

Innovative FRP Materials for Civil Engineering Infrastructure Applications

S. Rizkalla, E. Sumner

Constructed Facilities Laboratory, North Carolina State University, Campus Box 7533, Raleigh, NC, 27695
sami_rizkalla@ncsu.edu

ABSTRACT

This paper presents a brief description of three ongoing projects which are currently in progress at the Constructed Facilities Laboratory at North Carolina State University to investigate innovative uses of advanced composite materials in the form of FRP for civil engineering infrastructure applications.

The first study focuses on the use of carbon FRP materials to increase the flexural capacity of prestressed concrete bridge girders. The study includes testing of prestressed concrete girders strengthened with various CFRP materials under the effect of monotonic and cyclic loading conditions. Results show that the ultimate strength of prestressed concrete members can be increased up to 60 percent. The study concluded that strengthened girders can withstand one million fatigue cycles using a load range corresponding to a 60 percent increase of the live load. A current test involves the repair of a damaged AASHTO girder to regain its original capacity.

The second study consists of steel-concrete composite beams which were strengthened with high modulus CFRP materials and tested under both static and fatigue loading conditions. The results indicate that the elastic stiffness and ultimate capacity of steel structures can be increased by 45 percent and 65 percent respectively using high modulus CFRP materials. The results also demonstrate that strengthened steel bridge girders can withstand up to three million cycles using a load range representing up to a 20 percent increase of the live load.

The third study presents an innovative system for FRP panels designed to overcome delamination problems typically encountered in traditional FRP panels. The panels consist of GFRP laminates and foam core sandwich where top and bottom skin GFRP layers are connected together with through-thickness fibers. Addition of the through-thickness fibers increases the out of plane properties of the panel, prevents delamination and adds additional strength to the panel. The fundamental material properties of the panel are evaluated both experimentally and analytically. The influence of the panel thickness, through thickness fiber configuration and density and other parameters is discussed.

The results of these three projects demonstrate that FRP materials provide an effective alternative to conventional construction methods for use in different infrastructure applications.