Fatigue Performance Evaluation of FRP Reinforced Steel Tubular K-Joint

Zhihua Xiong, Wenwen Li, Yang Meng, Chenyu Zhao

College of Water Resources and Architectural Engineering, Northwest A&F University, Yangling, Shaanxi, China

Contact: zh.xiong@nwsuaf.edu.cn

Abstract

Welded steel tubular joints have been widely used in bridge engineering, but fatigue cracks are common in the joints under cyclic loads due to structural discontinuity and manufacturing defects. The formation and development of cracks have a great influence on the bearing capacity of joints, and even lead to the lack of safety of joints, thus the normal use of joints is affected. In this paper, for the cracked tubular K-joints under fatigue load, the change of stress intensity factor (SIF) before and after reinforced with carbon fibre-reinforced polymer (CFRP) is discussed by numerical simulation. The influence of the number of carbon fibre-reinforced polymer layers on the SIF of the reinforced joints is also discussed. The numerical simulation results show that the SIF can be effectively reduced by using CFRP to strengthen joint, and the fatigue performance of the joints can be greatly improved.

Keywords: circular hollow section gap K-joint; FRP reinforcement; finite element analysis; stress intensity factor (SIF).

1 Introduction

Fatigue is an inevitable issue in steel bridges, resulting in cracking even sudden failure after a certain number of cycles [1-2], and Oehme's [3] study shows that fatigue occupies the third place among the causes of failure of fatigue-prone steel structures. For bridge engineering, fatigue cracks are usually located at locations where the geometry suddenly starts to change, such as at the weld of a welded joint. Owing to the discontinuity of the welded joint structure and some unavoidable process defects in the welding process, the stress concentration caused by the local increase in stress here will lead to cracks [4]. Therefore, as fatigue damage is brittle damage and the formation and development of cracks have a large impact on the joint load capacity, can even lead to a lack of joints safety and thus affect the normal use of the joints. The fatigue life of the structure and the fatigue of the crack-prone area is very relevant, especially for the construction of a long time, the use of increased load and the aging state of the bridge structure. The problem of fatigue at the joints leading to a reduction in the reliability of the structure needs to be solved in an economical and efficient way.

As a promising material for structural reinforcement and repair, FRP is attractive in the implementations like bridge deck and other engineering scenario [5-7]. In the application of FRP, the design of the layering angle is very important. The author [8] investigated the stress concentration of pultruded GFRP perforated plate

https://doi.org/10.2749/nanjing.2022.1560
Distributed by structurae