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Temperature-dependent behaviour and viscoelasticity of fibre polymer composites and polymeric foams used in sandwich panels

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Summary

This research programme addresses the behaviour at elevated temperature/fire of GFRP sandwich panels and its main motivation is the development of adequate passive fire protection systems enabling their structural use in rehabilitation of buildings floors. These highly durable and lightweight panels are particularly advantageous for rehabilitation applications, as they reduce the structural strengthening needs of the remaining building members, which ultimately contributes to a reduction on the demand for raw materials. Moreover, GFRP panels with a recyclable core material will be used (PET foam, obtained from recycled plastics) - this specific type of sandwich panel presents several advantages over traditional solutions, namely in terms of reduced costs and sustainability (as it promotes the re-use of plastics). Additionally, they exhibit high thermal resistance and therefore contributeto the constructions energetic efficiency. The literature review showed that fire reaction related building requirements can be attained with commercially available flame-retardant phenolic resins. However, these solutions cannot ensure the fire resistance ratings that are typically required for buildings structural elements (60-90 min).

Recent experimental studies on pultruded GFRP profiles provided a reasonable understanding about their fire behaviour and allowed developing protection systems that enable their use in buildings; however, this knowledge is still not available for GFRP sandwich panels. The experimental tests to be performed will allow characterising the time- and temperature-dependent mechanical properties of the constituent materials (GFRP and core materials, small-scale mechanical tests, for tension, compression and shear) and the thermomechanical response of these panels under exposure to elevated temperatures/fire. Tailored passive fire protection systems will be developed, either as screen protection or as suspended ceilings (e.g. gypsum boards), and their efficacy will be evaluated through fire resistance tests on loaded GFRP slab panels. The experimental program will also provide input data for finite element (FE) models to be developed. The main innovations of the numerical modelling comprise: (i) the incorporation of the constitutive relations as a function of temperature and time (short-term creep behaviour) of all materials; and (ii) the assessment of appropriate failure criteria. After validation with experimental results, the models will be used to optimize the panels' geometry and fire protection schemes. Apart from providing the scientific community with very relevant results, this study aims at proposing fire design recommendations that will enable extending the safe use of GFRP sandwich panels for rehabilitation of building floors. Furthermore, collaboration with manufacturers and associated industry will allow for the development of technical and industrial capacity in this arising area of civil engineering.

Keywords

Glass fibre reinforced polymer (GFRP), PET foams, short-term creep, elevated temperature, experimental tests, tensile properties, compressive properties, shear properties.

General view of the equipment and instrumentation used for the core material characterization tests, and environmental chamber and universal testing machine.