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A novel anchor method for multi-tendon FRP cable: Concept and FE study

Xin Wang[1]*, Pengcheng Xu[1], Zhishen Wu[1,2], Jianzhe Shi[2]

1. Key Laboratory of C &PC Structures Ministry of Education, Southeast University, Nanjing, 210096, China
2. National and Local Unified Engineering Research Center for Basalt Fiber Production and Application Technology, Southeast University, Nanjing, 210096, China

* Corresponding author: Xin Wang
E-mail: xinwang@seu.edu.cn
Phone number: +86-13611514436
Postal address: Southeast University, Nanjing, 210096, China

Abstract: This paper proposes a novel anchor toward large-sized fiber-reinforced polymer (FRP) cable with multi tendons and optimizes the key factors that affect anchor efficiency using finite element method (FEM). The limitations of conventional anchors for FRP tendons/cables were first analyzed. A new type of conical anchor with novel continuous-fiber-reinforced load transfer component (LTC) was proposed to overcome shortcomings of conventional anchors. The four key factors affecting anchor efficiency including modulus variation, conical degree, anchor length and the thickness of LTC were analyzed respectively. The results show that the proposed anchor not only owns an essential advantage in bonding by integrating LTC and FRP cable but also realizes the variable modulus of LTC by changing the winding angle of fiber roving. The optimization of key factors reveals that the avoidance of shear and compressive stress concentration can be realized by LTC modulus variation, while the conical degree of LTC significantly affects compressive stress distribution and cable axial displacements. The anchor length controls both compressive stress distribution and peak shear stresses, whereas the LTC thickness at the loading end only affects the peak compressive stresses and axial displacement. The optimization of above four factors determines the design of the proposal anchor.
Keywords: anchor method; fiber reinforced polymer (FRP); cable; load transfer component

1. Introduction

Fiber-reinforced polymer (FRP) composites are widely accepted civil infrastructure reinforcing materials because of their superior physical, mechanical and chemical properties compared with conventional steel reinforcement [1-2]. In addition to common applications of FRP sheets for the externally bonded strengthening of existing constructions, other types of FRP composites (e.g., bars, tendons and profiles produced by pultrusion) have gradually become used in new construction as internal reinforcement in concrete members, bridge cables and decks [3-5]. Because of the anisotropy property of FRP-pultruded members such as FRP cables, the most efficient way to use FRP is to apply it as a tension-only element using a prestressing technology. By prestressing, the material use efficiency of FRP can be enhanced from 20% tensile strength (f_u) up to 65% f_u [6]. Moreover, structural behaviors such as the loads for concrete cracking, steel yielding for RC structures, lightweight and spanning ability for cable-supported bridges can be significantly enhanced using prestressed FRP. Typically prestressed FRP materials include carbon FRP (CFRP) and aramid FRP (AFRP) because of their high strength and high creep rupture stress, typically 0.65 f_u and 0.55 f_u [5]. E-glass FRP (GFRP) cannot be used as a prestressing member because of the limitation of its low creep rupture stress (0.3 f_u) [6]. In addition to conventional fiber composites, the newly developed