



# TEST REPORT

## TEST FOR THE DETERMINATION OF THE DYNAMIC MODULUS OF ELASTICITY BY THE FREQUENCY OF RESONANCE METHOD

### 1 | Identification

Name	LNEC/DE/NESDE
Address	Av. do Brasil, 101   1700-166 LISBON
Customer/applicant's order reference	DED/NCTC'S CONTRIBUTION TO THE "COLLECTION AND CONDUCT OF MECHANICAL CHARACTERISATION TESTS ON BEDDING MORTARS"

### 2 | Samples and sampling procedure

The masonry mortars' mixing was carried out by the client under the supervision of a technician from LNEC's Wall Coverings Unit (URPa) on 10 November 2025 at 2:00 pm. For this mixing following the provisions of Standard EN 1015-2: 1998 – Methods of test for mortar for masonry - Part 2: Bulk sampling of mortars and preparation of test mortars, a pre-measured mortar mix with 20% added sand was placed in the laboratory mixer's container. The mixer was then started in automatic mode at a relatively low speed. During the first 30 seconds, whilst the mixer was running, water was poured into the container. After two and a half minutes, the mixer was stopped and the material was mixed manually with a trowel, scraping the sides of the container to ensure a homogeneous mixture. The mixer was then switched on again at the same speed for an additional 30 seconds. The mortars' consistency was determined according to the standard EN 1015-3:1999 – Methods of test for mortar for masonry - Part 3: Determination of consistency of fresh mortar (by flow table) and the bulk density was assessed in accordance with standard EN 1015-6:1998 – Methods of test for mortar for masonry - Part 6: Determination of bulk density of fresh mortar. The sample was then cast into three metal moulds, each with three cavities measuring 160 mm × 40 mm × 40 mm, resulting in a total of nine test specimens. The average dimensions of the test specimens were 160.20 mm × 40.10 mm × 40.91 mm, intended for the tests for the determination of the dynamic modulus of elasticity by the frequency of resonance method. The sample and specimens' identification is presented in Table 2.1.

Table 2.1 – Identification of the sample and test specimens

Sample description	Quantity	Test specimens
RE-M5-20%	6 kg	RE-M5-20%_1 to 6



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## 3 | Tests carried out/Test conditions

### 3.1 Test Method

The dynamic modulus of elasticity determination test by the frequency of resonance method was carried out at 7 and 28 days of curing time at the Wall Coverings Unit (URPa) of LNEC, in accordance with the specifications of the standard NP EN 14146:2006 – Test methods for natural stone - Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency).

Before testing, the specimens were placed at a temperature of 20 °C (+3 / -2 °C) and a relative humidity of 95 ± 5% for 48 hours. They were then demoulded and kept in the same conditions for an additional period of five days.

After this period, the specimens were placed at a temperature of 20 °C (+3 / -2 °C) and a relative humidity of 65 ± 5%. They were then subjected to dynamic modulus of elasticity tests at the specified curing times.

For the determination of the dynamic modulus of elasticity test by the frequency of resonance method, a Zeus ZRM 2005 equipment was utilized.

## 4 | Results

Table 4.1 shows the dynamic modulus of elasticity, determined using the frequency of resonance method, values obtained at the curing times of 7 and 28 days.

**Table 4.1 – Values obtained for the dynamic modulus of elasticity  
by the frequency of resonance method**

Curing time	Specimens	Bulk Density (kg/m <sup>3</sup> )	Frequency (Hz)	Dynamic Modulus of Elasticity (GPa)
7 days	RE-M5-20%_1	1828	4115	3.17
	RE-M5-20%_2	1829	4080	3.13
	RE-M5-20%_3	1825	4215	3.32
	<b>Average</b>	<b>1827</b>	<b>4137</b>	<b>3.21</b>
	<b>Standard deviation</b>	<b>± 2</b>	<b>± 70</b>	<b>± 0.10</b>
28 days	RE-M5-20%_4	1644	5108	4.39
	RE-M5-20%_5	1631	5003	4.19
	RE-M5-20%_6	1632	5038	4.24
	<b>Average</b>	<b>1636</b>	<b>5050</b>	<b>4.27</b>
	<b>Standard deviation</b>	<b>± 7</b>	<b>± 53</b>	<b>± 0.10</b>

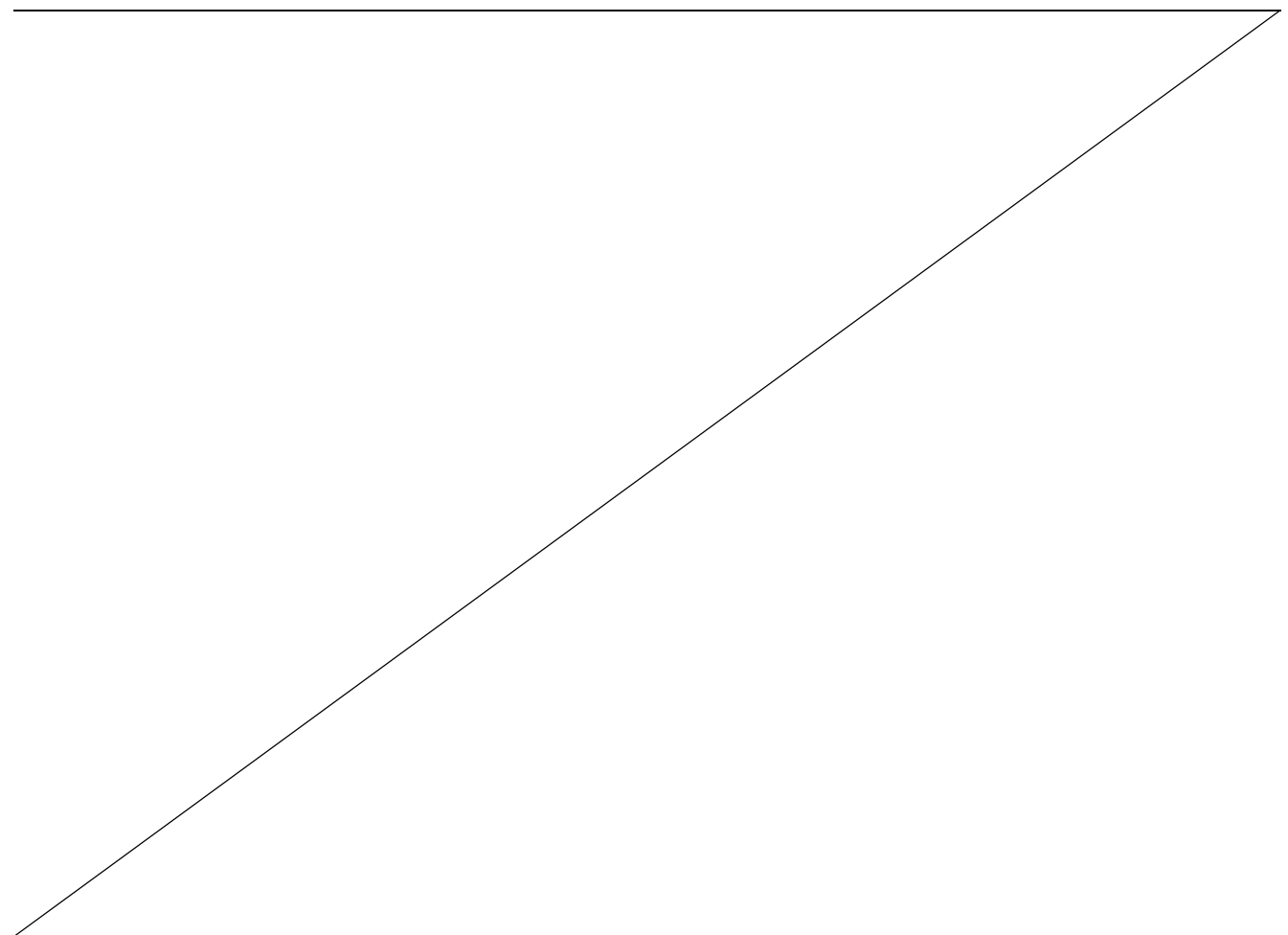


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## 5 | Comments

The results obtained in this test are part of the study on the mechanical characterisation of mortars conducted for LNEC/DE/NESDE.



Lisbon, LNEC, 27 March 2026

TESTED BY

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