Experimental Validation of the Acoustic Emission (AE) Method for the Cracking Process Determination and Location in Concrete Elements

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Summary

Verification of the acoustic emission method (AE), by the identification and analysis of active damage processes (IADP – identification of active damage processes), is presented in the paper. Experiments were carried out on concrete beams subjected to continuous loading, up to failure load. It was found that using this method, it was possible to detect and locate creation of cracks. It was even possible to recognise creation of cracks due to shear and bending .

Keywords: reinforced concrete, damage process, cracks identification and location, acoustic emission

1. Introduction

Diagnostic methods based on measurements of acoustic emissions have been intensively developed over recent years. That results from the advantages those methods offer, namely

- global character, i.e. possibility of testing the whole structure,
- rendering real loads, i.e. recording only active damages,

and also from advancements in devices and software which is capable of processing a large number of results.

One of them, the IADP method, is based on an observation that active destructive processes becomes a source of acoustic emission characterized by the parameters of the recorded signal, which make it possible to classify the signals and constitute the reference databases. Such the data base was created for growth of cracks due to shear and bending.

By measuring AE signals generated within structures under load and applying the model database, one can identify and locate the processes of active damage occurring in a tested element.

2. Experimental tests

Experimental tests were conducted on reinforced concrete beams with rectangular cross-section dimensions of 0,12× 0,30 m and a span of 3,0 m. It was a four point bending test where the beam was supported on two spherical bearings (one of which was sliding bearing; with plate dimensions 0,36×0,36 m) and loaded with two equal forces using hydraulic actuators. Actuators, between which the distance was 1,8 m, were also supported on spherical bearings and acting on the beam through fine rubber pads applied only to prevent acoustic emission noise. Load was applied monotonically, increasing until failure load with constant velocity 0,4 kN/min (Fig.1).

Concrete deformation on the lateral surfaces of the beams (with the use of a 3D optical scanner) and AE signals accompanying destructive processes were recorded. AE signals were

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then elaborated, growth of cracks due to bending was identified and localised, and compared with 3D optical scanner data (Fig.2) showing fairly good correlation.

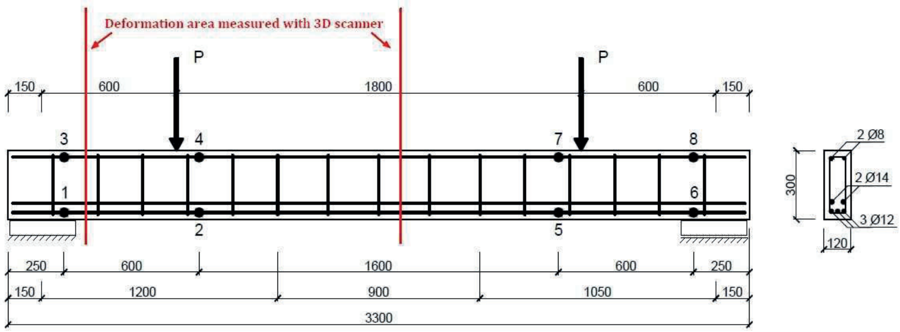

Fig. 1: Diagram of the loading of reinforced concrete beam, with spaced sensors (1-8) and marked deformation area measured with 3D optical scanner

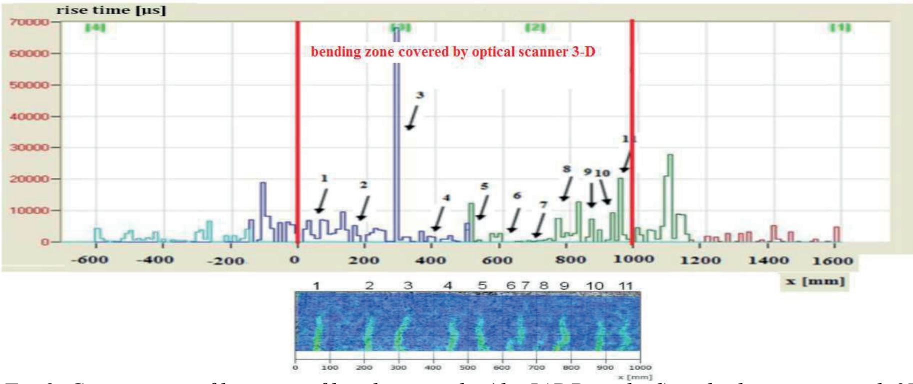

Fig.2. Comparison of location of bending cracks (the IADP method) with observation with 3D optical scanner.

3. Conclusions

It was found that:

- the IADP method can be applied to reinforced concrete (non-prestressed) members,
- it is possible to establish reference signal databases, where the process crack growth can be divided into two signal Classes corresponding to crack development due to shear and bending. Thus, the analysis of acoustic signals generated by a loading indicates not only the formation and propagation of cracks, but also provides information on what kind of cracks they are,
- it is possible to locate the process of crack growth.

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