

Design and Detailing of Advanced Composite Rehabilitation with and without Anchorage

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Abstract

Fiber-reinforced polymers (FRPs) are widely recognized as versatile materials for the retrofit and repair of structural members for a variety of existing deficiencies. As a supplement to the FRP, mechanical or composite anchorage is sometimes utilized to increase the performance of various FRP-reinforced structural members. With proper design and detailing, the use of composite anchors has proven to prevent premature debonding failure of externally bonded FRP. The performance of FRP-retrofitted concrete members continues to be cited as a high-priority topic for research and an assortment of tests have been completed to validate the use of composite anchors in different types of applications. This paper will review the performance of different tested assemblies using FRP with and without the use of composite anchorage, including state of the art testing on a beam-column assembly. In addition, there will be discussions on the variety of structural applications and specific detailing required on composite anchors to ensure a safe and durable strengthening system.

Keywords: FRP; composite; anchorage; beams; beam-column assembly; durability.

1 Introduction

The existing codes and guidelines related to the use of externally bonded Fiber-Reinforced Polymers (e.g. CSA S6-06, CSA S806, ACI 440.2-08) provide essentially no guidance on the use of advanced composite anchorage. There has been research completed and ongoing that is trying to better define the required detailing and performance improvements that can be realized when these fiber anchors are properly used. Although we would contend that there is much more research needed on this topic, we have completed enough that we can focus in on a few key details where the fiber anchors have proven their potential.

This paper will focus on the following key topics:

1. How to define the properties of the fiber anchors through materials testing.
2. The use of these fiber anchors for improved shear enhancement with three-sided beam applications.

3. The use of the anchors for tensile force development either through or into adjacent concrete.

2 Fiber Anchor Properties

The fiber reinforced polymer anchors are not flat like the sheets used in the external bonding, therefore their properties can't be captured using the ASTM D7565. The cured anchors are much more similar to FRP bars and, therefore, it is suggested that their properties be determined by the ASTM D7205, Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars. The tensile strength, tensile modulus and ultimate elongation should be based on the statistical analysis of twenty (20) individual test specimens for each anchor size and type. Note that as the anchor diameters increase, the properties will tend to decrease. We suggest a fair amount of conservatism when designing with anchor sizes that do not have specific test data.