Fayoum University

Faculty of Engineering

STRESS ANALYSIS OF COMPOSITE LAMINATED BRIDGE GIRDER UNDER VARIOUS TYPES OF LOADING

By

Emad Omar Ali Ali

A thesis submitted in partial fulfillment

Of

The requirements for the degree of

Master of Science

In

Civil Engineering

(Structural Analysis and Mechanics)

Department of Civil Engineering

Faculty of Engineering, Fayoum

FAYOUM UNIVERSITY

2014

STRESS ANALYSIS OF COMPOSITE LAMINATED BRIDGE GIRDER UNDER VARIOUS TYPES OF LOADING

By

Emad Omar Ali Ali

B.Sc. in Civil Engineering

Under the supervision of

Prof. Dr. Hany Ahmed EL-Ghazaly

Professor of Structural Analysis and Mechanics

Department of Civil Engineering

Faculty of Engineering - Fayoum University

Dr. Mohamed Abou EL-Maaty Amin

Assistant Professor, Department of Civil Engineering

Faculty of Engineering, Fayoum University

Dr. Mohamed Sayed Gomaa Mahmoud

Assistant Professor, Department of Civil Engineering

Faculty of Engineering, Fayoum University

Faculty of Engineering
Fayoum University
2014

ABSTRACT

Fiber reinforced polymer composite (FRP) is a new construction material, gradually gaining acceptance from civil engineers. Bridge engineering is among the fields in civil engineering benefiting from introducing FRP composite. In the past 15 years, experiments have been conducted to investigate the applicability of FRP composite in bridge structures, including the applications of FRP composite beam, deck, and column. Beam is one of the most important structural elements in bridge structural system, so knowing the structural behavior of beams is very important. In this study an analytical solution for stress analysis of composite laminated beam with Box-section has been developed. The solution includes the structural characteristics which are often ignored in the most published studies such as axial and bending stiffness. These structural characteristics have been used to calculate the stresses and strains in each ply of the Box-section. Also a computer program has been created using MATLAP language to calculate the stresses and strains obtained from the analytical solution for any Box-section subjected to axial force or bending moment. Furthermore, a finite element model has been developed using ANSYS software to validate the results obtained from the analytical solution and it has been seen a good agreement between results.

Moreover, a parametric study has been conducted using the developed finite element model. Various composite beam cross sections have been included in this study; equal flanges I-section, unequal flanges I-section, and square Box-section. The parametric study includes the effect of fiber orientation angle on the axial, bending, and torsional deformations. Furthermore, the effect of changing the number of layers in both the web and flange laminates on the formerly mentioned deformations (i.e. axial, bending, torsional deformations) has been studied. Also for each considered cross section and loading condition, the optimum fiber orientation angle and the optimum number of layers in web and flange laminates have been determined.