Lateral Bending and Torsion Buckling Analysis of Jiujian Yangtze River Arch-Stiffened Truss Bridge

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Abstract

Jiujiang Yangtze River Bridge is a double-deck highway and railway bridge over Yangtze River, the longest river in China. The central segment is a three-span continuous arch-stiffened truss structure with a longest span of 216 meters and maximum bridge height of 64 meters. This bridge is one of the longest continuous truss bridges in the world. Due to its high rise and long span length, the bridge lateral torsion bending buckling is of special concern. The purpose of the study presented here is to investigate the lateral buckling strength of the bridge. As there are numerous truss members, a new model for analyzing the buckling behaviors was developed. First, the truss and the arch are transformed into a continuous thin-wall structure and the rigidity of the cross-frame is distributed uniformly over its spacing. Then the simulated thin wall structure is further divided into a number of generalized arch-beam elements in the bridge longitudinal direction. The proposed model significantly reduces the number of finite elements and simplifies the input and output data files and engineers can quickly identify the main function of each type of member and improve their designs. The analytical results show that the proposed method provides good accuracy and that the most economical way to increase the bridge lateral buckling strength is to increase the lateral shear stiffness of the bridge arch portals. The proposed method and analytical results can be used in arch-truss bridge design and analysis.

Keywords: Steel Truss Bridge; Arch Bridge; Arch-Stiffened Truss Bridge, Highway Bridge, Railway Bridge; bridge model; Stability, Elastic Analysis, Plastic Analysis, Design.

1 Introduction

With the development of high strength materials, more longer and lighter bridges are being built in the world. For such bridges, the structural stability becomes an even more critical issue in design. The lateral buckling of truss bridges was first investigated by Engesser[1]. Then Muller-Breslau [2], Zimmernan[3] and Bleich[4], et al have done much research work on lateral stability of truss bridges. Research on the lateral buckling of arch bridges dates back to Timoshenko[5] who developed the lateral buckling equations for circular arch beams. Then Honcky, Stussi[6], Godden[7], Wastland[8], et al have studied the lateral buckling of other types of arch structures.

With the development of computers, finite element methods are widely used in the buckling analysis of truss and arch bridges. As there are a large number of members in a truss bridges, Li[9] proposed a new method by modeling the discrete truss structures as a thin-wall structure for analyzing truss bridge statics, stability, and vibration. Li and Shi[10] extended the method for analyzing the static behavior of arch-trussed bridges. Huang[11] further developed a method for analyzing the stability of arch-trussed bridges. Huang[12], Huang, et al[13-15] and Huang and Li[16] have

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