XV International Conference on Durability of Building Materials and Components
DBMC 2020, Barcelona
C. Serrat, J.R. Casas and V. Gibert (Eds)

Influence of Lightweight Concrete Block Support on Physical and Mechanical Characteristics of Applied Mortars

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Abstract. *The objective of the present work is to analyze the influence of the lightweight concrete block support on the physical and mechanical characteristics of the applied mortar. This work aims to understand how the physical and mechanical properties of the mortar are modified by the support. The methodology used consisted of conducting laboratory experimental tests to compare the behavior of mortar molded in standard moulds with the behavior of mortar applied to lightweight concrete block supports. Open porosity, bulk density, capillary water absorption, water vapor permeability and compressive strength were studied. These results have shown how the support influences the characteristics of the mortar, improving the understanding of the performance of the applied mortar. This study provides a global approach to the assessment of mortar characteristics, considering the analysis and comparison of mortar applied to the support and molded in the laboratory, according to current standards. Such understanding may contribute to the reassessment of the way mortars are produced, seeking to optimize their characteristics and compatibility with the support.*

Keywords: *Mortar, Support, Performance, Lightweight Concrete Block.*

1 Introduction

Coating mortars have an important role in protecting buildings from degradation agents (Flores-Colen, 2016). One of the most important in-service degradation agents is water, which can lead to physical, chemical and, in some cases, mechanical deterioration (Addleson, 1991). Thus, the performance of coating mortars is influenced by water capillary absorption, hygroscopic moisture content, water permeability, diffusion of water vapor, porosity, soluble salts content and propensity for the growth of microorganisms (Flores-Colen, 2013).

Therefore, it is very important to ensure the quality of the applied mortars, as they contribute significantly to the durability of buildings. For this, it is important to use mortars that are compatible with the supports and that will ensure adequate protection to the building. Thus, low water permeability, good water vapor permeability, good adhesion to the substrate, deformation capacity, among others, are sought (LNEC, 1968; Flores-Colen, 2009; Martins, 2008; Arromba, 2011).

The influence of different factors on the behavior of mortars, such as the quality of the binder, aggregate particle size, water-binder ratio, application conditions, and dosage, have been extensively studied (Torres, 2014; Veiga, 2005; Veiga, 1998; Valente, 1996). However, there are still few studies on the influence of the support on mortar characteristics (Torres, 2014). This work aims to contribute to this knowledge.

This research intends to identify how the lightweight concrete block support influences the performance of the applied mortar, considering that the applied mortar is in different conditions than those of mortars hardened in laboratory molds. Thus, the understanding of the characteristics of the applied mortar and the possibility of creating a correlation with the characteristics of the mortar hardened in laboratory molds, may enable a greater compatibility of the mortar with the support and provide data for the optimization of mortar composition. Such understanding may help to increase the in-service durability of mortars.

2 Materials and Methods

2.1 Materials

In this experimental campaign, the following materials were used: lightweight concrete blocks, with Leca expanded clay aggregates, with dimensions of 50 x 20 x 10 cm^3, CEM II / BL 32.5N cement and sand with well-distributed granulometry. For the cement mortar preparation, a cement/sand ratio of 1:4, in volume, and a water/cement ratio of 1:1, in weight, were used.

2.2 Methodology

A laboratory experimental campaign was carried out, for the comparison of the characteristics of the cement mortar hardened in standard laboratory metallic molds and the characteristics of the cement mortar applied to (and later detached from) lightweight concrete block supports.

For the execution of the tests and comparison of the results, the mortars hardened in the standard molds (with dimensions of 40 x 40 x 160 mm^3) were cut into slices of 40 x 40 x 15 mm^3, thus having the same dimensions of the mortar samples applied to the support and later detached.

To prepare the applied mortars, wooden molds were made in order to ensure a constant thickness (1.5 cm) of the mortar applied to the lightweight concrete block support, according to figure 1.

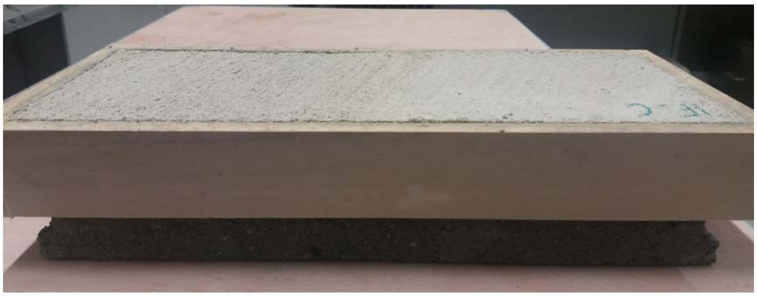

Figure 1. Lightweight concrete block with wooden frame and applied mortar.

As an initial step, the bricks were dried until mass stabilization, and, before applying the cement mortar, each support was wetted by spraying 100 ml of water.

The tests were performed after 28 days of curing. The curing was carried out according to the indications of EN 1015-11: 1999, both for the mortar hardened in the molds and for the mortar applied to the supports. The curing conditions were as follows:

• First 2 days: temperature of 20ºC +/- 2ºC, inside of a polyethylene bag (in the mold);

• Next 5 days: temperature of 20ºC +/- 2ºC, inside of a polyethylene bag (demolded);

• 21 days remaining: temperature of 20ºC +/- 2ºC, relative humidity of 65% +/- 5% (without the mold).

The tests carried out in this experimental campaign are listed in table 1. The results presented in the following sections refer to the average of results obtained in tests carried out on three specimens.

Table 1. Tests conducted and standards followed.

Test	Standard
Water absorption by capillarity	ISO 15148:2002
Open porosity	NP EN 1936:2008
Bulk density	NP EN 1936:2008
Water vapor permeability	ISO 12572:2016
Mechanical strengths	EN 1015-11:1999

3 Results and Discussion

3.1 Open Porosity

Open porosity represents the relationship between the volume of open pores and the apparent volume of the sample. Figure 2 presents the mean open porosity results and indicates a slight reduction in the open porosity of the detached mortar in relation to the mortar hardened in the mold. This can demonstrate a greater compactness of the applied mortar. In fact, when a mortar in the fresh state comes into contact with a porous support as is the case with lightweight concrete blocks, its mixing water together with the smaller particles is absorbed and as a consequence there will be a decrease in its pores and its open porosity.

3.2 Bulk Density

The determination of bulk density by the geometric method reflects the simple relationship between the dry mass and the apparent volume (including all voids) of a sample. Figure 3 shows a slight increase in the mean density of the mortar detached from the support in relation to the mortar hardened in the mold, which is consistent with the reduction of the open porosity.

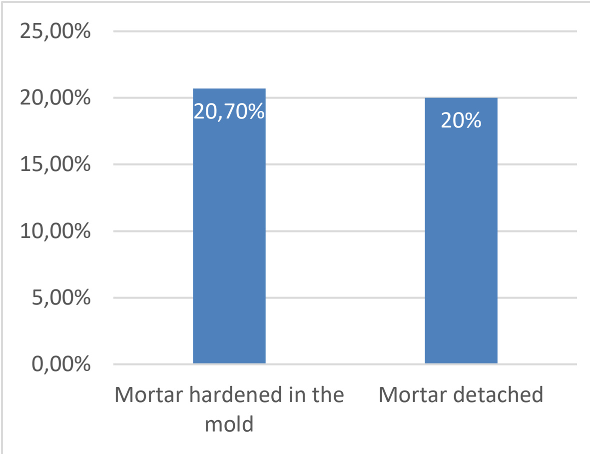

Figure 2. Open porosity.

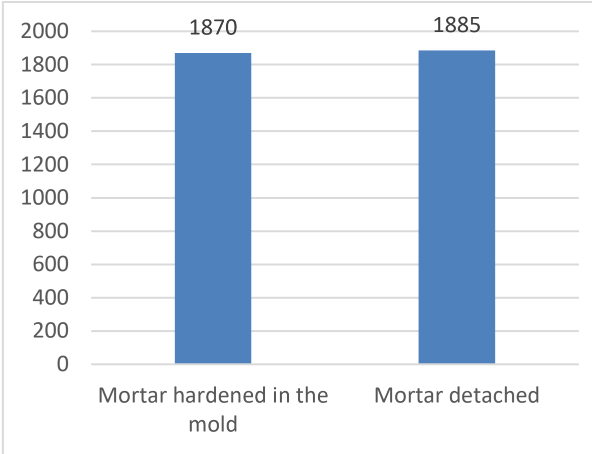

Figure 3. Bulk density (kg/m³).

3.3 Capillary Water Absorption

The water absorption coefficient provides an indication of the water-absorbing capacity of a mortar when placed in contact with a water film.

It can be seen, in figure 4, that the mortar hardened in the mold has a higher coefficient than the mortar detached from the lightweight concrete block support. These results confirm a slight increase in the compactness of the mortar applied to the lightweight concrete block, as mentioned in the discussion of the open porosity results.

3.4 Water Vapor Permeability

The water vapor permeability coefficient reflects the ability of a material to be traversed by water vapor. It can be seen, in Figure 5, that the mean water vapor permeability coefficient of the detached mortar is lower than that of the mortar hardened in the mold — such a result demonstrates a greater resistance to the passage of water vapor by the detached mortar in relation to the mortar hardened in the mold.

3.5 Compressive Strength

Figure 5 shows the mean results obtained in the compression test and indicates that the mortar hardened in the mold presented a slightly higher compressive strength in relation to the detached mortar. Although the decrease in open porosity could lead one to think that the mechanical strength would increase, it is possible that this decrease may be due to some weakening that may have occurred when detaching the mortar from the substrate.

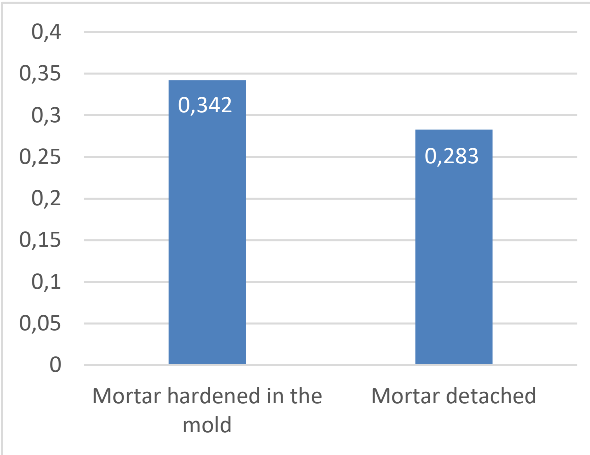

Figure 4. Capillary water absorption coefficient (kg / ($m^2.s^{0.5}$).

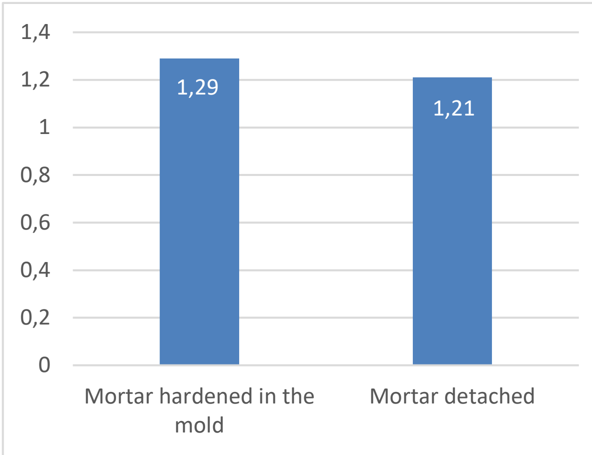

Figure 5. Water vapor permeability coefficient [(kg/(m.s.Pa).10^{-11}].

An expected result face to the obtained results for the characteristics already mentioned.

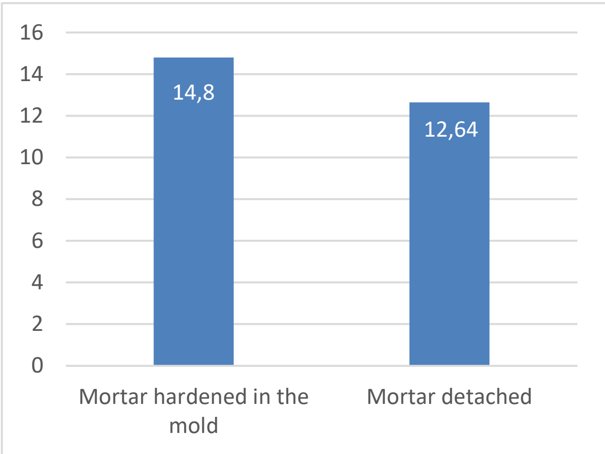

Figure 6. Compressive strength (MPa).

4 Conclusions

As a conclusion, it can be observed that the mortar detached from the support has slightly different characteristics in relation to the mortar hardened in the molds; however, it is not clear that these differences are due to the support. The support can influence the characteristics of the applied mortar, as already seen in previous works using the ceramic brick support (e.g. Torres, 2014), however this influence was not significant for the lightweight concrete block.

It can be seen that the mortar applied to the lightweight concrete block is slightly more compact, with less open porosity. Consistently, the lower water absorption and lower water vapor permeability occurred for the mortar applied to the support. Conversely, the compressive strength of the applied mortar is lower than that of the mortar hardened in the mold.

The influence of the support on the physical and mechanical characteristics of the applied mortar is a relevant issue in relation to performance and durability, and extensive studies on different types of supports and different types of mortar may increase the compatibility of the mortar/support interface.

Acknowledgements

The work presented was carried out within the framework of the IF MORTAR project (POCI-01-0145-FEDER-032223, PTDC/ECI-EGC/32223/2017,), within the scope of the Portugal 2020 program, financed by FEDER through the POCI program. The funding provided is kindly acknowledged. The authors also thank CERIS and CERENA, research units from IST.

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