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APPLICATION OF ACOUSTIC EMISSION METHOD DURING SETTING AND HARDENING CONCRETE IN TIMBER AND METAL MOULD

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Abstract
Concrete is a composite materials consisting of five basic components – cement (usually), water, additions, admixtures and aggregates different fractions. Hydration process starts after mixing cement and water. Chemical, mechanical and electrical properties are continuously changed during the process. Application of the Acoustic Emission Method at setting and hardening concrete samples are described in this article. The samples setting have made solidification in the wood and metal mould, for the assessment of the effect of material moulds on the number and nature of acoustic events.

Key words: *concrete, acoustic emission, mould, timber, metal*

1. Introduction

The setting and hardening process of concrete can be considered as the most critical time period during the life of a concrete structure. To assure high quality and avoid problems in performance throughout the life of the material, it is essential to have reliable information about the early age properties of the concrete. [Popovics, 1971] The properties of concrete are solely determined by the composition of its ingredients and the conditions during the setting and hardening process. [Ozturk et all, 1999]
There are many techniques to determine concrete properties. Therefore their application during early age is very complicated or impossible. [Struble et all, 2000] Sonic or ultrasonic method can be interesting for following concrete structure during lifetime. [Rapoport et all, 2000]

2. Theory of measurement

The hydration of cement is exothermic process. During hydration concrete obtain strength and other mechanical properties but it also shrinks. The shrinkage affects creation of micro-cracks which lower durability of the concrete. Course of total volume exchange is affected by temperature development, see Fig. 1. On the basis of the temperature course is possible to select the best way of concrete curing for avoiding of micro-cracking. During the early stages of curing the autogenously shrinkage decreases thermal expansion. After the peak temperature is reached, however, autogenously shrinkage and thermal contraction act together in reduction volume creating micro-cracks. [Morin et all, 2002]

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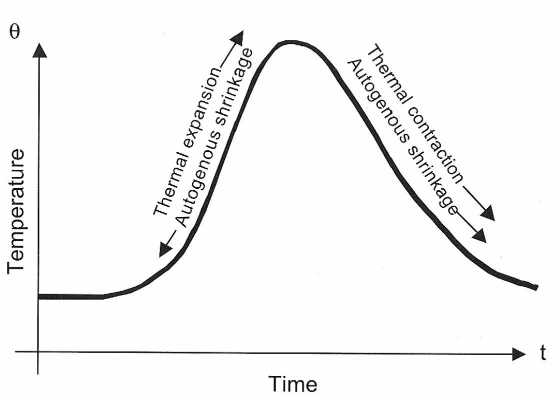

Fig. 1. Why is important to know heat development course of concrete [Aitcin, 1998]

To follow the tension changes and/or the crack generation, the Acoustic Emission Method is used. This method allows us to follow up active (dynamic) processes inside the structure. In consequence of local tension cumulation inside the material, there arise focuses of tension and, consequently, potential sources of acoustic emission. If the tension reaches or even exceeds the critical value at a certain point the accumulated energy will be released resulting in an acoustic event. This event is supposed to be accompanied by the formation of a micro-crack. The tension propagates through the material. The point at which the tension has arisen is called the acoustic emission source (Fig. 2). For simplicity, let us assume the propagation medium to be homogeneous and isotropic. In this case, a spherical wave propagates from the source, its energy decreasing with the distance from the source. Once the wave reaches the specimen surface it can be recorded by means of an acoustic emission sensor. It means that the position of the crack can be determined in the case of homogeneous isotropic materials and appropriate sensor positioning. [Kek et all, 2004], [Mazal, 2000], [Mazal et all, 2005], [Pazdera et all, 2005], [Uchida et all, 2000]

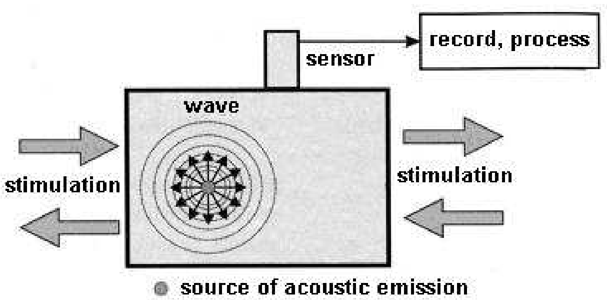

Fig. 2. Rise and propagation undulation at matters acoustic emission [Kreidl et all, 2006]

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3. Experimental setup

Two samples of length, 400 mm, height, 100 mm, and width, 100 mm, were measured simultaneously. Four acoustic emission sensors were placed on the surface of both samples. (see Fig. 3) Two sensors were placed on the sample from metal and the other two ones on the sample from wood. Each sensor was kept by specially made holder, so that the contact between sensor and sample surface was easy to achieve.

Fig. 3. Mounting acoustic emission sensors
(on the left side sample from wood, on the right side sample from metal)

4. Results

Four different mixtures are in graphs in Fig. 4. Each mixture was hardening in wood (solid line) and metal (dashed line) mould simultaneously. In all cases, the mixtures in metal mould are showing higher activity of acoustic emission. This higher activity is particularly evident in the early stage (several hours after mixing). Curve of cumulative counts of events has a larger slope the metal mould than the wood mould.

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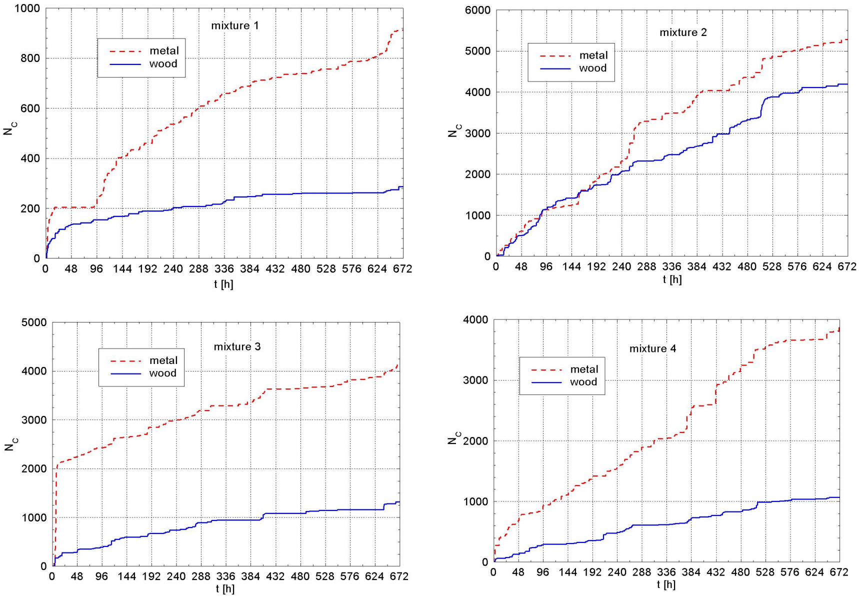

Fig. 4. Dependence of acoustic emission activity N_C on time t

5. Conclusion

Thus the metal mould has got better thermal conductivity than the wooden mould, because heat was faster transferred outward, which has given rise to more cracks. Method of acoustic emission again demonstrated the benefits of its use in the hardening of concrete particularly in its initial stage, which forms the final properties.

Acknowledgement

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