THE INFLUENCE OF THE ADDITION OF FLY ASH FROM BIOMASS COMBUSTION ON THE PHYSICAL AND CHEMICAL PROPERTIES OF PORTLAND CEMENT CEM II: THE PERSPECTIVE OF SUSTAINABLE CONSTRUCTION

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Co-funded by the European Union

UNIVERSITY OF SPLIT
FACULTY OF CHEMISTRY AND TECHNOLOGY

5th International Conference on ENVIRONMENTAL PROTECTION, SUSTAINABLE PRODUCTION, AND EXAMPLES OF BEST PRACTICES

INTRODUCTION

This study analyzes the effects of adding wood fly ash (WFA), to Portland cement CEM II. As a renewable, eco-friendly alternative, wood fly ash helps reduce carbon emissions and conserve natural resources, offering insights into optimizing its use in sustainable construction materials.

EXPERIMENTAL METODOLOGY

WFA addition affects the physical and chemical properties of Portland cement CEM II.

METHODS

- Granulometry - mesh sizes used: 500 µm, 250 µm, 150 µm, 125 µm, 80 µm, 71 µm, 63 µm, and 45 µm
- Conductometry - measurement conditions: active temperature (T_A) and reference temperature (T_R) 20 °C, the electrode constant c = 0.321 cm^{-1}, and the water/solid ratio (W/S) ranges from 0.30 to 0.60
- Microcalorimetry - measurement conditions: temperature 20 °C, total heat 280 J/g, heat capacity 43.5819 J/K and water/solid (W/S) ratio 0.50
- Method of determination specific surface area
- Method of determination density.

Figure 1. Conductivity measurement device

Figure 2. Microcalorimetry device

RESULTS

GRANULOMETRY

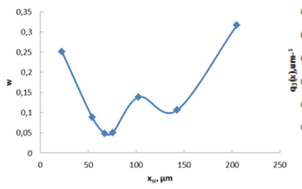


Figure 3. Mass percentage dependence on individual sieve size for WFA sample

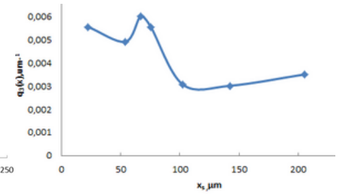


Figure 4. Probability density function for WFA sample

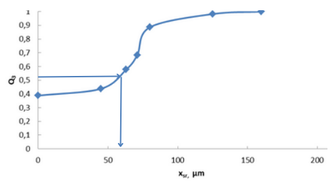
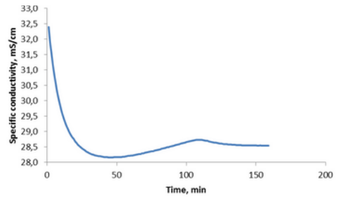


Figure 5. Cumulative distribution function for WFA sample

CONDUCTOMETRY



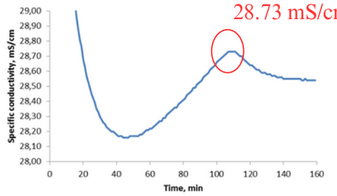


Figure 6. Specific conductivity of CEM II +3% WFA sample and maximum speciffic conductivity, depending on hydration time at W/S = 0.40

Table 1. Table of reaching maximum time and specific conductivity at W/S ratios from 0.30 to 0.60 for sample CEM II +3% WFA

W/S	Tmax, min	Specific conductivity max., mS/cm
0.30	104	24.51
0.35	108	26.30
0.40	111	28.73
0.45	118	32.15
0.50	137	30.31
0.55	144	29.48
0.60	158	31.63

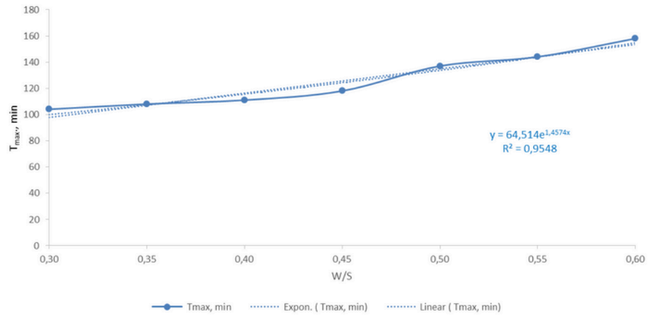


Figure 7. Maximum time display for sample CEM II +3% WFA at W/S ratios from 0.30 to 0.60

MICROCALORIMETRY

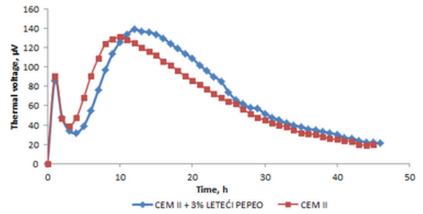


Figure 8. Dependence of thermovoltage on hydration time for CEM II+3% WFA sample

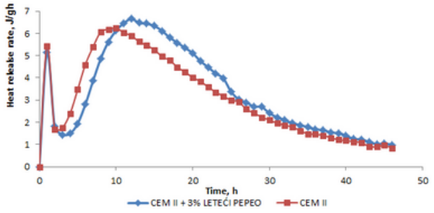


Figure 9. Dependence of heat release rate on hydration time for CEM II +3% WFA sample

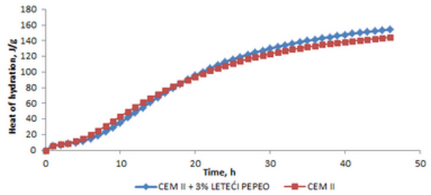


Figure 10. Dependence of hydration heat on hydration time for CEM II +3% WFA sample

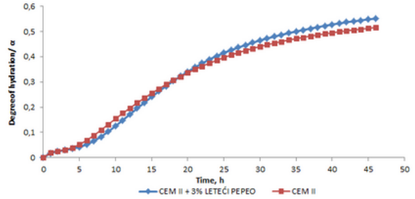


Figure 11. Dependence of degree of hydration on hydration time for CEM II + 3% WFA sample

The density of the sample of Portland cement CEM II is 3.53 g/cm³, and specific surface area is 3220.75 cm²/g.

CONCLUSION

The study on the influence of wood fly ash (WFA) addition on the physical and chemical properties of Portland cement CEM II yielded significant results from the perspective of sustainable construction. The key findings are as follows:

- **Increased conductivity**: 3% WFA addition boosted specific conductivity, likely due to added alkali ions.
- **Reduced thermal stress**: WFA lowered thermal voltage, potentially reducing early cracking.
- **Lower hydration heat**: WFA decreased the total heat released during cement hydration.
- **Slower hydration**: WFA moderated hydration, extending the time for full hydration.
- **Refined microstructure**: WFA resulted in a denser microstructure, potentially improving strength and durability.

ACKNOWLEDGEMENT (The research results were financed by the Ministry of Regional Development and European Union funds.)**

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