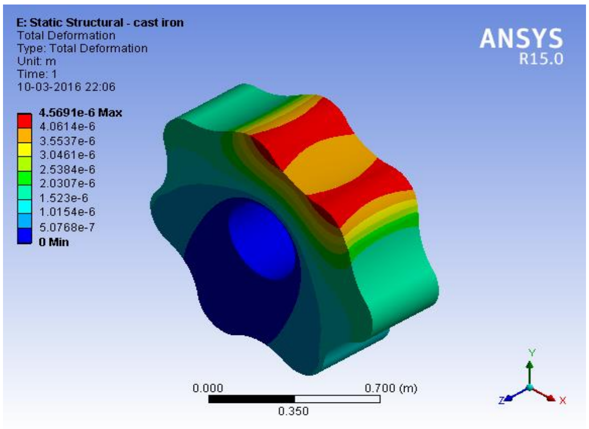
## STRUCTURAL ANALYSIS OF CAST IRON

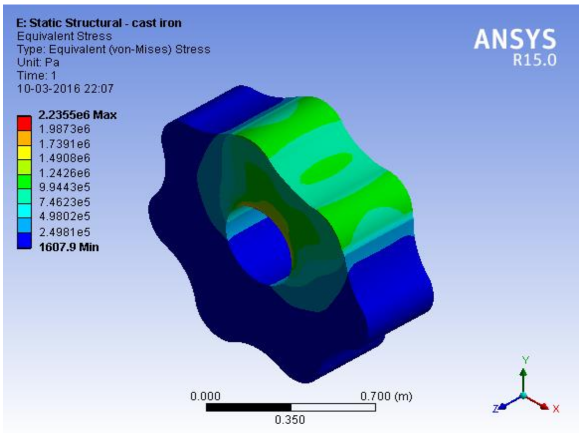
The diagrams shows the structural analysis of CAST IRON

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 4.5691e-6 m | 2.2355e6 pa | MAXIMUM |
| MINIMUM | 0 | 1607.9 pa | MINIMUM |

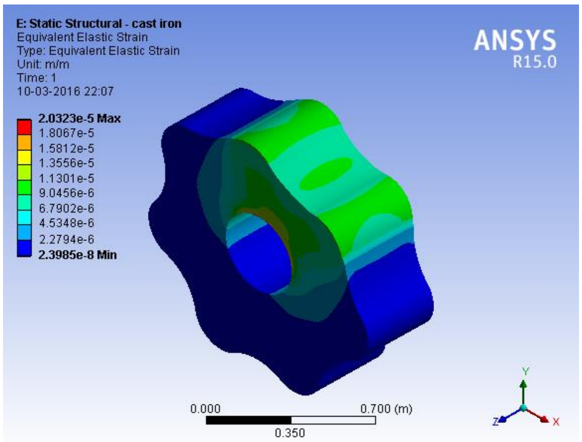
## TOTAL DEFORMATION OF CAST IRON




## EQUIVALENT STRESS VALUES ON CAST IRON




## EQUIVALENT STRAIN VALUES ON CAST IRON

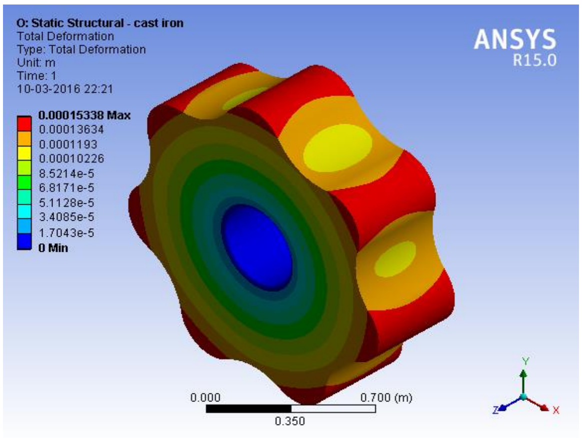



## THERMO STRUCTURAL ANALYSIS OF CAST IRON

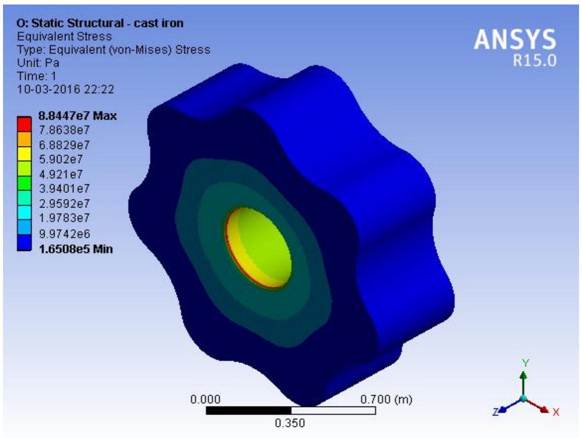
The diagrams shows the thermo structural analysis of cast iron

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 0.00015338 | 8.8447e7 | MAXIMUM |
| MINIMUM | 0 | 1.6508e5 | MINIMUM |

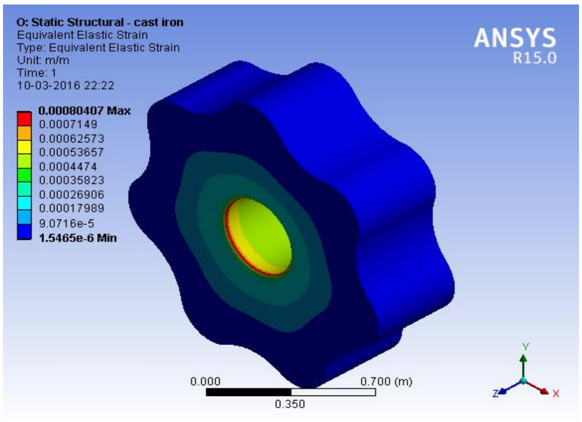
## TOTAL DEFORMATION OF CAST IRON




## EQUIVALENT STRESS VALUES ON CAST IRON




## EQUIVALENT STRAIN VALUES ON CAST IRON

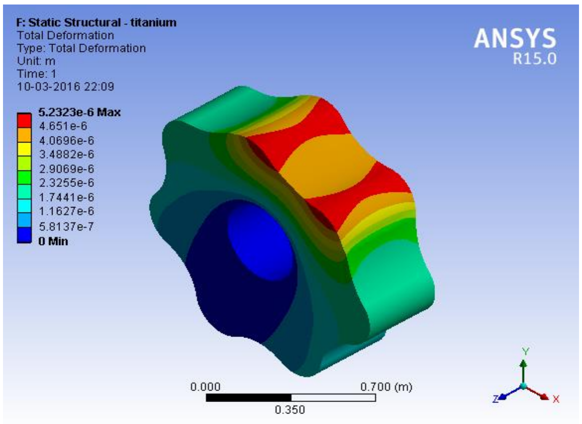


## STRUCTURAL ANALYSIS OF TITANIUM

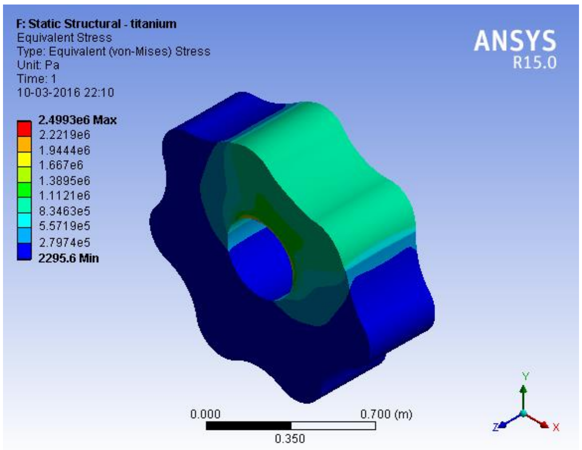
The diagrams shows the structural analysis of Titanium

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 5.2323e-6 m | 2.4993e6 pa | MAXIMUM |
| MINIMUM | 0 | 2295.6 pa | MINIMUM |

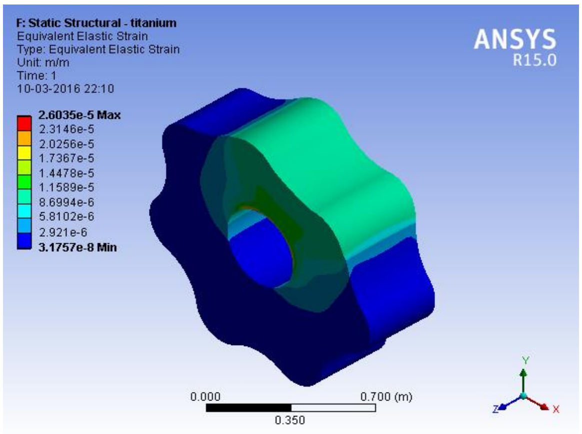
## TOTAL DEFORMATION OF TITANIUM




## EQUIVALENT STRESS VALUES ON TITANIUM




## EQUIVALENT STRAIN VALUES ON TITANIUM

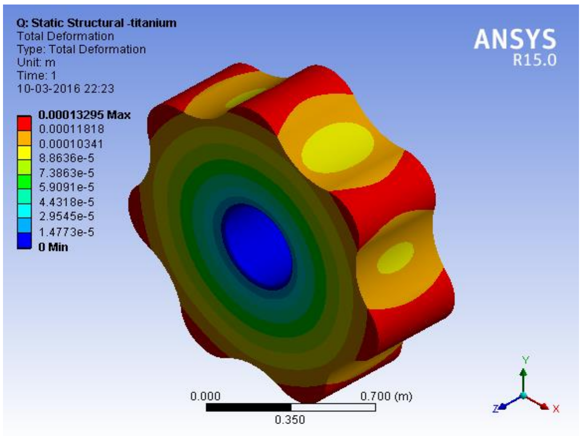



## THERMO STRUCTURAL ANALYSIS OF TITANIUM

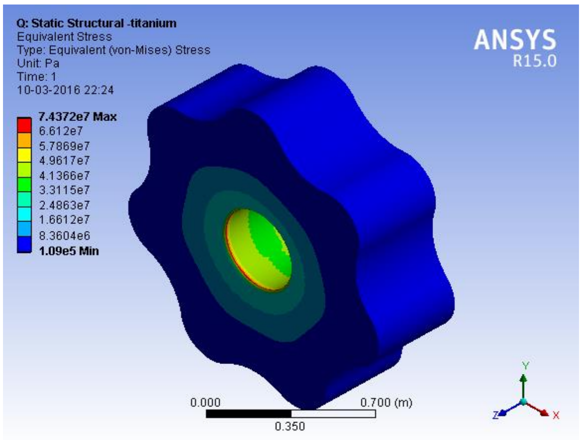
The diagrams shows the thermo structural analysis of Titanium

| TOTAL DEFORMATION | EQUIVALENT STRESS | EQUIVALENT STRAIN | TOTAL DEFORMATION |
|---|---|---|---|
| MAXIMUM | 0.00013295 m | 7.4372e7 | MAXIMUM |
| MINIMUM | 0 | 1.09e5 | MINIMUM |

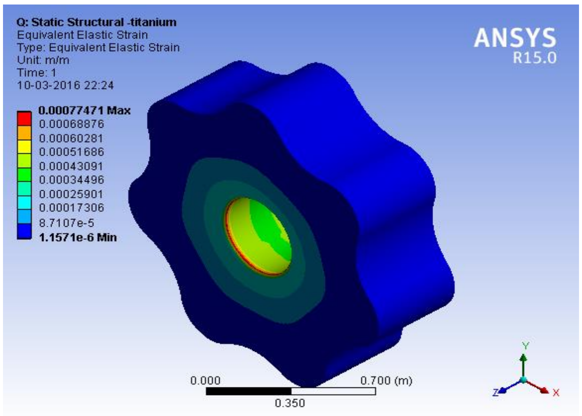
## TOTAL DEFORMATION OF TITANIUM




## EQUIVALENT STRESS VALUES ON TITANIUM

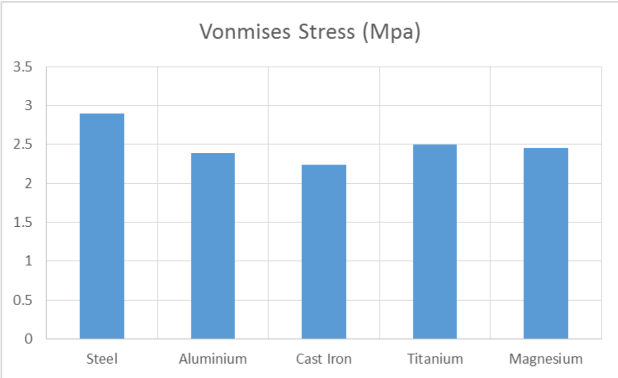


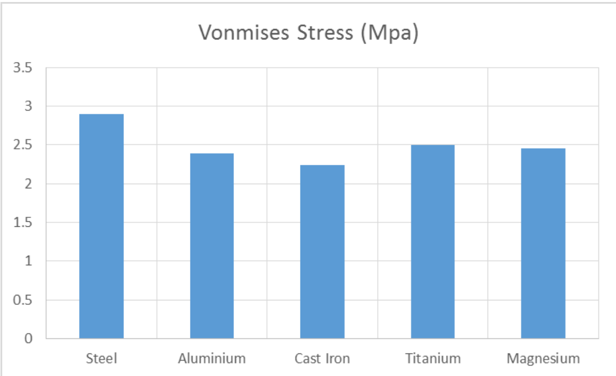

## EQUIVALENT STRAIN VALUES ON TITANIUM

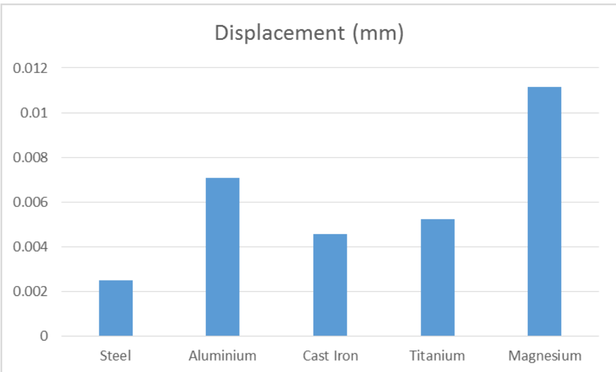


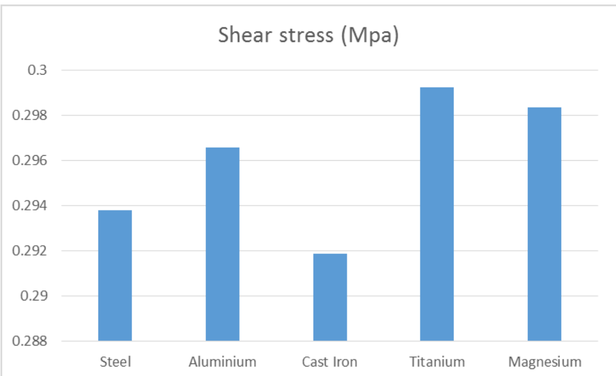
## STUCTURAL GRAPHS

In structural graphs of gerotor we are comparing the von-mises stresses, von-mises strain, and total deformation& shear stress values for different materials



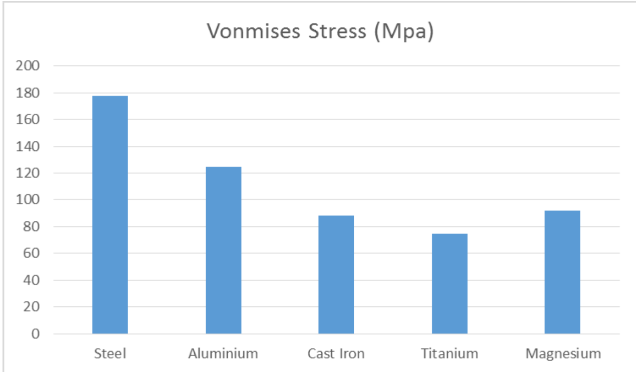



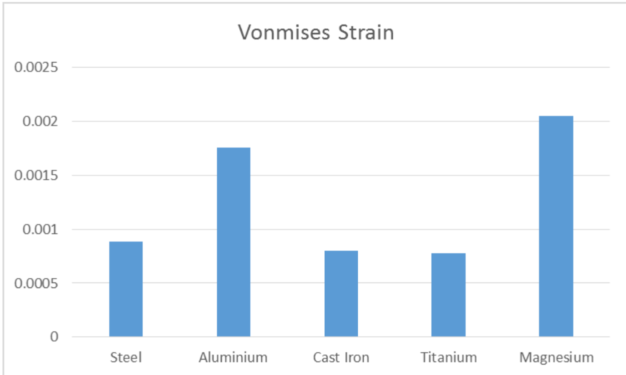



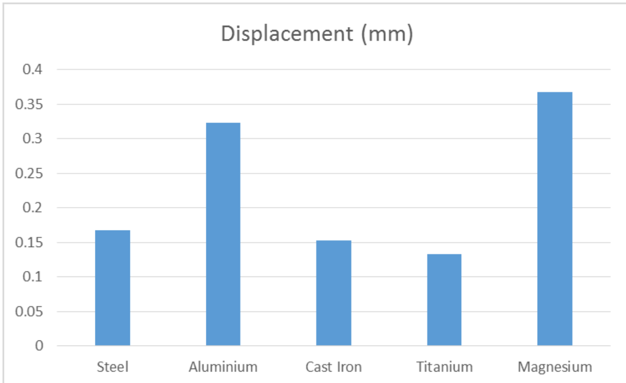



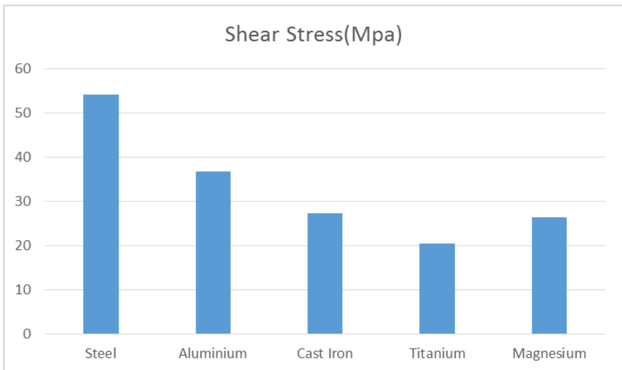

## THERMO STRUCTURAL GRAPHS

In thermo structural graphs we are comparing the graphs of von-mises stress, von-mises strain, total deformation and shear stress values for different materials.

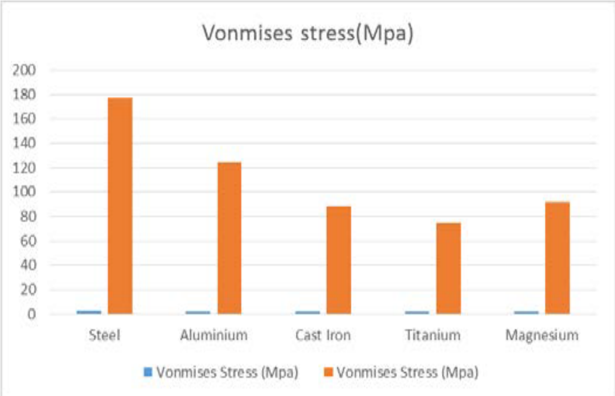


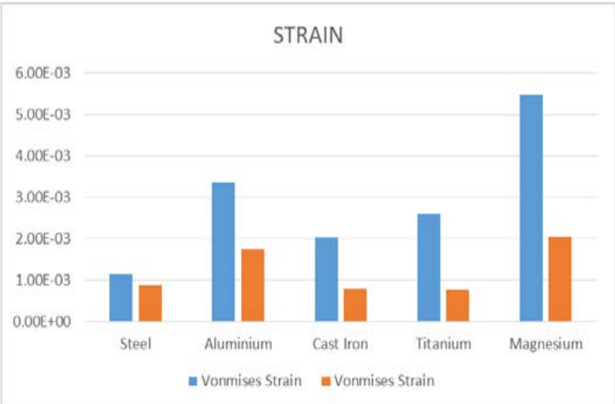



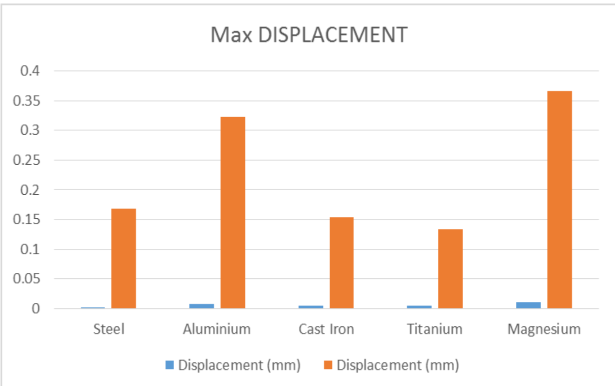



In below three graphs we are comparing both structural analysis and thermo structural analysis by taking the von-mises stress von-mises strain total deformation values for different materials




## CONCLUSION

Generally we use steel in design of gerotor and we compared with other materials such as aluminium, cast iron, titanium and magnesium. Therefore by above results we observed that von-mises stress & strain, total deformation is less for cast iron than other materials. So we used to suggest cast iron in design of gerotor inner rotor.

Even though from our results we observed titanium which gives better results after analysis but due to its high cost and other parameters we can't use titanium for designing of inner rotor of gerotor.

So we suggest cast iron which shows near results of stress, strain and deformation results which is almost similar to titanium.

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