DETERMINING THE ELASTICITY CHARACTERISTICS OF GYPSUM AND ITS COMPONENTS

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Abstract
*This paper describes the methods and devices required to determine the characteristics of gypsum-based building materials not included in the valid European standards. The properties of acoustic and sound absorbing materials for **α-**plaster based aerial constructions are based on the natural absorbing properties of perlite and of the expanded vermiculite, used in various percentages included within composite materials, called compositions. In order to determine the coefficient of elasticity of gypsum and of gypsum based components, the laboratory dynamic measuring system used consisted of a concentric axial force actuator, two control cylinders of the tested material on which two strain gauges linked to two Wheastone bridges were set, and which were connected to a data acquisition board connected to a computer. The measurement data established the velocity of the sound propagation through the gypsum cylinders in order to determine the modulus of elasticity of the material.*

Key words: sound-absorbing panels, manufacture, mold, noise

INTRODUCTION

The building materials are bound particle systems, known as molecules, atoms or ions that interact among them. If one of the particles oscillates, they will also oscillate along it as well as the foreign particles, the oscillations being propagated within the environment from particle to particle, as elastic waves (Darabont et al., 1998).

In order to determine the elastic constants of the materials, the device shown in the paper will be used. The device consists of an elastic shock wave generating device and an electronic device consisting of strain gauges and electronic devices for signal reception and processing. The oscillations of the waves are the result of the displacements caused by the elastic deformations of the environment. (Ungur, 2010).

MATERIAL AND METHODS

When designing and building the concentric axial force application device upon gypsum samples, one considered a technical study allowing the application of an axial force upon a gypsum cylinder and the possibility of determining the duration of the shock wave through the sample of the tested cylinder (Figure 1).

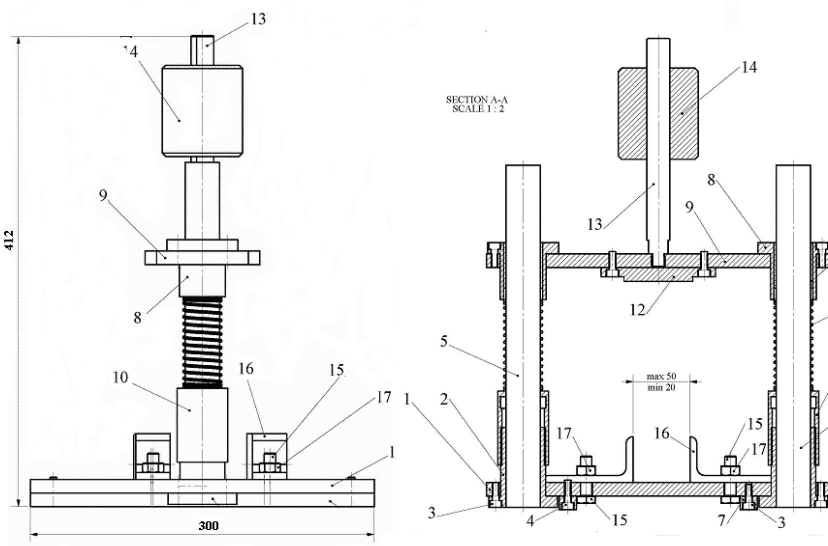

Fig. 1 Device for exerting the axial force

Where: 1 - bed plate, 2 - column support (2 pcs.), 3 - M6 fixing bolts (17 pcs.), 4 - M6 screws (3 pcs.), 5 - column (2 pcs.), 6 - M6 screw (2 pcs.), 7 - shoe (2 pcs.) 8 - guiding nut holder (2 pcs.), 9 - crosspiece, 10 - adjustment part, 11 - coil spring (2 pcs.), 12 - buffer, 13 - guiding axis, 14 - impact weight, 15 - M10 fixing screw (4 pcs.), 16- staple (4 pcs.), 17 - M10 screw nut (4 pcs.), 18 – antifriction nut.

The schema of the device for the determination of the elasticity modulus of building materials is shown in Figure 2.

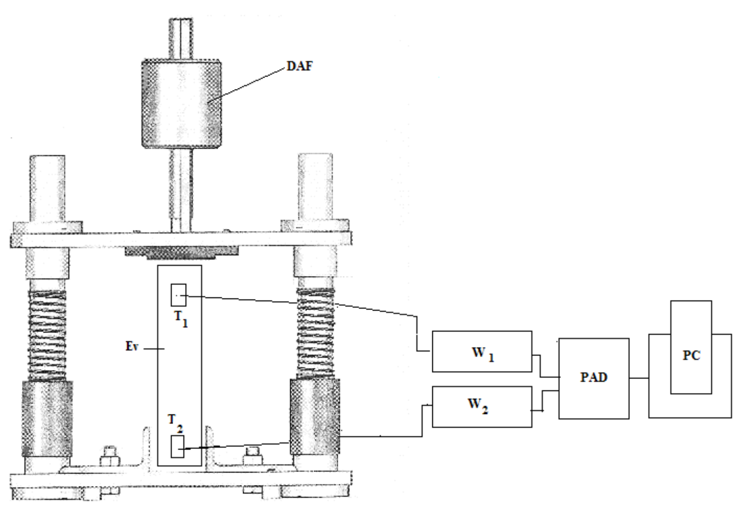

Fig. 2. Schema of the device for determining the modulus of elasticity of building materials

The mobile crosspiece-*9* along with the cylindrical columns-*5* forms, by means of the coil springs-*11*, an elastic system with the buffer-*12* and the front surface of the *Ev*-cylindrical test item, attached onto the bedplate with various staples-*16*, which, in turn, are attached to the bedplate with screws-*15* and nuts-*17* which run through the two shoes-*7*.

The balancing of the elastic force system vertically formed with the buffer-*12* and the *Ev*-test item is performed by the fine actuation of the adjustment parts-*10*, provided with fine thread acting through the springs-*11* on the crosspiece-*9* until the buffer-*12* touches the upper front surface of the *Ev*-test item. Subsequently, the m_1-mass impact weight-*14* is lifted at a height-*h*, followed by a free fall, and impacting on the crosspiece-*9* with *m*-mass and leading to a plastic collision. The process continues with a descending vertical movement that generates a vertical shock by means of the buffer-*14*, the upper front surface of the standard-*Ev* test item with a common mass ($m + m_1$), inducing therein compression strains and short longitudinal elastic mechanical waves (Ungur. et al., 2008).

The picture of the laboratory device used to determine the modulus of elasticity of gypsum-based building materials is shown in Figure 3.

Fig. 3. Laboratory device for determining the modulus of elasticity

RESULTS AND DISCUSSIONS

Dynamic tests required to determine the modulus of elasticity of gypsum-based building materials were made on two cylinders of different compositions, with a 500 mm length and to which two strain gauges were attached, with a 460 mm distance between centers.

With the help of the dynamic device shown in Fig. 3, several attempts were made, on the two gypsum cylinders, in order to determine the time of the shock wave passing through the cylinder, caused by the mechanical device-DAF. For each tested cylinder, a series of ten measurements (5 tests for each end of the cylinder) were performed, after which, an average time resulted from the 10 tests was calculated (Ungur, Mihaila, 2009).

In order to measure the time to pass through the two gypsum cylinders and implicitly, to determine the propagation speed through the cylinders, two special programs were used, the MATLAB program being utilized thus: "*Daqtest-2.m*" for data acquisition while the “*Assessment-1.m*" was used to display data and plot diagrams in order to determine time.

TEST 1: **I.O. Cylinder** (Figure 4) - is an 85% alpha plaster and 15% perlite gypsum used in orthopedic dressings and light corsets possessing the following technical characteristics: Plug-in/Grip time: beginning 8 min, ending 16 min, 116% water of normal consistency, 0.7 N / mm2 bending strength, 2.75 N / mm2 compressive strength, 0.72 g / cm3 density.

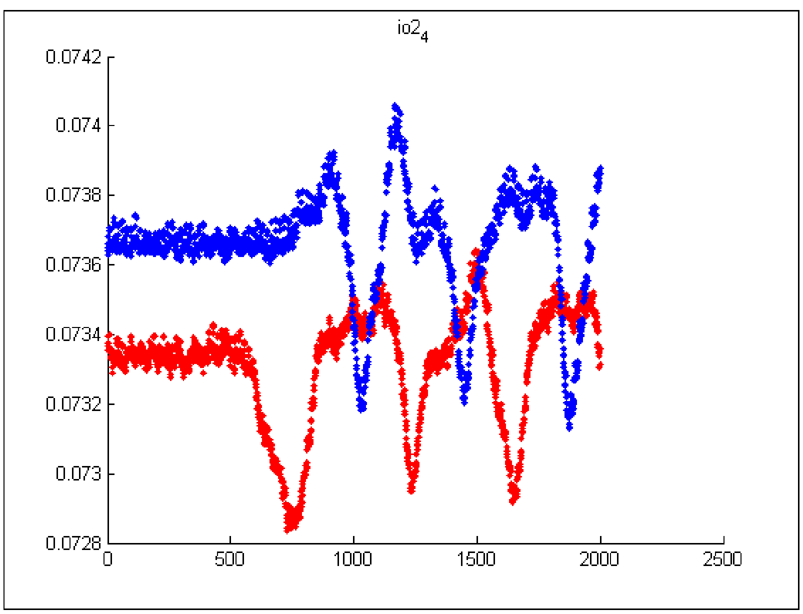

Fig. 4. Diagram for the determination of the propagation time for the I.O. cylinder.

Following the ten measurements, an average propagation time of $3{,}884 \cdot 10^{-4}$s was obtained. Knowing that the distance between the strain gauges is 460 mm, the propagation velocity can be determined:

$$v_{I.O.} = l_{I.O.}/t_{I.O.} = 0{,}46/3{,}884 \cdot 10^{-4} = 1184{,}34 m/s$$

The determination of the I.O. cylinder elasticity is done based on the following relationship:

$$E_{I.O.} = v^2_{I.O.} \cdot \rho_{I.O.} = 1184{,}34^2 \cdot 720 = 1{,}010 \text{ GPa}$$

TEST 2 : **C.A. Cylinder** (Figure 5) - is an 95% alpha plaster and 5% perlite gypsum plaster used for sound-absorbing and thermal insulating coffered panels: Plug-in/Grip time: beginning 11 min, ending 20 min, 70% water of normal consistency, 0.95 N / mm2 bending strength, 2.4 N / mm2 compressive strength, 0.68 g / cm3 density.

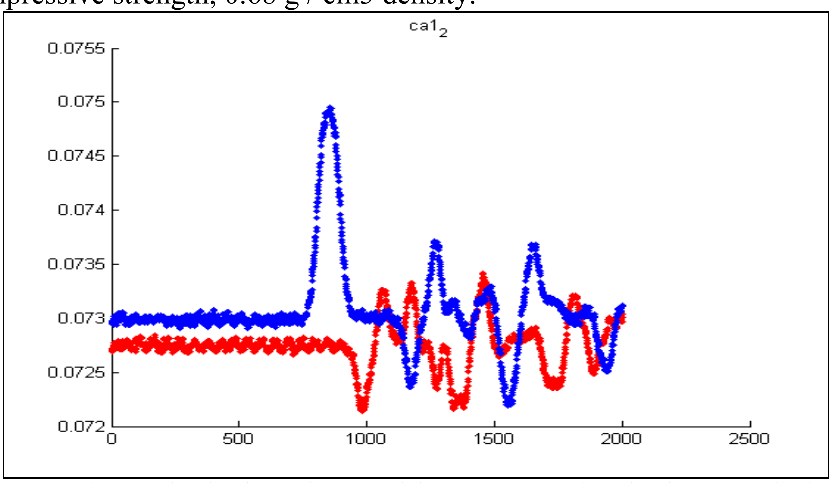

Fig. 5. Diagram for the determination of the propagation time for the C.A. cylinder

CONCLUSIONS

Following the ten measurements, a $3{,}589 \cdot 10^{-4}$s average propagation time was obtained. Knowing that the distance between the strain gauges is 460 mm, the propagation velocity can be determined according to the following formula:

$$V_{C.A.} = l_{C.A.}/t_{C.A.} = 0{,}46/3{,}589 \cdot 10^{-4} = 1281{,}69 m/s$$

The determination of the modulus of elasticity of the C.A. cylinder is performed according to the relationship below:

$$E_{C.A.}=v^2_{C.A.}\cdot\rho_{C.A.} = 1281{,}69^2\cdot 680=1{,}117\ \text{GPa}$$

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