Review on Fatigue Analysis of Crank Pin Web Fillet Region of 2 Wheeler Crank Shaft

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Abstract : **In this explore, we are going to work over a crankshaft of a 2 wheeler. By reverse engineering (hand measurement and calculation) dimensions of the crankshaft will be found out. Currently, crankshaft is prepared of medium carbon steel forged and hardened. 3D modeling will be done in CatiaV5.Meshing and analysis will be conceded out in Hypermesh and Ansys correspondingly. Fatigue cycle, Stress and deformation resolve be the amount produced of analysis.By following the same procedure for 3D modeling, meshing, re-analysis of crankshaft by using different radius will be done. But this analysis will include crankshaft made of optimum design with different orientation. Stress values have to be below dangerous value to ensure that the new design is secure. Once we get the results from analytical solutions, we make a prototype of the drive shaft and carryout experimental testing on it. The experimental values should be in-line with the analytical values.**

***IndexTerms* - Crankshaft,Fatigue analysis,Ansys,Hypermesh**

I. Introduction

A crankshaft is a mechanical part able to perform a conversion between reciprocating motion and rotational motion. In a reciprocating engine, it translates reciprocating motion of the piston into rotational motion; whereas in a reciprocating compressor, it converts the rotational motion into reciprocating motion. In order to do the conversion between two motions, the crankshaft has "crank throws" or "crankpins", 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.A crankshaft is often designed with a fillet radius to improving fatigue life of crankshaft. The fatigue life of crankshaft is depend on the proper fillet radius. This fillet radius is changes than fatigue life is also changes of crankshaft. In most of the time fatigue failure is occur in crank-pin web fillet region. The crankshaft fillet rolling process is one of the commonly adopted methods in engineering to improve fatigue life of the crankshaft. A finite element analysis is implemented to approximate the stress distribution induced in the crankpin fillet region. The modeling of crankshaft is created by catia. Finite element analysis is performed to obtain the variation of stress at critical locations and fatigue life of the crank shaft using the ANSYS software and applying the boundary conditions. Radius of fillet is changes in model of crankshaft to improvement in fatigue life. This work in doing for optimization of a crankshaft in crank-pin web fillet region with fatigue life as well as to study a relation between fillet radius/diameter of crankpin to fatigue life.

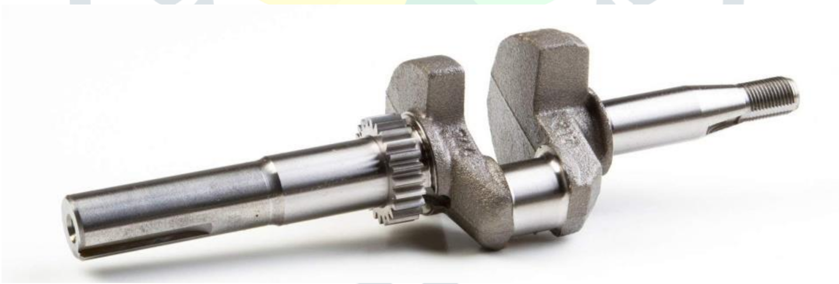

Fig.Crankshaft

II. Failure of crankshaft

Strength and stiffness to withstand the high loads is a common problem experienced in cyclic loading of crankshaft. Fillet areas of crankshaft undergo stress concentration which may lead to initiation of crack and finally failure of the crankshaft. To manufacture a crankshaft of suitable material which can have adequate strength, service life and durability is a challenge to all engineers. Crankshaft having less weight increases efficiency and power output and also cost reduction is possible with the changes in the materials. The main area of failure is web fillet as can be shown in picture.

III. Research methodology

In this section, contribution of different researchers is discussed

M.Finte, V.Infante, M.Freitas, L.Reis[2]-A Failure analysis of two damaged crankshafts are presented. one obtained from diesel engine of a mini backhoe, and another one from automobile vehicle. The diesel engine motor suffered a serious mechanical damage after 3 years in service the connecting rod n0 3 broke and in consequence, the crankcase and motor block suffered damage. The motor was repaired by a non authorized workshop, but maintaining the same crankshaft without being properly inspected.T he second crankshaft failed after 105000km in service. In both crankshafts a crack grew from the crankpin web fillet and their symmetric semielliptical crack..

Xuanyang Lei, Guicai Zhang, Song Xigeng, Jin Chen[12]-A new method for simulating non linear motion of cracked crankshaft is proposed and the transient vibration response of a cracked crankshaft is evaluated and analyzed. First the crankshaft without crack is simplified as a finite element model based on spatial Timoshenko beam element and the vibration modes of the crankshafts are calculated and compared with the results presented in other published literatures. Then frequently occurred crack in crankpin web fillet region is studied. According to the characteristics of this kind of crack a new spatial crack beam element is developed and a cracked crankshaft model which combines crack beam element and Timoshenko beam elements is established

G Gopal, Dr L Suresh Kumar[3] Study of an assembly of the Piston, Connecting rod and Crank shaft of a four wheeler petrol engine[3]. The components of the assembly have to be rigid and the assembly has to move as a mechanism. Hence, the analysis should involve a rigid-body analysis and flexible-body analysis. Static, Dynamic and Thermal analyses are done on the assembly of piston, connecting rod and crankshaft. The materials considered for piston are Aluminum alloy 6061 and Aluminum alloy 2618, for connecting rod are Aluminum alloy 6061 and Titanium and for crankshaft are EN308 and High Alloy steel. The main parts of the assembly i.e. engine piston, connecting rod and crankshaft are modeled and assembled as per the given design. And the Finite Element Analysis is done in Ansys. The meshing is done in Hyper Mesh.

Eknath B. Pore, Prof. D.R. Kotkar[9] Fatigue failure is a common problem experienced in cyclic loading of crankshaft. Fillet areas of crankshaft undergo stress concentration which may lead to initiation of crack and finally failure of the crankshaft.To manufacture a crankshaft of suitable material which can have adequate fatigue strength, service life and durability is a challenge to all engineers. Crankshaft having less weight increases efficiency and power output and also cost reduction is possible with the changes in the materials. To perform static and fatigue analysis of a crankshaft made of Aluminum Alloy (Al 5083) Reinforced with Silicon carbide (SiC) which was fabricated by ultrasonic assisted stir casting process to compare the stress distribution, deformation and fatigue life and safety factor with structural steel. This work checks possibility of whether a forged steel crankshaft can be replaced with a developed Al alloy crankshaft. The aluminum composite crankshaft has light weight about 1/3 of steel. Equivalent elastic strain, total deformation, and stresses are approximately equal in Al alloy composite crankshaft and structural steel crankshaft but it comes under the permissible tolerance limit. The maximum life value is more in an aluminum alloy crankshaft as compared to the crankshaft made of steel. Thus a steel crankshaft can be replaced with a developed Al alloy crankshaft.

LucjanWitek, MichałSikora[4]- has presented Stress and failure analysis of the crankshaft of diesel engine and identify the Failure analysis of the crankshaft of diesel engine. Failure analysis of the crankshaft of diesel engine was performed. Visual examination of the crankshaft fracture showed that beach marks, typical for fatigue failure were observed. The results of nonlinear static analysis showed that during work of the engine with maximum power the high stress area was located in crack initiation zone. Based on results of performed investigations it was concluded that the main reason of premature fatigue failure was high cycle fatigue of the material in external zone of the crank pin where the small structural radius was designed. The results of an interesting experimental and numerical analysis of the crankshaft segment are presented in study. The normal stress distribution in fillet of the crankshaft section subjected to bending was first obtained using linear-elastic finite element analysis (FEA). The residual stress distribution into crankshaft fillet vicinity (induced by a fillet rolling process) was next determined by elastic–plastic FEA. Based on calculated normal stresses, two fatigue models used to calculate the fatigue limits on surface cracks and in-depth cracks were examined by an experimental data. The results of nonlinear static analysis showed that during work of the engine with maximum power the high stress area was located in crack initiation zone.

R.SuganthiniRekha , Dr. S.Nallusamy[1] has done work on Modeling and Analysis of Crank Shaft With Metal Matrix Composites and identify the problem Evaluating and comparing the load and fatigue performance of two vying production techniques for crankshaft viz. forged steel and Ti-6Al-4V+12%TiC (Particle Reinforced Metal Matrix Composite) used in automobiles. Three dimensional model of crankshaft shaft is created using Pro-Engineer. Static simulation has to be conducted on two crankshafts of forged steel and Ti-6Al-4V+12%TiC from similar single cylinder four stroke engines. Finite Element Analysis (FEA) is to be performed to obtain the variation of stress magnitude at critical locations. The static analysis is done and is verified by simulations in finite element analysis software ANSYS. Ti-6Al-4V+12% TiC came into consideration for crankshaft as it has many advantages over the forged steels.

LucjanWiteka*, Feliks Stachowicza, ArkadiuszZałęskib [5] Main objective of investigations is explanation of failure reasons of the crankshaft of diesel engine. An additional aim of this work is determination the stress distributions in crankshaft during the work of the engine. In this study the modes, frequencies and stress states were also obtained for the crankshaft subjected to resonant vibrations Performed visual examination indicated that on crankshaft fracture the beach marks typical for fatigue failure were observed. Observation of crack initiation zone showed that the crack origin was not covered by corrosion products. The local surface corrosion on the fracture occurred because the crankshaft after failure was stored for a long time in a humid air. In next step of analysis the crankshaft was subjected to the material investigations. In order to check the real material properties the shaft segment was cut on 3 mm thick specimens. In this operation the wire- cut machine was used. The geometrical (3D) model of crankshaft was made using the Catia software. In next step the model was exported to the Abaqus program and divided onto finite elements. The nonlinear stress analysis of the crankshaft was made with the use of Abaqus program. As a result the stress distributions for crankshaft subjected to the operational loads were obtained Based on results of performed investigations it was concluded that the main reasons of premature failure are resonant vibrations of the crankshaft.

Mohammad JamalkhaniKhameneh, Mohammad Azadi[6] has studied Evaluation of high-cycle bending fatigue and fracture behaviors in EN-GJS700-2 ductile cast iron of crankshafts finding A high-cycle bending fatigue and fracture behavior of the EN-

GJS700-2 ductile cast Iron, which has been widely utilized for crankshafts in engines, was experimentally evaluated The studied material in this research was a ductile cast iron, entitled EN-GJS-700-2. Such material has been used for manufacturing engine crankshafts in automotive industries. The chemical composition of this material (standard specimens were extracted from crankshaft webs) was measured, comparing to standards. Obtained quantometric results showed that unless the copper element, other element percents have a good agreement with those values, mentioned in standards. The microstructure of the studied material can be seen in Fig. 1, for etched and un-etched samples. As known, mechanical properties of ductile cast irons have been directly related to their microstructure. The as-cast matrix microstructure of ductile cast irons may be entirely ferritic, entirely pearlitic, or a combination of ferrite and pearlite, with the spheroidal graphite distributed in the matrix. Besides, bainite and martensite were not found in the as-cast structure, since they were formed by the heat treatment process. The optical microscopy image from the studied material (considered from the pin journal of the crankshaft), was included ferrite-pearlite and nodular graphite phases. Ferrite halos (in regions) could be observed around nodular graphites. It should be mentioned that to obtain the material microstructure was etched by the 2% Nital conditi

XieWeisong, Zhang Junhong, Zhang Guichang,[7] work done on NVH and reliability analyses of the engine with different interaction models between the crankshaft and bearing finding The precision of the interaction model is very important to predict NVH and the reliability of an internal combustion engine. The interaction model between the crankshaft and the bearing is hard to be established precisely due to its complex interaction relationship and dynamic characteristic. Based on the FEM and CMS theory, the dynamic simulation model of the engine system is established, the dynamic theory is coupled with different lubrication models, different interaction models between the main bearing and the crankshaft are established to analyze the effect of lubrication model on NVH and reliability based on the dynamic simulation models and acoustic analysis model. Nonlinear spring model and hydrodynamic lubrication model are precise enough to predict the vibration or noise.

VI. DISCUSSION

In this research, we are going to work over a crankshaft of a 2 wheeler. By reverse engineering (hand measurement and calculation) dimensions of the crankshaft will be found out. Currently, crankshaft is made of medium carbon steel forged and hardened. 3D modeling will be done in CatiaV5.Meshing and analysis will be carried out in Hyper mesh and Ansys respectively. Fatigue cycle, Stress and deformation will be the output of analysis. By following the same procedure for 3D modeling, meshing,re-analysis of crankshaft by using different radius will be done. But this analysis will include crankshaft made of optimum design with different orientation. Stress values must be below critical value to ensure that the new design is safe. Once we get the results from analytical solutions, we make a prototype of the drive shaft and carryout experimental testing on it. The experimental values should be in-line with the analytical values

V. CONCLUSION

After studying the crankshaft geometry and structure and its static and dynamic loading parameters, we may be able to find out considerable amount of weight saving in the range of 20% to 30% when compared to conventional steel drive shaft. Earlier works were based on static loads which is static weight of shaft and torque applied but scope is there for analyzing the actual boundary condition stress and deformation on crankshaft while in running condition. Hence for after putting calculated dynamic loads in linear static analysis intend to bending analysis, torsional analysis and also the modal analysis, we can conclude with considerable amount of reduction in weight and increased mechanical properties and strength can be maintained in composite crankshaft application. The results of analysis will be validated by experimentation model under UTM bed and fixture based loading conditions.

VI. REFERENCES

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