© 2020 | International Journal of Scientific Research in Science and Technology
IJSRST | Volume 7 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
DOI : https://doi.org/10.32628/IJSRST

Design and Material Optimization of Camshaft In 150 CC Engine

B. Suman[1], Y Sudheer[2], C Raghunath Reddy[3]

[1]M.Tech Scholar, Department of Mechanical Engineering College, Tadipatri Engineering College, Tadipatri, Andhra Pradesh, India

[2,3]Assistant Professor, Department of Mechanical Engineering College, Tadipatri Engineering College, Tadipatri, Andhra Pradesh, India

ABSTRACT

Camshaft is the key component of automobile engine valve timing mechanism, whose machining precision will affect overall performance of automobile engine. This paper presents a kind of camshaft journals multi-parameters measuring instrument based on the actual requirement of camshaft production. The camshaft measuring instrument was auto measuring instrument composed of pneumatic control system, precision measurement system and computer-aided measurement system, which was developed for measuring journal diameter, roundness, conicity, journal radial runout relative to center holes connection, and number 2, 3, 4 journal radial runout relative to number 1 and 5 journal center connection, etc. The measurement repetition and stability were perfect, it was fit for high precision and fast measurement at production site.

Keywords : Camshaft, ICE, Numerical Control, Computer Aided Design

I. INTRODUCTION

CAMSHAFT

Since the origination of the automobile, the internal combustion engine has evolved considerably. However, one constant has remained throughout the decades of ICE development. The camshaft has been the primary means of controlling the valve actuation and timing, and therefore, influencing the overall performance of the vehicle. The camshaft is attached to the crankshaft of an ICE and rotates relative to the rotation of the crankshaft. Therefore, as the vehicle increases is velocity, the crankshaft must turn more quickly, and ultimately the camshaft rotates faster. This dependence on the rotational velocity of the crankshaft provides the primary limitation on the use of camshafts.

II. LITERATURE REVIEW

Cams are used for essentially the same purpose as linkages, that is, generation of irregular motion. Cams have an advantage over linkages because cams can be designed for much tighter motion specifications. In fact, in principle, any desired motion program can be exactly reproduced by a cam. Cam design is also, at least in principle, simpler than linkage design, although, in practice, it can be very laborious. Automation of cam design using interactive computing has not, at present, reached the same level of sophistication as that of linkage design.

The disadvantages of cams are manufacturing expense, poor wear resistance, and relatively poor high-speed capability. Although numerical control (NC) machining does cut the cost of cam manufacture in small lots, costs are still quite high in comparison with linkages. In large lots, molding or casting techniques cut cam costs, but not to the extent that stamping and so forth, can cut linkage costs for similar lot sizes. Unless roller followers are used, cams wear quickly. However, roller followers are bulky and require larger cams, creating size and dynamic problems. In addition, the bearings in roller followers create their own reliability problems. The worst problems with cams are, however, noise and follower bounce at high speeds. As a result, there is a preoccupation with dynamic optimization in cam design. Cam design usually requires two steps (from a geometric point of view):

1. synthesis of the motion program for the follower and
2. generation of the cam profile.

If the motion program is fully specified throughout the motion cycle, as is the case, for example, with the stitch pattern cams in sewing machines, the first step is not needed.

More usually, the motion program is specified only for portions of the cycle, allowing the synthesis of the remaining portions for optimal dynamic performance. An example is the cam controlling the valve opening in an automotive engine. Here the specification is that the valve should be fully closed for a specified interval and more or less fully open for another specified interval. For the portions of the cycle between those specified, a suitable program must be synthesized. This can be done, with varying levels of sophistication, to make the operation of the cam as smooth as possible. In general, the higher the level of dynamic performance required, the more difficult the synthesis process.

The second stage of the process, profile generation, is achieved by kinematic inversion. The cam is taken as the fixed link and a number of positions of the follower relative to the cam is constructed. A curve tangent to the various follower positions is drawn and becomes the cam profile. If the process is performed analytically, any level of accuracy can be achieved.

III. METHODS AND MATERIAL

INTRADUCTION TO CAD/CAM

Computer Aided Design(CAD):

Computer Aided Design(CAD) is the use of wide range of computer based tools that assist engineering, architects and other design professionals in their design activities. It is the main geometry authoring tool within the product life cycle management process and involves both software and sometimes special purpose hardware. Current packages range from 2D vector based drafting systems to 3D parametric surface and solid design modelers.

Introduction:

CAD is used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. cadis also extensively used in the design of tools and machinery used in the manufacturer of components. Cadis also used in the drafting and design of all types of buildings, from small residential types(house) to the largest commercial and industrial types. CAD is used thought the engineering process from the conceptual design and layout, through detailed engineering and analysis of components to definition of manufacturing methods.

INTRODUCTION TO PRO/E

PRO/E is the industry’s de facto standard 3D mechanical design suit. It is the world’s leading CAD/CAM/CAE software, gives a broad range of integrated solutions to cover all aspects of product design and manufacturing. Much of its success can be attributed to its technology which spurs its customer's to more quickly and consistently innovate a new robust, parametric, feature based model. Because that PRO/E is unmatched in this field, in all processes, in all countries, in all kind of companies along the supply chains. PRO/E is also the perfect solution for the manufacturing enterprise, with associative applications, robust responsiveness and web connectivity that make it the ideal flexible engineering solution to accelerate innovations. PRO/E provides easy to use solution tailored to the needs of small medium sized enterprises as well as large industrial corporations in all industries, consumer goods, fabrications and assembly. Electrical and electronics goods, automotive, aerospace, shipbuilding and plant design. It is user friendly solid and surface modeling can be done easily.

PRO/E INTERFACE

The main modules are:
Sketcher
Part Design
Assembly
Drafting

Sketcher:
Pro/E sketcher tools initially drafts a rough sketch following the shape of the profile. The objects created are converted into a proper sketch by applying geometric constraints and dimensional constraints. These constraints refine the sketch according to a rule. Adding parametric dimensions further control the shape and size of the feature.

Line, rectangle, palette, constrain, dimension modification, and text etc., are used as one of the feature creation tools to convert the sketcher entity into a part feature.

PART DESIGN

The Pro/E is a 3D parametric solid modeler with both part and assembly modeling abilities. You can use Pro/E to model simple parts and then combine them into more complex assemblies. With Pro/E, you design a part by sketching its component shapes and defining their size, shape, and inter relationships. By successively creating these shapes, called features, you can construct the part.

The general modeling process-
Planning concept of designing
Creation of base feature
Completion of other features
Analyzing the part design
Modifying the design as necessary

ASSEMBLY DESIGN:

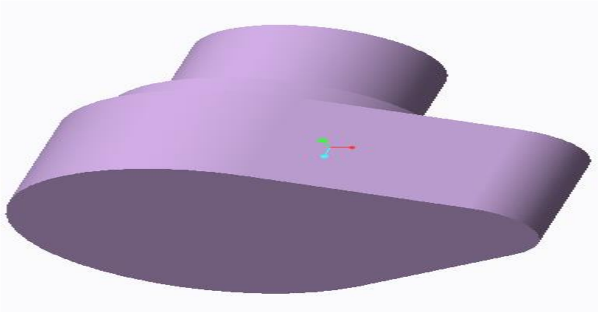
Pro-E assembly design gives the user the ability to design with user controlled associability. Pro-E builds individual parts and subassemblies into an assembly in a hierarchical manner according to the relationships defined by constraints. As in part modeling, the parametric relationships allow you to quickly update an entire assembly based on a change in one of its parts.

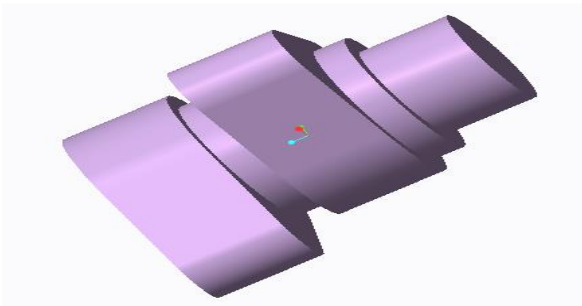
The general assembly process-
Layout the assembly
Based on design follow either top down or bottom up
Analyze the assembly
Modifying the assembly

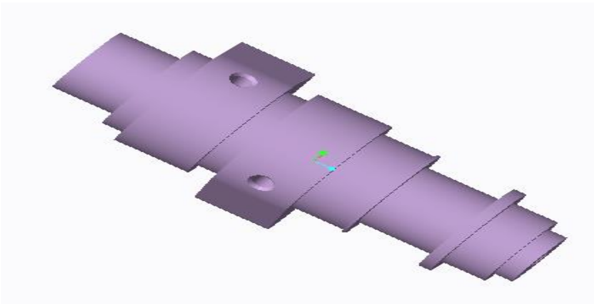
DRAFTING:

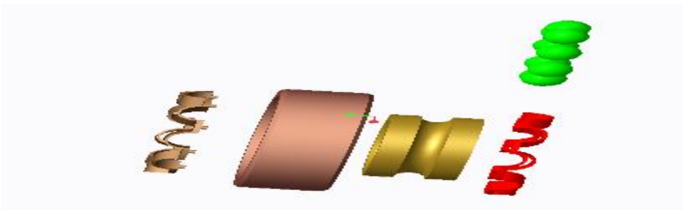
Drawings and documentation are the true products of design because they guide the manufacture of a mechanical device. Pro-E automatically generate associative drafting from 3D mechanical designers and assemblies. Associability of the drawings to the 3D master representation enables to work concurrently on designs and drawings. Pro-E enriches Generative Drafting with both integrated 2D interactive functionality and a productive environment for drawings dress-up and annotation.

CAM SHAFT modeling process:

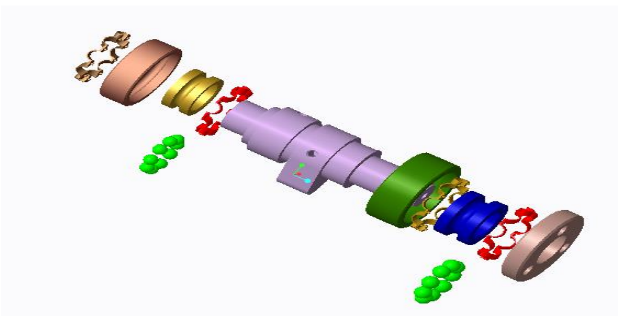




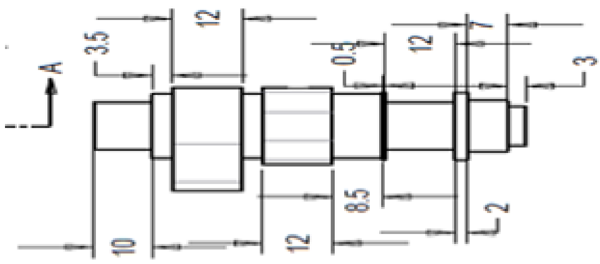




exploded view of bearing assembly



An Exploded view of total CAM shaft



Detailing view of cam shaft

FINITE ELEMENT ANALYSIS:

The finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in almost every industry. In more and more engineering situations today, we find that it is necessary to obtain approximate solutions to problem rather than exact closed form solution. It is not possible to obtain analytical mathematical solutions for many engineering problems. The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. It has been developed simultaneously with the increasing use of the high- speed electronic digital computers and with the growing emphasis on numerical methods for engineering analysis. This method started as a generalization of the structural idea to some problems of elastic continuum problem, started in terms of different equations.

PROCEDURE FOR ANSYS ANALYSIS

Static analysis is used to determine the displacements stresses, stains and forces in structures or components due to loads that do not induce significant inertia and damping effects. Steady loading in response conditions are assumed. The kinds of loading that can be applied in a static analysis include externally applied forces and pressures, steady state inertial forces such as gravity or rotational velocity imposed (non-zero) displacements, temperatures (for thermal strain). A static analysis can be either linear or non linear. In our present work we consider linear static analysis. The procedure for static analysis consists of these main steps

Building the model
Obtaining the solution
Reviewing the results.

MODELING AND ANALYSIS

It is very difficult to exactly model the brake disc, in which there are still researches are going on to find out transient thermal behavior of disc brake during braking applications. There is always a need of some assumptions to model any complex geometry. These assumptions are made, keeping in mind the difficulties involved in the theoretical calculation and the importance of the parameters that are taken and those which are ignored. In modeling we always ignore the things that are of less importance and have little impact on the analysis. The assumptions are always made depending upon the details and accuracy required in modeling. The assumptions which are made while modeling the process are given below:-

The disc material is considered as homogeneous and isotropic.

The domain is considered as axis-symmetric.
Inertia and body force effects are negligible during the analysis.

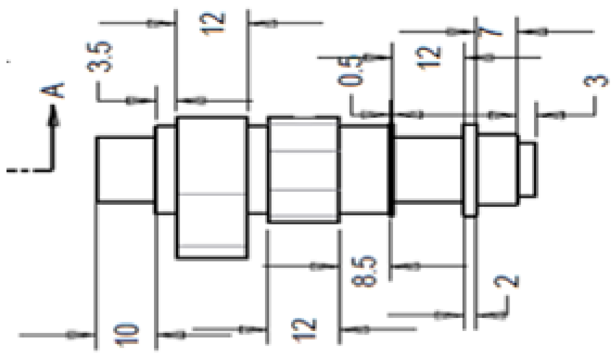
The disc is stress free before the application of brake.
Brakes are applied on the entire four wheels.
The analysis is based on pure thermal loading and vibration and thus only stress level due to the above said is done. The analysis does not determine the life of the disc brake.

Only ambient air-cooling is taken into account and no forced Convection is taken.
The kinetic energy of the vehicle is lost through the brake discs i.e. no heat loss between the tire and the road surface and deceleration is uniform.
The disc brake model used is of solid type and not ventilated one.
The thermal conductivity of the material used for the analysis is uniform throughout.
The specific heat of the material used is constant throughout and does not change with temperature.

DEFINITION OF PROBLEM DOMAIN

Due to the application of brakes on the car disc brake rotor, heat generation takes place due to friction and this thermal flux has to be conducted and dispersed across the disc rotor cross section. The condition of braking is very much severe and thus the thermal analysis has to be carried out. The thermal loading as well as structure is axis- symmetric. Hence axis-symmetric analysis can be performed, but in this study we performed 3-D analysis, which is an exact representation for this thermal analysis. Thermal analysis is carried out and with the above load structural analysis is also performed for analyzing the stability of the structure.

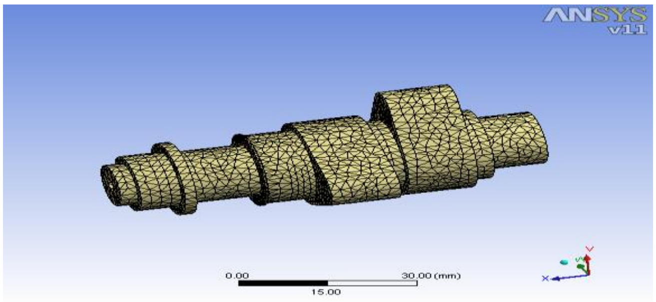
DIMENSIONS OF DIMENIONOF CAM SHAT



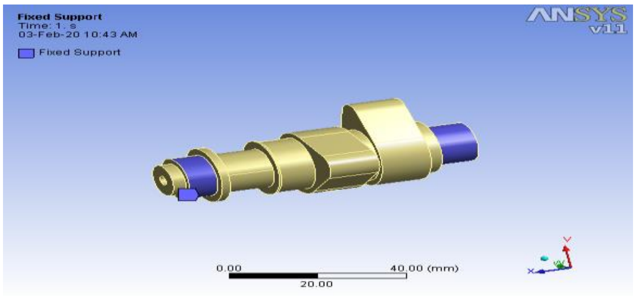
CREATING A FINITE ELEMENT MESH

According to given specifications the element type chosen is solid 90.Solid 90 is higher order version of the 3-D eight node thermal element (Solid 70). The element has 20 nodes with single degree of freedom, temperature, at each node. The 20-node elements have compatible temperature shape and are well suited to model curved boundaries.

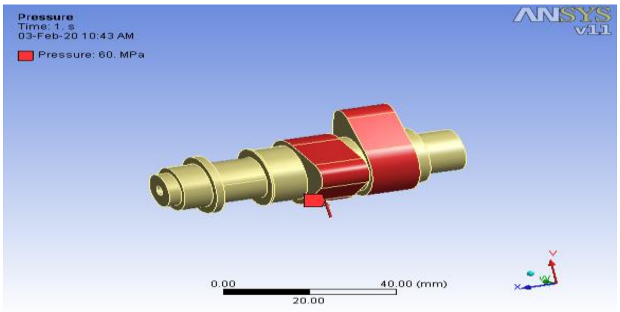
The 20-node thermal element is applicable to a 3-D, steady state or transient thermal analysis. If the model containing this element is also to be analyzed structurally, the element should be replaced by the equivalent structural element.



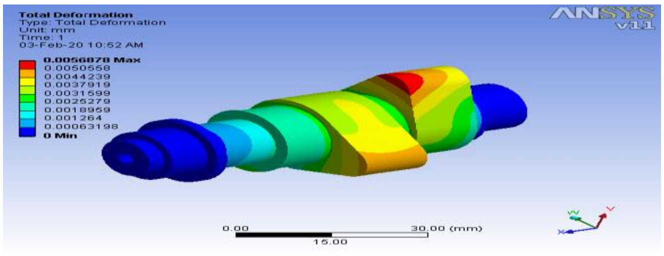
Mesh model



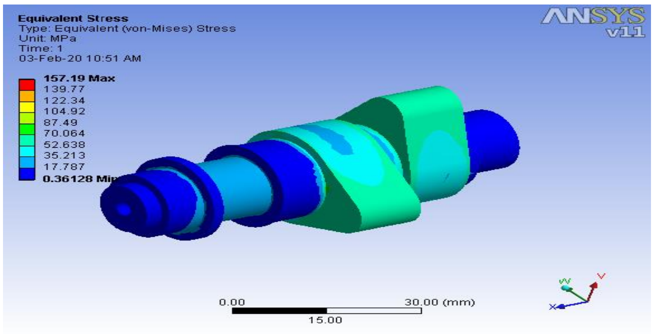
Fixed support



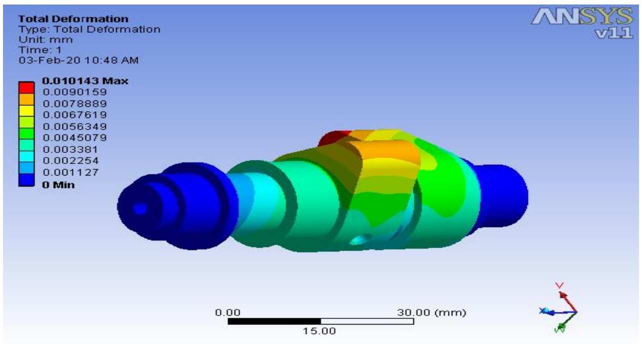
Presser application



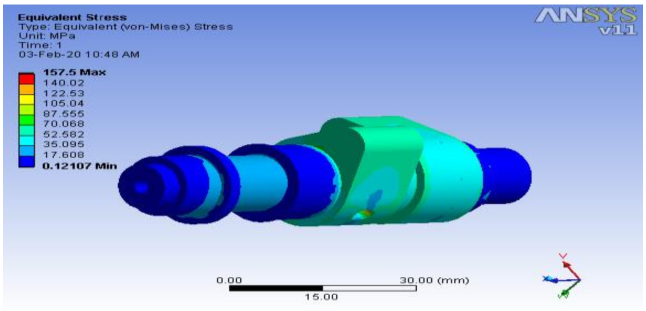
Structural steel total deformation



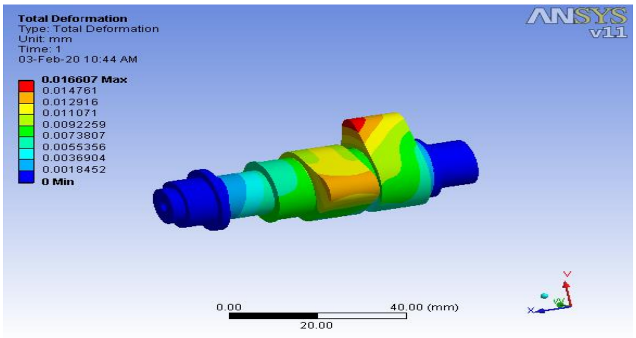
Structural steel Equivalents stress



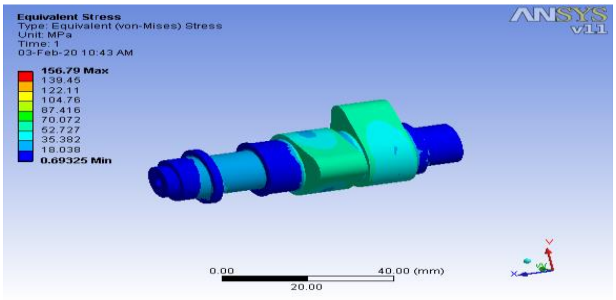
child cast iron total deformation



child cast iron equivalent stress

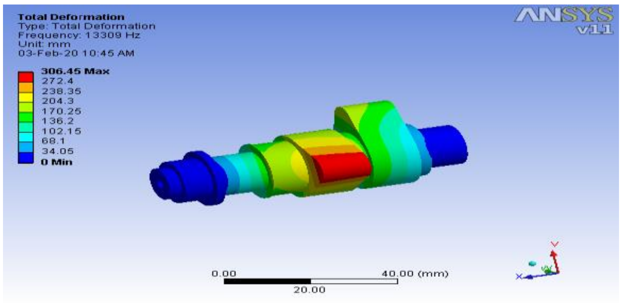


Aluminum alloy total deformation

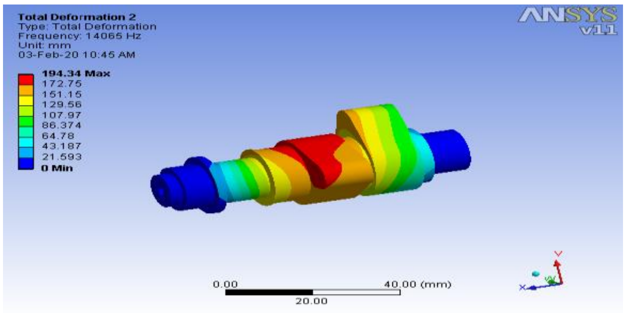


Aluminum alloy equivalent stress

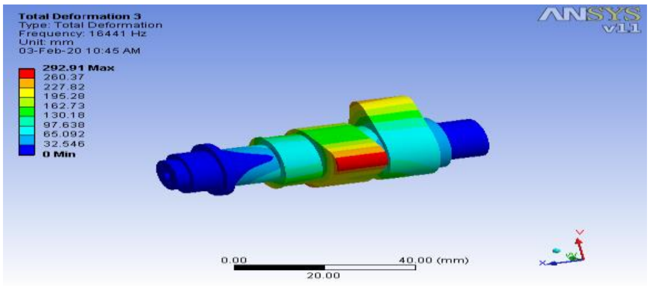
MODEL ANALYSI :



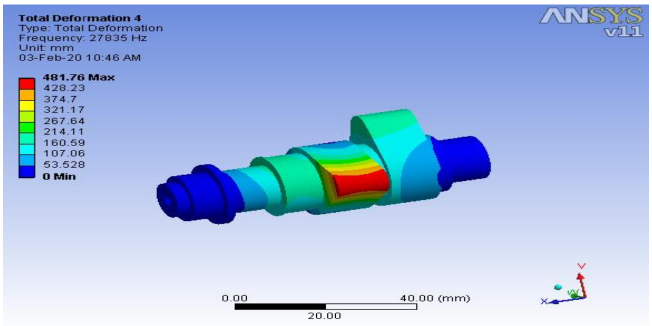
Aluminum alloy mode 1



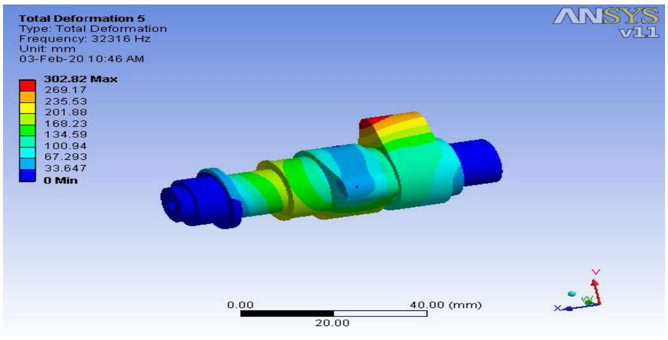
Aluminum alloy mode 2



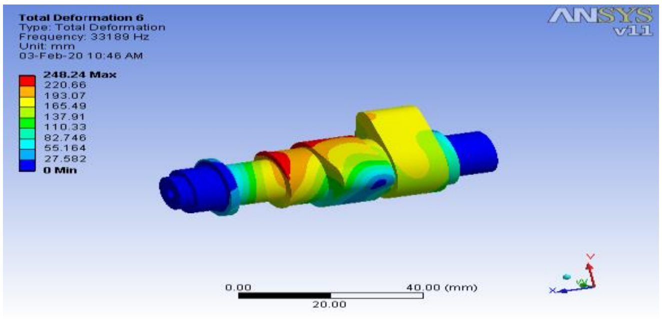
Aluminum alloy mode 3



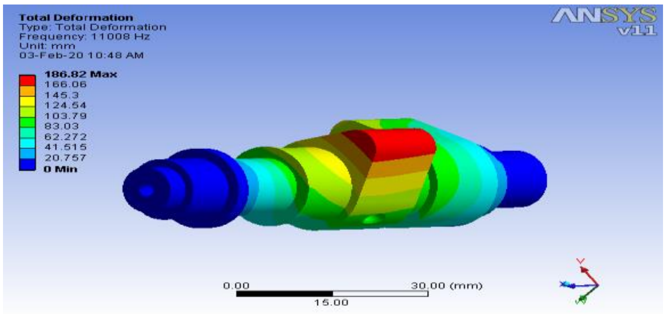
Aluminum alloy mode 4



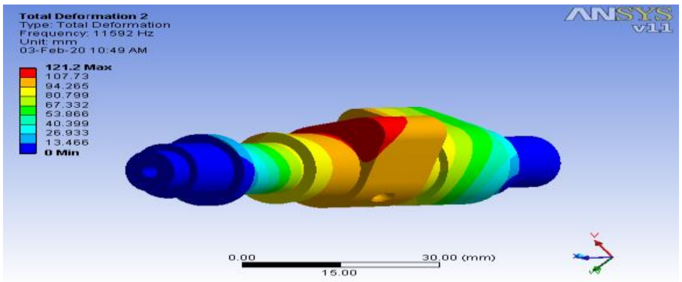
Aluminum alloy mode 5



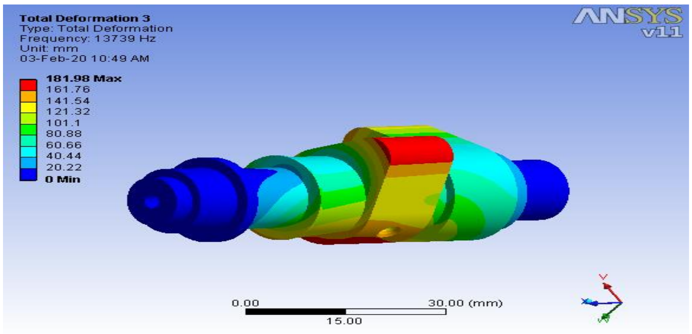
Aluminum alloy mode 6



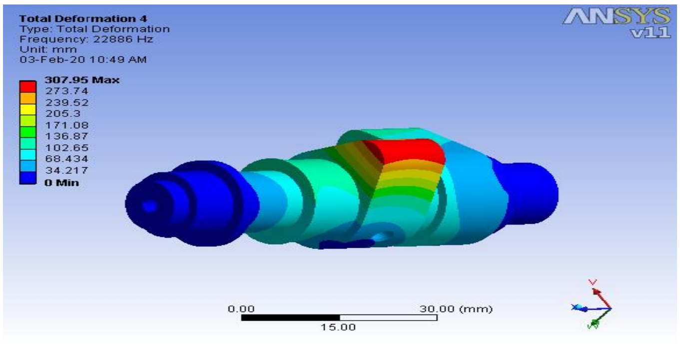
Child Cast Iron mode 1



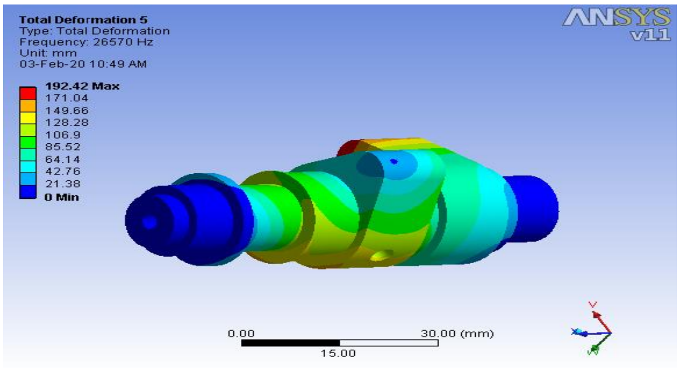
Child Cast Iron mode 2



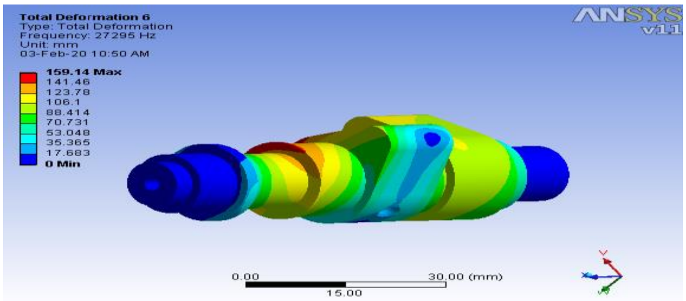
Child Cast Iron mode 3



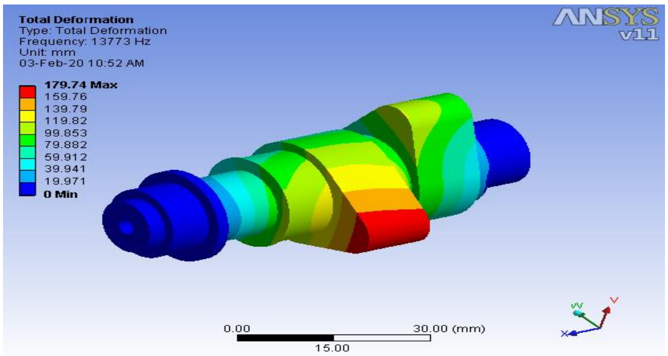
Child Cast Iron mode 4



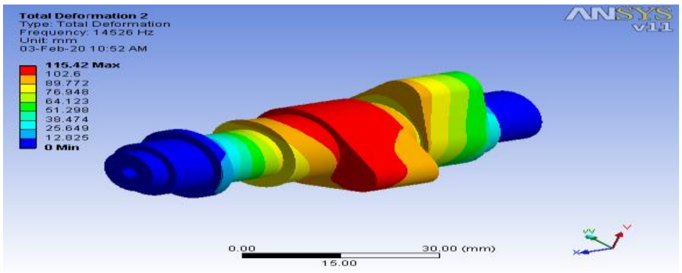
Child Cast Iron mode 5



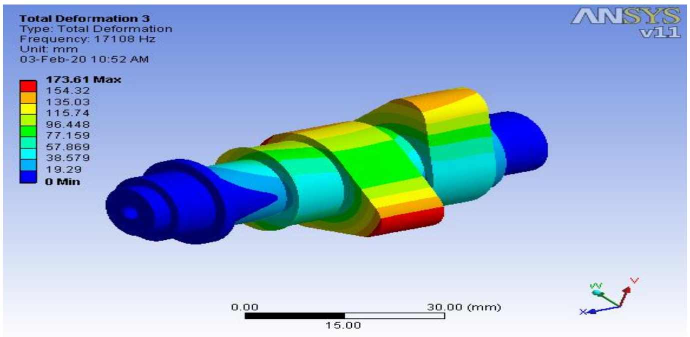
Child Cast Iron mode 6



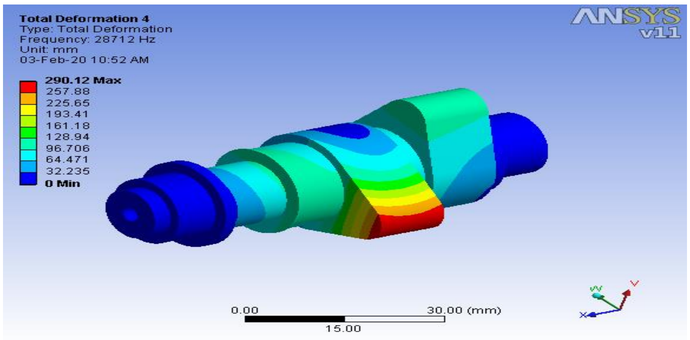
Structural steel mode 1



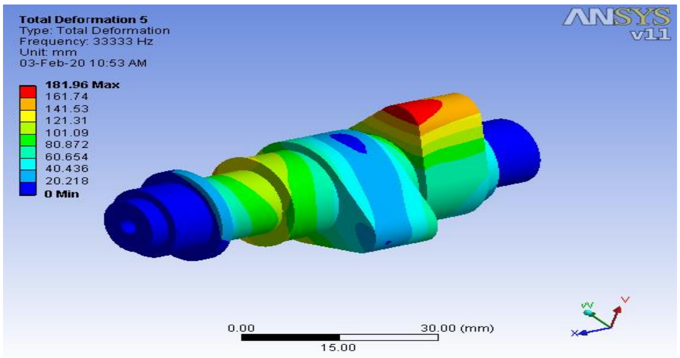
Structural steel mode 2



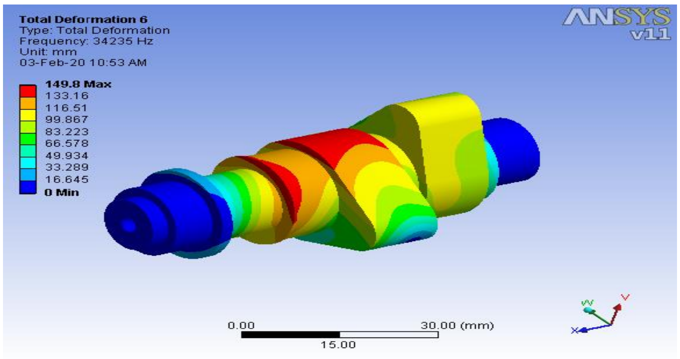
Structural steel mode 3



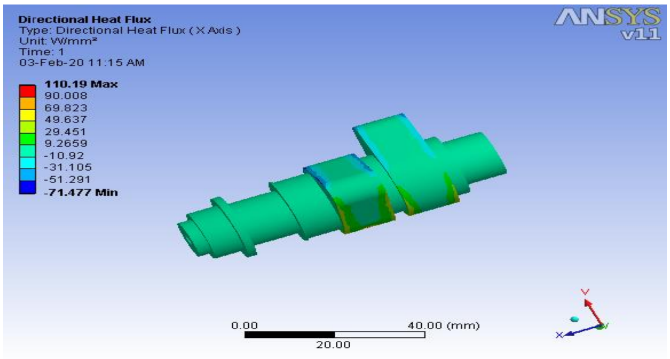
Structural steel mode 4



Structural steel mode 5

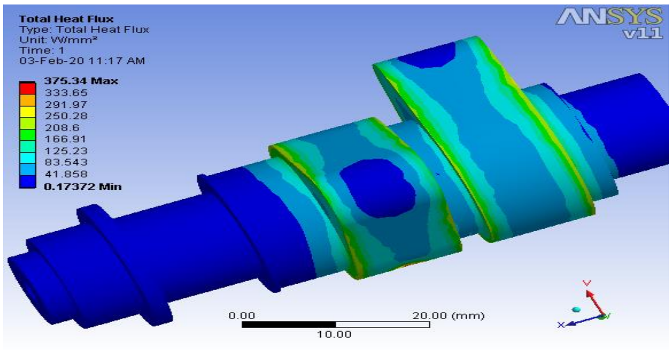


Structural steel mode 6

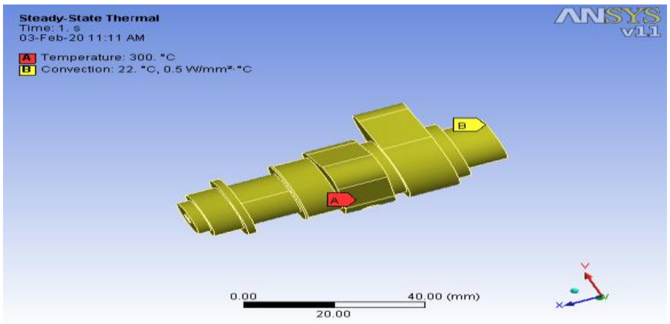


Aluminum alloy directional heat flux

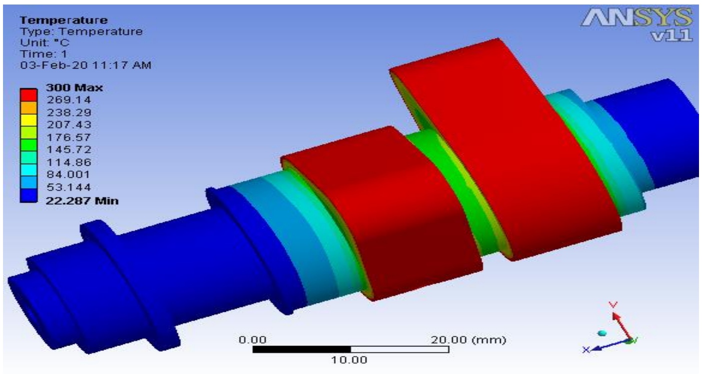
IV. THERMAL ANALYSIS RESULTS



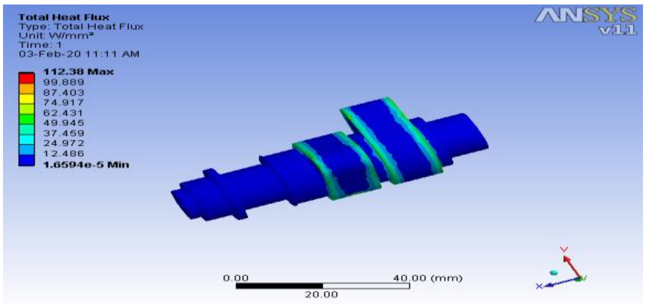
Child cast iron total heat flux



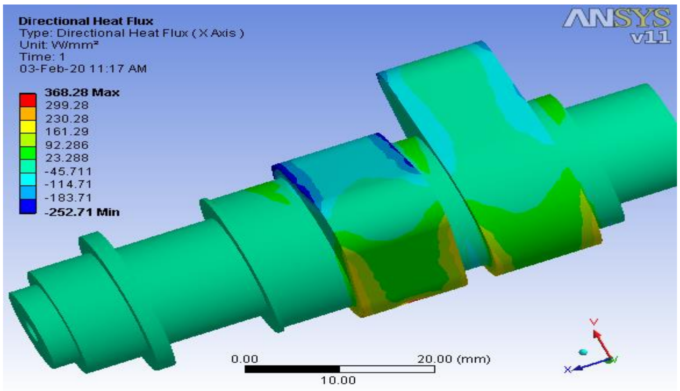
Thermal analysis settings



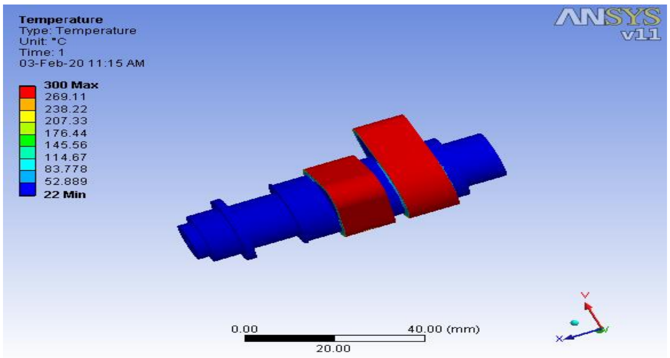
Child cast iron temperature



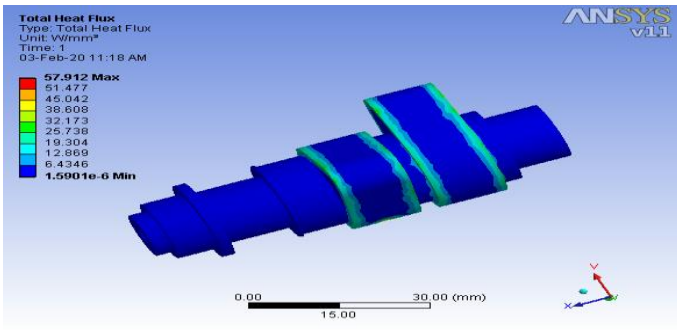
Aluminum Alloy total heat flux



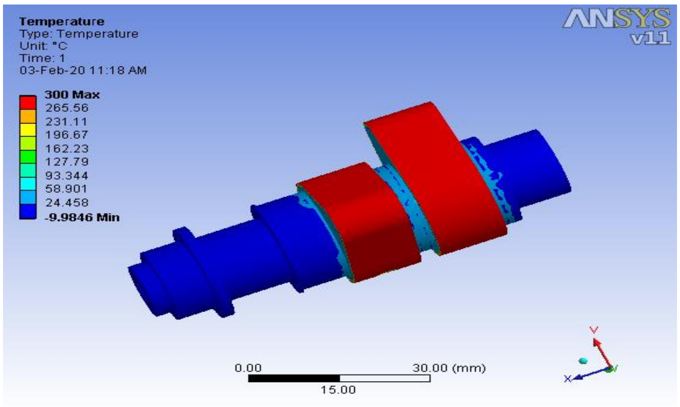
Child cast iron directional heat flux



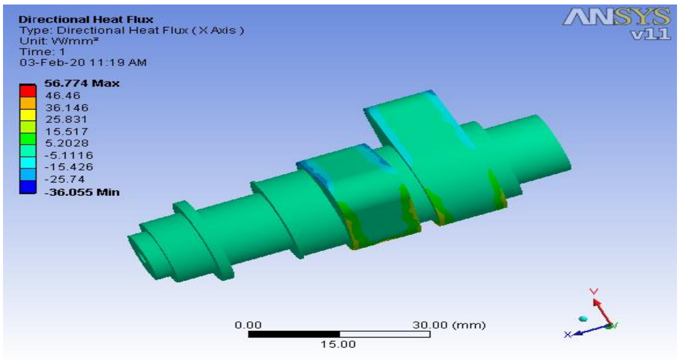
Aluminum alloy temperature



Structural steel total heat flux



Structural steel temperature



Structural steel directional heat flux

THEORETICAL CALCULATIONS

THEORETICAL CALCULATIONS OF CAMSHAFT

For 150cc 4 Stroke IC engine

D = Diameter of bore = 57mm

l = stroke = 58.6mm (length of stroke)

Area of piston a= $\frac{\pi}{4}$ D2 = $\frac{\pi}{4}$ (57)2

Velocity of piston v = $\frac{2\pi N}{60} = \frac{2X58.6X6000}{60}$ =11720MM/S

Area of part = ap

V p = mean velocity of gas flowing through part

V p = 90m/s = 90000mm/s

Ap vp = av

ap= $\frac{av}{vp}$=$\frac{1500.465*11720}{90000}$

dp= diameter of part

332.12=$\frac{\pi}{4}$ dp2

dp=20.56MM

Diameter of valve dv = 32.33mm

Maximum lift of the valve

α = 300

h= $\frac{dp}{4\cos\alpha}$ =$\frac{20.56}{4\cos\alpha}$ =5.93

Design of Camshaft

The cam is forged as one piece with the camshaft

The diameter of camshaft

D1 = 0.16cylinder bore+12.7

D1 = 0.1657+12.7 = 21.82mm

The base circle diameter is about 4mm greater than camshaft diameter.

Base circle diameter = 21.82+3 = 24.82mm = 25mm

Width of camshaft w1 = 0.09cylinder bore+6

W1 = 0.0957+6 = 11.13mm

OA = minimum radius of camshaft +(1/2diameter of roller) = 12.5+(1/241) = 33mm

Design of Key

D1 = 21.82mm

Width of key w = 0.25D1 = 5.455mm

Thickness of key t = 0.66w = 3.6mm

Length of key l = D+1.5D = 21.82 = 22mm

Gas pressure = 15.454N/mm2

Compression ratio = 10:1

So cylinder pressure and suction pressure is 10 times less than the gas pressure

Pc = Ps = 1.545N/mm2

Aluminum Alloys

Aluminum alloys are classified into two categories – Cast and Wrought alloys.

Wrought alloys can be either heat-treatable or non-heat treatable.

Alloys are designated by a 4 digit number. Wrought – the 1st digit indicates the major alloying element.

Cast – The last digit after the decimal indicates product from(casting - 0 or ingot -1)
Aluminum applications

Aerospace -
The absolute requirement for light structures, made only stronger by environmental regulations, make aluminum and its alloys now more than ever the number one material in the sky. In the last 35 years, newly designed alloys and increasingly innovative conversion and assembly processes have halved the weight of an airplane's structure. Their percentage in aircraft structures sold to airlines companies 70% of what goes into an airframe and are an indispensable part of the programs in the world.

Automotive -
Chassis, bodies, engine blocks, radiators, hubcaps... Driven by consumer needs and increasingly tight regulations, the automobile industry has made ample recourse to aluminum. A European car today contains on average 100 kg of aluminum, taking advantage of multiple properties of the materials: lightness (a 100 kg loss of weight reduces fuel consumption by 0.6 liters/100 km and greenhouse gases by 20%), resistance (improved road-handling, absorption of kinetic energy, shorter braking distance) and recycling (95% of the aluminum contained in autos is collected and recycled, and represents over 50% of the vehicle's total end-of-life value.) The automotive use of aluminum is expected to double in the next ten years.

Marine -
Marine transport is increasing its use of aluminum by capitalizing on its two leading qualities: lightness and corrosion resistance. Advanced alloys have enabled the design of high-speed ships, by lightening hulls by 40% to 50% over steel. Corrosion resistance, even on the water, makes for more durable hulls, masts and superstructures on pleasure boats and the bridges and superstructures of passenger ships and merchant ships.

Rail -
Lighter structures, resistance and durability have made aluminum crucial to rail transport applications. The French SNCF 2-level high-speed train is made of aluminum alloy sheet metal and extrusions, as are many subways and commuter trains throughout the world.

Building -
Commonly used in extruded, sheet-rolled or molded form for window frames and other glass supports, for siding and partitions, aluminum is a favorite element of modern architecture. It can be made into complex forms in an extensive range of colors, stands up to the weather and calls for very little maintenance. These features make it especially valued by architects and builders, who use it in public buildings (like hospitals, universities and office buildings), industrial buildings and private houses.

Packaging -
Modern packaging is one of the leading consumers of aluminum. Its lightness saves both on the material and the energy it takes to produce it. Its corrosion resistance and impermeability provide the protection and safety required for packaging foods and pharmaceuticals. And its complete recyclability makes it re-usable in the economic cycle. Long in use in the form of foil for flexible packaging, aluminum today has become a commoner sight in rigid and semi-rigid packaging, especially in beverage containers (over 25 billion aluminum cans have been used in greater Europe) but also in preserves, aerosols, bottle caps and lids, etc.

Mechanical industry and engineering -
The many features of aluminum and its alloys also account for its growing use in mechanical applications.

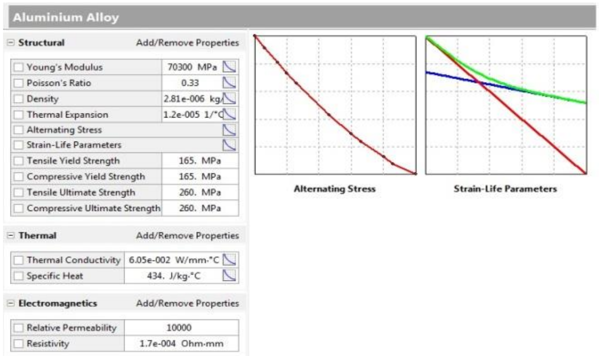
Makers of machines with moving parts, such as robots, are using an increasing number of aluminum parts to reduce inertia. In terms of heat exchange (liquid-to-liquid or liquid-to-gas), aluminum's thermal conductivity is critical in electronics, seawater desalination, HVAC exchangers and the plastics industry, where using aluminum alloy molds with pronounced mechanical properties (Alum old) can shorten fabrication cycles by up to 30%.

Energy distribution -

Aluminum's low density combined with its excellent electrical conductivity make it a crucial material in the distribution of electricity. Universally, and now practically exclusively, used for high-tension wires, aluminum can also be found in conductors (twice as light as copper), telephone cable shields and protectors against electrical and magnetic fields.

Sports and leisure -

Light and versatile, aluminum is now featured in numerous objects in our daily environment, from mass-marketed electronics (household appliances, refrigerators, radiators, CD coatings, etc.) to sports equipment (hang gliders, ski poles, golf clubs, off-road bikes, scooters) and leisure products (trailers, camping, diving and mountaineering equipment).

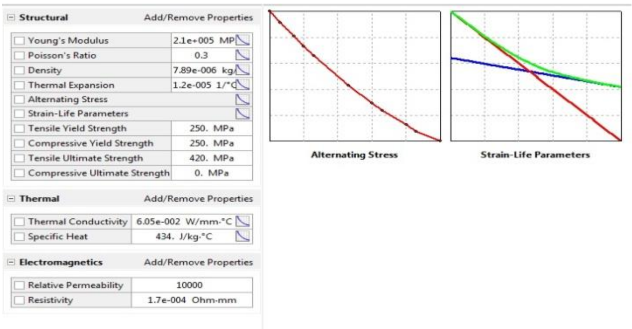


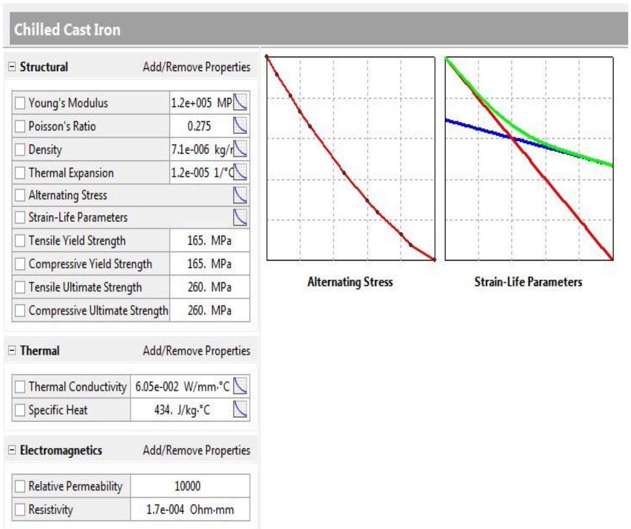
HISTORY OF THE STRUCTURAL STEEL INDUSTRY

The structural steel industry is over 100 years old. During that time, steel structures and the technical specifications governing their design have become more and more complex. The American Institute of Steel Construction (AISC), founded in 1921, developed the first standard Specification for the Design, Fabrication and Erection of Structural Steel for Buildings in 1923. This original document was 8 pages long. The AISC specifications have evolved through numerous versions, and the latest (ninth) edition was published in 1989. Known as Allowable Stress Design Specifications (ASDS), this document is 103 pages long. In 1986 AISC introduced the first of a new generation of specifications based on reliability theory, and this document is named Load and Resistance Factor Design Specification (LRFDS). The third edition (December 1999) of the LRFDS is 169 pages long.

Thus, in earlier days, specifications and standards used to be relatively thin documents that contained the basic essentials of a subject and were easy to assimilate and use. Growth in knowledge due to research and testing, and introduction of new steels, high strength bolts, and welding, has enabled far more complex structures to be built, and availability of computers has enabled far more rigorous analyses to be made, leading to more detailed and lengthy specifications. As correctly pointed out by Professor Hatfield [1], "Technical knowledge grows, rather than being superseded. Every generation of engineers, and of engineering graduates, is expected to know more than its predecessor.

Meeting these expectations requires adding topics and courses rather than replacing the old with the new." In a paper that won him the 1992 AISC T.R. Higgins Leadership Award, Professor McGuire [2] observed: "It is the nature of steel structures that all of their strength limit states--except fatigue, fracture, and tension member failure-- are in fact stability limits. An engineer should have an understanding of the various manifestations of this complex phenomenon as well as the scope and limitations of the classical and contemporary schemes used for dealing with them." In effect, the strength limit states are inelastic stability limits. Ideally, a first course in Steel Design should, therefore, be preceded by an introductory course on Stability of Structures and an introductory course on Plastic Analysis of Structures, as is the case with some European universities. As this sequence is not followed in most American universities, a textbook should include ample information about the behavior of members and structures so that the student designer understands the rationale of the design equations that he or she is using to design a structure. With the constant decrease in the number of credit hours allotted to design courses, it is not always possible to teach this in class but the material should be available in the textbook selected.





Result

structural analyses

structural steel

Total Deformation		shear stress		Equivalent strain		equivalent stress	
Max	Mini	max	mini	Max	mini	Max	mini
0.0056878	0	51.735	-54.032	0.00074854	1.72E-06	157.19	0.36128

child cast iron

Total Deformation		shear stress		Equivalent strain		equivalent stress	
Max	Mini	max	mini	Max	mini	Max	mini
0.010143	0	51.647	-54.225	0.0013125	1.0089e--6	157.5	0.12107

Aluminum alloy

Total Deformation		shear stress		Equivalent strain		equivalent stress	
Max	Mini	max	mini	Max	mini	Max	mini
0.016607	0	51.19	-53.814	0.0022304	9.86E-06	156.79	0.69325

V. CONCLUSION

From the above results obtained and graphical representation of the results, it is concluded that, maximum heat flux rate in the aluminum alloy as compare to other materials and it is good when we think about only heat flux rate. But the values of shear stress and total deformation is also very high in aluminum alloy and it is not good, these values should be low.

Shear stress is the main factor in the design consideration of camshaft. From the above four materials, the values of shear stress in child cast iron is minimum. And the value of total deformation is low in structure steel.

The maximum values of shear stress and total deformation is obtained at maximum load i.e. 3500N to 5000N. This load is obtained at initial/ starting stage of the vehicle (1650 to 1950 RPM). So it is recommended that, the vehicle should cross this range of engine speed as early as possible and the gray cast iron is the best material for manufacturing of camshaft.

VI. REFERENCES

[1]. A. S. Dhavale, V.R.Muttagi “Study of Modeling and Fracture Analysis of Camshaft” International Journal of Engineering Research and Applications, Vol. 2, Issue 6, November-December 2012, pp.835-842.

[2]. Mahesh R. Mali, Prabhakar D. Maskar, Shravan H. Gawande, Jay S. Bagi , “ Design Optimization of Cam & Follower Mechanism of an Internal Combustion Engine for Improving the Engine Efficiency”, Modern Mechanical Engineering, 2012, 2, pp.114-119

[3]. Bayrakceken H, Ucun I. & Tasgetiren S. “Fracture analysis of a camshaft made from nodular cast iron”. 1240-12453 NOV 2005.

[4]. Paradon V. “An Impact Model for Industrial CamFollower System: Simulation And Experiment”. 01-1111th OCT, 2007

[5]. G.K. Matthew., D. Tesar.(1976), Cam system design: The dynamic synthesis and analysis of the one degree of freedom model, Mechanism and Machine Theory, Volume 11, Issue 4, Pages 247-257. 6M.O.M Osman., B.M Bahgat., Mohsen Osman., (1987), Dynamic analysis of a cam mechanism with bearing clearances, Mechanism and Machine Theory, Volume 22, Issue 4, Pages 303-314.

[6]. Robert L Norton.(1988), Effect of manufacturing method on dynamic performance of cams— An experimental study. part I—eccentric cams, Mechanism and Machine Theory, Volume 23, Issue 3, Pages 191-199

Cite this article as :

B. Suman, Y Sudheer, C Raghunath Reddy, "Design and Material Optimization of Camshaft In 150 CC Engine", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 7 Issue 1, pp. 132-145, January-February 2020.
Journal URL : http://ijsrst.com/IJSRST1207134