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An Efficient Method for Précised Evaluation of Defect Features Using Eddy Current Technique

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1. Introduction

Rail road networks are subjected to frequent cyclic contact between rails and wheels. The increasing traffic across the country, rapid growth in speed and undeniably crying heavier axel loads than ever before causing the degradation of mechanical properties of the rails. Like many other metallic components, rail road also prone to metal fatigue due to cyclic loading and it can lead to partial or complete failure [1] if not addressed earlier. Précised measurement of the critical defects sizing such as surface cracks length, pattern and depth due to rolling contact fatigue or persisted stress concentration [2,3] is of more important to impose an effective maintenance strategies for rail road monitoring.

Amongst the several methods [4-6] eddy current technique caught the attention of researcher owing to its specific advantages such as simple, easy to use, robustness and cost effective compared to other techniques. Concurrently, vast research has been already established in the recent past to detect and define defects [7]. Earlier, defining the defects features using statistical techniques took ECT to next level in the nondestructive testing industry. In the present study, we proposed a simple yet an effective technique based on the zero mean normalization method to efficiently define the size of defects using eddy current signals with less efforts. A reliable ECT system including a plus-point probe was developed earlier, and the experiments were conducted on a thick magnetic steel plate (S45C) machined with two kinds of defects, changing depths and varying lengths keeping depth constant. Comparative study of defect length evaluation for the case of changing depth keeping length constant indicates that the new method shows less deviation while measuring the defect length compared to conventional method. The standard deviation in length estimation was 0.54772 whereas for conventional method it is 4.5978 which shows better performance.

2. Experimental Method

A simple ECT system composed of a function generator, ECT probe and a DAQ device to record the data was already established earlier. The ECT probe was fixed to scanner and it can be controlled by the Application developed in Lab VIEW environment. Two kinds of defects with changing lengths 2, 4, 6, 8,10mm keeping width and depth 0.17mm and 3mm respectively. Similarly, second class of defects with changing depth in 5 steps from 1mm to 5mm keeping the length 6mm and depth 3mm. Probe fixed to the scanner travel through the defect length at a constant speed controlled by Lab view program and records the data throughout the traversal.

3. Results and Discussion

A simple plus point sensor was used for this experiment. the working principle and detection phenomenon is based on the balancing and unbalancing of ac bridge. ECT signal measured after calibrations typically shows a peak similar to Gaussian pulse corresponding to each defect, 5 defects were scanned at a constant scanning speed. Since the scanning direction is along the length of the defect, the pulse width changes according to the defect length. In this study the focus is to evaluate the defect length, figure 2 shows the post processed signal using the proposed technique where a tangent parallel to the magnitude at each encounter of the Gaussian pulse i.e., at each extreme points of the pulse, a tangent will be aligned and it gives the width of the pulse such that defect length.

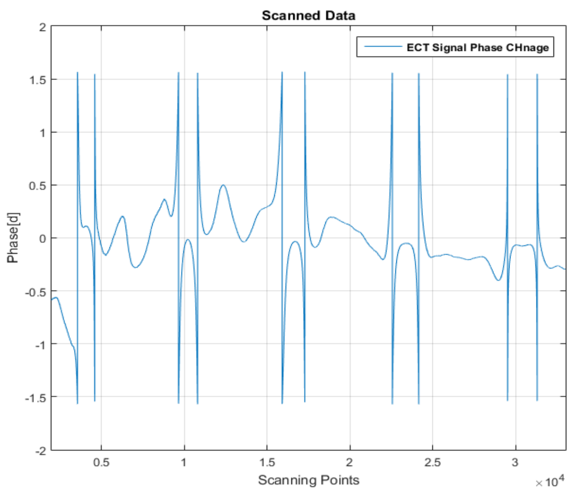

Fig.1 ECT signal from defects with varying defect length after processing using model

Figure1 and 2 shows the post processed signals of the scanned data obtained from changing defect depth and length respectively. It is clear that the distance between pair of tangents is approximately equal where the depth only changes, on the other hand the, it slowly increases as the length is increasing.

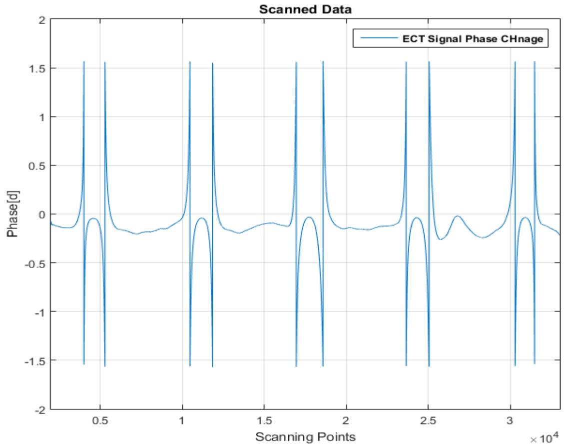

Fig.2 ECT signal from defects with varying defect depth after processing using model

During the calculation, a conventional method of full wave half width (FWHW), a generic method was used to calculate the pulse features, and proposed method was implemented on same set of data i.e., changing defect depth with fixed length to extract the pulse features. The error margin or standard deviation calculated in both the cases as represented in figure 3.

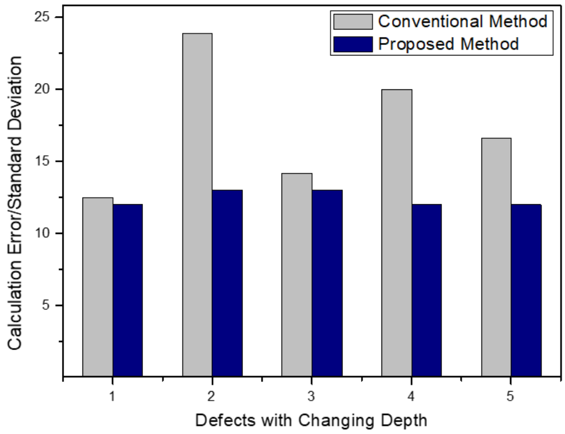

Fig.2 ECT signal from defects with varying defect depth after processing using model

Figure 3 shows the error margin at each defect from both the methods while calculating the defect length with changing depth. Since the length remains same in all cases, the error rate seems almost similar in proposed method where as in conventional method the deviation is more and repeatability is missing. From this instance we can strongly say that the new method has the potential to define the defect length at high precision. Moreover this is a simple approach to implement. Further studies are in row to define more discrete features of defects with the aim of finding defect depth and pattern using this technique and to bringout a comparative study of these techniques.

4. Conclusion

With the aim of defining defect lengths more accurately, the experiments were conducted on a mild carbon steel plate with two kinds of defects. Defect length was estimated from the recorded ECT signals using the method proposed. The error rate was greatly reduced and this method shows potential to evaluate defect length more accurately.

Acknowledgment

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