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Physical, thermal and mechanical behaviour of composites based on gypsum and juncus maritimus fibre

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INTRODUCTION & AIM

➢Nowadays, materials with a limited impact on the environment are required in the construction sector. Considering the interesting properties of natural elements such as natural fibers, it seems advantageous to use them to reinforce materials while protecting the environment and guaranteeing economic gain.

➢Along these lines, this research was devoted to studying the effect of untreated natural fibers extracted from the Juncus maritimus plant (from Southern Morocco) on plaster.

METHOD

- **Characterization of Raw Materials**

Fig.1: Plaster powder

Fig.2: (a) Juncus maritimus plant, (b) location of Juncus maritimus plant on aerial map

	Thermal conductivity (W/m.K)	Thermal diffusivity (mm^2/s)	Apparent density (kg/m^3)
Plaster	0.24	0.25	852.35
JM fibers	0.084	0.16	216.45

Table 1: Thermophysical properties of plaster and Juncus maritimus fibers

- **Mineralogical Composition of Fibers**

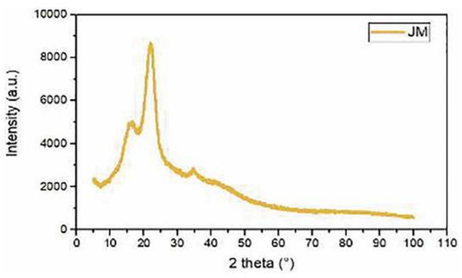


Fig.3: X-ray diffraction peaks of JM fibers

$$\mathrm{CrI}\ [\%] = \left[\frac{I_{200} - I_{am}}{I_{200}}\right] \times 100$$

- **Microstructural Characterization of Plaster and JM Fibers**

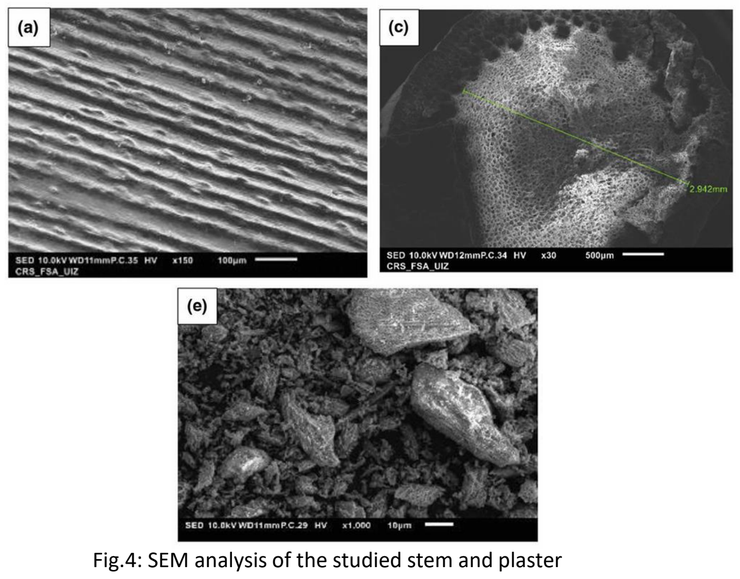


Fig.4: SEM analysis of the studied stem and plaster

- **MANUFACTURING THE COMPOSITE:**

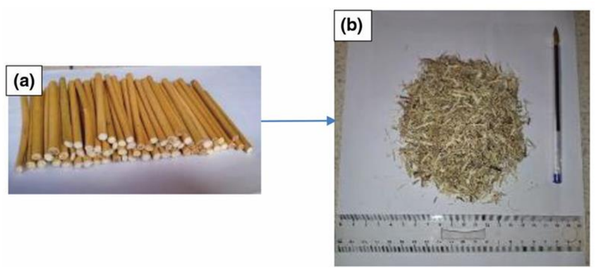


Fig. 6: (a) Mixing of fibers with plaster, (b) shapes of demolded composites

- **Rheological Behavior of Plaster Pastes:**

Fig.7: Manipulation of Marsh cone on the plaster paste incorporated by JM fibers

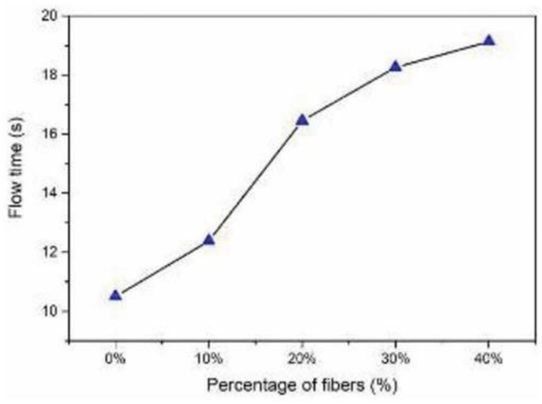


Fig.8: Impact of adding JM fibers on the flow time of plaster paste using the Marsh cone

- **MANUFACTURING THE COMPOSITE:**

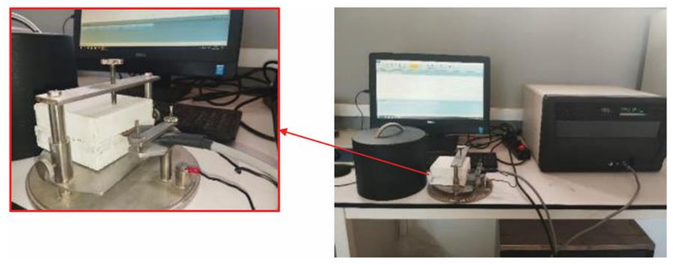


Fig. 10: (a) Three-point bending tests, (b) compressive tests

Fig,9: Measurement of thermal properties

RESULTS & DISCUSSION

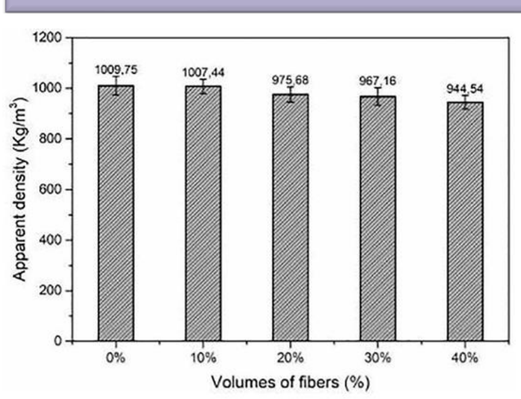
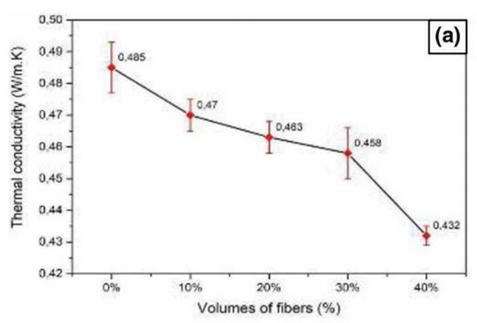
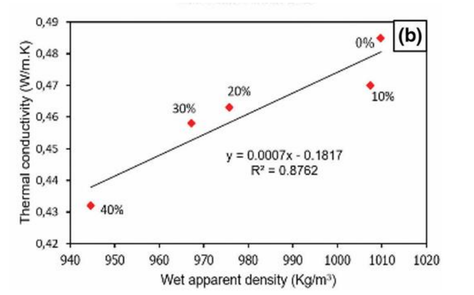


Fig.11: Bulk density of different composites



(a) Wet thermal conductivity of composites



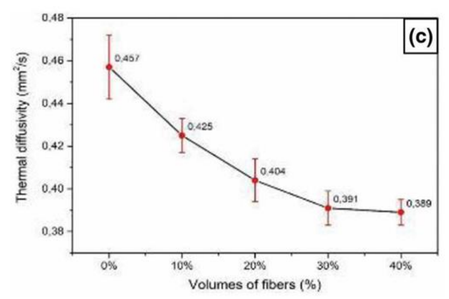


Figure 12: (b) correlation between density and thermal conductivity, (c) thermal diffusivity at different fiber volume contents

- **Mechanical Properties :**

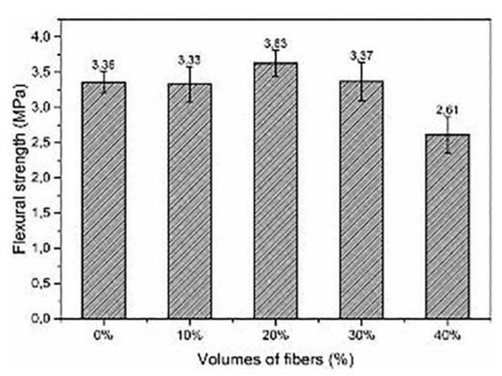


Fig.13: Flexural strength of composites

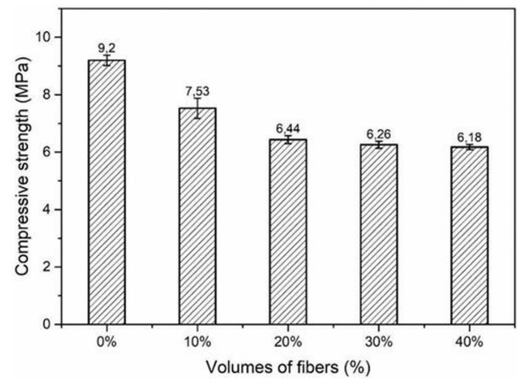
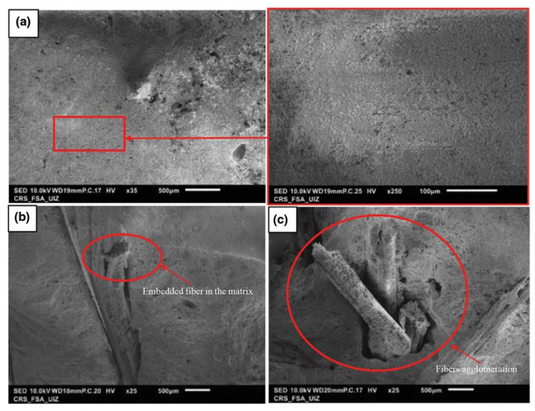


Fig.14: Compressive strength of composites

- **Microstructures of Composites :**



Fig,15: Secondary electron SEM images of the fracture face, (a) plaster, (b) plaster composite incorporated with 20% JM fibers, (c) plaster composite incorporated with 40% JM fibers

CONCLUSION

- Les résultats ont montré que ces fibres possèdent des propriétés intéressantes pour une application en tant que matériaux isolants en raison de leur indice de cristallinité élevé (42,45 %) et de leur structure poreuse.
- The incorporation of fibers in the gypsum matrix increases the lightness of the composite materials since the density of the fibers is lower than that of the gypsum.
- A 40% fiber content added to the plaster reduced the thermal diffusivity and thermal conductivity of the composites from 0.457 to 0.389 mm2 /s and from 0.4853 to 0.4324 W/m. K, respectively, highlighting the potential use of JM fibers as an additive to the plaster matrix to improve thermal comfort and energy efficiency inside buildings to reduce greenhouse gas emissions and energy consumption.
- The addition of 20% by volume of Juncus maritimus fibers improved the bending strength of plaster thanks to the high tensile strength of the fibers and the good adhesion between matrix and fibers, as confirmed by the microstructure of the fiber-matrix surface.

Overall, the incorporation of fibers into the plaster matrix is considered an effective technique for improving plaster's mechanical properties and thermal insulation.

FUTURE WORK / REFERENCES

Future orientations in the construction sector should focus on optimizing the incorporation of Juncus maritimus fiber, and studying the durability of the reinforcements studied, as well as the acoustic effect of Juncus maritimus fibers on the plaster matrix.