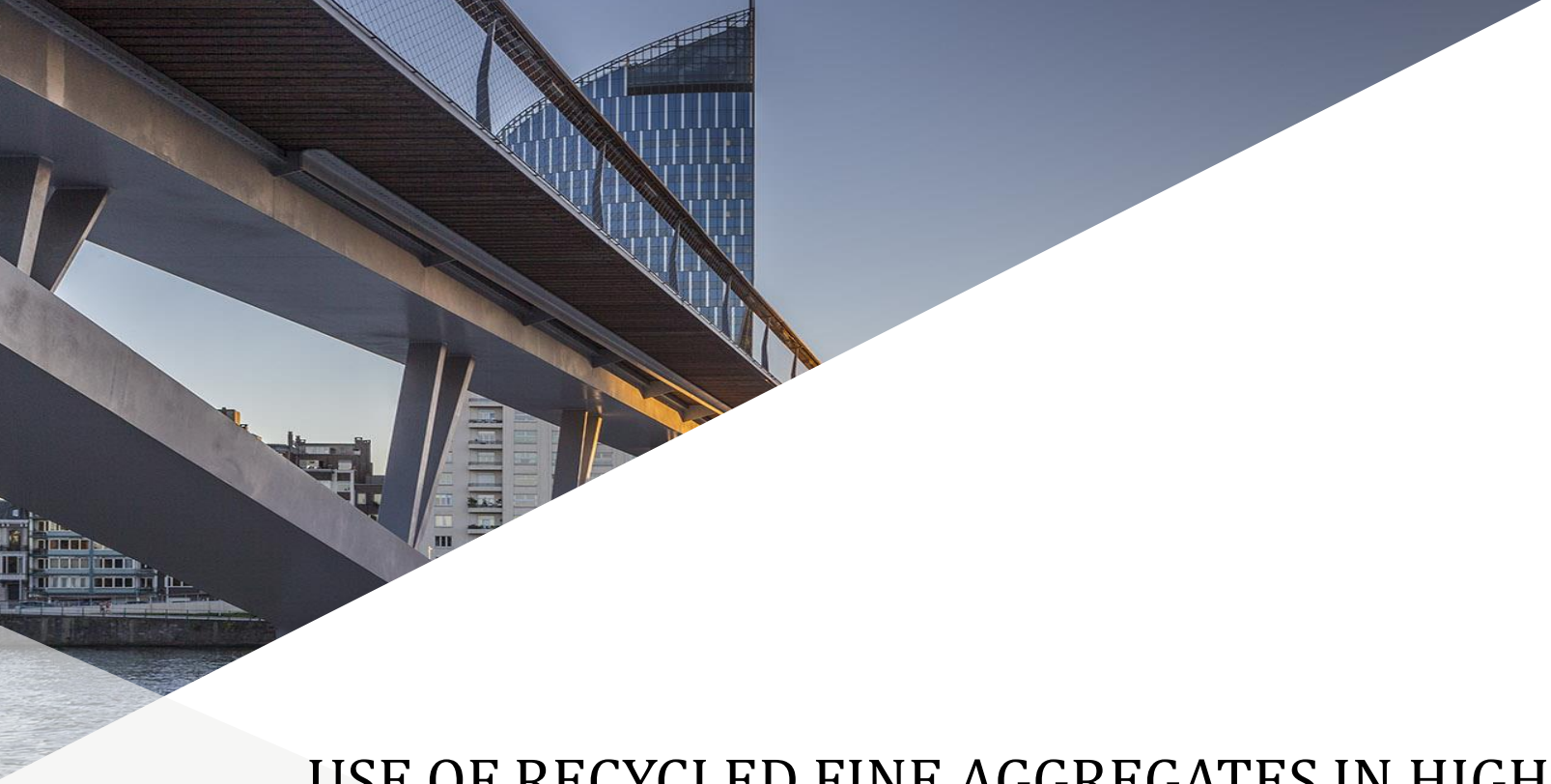

LIÈGE université
Sciences Appliquées

USE OF RECYCLED FINE AGGREGATES IN HIGH ADDED VALUE APPLICATIONS

1st International Conference on Advances in Engineering and Technology for Sustainable Development

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University of Liège
Hanoï, 2nd of November 2023

UEE
Urban & Environmental Engineering

TABLE DES MATIÈRES

INFLUENCE OF RFA OF THE PROPERTIES OF 3D PRINTING MORTAR

Comparison of the mechanical performances of a reference virgin sand mortar and a mortar designed with RFA :

- Both mixtures are designed to present the same workability

Washed concrete recycled fine aggregates 0/2

Natural crushed limestone 0/2

INFLUENCE OF RFA OF THE PROPERTIES OF 3D PRINTING MORTAR

Similar workability and printability :

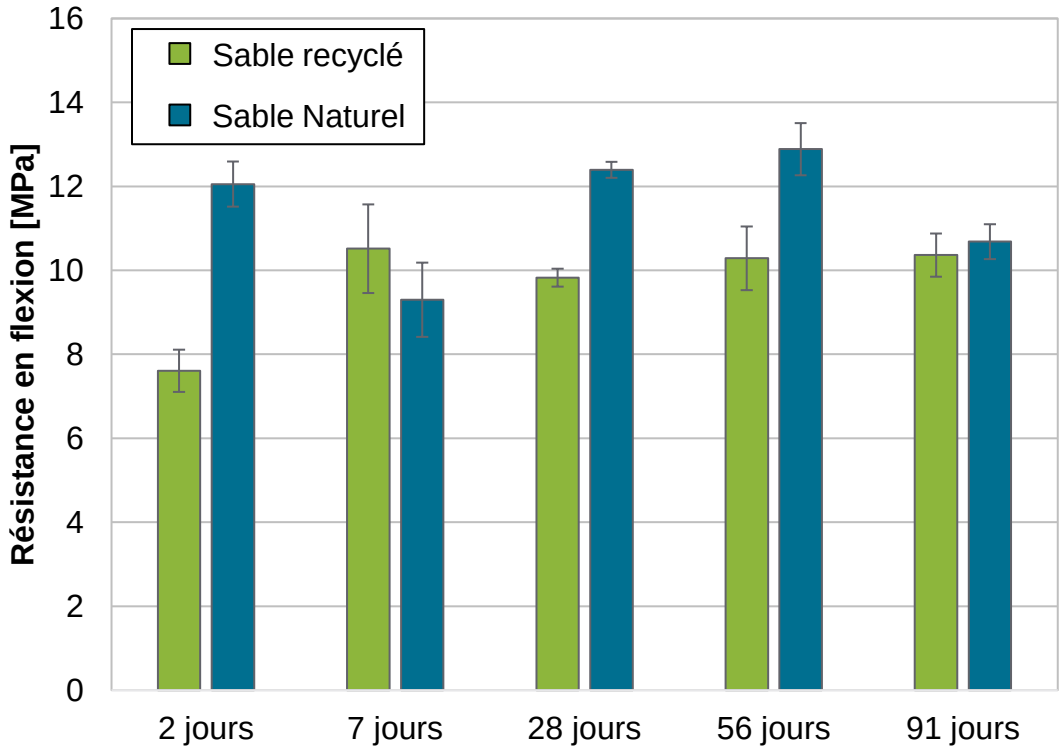
RFA 0/2 Tradecowall [kg/m³]	Vicat cement Performat CEM I 52.5N [kg/m³]	W_{eff}/C	SP [% SP/C]	VMA [% VMA/C]
995.6	905	0.29	2.50%	0.2%

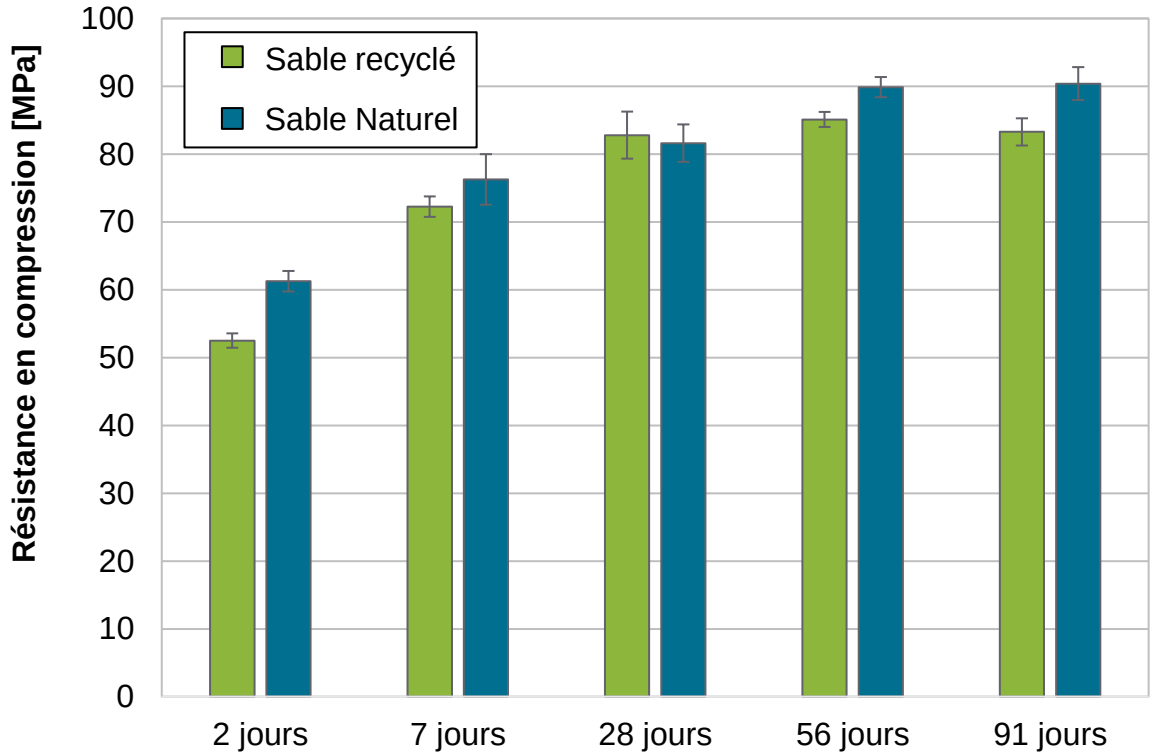
	Slump [mm]	Spread [mm]		
		10 chocs	15 chocs	25 chocs
RFA	43,7 ± 2,3	121,0 ± 1,9	128,0 ± 2,4	140,0± 3,1
Natural sand	45,4 ± 2,0	118,6± 1,5	124,8± 1,6	134,1± 1,9

INFLUENCE OF RFA OF THE PROPERTIES OF 3D PRINTING MORTAR

Mechanical characterization:

- Compressive strength
- Flexural strength
- Cast samples: prisms 4x4x16 cm

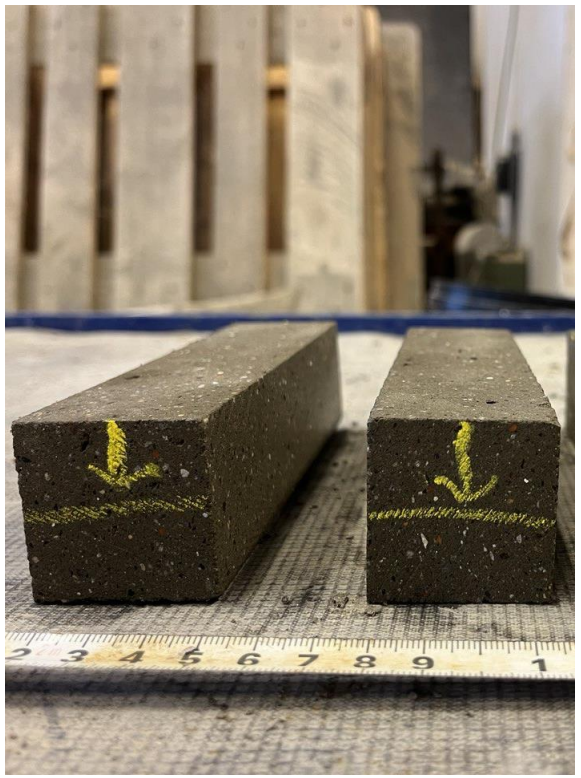




INFLUENCE OF THE PRINTING PROCESS

Printing of « S » shaped elements cut to extract prisms of dimensions 4x4x16 cm:

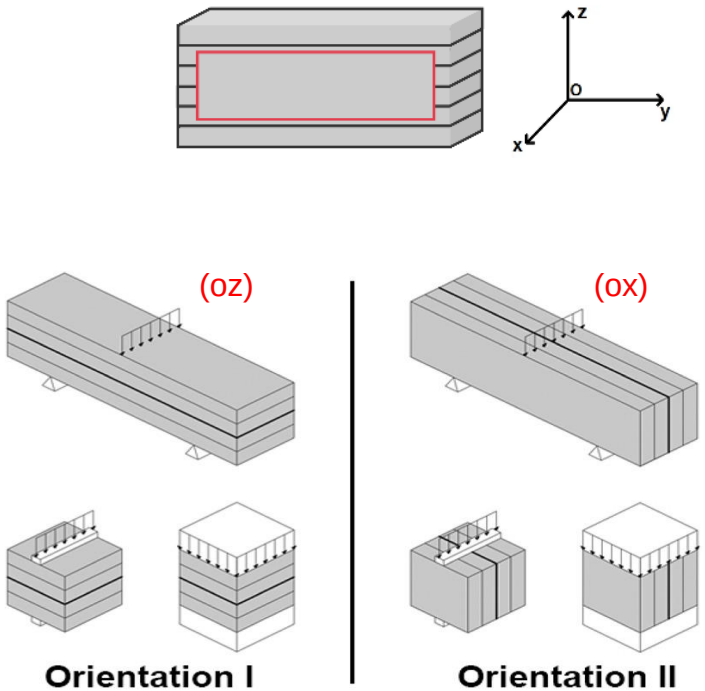
- Start of the humid curing after 48h (logisitics)



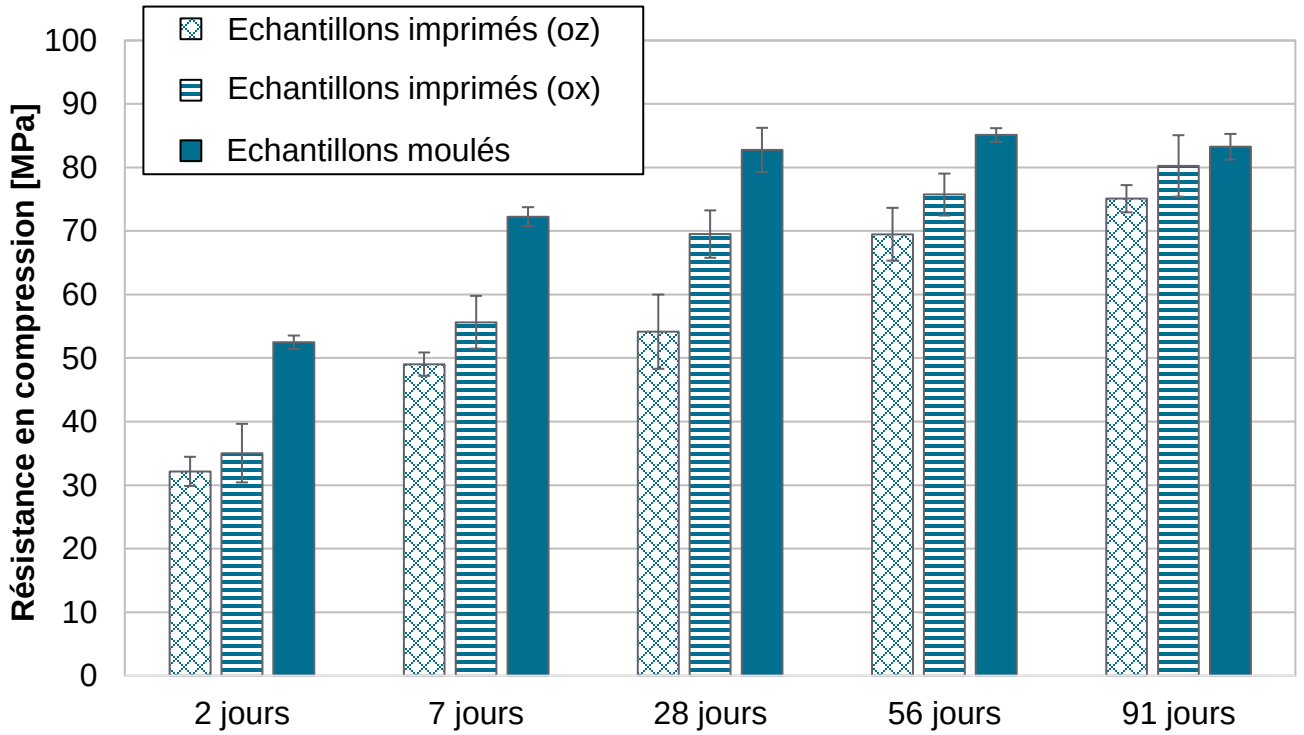
INFLUENCE OF THE PRINTING PROCESS

Compressive strength:

- Comparison of cast vs printed samples : significant loss of performances
- Anisotropy of the mechanical performances **Rc (oz) < Rc (ox)** *(wolf et al., 2019; Ma et al., 2019; Mechtcherine et al., 2020)*

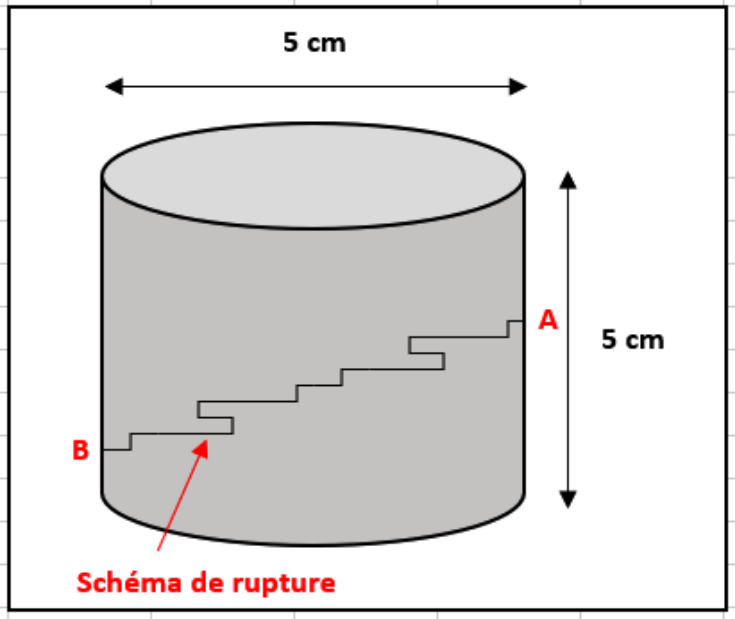


Considered configurations



Layer adherence (measured via direct tension test)

	7 days	28 days	56 days	91 days
Cast samples	-	-	-	2,92 ± 0,06
Printed samples	2,03 ± 0,11	2,51 ± 0,20	2,69 ± 0,31	2,25 ± 0,13



CONCLUSION

Influence of the type of sand:

- Slight decrease of the compressive strength (max 8%)
- No significant influence on the flexural strength

} Performances more than satisfying

Influence of the printing process:

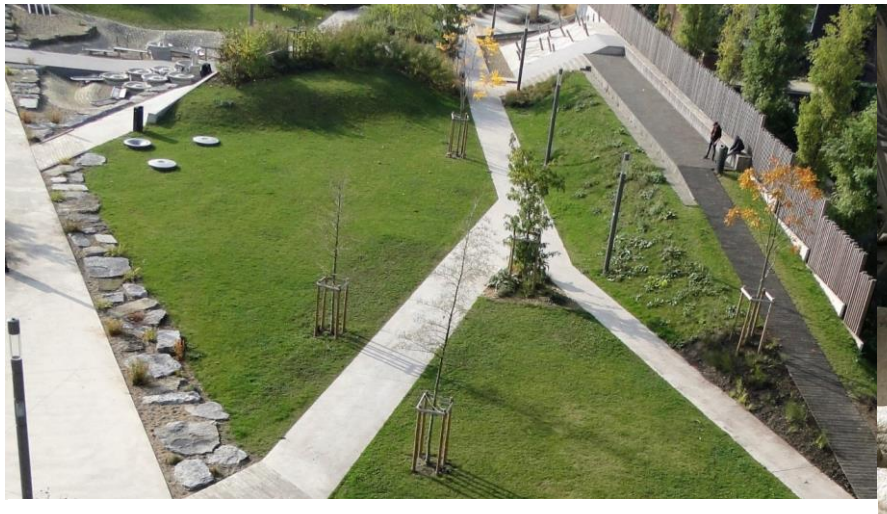
- Additive manufacturing : Loss of mechanical performance but still behaves very well

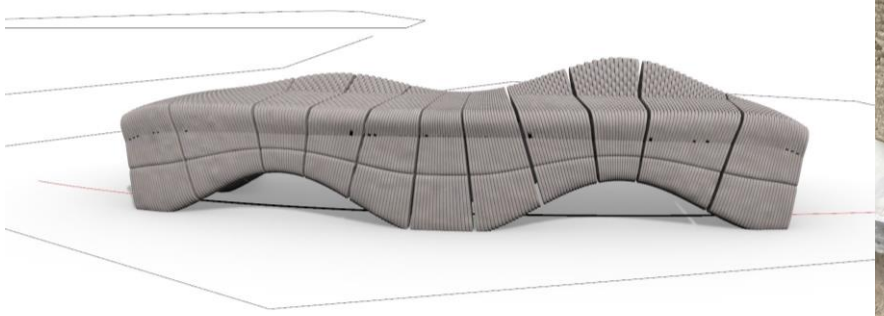
  No « weakness planes » at the interface between printed layers

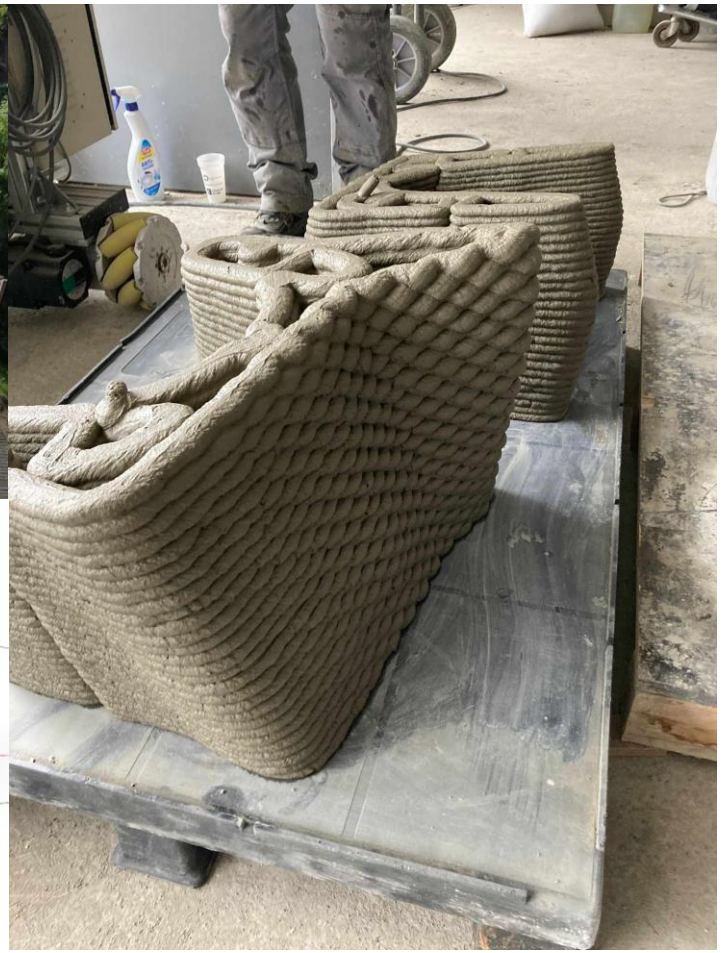
PILOT APPLICATION

Urban furniture – bench

Parc Bernard Serin in Seraing, Belgium







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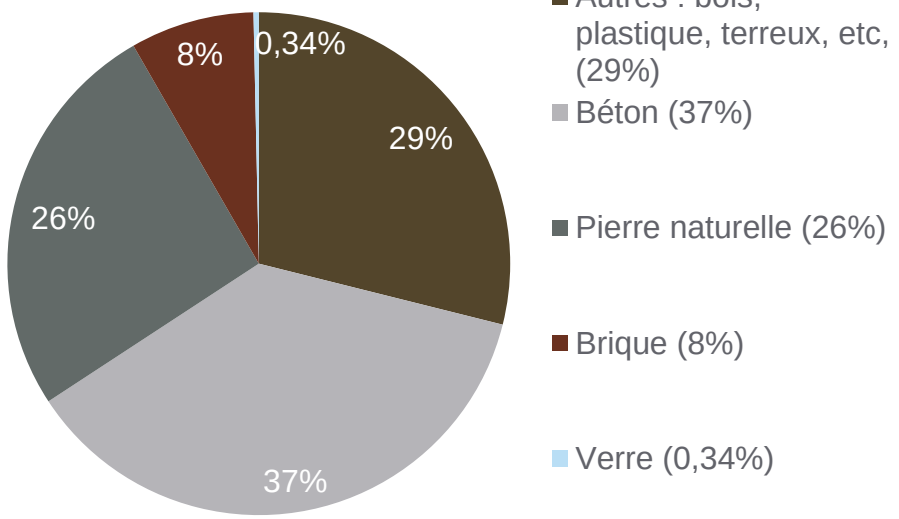
MERCI POUR VOTRE ATTENTION

GOAL

Develop the most environmentally friendly masonry material possible:

- Substitution of the primary ressources → Use of recycled concrete aggregates : **Pre-scalping fines**



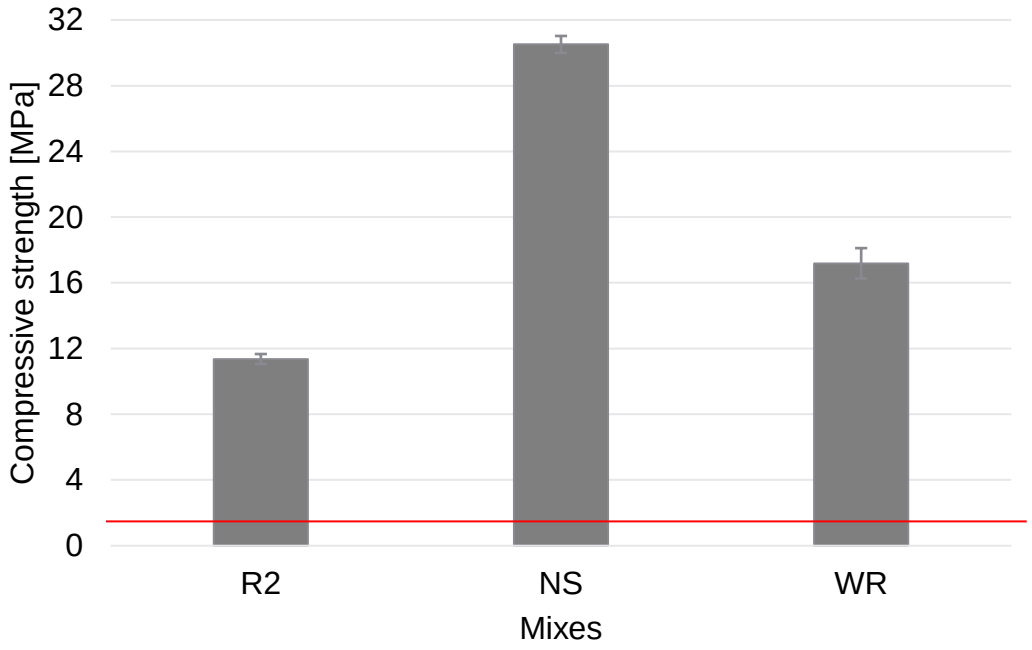
OBJECTIF

Develop the most environmentally friendly masonry material possible:

- Substitution of the primary ressources → Use of recycled concrete aggregates : **Pre-scalping fines**
- Reduce cement content
- Reduce water consumption

→ Rammed earth method

Comparison of the performances of a rammed earth wall with natural sand, washed recycled sand ans pre-scalping fines :

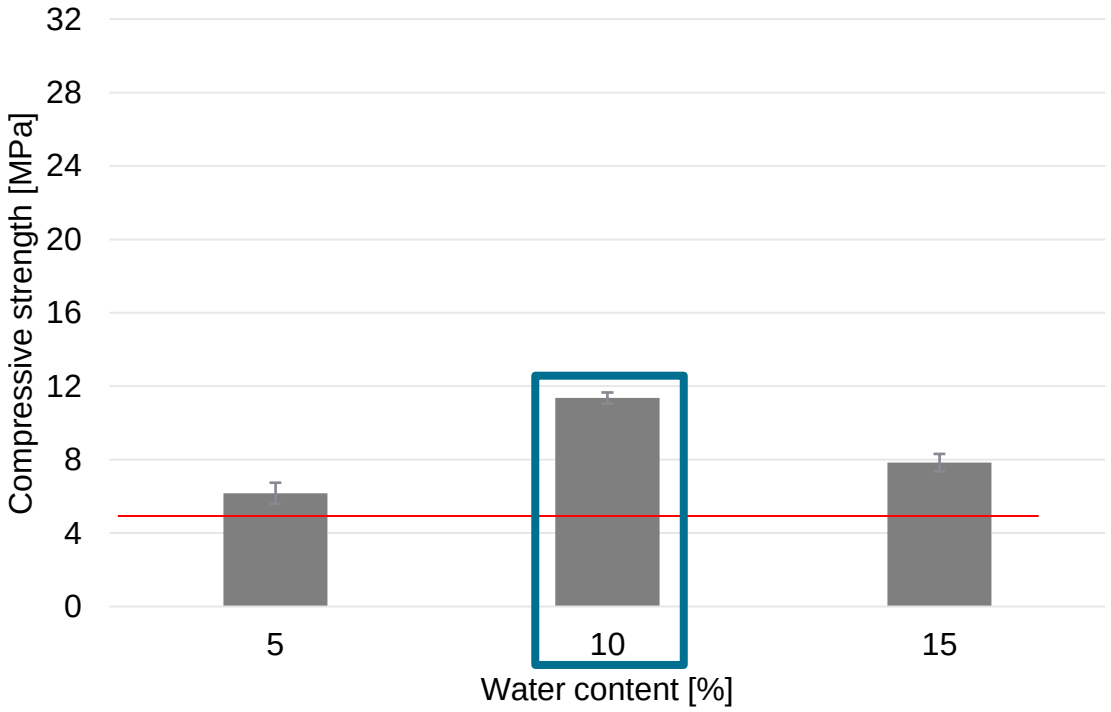


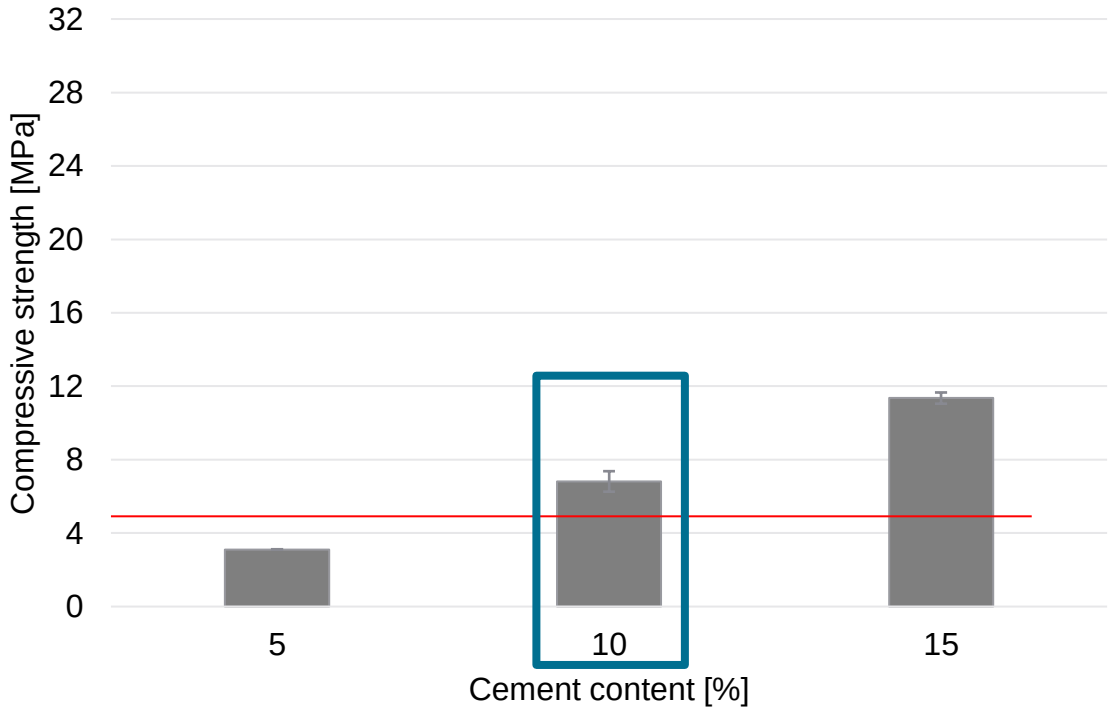
Significant loss of performance with pre-scalping fines but the samples still verify the minimal required compressive strength for masonry elements

MIX DESIGN AND OPTIMISATION

Optimisation of the mix design (wt%) :

- Influence of the water content: 5%, 10%, 15%
- Influence of the cement content : 5%, 10%, 15%





First draft of the composition : 80% pre-scalping fines, 10% water et 10% cement,

RAMMED CONCRETE PILOT