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OPTIMAL COMPOSITION OF PLASTER MORTAR REINFORCED WITH PALM FIBERS

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ABSTRACT :

The practical application of local resources (date palm fiber, sand dunes, and plaster) for the southern Algerian region is the goal of this investigation. significantly expanding the range of applications for these substances in the building industry. Even though gypsum is widely available, its applications are restricted to secondary processes like coating and ornamental features. There is very little use of palm fiber and sand dunes in construction. Sand dune material and palm fiber were incorporated into plaster and cement for the present investigation because of their mechanical and physical qualities, which enable their use in structure. The findings demonstrated that adding date palm fibers enhances both the mechanical (compression strength, flexural durability, etc.) and physical qualities (the density, retention of water, etc.) .

Keywords: Plaster Mortar, Palm Fiber Reinforcement, Composite Materials, Mechanical Properties, Sustainable Construction, Fiber-Reinforced Mortar.

INTRODUCTION

In the present experiment, plaster and cement with mechanical and physical qualities that enable their use in construction were combined with sand dunes and palm fiber. According to the outcomes, adding date palm fibers enhances both the mechanical and physical characteristics (compression strength, flexural endurance, etc.) as well as the density and absorption of water.

The shift to a more sustainable and greener economy has been expedited by the Kyoto Protocol on global warming. The main cause of this is the progressive substitution of renewable energy sources, including the effective utilization of regional substances, for petrochemical products. In order to improve the mechanical, physical, and structural aspects of construction materials, current materials research focuses on creating new composites of these materials [1].

Natural resources are abundant in Algeria, particularly in the South, and can be used directly in the building industry; nevertheless, in order to expand their use, it is necessary to research how they can be utilized. Plaster, sand dunes, and palm fibers are some of these resources that might be used which we will be taking into consideration. Due to these outcomes as well as the potential to increase the use of eco-materials, the most popular technique at the moment is the use of vegetable fibers to reinforce construction materials to improve specific features. Although Algeria has an abundance of fibers made from vegetables (from palm, alfalfa, hemp, and cotton), their application in construction is virtually non-existent.

The purpose of adding date palm fibers to plaster mortar is to increase its tensile strength and reduce its fragility. The main presumption is that the fibers permit the breaking technique to be judged, postponing the crack's initiation and allowing stabilization once it manifests. The impact of adding date palm fibers to mortar plaster on its mechanical and physical characteristics will be investigated in the present investigation. Here, we are examining the immediate and long-term impacts of date palm fiber length and rate on mortar plaster properties.

The goal of this project is to rationally integrate date palm fibers, gypsum, dune sand, and other indigenous materials into the construction industry while also improving them.

The investigation's two main goals are as follows:

- Examine the composition of a pure plaster pate and a mortar made of plaster on a foundation of dune sand.
- Enhance the mortar plaster's mechanical and physical qualities by fortifying it with date palm fibers and research the material's environmental sustainability.

MATERIALS USED

The resources utilized belong to those that are accessible locally:

Sand dunes:

We employed the sand dunes of GUERRARA (GHARDAIA) in our investigation. Table 1 shows the physical characteristics of the sand dunes that were employed.

Mixing water:

The public drinking water in the city of Ghardaïa's network is used as mixing water.

Lime:

Because air lime reduces the solubility of plaster and extends its working duration, it was utilized as a retardant of the plaster's setting duration. Furthermore, it has no effect on these mechanical characteristics.

Fibers:

In the laboratory, a chemical analysis of the lime was carried out using the diffractometer method by X-ray imaging. The diffractogramme below [Figure 1] (Table 2) [2] displays the findings of this technique in physics at the University of Laghouat.

Vegetables DOKAR fibers from date palms in the Ouargla region are utilized as fibers. Following calcination at 400 °C, the fiber powder's spectrochemical analysis revealed the following elements (Table 3) [3].

Plaster

It is a locally produced plaster from the Ghardaïa career of Oasis. It can be purchased on the open market. The fourth table provides a summary of the chemical analysis. To identify the plaster, we can list a few key characteristics in table 5.

FORMULATION OF PLASTER MORTAR WITH FIBER

In order to determine the composition of the mortar plaster reinforced by date palm fibers, we utilized the identical mixture as the traditional mortar, which is as follows:

We use the report E/(P+S) = 0,6 ; the S/P report is set to 0,5 ;6% lime air is added to delay the setting period.

We adhere to KRIKER's [3] recommendations while preparing date palm fibers, which include treating the fibers with water and then letting them dry in a free space.

The steps involved in the mixing process are as follows:

- Initially, we combine the sand and fibers until they are smooth.
- Next, we add the plaster, making sure to mix it thoroughly together with the sand and fibers;
- Subsequently, we add the mixing water, lime, and malaxant.

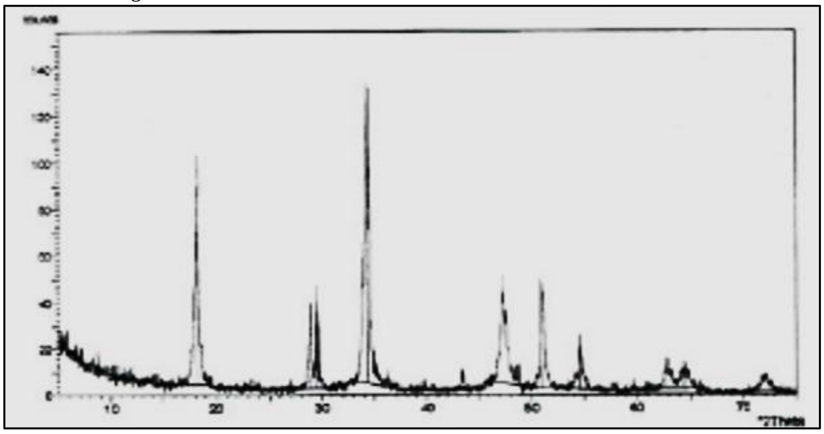

Fig 1.Diffractorgramme of the power lime by X-Ray

Table 1 The Physical properties of sand dunes

Property	Value
The apparent volumic mass ρ_a (kg/m³)	1489
The volumique absolute mass ρ_s (kg/m³)	2563
MF ModuleFinesse	1.19
Equivalent of sand ESV (%) - visual	93.6
Equivalent of sand to the piston ESp (%)	91.8

Table 2 : Chemical analysis of the powder of fibers calcined at 400° C

SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_2	PAF
48.04	6.12	2.51	0.05	4.88	14.21	1.81	2.80	0.42	0.45	18.08

Table 3: Physical and mechanical properties of the fibers used

Property	Value
Apparent volumetric mass	ρ_a = 512.21 – 1088.81 Kg/m³
Absolute volumetric mass	ρ_s = 1300 – 1450 Kg/m³
Apparent volumetric mass	ρ_a = 512.21 – 1088.81 Kg/m³
Absolute volumetric mass	ρ_s = 1300 – 1450 Kg/m³
Tensile strength [MPa]	
L = 100 mm	170 ± 40
L = 60 mm	240 ± 30
L = 20 mm	290 ± 20
Failure of deformation	d = 0.232 (diameter of fibers 8 mm)
Humidity rate	w = 9.5 – 10.5 %
Rate of absorption (after 24 h)	TA = 96.83 – 202.64 %
Diameter (fibers used)	d = varied between 0.2 – 1 mm

Table 4: Chemical analysis of plaster

Constituent	Percentage (%)
SiO_2	0.70
Al_2O_3	0.10
Fe_2O_3	0.08
CaO	32.15
MgO	0.53
SO_3	44.95
Na_2O	0.09
K_2O	0.03
Cl	0.002

Table 5: Essential Properties of Plaster

Property	Value
Apparent volumetric mass (kg/m³)	840–915
Absolute volumetric mass (kg/m³)	1100–1300
Refusal of sieve 800 µm	2.60%
Refusal of sieve 200 µm	14.20%
Fineness (Blaine method, cm²/g)	1500–8000
Setting Time (E/P = 0.6)	
Stage	**Time (min)**

Beginning	7
End	15
Flexural Strength (E/P = 0.6) [MPa]	
Time	**Strength (MPa)**
1 hour	3.48
24 hours	3.73
7 days	3.99
Compressive Strength (E/P = 0.6) [MPa]	
Time	**Strength (MPa)**
1 hour	8.51
24 hours	9.27
7 days	10.11

SAMPLE CONNECTIONS AND STORING CIRCUMSTANCES

Following mixing, it allows the mussels to form two distinct layers, vibrates the mortar with a rod to guarantee that the fibers are properly oriented and distributed, and then grinds and smoothed the mortar's surface. After the test components are put together, they are left outside in the testing facility. Following a 24-hour period, these are taken out and left in the open air at a temperature of 25°C±1°C until the test time; this process is designed to perform all compositions and experiments.

For the following experiments, (4x4x16) cm3 samples are utilized:

- Finding the density.
- Measuring water absorption.
- Calculating tensile
- Compression strengths

Plaster mortar composition enhanced with date palm fibers

We use the following actions to obtain a proper composition of mortar plaster enhanced with date palm fibers:

- At this point, we utilize the same mortar foundation plaster composition that we acquired in the previous stage.
- Regarding the fibers that we attempted to identify,
  - First, determine the best mass portion of fiber to add to the plaster mortar by utilizing date palm fibers of a consistent length L=10 mm and raising the quantity of fiber from 0% to 2% in increments of 0.5% by mass.
  - The ideal length for the ideal proportion that we previously discovered for each of the following lengths: 10 mm, 20 mm, 30 mm, and 40 mm.

When laying out all of the tests we were doing, the dough's workability was maintained until the setting period. because a mineral matrix becomes less workable when plant fibers are added.

All of the samples are kept in the laboratory's ambient air until they are 14 days old.

5 RESULTS AND DISCUSSIONS

Differences in the mechanical and physical characteristics of mortar plaster supplemented with 10 mm-long fibers in varying proportions.

The physical and mechanical characteristics of the mortar plaster reinforced by different fiber dosages vary as follows:

The density:

Figure 2 demonstrates that density marginally declines as fiber dose increases. This can be attributed to the rise in void volume caused by the addition of fibers, which results in a less thick plaster mortar. This outcome is consistent with DJOUDI's research. [2]

Strength of compression:

Figure shows that there is a minor gain in compressive strength between 0% and 1%, followed by a sharp rise at 1.5% and a subsequent decrease in compressive strength.

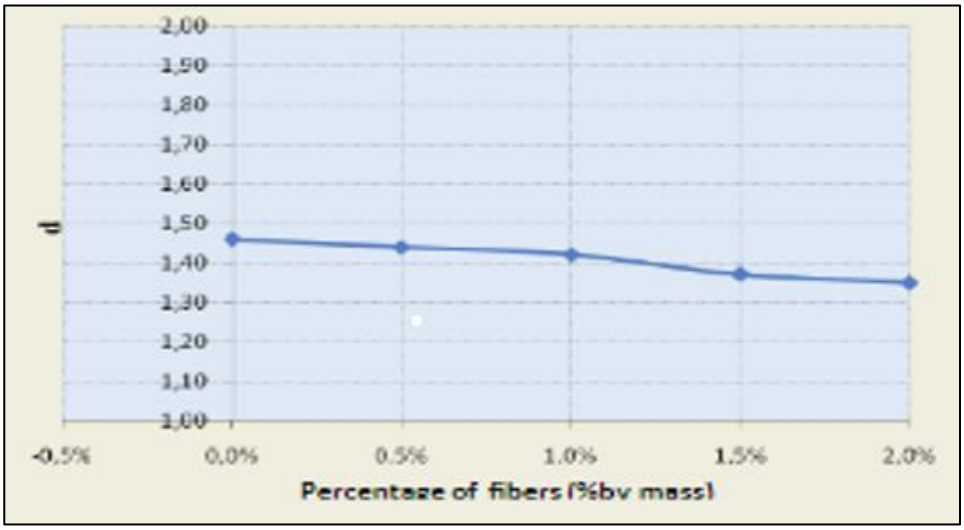

Fig 2: Variation of density of mortar of plaster in function of the percentage by mass of fibers

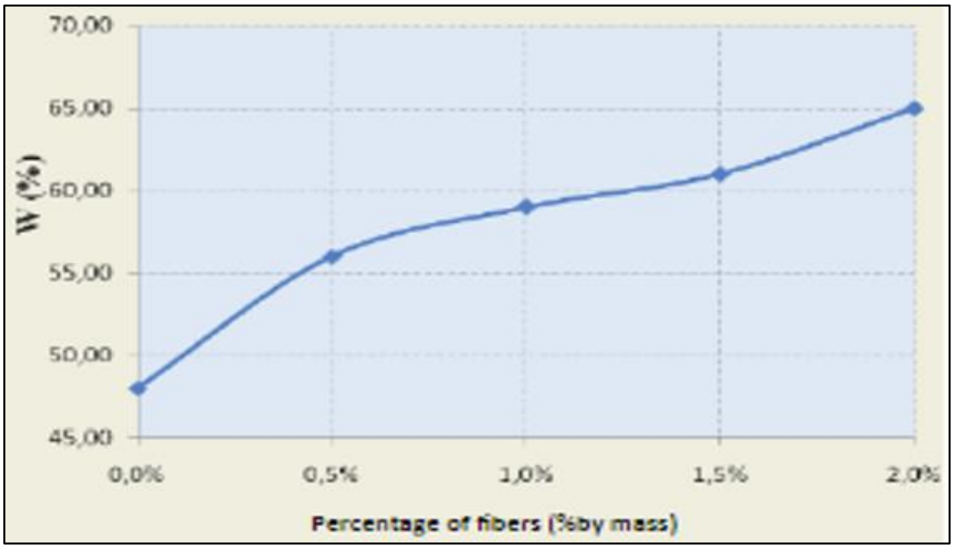

Fig 3: Variation of water absorption of mortar of plaster in function of the percentage by mass of fibers

The flexural strength

The fiber strength rises as the quantity of fiber increases, reaching its maximum at 1.5% fiber proportion. Above this proportion, it decreases, which is caused by an overabundance of fibers in the pulp, which results in inefficient fiber distribution. When F. Hernandez-Olivares [4] studied plaster reinforced with sisal fibers, he came at the same conclusion. Furthermore, during this test, it is possible to observe the occurrence of the fibers slipping between one another.

Recapitulation

The most significant performances for resistance to compression and flexion are obtained with fibers that are 20 mm in length. These fibers provide satisfactory density and water absorption results. Regarding dealing with, mortars strengthened with 20 mm-long fibers are easy to deal with and make deployment easier.

6. CONCLUSION

Considering all of our earlier tests. We may say that we have identified the ideal composition for a plaster mortar reinforced with date palm fibers that satisfies the various mechanical and physical properties and the specifications required for a building material, including density, water absorption, workability, and compression and flexural strengths. The following is the structure of our fiber-reinforced mortar plaster, which we tested for effectiveness: The evaluation S/P has been configured to 0,5; we consider the report E/(P+S) = 0,6; and as a setting time retardant, we add 6% air lime.

Using the fibers, obtain L = 20 mm fibers and a mass proportion of 1.5%. In some regions, the plaster mortar made from dune sand reinforced with date palm fibers appears to have a bright future. The material's technological and financial benefits enable significant advancements in future developments.

REFERENCES

1. C.A.R.M.A (2006) "Contribution to the improvement of some characteristics of dune sand-
2. Amina D (2001) "Structural and rheological characterization of plaster concretes and their reinforcements by the date palm plant fibers", thesis of magister. Link: https://tinyurl.com/ya64cup4
3. Kriker A (2005) "Characterization of date palm fibers and properties of concretes and mortars reinforced by these fibers in hot and dry climate", State doctorate thesis, ENP, Algiers. Link: https://tinyurl.com/yb5oq5g4
4. Abdessamed M (2006) "Influence of Mineral Fine Additions on the Mechanical Performance of Reinforced Concretes of Plant Fibers of Date Palm ",magister thesis.
5. Mokhtar, R. (2018). "Optimal composition of plaster mortar reinforced with palm fibers." *Journal of Civil Engineering and Environmental Sciences*, 4(2), 44–49. [DOI:10.17352/2455-488X.000027]
6. Rifaie, W. N., & Al-Niami, M. (2016). "Mechanical performance of date palm fibre-reinforced gypsums." *Innovative Infrastructure Solutions*, 1(18). [DOI:10.1007/s41062-016-0022-y]
7. Zahra, N. F., et al. (2018). "Mechanical Performance of Doum Palm Fiber-Reinforced Plaster Mortars." In *Design and Modeling of Mechanical Systems—III*. [DOI:10.1007/978-3-319-66697-6_46]
8. Naiiri, F. Z., et al. (2021). "Performance of lightweight mortar reinforced with doum palm fiber." *Journal of Composite Materials*, 55(5), 707–717. [DOI:10.1177/0021998320975196]
9. Rachedi, M., et al. (2020). "Thermal Properties of Plaster Reinforced with Date Palm Fibers." *Civil and Environmental Engineering*, 16(2), 259–266. [DOI:10.2478/cee-2020-0025]
10. Benmansour, N., et al. (2014). "Thermal and mechanical performance of natural mortar reinforced with date palm fibers for use as insulating materials in building." *Energy and Buildings*, 81, 98–104.
11. Djoudi, A., et al. (2012). "Performance of date palm fibres reinforced plaster concrete." *International Journal of Physical Sciences*, 7(21), 2845–2853.
12. Hamza, S., et al. (2013). "Physico-chemical characterization of Tunisian plant fibers and its utilization as reinforcement for plaster-based composites." *Industrial Crops and Products*, 49, 357–365.
13. Ozerkan, N. G., et al. (2013). "Mechanical performance and durability of treated palm fiber reinforced mortars." *International Journal of Sustainable Built Environment*, 2(2), 131–142.
14. Berrehail, T., et al. (2018). "Thermal Conductivity of Cement Stabilized Earth Bricks Reinforced with Date Palm Fiber." *AIP Conference Proceedings*, 1968(1), 030036.
15. Abani, S., et al. (2015). "Valorisation of date palm fibres in Sahara constructions." *Energy Procedia*, 74, 289–293.
16. Khedari, J., et al. (2001). "New lightweight composite construction materials with low thermal conductivity." *Cement and Concrete Composites*, 23(1), 65–71.
17. Khorami, M., & Ganjian, E. (2011). "Comparing flexural behaviour of fibre-cement composites reinforced bagasse: wheat and eucalyptus." *Construction and Building Materials*, 25(9), 3661–3667.
18. Sarikanat, M., & Demirci, C. (2014). "Physical and mechanical properties of randomly oriented coir fiber–cementitious composites." *Composites Part B: Engineering*, 61, 49–54.
19. Konin, A. (2012). "Effect of the type of binder on physico-mechanical and thermal properties of mortars with a basis of coir." *ARPN Journal of Engineering and Applied Sciences*, 7(3), 277–282.
20. Saha, P., et al. (2010). "Enhancement of tensile strength of lignocellulosic jute fibers by alkali-steam treatment." *Bioresource Technology*, 101(9), 3182–3187.
21. Kabir, M. M., et al. (2012). "Chemical treatments on plant-based natural fibre reinforced polymer composites: An overview." *Composites Part B: Engineering*, 43(7), 2883–2892.
22. Li, X., et al. (2007). "Chemical treatments of natural fiber for use in natural fiber-reinforced composites: a review." *Journal of Polymers and the Environment*, 15(1), 25–33.
23. Oudiani, A. E., et al. (2011). "Crystal transition from cellulose I to cellulose II in NaOH treated Agave americana L. fibre." *Carbohydrate Polymers*, 86(3), 1221–1229.
24. Salit, M. S., et al. (2015). "Selecting Natural Fibers for Bio-Based Materials with Conflicting Criteria." *American Journal of Applied Sciences*, 12(1), 64–71.