Classifying Failure Modes of Ultra-High-Performance Fiber Reinforced Concrete Fracture Beams Using Acoustic Emission Technique

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Abstract

Due to its homogenized microstructure and discrete fibers, ultra-high-performance fiber-reinforced concrete (UHPFRC) possesses exceptional compressive and tensile strength. They also have excellent ductility, and durability. As UHPFRC is increasingly used in bridge construction, non-destructive health monitoring can be used to understand its damage behaviour. This study examines the fracture behavior of UHPFRC beams under different parameters, such as fiber volume fractions 1.0% and 2.0%. The Acoustic Emission (AE) is employed to monitor all test beam fracture processes and to determine the crack type. The unsupervised K-means clustering technique is used to analyze AE parameters based on peak frequency and amplitude parameters. The research findings indicated that the failure mode in UHPFRC notched beams was primarily due to fiber pullout. The conventional failure mode classification and k-means clustering are not the same. Similarly, the clustering classification is carried out using the peak frequency versus amplitude. The ranges are decided based on the type of failure modes, such as fiber pullout, matrix debonding, and combined fiber pullout and matrix cracking.

Keywords: UHPFRC; Acoustic emission; Fracture test; Crack classification; Fracture process zone, Machine Learning, K-means.

1 Introduction

Ultra-high performance fiber reinforced concrete (UHPFRC) is a type of concrete that has closely packed fine particles and discrete steel fibers(1–4). Due to the absence of aggregates and more fibers, the failure mode of UHPFRC concrete is different. Due to the excellent mechanical and durability properties of UHPFRC concrete (5–9), structural engineers are inclined to use this material in important structures. To understand the level of damage after certain age or service load, it is

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