Tension Stiffening of Reinforced Concrete Shear Elements Strengthened with Externally Bonded FRP Sheets

Guang YANG
PhD Candidate
University of Houston
Houston, TX, USA
gyang@central.uh.edu

Mehdi ZOMORODIAN
PhD Candidate
University of Houston
Houston, TX, USA
szomorodian@uh.edu

Abdeldjelil BELARBI
Distinguished Professor
University of Houston
Houston, TX, USA
belarbi@uh.edu

Bora ACUN
Postdoctoral Fellow
University of Houston
Houston, TX, USA
bacun@uh.edu

Summary

The tensile contribution of concrete, known as tension stiffening, is usually neglected when calculating the strength of reinforced concrete (RC) members. However, tension stiffening affects the post-cracking stiffness and consequently the overall behavior in terms of deflection and crack width of the member under service load. There have been many investigations conducted on the tension stiffening effect in RC members, but very few on Fiber Reinforced Polymer (FRP) RC members. This paper presents the results of a study of the tension stiffening in FRP RC members based on 12 full-scale tensile tests. The results indicate that the presence of the externally bonded FRP material typically alters the main characteristics of the stress-strain relationships of concrete in tension and associated crack patterns.

Keywords: Fiber Reinforced Polymer; Reinforced Concrete; Strengthening; Tension Stiffening; Constitutive Laws of Materials; Anchorage System.

1. Introduction

Composite materials such as FRP have been widely used in strengthening of reinforced concrete structures for the last three decades. Well established analytical models are already available for analyzing and designing strengthened beams and columns under flexural and axial actions. However, the behavior of such members under shear stress field is still under investigation by several researchers due to the complexity of the behavior of such elements and structures. An efficient method to assess the overall shear response of a strengthened member is to identify the characteristic behavior and the contribution of each element/material constituting the structure [1]. As an example, an element from a girder strengthened by FRP sheets that is subjected to shear stress field can be isolated and the behavior of that specific element can be predicted by taking into account the inherent characteristics and material laws of the constituents that leads to understanding the global shear response of the girder (Fig. 1). The behavior of the shear element requires a set of equilibrium equations, compatibility conditions, and materials laws for steel and FRP reinforcements in the *l* and *t*

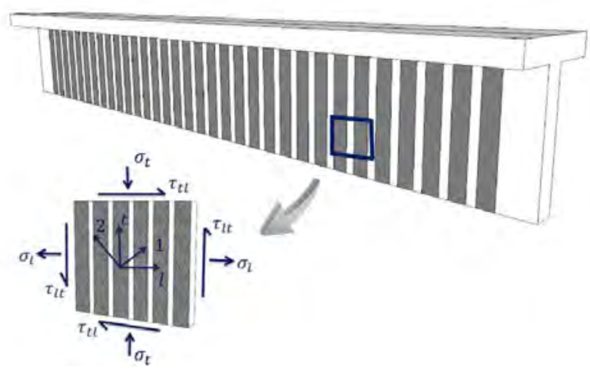

Fig. 1: Beam shear element with in-plane stresses

https://doi.org/10.2749/222137814814027648
Distributed by structurae