Projet TyCCAO

Typha Combustible Construction Afrique de l'Ouest

Sénégal et Mauritanie

Atelier de concertation TyCCAO

23 Juin 2017
Clermont-Ferrand, France

CARACTÉRISATION DES PROPRIÉTÉS MÉCANIQUES, HYGROTHERMIQUES ET ACOUSTIQUES DE MATÉRIAUX À BASE DE TYPHA AUSTRALIS ET D'ARGILE

PNEEB

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  - Argile de Thicky
  - Formulation
  - Elaboration
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  - Module apparent
  - Résistance en flexion
  - Cohésion
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- Propriété acoustique
  - Absorption acoustique
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  - Masse volumique apparente
  - Porosité
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- Propriétés hygrothermiques
  - Conductivité thermique
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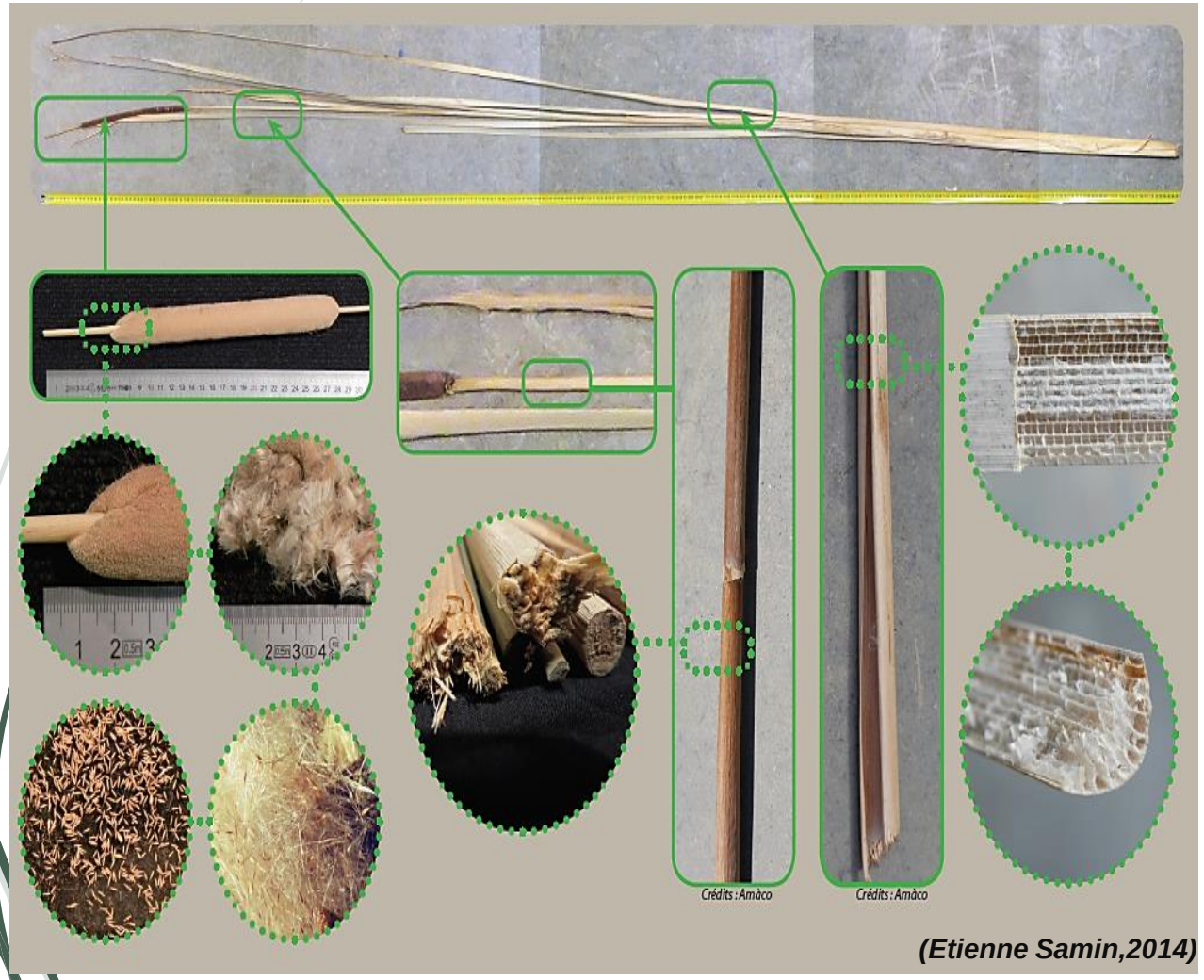
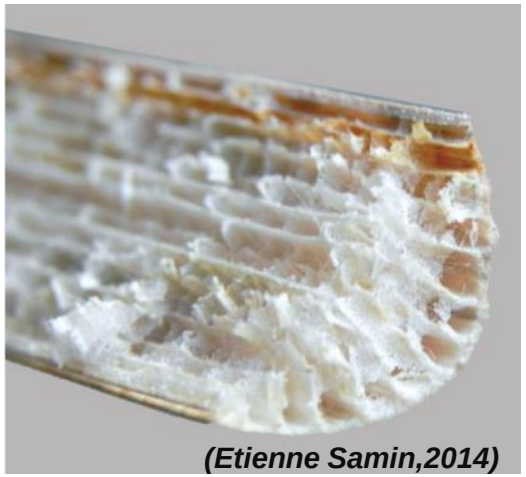
  - Capacité tampon hydrique
  - Perméabilité
  - Isotherme de sorption
- Comportement au feu
  - Réaction au feu

Matériaux

Typha Australis



(Etienne Samin,2014)



(Etienne Samin,2014)

- An herbaceous, monocotyledonous plant up to 3.50 meters long;
- A stem surrounded by flat leaves 1 to 2 cm in width;
- A 15 to 20 cm long brown spadix containing between 20 000 And 700,000 seeds ;
- Internal porous structure.

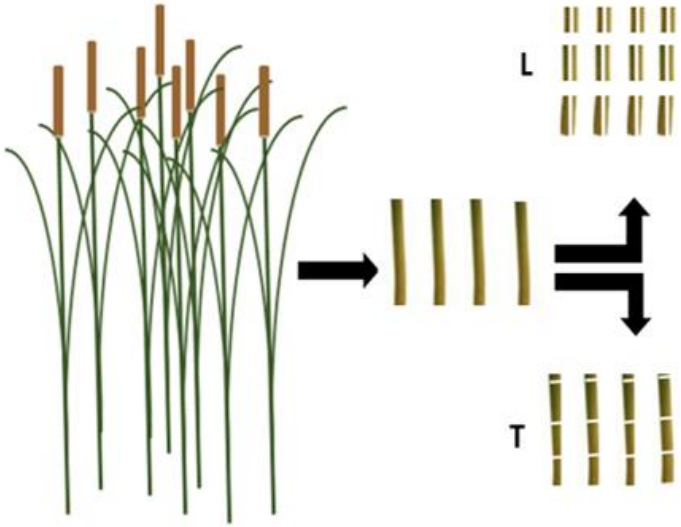
Materials

Typha Australis

The standard norms [ASN 2014] harvesting, transport, drying and storage of Typha australis:

- Manually ctting of Typha plants using a sickle at 20 cm above the water;
- Drying in the open air is carried out at the cutting site between 7 and 10 days;
- packaging in bales and transported by sea.

CARAVAGGIO BIO 60



Transverse fraction of Typha:

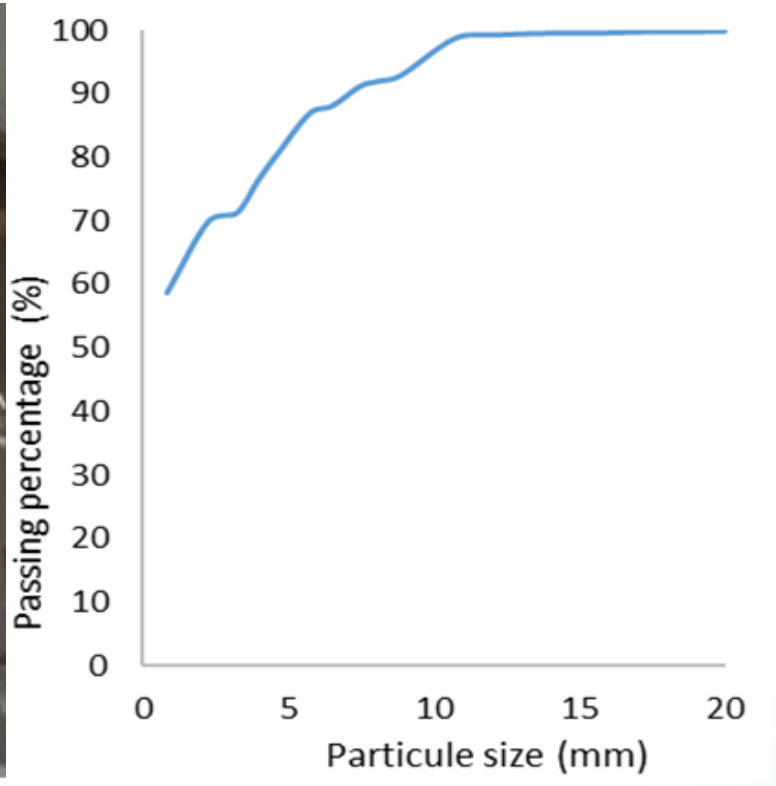
55 kg / m3 +/- 1.5

Longitudinale fraction of Typha:

60 kg / m3 +/- 1.2

Matériaux

Binder: Clay soil from Thicky town (Senegal)

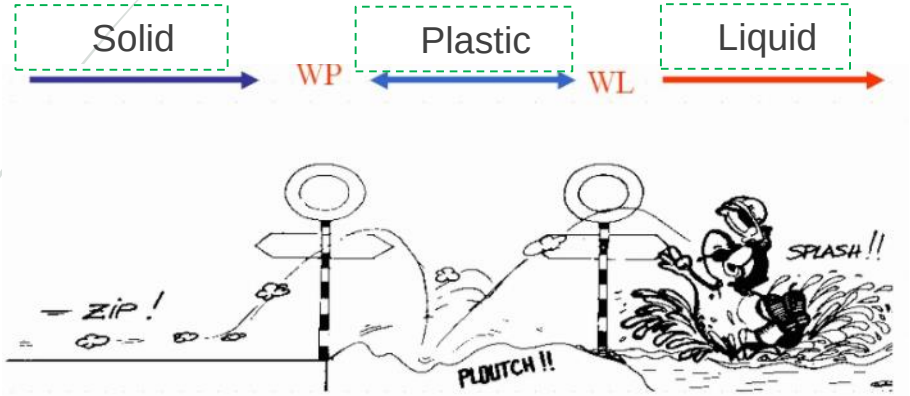


- Natural resource;
- Little processing;
- Technical process well known.

[Riveros Olmos 2016] shows that the Thicky soil it is a clayish one containing almost 62% of very fine particles,

Materials

Clay soil from Thicky town (Senegal)



Classification of the degree of plasticity as a function of the plasticity index

Plasticity index	Plasticity degree
0<IP <5	Non-plastic
5<IP <15	Moderately plastic
15<IP <40	Plastic
IP >40	Very plastic

Atterberg limits of Thicky soil

Liquidity limit [WL]	Plasticity limit [WP]	The plasticity index [Ip]
50,15%	19,19%	31,03

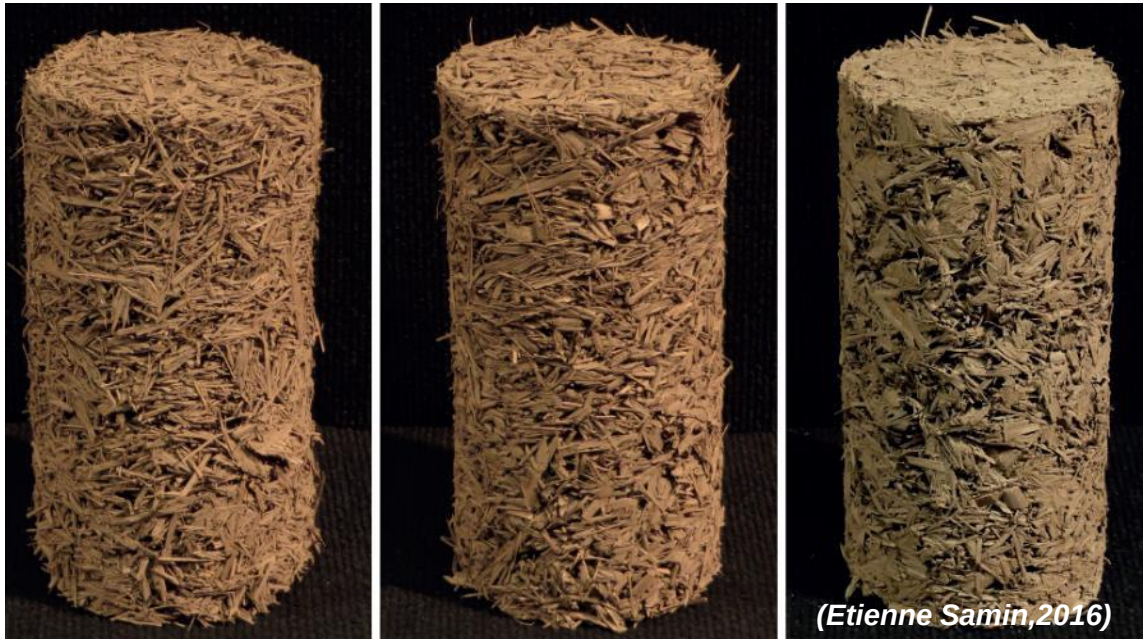
The results (tab 1) [Riveros Olmos 2016] show that the Thicky has a plasticity index between 15 and 40. According to the classification (tab 2), it is considered a very plastic soil.

Materials

Formulations

Formulations	Raw materials	Weight proportion (%)
1A	Aggregates: longitudinal cutting	33
	Clay	66
	Water	1
2A	Aggregates: cross cutting	28
	Clay	70,5
	Water	1,5
2B	Aggregates: cross cutting	15,5
	Clay	81
	Water	3,5

[Samin, 2017]



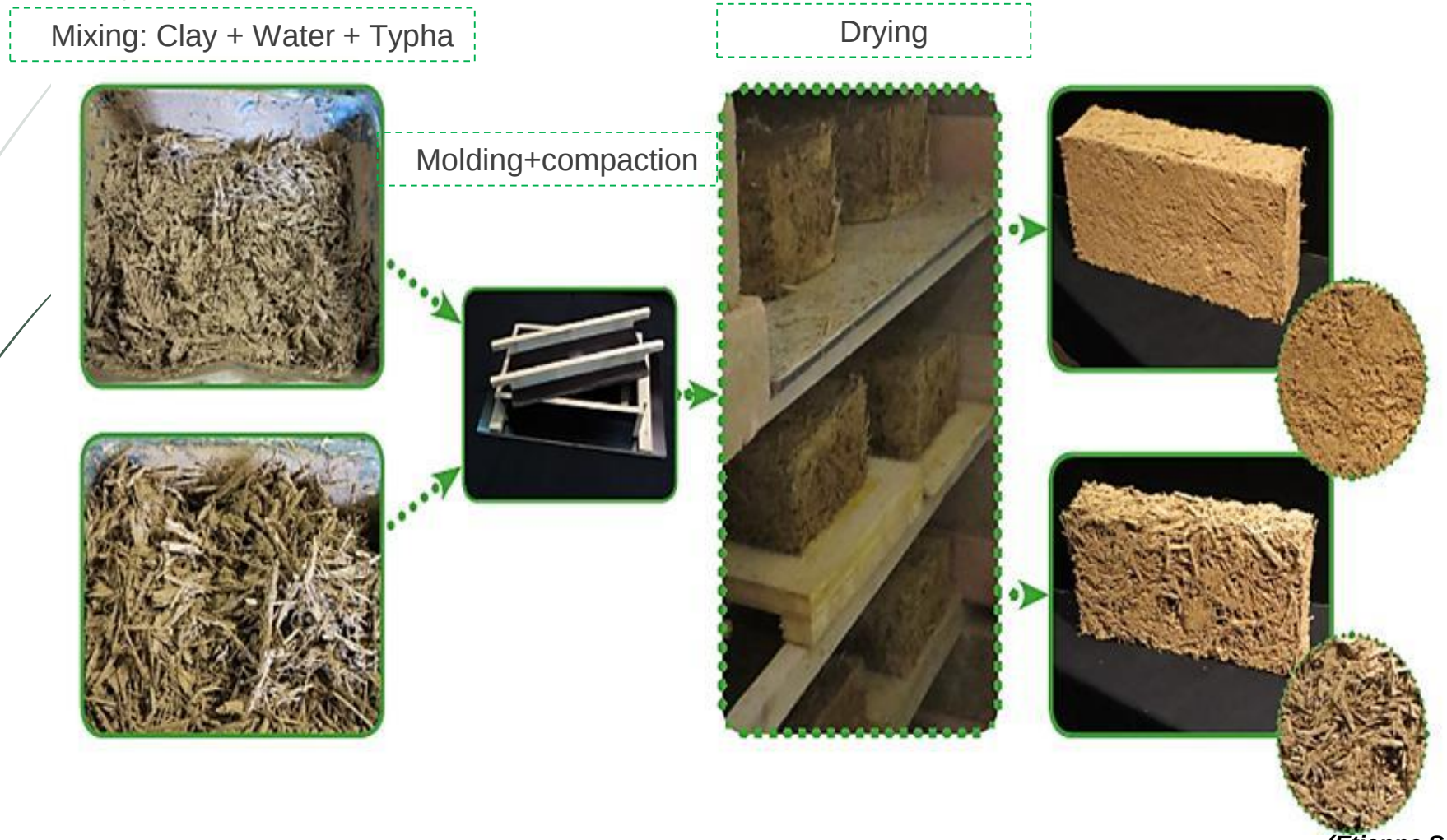
1A 2A 2B

- The 1A and 2A formulation : The same volume ratio in the Typha aggregate (80%);
- The 2B formulation: Typha aggregate volume ratio of 70%,

Formulation	Masse volumique ($kg.m^{-3}$)	Standard deviation
1A	322.990	9.710
2A	304.281	1.271
2B	585.499	3.814

Materials

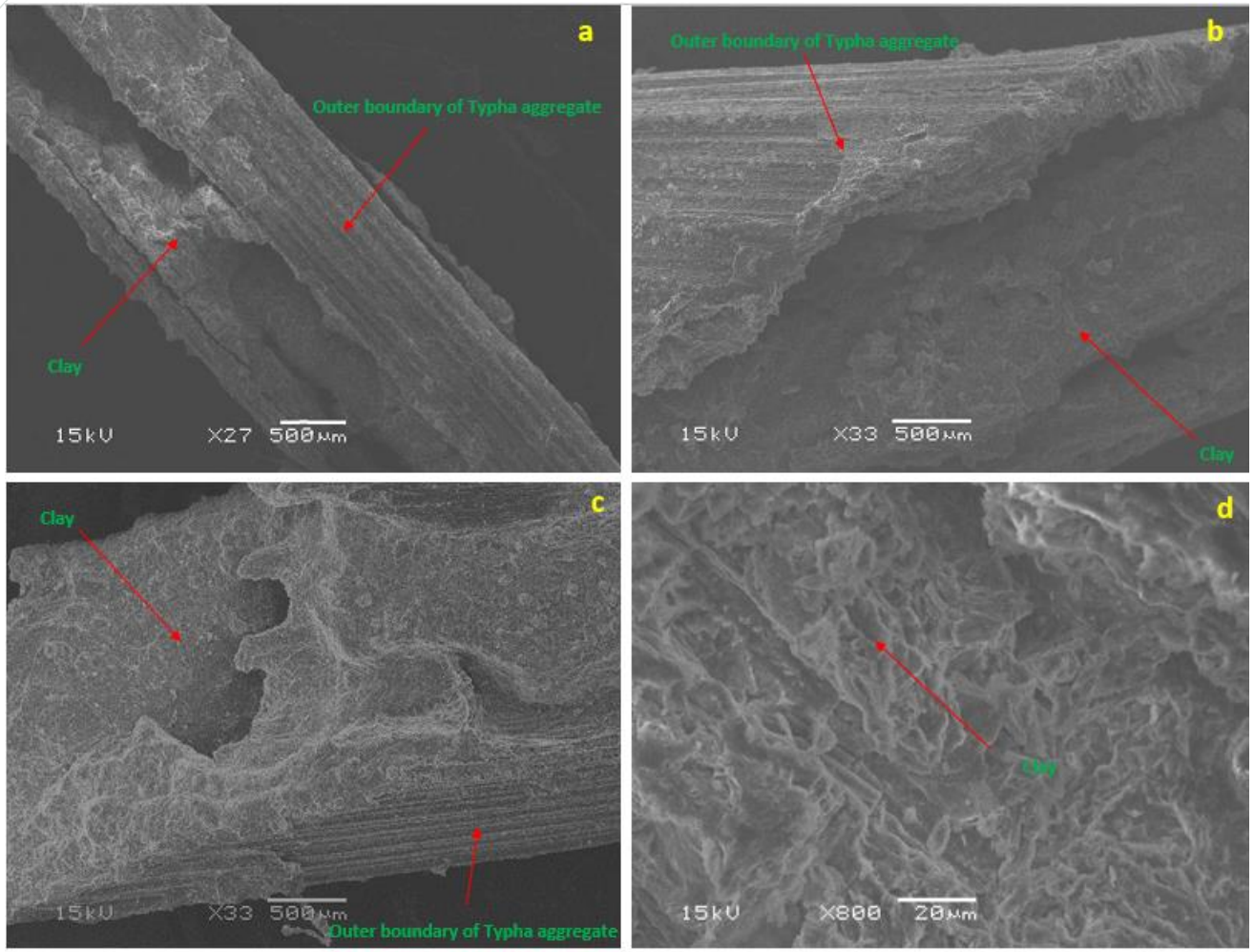
Elaboration



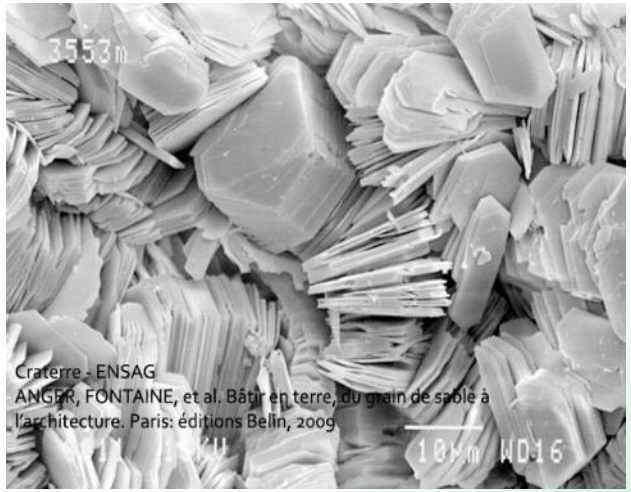
(Etienne Samin,2016)

Propriétés physiques

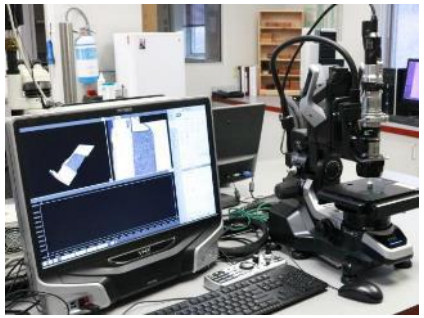
Imagerie



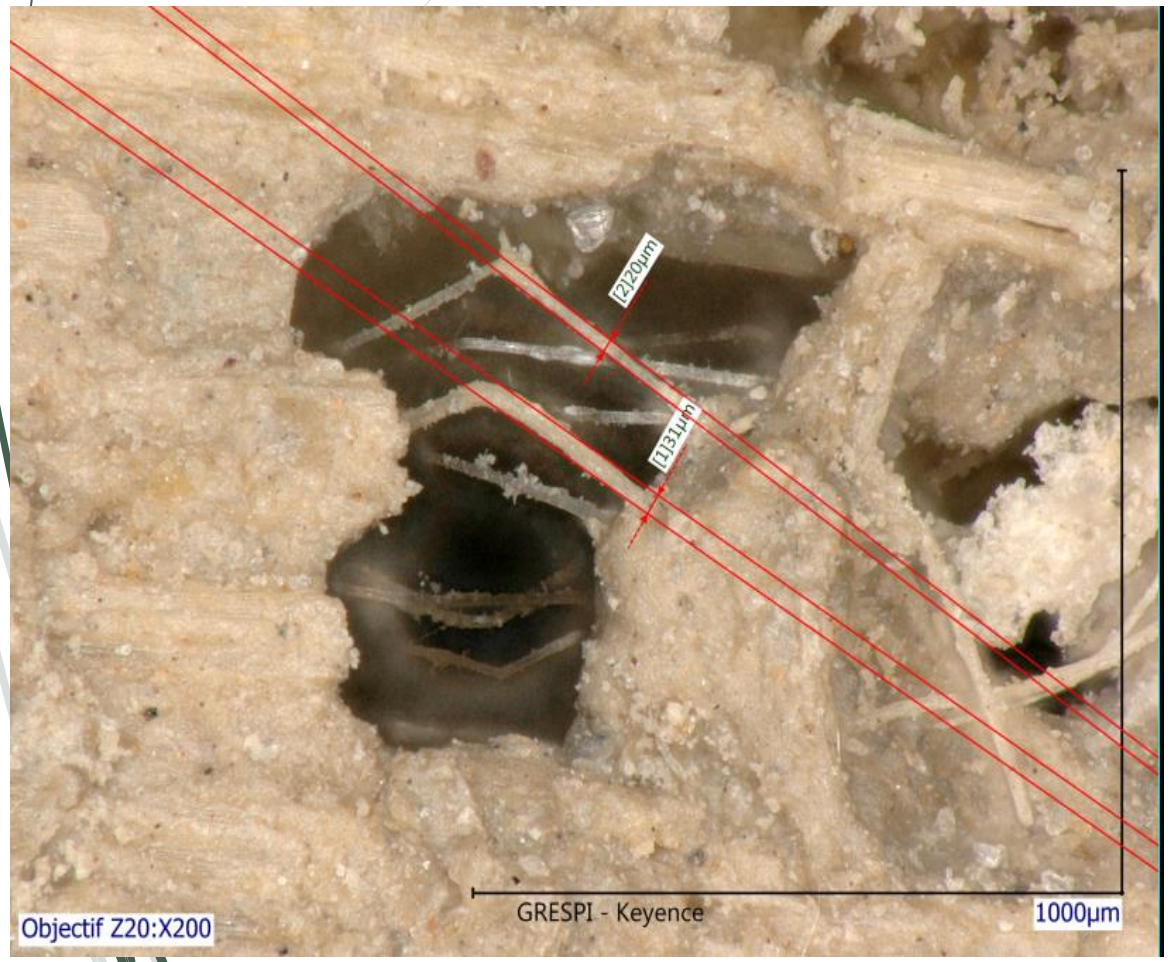
- Formulation 2A :62.0543
- Formulation 1A : 56.6060
- Formulation 2B : 52.0568

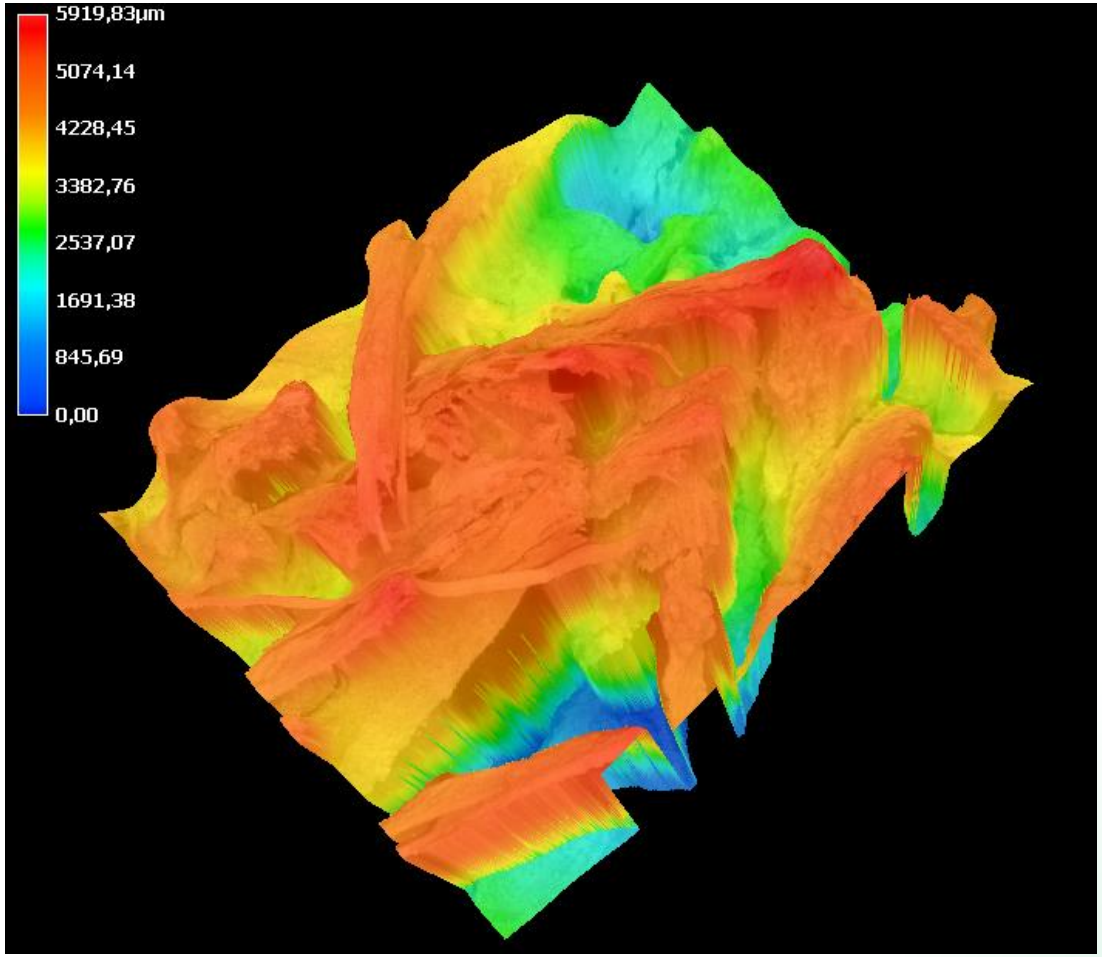


Propriétés physiques



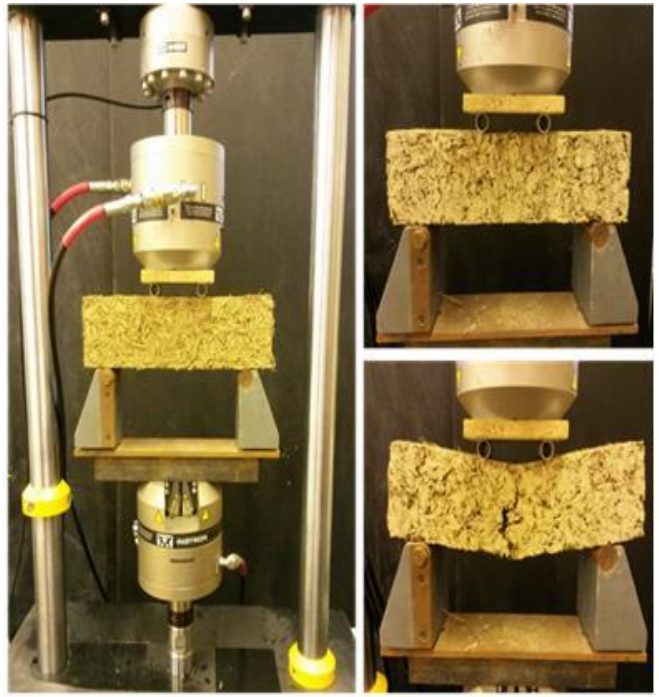
Imagerie

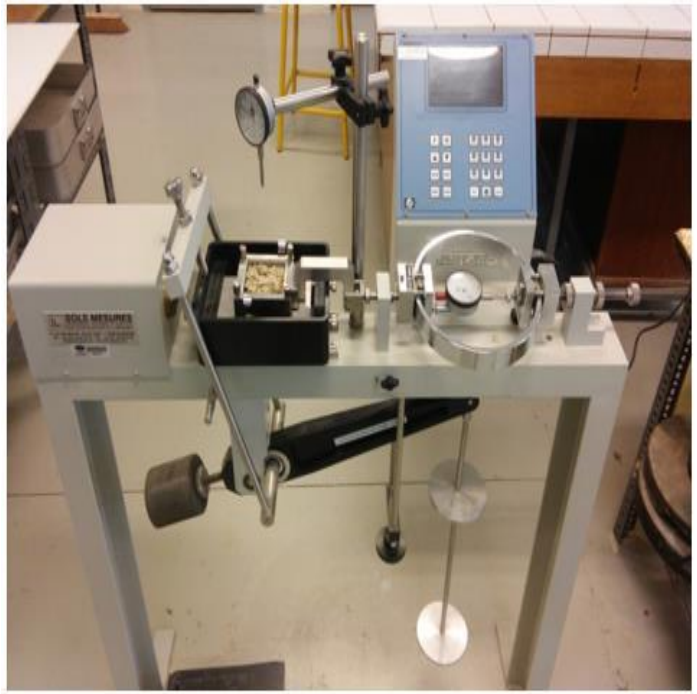


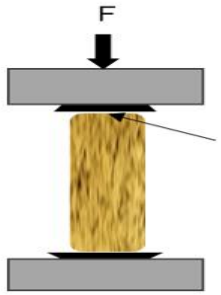


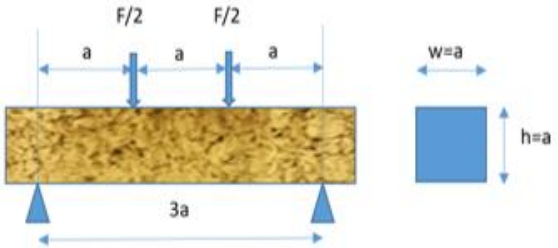
Propriétés Mécanique

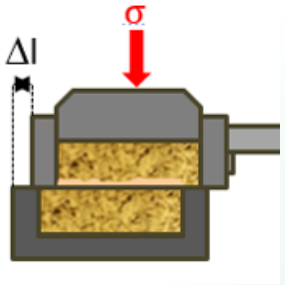
Compression, flexion , cisaillement





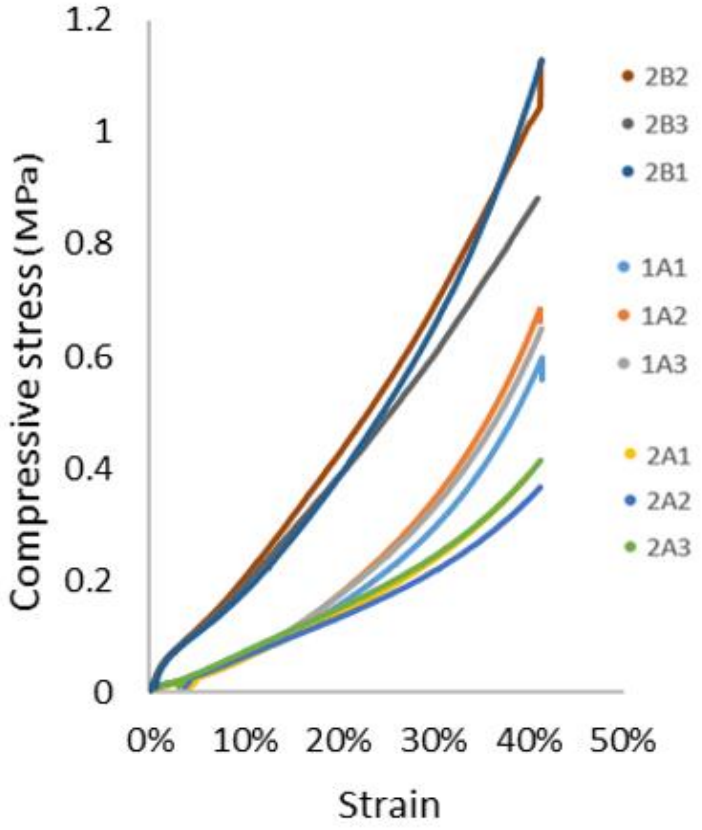


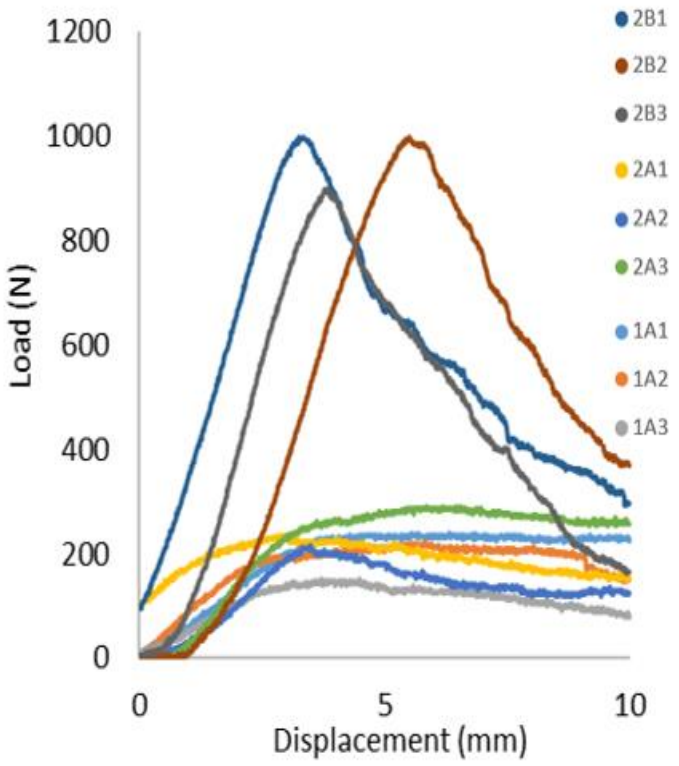


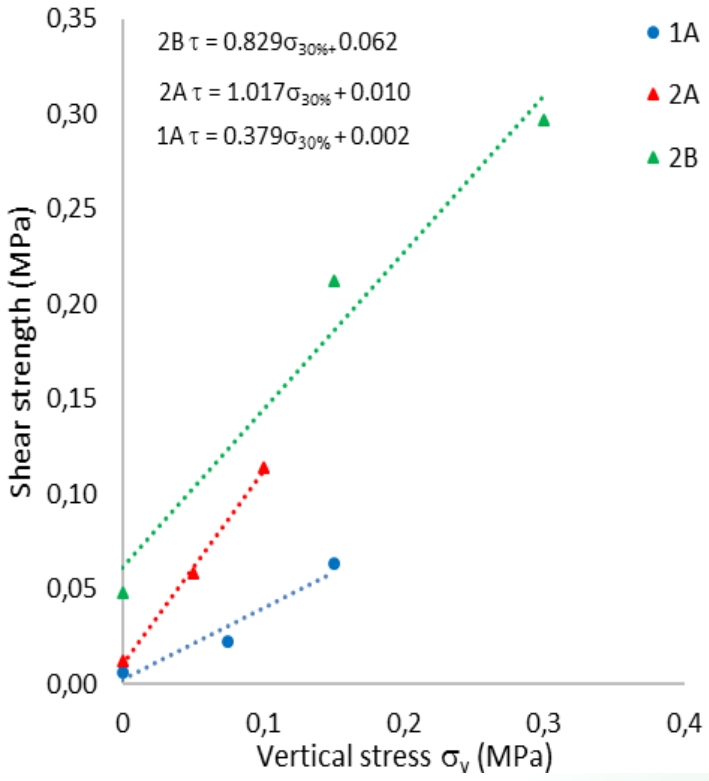


Propriétés Mécaniques

Compression, flexion , cisaillement



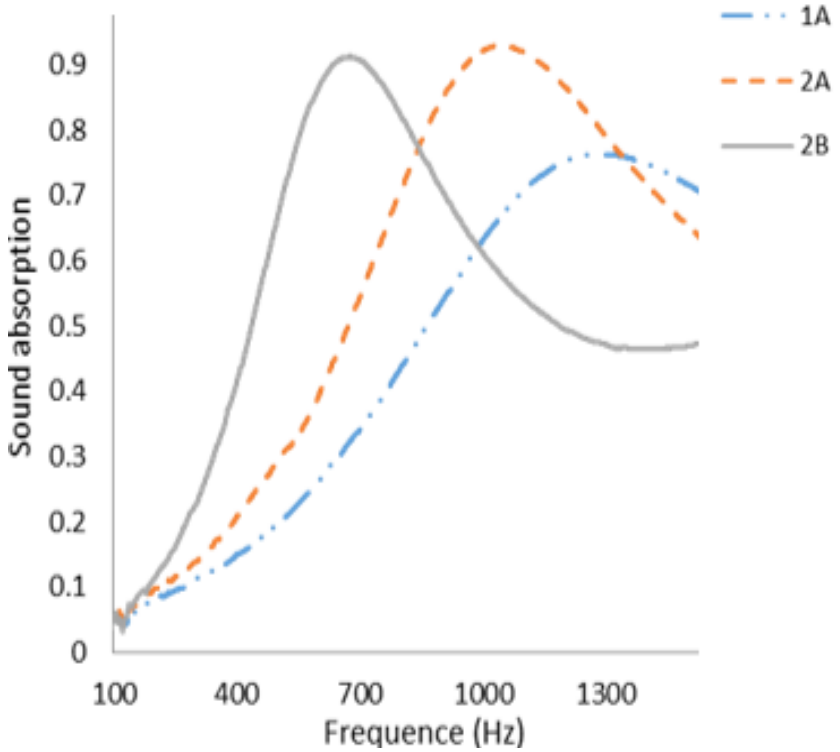


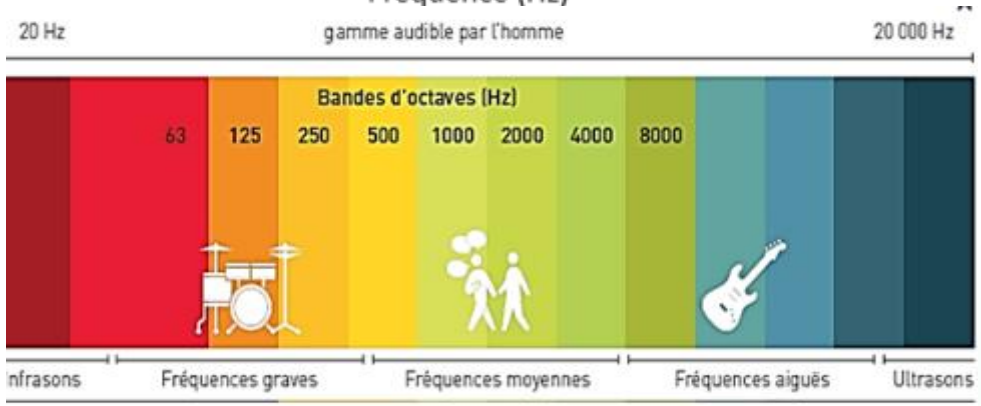


The Typha-earth agromaterial can not be used as structural material due to its low compressive performance

Propriétés Acoustiques

Absorption acoustique





- Formulation 2A :62.0543
- Formulation 1A : 56.6060
- Formulation 2B : 52.0568

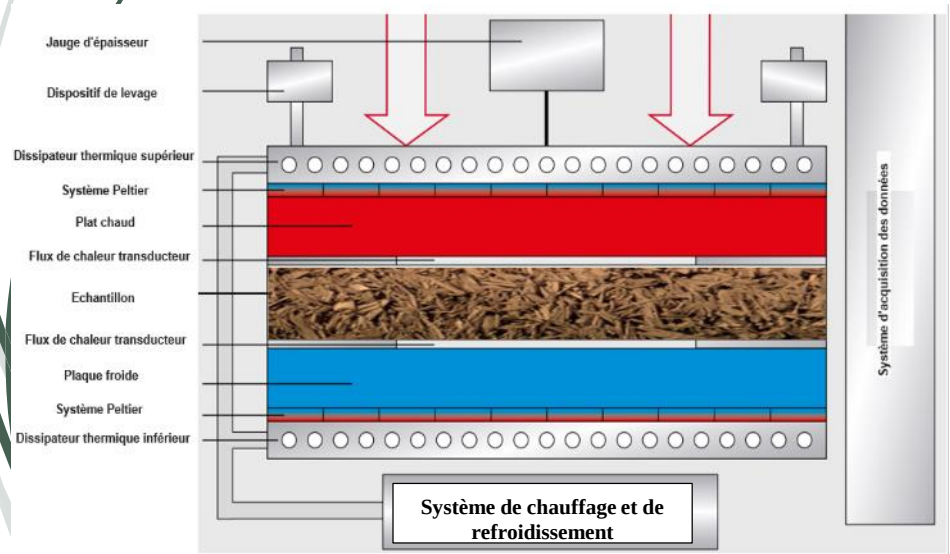
Propriétés Hygrothermiques

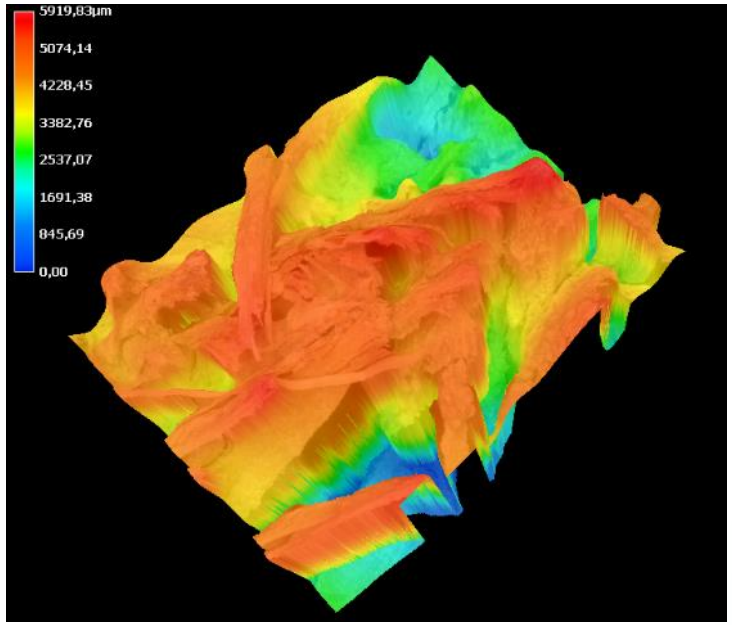
Conductivité thermique

$$\lambda = \frac{\Phi \,.\, \Delta x}{A \,.\, \Delta T}$$

Φ: le flux relevé par les fluxmètres,
Δx : l'épaisseur (m) de l'échantillon,
A : la surface (m^2),
ΔT : le gradient de température.

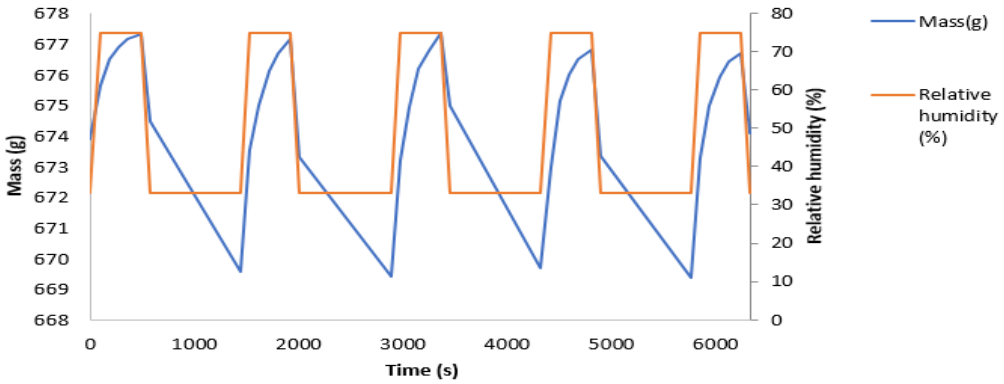
- Formulation 1A -2A :0,0653-0,0690 $W.m^{-1}.K^{-1}$
- Formulation 2B : 0,10-0,11 $W.m^{-1}.K^{-1}$

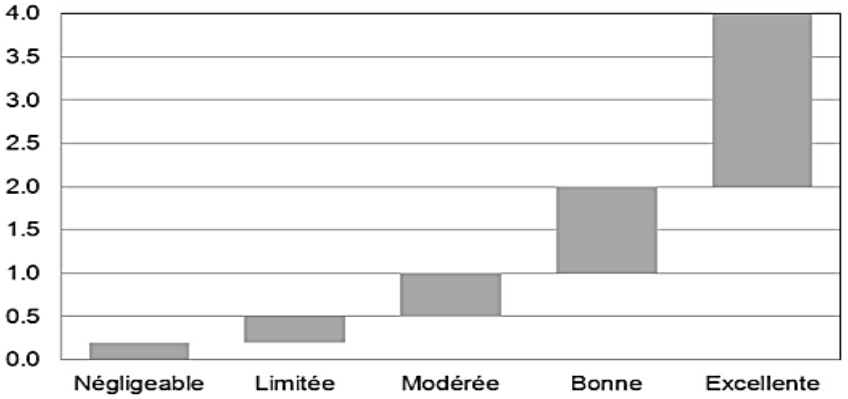




Propriétés Hygrothermiques

Capacité tampon hydrique





The Moisture Buffering Value (g/m².%.RH) is defined by:

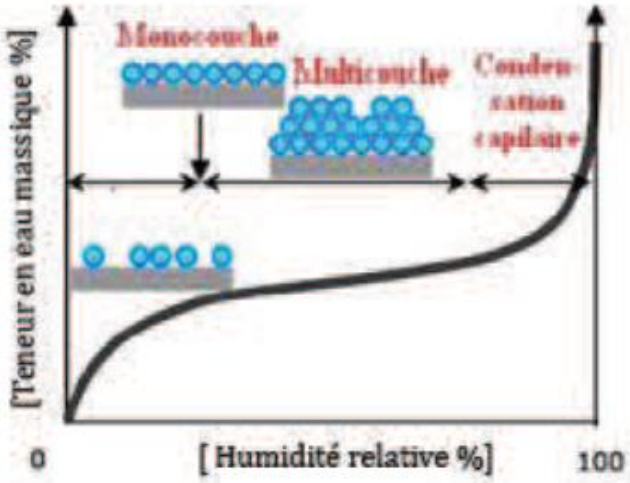
$$MBV = \frac{\Delta m}{A.(HRhigh - HRlow)}$$

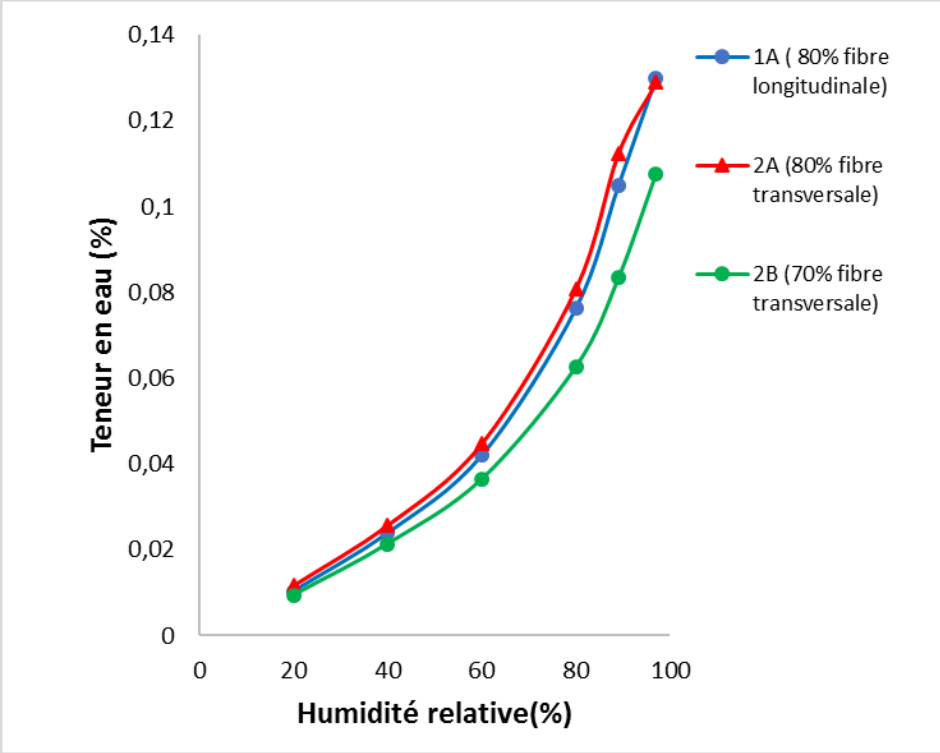
With Δm, the variation of the mass, A the section (m²), HRhigh and HRlow the high and low relative humidity

Formulation	MBV (g m^{-2} %RH^{-1})	Ecart type (g m^{-2} %RH^{-1})
1A	5,08	0,14
2A	3,71	0,11
2B	3,23	0,36

Propriétés Hygrothermiques

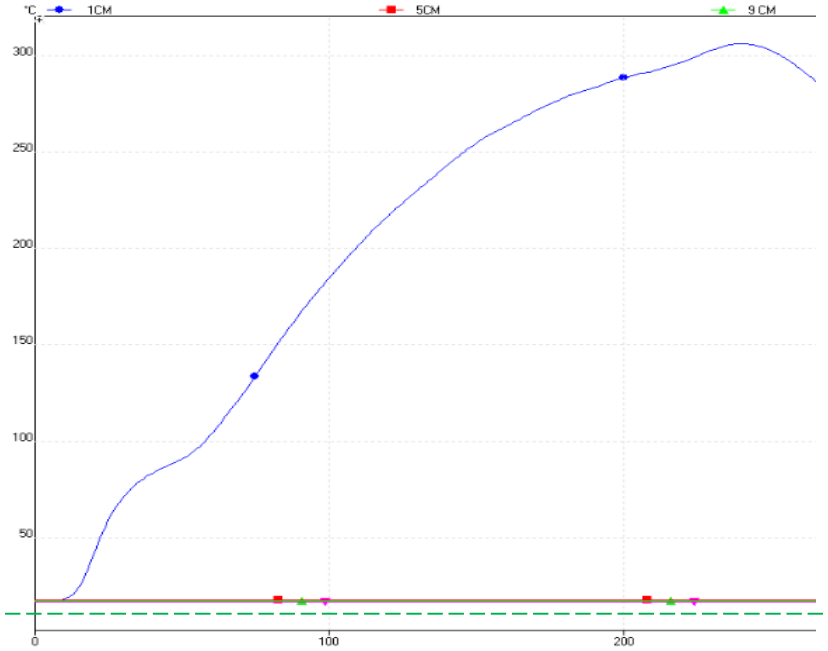
Isothermes de sorption





Comportement au feu

Réaction au feu (NF EN ISO 11925-2 2013)



During the test, the behaviour of the material is observed. It is necessary to check the following criteria:

- Presence of flame;
- Release of smoke;
- Presence of inflamed particles;
- Propagation of heat;
- Partial or total degradation of the sample.

Perpectives

- Formulation:
  - Variation de la teneur en granulat de Typha;
  - Comportement en fonction de l'humidité (mécanique, thermique et acoustique).
- Modélisation du comportement hygrothermique:
  - Capacité de sorption;
  - Couplage avec des systèmes ventilation hygrorèglable
  - A l'échelle de la paroi, à l'échelle du bâtiment;
  - Typologie de bâtiment.

(Arnaud Misse, 2016)