Beam-Column Behavior Of Circular And Rectangular Concrete-Filled FRP Tubes

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This paper describes the structural behavior and failure modes of concrete-filled glass fiber reinforced polymer (GFRP) circular and rectangular tubes, under axial compression loads, bending and combined axial loads and bending. The study included totally filled and partially filled tubes with central hole, as well as a tube-in-tube system with concrete filling between the two tubes. GFRP tubes were designed to provide strength and stiffness in both axial and transverse directions and also provide composite action. The study showed that under axial compression loads, the strength and ductility of concrete are improved due to confinement using GFRP tubes. The highest confinement level was achieved for totally filled tubes. Using central hole reduces the confinement effect, however, using inner tube can enhance the confinement for this type of members. Test results indicate that loading of the GFRP tubes reduces the confinement effectiveness. The study also demonstrated the benefits of concrete filling of the tubes in bending, and showed that higher strength-to-weight ratio can be achieved by providing central hole. The results indicated that the flexural behavior is highly dependent on the stiffness and diameter-to-thickness ratio of the tube, and to less extent, on the concrete strength. Test results also suggest that the contribution of concrete confinement to the flexural strength is insignificant, however, ductility of the member is improved. An analytical model is introduced to predict the behavior of axially loaded circular concrete columns confined by FRP tubes. The model is an extension to the confinement model introduced by Mander et al (1988) for concrete confined by steel reinforcement. The model is based on equilibrium, compatibility conditions and the bi-axial strength failure criteria of FRP tubes. For flexural members, a strain compatibility model has been developed, verified by the experimental results and used to provide a parametric study for the different parameters, significantly affecting the behavior. For beam-column members, a variable confinement model is introduced. The model accounts for the gradual reduction of confinement as the eccentricity of the axial load increases.

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