Influence of thermal treated concrete demolition waste on the properties of expanded perlite mortar

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Introduction

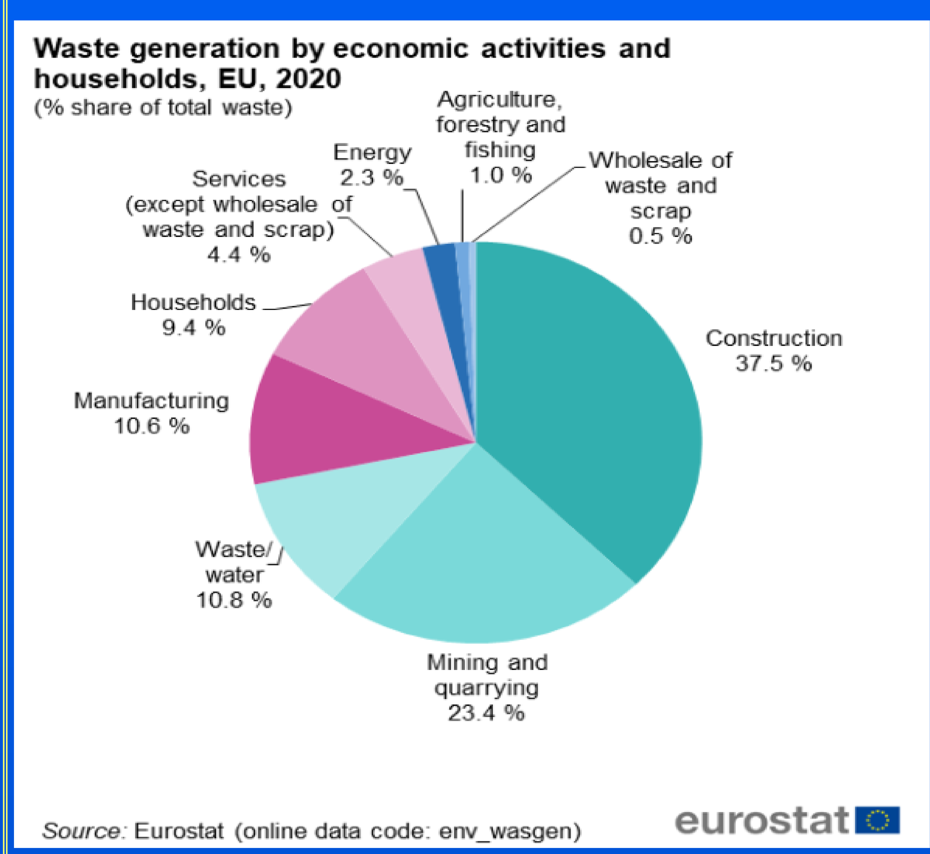

Figure 1. Distribution of the wastes produced in the European Union, in 2020 [1]

To achieve the European Union`s sustainable and circular economy goals have been developed strategies for reducing natural resources, reusing wastes, and decreasing carbon dioxide emissions. A main type of waste stream is construction and demolition wastes (CDW) representing over one-third of the wastes produced in the European Union (Fig. 1). The CDW consists of concrete, bricks, wood, glass, metals, and plastic (Fig. 2). The literature contains experimental data on investigating the potential of CDW as aggregates and cement. The study of characteristics of concrete after a fire has demonstrated that concrete that has become weak due to high temperatures can partially restore its mechanical properties and rehydrate after coming into touch with water (Alonso and Fernandez (2004)). Many studies on calcinated cement paste's properties and hydration process have been started in this context. This work aims to study some properties of expanded perlite mortars with thermal-treated concrete demolition waste.

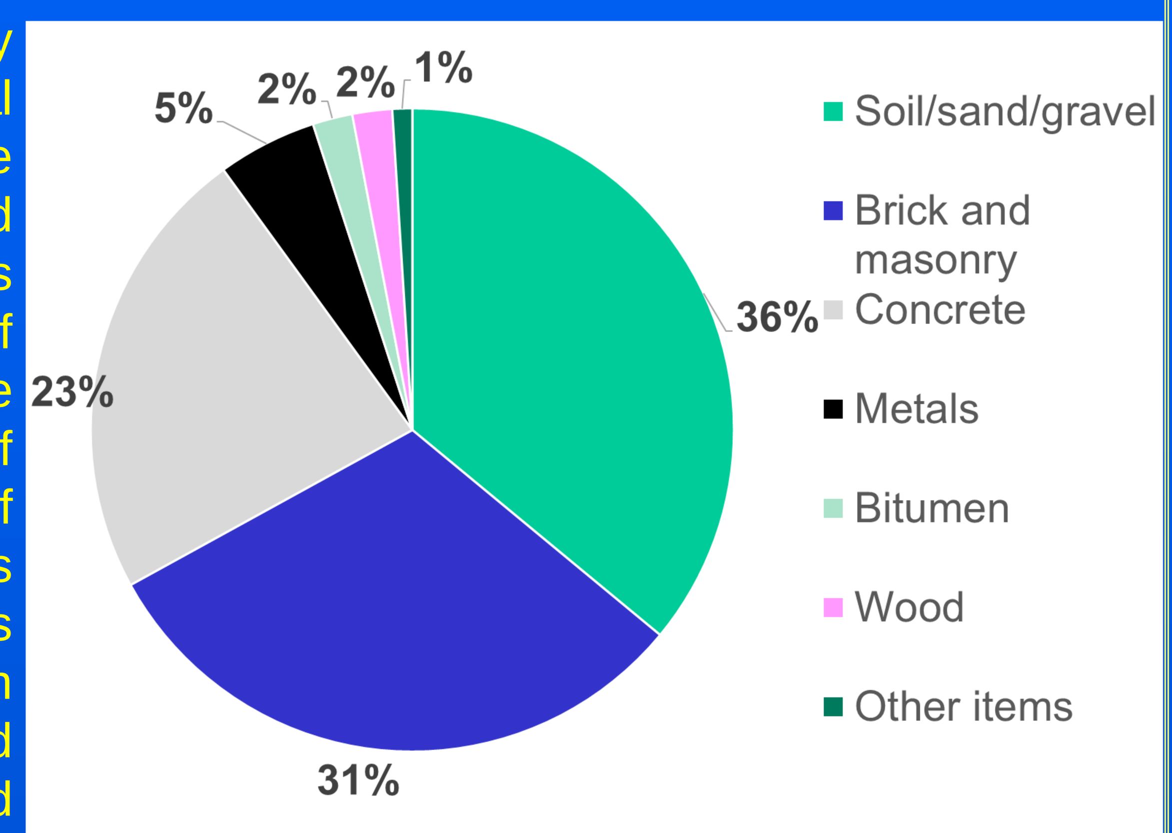

Figure 2. Composition of CDW [2]

Results & Discussion

Materials and methods

The following materials were used: Portland cement type CEM II/A-LL 42.5 R, expanded perlite sizes smaller than 2 mm, and water. The concrete demolition waste (TTM) was calcined at 550˚C for 3 hours and cooled in the oven to room temperature. This material partially substituted Portland cement (10 wt.%, and 30 wt.%) in mortars with expanded perlite: cement volume ratio of 3:1.

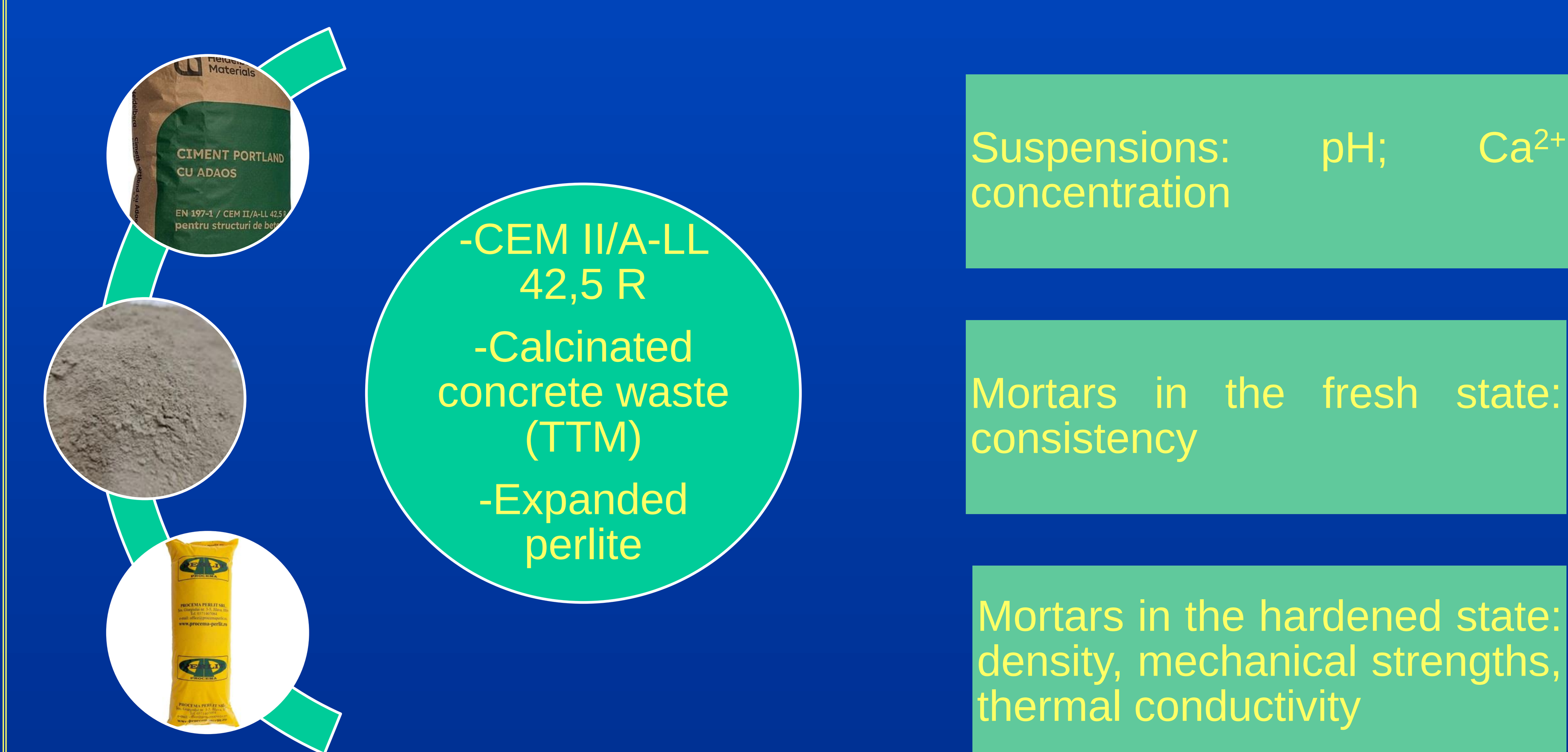

Figure 3: Work methodology

The assessment of pH and Ca^{2+} concentration in aqueous suspensions

Suspensions cement/water ratio of 1/50 and were mixed for 7 days. The Ca^{2+} concentration was assessed by complexometric titration. pH was measured with a Jenway 3540 pH meter. The results show that the pH of 50% TTM suspension was significantly lower than that of Portland cement (Fig. 4).

The discontinuous evolution of the CaO content in the liquid phase observed in Fig. 5 is associated with the degree of hydrolysis of the calcium silicates from the cement and the evolution of the formation of hydrated compounds. When TTM was used to replace 50% of cement, the concentration of CaO was at its lowest value.

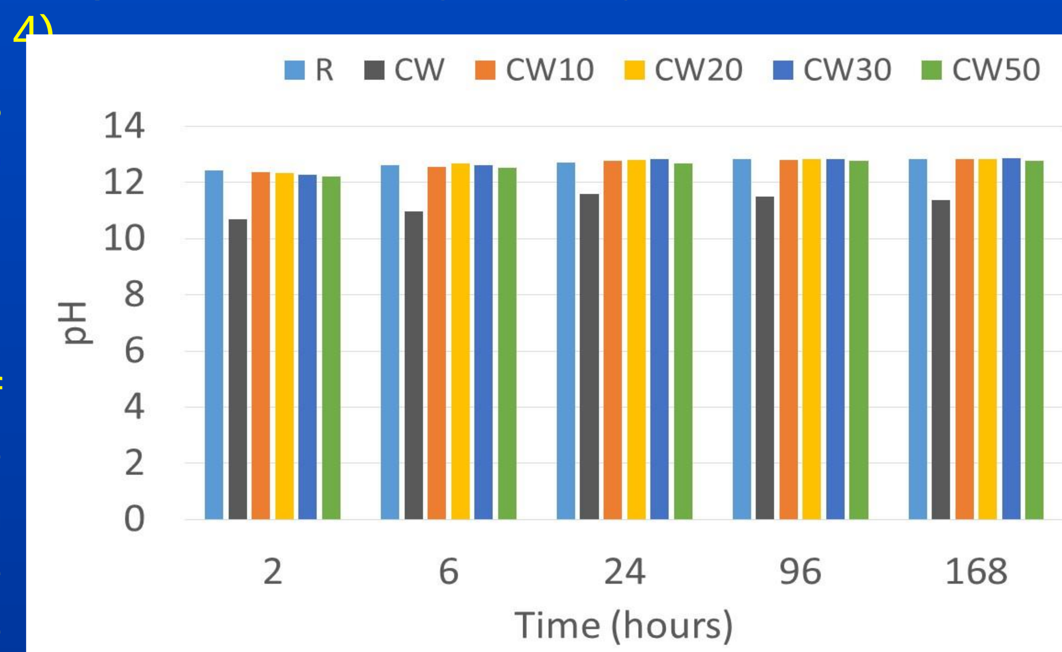

Figure 4: The pH of suspensions

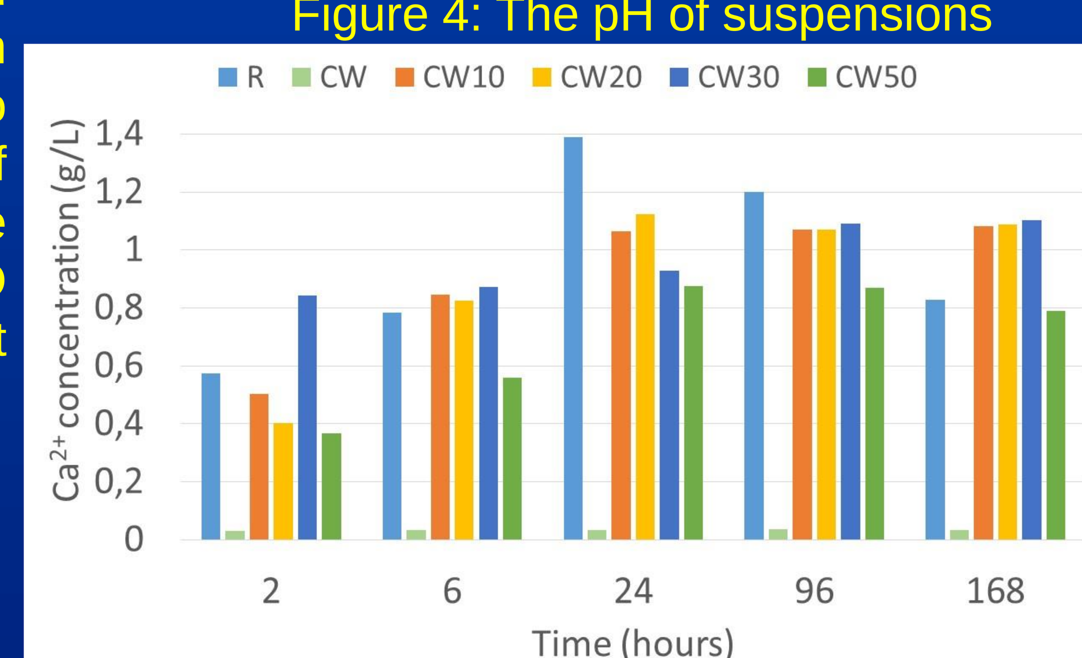

Figure 5: The Ca^{2+} concentration during time

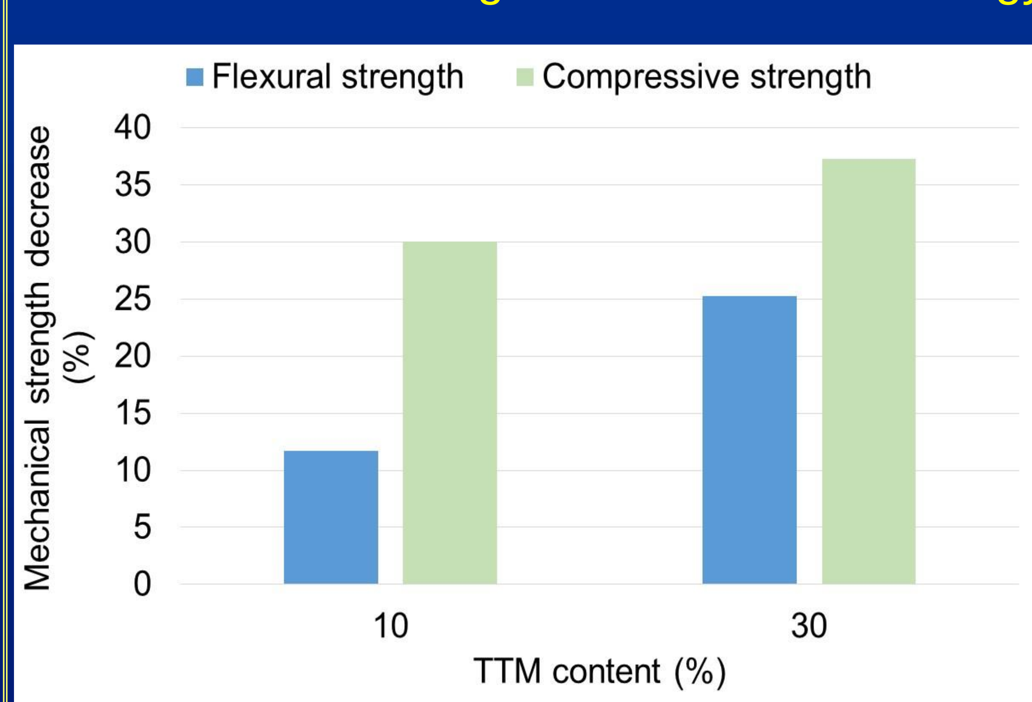

Figure 6: Decreasing in the 28 days mechanical strengths of mortars with TTM content

The properties of mortars

Consistency tested by the flow table method was between 140 and 200 mm.

The density of 28-day mortars decreased with an increase in TTM content.

The mechanical strengths were diminished when cement was partially substituted by calcinated demolition concrete waste, the lowest value corresponded to mortar with 30% TTM.

Conclusions

Partial substitution of cement by calcinated concrete demolition waste decreased the content of CaO in the solution. The mortars with expanded perlite and cement partially substituted by calcinated concrete waste were stable, and the value of consistency corresponds to a plastic mortar. Increasing TTM content decreased mechanical strengths. The mortars had good thermal insulation properties.

Acknowledgments

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References

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[2] Alsheyab, M.A.T. Recycling of construction and demolition waste and its impact on climate change and sustainable development. *Int. J. Environ. Sci. Technol.* **19**, 2129–2138 (2022). https://doi.org/10.1007/s13762-021-03217-1

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