10th International Conference on Composite Science and Technology
ICCST/10
A. L. Araújo, J. R. Correia, C. M. Mota Soares, et al. (Editors)
© IDMEC 2015

Abstract ID-PL05

ACHIEVING FIRE SAFETY FOR POLYMER COMPOSITES IN CONSTRUCTION

Luke Bisby

University of Edinburgh
Luke.Bisby@ed.ac.uk

Summary: Applications of fibre-reinforced polymer (FRP) composite materials for engineering and preserving durable structures have become ever more widespread since first being seriously considered for such applications in the early 1980s. FRPs are now widely used in certain structural engineering applications; the most common of these in construction are probably: (1) use of externally-bonded FRP sheets or plates for rehabilitation and strengthening of concrete, masonry, steel, or timber structures; (2) application of FRP rods or bars for internal reinforcement or prestressing of concrete structural elements; and (3) use of all-FRP structural sections (pultruded or otherwise) in various niche structural applications (e.g. marine, offshore, and certain other industrial applications).

Provision of appropriate fire resistance is a major design consideration in virtually all building and construction projects. Thus, when FRPs are considered for use in any of the above applications, questions are invariably (justifiably?) raised around fire safety and the structural fire resistance of all-FRP, FRP- strengthened, or FRP-reinforced or prestressed structural elements. Despite a considerable research effort in this area, particularly during the past decade, there is a persistent and widespread view within the construction industry that "fire and FRPs do not mix"; this has proved difficult to overcome for decades, and the perceived poor performance of FRPs in fire continues to discourage their use in structural applications in the built environment.

Concerns associated with the use of FRP materials when subjected to possible fire exposure stem from the well-established combustibility, toxicity, and thermo-mechanical sensitivity of polymer-based materials to elevated temperatures. Deterioration of mechanical and bond properties of FRP materials occurs at temperatures in the range of the glass transition temperature, Tg, of an FRP's polymer matrix. However, the consequences of this deterioration for the fire-survivability of all-FRP, FRP- strengthened, or FRP-reinforced or prestressed structural elements, under load, are neither well known nor properly quantified. A number of 'reaction-to-fire' considerations are also relevant when applying FRP materials in construction projects, particularly in buildings. These are associated with the combustibility and fire spread properties of the polymers used in FRP manufacture and adhesion, along with associated potential toxicity risks to building occupants.

In an effort to facilitate the widespread application of FRP composites in construction, this lecture will present a review of more than a decade's research by the author (and colleagues) on the fire performance and fire safety of FRP composites in various construction applications. The available research on FRP materials and systems is summarized and generalized, the myths and realities of the fire performance of FRPs are highlighted, significant remaining research gaps are discussed, and guidance for practicing engineers is presented. This includes research on Polymer adhesives, FRP materials themselves, FRP-strengthened concrete and steel elements, FRP reinforced and prestressed concrete elements, and all-FRP structural elements. Through this review, and by rationally considering the fundamental performance objectives for structures in fire, it is shown that fire-safe use of FRP composites in construction applications is, in many cases, less problematic than widely perceived.