Proceedings of the 4th World Congress on Civil, Structural, and Environmental Engineering (CSEE'19)
Rome, Italy – April, 2019
DOI: TBD

Extending the Service Life of Prestressed Concrete Cored Slab Bridge Superstructures with Prestressed Mechanically-Fastened Fiber-Reinforced Polymer Plates

Rudolf Seracino*, Gregory Lucier, Brad McCoy, Zakariya Bourara, Juliet Swinea
*Department of Civil, Construction, and Environmental Engineering
North Carolina State University
Raleigh, NC 27695, USA
rudi_seracino@ncsu.edu

Prestressed concrete cored slabs comprise a significant percentage of the common bridge superstructure systems across the United States. Many such bridges are in varying states of distress and require retrofit to extend their useful service life prior to superstructure replacement. In extreme cases, bridge superstructures are replaced after only 40 years of service due to deterioration from corrosion of the internal prestressing steel. To be effective, the retrofit must be designed to address both the inventory and operating load ratings so that the bridge may remain in-service for 3-5 years without posted load or speed limits, lane restrictions, or closure until superstructure replacement is scheduled. The retrofit solution must not only be able to increase sectional capacity, but also reduce stresses developed under service conditions to within allowable limits. To achieve both of these requirements an innovative solution is proposed that consists of a prestressed hybrid glass-carbon pultruded fiber-reinforced polymer (FRP) plate that is mechanically fastened to the concrete element. In order for the retrofit to be adopted by departments of transportation, the retrofit must also be rapidly and easily installed and within the limits of annual maintenance budgets.

Following a brief overview of the problem addressed with this retrofit system, details are presented on: (i) the optimization undertaken to design the mechanical fastener layout, (ii) the characterization of the fundamental material behavior under static tension, cyclic fatigue, and sustained tensile loading, and (iii) the development of a prototype prestressing mechanism eliminating the need for expensive or elaborate equipment. Digital Image Correlation (DIC) was employed in the material level testing to obtain continuous strain field data and better understand the fundamental failure mechanisms. In addition, sufficient replicates of various treatment groups were tested to enable a rigorous statistical evaluation of the design capacity of the retrofit system. Finally, the designed retrofit was deployed on full-scale prestressed concrete beams that were obtained from an in-service bridge and tested to failure in flexure at the Constructed Facilities Laboratory.