Ultrasonic and impact spectroscopy monitoring on internal sulphate attack of cement-based materials

V. Genovés, F. Vargas, J. Gosálbez, A. Carrión, M.V. Borrachero, J. Payá

PII: S0264-1275(17)30324-6
DOI: doi:10.1016/j.matdes.2017.03.068
Reference: JMADE 2902

To appear in:

Received date: 11 November 2016
Revised date: 16 March 2017
Accepted date: 22 March 2017

Please cite this article as: V. Genovés, F. Vargas, J. Gosálbez, A. Carrión, M.V. Borrachero, J. Payá, Ultrasonic and impact spectroscopy monitoring on internal sulphate attack of cement-based materials, (2017), doi:10.1016/j.matdes.2017.03.068

Ultrasonic and impact spectroscopy monitoring on internal sulphate attack of cement-based materials

V. Genovés[a,*], F. Vargas[a], J. Gosálbez[b,**], A. Carrión[b], M. V. Borrachero[a], J. Payá[a]

[a] *ICITECH, Universitat Politècnica de València, Camino de Vera, s/n 46022 Valencia, Spain*
[b] *ITEAM, Universitat Politècnica de València, Camino de Vera, s/n 46022 Valencia, Spain*

Abstract

An exhaustive monitoring of an internal sulphate attack of Portland cement-based materials is addressed. Four series of Portland cement mortars with different amounts of gypsum (0%-2% SO_3 respect to the cement by mass) were monitored by means of physical, microstructural and non-destructive tests, studying specimens with a low expansion rate to examine the sensitivity of the applied techniques. The expansion analysis has shown the suitability of a fitting model, allowing the examination of two characteristic parameters: the characteristic time of the expansion reaction and the maximum amplitude of the expansion. In the mechanical analysis, higher values of Rc and Rf were attained as the gypsum content decreased. A microstructural analysis (thermogravimetry and FESEM) supported ettringite formation and expansion process. These results have been correlated with non-destructive tests: impact resonance acoustic spectroscopy and ultrasonic measures. The dynamic modulus and ultrasonic pulse velocity have closely predicted the stiffness of the specimens. The total material attenuation (absorbed energy of the chirp signal ultrasonic wave) presented different trends, showing clear differences for the most damaged series (2% SO_3). Attenuation supplied interesting information about the hardening process and the microcracking effect due to a mortar expansion higher than 0.04%. The novelties of this study are the exhaustive monitoring of an internal sulfate attack, as well as the examination of the sensitivity of brand new NDT techniques when this damage process overlaps with the curing process.

Keywords:
Sulphate attack, Non-Destructive test, Chirp signal, Ultrasonics, Acoustic spectroscopy, Microstructure

1. Introduction

Sulphate attack is considered one of the most aggresive causes of concrete degradation. Ettringite triggers expansion mechanisms that have harmful effects on the Portland cement matrix, causing micro-cracking and, consequently, a reduction in the stiffness and strength. Primary ettringite has no negative effect because the expansions produced by the reaction between C_3A and the sulphate anions are absorbed by fresh concrete.

*Corresponding author E-mail address: vigegme@upv.com
**Corresponding author E-mail address: jorgocas@dcom.upv.es