Background

There has been extensive testing of FRPs used in aerospace and marine vessels but until recently, very little work had been done on FRP materials for infrastructure applications. Research has deemed fire resistance the most critical need with respect to the perceived lack of available information for the increased use of FRP materials in infrastructure.

Fire concerns are divided into four basic categories: smoke and toxicity, flame spread, fire endurance, and heat release. It is known that common matrix materials such as polyester, vinylester, and epoxy support combustion and evolve large volumes of dense black smoke with sufficient heat flux. FRPs can suffer degradation in strength, stiffness, and bond properties at even mildly increased temperatures. Degradation of mechanical properties at high temperature is generally governed by the properties of the polymer matrix. Figure 1 shows the temperature-dependent strength of carbon, glass, and aramid fibers. Carbon fiber in a thermoset resin is more susceptible to degredation due to heat as shown in Figure 1. The carbon fiber itself though is shown to have little loss is strength due to increased temperature.

Work at UMaine

UMaine is continuing with work to evaluate the fire resistance of hybrid FRP composites. The resin being used in future bridges will has been designed for infrastructure applications and has "good fire-resistant properties."[1] Initial preliminary as part of Demkowicz (2011) consisted of a small ignition test that was conducted to assess the flammability of the material. The intent of this experiment was to determine if a person holding a typical lighter to the arch material could significantly damage the structure. The test was conducted by holding a Bunsen burner to a sample of the composite material and recording how long it took to ignite, if it did so at all. This experiment was adapted from the Aircraft Materials Fire Test Handbook (U.S Department of Transportation and Federal Aviation Administration 2000). The composite sample used was a narrow concrete filled composite ring that was representative of the arch. The composite ring consisted of one layer of E-glass braided fibers and one layer of carbon braided fibers infused with the DERAKANE 8084 resin. It is important to note that the concrete in the sample tested may help dissipate the heat from the flame, therefore increasing the ignition temperature as opposed to testing only the thin composite laminate.

The flame was held against the outside of the sample for 10 minutes. After 10 minutes there was no ignition and the test was stopped. Since the material did not ignite it appeared that the composite would not be significantly damaged by a short-term exposure to a typical lighter. After the test, the sample was visually inspected and very little change in the composite was observed. The ignition test setup can be seen in Figures 2 & 3.

[1] Johnson, Thomas "Ashland launches Derakane resin for premium infrastructure market" Reinforcedplastics.com. http://www.reinforcedplastics.com/view/16061/ashland-launches-derakane-resin-for-premium-infrastructure-market/.18 Feb 2011.

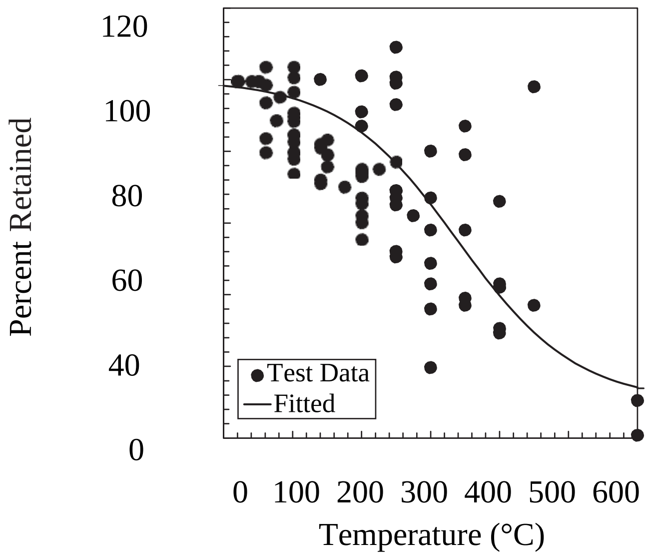

Figure 1. Variation in Tensile Strength with Temperature of unidirectional CFRP (various resins)

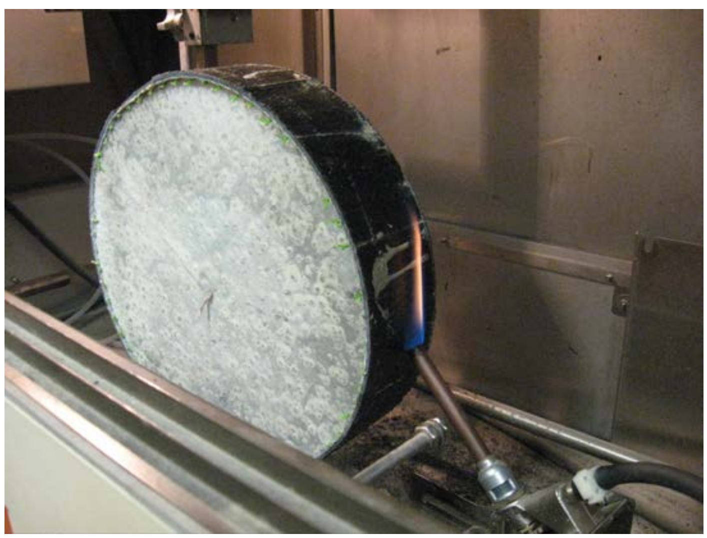

Figure 2. Ignition Test Setup

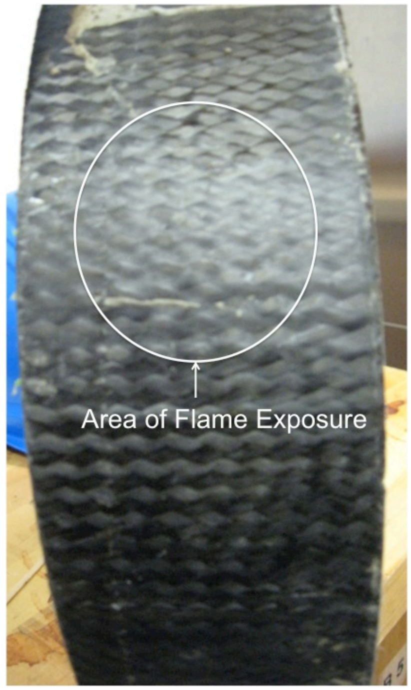

Figure 3. Area Exposed to Flame