Crack Detection Location of Mechanical System Using Frequency Response Function

C.J. Kim[1*], I.P. Kang[1], B.T. Kim[1], S.J.. Kim[1] and J.H.Shon[1]

[1]Department of Mechanical Design Engineering, Pukyong National University, Busan, South Korea

[*]Corresponding author: cjkim@pknu.ac.kr

1. Introduction

Mechanical system is manufactured under several manufacturing process and it is possible to have cracks on responsible system during these process. Some cracks are visible to identify it even with visual inspection but micro-level cracks should be conducted to inspect it with non-detection techniques. The selection of non-detection method is subjected to the nature of responsible material as well as crack initiation and several candidate technology can be possible apply it, such as sensing of eddy current, x-lay based vision or others. One of critical factor to affect the selection of efficient method is the length of crack and more effort should be devoted on the identification of crack if the crack length is limited into micro-levels [1-2].

Cold forging process one of major shaping process to make a form from non-mature materials under high pressure condition and crack initiations are difficult to prevent it during process. Rather it is practically acceptable to control the length of crack within the required level from customers and the eddy current sensor-based non-detection inspection have been widely used in industry owing to the fast inspection time as well as the low cost facility as compare to other inspection ones. However, the resolution regarding the eddy current sensor is more than 100-200 micro meter of crack length and the specific capacity is dependent on the nature of material and the quality of surface.

The allowable length of crack becomes strict by customers because the reliability on the cracked mechanical component is inversely proportional to the length of crack and the working inspection method with the eddy current sensor does not satisfy the updating experimental consequences. The current length of crack is more than 150~200 micro meter and these requirement fall within the inspection resolution with eddy current sensor, however, the revised limitation will be less than 100 micro meter in near future. So, new inspection method is proposed with impact testing using impact hammer. The basic idea was derived from the sensitivity of resonance frequency over cracked length and it was observed that the bifurcation of resonance frequency appears according to the crack length's increase [3-4]. The resolution of inspection method with impact testing can be minimized up to 50 micro meter in specimen test with crack.

In this paper, the influence of response location was studied for cracked system by using impact testing and the compared test results of coherence functions in resonance frequency. If the influence factor derived from the response location is considerable in the crack length inspection, the proposed non-detection test with impact hammer may spoil its reliability since the position of crack at the target system is randomly changed according to the condition of the cold forging process. The target system was chosen with cracked bevel gear used in a ground vehicle and frequency response function was compared for different sensing locations.

Acknowledgment

This work was sponsored by National Research Foundation of Korea (Grant No. 2017R1D1A1B03034510).

References

[1] R. I. Stephens, A. Fatemi, R. R. Stephens, H. O. Fuchs, Metal Fatigue in Engineering(2nd Ed.), Singapore, John Willey &Sons, 2001.

[2] Y. L. Lee, M. E. Barkey, H. T. Kang, Metal Fatigue Analysis Handbook, Tokyo, Elsevier, 2012.

[3] C.J. Kim, I.P. Kang, J.H. Sohn, Micro crack detection of mechanical part using coherence function near resonance frequency, 8th International Conference on Engineering Failure Analysis, P.39, 2018.

[4] C.J. Kim, Crack inspection device and crack inspection method using the same, 10-2017-0165182(Korea patent application no.), 2017