

ABSTRACT

When carbon steel is exposed to saltwater, an electrochemical process occurs between the salt water and carbon steel. This microscopic process begins on the surface of the carbon steel but eventually runs deep into the material, reducing the carbon steel's tensile strength. Prestressed concrete bridges are commonly placed in locations that are exposed to saline environments. The structural members are likely to face deterioration or require more maintenance than members prestressed with non-corrosive materials. To reduce the deterioration mitigation efforts and costs, high strength stainless steel (HSSS) has intrigued bridge engineers in more recent years as an alternative to carbon steel in prestressed concrete members. HSSS provides non-corrosive properties, potentially acting as an equitable replacement for carbon steel in the long-term. Current American Association of State Highway and Transportation Officials (AASHTO) specifications provide a method for predicting the stress of prestressed strands under ultimate strength conditions, but these equations were developed for carbon steel. Florida Department of Transportation (FDOT) has promoted the use of HSSS in their Florida Slab Beams (FSB), but accuracy of the current AASHTO method had not been investigated. This study found that the current AASHTO method provides non-conservative results for nominal flexural resistance and stress in prestressed tendons, and therefore proposes an equation for HSSS stress in FSBs. The non-conservative results for the current AASHTO equation were found via a parametric study, comparing an extensive strain compatibility approach and calculated values from AASHTO. Furthermore, FDOT provides a Mathcad file for bridge design engineers' use, that is aimed at simplifying the FSB design process. A representative model was created to mimic the FDOT provided program, within an accuracy of 99.7%. This model was utilized in all parametric studies. Within the proposed equation's scope, 585 cases of FSBs prestressed with HSSS were carried out with a variety of independent factors. The factors considered included: strand configuration, length of the member, height of the member, width of the member, effective prestress, and compressive strength of the concrete topping. Creation of the proposed equation considered all these factors, as well as the existing FDOT design standards for FSBs. Out of the 585 cases, only 1.5% of calculated nominal flexural resistance values were considered over-estimations, in which the largest over-estimation was 0.5%. In a linear regression analysis, the r^2 value was calculated to be 0.98, solidifying the accuracy of the proposed equation that predicts stress in FSBs prestressed with HSSS.