Plasticity and damage characteristic of acoustic emission signals for S460 steel exposed to tensile load

Cheng, L.; Xin, H.; Groves, R.M.; Veljkovic, M.

Publication date
2020

Document Version
Final published version

Citation (APA)
Cheng, L., Xin, H., Groves, R. M., & Veljkovic, M. (2020). *Plasticity and damage characteristic of acoustic emission signals for S460 steel exposed to tensile load*. Abstract from Virtual conference on mechanical fatigue.

Plasticity and damage characteristic of acoustic emission signals for S460 steel exposed to tensile load

L. Cheng[a*], H. Xin[a], R. M. Groves[b], M. Veljkovic[a]

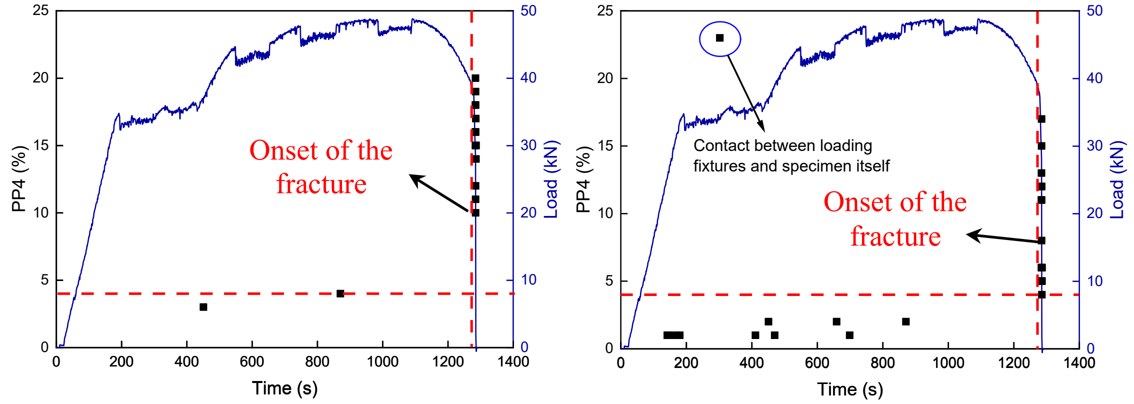
[a]*Faculty of Civil Engineering and Geosciences, Delft University of Technology, Netherlands*
[b]*Aerospace Non-Destructive Testing Laboratory, Faculty of Aerospace Engineering, Delft University of Technology, Netherlands*
**Corresponding author: l.cheng-2@tudelft.nl*

Keywords: Acoustic emission; Spectral analysis; Digital image correlation.

ABSTRACT

S460 steel is increasingly used in civil engineering, especially in a harsh environment such as offshore structures [1]. Material damage is inevitable for structures subjected to static and dynamic loads during their technical life time. Thus, monitoring material damage is important for providing information regarding critical damage of in-service structures. Non-destructive testing (NDT) techniques have been widely used for damage detection in recent years. Acoustic emission (AE), one of the efficient NDT techniques, can identify material damage based on the rapid release of strain energy as bursts of transient elastic waves. Previous research showed that the AE technique is sensitive and reliable in the detection of the material damage [2,3]. Specifically, AE signals contain information on a number of damage factors, such as material types, plasticity level, loading conditions and microdefects [4].

This paper focuses on the application of the AE technique to identify the tensile deformation of S460 steel. Tensile coupon tests were performed until final fracture with AE monitoring using two VS600-Z2 sensors. As experimentally supportive methods for AE interpretation, specimen elongation measurement and Digital image correlation (DIC) measurement of the surface displacement were used. Spectral analysis was carried out as the frequency spectrum of AE signals is a more reliable description of AE sources [5]. The onset time of a crack is identified from the power spectrum intensity of the AE bursts, see Fig. 1. PP4 is the percentage of power of each AE signals from 700 kHz to 1200 kHz as mathematically expressed by Eq. (1). It indicates that the AE technique is able to distinguish plasticity and damage of S460 material. The results will form the basis of a future fatigue damage assessment of in-service critical structure components.



(a) sensor 1 (b) sensor 2

Fig. 1. Applied loading profile correlated with a scatter plot of PP4 values of AE signals recorded during test

$$PP4 = \int_{700}^{1200} U^{2}(f)df \,/\, \int_{0}^{1200\text{kHz}} U^{2}(f)df \qquad (1)$$

REFERENCES

[1] Versaillot, P. D. Effects of cyclic loading on the mechanical properties of steel. Universitatea Politehnica Timisoara, Romania (2017).

[2] Chen, H. L. R., Choi, J. H. Acoustic emission study of fatigue cracks in materials used for AVLB. Journal of Nondestructive Evaluation 23(4), 133-151 (2004).

[3] Johnson, M. Waveform based clustering and classification of AE transients in composite laminates using principal component analysis. Ndt & e International 35(6), 367-376 (2002).

[4] Haneef, T., Lahiri, B. B., Bagavathiappan, S., Mukhopadhyay, C. K., Philip, J., Rao, B. P. C., Jayakumar, T. Study of the tensile behavior of AISI type 316 stainless steel using acoustic emission and infrared thermography techniques. Journal of Materials Research and Technology 4(3), 241-253 (2015).

[5] Wirtz, S. F., Beganovic, N., Söffker, D. Investigation of damage detectability in composites using frequency-based classification of Acoustic Emission measurements. Structural Health Monitoring 18(4), 1207-1218 (2019).