Waste glass valorisation in materials for passive fire protection

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Abstract

In this doctoral thesis, new types of fire protective coatings (intumescent and based on magnesium-phosphate cement) were obtained and tested. These coatings can prevent the spread the fire, smoke release, and protect the steel structures of the buildings, in the event of a fire.

Organic paints based on acrylic, polyurethane, epoxy resins and inorganic paints based on sodium silicate with addition of intumescent materials, were obtained and tested in this study. The intumescent additions were obtained by the alkaline activation with a NaOH solution of waste glass powder with/without different types of additives.

In the case of magnesium-phosphate coatings, waste glass powder was used to substitute part of dead burned magnesia or to obtain lightweight aggregate.

To improve some properties of the studied materials (fire resistance, mechanical strengths, setting time, adhesion to the steel plate, etc.), in the compositions of paints/coatings were also added various materials (slag, borax, sodium carbonate, fly ash, organic polymer, expandable graphite, expanded perlite, etc.)

The paints/coatings were analysed before and after thermal treatment or after the direct contact with a flame, using different methods: X-ray diffraction (XRD), optical microscopy, scanning electron microscopy (SEM&EDX), differential thermal analysis (DTA) and thermogravimetry (TG); other assessed properties were: viscosity (for paints), setting time (for magnesium-phosphate cements), apparent density, compressive strength, adhesion to the steel plate. The composition of these paints/coatings has been optimized to obtain materials with good resistance to high temperatures, which can provide an effective protection of the steel structures, in the event of a fire.

The coatings studied in this doctoral thesis can protect steel structures in the event of a fire, extending the time in which the metal reach the critical temperature, thus extending the time up to steel structure advanced degradation and potential collapse of the building. This research responds to the current needs connected with the valorisation of waste (glass, fly ash, blast furnace slag), as they are currently defined in the global, european and national environmental policies.

Keywords: waste glass, intumescent material, organic paint, inorganic paint, magnesium phosphate cement, fire test.