Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 6, No. 1, January, 2020

Comparative Approach to Flexural Behavior of Reinforced Beams with GFRP, CFRP, and Steel Bars

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Received 06 August 2019; Accepted 03 November 2019

Abstract

The replacement of conventional steel bars with GFRP or CFRP is one of the main topics discussed in this paper, including the main parameters and properties of the materials. The design procedures should account for the properties and will focus on the tensile strength and modulus of elasticity. It will also consider corrosion under environmentally aggressive conditions. This paper presents an experiment on the flexural behavior of concrete beams reinforced with GFRP and CFRP bars and compares these results with theoretical analysis based on different standards such as ACI, Eurocode, and CSA. Twelve reinforced concrete beams will be tested using four-point loading. The geometrical parameters of the tested beams are 130×220×2200 mm, reinforced with different diameters for GFRP and CFRP. The reinforcement ratio and strength of concrete influence the behavior of GFRP, CFRP, and RC beams and contribute to reduce the deflection and crack width. Based on this research, the closest approximation of the experimental results is observed with ACI standards. At this stage, these bars can be used in structures without strict requirements for exceeding the Serviceability Limit State. The non-integration of tension stiffening and regression performance of cracking moment in prediction expressions imposed the differences from experimental results.

Keywords: RC Beams; GFRP; CFRP; Deflection; Cracks.

1. Introduction

For a long time, researchers and civil engineers have been searching for alternatives to steels and alloys to reduce the high costs of repair and maintenance of structures damaged by corrosion. Development of polymer materials and technology was also an indicator of the research on civil engineering structures. The most important impact is on applications in structures under severe environmental conditions. The use of polymer materials instead of steel bars in concrete led to the application of Fiber Reinforced Polymers (FRP) in the field of engineering in structure elements. The behavior of FRP bars under environmentally aggressive conditions, their light weight, non-magnetic characteristics, and mechanical properties such are tensile strength, are beneficial parameters for the replacement of conventional steel in elements of structures. However, use of these materials is limited because the modulus of elasticity, ductility, large creeps, bond between the FRP bars and concrete and high cost can disorient other parameters [1].

Theoretically, there are no conceptual differences between the classical theories of steel-reinforced concrete elements. According to CNR-DT [2], it is the different mechanical behaviors of FRP material that need to be considered, whose constitutive law is fundamentally linearly elastic up to failure.

Many researchers working in this field, reinforced members with FRP analyze the linear relations between stress and

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http://dx.doi.org/10.28991/cej-2020-03091452