Characterization Of Mortars With Ultrasonic Transducer

H.Lotfi[1]*, B.Faiz[1], A.Moudden[1], [2], D.Izbaim[1] , A.Menou[3], G.Maze[4]

[1] Laboratoire Métrologie et Traitement de l'Information Faculté des Sciences B.P. 8106 Agadir Morocco
Phone: +212667099598; e-mail: lotfi.hicham@yahoo.fr
[2] Ecole Supérieur de Technologie Agadir Maroc
[3] ONDA Casablanca Maroc
[4] Laboratoire Ondes et Milieux Complexe Université Le Havre France

Abstract: The durability of mortar structures is affected by chemical and mechanical factors, such as abrasion, temperature variation..., the Degradation of mortar structures located under flowing water in their structure or high humidity atmospheres. In this study we presented a method for ultrasonic non-destructive characterization in mortar to follow the evolution of the signals back scattered by mortar structures for different size of sand, Samples were manufactured using same water/cement ration (w/c) 0.65, and cement/sand ration (c/s) 0.5. The processing of the ultrasound wave has been chosen to follow the hardening of mortar and to understand the mechanisms driving to the degradation of mortar in relation with microstructure.

Keywords: Mortar, microstructure, signal, processing ultrasound

I. Introduction

The research described in this paper has the objective to develop a method that allows the description of physical parameters of mortar. An ultrasonic wave reflection technique based on high frequency shear waves has been developed recently [1, 2]. The method measures the reflection coefficient ultrasonic waves at the interface of a buffer material and hydrating cementitious materials. The study of the hardening was then approached by other techniques based on the measurement of release of heat during the hydration, electronic microscopy and the electric conductimetery. This short outline shows that the methods of characterizations by ultrasounds did not advance yet in civil engineering. In this context, we present a Non -Destructive investigation based on the emission of the ultrasonic waves to follow the evolution of the Ultrasonic velocity in real time.

The measurement of the ultrasonic wave velocity has been used to characterize hardening and setting of cementitious materials [3-4], characterizing the hardening of mortar by ultrasonic techniques is very attractive because these techniques are not destructive and permit the observation of the hardening in real time. [5-6-7] had used a reflection method to evaluate material properties of isotropic materials.

II. Experimental procedure

II-1. Ultrasonic method

The incident acoustic wave is considered as a plan wave. Part of the ultrasonic energy is transmitted into the mortar through Plexiglas and, after viscoelastic propagation in the mortar; part of the energy is reflected from Glass and returns to the same transducer used as receiver. Fig.1. showed the different paths taken by the ultrasonic wave. Each path provides an echo which is labelled E_n.

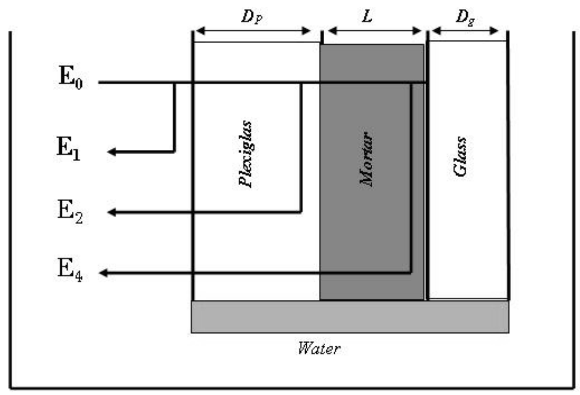

Figure 1- *different paths of propagation in mortar*

Fig.2. presents the signal composed of echoes E_1, E_2 and E_4 reflected by the vessel enclosing the mortar using the 0.5 MHz central frequency transducer. The first E_1 echo

reflected on the bottom surface of plate 1 (Plexiglas), this is not important because it is not used in this study. The second echo E_2 corresponds to the reflection on the interface between the second Plexiglas face and the mortar sample enclosed in the vessel. The last echo E_4 corresponds to the reflection on the interface between the mortar and the first face of plate in glass (plate 2).

The choice of the vessel material (Plexiglas) is done in relation with the characteristics of the mortar and its thickness (Dp=2cm) is chosen in order to sufficiently attenuate echoes (reflection in plate 1). In this study, only spectral properties of echoes E_2 and E_4 was analyzed to determine viscoelastic parameters of the mortar in real time

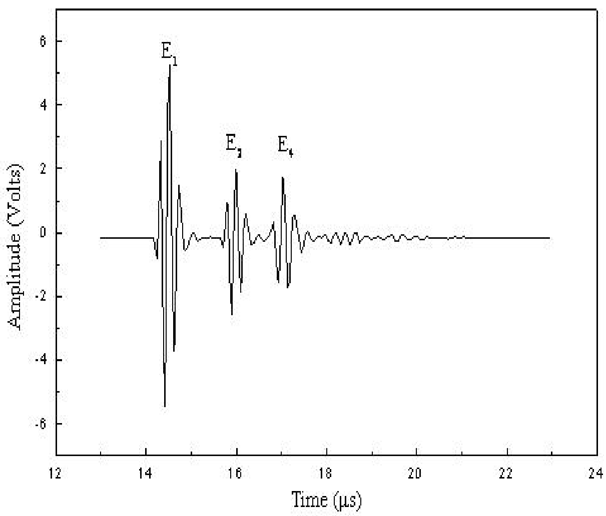

Figure 2- *reflected echoes by the mortar with the 0.5MHz transducer*

II-2. Samples

Portland cement mortar with water/cement (w/c) ration (0.65) and cement/sand (c/s) ratio (0.5), sand aggregates with diameter (0.2, 0.25, 0.315 and 0.5 mm) were investigated. Portland cement CPJ 45 produced in Agadir, Morocco, was used as the cementitious materials. The sand used was a river sand of OUED SOUSS with mass volume absolute (2630 g/cm3), mass volume apparent (1460g/cm3) and content in water of 3,3%. The mortar were cured at isothermal conditions at 42°C through the duration of the experiments , the temperature chosen according to the climate of the regions in south of Morocco.

III. Ultrasonic velocity measurement

One of the most important viscoelastic parameters for following the hardening, in real time, of mortar and other materials is the ultrasonic velocity. Velocity v applies in general at the known interrelationship of $V = 2.L/\Delta t$ with travel time Δt which is the variation of time between echoes E4 and E2, and travel path L, number 2 refer to double path of signal backscarted by the mortar inclosing in the vessel (method of echoes).

In Fig.3 a light increase of ultrasonic velocity is observed, from where the influence of the bubbles of air is very weak, and water in the structure is completely consumed at the period of hardening of mortar. It's clearly that the wave velocity increase with age, it is assumed in [8-9] that the pulse velocity increases with the increase of mortar strength. The velocity increases strongly in the interval of time (15h to 50h), after 50h the velocity becomes almost constant, it is the period of hardening of the mortar. Thus for the same temperature and the same mass ratios of cement/sand and water/sand the velocity of the signals backscarted is very important for the mortar containing sand particle size 0.315mm.

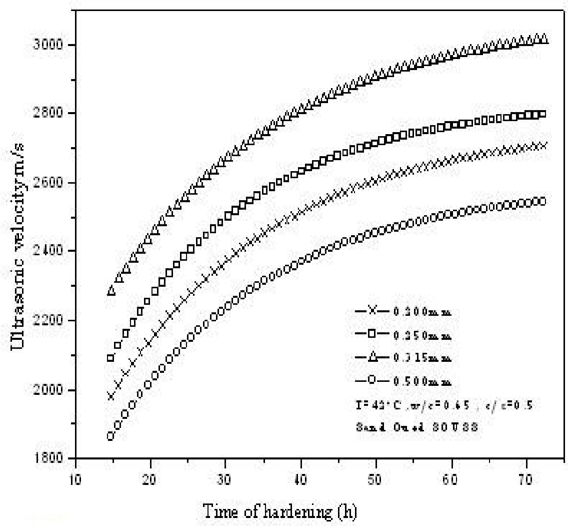

Figure 3- *evolution of ultrasonic velocity in the mortar for various sand sizes*

IV. Conclusion

The object of this paper is a novel technique for the investigation of cementitous materials using the processing of ultrasonic signal. Preliminary results show that it is possible to test mortar using ultrasonic velocity,

this viscoelastic parameters would help in obtaining the necessary data required by mechanical models to the evaluation and prediction of the strength of mortar within structure.

Acknowledgments

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