CRACKS PROGRESSION MONITORING IN FIBRE REINFORCED CONCRETE

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Abstract

The contribution deals with cracks progression monitoring in bended fibre reinforced concrete elements either by deformations measuring or by measuring of ultrasonic waves propagation speed including magnitude change evaluation of this waves.
It is possible to illustratively show the fibre reinforced concrete behaviour within every stage of the test with „B – scan“ – the ultrasonic tracing method, especially at the moment of cracks appearance. This tracing method also allows obtaining interesting information about activation of fibres scattered in profile and concrete failures rate.

Keywords: fibre reinforced concrete, bending strength, ultrasonic waves, deformation, crack**.**

1 Introduction

Testing method for monitoring of fibre reinforced concrete traverses behaviour within cracks' appearance area was modified according to procedure described in ČSN 73 6174 – Assessment of elastic modulus and deformability of concrete from the bending strength test results. The method is based on measurements of deflection of tested traverse exposed to flexural stress by two loads situated in thirds of its length.
Ultrasonic wave measurement is based on monitoring of ultrasonic wave impulses going through sample from transmitter to receiver. Signals which are coming in different time are assigned by colours according to the signal's intensity. Changes in the material structure cause signal strength decrease which is shown by the change of colour scheme.

2 Cracks progression monitoring in fibre reinforced concrete

2.1 Procedure of bending strain test on fibre reinforced concrete traverse

The test might be split into two parts. The procedure follows standard ČSN 73 6174 until a crack appears. The load is continuously increased by individual steps which are equal to approximately a tenth of estimated value of the force which corresponds to a bending strength. The regeneration by decreasing the load down to a value of the force applied in the first loading cycle has to be done after each cycle. The basic load depends on a type of

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concrete and proportions of samples. It is possible to calculate modulus of elasticity and deformability of concrete by measured elasticity and overall deformations for each loading step. This can provide the view of concrete deformation behaviour within different tension levels. The second phase begins after the crack origin. The strain from the first phase continuous further on until the value of the load which corresponds to required deflection is found. The traverse deflection measurement is supplied by ultrasonic measurement with graphic output in both phases.

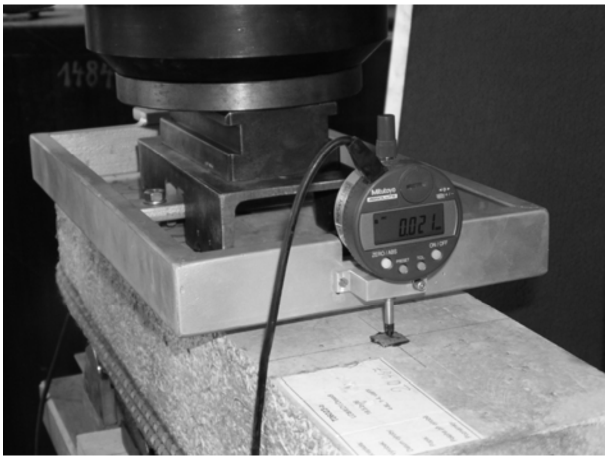

Fig 1 Frame for the traverse deflection measurement

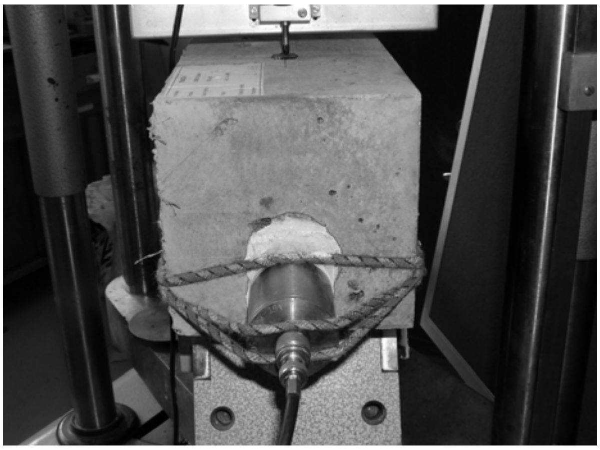

Fig 2 Ultrasonic sound in traverse's front

2.2 Principle of „B – scan“ – the ultrasonic tracing method for cracks progression monitoring

The basic principle of B – scan evaluation is the fact that the maximum magnitudes of received signal have red colour in this graphic output (this corresponds to the factory settings of B – scan viewing by CONCRETEST 2000 the software). If the signal is growing weaker therefore the magnitude decreases the red colour will be continuously changed by the rainbow scheme.
The percentage of red colour contained in B – scan graphic output is easy to find out due to the RGB break up principle (because most of the colours can be expressed by three basic colours – red, green, blue). The highest signal intensity corresponds to the colour level R255, G0, B0. This function is common in most of the graphic software (Photoshop, Corel, etc.). It is important to realise that white colour is created by a composition of red, green and blue colour with the highest intensity level in the RGB spectrum. Therefore, the white percentage part must be taken of the red percentage part. Amount of the red colour shows the amount of the maximum magnitude at appropriate time period

2.3 Unreinforced concrete testing

The loading process of unreinforced concrete traverse by the super and sub loading cycles is shown in the following figures. Fig. 3 shows the typical B-scan with received signal intensities regularly alternating during the test. There is a B-scan evaluation by the red colour level on Fig. 5. Shorter time cycles for reading the intensity of red colour were used for evaluation of two last load levels. The reason was accuracy increasing of the unreinforced concrete sample behaviours monitoring just before failure appearance. It is evident that the material structure of the sample is non-reversibly changed when the load is 27 kN. This was also confirmed by deformation measurement (Fig. 4).

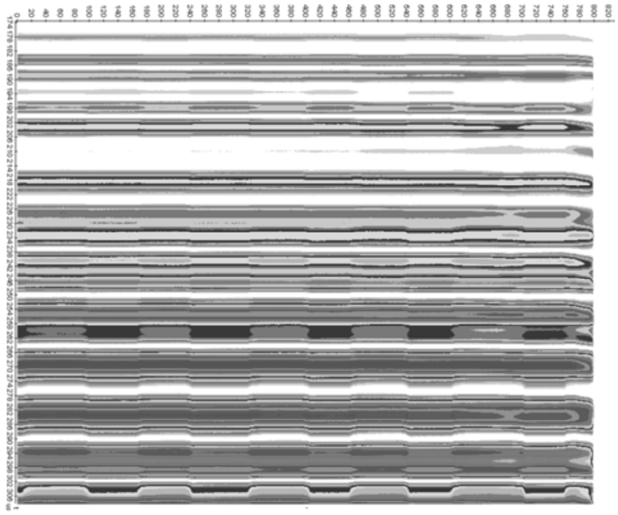

Fig. 3 B – Scan unreinforced concrete sample

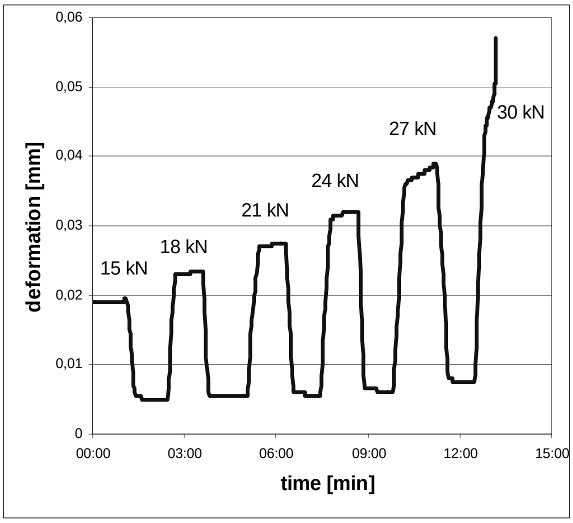

Fig. 4 Deformation process of unreinforced concrete sample during loading testing

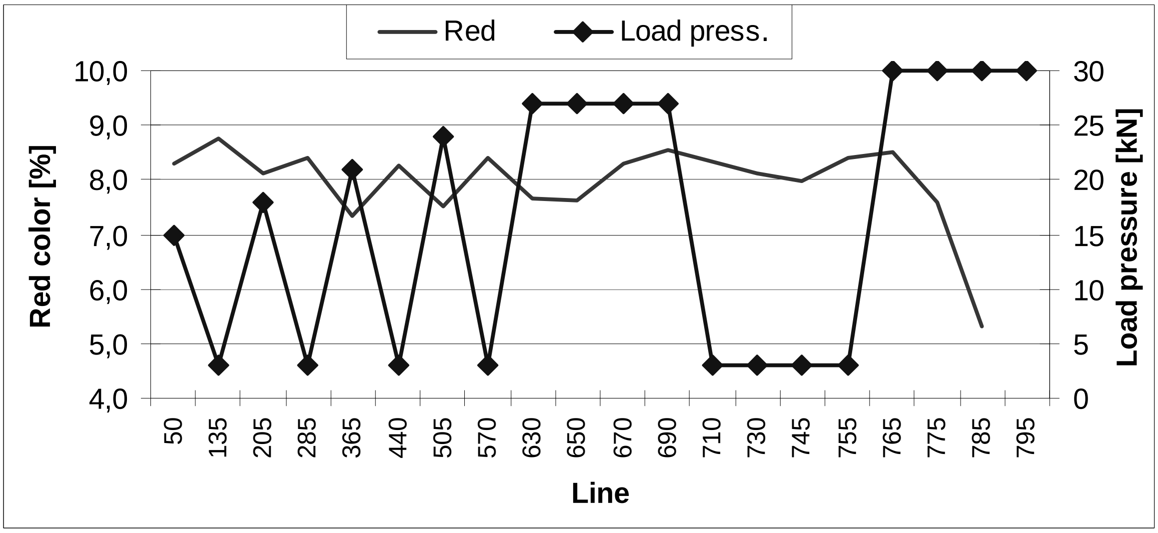

Fig. 5 Appearance of red colour in B – scan during the loading testing

2.4 Wire reinforced concrete testing

A B – scan record of wire reinforced concrete sample testing is shown in Fig. 6 and the evaluation of B – scan red colour intensity is in Fig. 7. The crack is generated while the load is 45 kN, then the intensity of red colour sharply decreases. The crack closes while the load is grown down in the same time the ultrasonic signal increases.

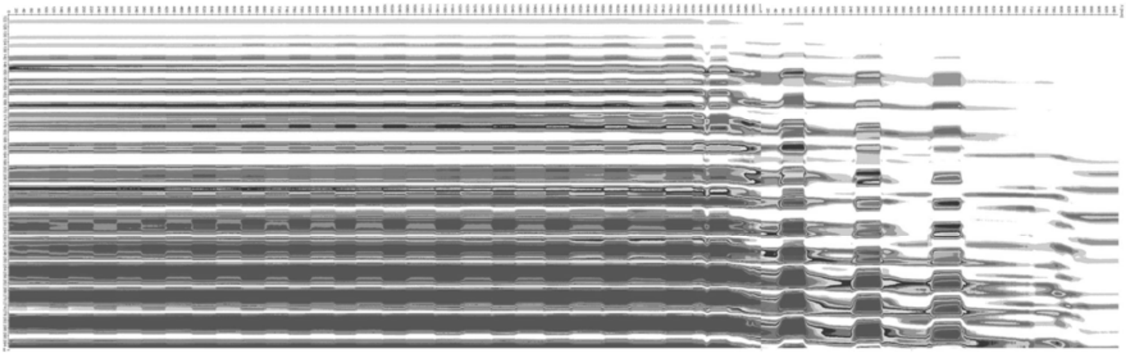

Fig. 6 B – scan output of wire reinforced concrete sample testing process

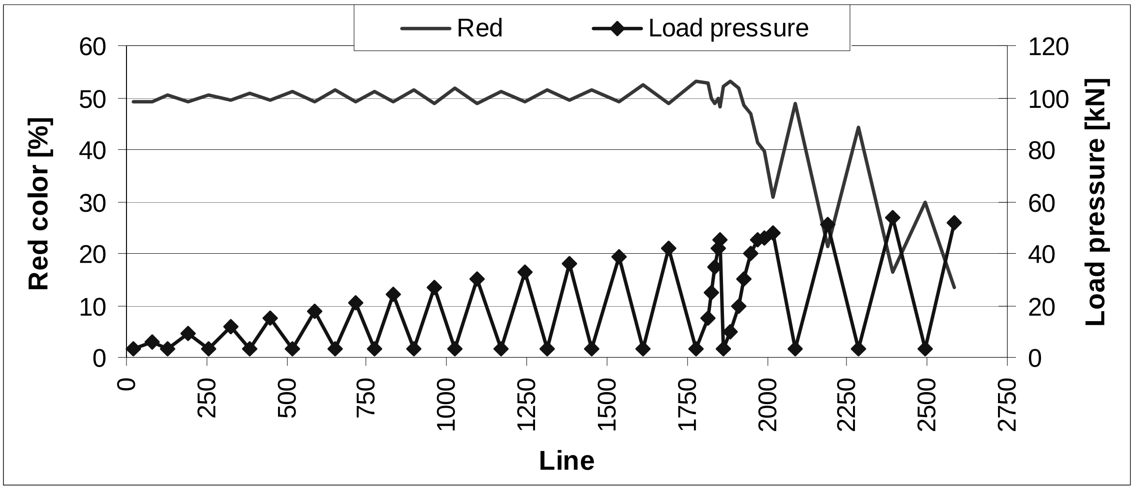

Fig. 7 Appearance of red colour in B – scan during the wire reinforced concrete loading testing

3 Conclusions

The previous examples of ultrasonic B – scan graphic output analysis of samples loaded by bending provide better identification of changes in those material structures especially in connection with cracks and micro cracks generation and progress. Described method of ultrasonic wave signal it is possible to use also for analysing unreinforced composite materials. Despite of it the method gives much better results while the composites with scattered reinforcement are analysed. In this case the material strength seemingly increases but this growth is caused by the activation of scattered fibres.

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References

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