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Sustainable Adobe Composites: Thermal, Mechanical, and Durability Properties Enhanced with *Juncus maritimus* Fibres

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INTRODUCTION & AIM

This study investigates adobe reinforced with Juncus maritimus fibres at 20%, 40%, and 60% to enhance thermal behaviour, mechanical performance, and durability. The raw materials were characterised, and thermal, mechanical, and water-absorption tests were carried out to evaluate how fibre content influences the efficiency and resistance of the composites, highlighting the potential of Juncus maritimus as a natural reinforcement for durable, thermally efficient building materials.

METHOD

- **Characterization of Raw Materials**

Figure 1. Techniques used to measure geotechnical soil properties: a. b) Atterberg limits, c) Methylene blue, d) Sand equivalent

Figure 2. a. b) Materials used to measure pH, salinity, electrical conductivity, c) Calcium carbonate content, d) Organic matter

Rush	Chemical Composition				
	Cellulose (%)	Holocellulose (%)	Lignin (%)	Hemicellulose (%)	Ash (%)
JM (region 1)	40.99	68.84	18.54	27.84	7.3
JM (region 2)	53.10	88.46	13.05	35.36	5.29

Table 1. Chemical composition of Juncus maritimus plants collected in Tunisian regions

Atterberg Limit			MBV	Specific Surface (m^2/g)	Sand Equivalent (%)	Absolute Density (kg/m^3)	Bulk Density (kg/m^3)	Porosity (%)
WP	WL	PI						
22,345	35,452	13,107	2,332	48.80	16,72	2640,7	1416,53	46.35

MBV: Methylene blue value

Table 2. The geotechnical and physical properties of the soil

Chemical Properties of Soil	Unit	Results
PH	-	7,78
Electrical conductivity	$\mu S/cm$	1651
Salinity	ppT	0,89
Content of $CaCO_3$	%	8,79
Organic matter	%	1,2

Table 3. Chemical properties of soil

Oxides	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	P_2O_5	L.O.I
Masse (%)	54,67	13,82	3,77	12,04	1,14	0,16	4,08	0,99	0,07	7,48

Table 4. Chemical analysis of the soil

- **Methods for Evaluating Thermal and Mechanical Properties of Adobe**

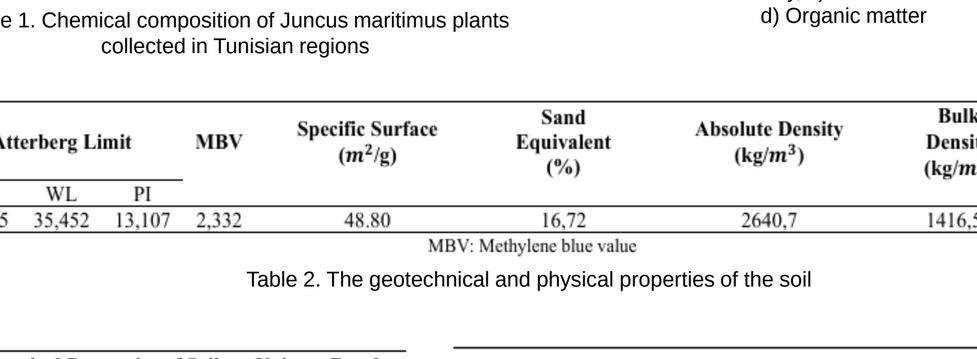

Figure 3. Thermal test on (10×10×2,5 cm3) prisms of adobe bricks

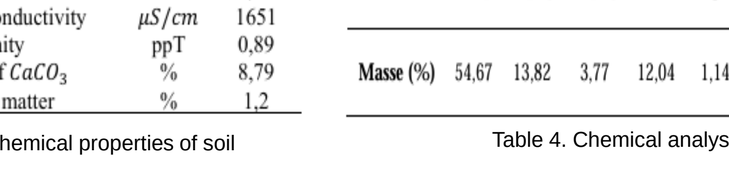

Figure 4. Mechanical test on (4×4×16 cm3) prisms of adobe bricks

RESULTS & DISCUSSION

- **Thermophysical properties**

Figure 5. Bulk density of composites for different volume percentages of additive

Figure 6. Thermal conductivity of dry composites at different volume contents of fibre additives

Figure 7. Variation of thermal conductivity with dry density across different composites

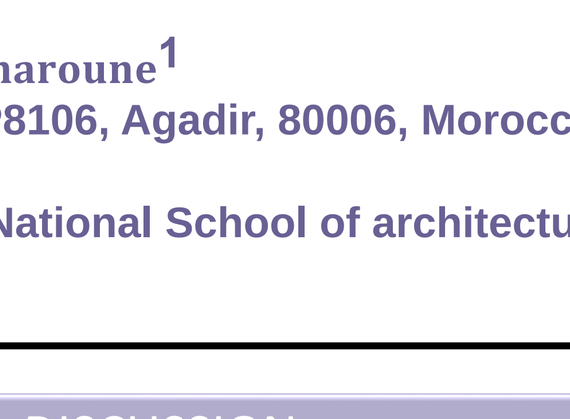

Figure 8. Variation in thermal diffusivity as a function of

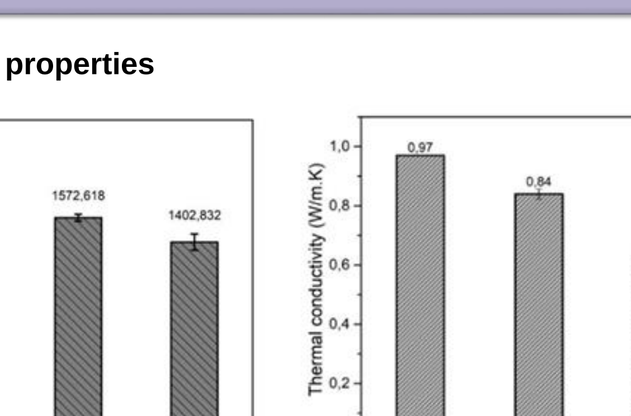

Figure 9. Thermal effusivity and heat capacity of adobes

- **Mechanical and durability properties**

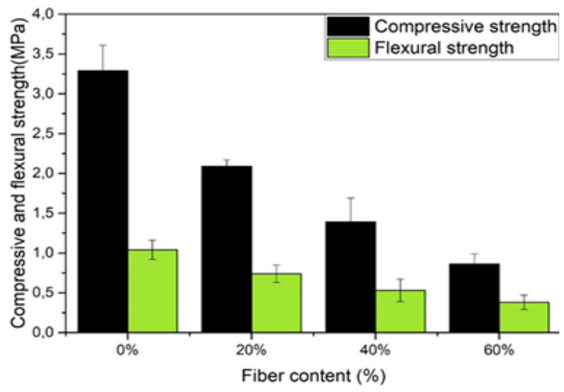

Figure 10. Compressive and flexural strength of different composites at 60 days

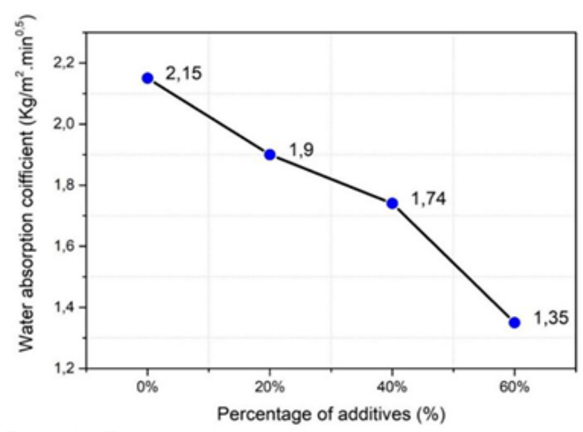

Figure 11. Evolution of capillary water absorption in composites

CONCLUSION

Incorporating Juncus maritimus fibres lightens adobe materials while markedly enhancing their thermal insulation and resistance to moisture rise. Although mechanical strength decreases with higher fibre content, the values remain within acceptable limits for load-bearing applications. Overall, these fibre-reinforced adobes offer a promising, sustainable solution for improving indoor comfort and building performance.

FUTURE WORK / REFERENCES

Future work should focus on optimizing fibre content, evaluating the long-term durability of Juncus maritimus-reinforced adobes, and exploring their acoustic and hygrothermal performance to better assess their potential in sustainable construction.