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Julie Lossignol, Jérôme Quirant, Julien Averseng

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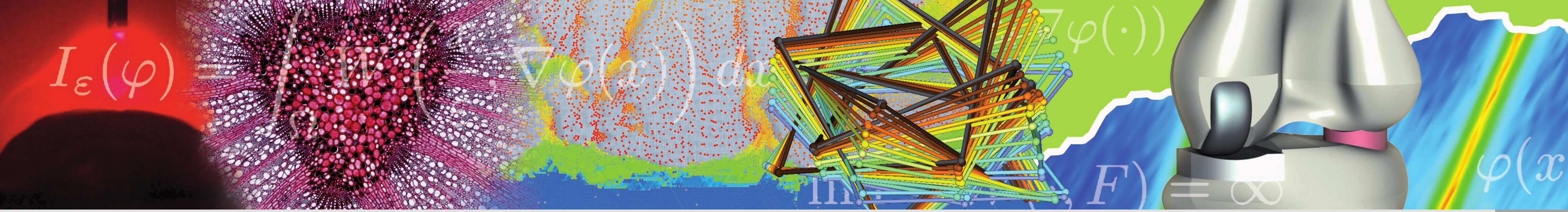
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# CREEP STUDY ON STRAW BALES WALLS

J. Lossignol<sup>1\*</sup>, J. Quirant<sup>1</sup>, J. Averseng<sup>1</sup>

<sup>1</sup>LMGC, Univ. Montpellier, CNRS, Montpellier, France

\*Corresponding author; e-mail: julie.lossignol@umontpellier.fr

## Context and objectives

### Background

- Load-bearing straw bales construction is used since the late 19<sup>th</sup> century in Nebraska (USA)
- There is no official standard for the Nebraska technique, only a professional reference (RFCP, 2018)



Figure 1 – Wall assembly using Nebraska technique (Source : J. Lossignol, 2021)

### Bibliographic review

- Many experimental works about compression and shear but almost nothing about relaxation, creep and buckling
- No existing numerical modelling

### Objective

To build an experimental dataset in order to develop a multi-parameter creep behaviour model.

### Parameters to investigate

According to the literature, the relevant parameters impacting straw bales creep are :



The impact is quantified through creep testing on 6 walls :

Table 1 – Parameters studied for creep walls investigation (Source : J. Lossignol, 2021)

Wall	Preloading strain rate[%]	Load[kg]	Studied parameter
1	5	780	Control
2	5	780	Repeatability
3	3	780	Preloading
4	6	780	Preloading
5	5	1180	Loading
6	5	530	Loading

## Experimental setup

### Premises layout

Pictures for DIC require some specific environmental conditions :

- The lighting must be properly controlled and homogeneous
- The specimen must remain undisturbed during the experiment

Then refurbishment works of a storage area and the structural design of a timber enclosure have been realized

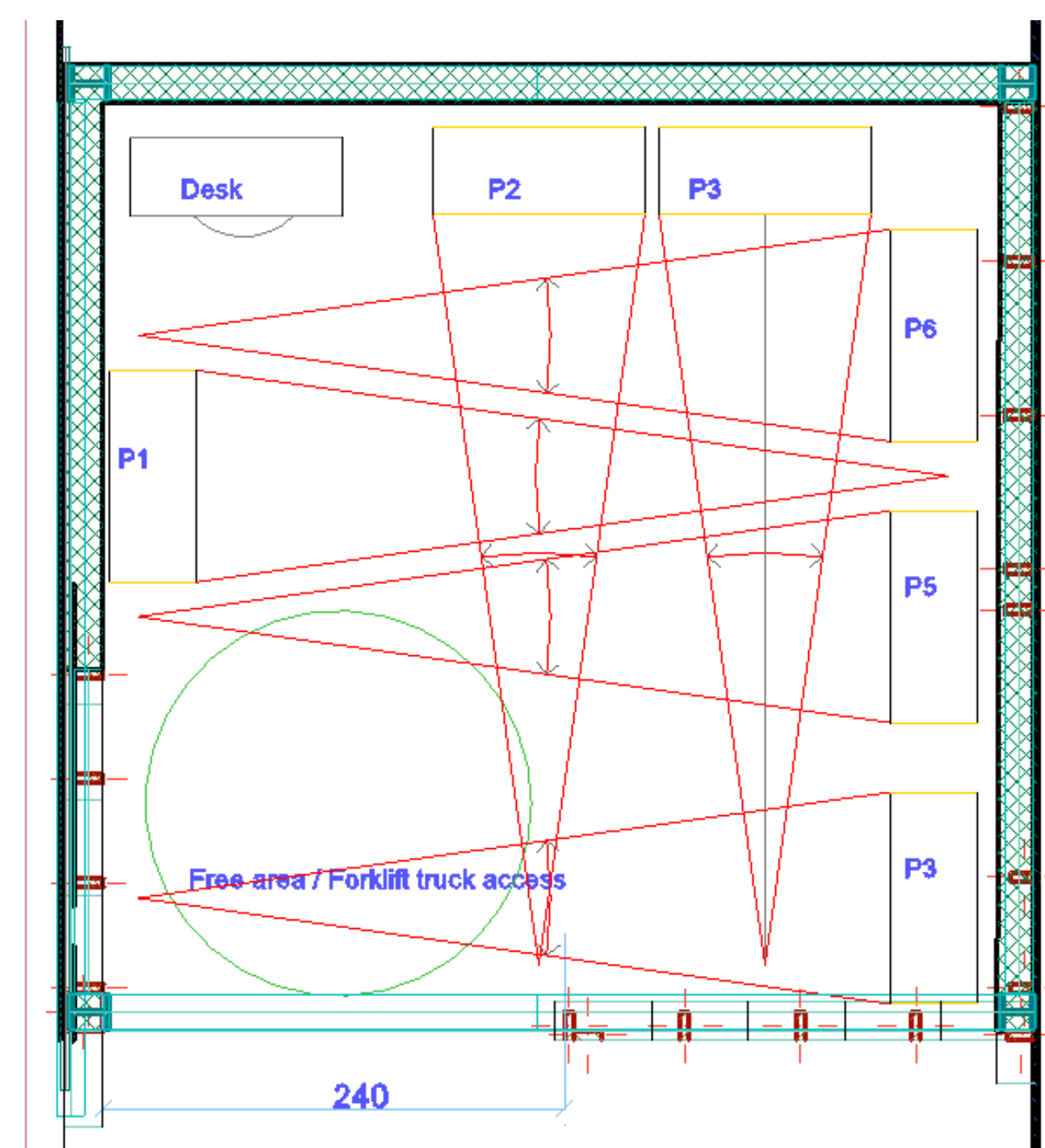


Figure 4 Experimental zone layout - design by C. Hamelin and modifications by J. Lossignol (Source : J. Lossignol, 2021)

### Test configuration

#### Structural design

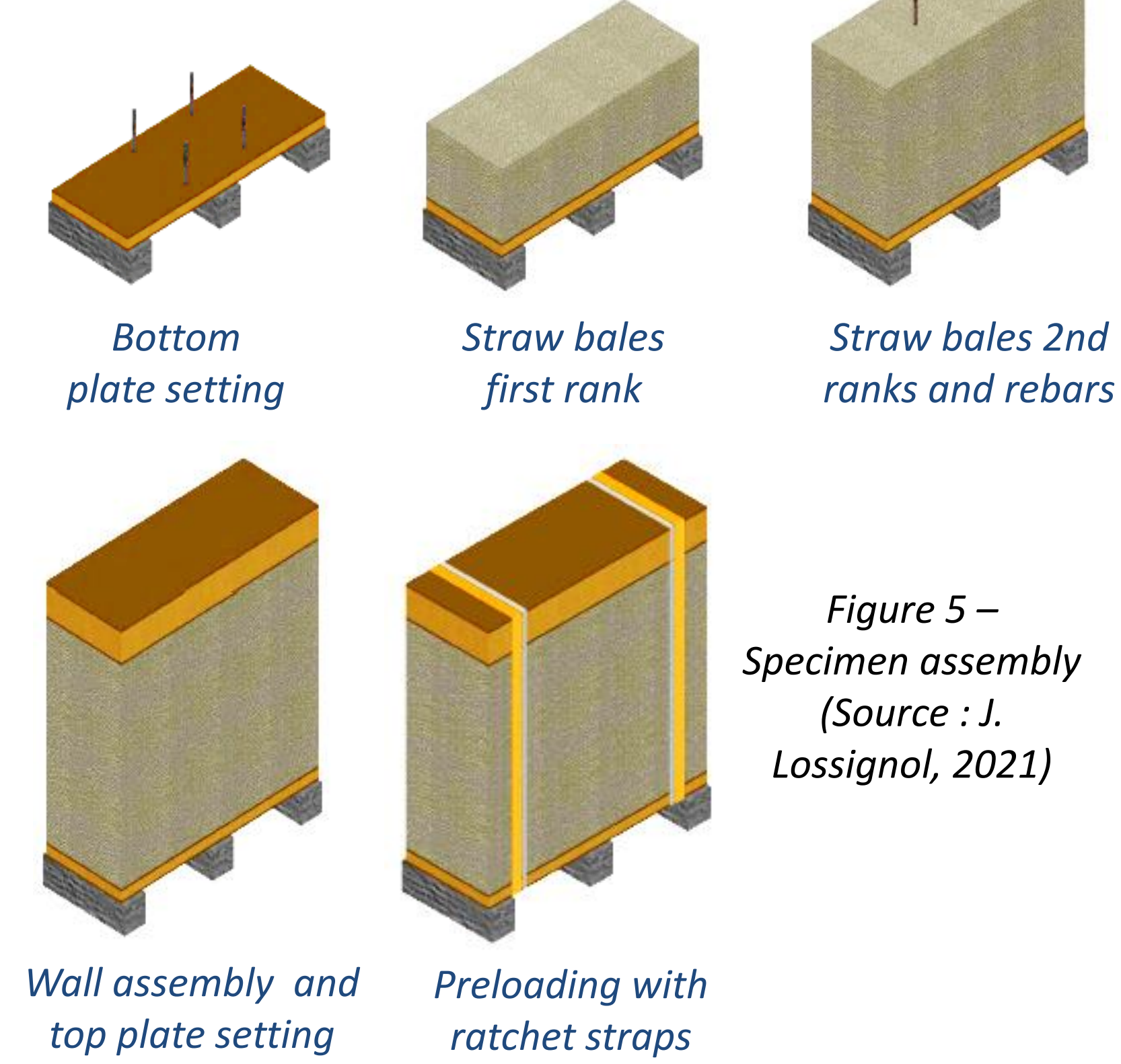


Figure 5 – Specimen assembly (Source : J. Lossignol, 2021)



Figure 6 – Test setup (Source : Photo library - J. Lossignol, 2021)

## Instrumentation systems

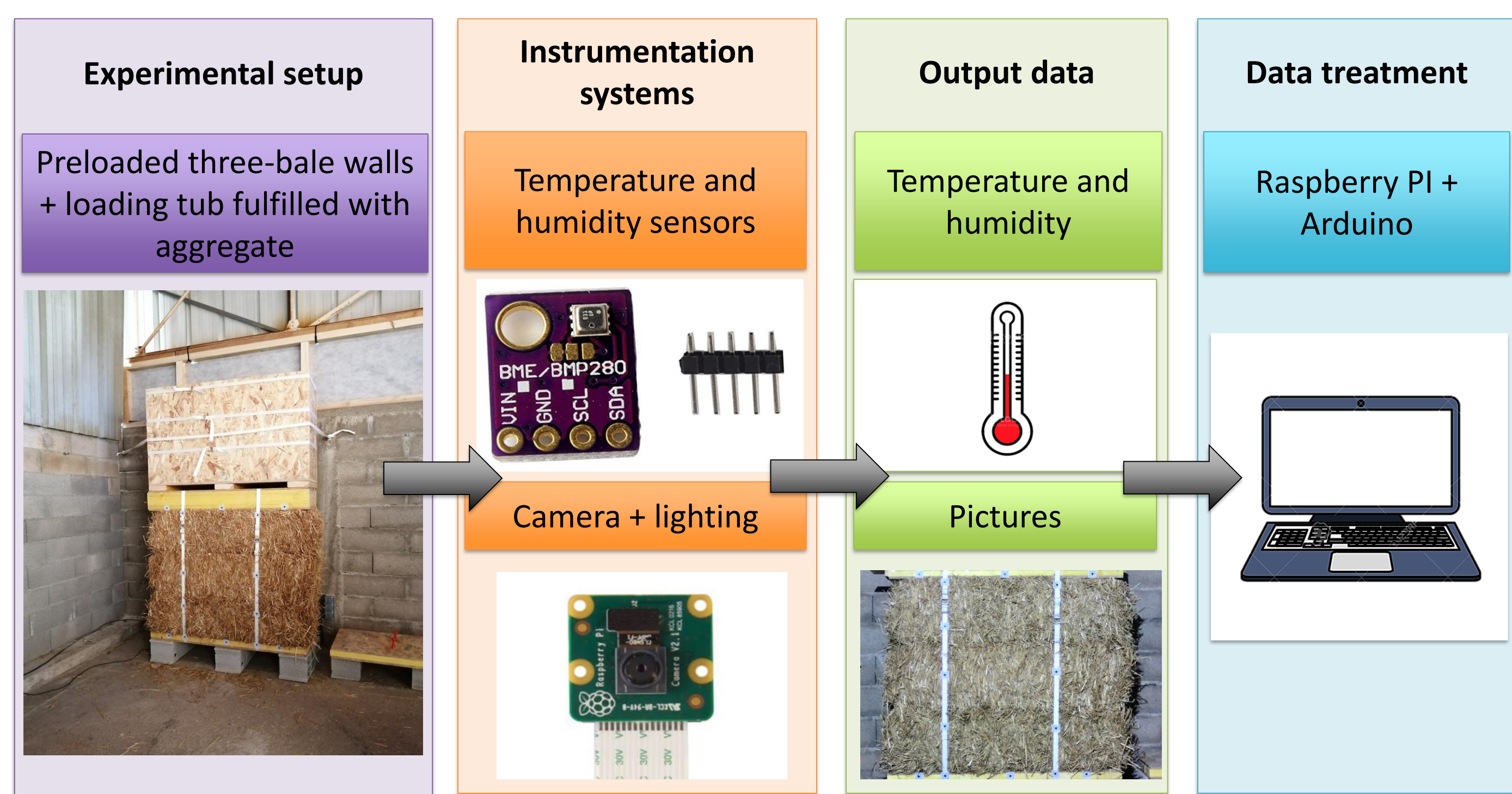


Figure 2 – Process chart of instrumentation systems (Source : J. Lossignol, 2021)

### Digital Image Correlation

full-field and non-intrusive deformation measurement on planar systems, using pattern matching, photometric mapping and interpolation using shape functions

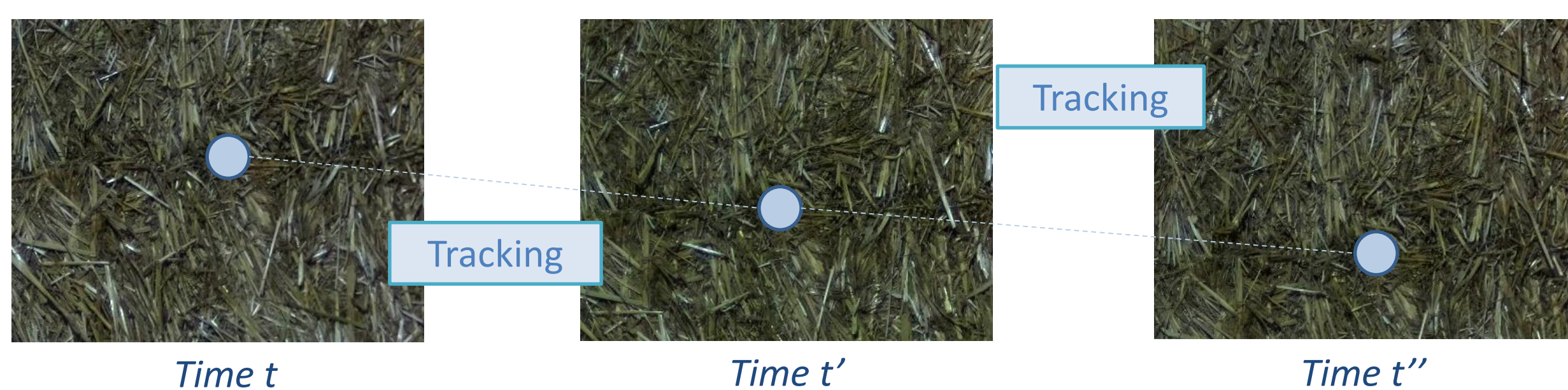


Figure 3 – DIC principle (Source : J. Lossignol, 2021)

### Humidity and temperature sensors

monitoring the internal and external temperature and humidity in the walls over time

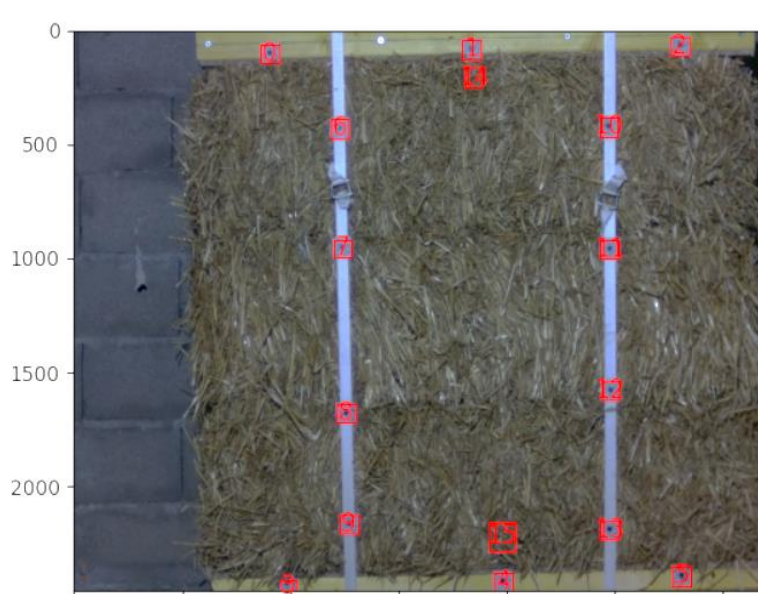
### Dynamometers

measuring the load value during the preloading phase

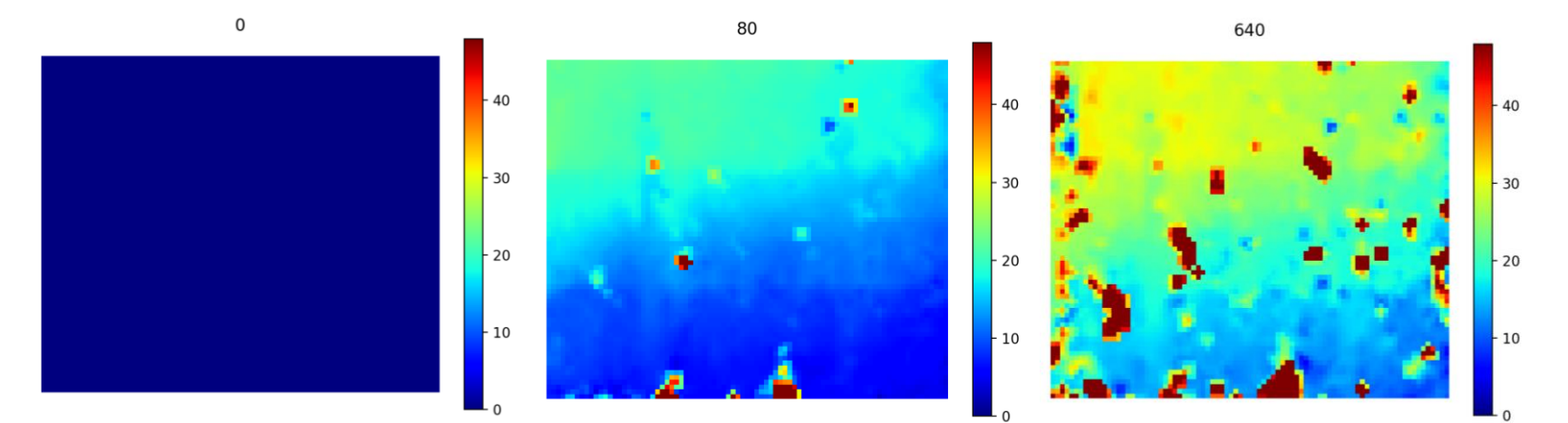
## Results and conclusion

### Preliminary tests on a wall

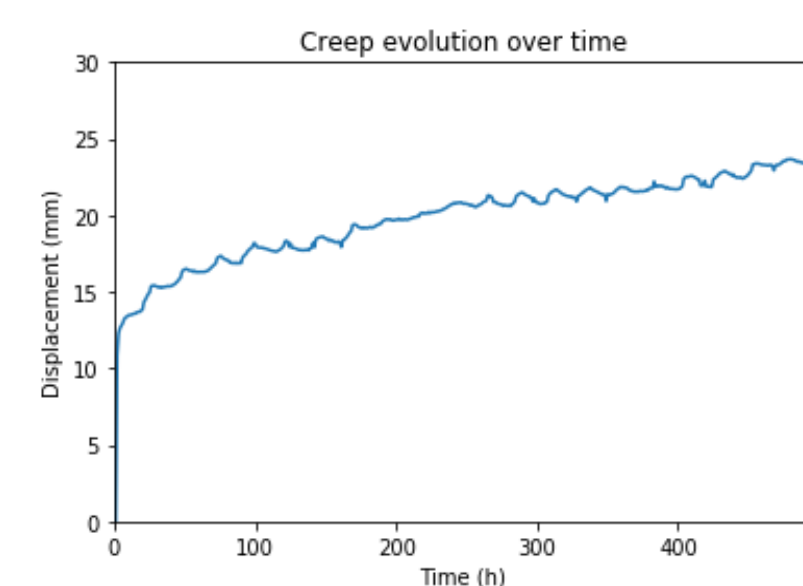
Loading of 3,73kN/m, 5% preloading strain rate, bales density of 116kg/m<sup>3</sup>



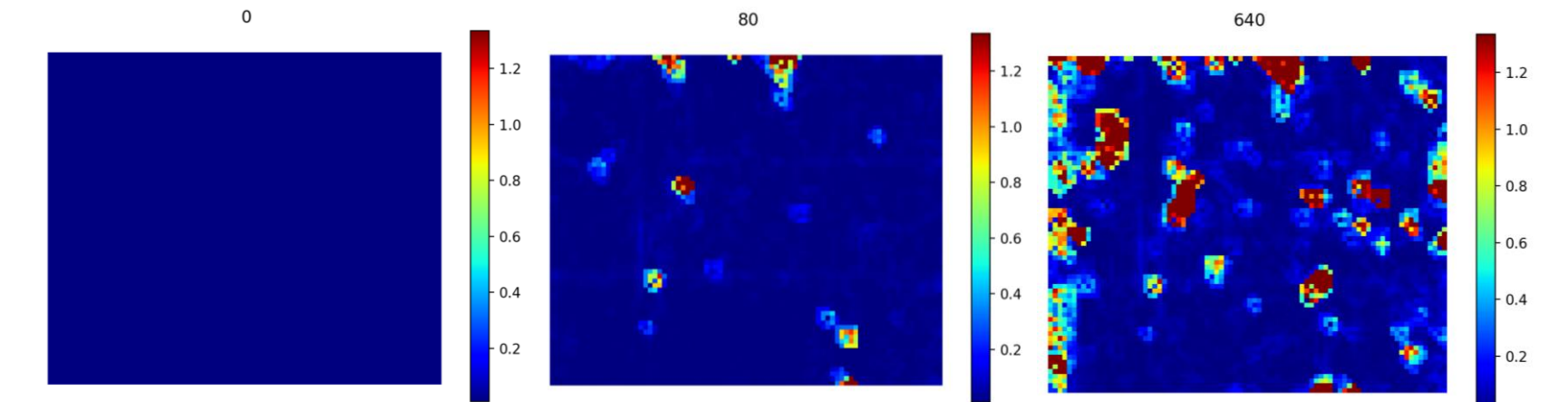
Targets tracking on the wall



Displacement graphic representation at D0, D+4, à D+28



Creep evolution of the wall over one month



Strain graphic representation at D0, D+4, à D+28

Figure 7 – Results from a Python data post-treatment software (Source : J. Lossignol, 2021)

### Conclusions and research prospects

- The refurbishment works enabled to get a good lighting and then satisfying results by DIC.
- Pictures acquisition is discrete so continuous information need to be interpolated
- Force measurements must be consolidated as they are affected by strap friction during pretensioning
- Tests will be conducted on walls varying the bales density and integrating bracing systems to understand their contribution to the creep phenomenon.

### References

- Réseau français de la construction en paille (2018) Règles professionnelles de construction en paille. 3e édition réorganisée et augmentée. Editions le Moniteur. Paris
- J. Lossignol (2021) Etude du fluage sur des murs en paille porteuse – PhD report (internal)

