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CAD Modelling and Topological Optimization of Two Wheeler Hero Motorcycle Crankshaft using ANSYS

Divyanshu Singh[1], R.K. Ambikesh[2]

[1]PG Scholar, H.B.T.U, Kanpur - 208002
[2]Assistant Professor, H.B.T.U, Kanpur - 208002

Abstract – *Crankshaft plays major role is working of an engine. It translates the reciprocating motion of the piston to rotational output. An engine without a crankshaft is unimaginable, it a high volume manufactured component so weight optimization of crankshaft will play major role in not only increasing the efficiency of an engine but also reducing the cost of productivity. Design, modelling and optimization of a crankshaft plays significant role in producing an efficient crankshaft. In this work 3D CAD model is created using Creo modelling software based on original dimensions of existing crankshaft of two wheeler motorcycle measured manually. Use of high end software produces a replica of component with least error. Stress Analysis is done using Ansys Mechanical workbench. Further topological optimization of the crankshaft is done to remove extra material with negligible changes in stress acting on crankshaft using ANSYS. In this work reduction of 5.05 % of weight of crankshaft is observed which is highly significant in increasing the productivity of an automobile industry by cost reduction.*

Key Words: Modelling, Optimization, Ansys, Crankshaft

1. INTRODUCTION

Crankshaft converts reciprocating motion of piston to roational output. The output from the crankshaft is transferred as driving input for running the other components of an automobile. Crankshaft consists of a crankpin, crankweb, main journal, oil passages and main shaft. Sound Design of crankshaft is essential since the it undergoes cyclic loading throughout its lifecycle which may cause failure. It is connected to piston via connecting rod in four bar mechanism.

Ding and Li[1] in their research concluded that FEM is effective tool for stress analysis of crankshaft. Fatemi[2] concluded dynamic analysis is more significant criterion for optimization. Brahmbhatt and Choubey[3] found that journal edge has high stress. Thejashreea[4] optimized crankshaft by 12.8% by geometrical optimization.

1.1 Computer Aided Modelling

Computer assisted modelling is highly significant CAE tool to produce an exact replica of original component within a short span of time with high end accuracy. Various softwares are available for three dimensional modelling like Solidworks, Catia, Creo and many more. These modelling softwares have highly developed features to produce a high end model for analysis and optimization purpose.

1.2 Topological Optimization

Topological optimization is an optimization technique to remove extra material from least stressed region. Used for weight optimization of crankshaft in this study. The extra material on crankshaft will be reduced by this optimization technique.

2. DIMENSION MEASUREMENT AND COMPUTER AIDED MODELLING

The existing crankshaft of Hero two wheeler is measured manually and weight of the existing crankshaft is measured using weighing machine and is found to be 1.78 kg and material of crankshaft is medium carbon steel. A 3D model of the crankshaft is made in Creo modelling software. All dimensions are taken in mm and the geometry is saved in .IGES format.

Maximum Gas Pressue = 2 MPa

Material of Crankshaft = Medium Carbon Steel

Bore (D) = 49.5 mm

Stroke (L) = 58 mm

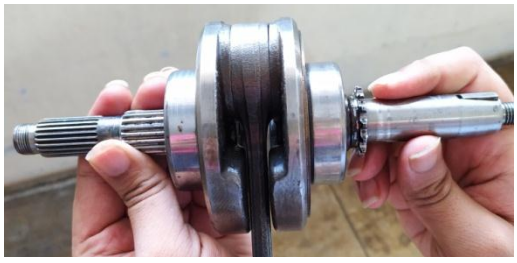

Fig – 1: Crankshaft of Hero Motorcycle

Table 1: Dimensions of Crankshaft

Dimensions	Value
Diameter of Crankpin (d_c)	25 mm
Length of Crankpin (l_c)	36 mm
Crankweb Diameter (d_w)	96 mm
Thickness of crank web (t)	14.5 mm
Journal Diameter	23 mm

Table 2: Chemical Constituent of Medium Carbon Steel

Constituent	C	Mn	S	P	Fe
Percentage	0.4	0.5	0.04	0.03	99.03

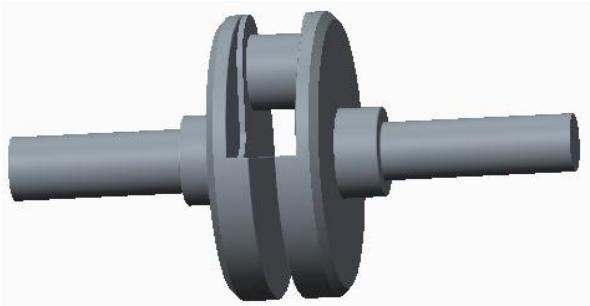

Fig - 2: Crankshaft Model in Creo

3. ANALYSIS IN ANSYS

The crankshaft model is imported in ANSYS mechanical. The boundary are applied by fixing the main journals on either side of the web and load of 3.14 KN is applied on center of crankpin. Meshing is done by using tetrahedron method and refinement of crankpin is done. Von mises stress is used as criterion for optimization results of which are obtained now which will be further compared with optimized crankshaft in proceeding steps. Von mises stress after FEA is found to be 27.6 MPa in this step.

4. OPTIMIZATION

Crankshaft is produced in large volume so reduction in its weight will reduce cost significantly. Topological optimization is technique used for weight optimization of crankshaft in this study using ANSYS mechanical.

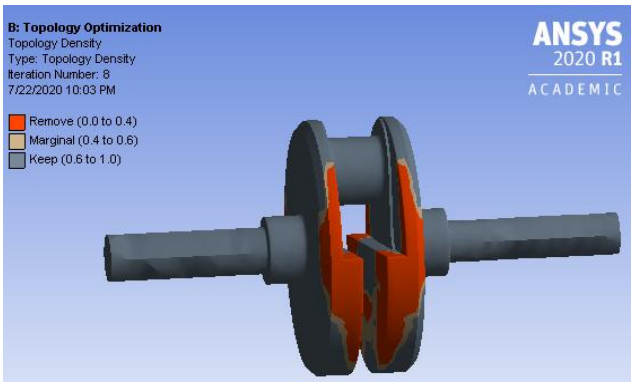

Fig - 3: Topological Optimization of Crankshaft

4.1 Optimized Model

Now on basis of topological optimization 3D optimized crankshaft model is prepared in Creo

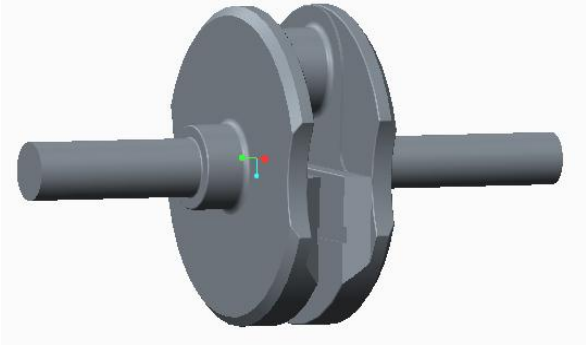

Fig - 4: Optimized 3D crankshaft Model

4.2 FEA of Optimized Model

Now FEA of optimized crankshaft is done to check stress on optimized crankshaft compared to original and weight reduction is compared.

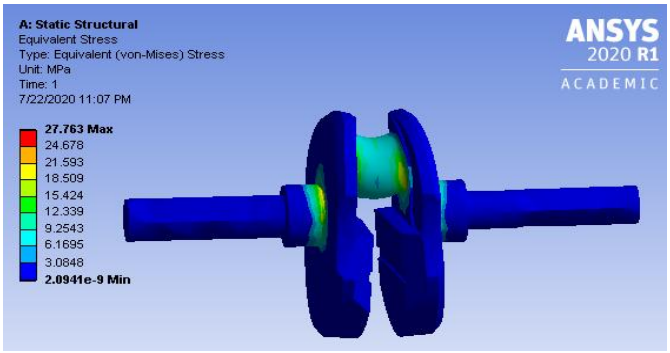

Fig – 5: Von Mises Stress of Optimized Crankshaft

Table 4: Comparison of weights of original and optimized crankshaft

	Original Crankshaft	Optimized Crankshaft	Percentage Reduction
Weight	1.78 kg	1.69	5.05 %

5. CONCLUSION

The weight of the crankshaft is reduced by 5.05 % which is highly significant with 0.5 % increases in von mises stress which is negligible. Since material requirement reduces so cost of manufacturing reduces hence overall productivity of crankshaft increases along with improvement in engine efficiency. Topological Optimization for weight optimization is an effective weight optimization technique for mechanical components.

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BIOGRAPHIES

Divyanshu Singh has completed Bachelor of Technology in Mechanical Engineering and currently pursuing Masters in Mechanical Engineering with specialization in CAD at Harcourt Butler Technical University, Kanpur.

Mr. R.K. Ambikesh is Assistant Professor in Department of Mechanical Engineering at Harcourt Butler Technical University, Kanpur and has 20 years of teaching experience.