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# HIGH-VOLUME USE OF WOOD BIOMASS ASH IN CEMENTITIOUS MATERIALS

Désiré NDAHIRWA<sup>1\*</sup>, Nathalie LEBLANC<sup>1</sup>, Hélène LENORMAND<sup>1</sup>, Hafida ZMAMOU<sup>1</sup>

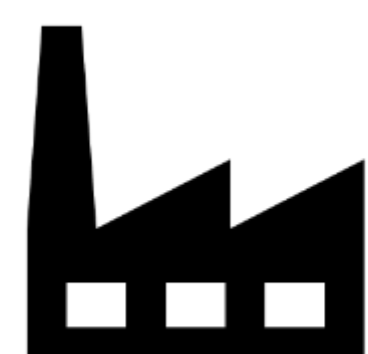
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## 1. Introduction

### Impact of cement and building sector on the environment

Cement industry [1,2]



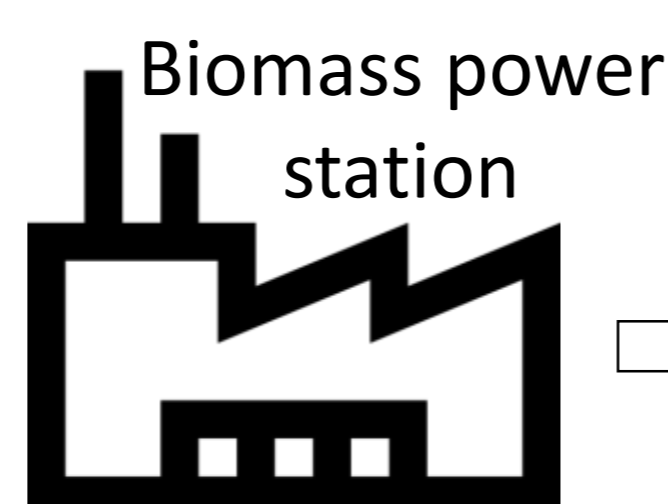
CO<sub>2</sub>  
6-9%

4-5 GJ/ton  
energy use

In France



44% of energy consumption [3]



Applications

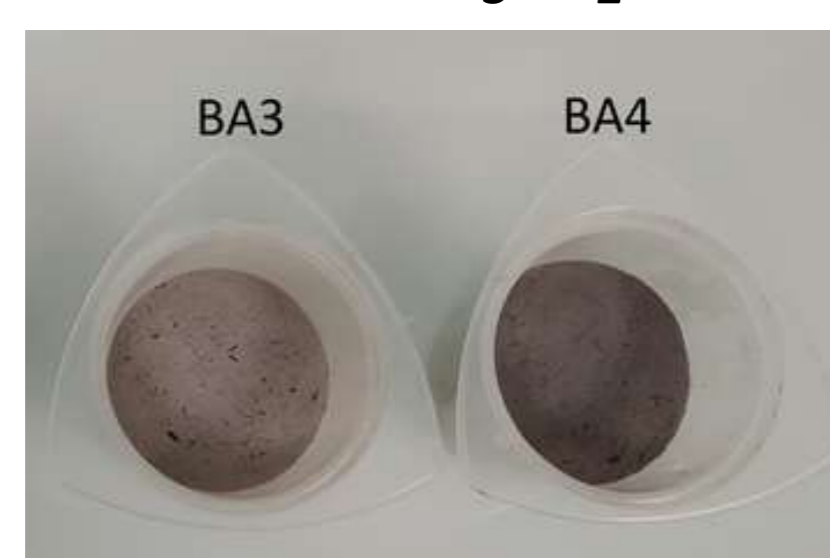
- Supplementary cementitious material in mortar and concrete production [4]
- Clinker partial replacement in production of blended cements [5]

This study aims at using of high-volume ( $\geq$  minimum 80%<sub>weight</sub>) wood biomass ash to elaborate a binding matrix for bio-based insulating mortars.

## 2. Materials and methods

### Raw materials :

- Ordinary Portland cement OPC (CEM II) 32.5N
- Natural hydraulic lime (NHL) 3.5
- Biomass fly ash : BA3 and BA4 (supplied by a local biomass power plant); The main **oxide compounds**: CaO, SO<sub>3</sub>, K<sub>2</sub>O, MgO, P<sub>2</sub>O<sub>5</sub>, SiO<sub>2</sub>.



### Mixture proportion

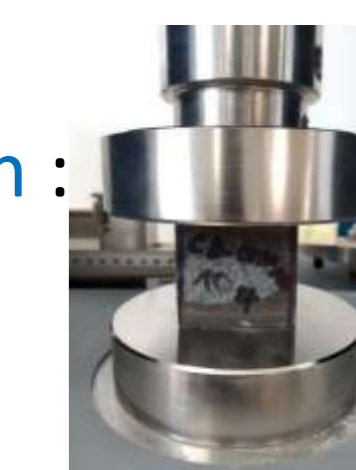
Mixture designation	BA (%)	OPC (%)	W/BA ratio	Mixture designation	BA (%)	NHL (%)	W/BA ratio
OPC100	0	100	0.5	NHL100	0	100	0.5
BA3-OPC0	100	0	0.5	BA3-NHL0	100	0	0.5
BA4-OPC0	100	0	0.5	BA4-NHL0	100	0	0.5
BA3-OPC5	95	5	0.5	BA3-NHL5	95	5	0.5
BA4-OPC5	95	5	0.5	BA4-NHL5	95	5	0.5
BA3-OPC10	90	10	0.5	BA3-NHL10	90	10	0.5
BA4-OPC10	90	10	0.5	BA4-NHL10	90	10	0.5
BA3-OPC20	80	20	0.5	BA3-NHL20	80	20	0.5
BA4-OPC20	80	20	0.5	BA4-NHL20	80	20	0.5

### Mechanical properties :

- ✓ **Flexural strength** : prismatic specimen, dimensions: 40x40x160 mm<sup>3</sup>



- ✓ **Compressive strength** : Cubic specimen, dimensions: 40x40x40 mm<sup>3</sup>



## 3. Results and discussion

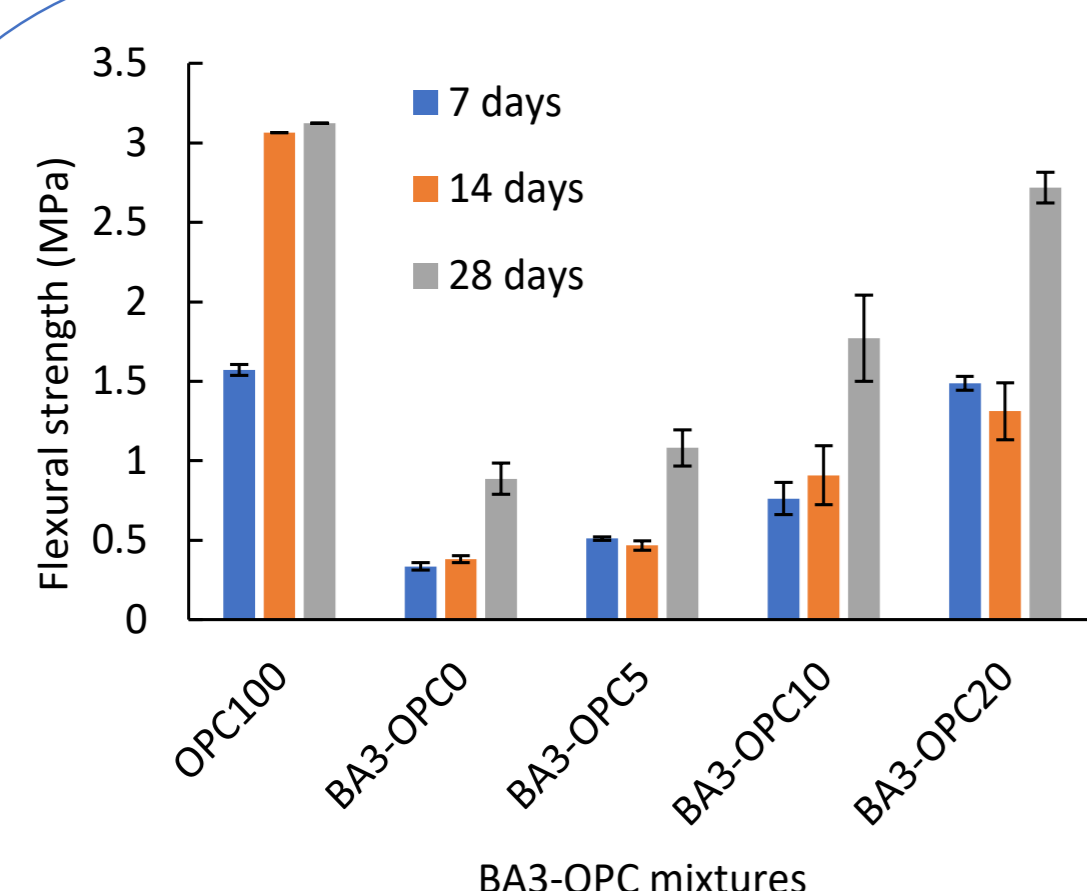


Figure 1: Flexural strength ( $R_f$ ) of BA3 and BA4 mixtures containing OPC

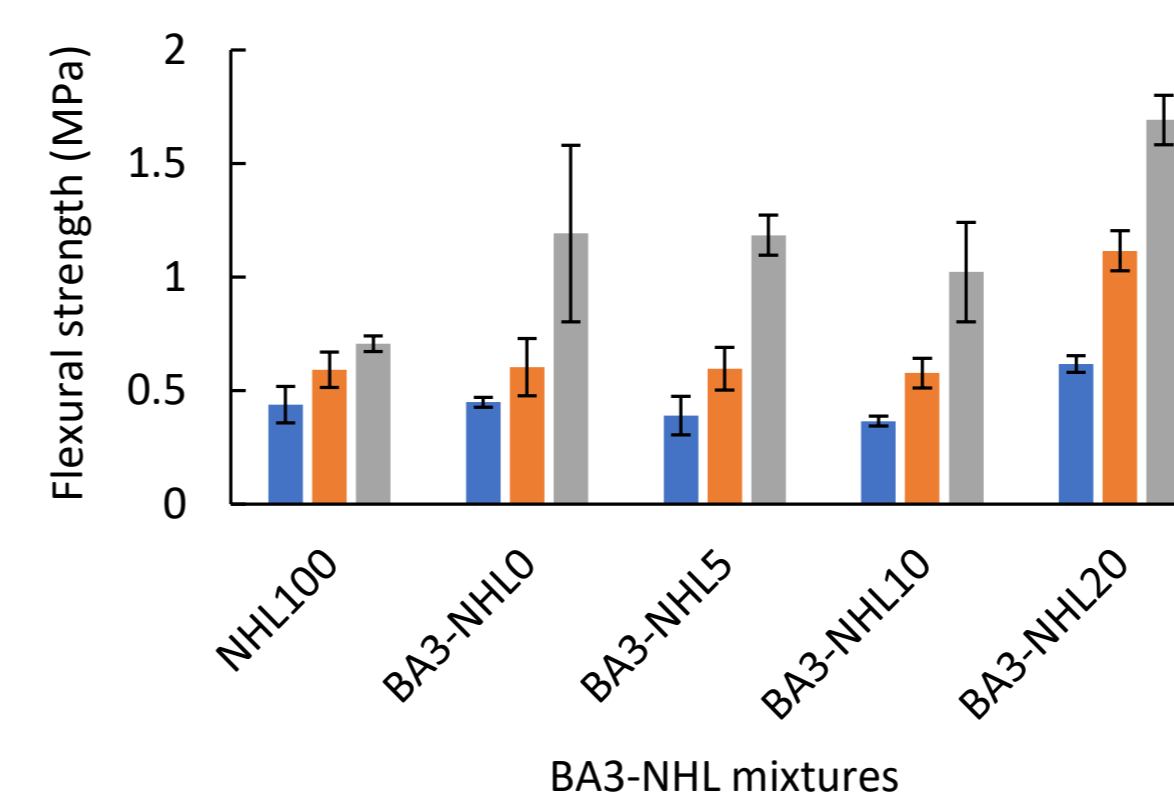
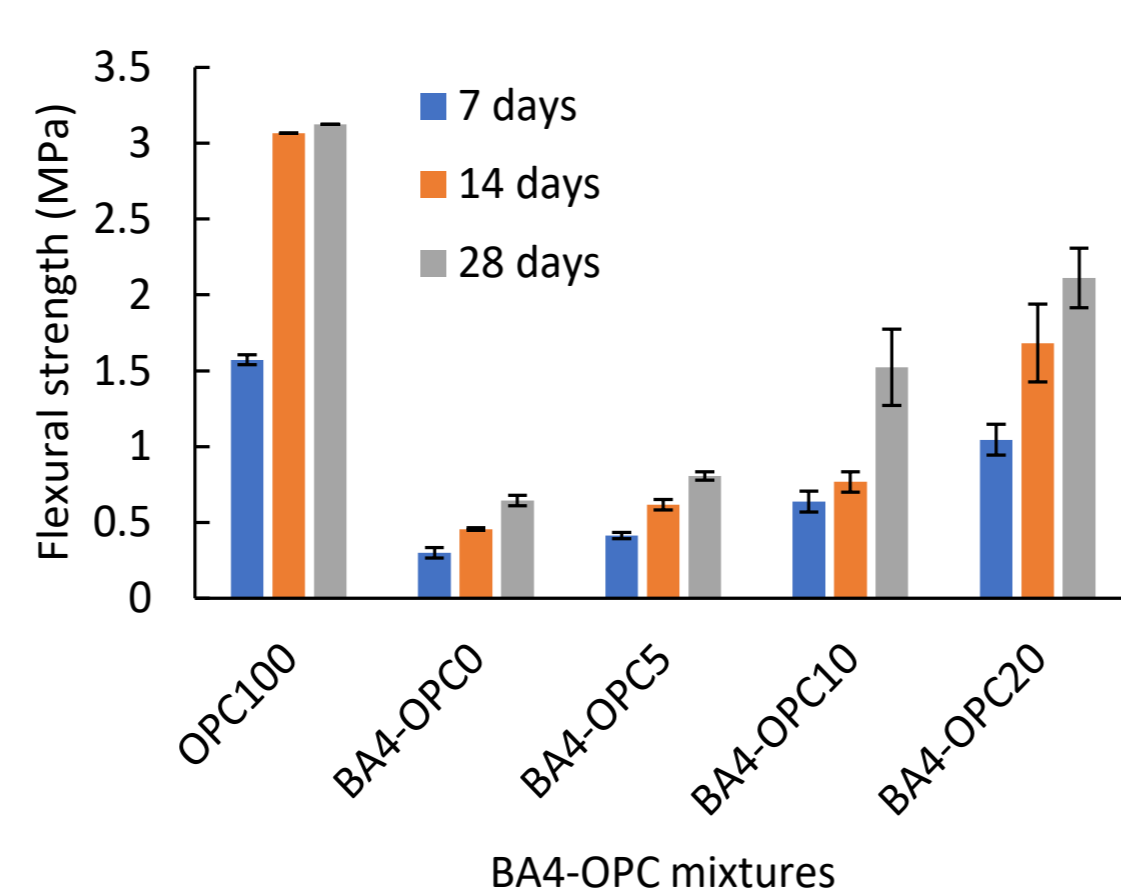


Figure 3: Flexural strength ( $R_f$ ) of BA3 and BA4 mixtures containing NHL

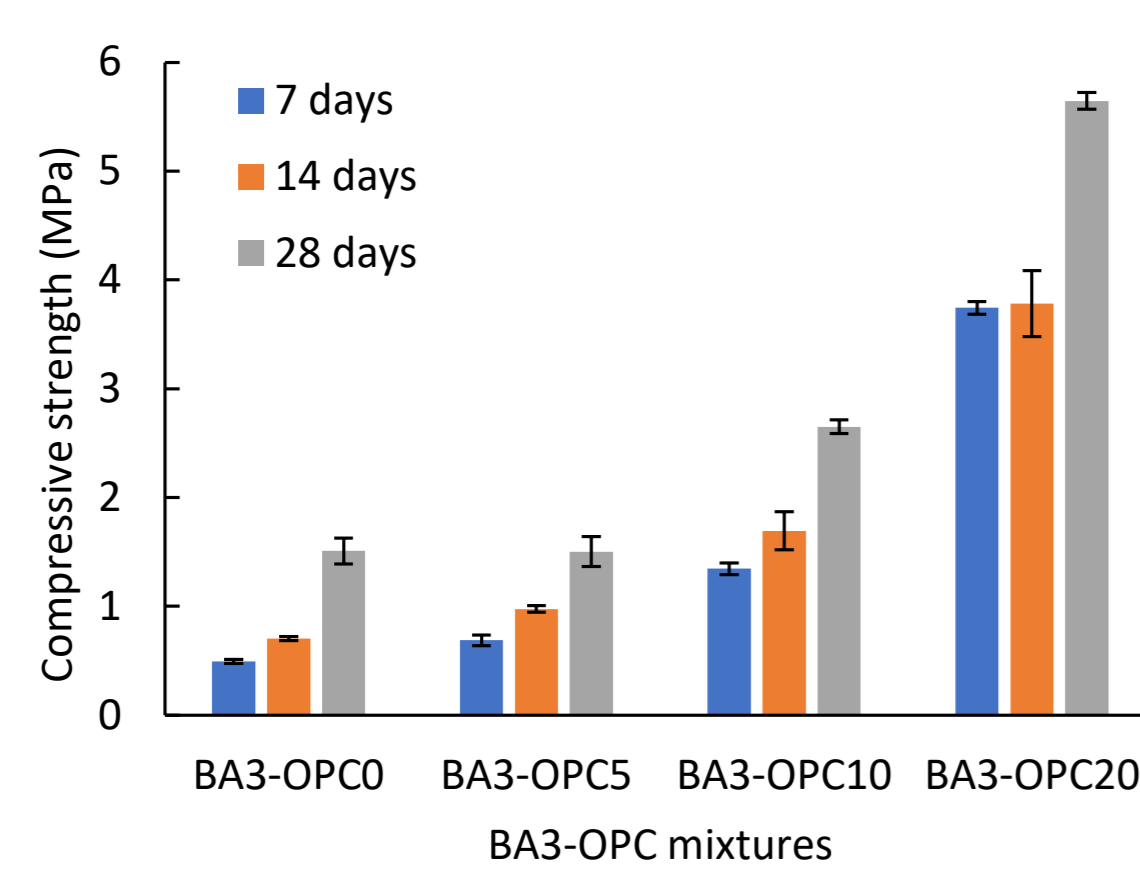
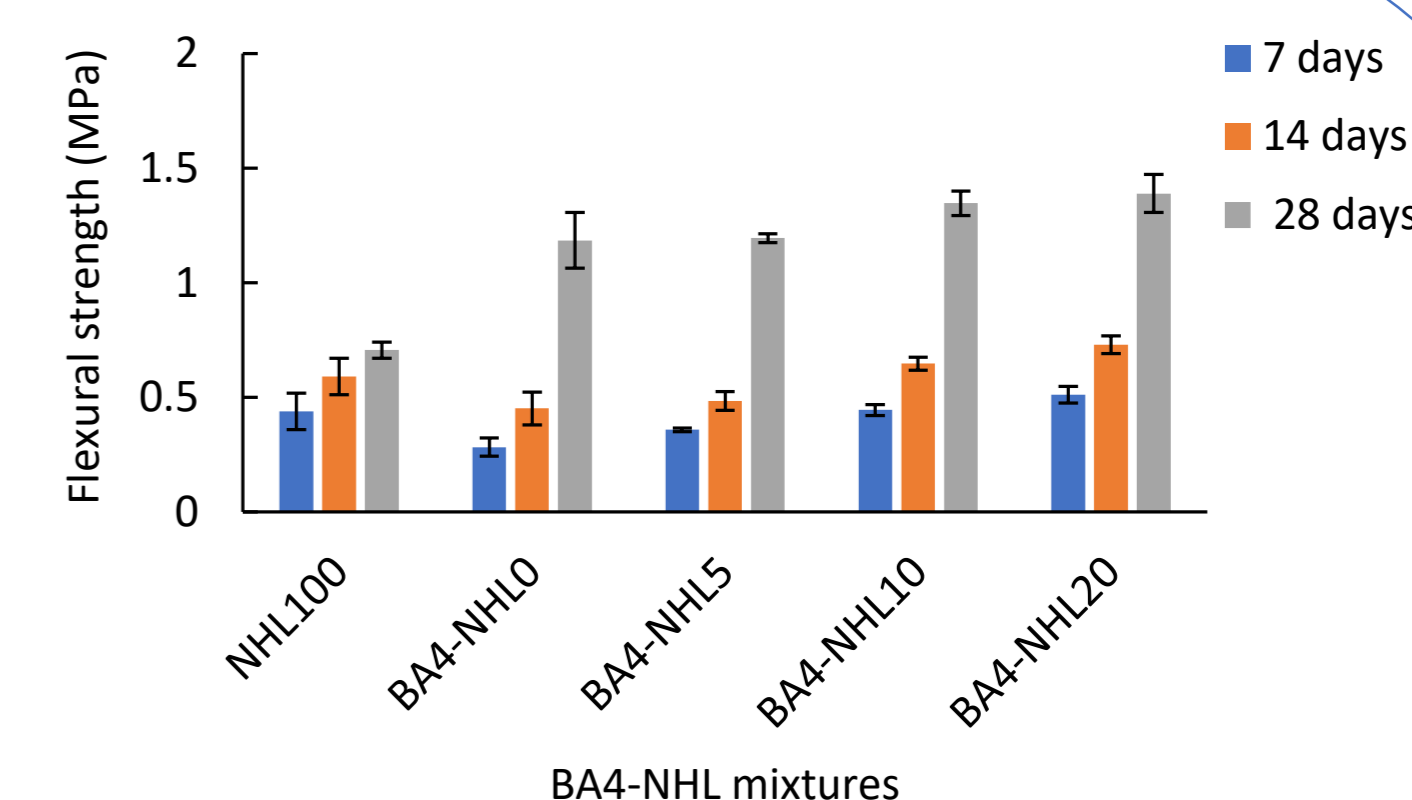


Figure 2: Compressive strength ( $R_c$ ) of BA3 and BA4 mixtures containing OPC

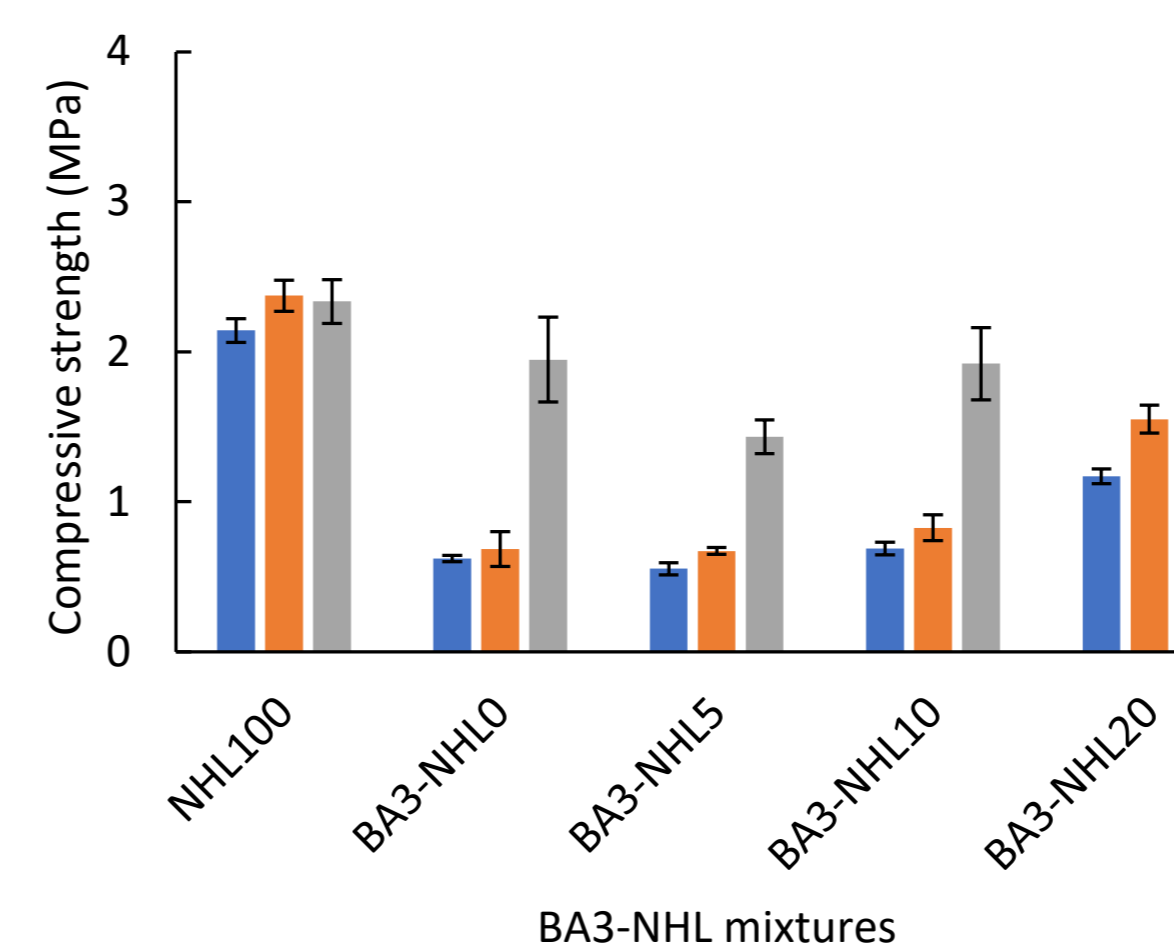
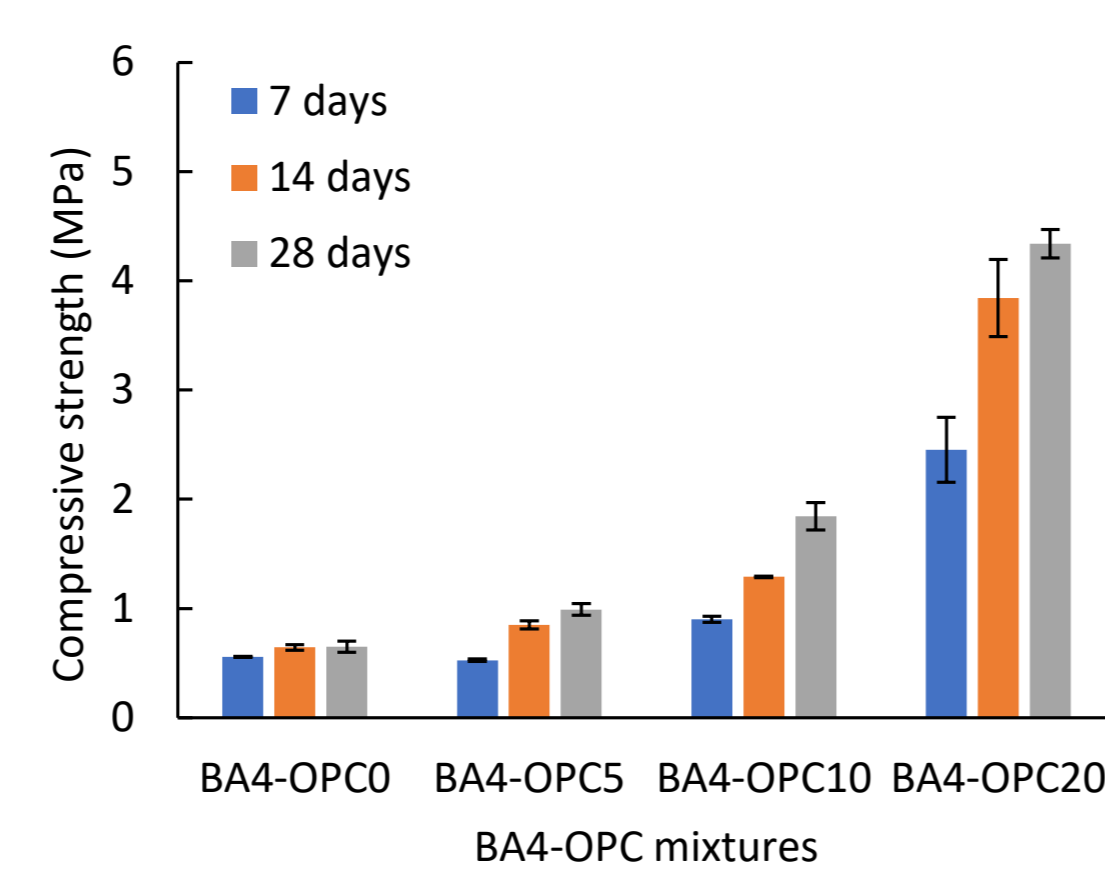
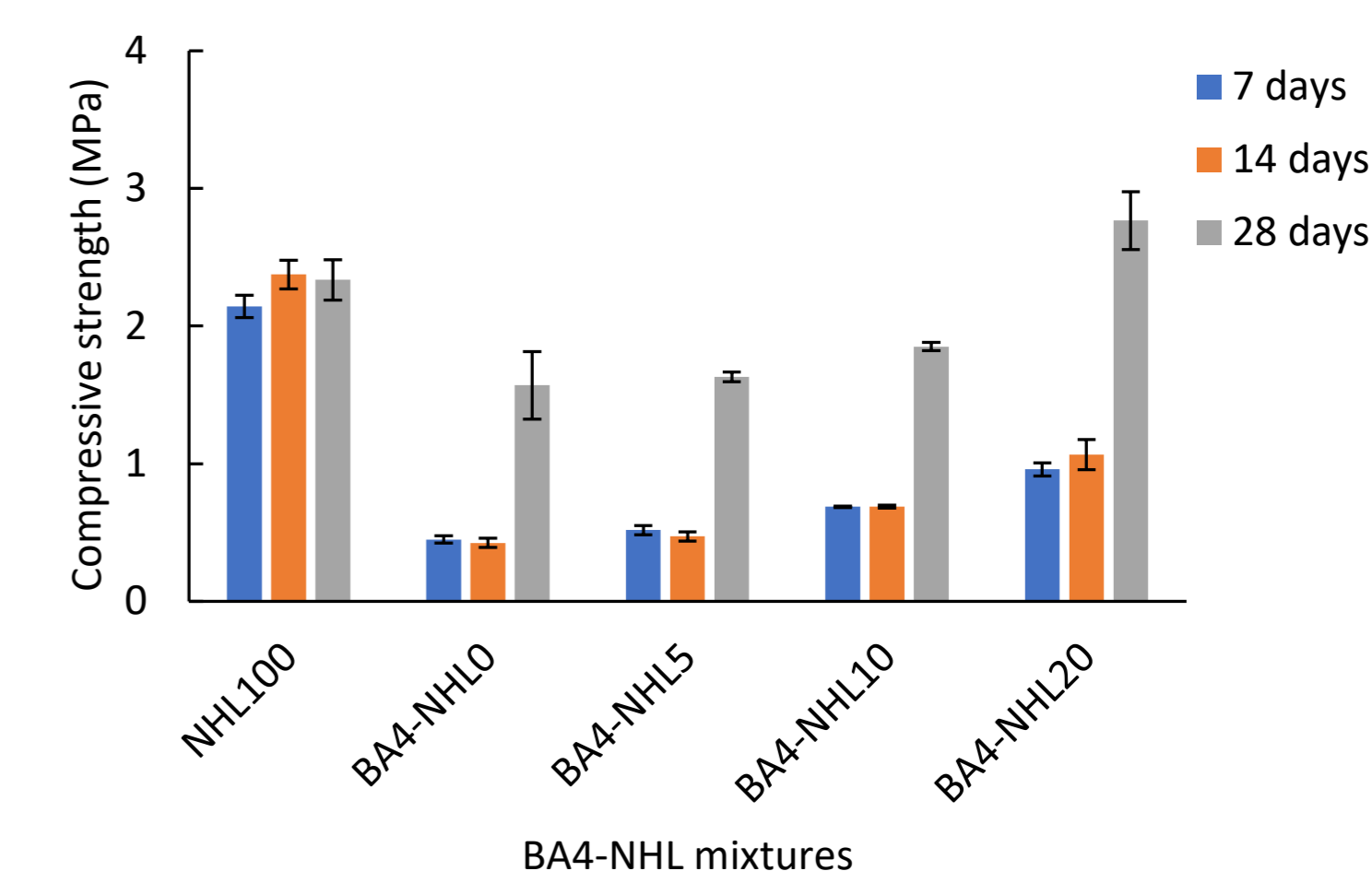


Figure 4: Compressive strength ( $R_c$ ) of BA3 and BA4 mixtures containing NHL



- $R_f$  and  $R_c$  increases with increase in OPC content and curing time.
- (BA3 or BA4)-OPC pastes indicate relatively lower  $R_f$  and  $R_c$  compared to OPC paste.

- $R_f$  and  $R_c$  tend to increase with increase in NHL content and curing time.
- (BA3 or BA4)-NHL pastes show slightly higher  $R_f$  in comparison with the reference NHL paste.
- The  $R_c$  of NHL100 is higher than (BA3 or BA4) pastes containing NHL (5 and 10%).

## 4. Conclusions

- The reference BA3 and BA4 pastes (100% BA content) exhibited relatively lower compressive and flexural strengths compared to the pastes incorporated with OPC and NHL.
- The OPC addition into BA3 and BA4 pastes resulted in a significant increase of the strength while, BA3 and BA4 pastes containing NHL at similar content showed slight improvement.
- Considering BA3 and BA4 pastes, the best mechanical performance was observed on the paste BA3-OPC20, exhibiting the compressive strength of 5.6 MPa and flexural strength of 3.1 MPa at 28 days.
- The BA-OPC pastes containing up to 20% OPC content could potentially be used as a binder in the production of insulating bio-based mortars.

## 5. References

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