



Formulation strategy of a geopolymer-based mortar for sustainable 3D printing

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Context



- Productivity increase
- Efficient material use



- Complex rheology tuning

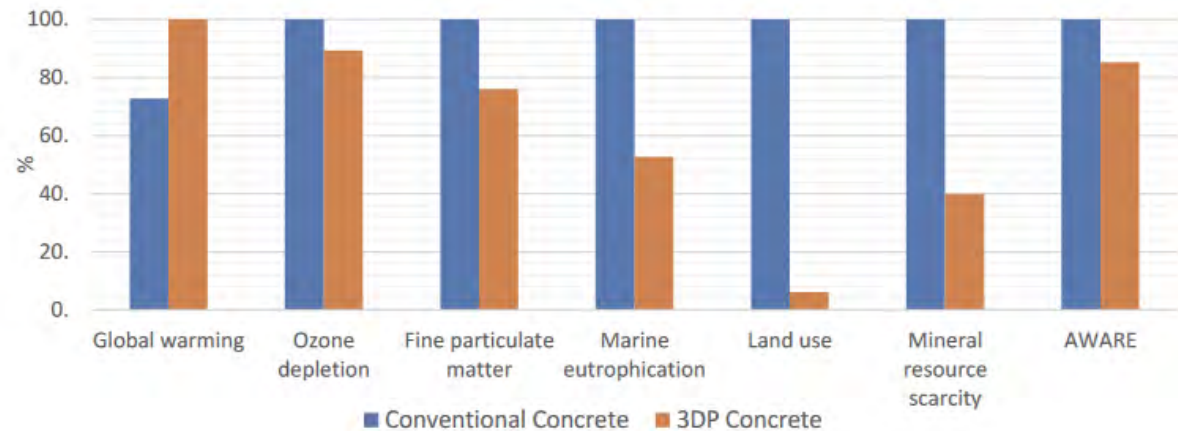


Fig. 1 Comparison between 1 m² 3DP Concrete wall with 1 m² Conventional Concrete [1]

Geopolymers :

- Rapid hardening at ambient temperature
- Mechanical performance
- Cement-free = **Sustainable***

Context

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Context

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- Materials aspects : low carbon cement, geopolymers, clays
- Rheological and mechanical aspects : fresh and hardened states
- Building aspects: LCA of 3D printing, reinforcement
- ...



Context

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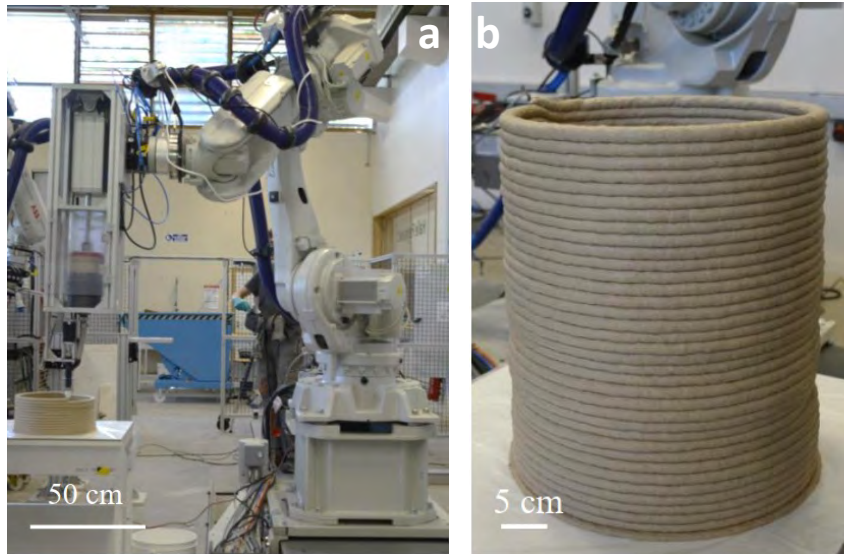


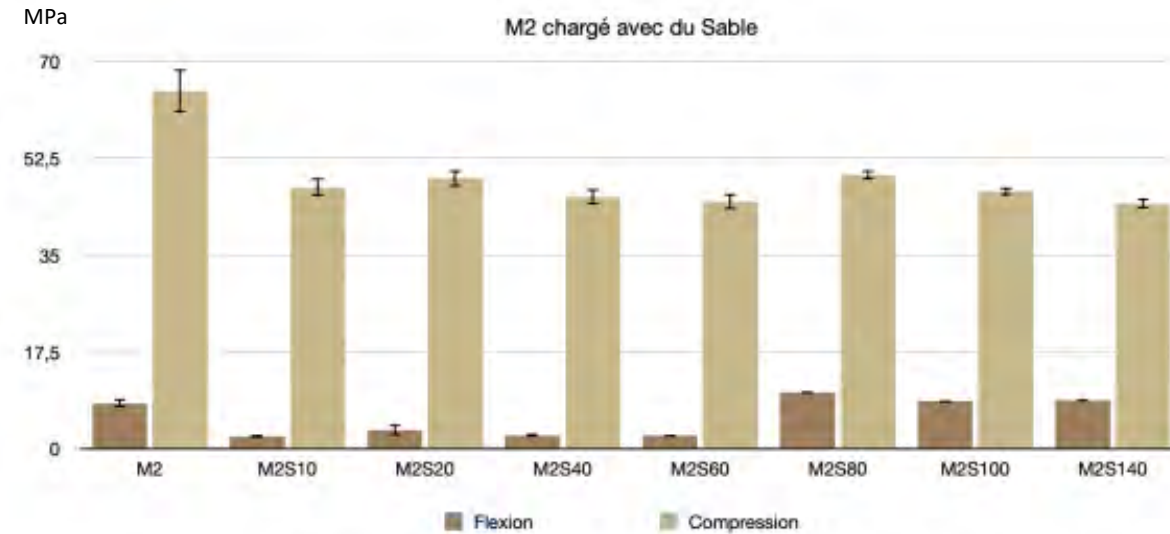
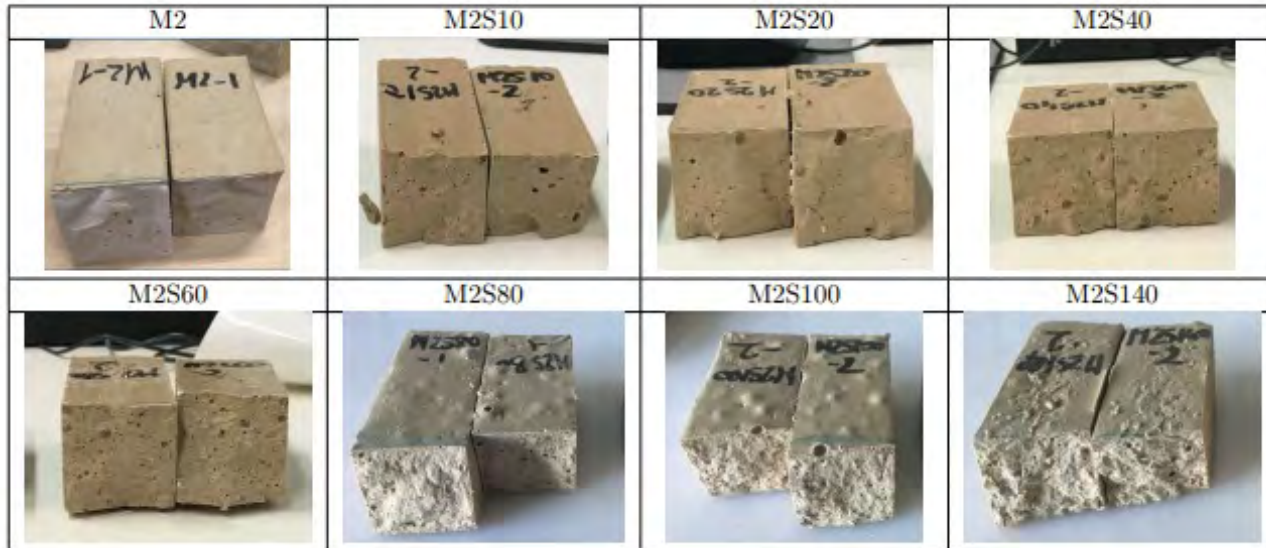
Fig. 2 **a)** 3D printing equipment and **b)** Example of a printed MK/K-Si based geopolymer composite (H=45cm) [2]

Geopolymer composite :

- High strength
- Precise application
- No sustainability criteria

Preliminary work

Formulations



- Sand additions are possible
- Earth additions significantly reduce the workability !

Current work

Study orientation

GP matrix design for exponential hardening in the desired time frame

Objective : Addition of earth without workability loss

Earth/sand mix

Presaturation

Superplasticizer

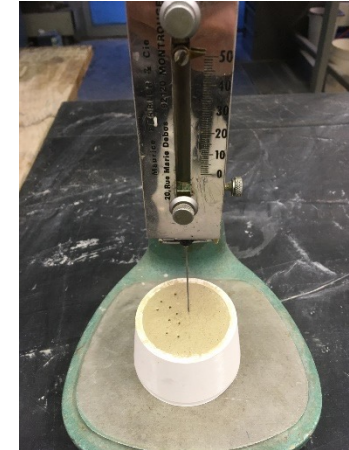
Earth treatment

- Not optimal LCA

- Slows the geopolymerization

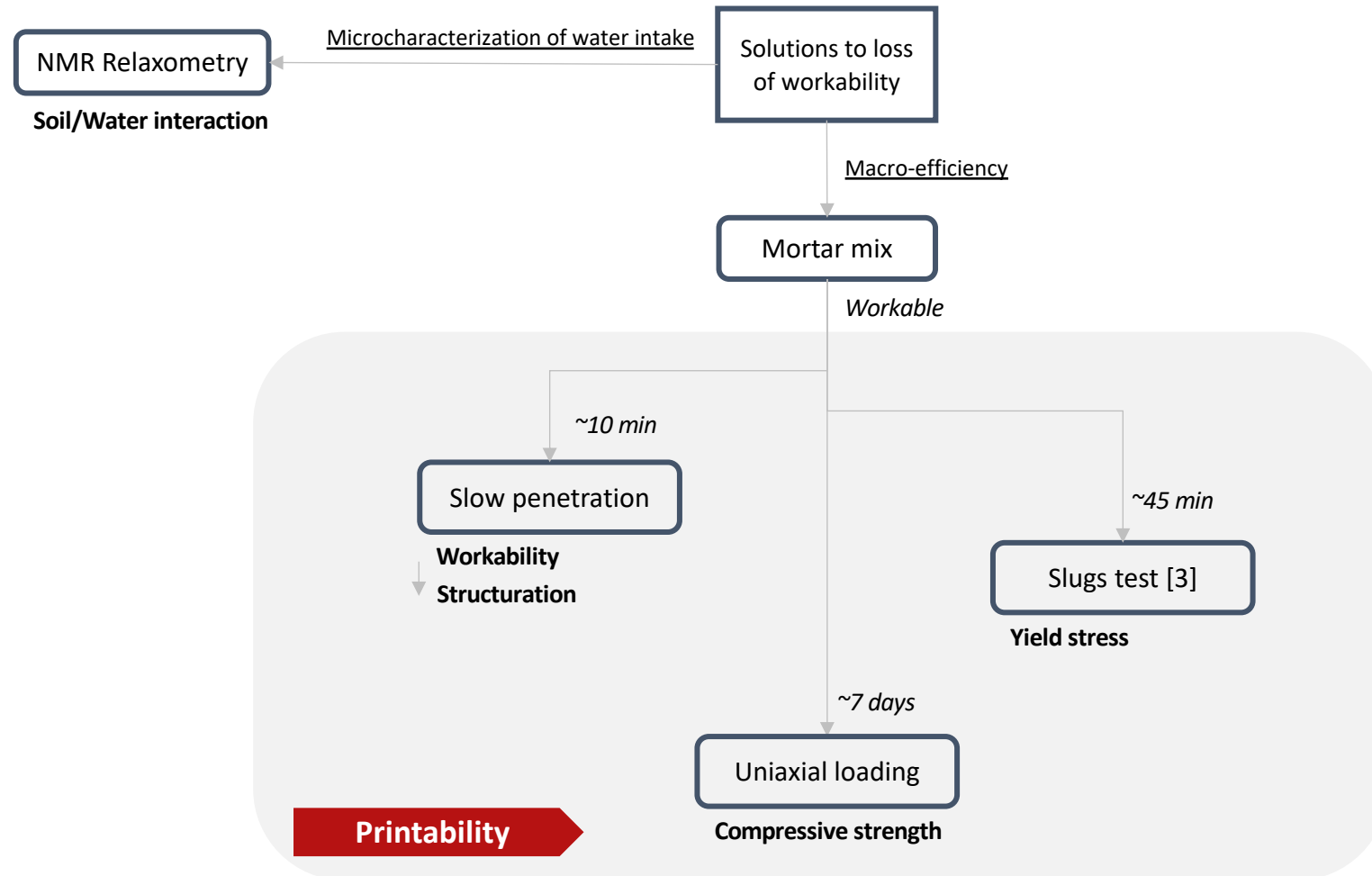
- No fluidifying effect

- To investigate



Current work

Strategy

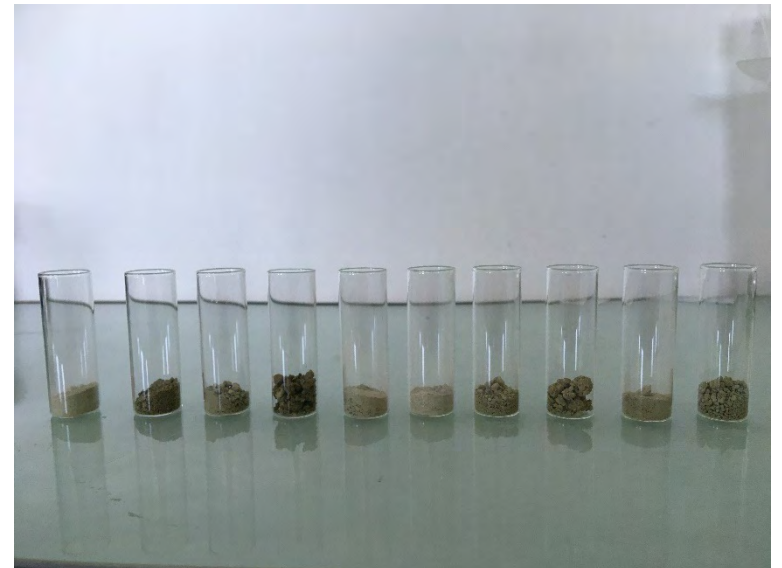
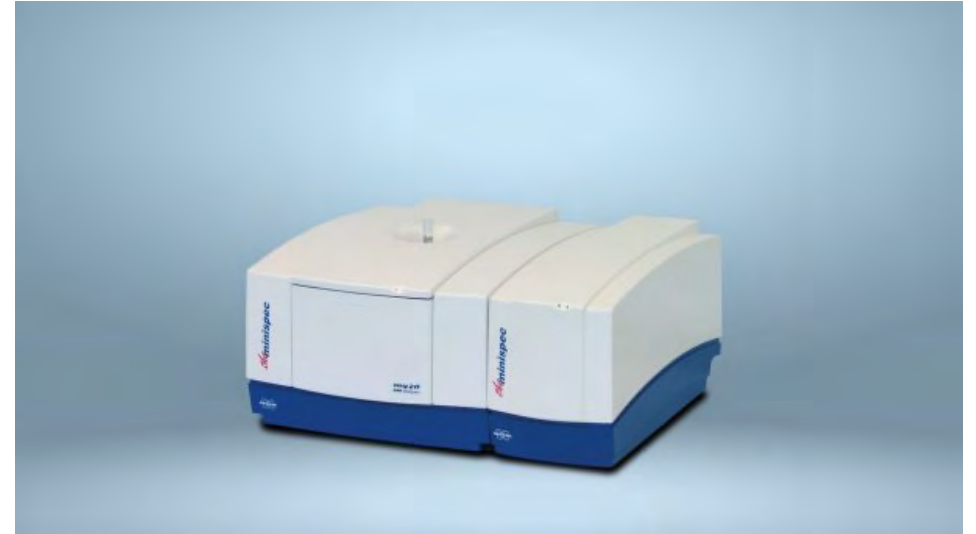


Current work

Strategy – NMR relaxometry

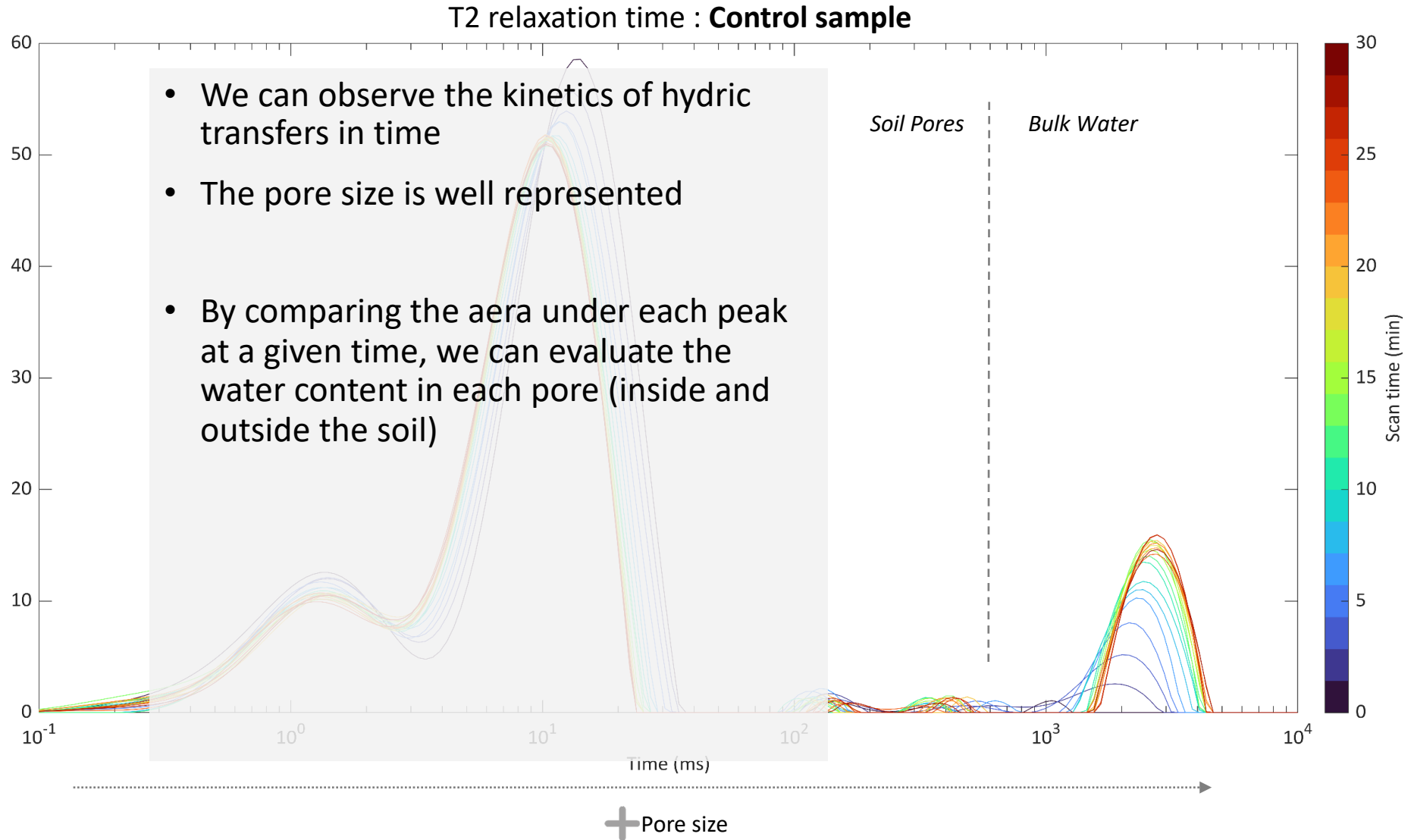
Nuclear spin relaxation [4] :

- Non-destructive test
- Probe from micro to macro to evaluate the motion of water molecules



First results

NMR relaxometry



Conclusion & perspectives

- Including an LCA criteria in the formulation
- Include aggregates in the GP-mortar in order to reduce its environmental impact while also increasing its buildability
- Prevent a loss in workability while ensuring the rate of geopolymerization
- Print a structural application
- Optimize the formulation with a design of experiments and a prediction of material properties using a neural network

Questions