FFW 2026

Fracture Fatigue and Wear

GHENT UNIVERSITY

Total fretting fatigue life prediction of Ti-6Al-4V at 260°C using cohesive zone modelling

FFW1529

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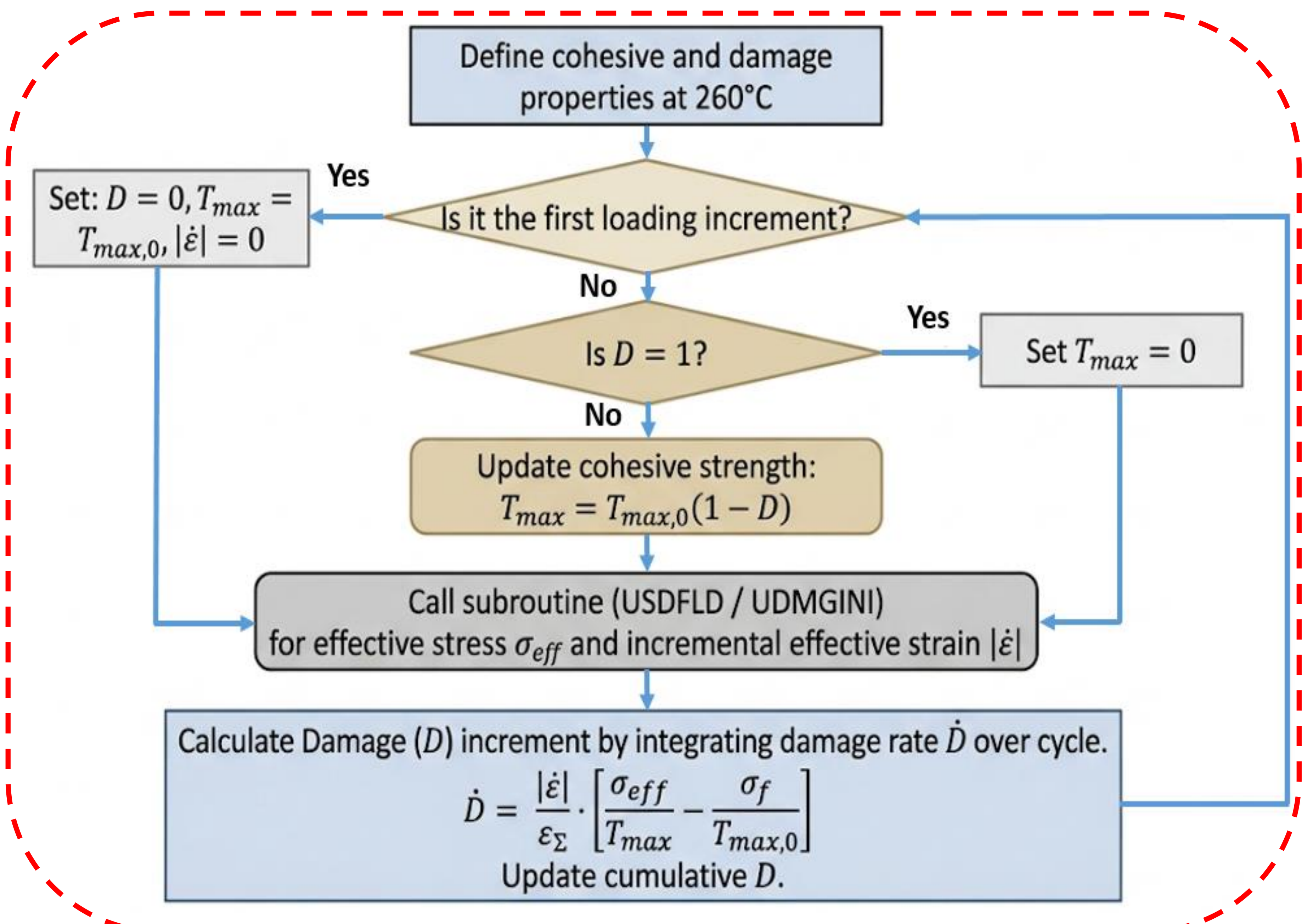
Introduction

This study presents a coupled finite element methodology for predicting the total fretting fatigue life of Ti-6Al-4V at 260°C by integrating a cyclic cohesive zone model with the extended finite element method (XFEM). A bilinear traction separation law is adopted, with the initial cohesive strength taken equal to the material ultimate tensile strength at the corresponding temperature.

Methodology

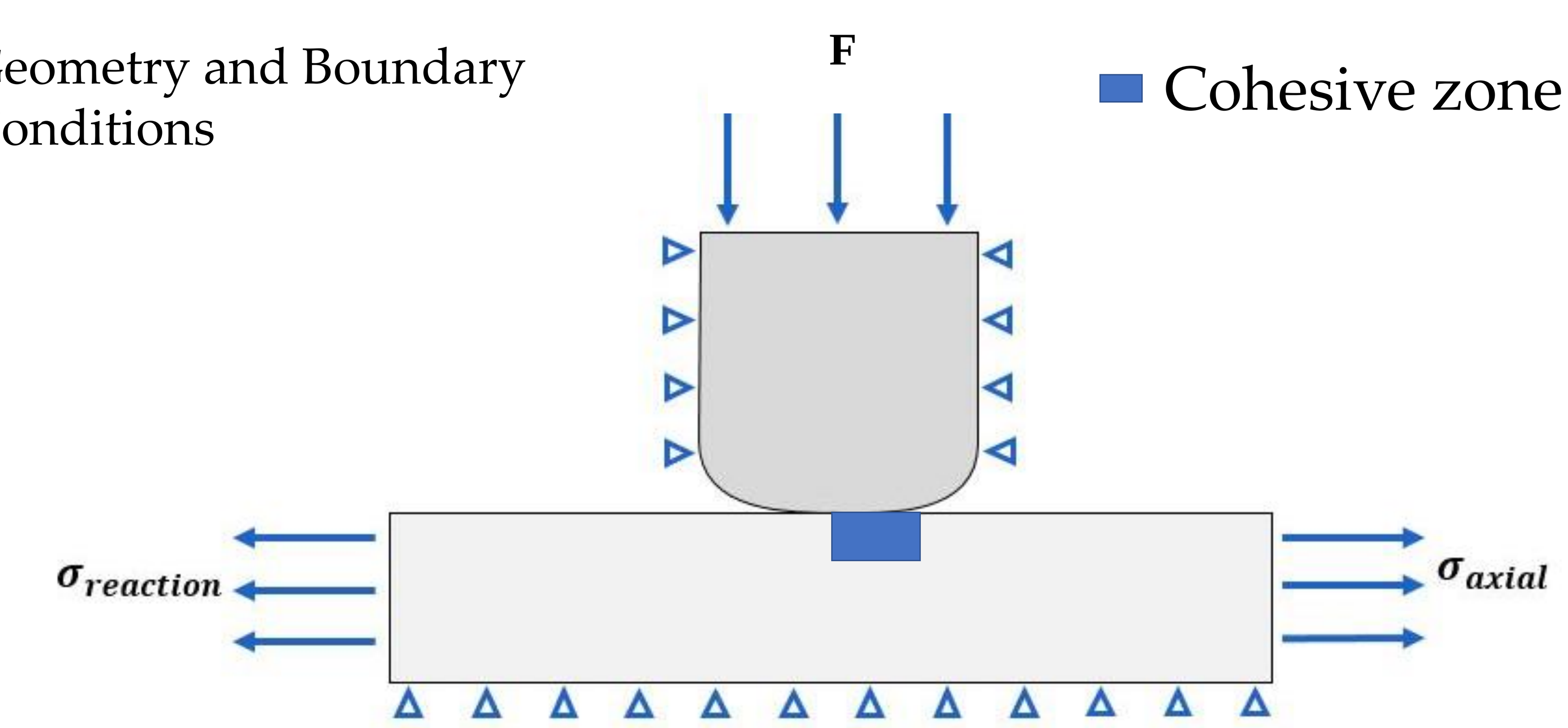


Extract crack increment and corresponding number of cycles

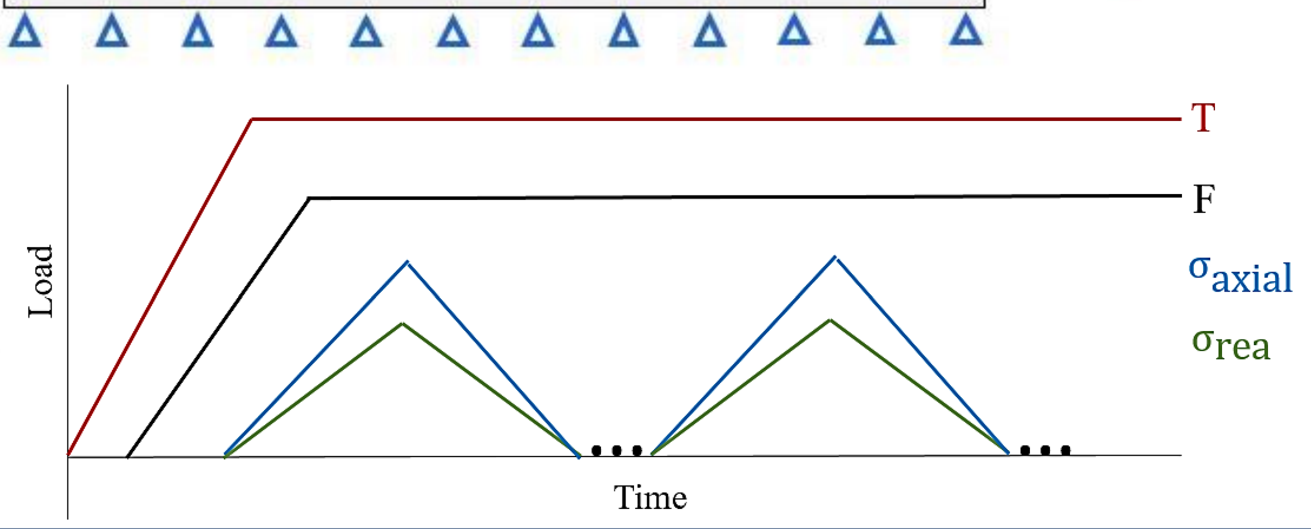
Power law constants using linear regression $a = A N^m$

Numerical Model

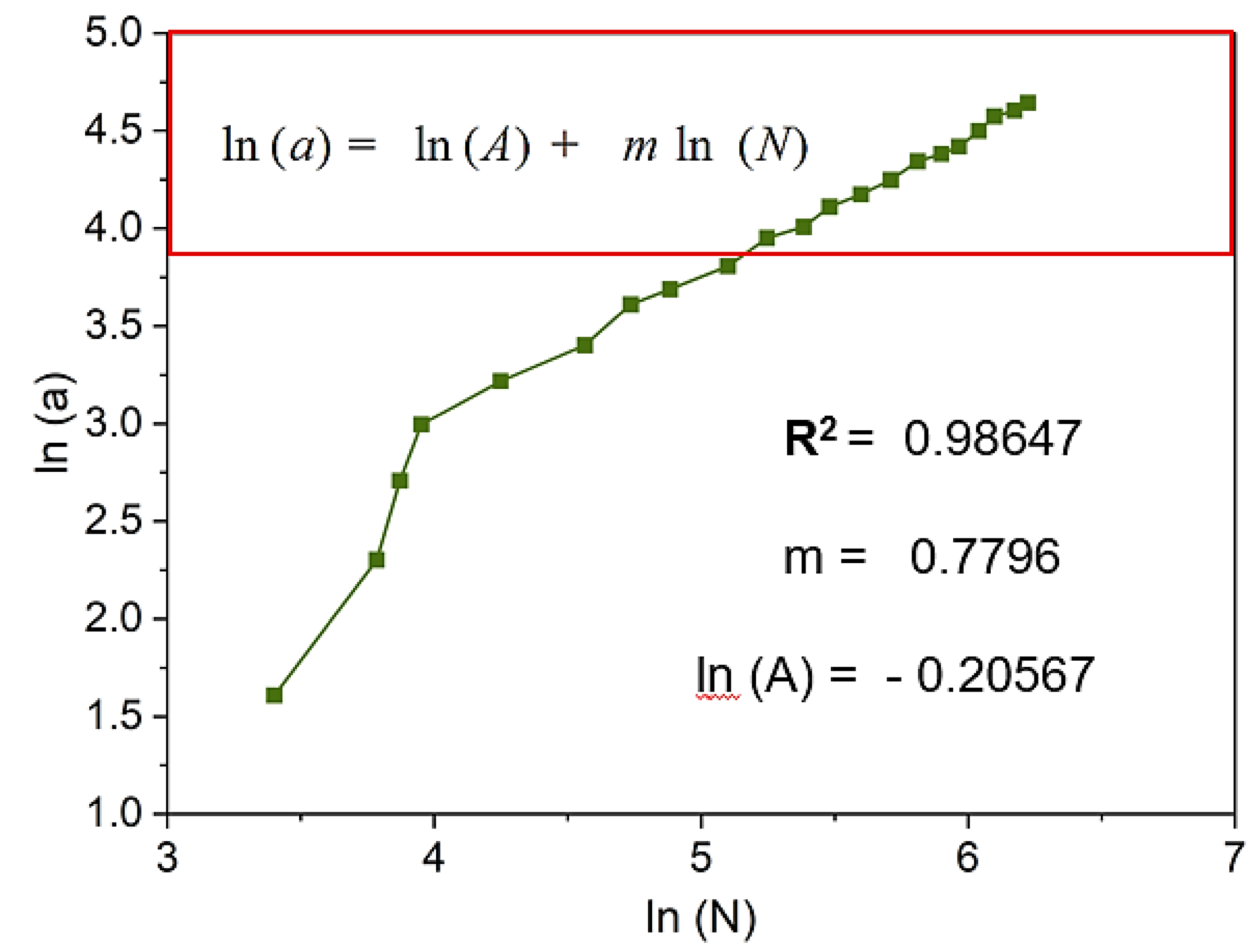
Geometry and Boundary Conditions



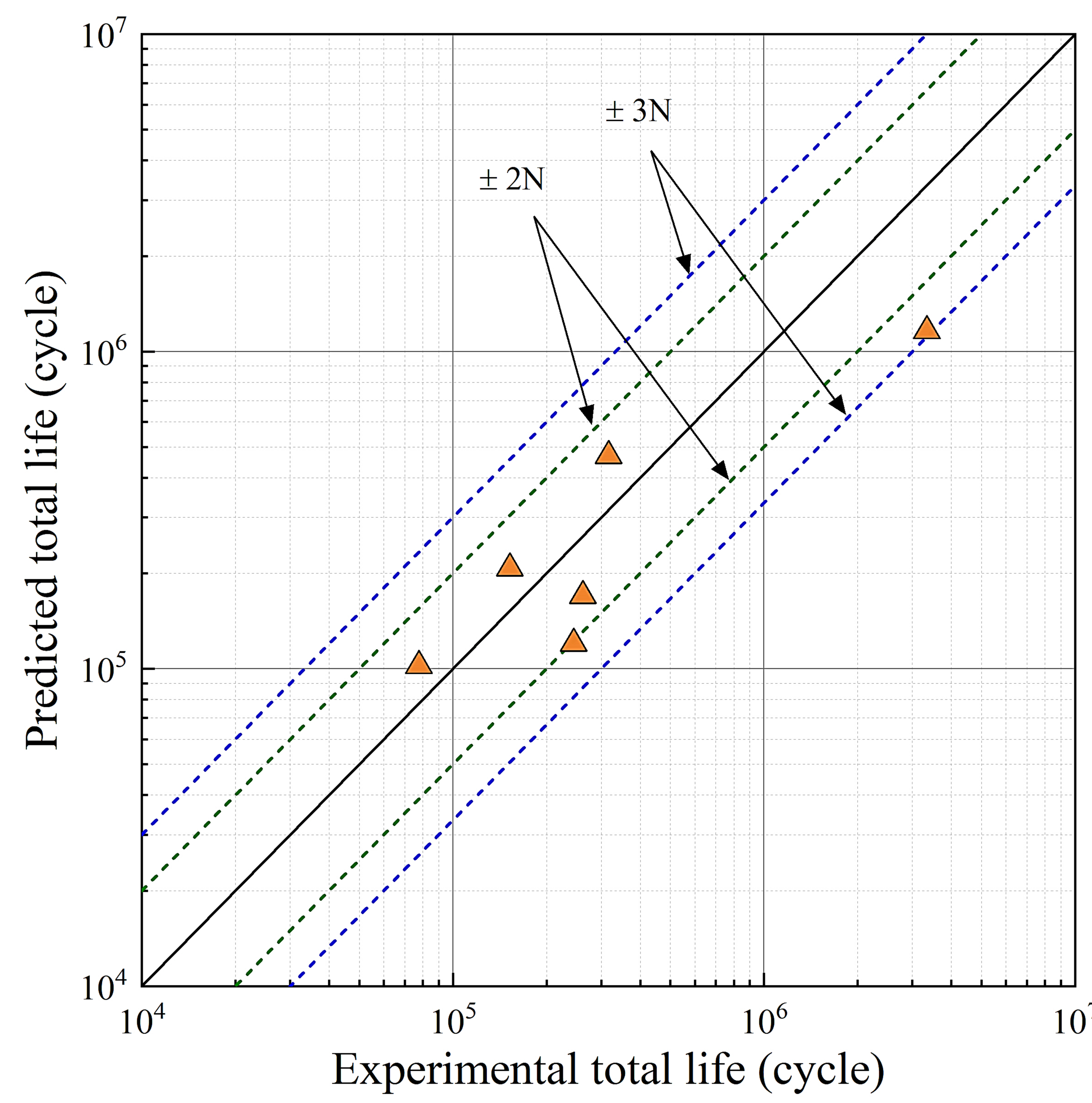
Loading Sequence



Results



Estimation of power law constants for test F1



Comparison between predicted and experimental total life

Conclusions

- Coupled CZM–XFEM predicts total fretting fatigue life of Ti-6Al-4V at 260°C without separate initiation and propagation criteria.
- Two crack growth regimes identified: nonlinear for short cracks (a < 50 µm), transitioning to linear behaviour enabling reliable power-law extrapolation.
- All predictions fall within a 3N scatter band, confirming the cycle-dependent cohesive damage law captures fatigue degradation accurately under high-temperature fretting fatigue.
- Computational cost is reduced by limiting cycle-by-cycle simulation to 120 µm, then extrapolating analytically to failure.