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Non-Destructive Evaluation of Micro-Cracked SCC by Ultrasonic Waves

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1 Introduction

Self-Compacting Concrete (SCC) is an effective, reliable and safer technology to cast-in-place concrete structures. However, the large amount of paste required to achieve its high flowability may increase microcracking caused by drying shrinkage at Early Age (EA) due to curing conditions, damaging concrete members (Barluenga *et al.*, 2018). In this case, an evaluation of the hardened SCC may be necessary and Non-destructive testing techniques (NDT) can be suitable. Among NDT, Ultrasonic pulses (US) have showed to be very useful due to its portability, easiness of application and sensitivity to changes in material microstructure, porosity and presence of defects (Palomar *et al.*, 2017). Thus, the aim of this study was to compare US parameters to hardened parameters of cracked and un-cracked SCC.

2 Experimental Program, Results and Discussion

An experimental program using transmission 250 kHz ultrasonic P- and S- waves was carried out on SCC with limestone filler (LF), microsilica (MS) and nanosilica (NS), set and hardened in different curing conditions: 10, 20 and 30 °C and 40 and 80 % RH. Free shrinkage uncracked specimens and double displacement restrained slabs were tested. Cracking due to EA shrinkage was measured on the slabs. US transmission time and wave amplitude were recorded. US pulse velocity (Pw and Sw) and attenuation coefficient (AT_{250}) were calculated. Some physical and mechanical properties of cracked and un-cracked samples were measured. Changes in SCC compositions and curing conditions modified EA cracking potential and hardened properties of un-cracked and cracked samples. In addition, US parameters in both samples varied due to compositions and curing conditions, although the effect it is not linear. US paramters of cracked and un-cracked SCC samples are compared. US velocities of un-cracked samples were higher than cracked samples, as expected (Selleck *et al.*, 1998). Besides, the attenuation coefficient of un-cracked SCC samples was lower than the micro-damaged samples, as described in the literature (Yim *et al.*, 2012). EA cracking potential was assesed for SCC samples set and hardened under same curing conditions, using P- and S-wave velocity ratio (Pw/Sw) of un-cracked samples. EA cracking potential was assesed for SCC samples set and hardened under same curing conditions, using P- and S-wave velocity ratio (Pw/Sw) of un-cracked samples.

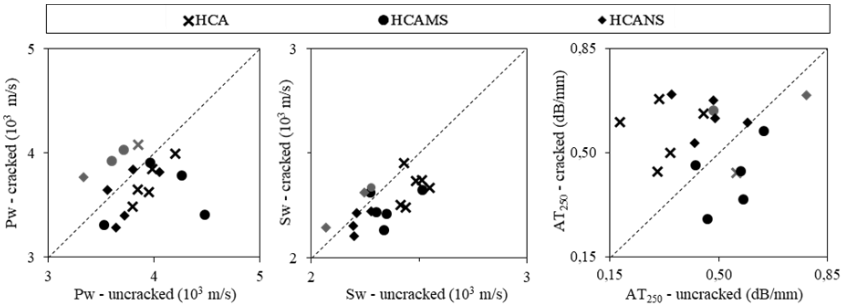

Figure 1. Ultrasonic pulse velocities (Pw and Sw) and attenuation coefficient: un-cracked vs cracked values.

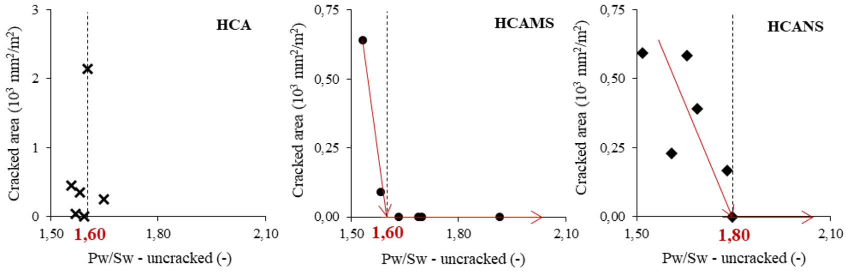

Figure 2. P- and S-wave velocity ratio (Pw/Sw) for un-cracked samples vs EA cracking parameters (A_c).

3 Conclusions

In conclusion, the interest of transmission US waves as evaluation technique for microdamaged SCC was highlighted, identifying correlations for SCC microcracking based on US parameters.

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