**Rheology of polymer cement mortars for concrete repair**

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## Abstract

This article provides the characterization of mortars for repairing reinforced concrete elements. The features that make the mortar cement with polymer (PCM) a good option for the repair of concrete structures are approached. It is also mentioned the importance of the knowledge of the mortar rheology behavior. Experimental tests were carried out for the characterization of rheological and mechanical behavior of concrete repair mortars. Three polymer cement mortars (PCM) and two reference cement mortars (CM) were studied. Restrained shrinkage, adhesion (bond strength) and compressive and flexural strength tests were performed. For the evaluation of shrinkage restrained, Ring Test and German Angle Method were conducted. The Pull-off test was chosen to characterize the bond strength of the mixtures made in the laboratory. It was also evaluated the ease of application of all the mortars studied on slabs of reinforced concrete (floor, wall and ceiling). The rheological parameters of each mortar were evaluated by the consistency test, qualitatively, and by the rheometry test to determine the yield stress value ($g$) and viscosity ($h$) of cement reference mortars and polymer cement mortars.

***Keywords:*** Polymer cement mortars (PCM), Cement mortars (CM), Adhesion, Applicability, Rheology, Rheometry.

## 1. Introduction

The need to repair reinforced concrete structures is not new. However, it’s still a current phenomenon, since concrete is certainly the most used material in construction.

Generally, cement mortars (CM) are highly used in structure repairing. However their accomplishment is insufficient due to its low adhesion to concrete support, high retraction and permeability. Therefore, some polymers were developed which when added to cement materials allow more durable repairs. The addition of polymers cause the appearance of a polymeric film, continuous or not, that allows the produced mortar to get a greater resistance to the penetration of aggressive agents (Afridi et al. 2003). Fowler (1999) and Ohama (1995) refer that the polymeric additives substantially improve the mortar, for low water/cement ratio (W/C), and polymer/cement ratio (SB/C) between 10% to 20%, also confirmed by Wang et al. (2011).

Polymer cement mortars (PCM) have the following advantages: greater adhesion to the support material (Afridi et al, 1995); lower permeability to water (Zhong and Chen, 2002); penetration of carbonation reduction (Ohama, 1998); greater resistance to acid environments, higher tension and flexural strength (Ribeiro Vieira da Silva, 2007), controlled shrinkage (Chastre, 2014) and increased fluidity (Wu et al., 2002).

The workability is a subjective mortar’s property, which depends on at least two parameters: fluidity, which is related to the ease of handling of the mortar; and cohesion, which is associated with resistance to exudation (Reis, 2008). The workability can be measured by flow table test, spreading, which is a rheological characterization tool, wherein the spreading obtained is related to the shear stress of the fluid (Roussel et al., 2005). However, the flow table test does not assess these rheological parameters, quantitatively, for mortars with different rheological parameters can have the same fluidity. The rheometry test allows quantifying the yield stress and viscosity through Eq. 1, which represents the flow curve analytically. The flow curve is characterized by the torque ($T$) variation with the rotation speed ($N$).

$$T = g + Nh \quad (1) \qquad \tau = \tau_0 + \eta\dot{\gamma} \quad (2)$$

The $g$ parameter is a proportional constant to yield stress and $h$ is a proportional constant to viscosity, according to Paiva et al. (2006). For Banfill (2003) the rheological behavior of a cement mortar is described by the Bingham model (Eq. 2) in which $\tau$ is the shear stress, $\tau_0$ is the yield stress, $\dot{\gamma}$ is the shear rate and $\eta$ is the viscosity.

In this article the properties in fresh and hardened state of PCM and CM will be compared. The composition of the mortars was conditioned by spreading target of 200 ± 10 mm, a value that has been adopted by other researchers (Ribeiro et al, 2008; Pina (2009), Dias, 2011; Damian, 2012). Two PCM were produced according to the data sheet for the polymer and a PCM with 15% polymer. The CM were produced with the same amount of water from the PCM.

## 2. Experimental

### *2.1. Materials*

The cement used is type CEM I 42.5 R according to EN 197-1. The sand particle size analysis was performed according to NP EN 933-2, characterized by a maximum size of 2 mm particles (Table 1), as recommended by Viskomat NT (Fig. 1). The superplasticizer (SP) was polycarboxylic acid based, with density 1.04 g/cm$^3$ and polymer was styrene-butadiene latex (SB) based with 25% solids content. The mortars' complete composition is shown in Table 2. Concrete C30/35 was also produced for the slabs production needed to analyze the application of mortars and the bond strength test. The cement and superplasticizer used in the concrete were the same as those used in the production of mortars. The complete concrete composition is shown in Table 3.

**Table 1 - Particle size distribution.**

| Sieve size (mm) | Total residue on sieve (%) |
|---|---|
| 2 | 0,14 |
| 1 | 1,02 |
| 0,5 | 46,72 |
| 0,25 | 89,56 |
| 0,125 | 99,52 |
| 0,063 | 99,74 |

**Fig. 1 – Viskomat Rheometer NT.**

### *2.2. Mortar mixing and testing procedures*

All mortars were produced with a Cement/Sand ratio 1:2,8 (weight). The procedure to prepare the mortars for testing was: (a) components weighing (b) introducing the cement into the mixer container, (c) mixing the polymer or superplasticizer with water, (d) introducing the water (and ) automatic mixing of the components for 3 minutes, (f) introducing the sand in the mixer's container after 30 seconds of mixing. The amounts of water, superplasticizer and polymer were conditioned by the objective of 200 ± 10 mm spreading.

In fresh state, the mortars were subjected to the following tests: flow table test (ASTM C 1437), air content (EN 1015-7, Method A), density (NP EN 12350-6), setting time (NP EN 196-3), application of mortars (floor, wall and ceiling) and rheometry. The rheometry test was carried out for 2 hours with 30 min intervals, and the chosen speed profile was the decreasing "step", in which the speed was kept constant for 3 min to 200, and 1 min to 180, 160, 140, 120, 100, 80, 60, 40, 20 rpm (Fig. 2). The spreading assay was performed for 3 hours with 15 min intervals.

In the hardened state the bond strength (EN 1542), the compressive and flexural strength (NP EN 196-1), and the shrinkage restrained (Ring Test and German Angle Method) were tested. The assays of resistance to flexion and compression strength were tested for two types of curing: moist-dry cure (4 days in a moist room with

T=23±2°C, HR=100% + 24 days in dry room with T=21±2°C °C, HR=70±3%) and moist cure (28 days in a moist room with T=23±2°C, HR=100%). The concrete slump test was performed according to NP EN 12350-2 and NP EN 12390-3 standard was used for the concrete compressive strength evaluation.

**Table 2 - Mortars formulation.**

| Materials (g) | Mortars | | | | |
|---|---|---|---|---|---|
| | PCM-SB-1 | PCM-SB-2 | PCM-SB-5 | CM-1.2 | CM-5 |
| Cement (C) | 500 | 500 | 500 | 500 | 500 |
| Sand (S) | 1400 | 1400 | 1400 | 1400 | 1400 |
| Superplasticizer (SP) | - | - | - | 2,5 | 5,5 |
| Polymer (SB) | 101,8 | 73,3 | 300,0 | - | - |
| Solid Content (polymer) | 25,4 | 18,3 | 75,0 | - | - |
| Liquid Content (polymer) | 76,3 | 55,0 | 225,0 | - | - |
| Mixing Water | 185 | 200 | 3 | 255 | 228 |
| Total Water* (W) | 261,3 | 255,0 | 228,0 | 255 | 228 |
| C/S ratio | 1:2,8 | 1:2,8 | 1:2,8 | 1:2,8 | 1:2,8 |
| W/C ratio | 0,52 | 0,51 | 0,46 | 0,51 | 0,46 |
| SB/C (%)** | 5 | 4 | 15 | 0,5 | 1,1 |

***Total Water = Liquid Content + Mixing Water, **SB/C = Solid Content of Polymer/Cement**

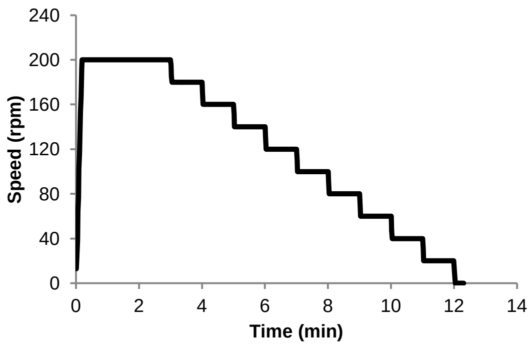


**Fig.2 - Schematic representation of the velocity profile “step”.**

**Table 3 – Concrete formulation used in slabs.**

| Materials (Kg) | |
|---|---|
| Cement | 19,00 |
| Sand | 35,80 |
| Small Crushed Stone | 11,00 |
| Crushed Stone 1 | 38,40 |
| Water | 9,50 |
| W/C ratio | 0,5 |
| Superplasticizer (g) | 45 |
| Slump (mm) | 60 |

## 3. Results and Discussions

### *3.1. Air content and density*

According to Ribeiro (2004) the value of the air content in cement mortars varies between 3% and 5%. However, Ohama (1998) states that with the presence of the polymer, the air content of the mortar can vary between 5% and 20%. This author also verified that the air content decreased with the increase of the proportion of polymer (Ohama, 1995). Specifically with PCM-SB, Fu and Chung (1996), concluded that the density of the PCM decreases with the increasing SB/C ratio, though the air content has also decreased.

It was expected that the CM presented a lower air content in the absence of polymer, however, as shown in Table 4, the added superplasticizer had the same effect as the polymer in the PCM, even the two types of mortars reaching the same amount of air content. The decrease of this parameter in the PCM-SB-5 mortars and CM-5 comes from the decrease of the W/C ratio.

The values of density will not meet the Fu and Chung (1996) conclusions, since they increased with the increase ratio SB/C (Table 4), however PCM-SB-5 has a lower ratio W/C, which enables an increase in density. Even achieving the same amount of air content, PCM have a lower density of the CM. This phenomenon can be explained by the increase of closed pores, with the addition of polymer mortars (Barluenga and Olivares, 2004).

**Table 4 – Mortars fresh state proprieties.**

| Mortar | SP (%) | SB (%) | W/C ratio | Spread (mm) | Air Content (%) | Density (kg/m$^3$) | Initial setting time (min) | Final setting time (min) |
|---|---|---|---|---|---|---|---|---|
| PCM-SB-2 | 0 | 4 | 0,52 | 209 | 12 | 1748 | 165 | 310 |
| PCM-SB-1 | 0 | 5 | 0,51 | 206 | 12 | 1788 | 150 | 305 |
| PCM-SB-5 | 0 | 15 | 0,46 | 201 | 12 | 1899 | 215 | 315 |
| CM-1.2 | 0,5 | 0 | 0,51 | 203 | 9 | 2110 | 210 | 330 |
| CM-5 | 1,1 | 0 | 0,46 | 182 | 9 | 2137 | 210 | 325 |

### *3.2. Setting time*

Table 4 shows that the small polymer dosage in the PCM and PCM-SB1-SB-2, produced an initial lower setting time. This behavior is due to the effect of setting accelerator, the styrene-butadiene polymer, according to Ali et al. (2006). All other mortars obtained an initial setting time very similar.

### *3.3. Rheometry, flow table measurements and application in concrete*

In the rheometry and spreading test there was great difficulty in testing the CM-5, because it got 182mm initial spreading (Table 5) and in rheometry could only be tested up to 30 minutes after mixing. When applying CM-5 to concrete, it just joined on the floor slab.

In Table 5 the effect of the polymer up to 90 minutes is visible, comparing the PCM-SB-1 and SB-2-PCM mortar, with the CM-1, wherein the PCM showed a less sharp decline in loss of spreading. However, on the 135th minute, all the mortars obtained a very similar spreading difference, regarding the initial spread. Against expectations PCM-SB-5, despite having a higher dosage of polymer, expressed a very abrupt decrease spreading within 90 minutes, having a difference of 23 mm spreading over PCM-1 and SB-PCM- SB-2 and having very close values of the two CM. This unevenness is provided by the great viscosity of this mortar.

**Table 5 – Spread evolution in time of mortars.**

| Mortar | Time (min) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 |
| PCM-SB-1 | 209 | 206 | 204 | 198 | 195 | 190 | 188 | 173 | 171 | 165 | 163 | 152 | 144 |
| PCM-SB-2 | 206 | 204 | 202 | 197 | 196 | 195 | 189 | 185 | 177 | 163 | 151 | 147 | 142 |
| PCM-SB-5 | 201 | 198 | 194 | 188 | 183 | 174 | 166 | 164 | 163 | 159 | 157 | 153 | 147 |
| CM-1.2 | 203 | 196 | 185 | 180 | 176 | 170 | 165 | 156 | 156 | 149 | 146 | 141 | 137 |
| CM-5 | 182 | 173 | 173 | 173 | 169 | 168 | 165 | 159 | 153 | 145 | 143 | 141 | 135 |

The ceiling surface is the most adverse to the application of mortars, and the presence of the polymer made a difference in the adhesion to the support, since no CM joined to the ceiling. However, the spreading of 200 ± 10mm has proved to be excessive when used in ceilings. Of all the mortars, the hardest work was the PCM-SB-5, due to its "sticky" texture, due to the low amount of water in its composition, promoting difficulties in freeing the application material.

Increasing the dosage of polymer, in small dosages, caused a reduction in both yield stress (***g***) (Fig. 3, Fig. 4) and viscosity (***h***) (Fig. 4). This was evident during the application of PCM-SB-1 mortars, PCM-SB-2 and CM-1.2, slabs, since CM-1.2 could only be analyzed for up to 60 minutes in the rheometer and could not be applied on the ceiling. However, for high polymer content, the parameters ***g*** and ***h*** increased (Fig. 5-7), justified by "sticky" texture of the mortar, so that PCM-SB-5 showed a higher torque to the CM-5.

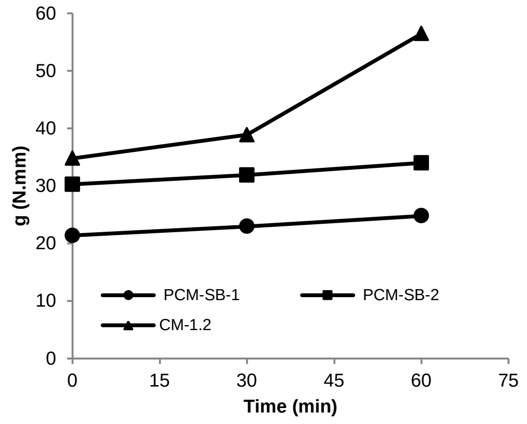


**Fig. 3 - Variation of *g*, over time, for mortars with W/C ratio = 0.51 and with the same initial spread.**

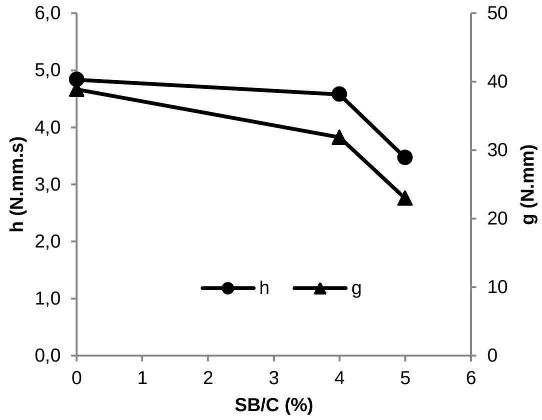


**Fig. 4 - Variation of the parameters of *g* and *h* with polymer dosage, 30 minutes after the first mixture for mortars with W/C = 0.51 and with the same initial spread.**

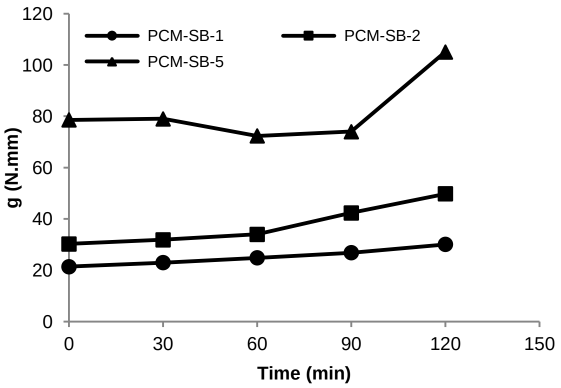


**Fig. 5 – Variation of *g*, PCM-SB, with the same initial spreding, over time.**

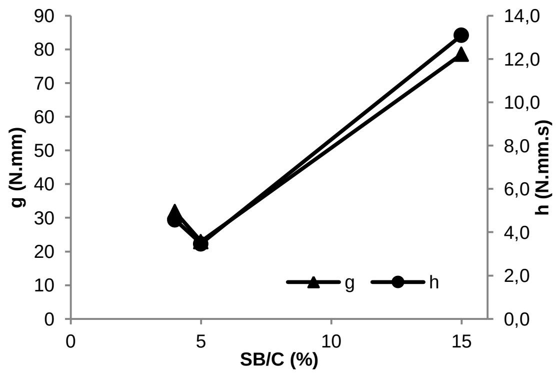


**Fig. 6 – Variation of *h* with polymer dosage, 30 minutes after mixing, for PCM-SB.**

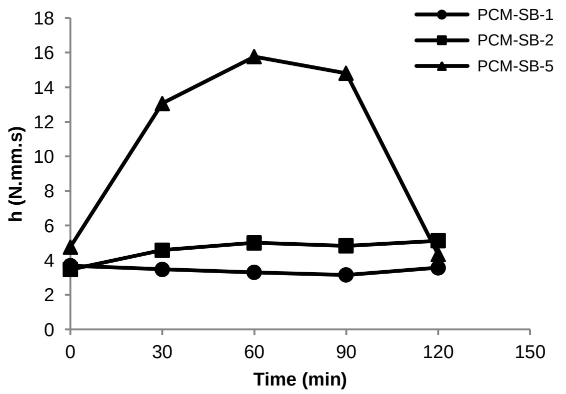


**Fig. 7 – Variation of *h*, PCM-SB, with the same initial spreading, over time.**

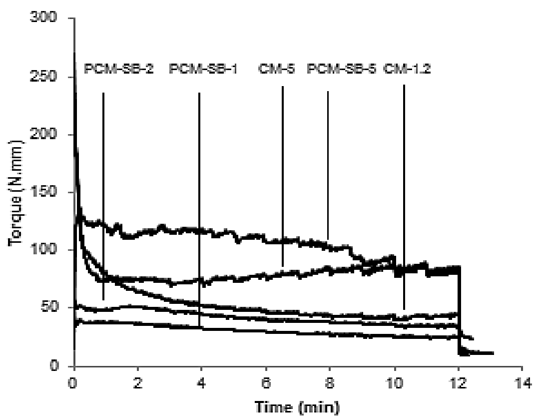


**Fig. 8 – Variation of the Torque over time, 30 minutes after the first mixture, to PCM-SB and CM.**

Increasing the water content permitted a significant decrease of torque in mortars (Fig. 8). Fig. 9 and Fig. 10 allow verifying the conclusion of Senff et al. (2009), that is, the flow table test is more related to the yield stress than to the viscosity. In the PCM-SB-1 and SB-2-PCM mortars, the decreasing of the parameter ***g*** with spreading is almost linear. In PCM-SB-5 this regression has a minor adjustment due to the erratic behavior presented, caused by the ratio SB/C = 15%. The $g$ and $h$ values for the studied time, are shown in Table 6.

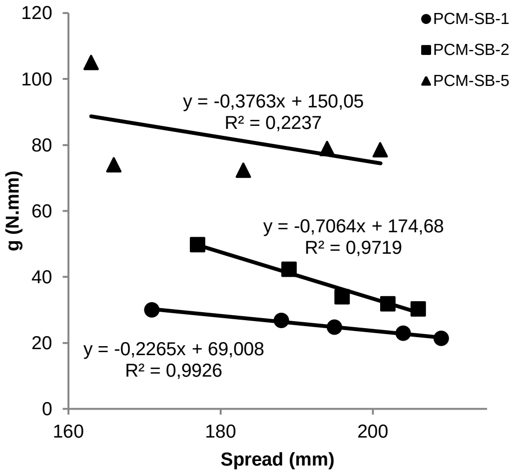


**Fig. 9 – Spreading variation with viscosity, to PCM-SB.**

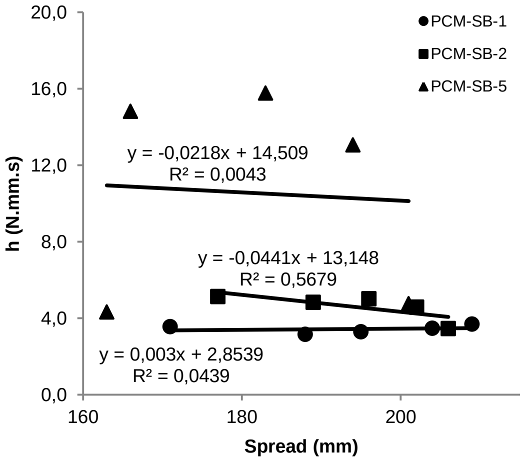


**Fig. 10 – Spreading avriation with yield stress, to PCM-SB.**

**Table 6 - Rheological parameters of the mortars tested 0, 30, 60, 90 and 120 min after mixing.**

| Time | Parameter | Mortars | | | | |
|---|---|---|---|---|---|---|
| | | PCM-SB-1 | PCM-SB-2 | PCM-SB-5 | CM-1.2 | CM-5 |
| 0 min | g (N.mm) | 21 | 30 | 79 | 35 | 62 |
| | h (N.mm.s) | 3,7 | 3,5 | 4,8 | -0,37 | -2,8 |
| | $R^2$ | 0,96 | 0,90 | 0,97 | 0,04 | 0,11 |
| 30 min | g (N.mm) | 23 | 32 | 79 | 39 | 89 |
| | h (N.mm.s) | 3,5 | 4,6 | 13,1 | 4,8 | -4,5 |
| | $R^2$ | 0,97 | 0,94 | 0,96 | 0,81 | 0,88 |
| 60 min | g (N.mm) | 25 | 34 | 72 | 56 | - |
| | h (N.mm.s) | 3,3 | 5,0 | 15,8 | 2,4 | - |
| | $R^2$ | 0,95 | 0,99 | 0,98 | 0,10 | - |
| 90 min | g (N.mm) | 27 | 42 | 74 | - | - |
| | h (N.mm.s) | 3,2 | 4,8 | 14,8 | - | - |
| | $R^2$ | 0,92 | 0,82 | 0,94 | - | - |
| 120 min | g (N.mm) | 30 | 50 | 105 | - | - |
| | h (N.mm.s) | 3,6 | 5,1 | 4,3 | - | - |
| | $R^2$ | 0,97 | 0,89 | 0,46 | - | - |

### *3.4. Restrained Shrinkage*

For each mortar a ring ($Ø_{ext}$ = 127mm, $Ø_{int}$ = 90mm) was used and two angles (30x30x30 $mm^3$). According to Resende (2007) Eq. 3 allows to calculate the amount of shrinkage in the ring and Eq. 4 allows the calculation of the value of shrinkage in the angle.

$$\varepsilon_{sh,} = W_{cr,ring} / (\pi \times Ø_{med}) \qquad (3) \qquad\qquad \varepsilon_{sh,} = W_{cr,total} / l \qquad (4)$$

The $W_{cr,\,ring}$ (mm) is the sum of opening crack, at 40 days of age, $Ø_{med}$ (mm) is the average inner diameter and the outer ring. The $W_{cr,\,total}$ (mm) is the average sum of the opening crack, each set of angles corresponding to the same mortar after 90 days of age, $l$ (1000mm) is the length of the angle and $\varepsilon_{sh,\,r}$ is the value of the restrained shrinkage.

Contrary to expectation, the PCM-SB-1 and PCM-SB-2 mortars presented a greater shrinkage than CM-1.2, in German Angle Method (Table 8), showing an inefficiency of the polymer used, of styrene-butadiene, in the formulation of mixtures which according to Resende (2007) it is indeed appropriate to nullify the cracking provoked by shrinkage. However, in the case of PCM-SB-5, the opposite result occurs, having almost a third of the shrinkage CM-5.

It is not possible to make a parallel between the results of both tests, mentioned in the previous paragraph. Fig. 11-a and Fig.11-b show the cracking of PCM-SB-1 mortar, on Ring Test Method Angle and German, respectively.

**Table 7 – Mortars Shrinkage on the Ring Test.**

| Mortars | Crack Age (days) | Nr of cracks | $W_{cr}$ (mm) | $\varepsilon_{sh,\ rest}$ ($x10^{-3}$) |
|---|---|---|---|---|
| PCM-SB-1 | 30 | 1 | 0,13 | 0,38 |
| PCM-SB-2 | 0 | 0 | 0 | 0 |
| CM-1.2 | 30 | 1 | 0,09 | 0,26 |
| PCM-SB-5 | 0 | 0 | 0 | 0 |
| CM-5 | 0 | 0 | 0 | 0 |

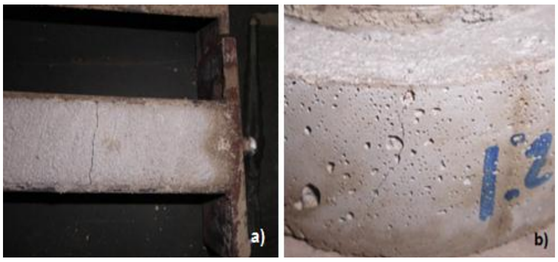


**Fig. 11 – PCM-SB-1 cracking, on the Ring Test (a) and German Angle Method (b)**

**Table 8 – Mortars shrinkage on the Gemran Angle Method.**

| Mortars | Specimen | Age of the first crack (days) | Nr of cracks | $W_{cr}$ (mm) | $W_{cr,\ total}$ (mm) | $\varepsilon_{sh,\ r}$ ($x10^{-3}$) |
|---|---|---|---|---|---|---|
| PCM-SB-1 | A | 7 | 1 | 0,5 | 0,5 | 0,5 |
| | B | 7 | 1 | 0,5 | | |
| PCM-SB-2 | C | 6 | 1 | 0,8 | 0,4 | 0,4 |
| | D | 0 | 0 | 0 | | |
| CM-1.2 | E | 9 | 1 | 0,4 | 0,33 | 0,33 |
| | F | 31 | 3 | 0,26 | | |
| PCM-SB-5 | G | 14 | 1 | 0,1 | 0,25 | 0,25 |
| | H | 14 | 1 | 0,4 | | |
| CM-5 | I | 6 | 1 | 0,6 | 0,65 | 0,65 |
| | J | 6 | 1 | 0,7 | | |

## *3.5. Bond Strength*

Both the PCM-SB-1 and PCM-SB-2 (Table 9), have values outside the expected where in the first case the ceiling adhesion was higher than on the wall, and in the other case the adhesion on the floor was lower than on the wall.

Comparing the PCM-SB, shows what Ukrainczyk and Rogina (2013) had already concluded, the bond strength increases with polymer content.

In conclusion, none of the average values of bond stress respects what was specified in NP EN 1504-3 for structural mortars R3 class at 28 days of age (≥ 1,5MPa), due to the preparation technique used (hammer and chisel), for all tests had an adhesive rupture (mortar-concrete interface).

Fig. 12-a shows a paving slab and 5 samples of the pull-off test. In Fig. 12-b is shown a test specimen after the pull-off and Fig. 12-c shows the paving slab after the test pull-off has been performed.

**Table 9 - Bond strength of mortars**

| Bond Strength (MPa) | | | | | |
|---|---|---|---|---|---|
| Surface | Mortars | | | | |
| | PCM-SB-1 | PCM-SB-2 | PCM-SB-5 | CM-1.2 | CM-5 |
| Floor | 0,54 | 0,55 | 1,2 | 1,14 | 0,63 |
| Wall | 0,26 | 0,61 | 1,19 | 0,24 | –* |
| Ceiling | 0,48 | 0,13 | 0,96 | –* | –* |

*** Could not apply the mortar by nonadhesion.**

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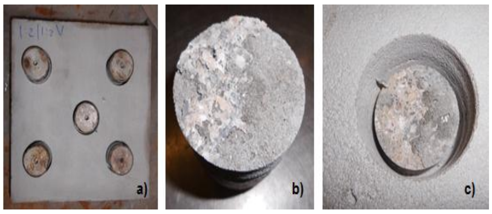


**Fig. 12 - Paving slab with 5 test samples (a), after the specimens pull-off test (b) after the paving slab pull-off test (c).**

*3.6. Compressive and flexural strength*

For Wang et. al. (2005), Bureau et al. (2001) and Killermann and Schulze (2001) the compressive strength of the polymer cement mortar, is generally lower than for the unmodified. According to Knapen and Gemert (2015) this is due to the greater entrainment of air, which is opposed to the possible enhancement of the hydrated cement matrix. This air entrainment reduces the mortar density and consequently the compressive strength. Schulze (1999) states that the increase in the W/C ratio causes a reduction in compressive strength and flexural strength in polymer cement mortars.

Aggarwal et al. (2007), Gemert et al. (2004) and Fowler (2004) found that the flexural strength at 28 days of PCM, increases with the increase of SB/C according to a linear function. Rixom and Mailvaganam (1999) explain that it is due to the increased bonding strength between the hydrated cement and aggregate components, and the existence of polymeric film widespread in the cement matrix.

For PCM, Rogina and Ukrainczyk (2010), Hassan et al. (2001) and Maranhão (2015) obtained better results with compressive strength and flexural strength with the dry cure. Moreover Parghi and Alam (2016), Resende (2007) Jenni et al. (2006) concluded that the cure should include a wet stage, which will hydrate the cement, and a dry phase, which will allow the formation of the polymer film, enabling the maximization of the results obtained by the incorporation of polymers. According to Wang et al (2006) polymeric film retains sufficient water for the hydration of the cement.

**Table 10 - Results of Compression and Flexion of the PCM-SB tests with moist-dry cure and wet cure.**

| Mortars | Test | | | |
|---|---|---|---|---|
| | Compressive strength (MPa) | | Flexural strength (MPa) | |
| | Moist-dry Cure | Wet Cure | Moist-dry Cure | Wet Cure |
| PCM-SB-1 | 29,2 | 30,5 | 6,0 | 5,3 |
| PCM-SB-2 | 23,5 | 22,8 | 5,4 | 4,6 |
| PCM-SB-5 | 33,5 | 26,5 | 8,5 | 7,2 |

In Table 10 one can see that increasing SB/C promoted an increase of the compressive strength of the PCM-SB, and that the tensile strength by bending increased linearly with the polymer concentration (Fig. 13). The CM showed higher flexural strength than PCM-SB-1 and SB-2-PCM and greater resistance to compression than any PCM-SB. Although the compressive strength, analyzing NP EN 1504-3, it is concluded that all except PCM-SB-2, satisfy the specified condition for R3 structural class (compressive strength ≥ 25MPa), with the CM integrating the structural class of R4 (compressive strength ≥ 45MPa). The Fig. 14 shows a linear growth of compressive strength with the density of mortars.

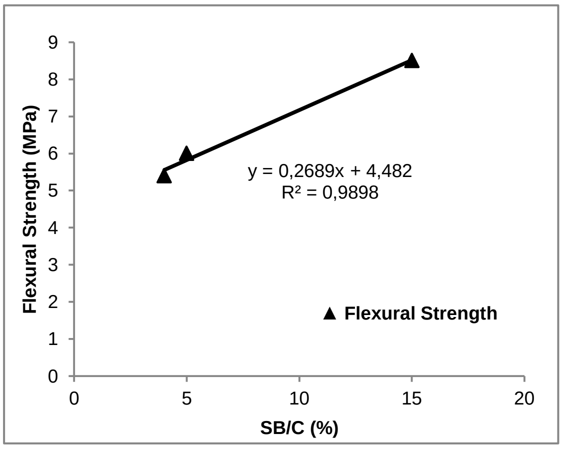


**Fig. 13 – Flexural strength variation with the polymer dosage.**

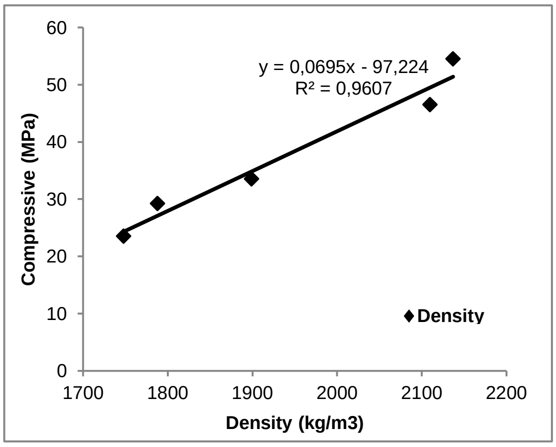


**Fig. 14 - Density variation with the polymer dosage.**

The results shown in Table 10 go against the conclusions of Parghi and Alam (2016), Resende (2007) and Jenni et al. (2006). All the mortars had a higher compressive and flexural resistence in moist-dry cure, except PCM-SB-1 compression strength, after 28 days. In wet cure, flexural strength also increased with the enlargement of the polymer content in mortars

## 4. Conclusions

In the spreading flow table test, the superplasticizer proved to be ineffective for the CM-5 reference mortar, since it has not reached the spreading 200±10mm. However, for the CM-1.2, a very small dosage of superplasticizer (0,5%), allows achieving the same spreading as the polymer cement mortar.

The styrene-butadiene polymer had a setting accelerator effect on the mortar when it was used.

During the application of mortar, it was found that the spreading of 200 ± 10mm was unsuitable for the application of mortar on the ceiling and PCM-SB-5 was very difficult to apply because it had almost no water in its composition.

By comparing the results of spreading, over time, with the rheometry test, it was found that spreading obtained through the mortar is directly related to yield stress. It is also noted that the yield stress (***g***) and the viscosity (***h***) decreased with the increase in the polymer/cement ratio, and that the increase in the W/C ratio caused a decrease of torque in the CM.

The PCM-SB-5 mortar obtained in this assay yield stress and viscosity values higher than PCM-SB-1 and SB-2-PCM, evaluating quantitatively the already observed after being manually applied. The insufficient workability of the CM was justified by the high values of yield stress and viscosity, not being possible to assess all times studied for the PCM-SB.

In the restrained shrinkage and bond strength test, the polymer used showed to be effective only for the relation Polymer/Cement=15%.

In the compressive strength characterization, the CM showed better results. However, in the PCM-SB, the compressive strength was higher with the increase of the ratio polymer/cement. The evaluation of the flexural strength was subsidized with the increase of polymer in mortars and its dosage.

The moist-dry cure allowed better results than the wet cure in the resistance to compressive and flexural strength.

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