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Guest Editorial: Thermo-Structural Response of Composites Exposed to Fire

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This special issue provides a collection of papers on measuring and modeling the thermo-structural behavior of fiber reinforced polymer (FRP) composite materials during fires. FRP composite materials are being used more frequently and in a broader variety of applications. As indicated in Figure 1, the amount of FRP has increased by an order of magnitude in the last 30 years. The transportation industry, which includes automobiles, marine craft, trains and airplanes, is one of the largest consumers of composites. In transportation, the use of FRP has been primarily on interior surface finish and parts that require special shapes that are difficult/impossible to achieve with conventional materials (i.e., steel, aluminum). In recent years, FRP is being used more in structural applications. Some examples include railcar floor systems, naval ship bulkheads and decks, aircraft bodies, and reinforcement in structural columns. One of the primary design challenges that remains with FRP materials is their fire performance.

The fire performance requirements depend on the material application and may include fire resistance, flammability, as well as smoke and toxic gas generation. The initial step in predicting the material behavior for all fire performance areas is to determine the heat and mass transfer through the material. For combustible materials such as FRP, this is done using a pyrolysis model that includes temperature dependent thermal properties, decomposition kinetics and energetics, and a means to predict pyrolysis gas flow out of the material. In this special issue, the papers focus on predicting the fire resistance of composite materials with a primary emphasis on predicting structural integrity. As a result, methods for predicting the structural response are also required in addition to the pyrolysis model. This area has not been as extensively studied as flammability and smoke and toxic gas generation. As a result, there are limited experimental methods available to understand material performance on a small scale and few studies on modeling its combined thermo-structural response.

The papers in this special issue provide advancements in experimental and computational methods for quantifying the thermo-structural response of FRP materials exposed to fires. This includes papers describing experimental methods for obtaining thermal and decomposition properties as well as different pyrolysis models for predicting heat and mass transfer through FRP composites. Two papers provide methods for generating mechanical properties for FRP composite materials at elevated temperatures. In addition, these papers present similar small

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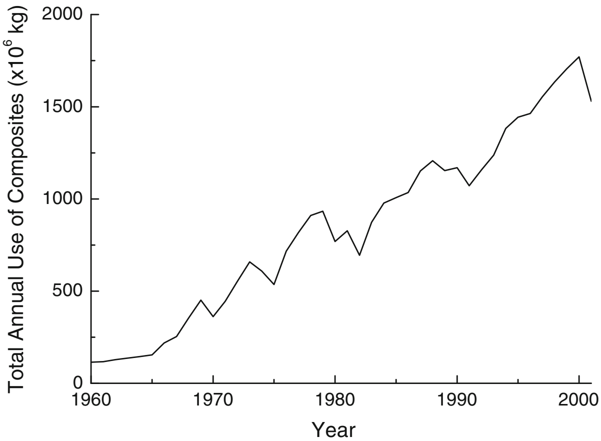

Figure 1. Total use of polymer composite materials in the United States between 1960 and 2000. (*Source*: Composites Fabrication Association).

scale constant heat flux mechanical test methods that can be used to understand the response of FRP composite materials during fire exposures. Two papers present simplified models for predicting the structural response of composites exposed to a constant heat flux exposure. In two other papers, detailed thermo-structural response modeling techniques are described. These studies were performed as part of an international, collaborative research program to further the understanding of composite FRP materials during fire. As a result, the same FRP construction materials were considered in all of these studies providing a unique opportunity to evaluate different experimental and computational methods.