Journal of Asian Scientific Research 2(11):737-741

Journal of Asian Scientific Research

journal homepage: http://aessweb.com/journal-detail.php?id=5003

FAILURE ANALYSIS OF A FRACTURED CONNECTING ROD

M.N. Mohammed[1]
M.Z. Omar[2]
Zainuddin Sajuri[3]
A. Salah[4]
M.A. Abdelgnei[5]
M.S. Salleh[6]

ABSTRACT

In many cases, the major reason behind or causing catastrophic engine failure is the occurrence of the connecting-rod failure and sometimes, such a failure can be attributed to the broken connecting rod's shank especially when there is a probability of being pushed through the side of the crank-case, thereby making the engine irreparable. Thus, the major aim of the current work is to analyze the connecting rod failure. The study applied a finite element analysis and metallographic examination. Based on the findings, it was found that it is possible for each casting defect to develop depending on the cyclic loading behavior of the connecting rod into the start point for crack initiation before the occurrence of catastrophic failure.

Key Words: Connecting rod, Fatigue, FEM

INTRODUCTION

Conversion of the piston's reciprocating motion into the rotational motion of the crankshaft is the major function of the connecting rod. Since the connecting rod has two ends, one of its ends is connected to the piston by the piston pin, and the other end moves in a circular shape or revolves with the crankshaft and is separated in a way that it allows it to get clamped around the crankshaft

[1] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

[2] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

[3] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

[4] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

[5] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

[6] Department of Mechanical and Material Engineering Universiti Kebangsaan Malaysia, Malaysia.

(Mirehei 2008). Generally describing the connecting rods, they are produced by using casting or forging and materials such as steel, but it can be aluminum or titanium which is used for making up or producing them for high performance engines, or of ductile cast iron for low cost. Moreover, the connecting rod is occasionally made of pearlite ductile iron (nodular graphite cast iron), which is frequently used as a substitute of wrought or cast steel components (Roman2008 and Martin 2004).

During the operation of the engine, the connecting rod undergoes is prone to tensile, compression, and buckling loading. In many cases, the major reason behind or causing catastrophic engine failure is the occurrence of the connecting-rod failure and sometimes, such a failure can be attributed to the broken connecting rod's shank especially when there is a probability of being pushed through the side of the crank-case, thereby making the engine irreparable (Roman2008 and Whittaker).

However, specifically describing such a failure, it is important to point out at the different reasons for this failure such as fatigue near a physical defect in the rod, the overheating of the engine, cracking, lubrication failure in a bearing which is usually caused by inaccurate or faulty maintenance, failure of the rod bolts which is due to defect, improper tightening ,and re-use of already used (stressed) bolts where not recommended. Figure 1 shows the failure on connecting rod (Biancolini 2003 and Su Young 2006).

Despite the fact that such failures are frequently projected in televised competitive automobile events, their occurrence on production cars during normal daily driving is quiet rare. Therefore, the current work aimed to analyze the connecting rod failure by using visual &metallographic testing and finite element analysis method.

Fig-1. Failure on Connecting Rod

FAILURE ANALYSIS

Finite Element Analysis

Finite element method (FEM) is defined as a new method used for analyzing fatigue and estimating the component durability which is more advantageous than other techniques. By the finite element analysis method and the MSC Patran software, It is able to analyze the different car components from varied aspects such as fatigue and consequently save the time and the cost. The way that defined loadings was effective on the results achieved. So, they should fit as much as possible the real conditions. Stress concentration factors indicated the difference between the real and the working condition. Thus, by using this technique, it is possible to access the distribution of the stresses/strains over the entire component to obtain the accurate critical points by using MSC patran software. The deformation of the connected rod under tensing and compression loading is displayed in Figures 2&3 respectively. In suction stroke, it is indicated that it undergoes high tensile stresses cyclic load. From analysis, Von Mises stress is 1.97 E 3 N/mm3 = 1.97 E9 N/m3. Given Sy = 207E9 N/m3. safety factor. N = 207E9/1.97E9 = 105.1

Fig-2. The Von Misses stresses in tension loading of the connecting rod

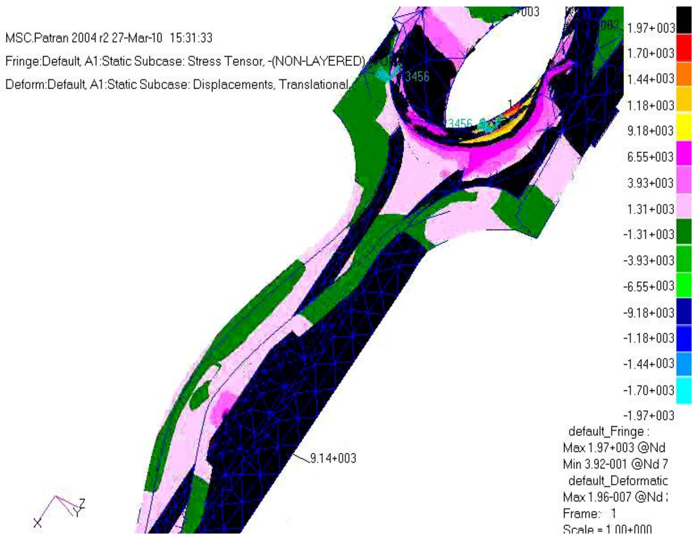
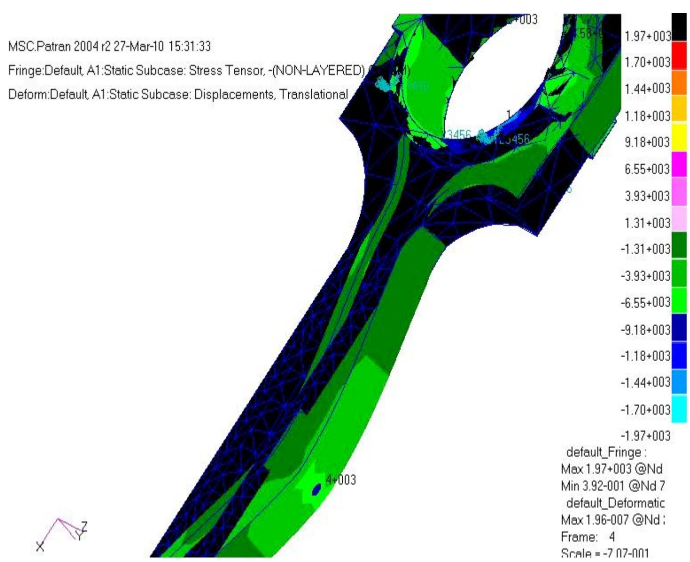


Fig-3. The Von Misses stresses in compressive loading of the connecting rod

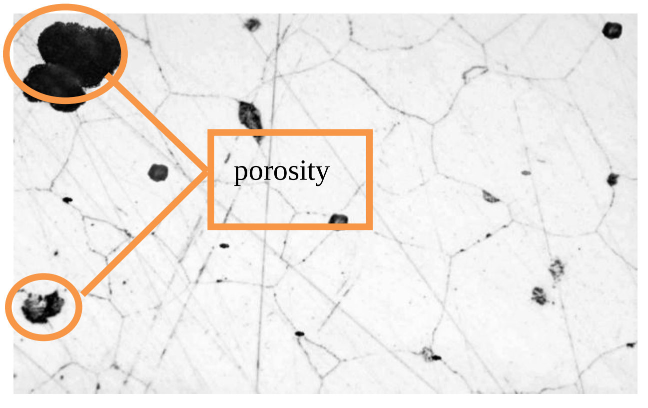


METALLOGRAPHY

The cross-section of the fractured surface is shown in Figure 4, and the rod's microstructure is shown in Figure 5. A section through the crack origin was adopted, mounted, polished and etched in 4% nital (Nitric acid 1-10ml + Ethanol 100ml) and 0.5% hydrofluoric acid in water. Microscopic examination in Figure 5 revealed a microstructure of a ductile iron specimen with little porosity

Fig-4. Fractured surface at the end of connecting rod

Fig-5. Metallographic of casting defect of the connecting rod



DISCUSSION

Based on the results obtained from analyzing the finite element, it can be noticed that the connecting rod subjected into diverse loads led to some deformation during the compression and power stroke. The results also revealed that there is a repetition of the loading with every crankshaft revolution, so this means that it supported the fatigue load. Due to this loading, each casting defect is potential to develop itself as the initial point for fatigue-crack initiation.

Each crack made the crack progress by one striation after an initial propagation and therefore, the rupture occurred at any critical crack size. Moreover, the striations of the fractured surface under consideration were not seen to be clear and reliable enough as to determine the initial point. Thus, based on the plastic straining marks that were detected and metallographic testing, it can be summed up that the occurrence of this fracture was due to tiny plastic deformation that preceded the crack opening, which finally, caused this fracture.

CONCLUSION

Based on the results of the experiments obtained by analyzing the finite element in the present study, it can be concluded that the occurrence of the connecting rod failure was due to the fatigue crack growth mechanism which came as a result of higher stress being combined with the porosity (manufacturing defect) in initiation and growth of a fatigue crack followed by catastrophic failure. Thus, it can be recommended that materials with good mechanical properties should be selected, and they should be free from manufacturing defects. Finally, lubrication engine system should be regularly checked, and all these are highly recommended to ensure long life connecting rod.

REFRENCES

Mirehei, A., Zadeh, M.H., Jafari, A. and Omid, M (2008) "Fatigue analysis of connecting rod of universal tractor through finite element method (ANSYS)" Journal of Agricultural Technology Vol.4, No.1, pp. 21-27.

Roman Celin, Boris Arzenek, Dimitrij Kmeti (2008) "A Metallographic Examination of a Fractured Connecting Rod" Professional article/Strokovni ~lanek MTAEC9, Vol. 42, No.2, pp.93.

Martin, G. G (2004) "Failure of Stationary Pump Engine piston" Journal Of Failure Analysis And Prevention, Volume Vol. 4, pp. 37-39

Whittaker D (2001) "The competition for automotive connecting rod markets" Metal Powder. Report, Vol. 56, No.5, pp. 32-37.

Biancolini M.E., Brutti C., Pennestrì E. and Valentini P.P (2003) "Dynamic, Mechanical Efficiency and Fatigue Analysis of the Double Cardan Homokinetic Joint" Int. J. of Vehicle Design. Vol. 33, No.1, pp. 47-65.

Su Young Lee, Seong Beom Lee, Heung Seob Kim, Tae-Gu Kim, Moon Gab Kam and Jung Whan Yoon (2006) "Failure Analysis of Connecting Rod at Big End" Key Engineering Materials, Vol.306 - 308