BUCKLING STRENGTH OF GFRP EQUAL-LEG ANGLE STRUCTURAL MEMBERS UNDER CONCENTRIC AXIAL COMPRESSION

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Abstract

This paper presents the results of a study on the buckling strength of glass fiber-reinforced plastic (GFRP) equal-leg angle structural members subjected to the concentric axial compression. The angle members were made of glass fiber reinforced with polyester resin and manufactured by a pultrusion process. A total of 32 specimens with slenderness ratios ranging from 12 to 187 and leg width-to-thickness ratios of 8, 12, and 16 were tested. The experimentally obtained buckling loads were also predicted by using analytical formulas. The analytical formulas were developed by modifying a well-known elastic flexural-torsional buckling theory with some factors concerning the orthotropic behaviors of the GFRP material. Coupons cut from the angle specimens were tested using compression and in-plane shear coupon test to determine necessary material properties. The analytical results were then correlated to the test results and those calculated by the nominal buckling strength equations proposed by Zureick and Steffen to validate the adequacy. Finally, the design equations for the angle members were proposed.

Keywords: Glass fiber reinforced plastic, GFRP, angle member, axial compression, flexural buckling, flexural-torsional buckling, buckling strength

Introduction

Glass fiber-reinforced plastic (GFRP) composite has emerged as an effective material for civil engineering structures for over 20 years (Ballinger, 1990). The GFRP material has superior characteristics in corrosion resistance, strength-to-weight ratio, and ease of handling in construction over the conventional materials such as steel and reinforced concrete. Many American, European, and international industries are currently producing a variety of GFRP structural sections such as I, W, angle, channel, and box. Among various types of manufacturing processes that have evolved during the past four decades, the pultrusion process appears to offer the highest productivity-to-cost ratio (Zureick and Scott, 1997). This is because it allows a mass production of long, straight, and constant structural sections. While the GFRP structural sections become readily available, designers of such components are facing an immediate problem in the lack of reliable design criteria. Thus, there is an urgent need to understand the behavior and strength of the GFRP structures and their components under various types of loading condition.

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