POPULAR SCIENTIFIC SUMMARY OF THE PROJECT

Reinforced concrete is the most common building material used nowadays with a track record of more than 200 years, owing to its versatility, relatively low cost and high durability. However, the environmental footprint of concrete making is significant since its binding component, Portland cement, although constitutes only several percent of the overall concrete mix volume, is produced through a thermal energy intensive process. This implies the release of huge amounts of CO_2 to the atmosphere, emitted during the combustion of fossil fuels (oil, gas, coal, petroleum coak), the calcination of limestone, and other necessary energy-consuming activities. The improvement of sustainability of cement production process and the reduction of its environmental footprint is achieved in the last decades through the replacement of clinker with natural or technogenic SCMs, as described in the European standard EN 197-1:2011. However, the policy towards significant reduction of industrial CO_2 emissions will limit the availability of two of the most widely used SCMs (Supplementary Cementitious Materials) – fly ash and blastfurnace slag – for the production of cement in the near future. Current trends focus on the use of ternary cements, utilizing calcined clay and limestone along with clinker. Such cements fall under the type CEM II/C-M in the new European standard EN 197-5:2021. Another aspect to consider, regarding the sustainability of cement-based materials, is the concrete waste produced at the end of service life of structures, being prevalent in construction and demolition waste. The average recovery rate of this material in the EU in year 2020 accounted to 89%. The common practice to recycle concrete waste consists of crushing and separation of the coarse and fine fractions, which are proportioned approx. as 4:1 or 3:1. The coarse fraction with particle size larger than 4 mm may replace 30–50% of natural aggregates in new concrete, however, the fine fraction (particle size below 4 mm) is not suitable for concrete production, mainly due to its extensive water absorption. The latter consists of hardened cement paste, sand and fine aggregates. Recently, efforts to exploit the recycling potential of concrete waste fines have been performed. Data show that the CO_2 emissions of the production of limestone-calcined clay cement and cement containing carbonated recycled concrete fines (50% and 60% clinker content, respectively) are 23% and 38% lower, respectively, compared to type CEM II/B-LL cement (65% clinker content). In this context, a new European standard which is under development (prEN 197-6:2022), specifies the composite cements incorporating recycled concrete fines.

The main objectives of the project include systematic experimental investigations on the effect of cement paste composition on the microstructure and reactivity of the material obtained after carbonation treatment of cement paste fines (Carbonated Cement Paste Fines - CCPFs); the utilization of the produced CCPFs as SCMs in cement formulation and the durability of CCPFs-containing cementitious materials against sulfate/chloride attack and carbonation. The obtained knowledge will provide fundamental information necessary for the formulation of modern ternary cements containing CCPFs, in view of both the environmental impact of the binder and the performance of the material at specific service-life conditions.

The obtained results will provide fundamental knowledge about the recycling potential of different cement paste fines, considering the hydration and durability characteristics of new binders formulated on their basis. This information can be utilized for the recycling of versatile fine concrete waste, which is currently landfilled, and the design of innovative cements and concretes of low environmental footprint, in agreement with the EU targets regarding sustainability.

The results of the project will be published in prestigious international peer-reviewed journals and presented in international conferences, organized or supported by well-known scientific organizations in the field of building materials research.