Mortar of lime and natural cement for the restoration of built cultural heritage

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Abstract— *The cultural heritage built in Algeria shows the diversity and the durability of building materials in use. The need to restore the archaeological monuments requires the use of the long-lasting, successful and compatible materials used by former builders. We propose in this study the exploitation of the natural cement as an addition in the formulations of mortars of restoration.*

Samples were developed with air lime with the addition of (5%, 10% and 15%) natural cement. The results of analysis of the physical and mechanical characteristics showed an improvement of the properties of elaborate mortars.

The content of 10% of addition gave better results in terms of absorption (16.60%) and mechanical resistance to the compression (1.62 MPa) and to the flexion (0.10 MPa), with regard to the other percentages, it indicates a compatible use with the restoration in old buildings.

Keywords— Mortar, Lime, Natural cement, Characteristics, Restoration.

I. INTRODUCTION

The mortar is one of building materials used to show solidarity of elements between them, assure the stability of the work and fill chinks between the blocks of construction. Generally, the mortar consists of a sociable disposition (binder), an aggregate (grease remover), an addition and a water [1,2].

To obtain hydraulic and resistant mortars, the former (old) builders used some lime, some sand with addition of pozzolana and the plundered brick [3]. The natural cement discovered at the beginning of the 19th century by Louis Vicat, brings to mortars of lime, the short-term resistance and limits its retreat (withdrawal) without disrupting (perturbing) so much the character to let inhale the walls of construction of old (former) buildings [4]. The various civilizations which followed one another in Algeria, the imprint of their buildings is marked well by the difference of materials used in the constructions.

Our work is aimed at developing mortars of air lime of Ghardaia with the use of natural cement (quick) as addition with different percentages (5, 10 and 15%). Two other mortars were developed as references, the first one consists of 100% of air lime and the second contains 100% of natural cement as sociable disposition (binder). The comparison between the physical and mechanical results (profits) [5] of various types (chaps) of elaborate mortars showed that the addition of 10% of natural cement gave better results with regard to (compared with) the other percentages as for the absorption, the retreat (withdrawal) and the mechanical resistance in the compression and in the flexion.

These results (profits) allow the use of natural cement as an addition in mortars of lime to improve certain physical and mechanical characteristics, while keeping the compatible character with former buildings. To widen the interval of addition of natural cement for various contents will allow to encircle better the behavior of this hydraulic sociable disposition(binder) in the restoration(catering) of historic monuments [6].

II. EXPERIMENT

The various raw materials used in the elaboration of mortars to be characterized are as follows:

The sociable dispositions (binders), Air lime of Ghardaïa, Natural cement (Roman cement) / VICAT, - Grease removers (aggregates): Black sand (Oued), with a size grading, Fine yellow sand , Plundered brick, with a size grading .and Natural cement.

Test tubes were realized according to the references normative as base(basis) of composition and work. Mold: 4x4x16cm and Proportion: 1Volume (sociable disposition) + 3Volume (aggregates) + 1Volume water Five realized compositions are presented in table 1.

TABLE 1

THE VARIOUS TYPES OF MORTARS DEVELOPED AT THE LEVEL OF THE LABORATORY.

Type of mortar	Composition
Mortar of lime (100 %)	Air lime of Ghardaia + black sand + yellow sand + plundered brick + water
Mortar of lime with 5 % of natural cement	Air lime of Ghardaia + black sand + yellow sand + plundered brick + 5 % of natural cement + water
Mortar of lime with 10% of natural cement Mortar of lime with 15 % of natural cement Mortar of natural cement (100 %)	Air lime of Ghardaia + black sand + yellow sand + plundered brick + 10 % of natural cement + water Air lime of Ghardaia + black sand + yellow sand + plundered brick + 15 % of natural cement + water Natural cement + black sand + yellow sand + plundered brick + water

The percentage of the addition of the natural cement was taken with regard to the weight of the sociable disposition (lime Ghardaia).

2.1. Results of analysis

The samples of mortars underwent (in the laboratory of Ceramic, Boumerdes University), the analysis of the following physical characterizations (humidity, density, specific mass, absorption of water), and at the level of research laboratory LMMC Boumerdes samples underwent the analysis of the following mechanical characteristics (fold resistance, compression resistance) [7,8]. The results are given in table 2 and figure 1.

TABLE 2

PHYSICAL CHARACTERISTICS OF ELABORATE MORTARS

Samples	Humidity (%)	Absorption (%)	Density (g/cm^3)	Specific mass (g/cm^2)
Mortar of lime (100 %)	0.77	15.60	1.64	2.25
Mortar of lime with 5 % of natural cement	2.16	17.02	1.68	2.01
Mortar of lime with 10% of natural cement	1.77	16.60	1.70	2.21
Mortar of lime with 15 % of natural cement	2.25	17.32	1.68	2.06
Mortar of natural cement (100 %)	6.37	15.52	1.76	2.20

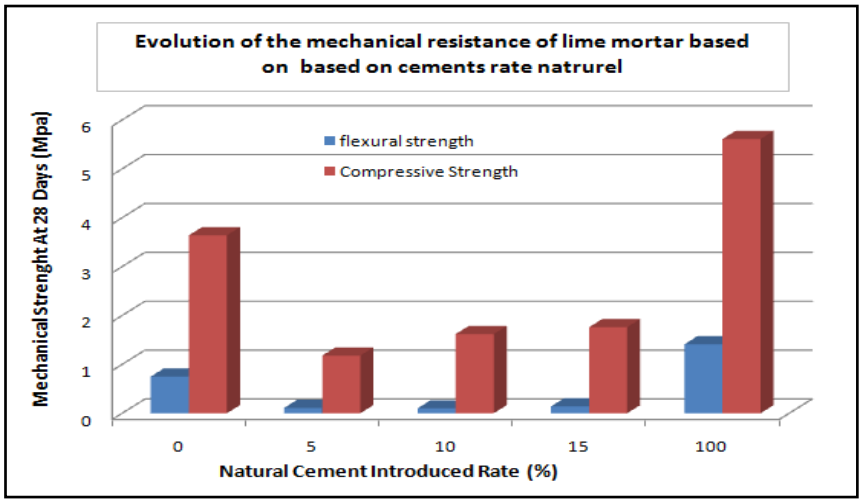

FIGURE1: MECHANICAL CHARACTERISTICS OF ELABORATE MORTARS

2.2. Discussion

Through the obtained results (profits), we can notice that the values of absorptions vary from 15.52% to 17.32%, densities enter 1.64 and 1.76g/cm^3 and the specific masses of 2.00 in 2.25g/cm^3. This shows that the values of the physical characteristics are very close. .Les values of the mechanical resistance in the flexion vary between (0.10 and 0.75 MPa, values which are also very close. On the other hand, we notice that the mechanical resistances of the sociable dispositions (binders), the lime 100% and natural cement 100%, are different with regard to (compared with) the various additions.

The use of natural cement as addition showed that the latter has a role more at least complementary (additional) with the lime (acceleration of grip (taking) without disrupting (perturbing) its qualities, and we noticed that the mortar which contains the proportion of 10% of natural cement gave better results (a 16.60% absorption and a compression resistance which arrives at 1.62 MPa) with regard to(compared with) the other proportions.

The use of the natural cement as sociable disposition showed that this cement improves the mechanical resistance and lowers (dims) the degree of absorption of water of the mortar (a 15.52% absorption and a compression resistance of 5.61 Mpa), with the quick character which asks for a fast and on-the-spot use of this mortar [9].

III. CONCLUSION

The values of the physical and mechanical characteristics fléxion, various compositions developed at the level of the laboratory are very close, which shows that the addition of the natural cement is very compatible with the use (custom) in the former (old) buildings.

The content of 10 % of added natural cement gave the physical and mechanical better results with regard to the other 5 % additions and 15%. The mortar containing 100 % of natural cement gave better one value of absorption of water (15.52%) and a mechanical resistance in the compression (5.61Mpa which is upper to the other compositions. This shows that the addition of the natural cement improves the physical and mechanical characteristics of the mortar and confers him a use in the former built, particularly as mortar of damp-proofing filler or terrace.

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