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ICFPD method application for crack initiation determination for Charpy size 3-point bend specimens

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1 Introduction

Fracture mechanics has attained a great attention in establishing ultimate load limitations and assessing the integrity for a large number of engineering structures of multifarious types. Fracture mechanics based integrity assessment procedure of components requires fracture toughness properties of the materials that have to be independent of the geometry and the size of the component or the specimen. This prerequisite of transferability must be satisfied, as the component to be assessed usually differs in size and geometry from the small scale specimens that are used for testing according to the test standards [1, 2]. As a material characteristic, the physical crack initiation point can be considered, but its determination is complicated.

New Induced Current Focused Potential Drop (ICFPD) method development for the J_i determination for Single Edge Notched Bend specimens (SENB) of Charpy size is presented in this paper. The results obtained with the ICFPD method are compared with the SZW based results.

2 Principles of Induced Current Focusing Potential Drop Method

Induced Current Focusing Potential Drop Method (ICFPD) is a variant of ACPD method. It differs mainly from a conventional current potential drop in that, that the ICFPD technique takes advantages of electromagnetic induction to provide a specimen with an alternating current, while for a conventional ACPD technique, the alternating current is directly supplied to the specimen through current terminals.

The use of an induced current can focus a current in the vicinity of the induction wire and that characteristic of the induction current technique results in the advantages of the ICFPD technique compared to a conventional ACPD technique both in sensitivity and in availability, as described below:

- Current can be focused at desired local area.
- A big electrical source is not necessary regardless of the specimen size.
- Measurement work is quicker and easier because there is no need to have current terminals.

The ICFPD method is used for the non-destructive testing for the surface and near surface crack detection in components at present. It was found by the authors [3] that the ICFPD method provides higher accuracy then conventional ACPD method for the crack size prediction. In the presented study is this method modified for the desired application.

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3 Testing

Tests were performed on MTS 250 kN servo-hydraulic testing system. As ACPD measuring device Matelect CGM5 was used. The device supplies stable current up to 2A with frequencies within the range 0.1-100 kHz. It also measures the potential drop on the specimen. The data were fed from DCGM4 into MTS controller and the data were acquired together with measured force and displacement values. Example of the record obtained is shown in the Fig. 1.

As an reference method for the crack initiation determination Stretch Zone Width method (SZW) was used. The initiation value of the J-integral is determined from the measured J-R curve obtained with the use of the Unloading Compliance (UC) technique. The UC measurement was done automatically by the MTS Fracture toughness application.

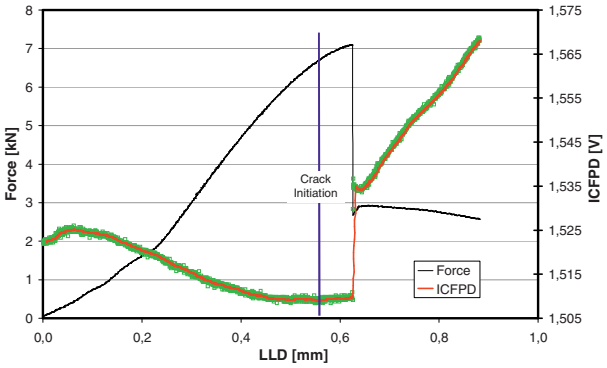

Figure1. Verification of the ICFPD method performance for the crack initiation determination.

4 Conclusions

The paper deals with the development and the performance check of the Induced Current Focused Potential Drop method for the crack initiation determination for single edge notched bend specimens of Charpy size with stable subcritical crack extension. The method was developed and suitable testing parameters were found. It was proven that the method is able to detect the crack initiation event. On the basis of the crack initiation point detection initiation J_i integrals were determined and compared with the J_i values obtained with the Stretch Zone Width based method that is considered as a reference. The J_i values obtained with the ICFPD method were noticeably higher than the SZW based results. The analyze of the test revealed that this difference is caused by deformation of the specimen insulators. When these factors were taken into account and the results were reconsidered, very good agreement between both methods was found. For more precise ICFPD method assessment are necessary additional tests with modified electric.

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