Fatigue Tests on Compact-tension Specimens Repaired by CFRP

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Abstract

Six fatigue tests were conducted to investigate the fatigue behaviour of CFRP-repaired compact-tension specimens (CT specimens), considering the effects of CFRP material type, patch configuration and patch layer numbers. Beach marking technique and digital image correlation (DIC) technology were employed to depict the crack propagation and the strain distribution on the specimens. The differences in fatigue life and fatigue crack growth rates (FCGR) results reveal that CFRP patches can prolong the fatigue life, even tripling the cycle number in a test. There is a salient advantage in double-side repairing compared to its one-side counterpart. However, the CFRP sheet layer number doesn't guarantee the strengthening efficacy. The specimen repaired by CFRP plate had a mixed failure mode of adhesive layer failure and CFRP debonding. The failure mode of CFRP-sheet repaired specimens was a mix of CFRP debonding, delamination and adhesive layer failure.

Keywords: compact-tension specimen; steel plate; CFRP; digital image correlation (DIC); fatigue life; fatigue crack propagation rate (FCGR).

1 Introduction

Metallic infrastructures subjected to cyclic loads including wind load and traffic load are susceptible to fatigue crack initiation and propagation. Crack propagation may cause brittle failure. Repairing fatigue-damaged steel components with CFRP material has shown many advantages including longer fatigue life extension[1,2], reduction of residual deflection and transformation of failure modes. Fatigue performance improvement has become one of the most important aspects of CFRP strengthening of metallic structures[3].

Previous research on the CFRP reparation of mode-I cracks was based on various kinds of steel plate specimens including centre-cracked steel plates[4,5], edge-cracked steel plates[4,6], I-beams and rectangular hollow-section beams[7]. In the experiments, the specimens are predominantly under tension except for steel beams. CFRP collaborates with the steel substrate, simply bearing tension. CT specimen is classic in tests related to fracture mechanics such as fatigue crack growth rate (FCGR) and fracture toughness determination. A relatively low load could realise a high stress intensity factor (SIF) on the CT specimen[8]. Also, the specimen is under bending during the test. Some researchers have conducted experimental research on CT specimens to study the effects of various CFRP fatigue strengthening strategies[1,2,9–12]. Factors including initial damage level, CFRP patch configuration, CFRP material quantity and even steel types of different ages[9–12] were under investigation. However, the experiments on double-side repaired CT specimens

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