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Modelling and Analysis of I.C Engine Crank Shaft by Using Different Materials and Loads

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ABSTRACT:

Crankshaft is a component in an engine which converts the reciprocating motion of the piston to the rotary motion. Where as in a reciprocating compressor, the same principal is used to convert rotational motion into reciprocating motion. "Crank throws" or "crankpins", are used in order to do the conversion between two motions, which additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.

The design of a crankshaft is of 4 stroke single cylinder S.I engine. So that two revolution of crankshaft for each stroke. The peak pressure acting on the engine crankshaft. The crankshaft of the located model is designed using pro engineering with the accurate dimensions and material standards. Pro engineer is one of the best design software in design tools were we can easily design components based on it dimensions and analysis in ansys with accurate results.In this project comparison of results for crank shaft with different load conditions with two different materials (i.e. nodular cast iron, forged steel). The results are taken and evaluated with the given load conditions and optimum results are shown.

1.INTRODUCTION:

In today's automotive industries one has to produce components with low cost and upgraded features. With the help of optimization techniques and computational methods, the designed model which meets the required properties and expectations before the actual production by saving time and resources. A crankshaft is one of the main component through which the conversion of motion initiation takes place in an engine. This is designed in such a way that additional bearing surfaces, whose axis is offset from that of the crank.

For every cylinder there exists a crankshaft connected to the bigger ends of a connecting rod to transmit the motion. The complexity of the design depends on the type of engine and vibrations subjected on each stroke, in this thesis we use simple crankshaft because of the single cylinder in an engine. In high end engines we use more main bearings for the high performance and vice versa.

Some of the general considerations in designing a crankshaft are the type of loads and stresses caused by it, selection of material, motion of parts or kinematics of the crankshaft, form and size of parts, convenient and economical features like minimization of wear, and use of standard parts. Failure of the Crankshaft will result in the failure of the engine. The crankshaft materials which are commonly used are follows: Billet steel, steel forging, cast steel, nodular iron, malleable steel, but in some cases cast iron. And usually forged cranks are preferred due to their high output durability. The worth discussing when considering the design of the crankshaft is non constant fillets and non circular contours which is more critical factor in overall design.

Material properties and influence on parts:

The main criteria are which are to be fulfilled by the crankshaft for the proper functioning. 1) Enough strength and rigidity to withstand forces and keep distortion a minimum. 2) The vibration should be minimum while it is subjected to critical speed 3) Minimum weight and bearing pressure to a value dependent on the lubricant available. The material should be chosen by the method of manufacturing and poses very high strength. The ultimate strength of about 784 to 940 Mpa is generally used for transport engines whereas cast iron used for crankshafts with ultimate tensile strength about 350 to 525 Mpa.

As we may not know the deflection of crankshaft (front to rear) accurately, that the engine which is running behind those in the front. Depending upon how much deflection is occurring rearward cylinders may be running in a retarded position, relative to those in front. Some adjustment to spark timing to these cylinders can be helpful. To minimize the stacking of events from deflection in both cam and crank by reducing the amount (frequency and amplitude) using torsional vibration damper is mandatory to extending performance and power.The cases which influence the parts are forging and casting, Machining, fatigue strength, hardening, counterweights, stress on crankshafts.

Design formulae:

The displacement of the end of the connecting rod is approximately proportional to the cosine of the angle of rotation of the crank, when it is measured from top dead center (TDC). So the reciprocating motion created by a steadily rotating crank and connecting rod is approximately simple harmonic motion:

$$x = r\cos\alpha + l$$

Here x is the distance of the end of the connecting rod from the crank axle, l is the length of the connecting rod, r is the length of the crank, and α is the angle of the crank measured from top dead center (TDC). Technically, the reciprocating motion of the connecting rod departs from sinusoidal motion due to the changing angle of the connecting rod during the cycle, and is expressed (see Piston motion equations) as:

$$x = r\cos\alpha + \sqrt{l^2 - r^2\sin^2\alpha}$$

Maximum Principal Stress: (σ1)

Where

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left[\frac{\sigma_x - \sigma_y}{2}\right]^2 + \tau_{xy}^2}$$

σx - Stress in x direction, in MPA or N/mm2

σy - Stress in y direction, in MPA

τ_{xy} - Shear stress, in MPA

Minimum Principal Stress: (σ2)

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left[\frac{\sigma_x - \sigma_y}{2}\right]^2 + \tau_{xy}^2}$$

Maximum Shearing Stress: (τmax)

$$\tau_{max} = \pm\sqrt{\left[\frac{\sigma_x - \sigma_y}{2}\right]^2 + \tau_{xy}^2}$$

Torsion stresses: (τ)

The Torsion formula is given by,

$$\frac{T}{J} = \frac{G\theta}{l} = \frac{\tau}{r}$$

Here

T=Torque or Torsion moment, N-mm
J =polar moment of inertia, mm4
=432dπ,
Here d is the solid shaft diameter.
=(4432iodd−) π, Where do and di are outer and inner diameter of the hollow shaft respectively.
G =Modulus of elasticity in shear or modulus of rigidity, MPA
Ɵ =Angle of twist, radians
L = Length of shaft, mm
R =Distance from the Neutral axis to the top most fibre, mm
= 2d (For solid shaft)
= 2od (For hollow shaft)
Bending Stresses: (σb)
The bending equation is given by

$$\frac{M}{I} = \frac{E}{R} = \frac{\sigma_b}{c}$$

Here M=bending moment, N-mm
I =Second moment of area, mm4
=464dπ (For solid shaft)
=(4464iodd− π), (For hollow shaft)
C =Distance from the Neutral axis to the extreme fibre, mm
=2d (For solid shaft)
=2od (For hollow shaft)

2.RELATED WORK:

PRO E

Creo elements/Pro offers a wide range of tool to generate the complete digital representation of the product being design.

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In addition to this industrial and standard pipe work companies uses this geometry tools for other integrated design disciplines and complete wiring definitions, which are also available to support collaborative development. A number of concept design tools that provide up-front Industrial Design concepts can then be used in the downstream process of engineering the product. These range from conceptual Industrial design sketches, reverse engineering with point cloud data and comprehensive free-form surface tools. As the pro-e is used for designing of crankshaft and the following snapshots describe process of design in this software.

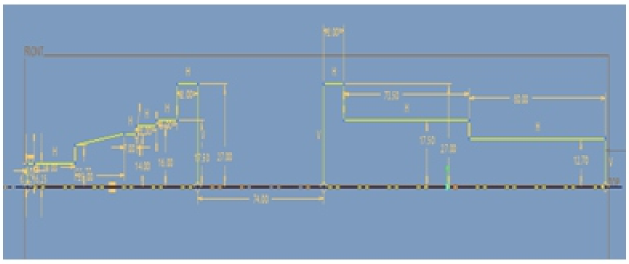


Figure 1: Initial 2D profile of a crankshaft.

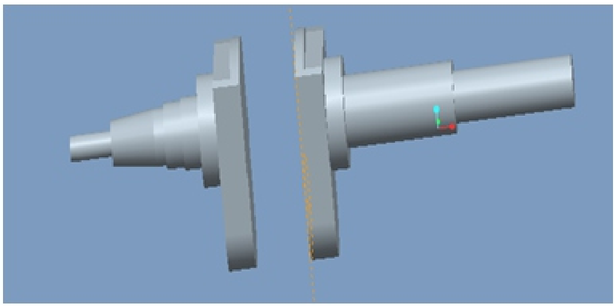


Figure 2: 3d model of a crank shaft by using revolve and extrude option to its 2D sketch.

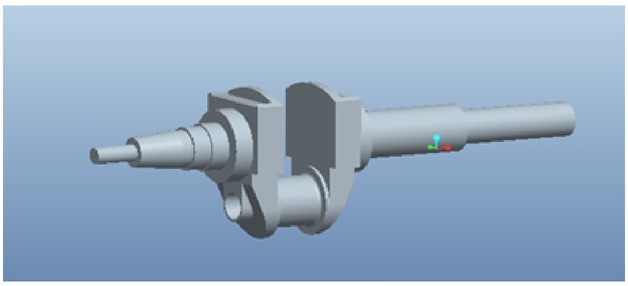
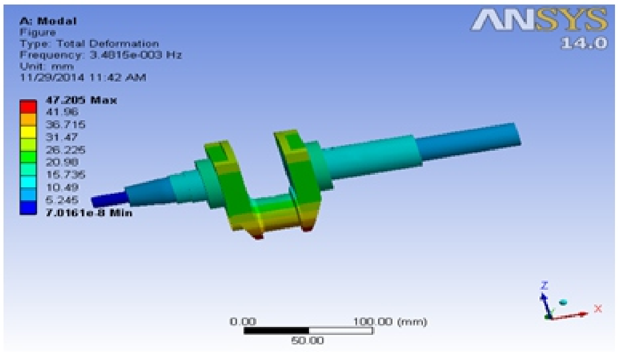


Figure 3: Generated 3D view of a complete crankshaft

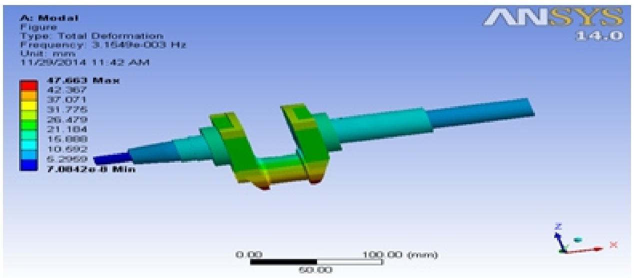
ANSYS:

Ansys is analysis software used to evaluate the equivalent stresses by subjecting loads on it. Simple computational model of a crankshaft is taken and following materials (i.e. Structural steel, Forged steel) are considered. Each material is taken and different loads are applied on it. Modal and static structural analysis is done on a crankshaft and evaluated results are obtained which are compared and the optimum material and design is considered. The both results are shown in the following snapshots.

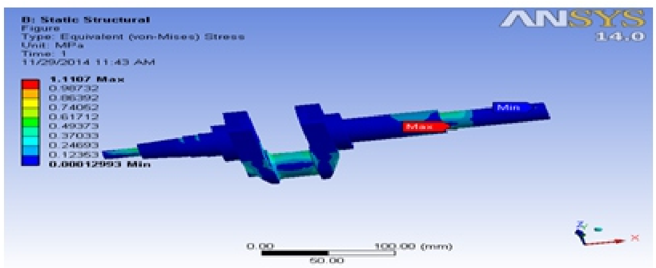
3.Modal analysis
Structural steel



Forged steel.



4.Static structural analysis
Forged steel



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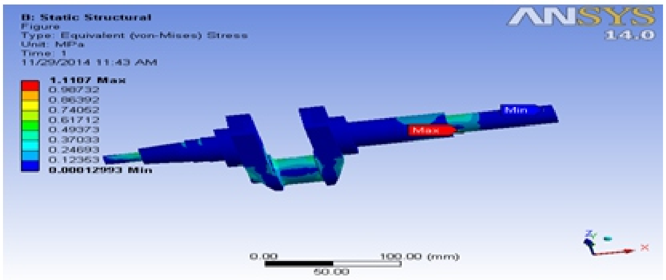
Structural steel



5.CONCLUSION AND FUTURE SCOPE:

According to the analysis the values of NCI is more than CS when comparison was done. Although the values are high for NCI it is suitable for the Crankshaft design because it can sustain with its strength. The future scope of this project is to be done by using different materials (composites and aluminum alloys) and may get good results which will be useful for high performance engines.

BABLIOGRAPHY:

1.Hall, Bert S. (1979), The Technological Illustrations of the So-Called "Anonymous of the Hussite Wars". Codex Latinus Monacensis 197, Part 1, Wiesbaden: Dr. Ludwig Reichert Verlag, ISBN 3-920153-93-6 .

2.al-Hassan, Ahmad Y.; Hill, Donald R. (1992), Islamic Technology. An Illustrated History, Cambridge University Press, ISBN 0-521-42239-6 .

3.Laur-Belart, Rudolf (1988), Führer durch Augusta Raurica (5th ed.), August .

4.Mangartz, Fritz (2010), Die byzantinische Steinsäge von Ephesos. Baubefund, Rekonstruktion, Architekturteile, Monographs of the RGZM 86, Mainz: Römisch-Germanisches Zentralmuseum, ISBN 978-3-88467-149-8

5.Sprules, E. (2000). The biomechanical effects of crank arm length on cycling mechanics. Retrieved July 17, 2009, from SPORTDiscus database.

6.Morris, D., & Londeree, B. (1997, October). The effects of bicycle crank arm length on oxygen consumption. Canadian Journal of Applied Physiology, 22(5), 429-438. Retrieved July 17, 2009, from SPORTDiscus database.

7.Gonzalez, H., & Hull, M. L. (1989). Multivariable optimization of cycling biomechanics. Journal Of Biomechanics, 22(11-12), 1151-1161.

8.Too, D., & Landwer, G. (2000, March). The effect of pedal crank arm length on joint angle and power production in upright cycle ergometry. Journal of Sports Sciences, 18(3), 153-161.

9.Hull, M.L., & Gonzalez, H.(1988). Bivariate optimization of pedalling rate and crank arm length in cycling. Journal Of Biomechanics, 21(10), 839-849.

10.Mileva, K., & Turner, D. (2003, October). Neuromuscular and biomechanical coupling in human cycling: Adaptations to changes in crank length. Experimental Brain Research, 152(3), 393-403.