Preliminary Results of the Potential Use of Reed as a Biosourced Aggregate in Agro-Concrete.

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Context

The carbon impact of construction materials as well as the increase in demand for air conditioning linked to the increase in temperatures due to global warming is significant. In this context, biosourced materials can be a promising solution with their thermal and hygrothermal properties and their natural origin. Furthermore using low carbon binder can be a way to reduce the carbon impact of construction sector.

The Common Reed (or Phragmites australis) is the most widely-distributed flowering plant and can be found on every continent except Antarctica. The use of reed, thanks to its invasive nature, would not only provide a widely available material, but also respond to the desire to reduce its presence in certain areas. Different studies have already been carried out putting in light the promising potential of this biosourced material in construction.

Current challenge : finding a compromise between thermal, mechanical (short and long term) and hygrothermal performances of agro-concrete

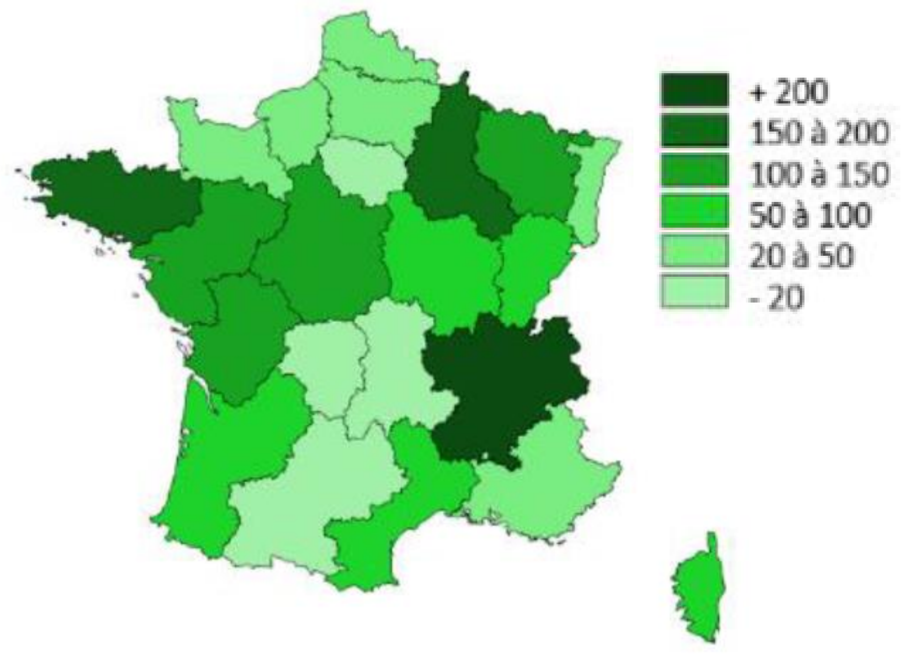

Figure 1 : Number of reed beds according to regions of France. *(from Mathilde Honoré, 2021)*

Objective : Present an exploratory study on the potential use of reed as a bio-based aggregate with low carbon binder in order to produce agro-concretes with interesting thermal and hygroscopic properties while improving mechanical strength.

Materials

Figure 2 : Reed aggregates as provided.

Figure 3 : CEM II/ C-M (S-LL) from EQIOM used in the study.

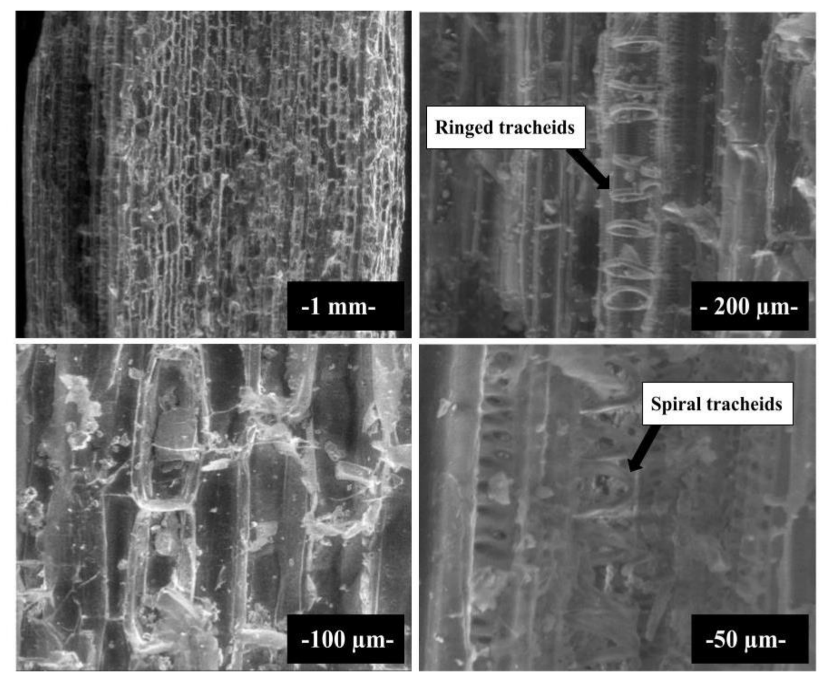

Figure 4 : Longitudinal and Transversal section of the reeds observed with the SEM.

Characterization of the Reeds Aggregates

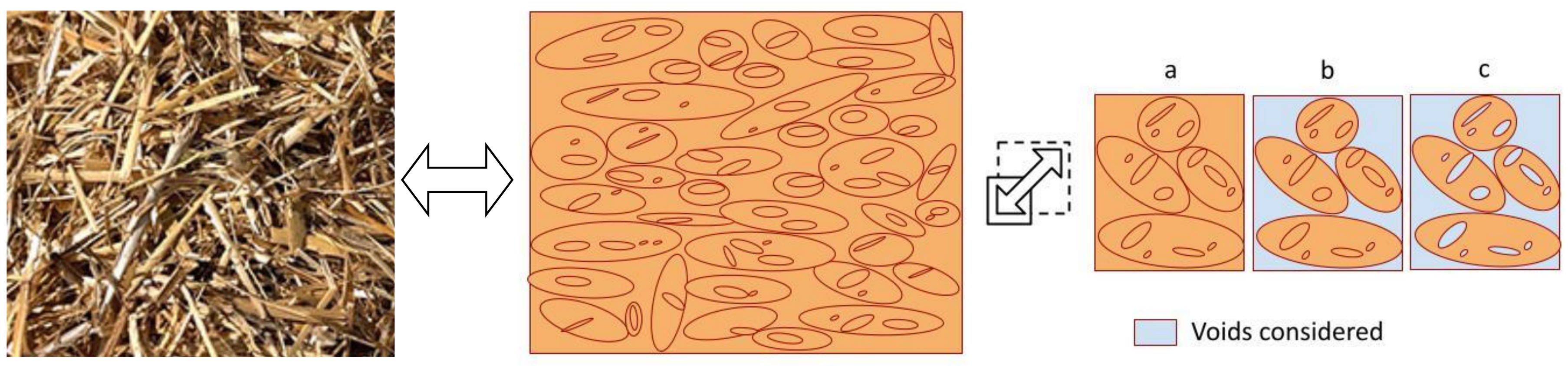

Figure 5 : Illustration of the different voids considered for the different porosities :
a : Bulk density ; b : Apparent density ; c : Skeleton density.
(adapted from Céline Badouard, 2023)

	Values	Standard deviation
Initial water content	6.54 %	0.16
Bulk Density	113.63 kg.m^{-3}	6.70
Apparent Density	526.37 kg.m^{-3}	10.38
Skeleton Density	1262.27 kg.m^{-3}	55.85
Water absorption	259.44 %	6.04
Intergranular porosity	78.41 %	-
Intragranular porosity	58.29 %	-
Total porosity	90.99 %	-
Thermal Conductivity	0.071 W/m.K	0.003

Table 1 : Summary of reed characteristics.

Results

→ Reed-concrete was produced. Its compressive strength was compared to other biosourced concrete in the litterature. All had a compressive strength of less than **1.1 MPa**. In Figure 6, a comparison of their density and thermal conductivity put mainly in light **the relatively low thermal conductivity value with the dry density of almost 1000 kg/m³** .

→ One reason of the low mechanical strength results obtained might be the **chemical interactions between bio-aggregate and the binder**, that is known to have an impact on the cement hydration. This aspect is analyzed with the Vicat test.

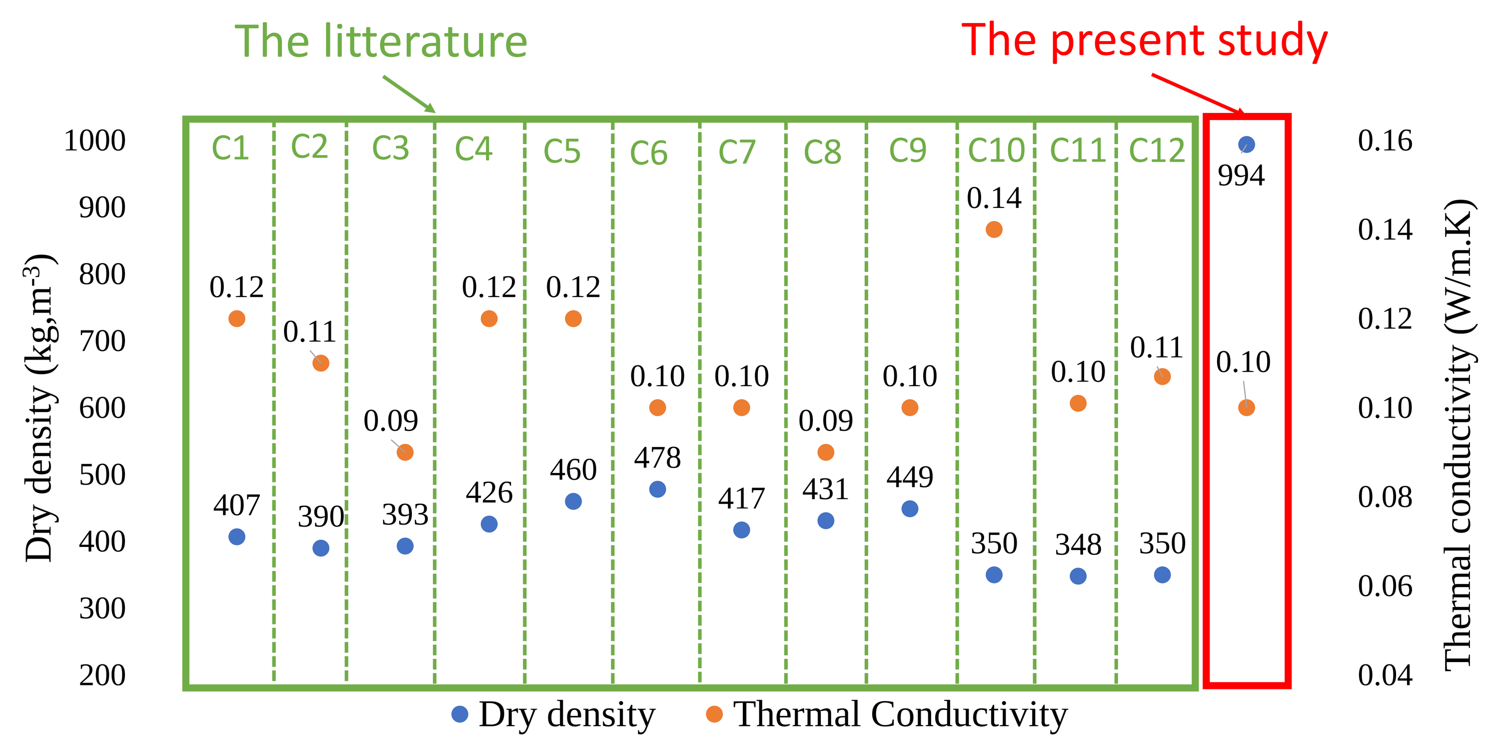

Figure 6 : Comparison of the dry density and thermal conductivity of the reed concrete studied here with the biosourced concretes C1 to C12 studied in the literature

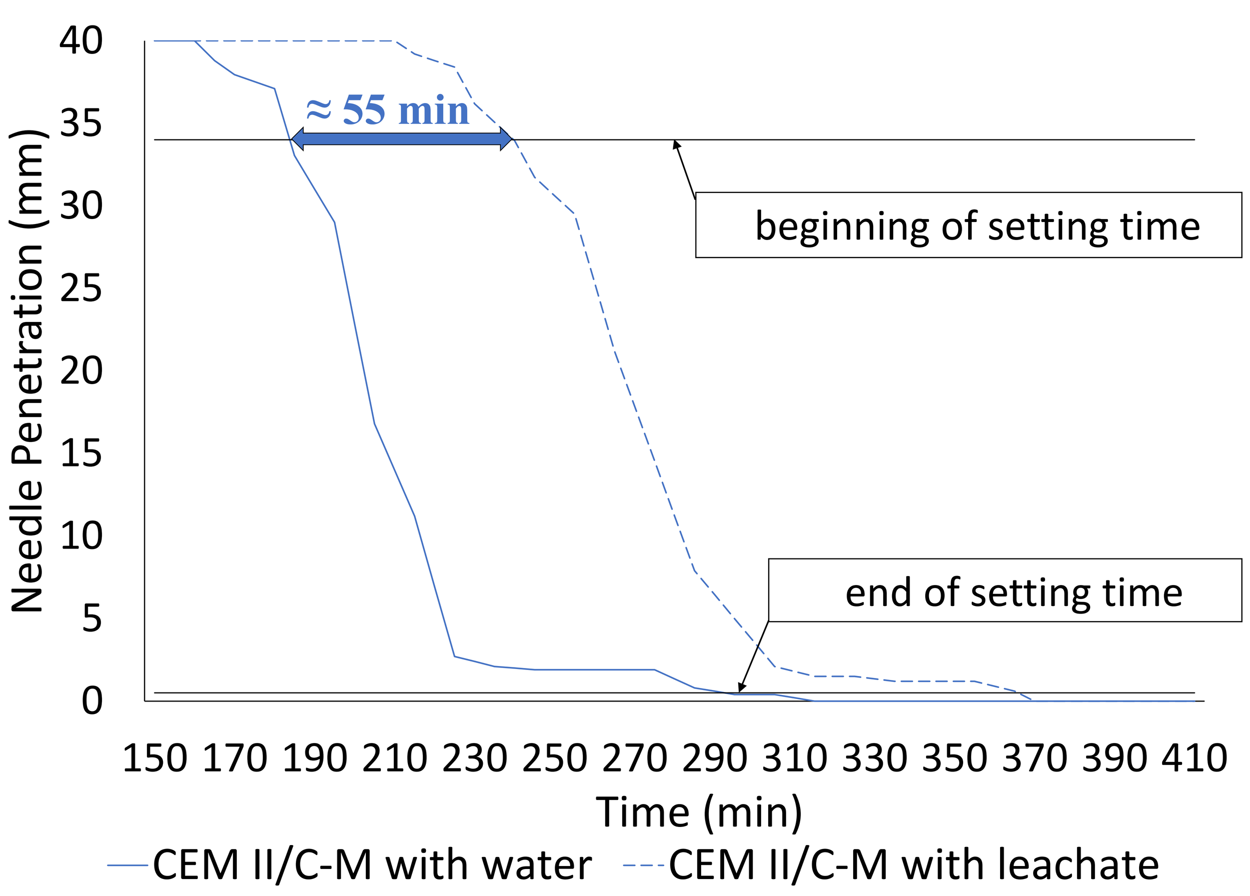

Figure 7 : Results of Vicat test performed on pastes prepared with water and with reed leachate.

Table 2. Delay in setting obtained with reed leachate compared with other biosourced materials studied in the literature.

Type of biosourced material	Type of binder	Delay (min)
Diss	Cement	210
Rice	CEM II B-LL	20
Wood	CEM III	65
Hemp	CEM I	~230
	Mix binder 1*	~100
	Mix binder 2*	~55
	Mix binder 3*	~110
	Pure lime binder	~35
Reed	CEM II/C-M	55

The litterature (Diss to Hemp) — The present study (Reed)

**Mix binder 1, 2 and 3 are derived from the Tradical PF70 and all composed of 43% cement, 40% aerial lime and 17% finely ground calcium but have 3 different porosity and particle size.*

Take Home Message

- Potential of reed fibers to reach low thermal conductivity values even in a high density and its potential for optimization.
- An analysis with existing studies on Vicat test performed on other leachates showed an acceptable delay for the reed fibers studied in this work.

Implications

- Studying deeply the interaction between reed and cement matrix in order to optimize the binder-aggregate interaction and improve its mechanical properties.

References
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