American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-8, Issue-12, pp-159-163
www.ajer.org
Research Paper Open Access

Development Of Dosage Methodology For Mortar To Plaster

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ABSTRACT: Grouting mortar can be defined as a dry industrial product composed of Portland cement or other binder, mineral aggregates and chemical additives which, when mixed with water, form a sticky, plastic and adherent mass, which is used in the construction of wall cladding. Existing dosage formulations are deficient in producing a quality mortar and are often not intended for use. In the ceramic industry a very efficient suspension dosage methodology based on the Brongniart formula is used. In this work, using a scientific methodology, a new mortar dosing procedure was proposed comparing with the standard formula with Brongniart formulation. To validate the methodology the following parameters were determined: consistency, bulk density and suspension volume. The results showed that the mortar with new methodology can be used satisfactorily in the dosage.
Key-word: Mortar, dosage, methodology, raw materials

Date of Submission: 20-12-2019 Date of acceptance: 31-12-2019

I. INTRODUCTION

The ABNT NBR 13.281: 2005 [1] defines mortars as a homogeneous mixture of fine aggregate (s), inorganic binder (s) and water, whether or not containing additive, with adhesion and hardening properties. Mortars can be dosed on site or in their own installation (industrialized mortar). They can be used in various places with differentiated function, each of the work lives up to a series of properties that correspond to a specific type of mortar. Mortars must have a series of properties for application on walls, including allowing deformations necessary for various types of environments / situations, resisting the loads acting and also have adequate resistance to compression, traction and attack of chemical agents from materials. among others (MARTINELLI, 1989) [2]. Mortars are widely consumed in the world, either as wall, ceiling and floor coverings or as sealing and structural masonry settlements (SANTOS, 2011) [3]. In recent years construction companies are replacing mortars produced on site with industrialized mortars, mainly due to the difficulty with dosing due to the inaccuracy presented in existing formulas and procedures (BARBOSA and SANTOS, 2013) [4].

It must be borne in mind that the various mortar methodologies currently available are inaccurate or very restrictive to some regions or types of materials. Current methodologies include: seeking the optimal content of plasticizer material according to Selmo (1991) [5] for generalist conditions, without highlighting the relation between this plasticizer and humidity; or in meeting specific conditions such as building façades, according to Selmo (1991) methodology [5]; the use of region-specific clay-based plasticizers (kaolin and sandy), as in the work of Gomes and Neves (2002) [6]; dosage through adjustment, based on particle packing concepts, the fine grain size curves according to Carneiro (1999) [7] among others. Regarding the preparation method, Neto (2017) [8] studied the rheology of mortars and found that the preparation procedure strongly influences its properties in the fresh and hardened state. Studies have shown that composition, water / dry material ratio, additives and mixing time influence rheological parameters. Another aspect that has been studied, but less explored, is the influence of the mixing sequence of mortars on their properties. It is known that for the mortars to perform their functions, it is necessary that they present, in the fresh and hardened state, a set of properties that must be properly prescribed as to the type and conditions of use. The mortar must ensure beyond the aesthetic appearance on a wall, must have low porosity to prevent the passage of water especially capillarity.

The capillarity is one of the properties responsible for the water absorbed by the mortar coatings under the action of rising ground water at the base of the coatings. This phenomenon refers to the movement of water through the mortar capillaries without significant hydrostatic pressure. Capillary absorption allows the ease of water entry and transport within the porous structure of these coatings to be assessed. This property is closely linked with other properties such as hardened mass density, void content and incorporated air content. Araújo (2012), Ramachandran (1984) states that mortars with poorer cement traits present greater absorption by capillarity. According to these authors, the additives cause the cement matrix capillaries to be interrupted by the incorporated air bubbles resulting in a closer capillary network, which justifies their low capillary absorption.

The dosage methods currently available for coating and setting mortars present diverse approaches that are often not followed by the academic community. Some works can be cited, such as Selmo (1991) [5], which was based on the definition of the optimal content of plasticizer material and water to desired consistency, indicating some checks (existence of cracks, surface texture, adhesion, strength). surface, permeability, water absorption, cost-effectiveness) according to work conditions; Selmo [5], who proposed an evolution of the previous method with lime insertion, Lara et al. (1995) [9], who proposed to dose mortars from basic traces of the maximum consumption of fines and water to the consistency of 260 ± 10 mm, with process through formulas and reference to tables.

In this project we intend to apply a recognized consolidated calculation methodology in the ceramic segment based only on the actual specific mass of the raw materials and the apparent density of the final mixture. If consistency changes, this should be corrected with the introduction of additives so that the water should not be changed. In turn, the aim is to change water to correct consistency because it is faster and less costly.

II. MATERIALS AND METHODS

2.1 SAMPLE PREPARATION

The sand sample was collected from approximately 20 kg and dried in an oven (105 ± 5) °C for 24h. The cement used was Poty CP 32 and the lime used was of the super lime brand sieved in the 0.075 mm opening.

2.2 TECHNOLOGICAL CHARACTERIZATION ASSAYS

Particle size analysis: The particle size distribution test was performed in accordance with NBR 7217 2016 [10].
Specific sand mass: the test was performed by Chapman's method according to NBR NM 52 [11].
Fineness: The test method for determination of Portland cement fineness using 0.075 mm aperture 7 sieve was performed according to NBR 11579 [12] by manual and mechanical procedures.
Real specific mass of cement and lime: The measured mass representative of the actual density was determined using Micromeritcs AccuPyc II 1340 helium pycnometer.
Unit mass: Raw materials were tested by bulk density according to the procedure of (Amoros, 2011) [13].

2.3 PREPARATION OF FORMULATIONS

A trace was defined for the survey, as shown in Table 1. The trace is a mixture of cement and sand.

Table 1: Mortar formulations chosen for comparison

Raw Material	Trace
Cement	1
Lime	-
Sand	4
a/c	0,9

The mixtures were calculated by determining the consumption of raw materials as well as the amount of water based on Eq 1. Where C is cement consumption in g, are the specific masses of cement, sand is the water-cement ratio, the which can be represented by the expression 1: a: x. The volume in cm^3 corresponds to the specimens to be produced, and the volume can be changed according to the number of specimens to be conformed.

$$C = \frac{Volume}{\frac{1}{\gamma_c} + \frac{a}{\gamma_a} + x} \qquad \text{Eq 1}$$

The raw materials were weighed on a scale with a load capacity of 2100 g and a resolution of 0.01 g, model JH2102. In this experiment, the mortars were produced using a 5 liter vertical axis mechanical mixer (mortar), Edutec brand. Initially, the water content was determined to obtain the standard consistency index

prescribed in NBR 13276 (ABNT, 2005) [14], reaching a consistency in the interval (210±10) mm. With fresh mortar the bulk density and consistency were measured. Then using the Brongniart Eq 2 and 3 formula, solids and water were calculated for the preparation of ceramic suspensions, where V_{sus} and V_{water} are respectively the suspension volume and the water volume, and MER, MEA and Ms are the actual specific mass of raw materials, apparent specific mass of each raw material and solids or dry mass. The results were compared and analyzed.

$$V_{sus} = \frac{V_{H_2O}}{\frac{MER-MEA}{MER-1}} \quad \text{Eq 2}$$

$$M_s = V_{sus} \times MER\left(\frac{MEA-1}{MER-1}\right) \quad \text{Eq 3}$$

2.4 TESTS WITH MORTAR IN THE FRESH STATE

For comparison of the formulations, the apparent specific mass of the suspension and the fresh air content and content were determined according to NBR 13278: 2005 [15] and equations Eq 4 and Eq 5.

$$d = (mc - mv)/ Vr \quad \text{Eq 4}$$

At where: d – fresh mortar mass density (g/cm³);
mc – mass of the container containing the test mortar (g);
mv – empty cylindrical container mass (g);
Vr – cylindrical container volume (cm³).

At where d - is the fresh mortar density and dt is the theoretical mortar density. The theoretical mortar density can be obtained by the weighted average mass specific real of each component. The consistency index was determined according to NBR 13276 [14].

III. RESULTS AND DISCUSSIONS

For the production of the mortar, a fine aggregate was used, whose particle size is shown in Figure 1. The sand has a fineness modulus 1.80 considered satisfactory [15].

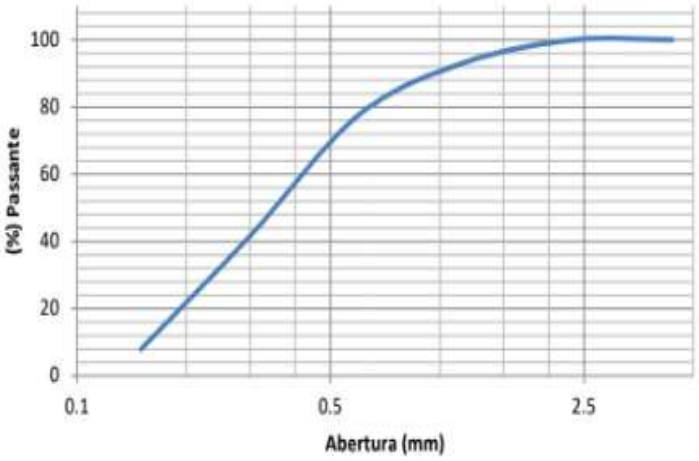

Figure 1: Sand particle size analysis

According to Table 1 is presented the physical characterization data of the raw materials, which are in agreement with other works [16].

Tabela 1: Physical characterization of raw materials

Raw Material	Metod	Units	Results
Cement	Mea	g/cm^3	1,04±0,004
	Mu	g/cm^3	1,04±0,001
	Mer	g/cm^3	3,27±0,001
	Fineness	(%)	1,00±0,001
Sand	Mer	g/cm^3	2,60±0,001
	Mu	g/cm^3	1,50±0,001
	Mf	g/cm^3	1,80±0,001

Mea- apparent specific mass; Mu – unit mass;
Mf-fineness module; Mer-real specific mass

Initially the weighted Mer of the formulations was calculated and 2.74 g / cm^3 was obtained. Using Eq 1, mixing was performed from the proposed trace presented in Table 2. For the proposed trace, mixtures with different a / c contents were performed to define the best consistency between 220±10 mm, and the relation a/c 0.9 sufficient to meet proper wall application. For the mortar formulation using Eq 1 the data to be used in both formulas were obtained: water volume (368.8 cm^3), solids content (2183 g) to make the mixture. After the mortar was produced, the apparent specific mass of the MEA suspension (1.97 g/cm^3) and suspension volume (1294 cm^3) were measured. From the obtained data they served as parameter for comparison of the formulas.

To use the Brongniart Eq 1 formula, the water volume and solids content used in the standard Equation 1 tests were kept constant. From Eq 1 the Vsus suppression volume is obtained. It was observed that in Brongniart's formulation the factor (MEA-1) and (MER-1) considers the suspension fully liquid and the consistency increases exponentially. The factor is considered the degree of saturation of the suspension. Thus, it was replaced by other factors ranging from 0.17 to 0.8 as shown in Table 2. Thus, the results approximate the standard formula when factor 1 is replaced by 0.3.

Table 2 shows the w/c ratio that was kept constant in the experiments. the brongniart formula was changed according to Eq 5.

$$M_s = V_{sus} \times MER\left(\frac{MEA - 0,3}{MER - 0,3}\right) \qquad \text{Eq 5}$$

Table 2: Analysis of fresh mortars

Vw	SV	SM	MEA	MER	Degree of saturation
368,8	1294	2183	1,97	2,74	STANDARD
368,8	929,18	1535,453	1,97	2,74	0,8
368,8	977,08	1666,689	1,97	2,74	0,7
368,8	1024,98	1797,924	1,97	2,74	0,6
368,8	1072,87	1929,159	1,97	2,74	0,5
368,8	1120,77	2060,395	1,97	2,74	0,4
368,8	1144,72	2126,012	1,97	2,74	0,35
368,8	**1168,66**	**2191,63**	**1,97**	2,74	**0,3**
368,8	1197,40	2270,371	1,97	2,74	0,24
368,8	1216,56	2322,865	1,97	2,74	0,2
368,8	1230,93	2362,236	1,97	2,74	0,17

Vw: water volume (cm^3); Sv; suspension volume; SM solids mass (g),
Mea- apparent specific mass

As noted in Figure 2, it is possible to make a relationship with both formulas. There is a strong correlation between them, especially relating the packing factor, bulk density, solids content and suspension volume when using EF = 0.78 and MEA = 1.97 g/cm^3.

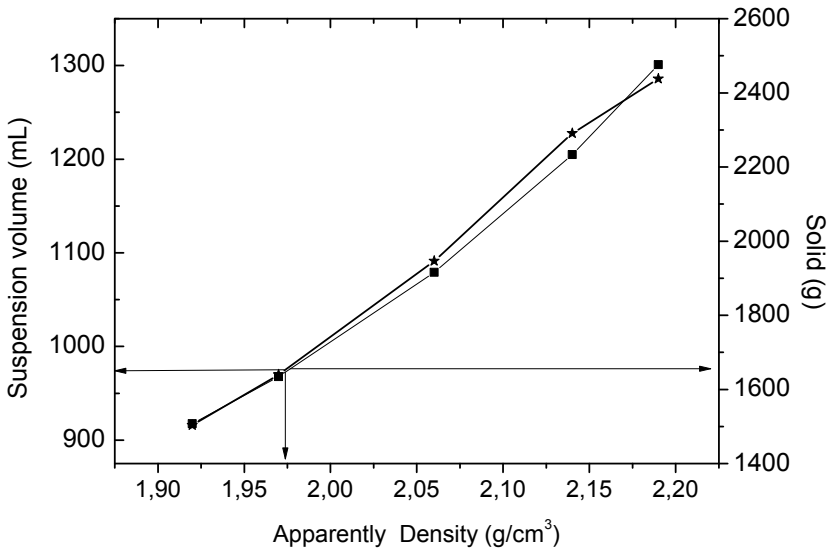

Figure 2: Apparently density and solid and suspension volume.

IV. CONCLUSIONS

Two formulas that measure solids and water content were compared. One standard and another used in the ceramics industry, called Brongniart's formula Brongniart's formula only approaches the standard when a factor of 0.3 to 0.4 is used. Therefore, the formulation of the standard proved to be very efficient in determining the suspension volume, and often the consistency had to be corrected. Brongniart's formulation presented a difference of 8% in relation to bulk density. The justification is that Brongniart's formula considers fully saturated suspension, while the standard considers only a packing factor of 70 to 80%.

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Bruno S. Figueiredo "Development Of Dosage Methodology For Mortar To Plaster" American Journal of Engineering Research (AJER), vol. 8, no. 12, 2019, pp 159-163