

Alternative RC Sections Using Rectangular Concrete-Filled FRP Tubes

Siddhwartha Mandal¹, Amir Fam², and Sami Rizkalla³

ABSTRACT

The feasibility of using concrete-filled rectangular filament-wound glass fibre reinforced polymer tubes (CFRFT) as structural members has been explored. Three CFRFT beam specimens and five short columns were tested. The behaviour of CFRFT was compared to conventional concrete-filled rectangular steel tubes (CFRST) of similar reinforcement ratios as well as to conventional RC sections reinforced with steel rebar. An analytical model has been developed to predict the moment-curvature responses of beams and the complete interaction curves of beam-column members. The model accounts for different laminate structures of the flange and the web of the FRP tube through the Classical Lamination Theory (CLT). The gradual reduction of stiffness resulting from the progressive failure of different FRP layers oriented at various angles is accounted for through the Ultimate Laminate Failure (ULF) approach. The model adopts the cracked section analysis using layer-by-layer approach. The model has been utilized to evaluate the effects of laminate structure, hybrid laminates, thickness of the tube, and to optimize the inner void of partially filled tubes. Comparisons of the behavior of CFRFT with CFRST and conventional RC sections showed that CFRFT is a practical and feasible system that offers similar flexural strength to CFRST of similar reinforcement ratio. Additionally, CFRFT could provide axial load-bending moment interaction curves comparable to those of RC sections of similar reinforcement index.

¹ Master's Student, Dept. of Civil Eng., Queen's University, Kingston, ON K7L 3N6

² Assistant Professor and Canada Research Chair in Innovative and Retrofitted Structures, Dept. of Civil Eng., Queen's University, Kingston, ON K7L 3N6

³ Distinguished Professor of Civil Engineering and Construction, Director of the Constructed Facilities Laboratory, Civil Engineering Department, North Carolina State University, Raleigh, NC 27695-7533