DURABILITY OF LIGHTWEIGHT GEOPOLYMERS FOR PASSIVE FIRE PROTECTION: STEEL CORROSION BEHAVIOR IN CHLORIDE-RICH ENVIRONMENT

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Different technologies are currently developed as promising passive fire protective coatings, due to the fact that fire protection of steel structures is an important requirement for structural components for several civil and industrial applications. Among the others, geopolymers have attracted lot of attention as promising materials suitable for high temperature applications. An optimized mix-design makes their amorphous structure more stable, when exposed to direct fire or heating from high temperatures, compared to ordinary Portland cement-based materials (OPC). However, the durability of a fire protective coating strongly depends on its adhesion on steel and its ability to prevent and/or mitigate steel corrosion phenomena. For these reasons, the understanding of the corrosion behavior of steel coated with geopolymer-based fireproofing coatings is necessary for ensuring the service life of the structure.

This study aims at characterizing the corrosion behavior of carbon steel coated by different geopolymeric mortars applied as passive fire protection systems. In particular, fly ash-based geopolymeric mortars were applied as coatings on carbon steel plates. They were lightened by the combination of lightweight aggregates, e.g. expanded perlite, and chemical foaming agents, such as hydrogen peroxide (H_2O_2), in order to ensure good properties at high temperatures. In addition, geopolymeric paste and mortar containing quartz aggregate were also prepared as reference samples.

The corrosion process was evaluated using an electrochemical approach. The samples have been tested by accelerated ageing methods, such as exposure to salt spray chamber to simulate a chloride-rich environment, such as marine aerosol. The monitoring process has been done applying non-destructive techniques and it is still ongoing. In particular, open circuit potential (OCP) and linear polarization resistance (LPR) have been recorded during the exposure. In parallel, polarization curves have also been carried out at different stages of the ageing exposure to better characterize the corrosion condition of the steel substrates. In addition, adhesion between the different geopolymeric coatings and the carbon steel plates has been evaluated before and after the artificial ageing in the salt spray chamber. Finally, density and porosity measurements were also carried out to better characterize the physical properties of the geopolymers.

In this contribute, preliminary results are reported about short-term exposure. They show that in absence of any aggressive species, fly ash-based geopolymeric mortars provide a highly alkaline environment in the early curing time, enabling the passivation of carbon steel. Finally, steel corrosion behavior has been analyzed as a function of the pore structure of the geopolymeric matrix.