International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 06, June-2019

Metallurgical Analysis of Fractured Connecting Rod

Anil Madaan[a], B.L.Gupta[a]
[a] Govt. Engineering College Bharatpur (Raj.) 321001

***Abstract-* In automotive field the connecting rod is the main moving part and an important component of engine. The basic function of connecting rod is to transmit the push and pull forces from piston pin to the crank pin. The connecting rod transmits the reciprocation motion of piston to the rotary motion of crank shaft. A failure investigation has been conducted on four stroke engine connecting rod. The fracture occurred at the big end of the connecting rod. Visual and scanning electron microscopy observations show that a lot of axial grooves appear on the internal surface close to the fracture and the fatigue cracks initiated from the axial grooves. It also indicates that the multiple-origin fatigue fracture is the dominant failure mechanism.**

1. INTRODUCTION

The connecting rod does the important task of converting reciprocating motion of piston into rotary motion of crankshaft. Connecting rod has three main pats. The piston pin end, the center shank and the big end. The piston pin end is the small end, the crank end is the big end and the center shank is of I-cross section. Connecting rod is acted upon by gas loads and inertial loads during its operation. The magnitude of inertia forces is constant but gas forces are varying in nature. Due to fluctuating nature of these forces the chances of connecting rod failure because of fatigue are high.The connecting rod of an IC engine is made by the drop forging process and the outer surface is left unfinished. The material used for the connecting rod are either medium carbon steels or alloy steels. The alloy steels include nickel chromium or chromium molybdenum steels used for connecting rod of automobile and aero engine

This paper describes the observation on the internal surface of the failed connecting rod, the crack initiation process, and the fractographic study. The possible reasons for failure were assessed.

2. LITERATURE FINDINGS

M.N. Mohammed, M.Z. Omar et al (2011) studied that connecting rod failure was due to the fatigue crack growth mechanism which came as a result of higher stress being combined with porosity (manufacturing defect) in initiation and growth of a fatigue crack followed by catastrophic failure. Ziya AKSOY et al (2012) found through SEM observation that fracture is cleavage, brittle, and intergranular, fine pearlite grains were observed. Saharash Khare, O.P. Singh et al (2012) results shows high interfacial pressure and stresses near the junction of web and flange of the connecting rod, also it was found that high wear at the interface of crank pin, roller bearings and big end surfaces was the main culprit of noise and vibration in IC engine.

3. ANALYSIS

The fracture analysis of the connecting rod was done by visual inspection and SEM. SEM observation has been taken using Scanning Transmission Electron Microscope (SEM) Model JSM6100 (Jeol) with Image Analyser.

4. VISUAL INSPECTION

The failed connecting rod of Hyundai is shown in Fig . It is found that the fracture had taken place on the transition region between big end and the connecting rod shank. Beach marks typical of fatigue crack propagation are present . According to the curvature of the beach marks, the fatigue origin and the fatigue propagation direction were determined.The area of the fatigue crack propagation from the cracks that initiated at the internal surface is larger than that of the fatigue crack propagation where the crack initiated from the external surface.

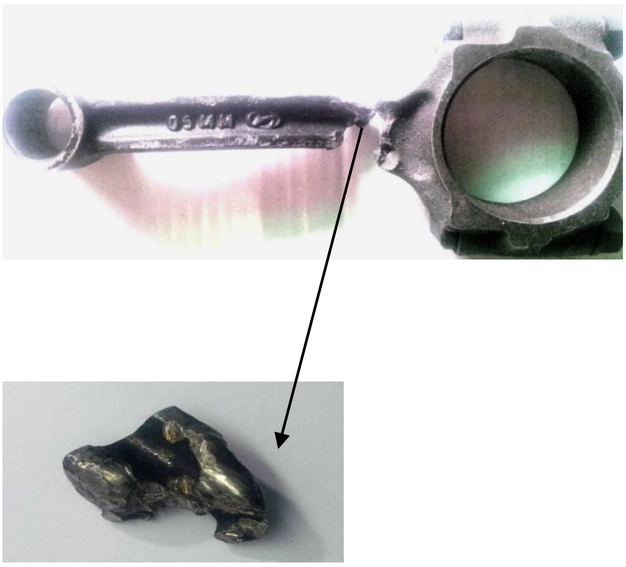

Fig.1 Fractured Connecting Rod and Specimen according to SEM tool Holder

5. SCANNING ELECTRON MICROSCOPE

SEM produces images of sample by scanning it with the help of beam of focused electrons. After that electron interacts with atom in sample which produces various signals that can be detected and which contains information about sample`s surface topography and composition. And SEM can achieve better resolution than 1 nanometer. The highly common SEM mode is detection of the secondary electrons which are emitted by atoms excited by the electron beam. The number of secondary electrons which are to be detected depends upon the angle at which beam meets surface of specimen, i.e. on specimen topography.

By scanning the sample and collecting the secondary electrons with a special detector with an image displaying the topography of the surface is created. The Scanning Electron Microscope (SEM) consists of an energetically well-defined and highly focused beam of electrons scanned across a sample. The microscope also uses a LaB6 source and is pumped using turbo and ion pumps to maintain the highest possible vacuum. Images at various resolution are taken to study the defects properly.

Fig 2: JEOL SEM Model JSM6100

6. EXPERIMENTAL PROCEDURE

A failed connecting rod has been from the workshop and a piece have been taken out from the failed area of camshaft. After that piece has been converted into specimen for undergoing SEM in the dimension of 14mm x 7mm. The operating environment of a standard scanning electron microscope dictates that specialist preparation techniques are used.

7. RESULTS AND DISCUSSION

The images found through SEM in the present observation are shown next

7.1 Casting Defects

Gas porosity is the formation of bubbles within the casting after it has cooled. This occurs because most liquid materials can hold a large amount of dissolved gas, but the solid form of the same material cannot, so the gas forms bubbles within the material as it cools. Gas porosity may present itself on the surface of the casting as porosity or the pore may be trapped inside the metal, which reduces strength in that vicinity. Nitrogen, oxygen and hydrogen are the most encountered gases in cases of gas porosity.

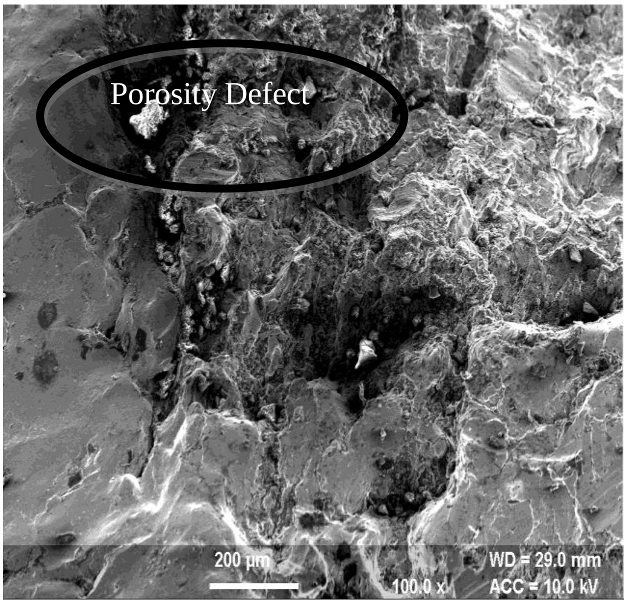

Fig 3: Image was taken at an manufacturing range of 100x

7.2 Brittle Fracture

Beach marks or fatigue striations typical of fatigue crack propagation morphology were observed on fractures. It is showing casting defects i.e. gas porosity, dendritic shrinkage and accumulated inclusion, together with initiated crack. The characterstics of this shows that fracture is a brittle fracture-granular fracture (also cleavage fracture).

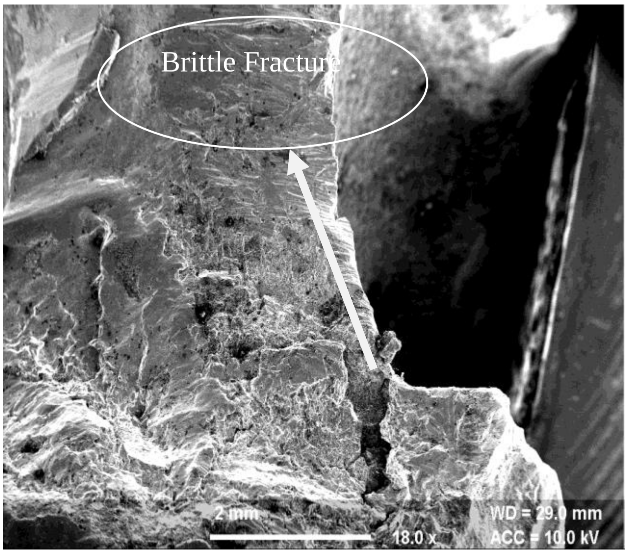

FIG4 .Image was taken at an manufacturing range of 100x

7.3 Impure surfaces at higher magnification

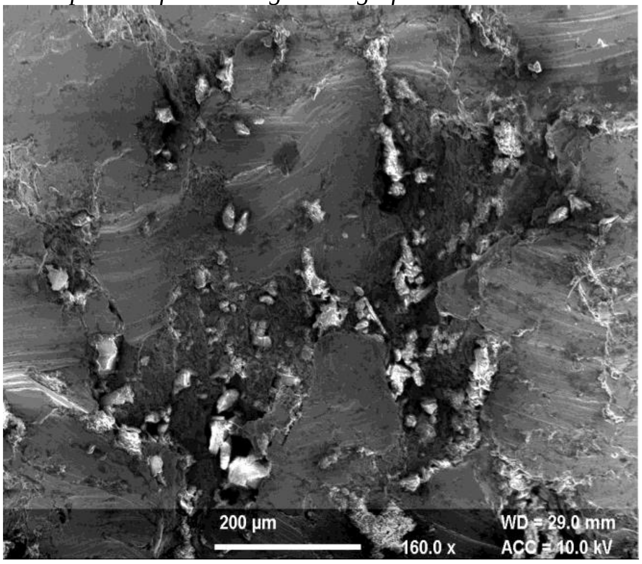

Fig 5: The image was taken at a magnification of 160x. to see the impure surface. White like crystals like material is impurity

8. CONCLUSION

Fracture took place on the small head of the connecting rod. Multiple-origin fatigue fracture is the dominant failure mechanism of the fractured connecting rod. • A lot of axial grooves appeared on the internal surface of the small head of the failed connecting rod, which are related to the machining or assembling process. The fatigue cracks initiated from the axial grooves by the alternative load so that the multiple origin fatigue fracture took place on the connecting rod. Failure of connecting rod may lead to failure of other components and can cause harm while in use. Finally connecting rod should be designed with high reliability. It must be capable of transmitting axial tension and compression and bending stresses caused by thrust and pull on the piston and by centrifugal force without bending or twisting. So the homogeneous and continuous structure is a desired factor for connecting rod.

9. REFERENCES

[1] M.N. Mohammed,M.Z. Omar, Zainuddin Sajuri A. Salah, M.A. Abdelgnei ,M.S. Salleollh Failure analysis of a fractured connecting rod" Journal of Asian Scientific Research 2(11):737-741

[2] Ziya AKSOY, Zafer OZDEMIR, Tekin OZDEMIR, " A metallographic examination of fracture splitting C70S6 steel used in connecting rods" Fen Bilimleri Dergisi, 24(2)(2012) 45-58.

[3] Cristy V Vazhappilly, P. Sathiamurthi, " Stress analysis of a connecting rod for weight reduction" Intenational Journal of Scientific and Research Publication, volume 3, Issue2, February2013, ISSN 2250-3153

[4] Saharash Khare, O.P. Singh, K. Bapanna Dora, C. Sasun, " Spalling investigation of connecting rod" ELSEVIER, Enineering Failure Analysis 19(2012) 77-86

[5] Bin Zheng, Yongqi Liu and Ruixiang Liu, " Stress and fatigue of connecting rod in light vehicle engine" The open Mechanical Engineering Journal, 2013,7,14-17.

[6] 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.

[7] R.K. Pandey, "Failure of diesel-engine crankshafts" Science Direct, Engineering Failure Analysis 10(2003) 165-175

[8] Xiao Lei Xu and Zhi Wei Yu, "Failure Analysis of a Diesel Engine Connecting Rod" J Fail. Anal. and Preven. (2007) 7:316–320 DOI 10.1007/s11668-007-9058-9

[9] Vivek. C. Pathade, Bhumeshwar Patle and Ajay N. Ingale, "Stress Analysis of I.C.Engine Connecting Rod by FEM" International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 3, March 2012

[10] Osman Asi, "Failure Analysis of a Crankshaft made from ductile cast iron" Science Direct, Engineering Failure Analysis 13 (2006) 1260-1267