World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:16, No:12, 2022

# An Analytical Approach for the Fracture Characterization in Concrete under Fatigue Loading

**Authors :** Bineet Kumar

**Abstract :** Many civil engineering infrastructures frequently encounter repetitive loading during their service life. Due to the inherent complexity observed in concrete, like quasi-brittle materials, understanding the fatigue behavior in concrete still posesa challenge. Moreover, the fracture process zone characteristics ahead of the crack tip have been observed to be different in fatigue loading than in the monotonic cases. Therefore, it is crucial to comprehend the energy dissipation associated with the fracture process zone (FPZ) due to repetitive loading. It is well known that stiffness degradation due to cyclic loadingprovides a better understanding of the fracture behavior of concrete. Under repetitive load cycles, concrete members exhibit a two-stage stiffness degradation process. Experimentally it has been observed that the stiffness decreases initially with an increase in crack length and subsequently increases. In this work, an attempt has been made to propose an analytical expression to predict energy dissipation and later the stiffness degradation as a function of crack length. Three-point bend specimens have been considered in the present work to derive the formulations. In this approach, the expression for the resultant stress distribution below the neutral axis has been derived by correlating the bending stress with the cohesive stresses developed ahead of the crack tip due to the existence of the fracture process zone. This resultant stress expression is utilized to estimate the dissipated energydue to crack propagation as a function of crack length. Further, the formulation for the stiffness degradation has been developed by relating the dissipated energy with the work done. It can be used to predict the critical crack length and fatigue life. An attempt has been made to understand the influence of stress amplitude on the damage pattern by using the information on the rate of stiffness degradation. It has been demonstrated that with the increase in the stress amplitude, the damage/FPZ proceeds more in the direction of crack propagation compared to the damage in the direction parallel to the span of the beam, which causes a lesser rate of stiffness degradation for the incremental crack length. Further, the effect of loading frequency has been investigated in terms of stiffness degradation. Under low-frequency loading cases, the damage/FPZ has been found to spread more in the direction parallel to the span, in turn reducing the critical crack length and fatigue life. In such a case, a higher rate of stiffness degradation has been observed in comparison to the high-frequency loading case.

**Keywords :** fatigue life, fatigue, fracture, concrete
**Conference Title :** ICSFMFC 2022 : International Conference on Structural Fracture Mechanics and Fatigue Control
**Conference Location :** Kuala Lumpur, Malaysia
**Conference Dates :** December 09-10, 2022