Ansys of Honda Unicorn Bike Crankshaft to Reduce Stress & Weight by Optimization in Design

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Abstract— Crankshaft is large volume production component with a complex geometry in the diesel engine. This converts the reciprocating displacement of the piston into a rotary motion of the crank. The crank shaft takes the power from piston which is generated due to combustion process inside the combustion chamber of the cylinder. During the power transmission process the load acts at a particular crank angle to the max and hence the connecting rod is analysed for the stress developed, due to load conditions and the changes mentioned. In the present work Statics structure ANSYS is done to find out maximum von misses stress and deformation in the crankshaft of diesel engine. Material is taken in this paper of crankshaft is Structural steel. In this paper we have used 4 stroke petrol engine crank shaft of Honda Unicorn bike (149.2cc). The modeling of the crankshaft is created using SOLIDWORKS Software. Finite element analysis (FEA) is performed to obtain the variation of stress at critical locations of the crank shaft using the ANSYS software and applying the boundary conditions. Presser is applied on the crankshaft is 5MPa in the form of load. The objectives involve modeling and analysis of crank shaft, so as to identify the effect of stresses on crank shaft. Optimization is done in the crankshaft design and ANSYS is done after optimization. The results are compared of crankshaft stress and deformation before and after optimization in design. Results are coming best in the optimized design of crankshaft.

Key words: Crankshaft, Solid Works, Static Structure, ANSYS, FEA, Structural Steel

I. INTRODUCTION

Crankshaft is extensive volume creation segment with an unpredictable geometry in the diesel engine. The Crankshaft shaft takes the power from cylinder which is produced because of burning procedure inside the ignition council of the barrel. Amid the power transmission process the heap demonstrations at a specific Crankshaft edge to the maximum and henceforth the associating pole is investigated for the pressure created, because of load conditions and the progressions said. Connecting rod consists of small end, a Centre shank and big end. Small end of connecting rod has a hole throughout which is provided with a bush and is connected to the piston with the help of gudgeon pin. Big end is usually made into two halves so that it can be mounted over the crank –pin bearing shells easily [4]. The split of big end is fastened to it with the help of two bolts and bearing is allowed by inserting thin metallic strip. The piston end bearing is pressure lubricated and crank end bearing is splash lubricated. Notwithstanding the crank throws, the crankshaft is likewise contained painstakingly composed weights and balances to diminish engine vibration. Either end of the crankshaft is associated with the engine piece by the crank bearings. It is commonly associated with a flywheel to diminish the throb normal for the four-stroke cycle, and once in a while a tensional or vibration damper at the opposite end, to decrease the tensional vibrations frequently created along the length of the crankshaft by the cylinders most remote from the yield end following up on the tensional elasticity of the metal [5]. Notwithstanding the crank throws, the crankshaft is likewise contained painstakingly composed weights and balances to diminish engine vibration. Either end of the crankshaft is associated with the engine piece by the crank bearings.

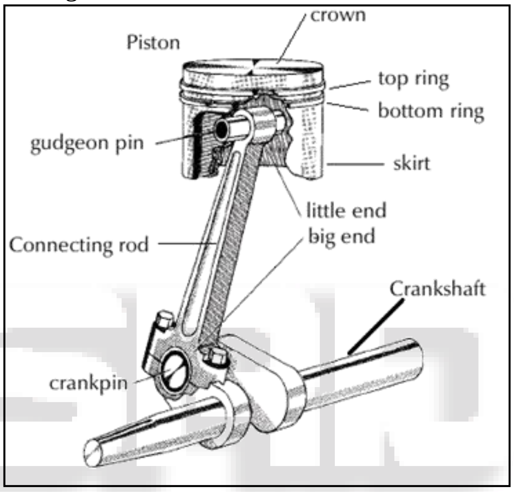

Fig. 1: Crankshaft in an Engine

Crankshafts can be produced from a steel bar for the most part through move fashioning or cast in bendable steel. Today an ever increasing number of producers tend to support the utilization of manufactured crankshafts because of their lighter weight, more conservative measurements and better characteristic damping. With manufactured crankshafts, vanadium micro alloyed steels are for the most part utilized as these steels can be air cooled in the wake of achieving high qualities without extra warmth treatment, with special case to the surface solidifying of the bearing surfaces [4]. The low amalgam content additionally makes the material less expensive than high composite steels. Carbon steels are likewise utilized, however these require extra warmth treatment to achieve the coveted properties. Cast press crankshafts are today for the most part found in less expensive generation motors, (for example, those found in the Ford Focus diesel motors) where the heaps are lower. A few motors likewise utilize cast press crankshafts for low yield variants while the more costly high yield adaptation utilizes fashioned steel.

II. LITERATURE REVIEW

This chapter includes the literature review of the previous work done by various researchers in the field of finite element methods and crankshaft. The past work is either in the form of analytical study or experimental results. We have presented a review of the relevant study in order to collect more information regarding our work. Following is the literature review of some of the relevant work done in the past:

Lucjan witek et al. [2017] In this paper, the crankshaft model is created by Pro/ENGINEER software. Then the model created by pro/Engineer was imported to ANSYS software. The maximum deformation appears at the centre of crankshaft surface. The maximum stress appears at the fillets between the crankshaft journal and crank cheeks, and near the central point Journal. The edge of main journal is high stress area. The crankshaft deformation was mainly bending deformation under the lower frequency. And the maximum deformation was located at the link between main bearing journal and crankpin and crank cheeks. So this area prone to appear the bending fatigue crack.

K.SANDYA et al. [2016] Proposed that maximum deformation appears at the center of crankpin neck surface. From the results it is concluded that the crankshaft design is safe since the von-misses stresses are within the limits. The maximum deformation was located at the link between main bearing journal and crankpin and crank cheeks. And also weight of the crank shaft is reduced by 43.36%. Hence it is concluded that metal matrix composite is suitable for the crank shaft. The project carried out by us will make an impressing mark in the field of automobile.

M.Naveen Ram et al. [2015] Introduced that Experimental results from testing the crank shaft under rotational know about the industrial design. Velocity and moment are listed in the Table. Analysis has been carried out by optimizing the material metal matrix composite. The results such as total deformation, equivalent elastic strain and equivalent stress for each material are determined. Comparing the optimized materials and the conventional material, metal matrix composite has the low values of total deformation, stress and strain. And also weight of the crank shaft is reduced by 43.36%.

Bhumesh J. Bagde et al. [2013] Proposed that comparison of analysis results of all five materials will show the effect of stresses on different materials and this will help to select suitable material. The manual calculations using finite element method considering bigger portion of crank shaft will ensure result validation for software results. The time and efforts required for analysis using software is very less and accuracy is also good. So we can say that FEA is a good tool to reduce time consuming theoretical work.

K. Thriveni et al. [2013] Proposed that

1) The maximum deformation appears at the centre of the crankpin neck surface.
2) The maximum stress appears at the fillet areas between the crankshaft journal and crank cheeks and near the central point journal.
3) The value of von-misses stresses that comes out from the analysis is far less than material yield stress so our design is safe.

III. OBJECTIVE OF THE STUDY

a) Study the effects of the loads acting on the crankshaft under the considered loading conditions.
b) Running sensitivity analysis for modifications in the sensitive parameters to optimize the crankshaft design and reduction of weight.
c) Comparison of the final optimized designs of the crank shaft and finalization of the one optimum model with highest mass reduction percentage and low Stresses and Deformation.

IV. METHODOLOGY

In our proposed work, we shall prepare the model of crankshaft in SOLIDWORKS in IGES format and perform statics structural analysis of crankshaft and evaluate the von-misses stress and deformation occurring in crankshaft. In our project composite element structural member is analyzed using the software called ANSYS. Normally as in all other analysis software the structure is created and property is allotted to the structure that you had created. Then the load is applied to the structural member as required. In all analysis software the loads are applied on the top of the member of structure created or in the top of nodes that connect the R.C. member created where we get the result like bending moment and shear fore of the structure member created and it is the common result `we get in all types of analysis software.

V. GEOMETRIC MODELING & FINITE ELEMENT ANALYSIS

A. Sketcher

Sketcher is utilized to make two-dimensional portrayals of related inside the part. We can a harsh layout of bends, and afterward indicate conditions called imperatives to characterize the shapes all the more decisively and catch our outline part. Each bend is alluded to as a portray object. To make a new portray, picked begin to mechanical outline and sketcher at that point select the reference plane or portray plane in which is to be made.

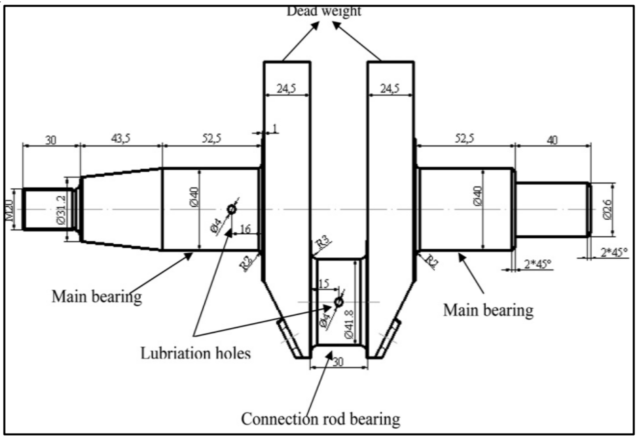

Fig. 2: Crankshaft Design

B. Modeling

SOLIDWORKS software is used to create crankshaft model. SOLIDWORKS is an interactive computer aided designing and manufacturing system. The cad functions automate the normal engineering, design and drafting capabilities found in today’s manufacturing companies. Creation of a 3-D model in SOLIDWORKS can be performed using three workbenches i.e.: sketcher, modeling and assembly.

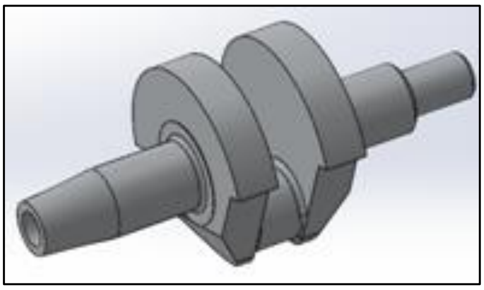

Fig. 3: Crankshaft Model

Density	7850Kg m^-3
Young's modulus	200000MPa
Poisson ratio	0.3
Tensile yield strength	758MPa
Tensile ultimate strength	260MPa

Table 1: Structural Steel Properties

C. Finite Element Analysis

The Finite Element Analysis (FEA) or Finite Element Method (FEM) is a numerical procedure, which could give close precise answers for complex field issues. Fundamentally this technique includes separating the intricate structures into known number of littler structures or components. This capacity of the strategy is called discretization or cross section, which makes the method more viable in breaking down sporadic molded structures in an assortment verity of designing issues. The conventional item advancement process depends on crucial building conditions and powerful in breaking down customary molded basic issues. However for complex physical issues the outline procedure is more reliant on broad testing, which typically makes the procedure costly. The cutting edge item advancement process with FEA innovation does not kill the item testing process, but rather its capacity to examine complex physical issue effortlessly and successfully can diminish the underlying model testing in the plan phases of the item improvement process.

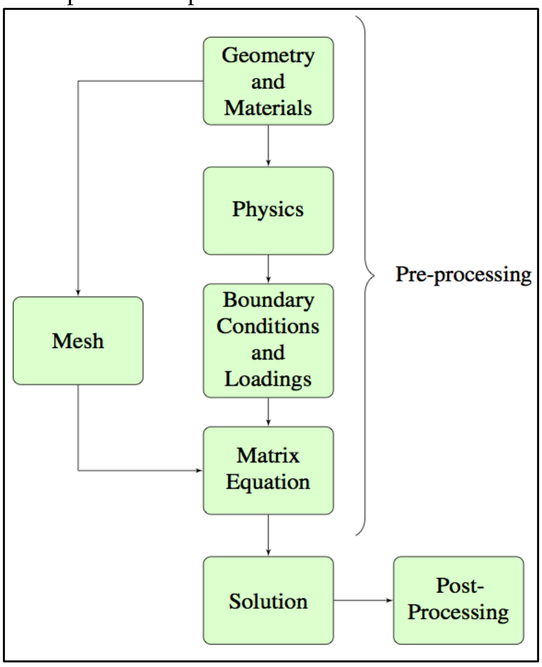

Fig. 4: Finite Element Analysis procedure

D. Mesh Generation

Cross section is the way toward separating the solids or surfaces into discrete components. It can be either done physically or naturally. If there should arise an occurrence of manual discretization, the model will be worked by determining the directions of every hub and interfacing the hubs to frame the components, which will in the end procure the state of the question being discredited. This procedure can be monotonous and arduous and may not be plausible for extremely complex parts.

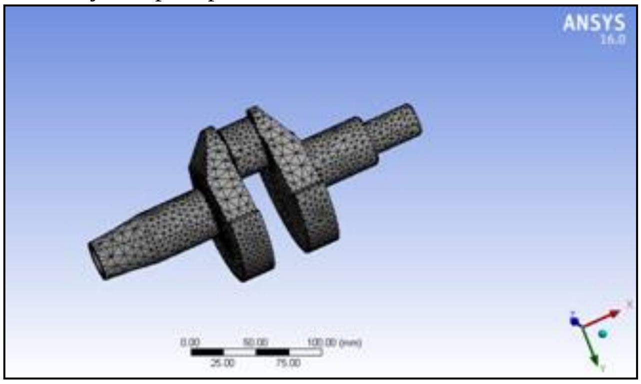

Fig. 5: Meshing of Crankshaft Model

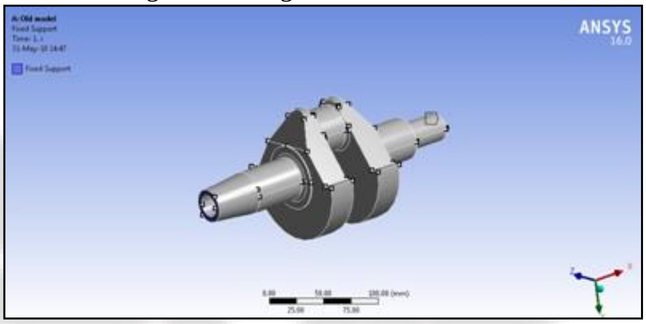

Fig. 6: Fixed Support of Crankshaft Model

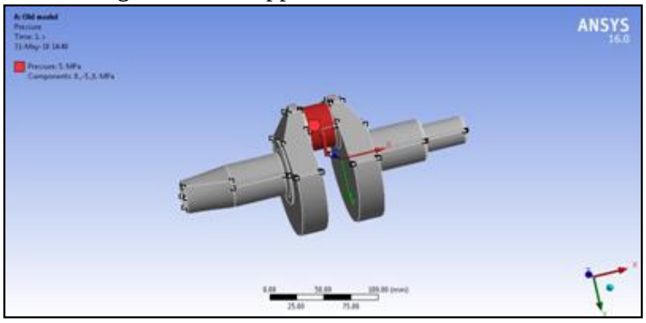

Fig. 7: Force Apply on Crankshaft Model

VI. RESULTS & DISCUSSIONS

A. ANSYS of Existing Design

After obtaining results of analysis of the conventional crankshaft design, the maximum deformation developed is found to be 0.11265mm as shown in Fig. (8).

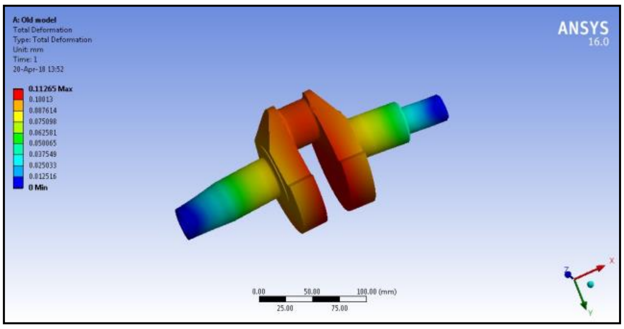

Fig. 8: Max Deformation in Crankshaft

The maximum stress produced in the Crankshaft is 269.2N/mm^2 as shown in Fig. (9).

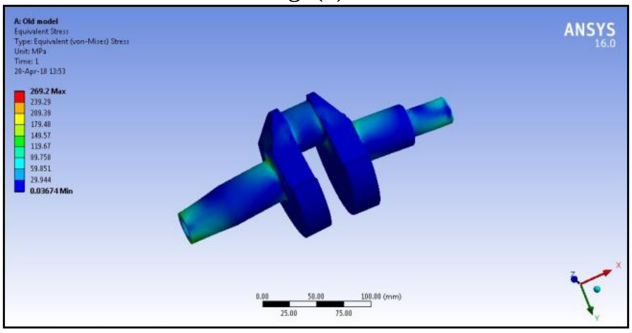

Fig. 9: Max Stress in Crankshaft

The maximum strain produced in the Crankshaft is 0.0014779N/mm^2 as shown in Fig. (10).

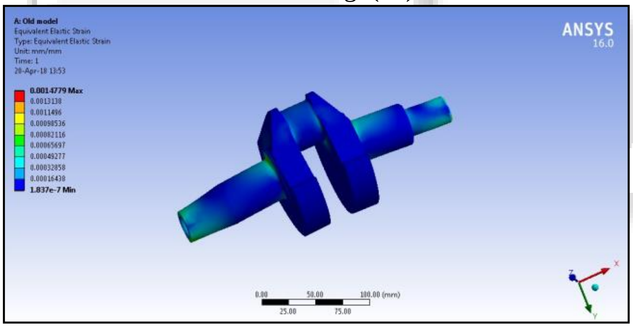

Fig. 10: Max Strain in Crankshaft

B. Design Changes (New Design)

These figures below are shown the results of the crankshaft after optimization in design. After obtaining results of analysis of the new crankshaft design, the maximum deformation developed is found to be 0.11189mm as shown in Fig. (11).

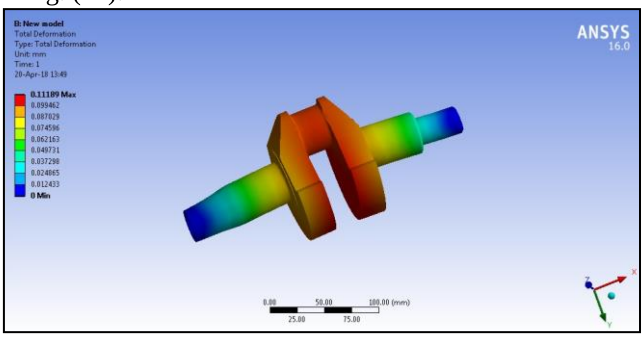

Fig. 11: Max Deformation in Crankshaft

The maximum stress produced in the crankshaft is 269.2N/mm^2 as shown in Fig. (12).

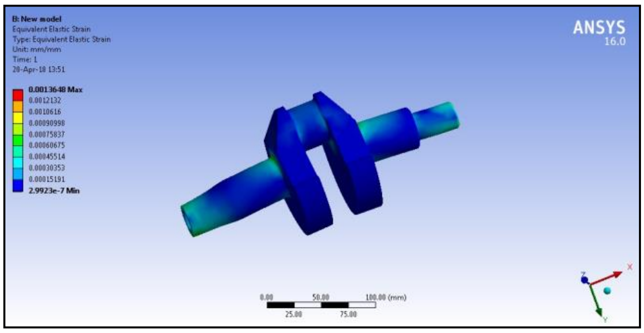

Fig. 12: Max Stress in Crankshaft

The maximum strain produced in the Crankshaft is 0.0013648/mm^2 as shown in Fig. (13).

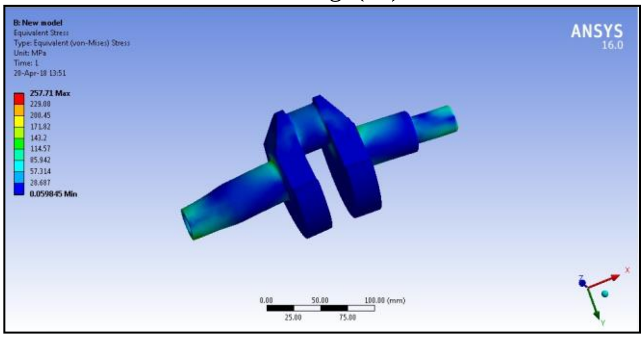

Fig. 13: Max Strain in Crankshaft

C. Graph Comparison

These graphs shows the comparison results between the stress and deformation produced in the conventional and new Crankshaft design.

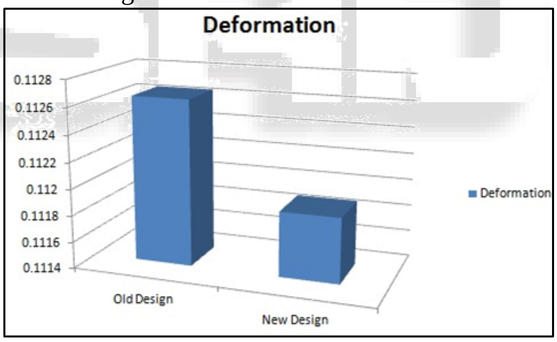

Fig. 14: Deformation Comparison

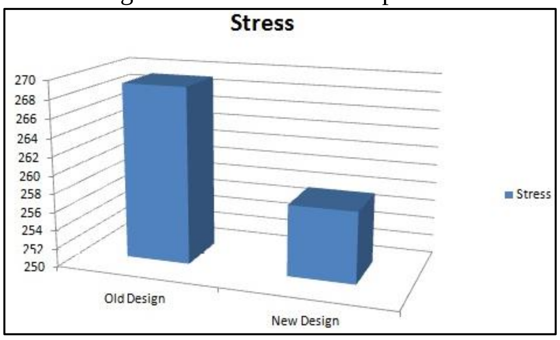

Fig. 15: Stress Comparison

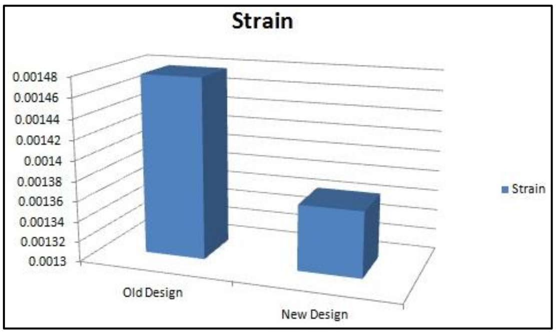

Fig. 16: Strain Comparison

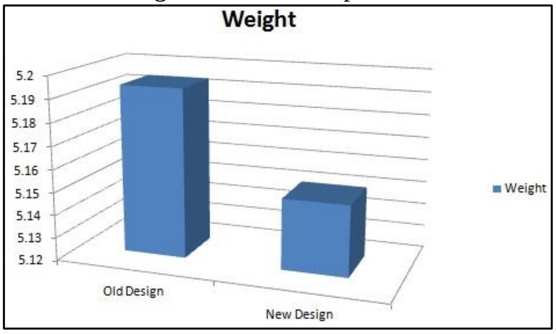

Fig. 17: Weight Comparison

From the above graphs we can see that Maximum deformation produced in the crankshaft before optimization 0.11265 and after optimization 0.11189. Maximum stress produced in the crankshaft before optimization 269.2 and after optimization 257.71.Maximum strain produced in the crankshaft before optimization 0.0014779 and after optimization 0.0013648.And maximum stress produced at the middle circular rod. The results are coming after the optimization in crankshaft model is best as compared to the old model design.

VII. CONCLUSION

Crankshaft is one of the most important moving parts in internal combustion engine. Crankshaft is a large component with a complex geometry in the engine, which converts the reciprocating displacement of the piston into a rotary motion. It must be strong enough to take the downward force during power stroke without excessive bending. So the reliability and life of internal combustion engine depend on the strength of the crankshaft largely.

From the above results we can see that:-

1) Maximum deformation produced in the crankshaft before optimization 0.11265 and after optimization 0.11189.
2) Maximum stress produced in the crankshaft before optimization 269.2 and after optimization 257.71.
3) Maximum strain produced in the crankshaft before optimization 0.0014779 and after optimization 0.0013648.

Max Deformation, Stress and Strain are produced in the old design of the crankshaft. The optimized design has less stress produced as compared to the old design. And also the weight decrease in the new optimized design (approximate 0.83%).Therefore we can prefer the new optimized design of the crankshaft.

A. Future Scope

Following Recommendations are there for future scope:-

1) The whole analysis can be repeated with more materials used for crankshaft.
2) The mass of crankshaft can be further reduced from the insensitive parameters.
3) The vibration analysis of crankshaft can be helpful for further study of the vibrations produced in the engine.

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