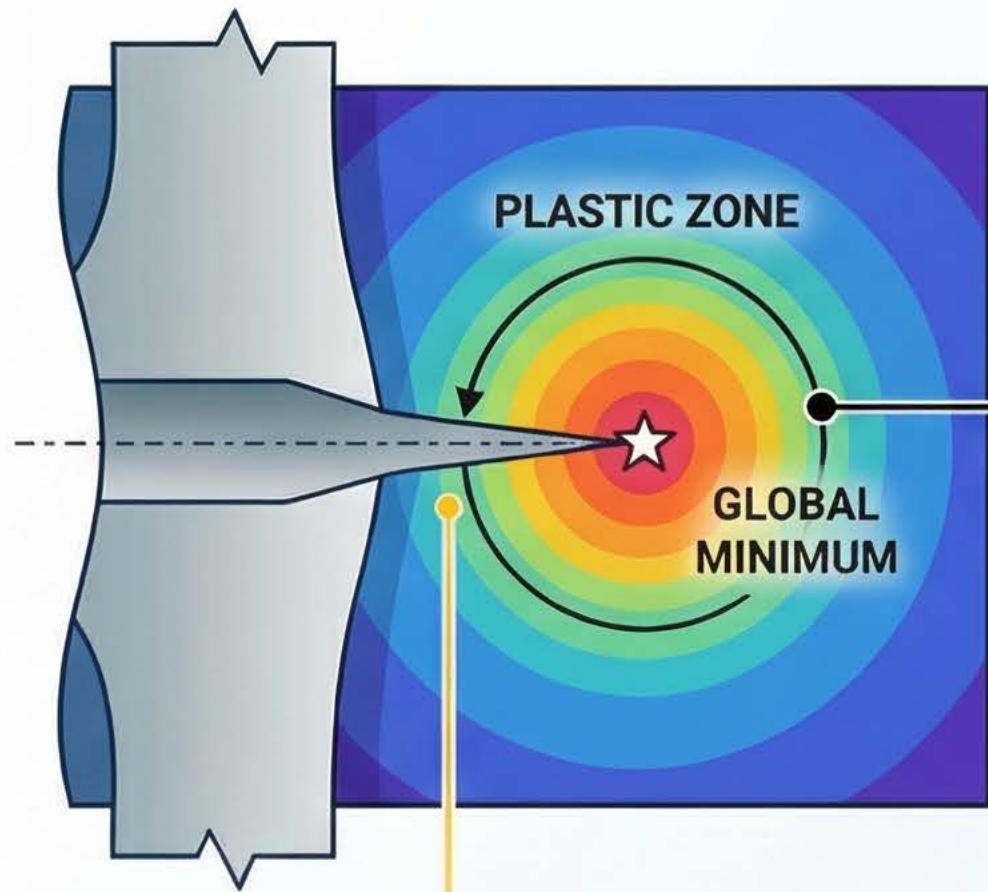


Predicting Structural Failure: The GMPZR Crack Initiation Model

Based on Generalized Minimum Plastic Zone Radius Criterion for Engineering Components

The Prediction Framework

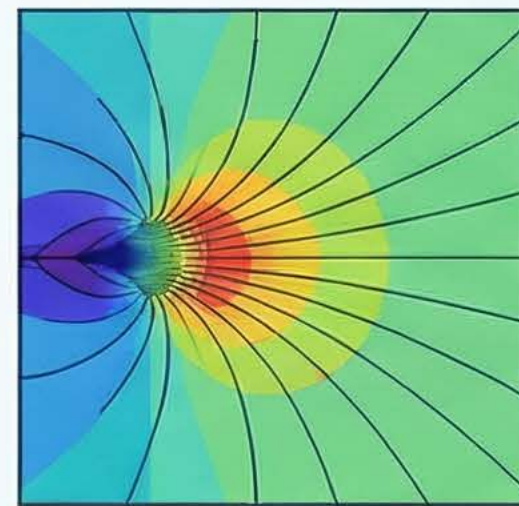


Essential Material Properties (IF Steel)

Property	Value
Elastic Modulus (E)	197 GPa
Yield Strength (σ_y)	155 MPa
Poisson's Ratio (ν)	0.3

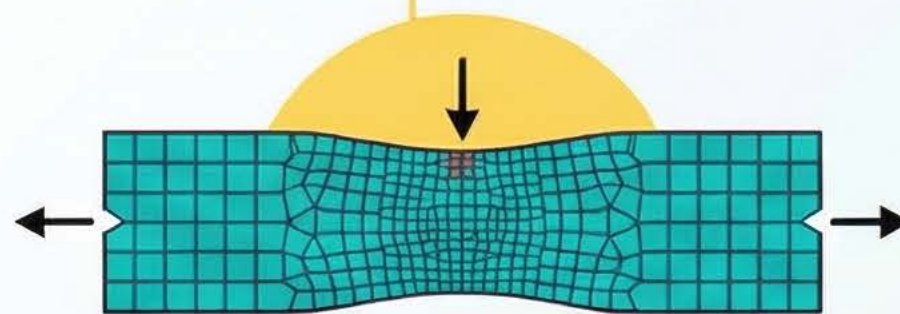
THE GMPZR CRITERION

Cracks initiate where the plastic zone radius reaches its global minimum.



T-STRESS SIGNIFICANCE

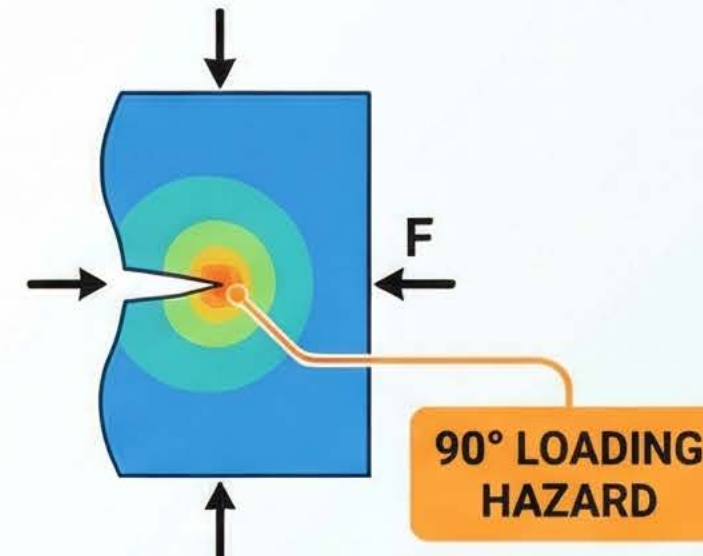
Non-singular T-stress significantly affects plastic core shape and crack growth direction.



HIGH-FIDELITY FEA SIMULATION

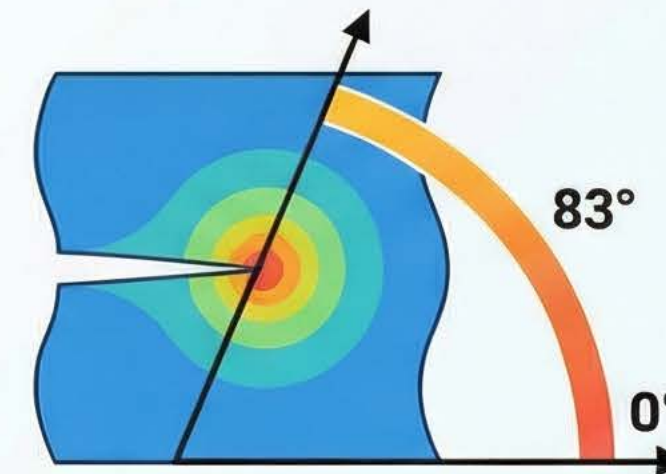
2D stress analyses were performed using ABAQUS on interstitial Free (IF) steel.

Critical Results & Application



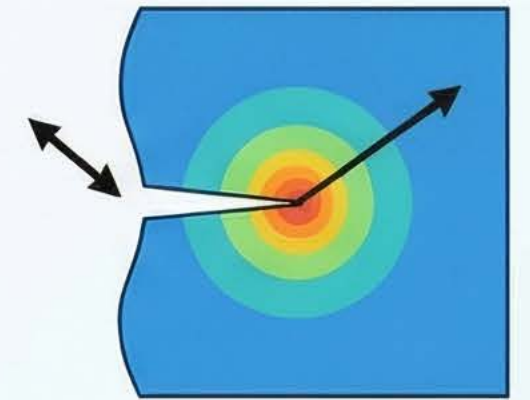
MODE I LOADING (DANGEROUS)

Mode I loading is more dangerous, causing earlier fractures than shear modes.



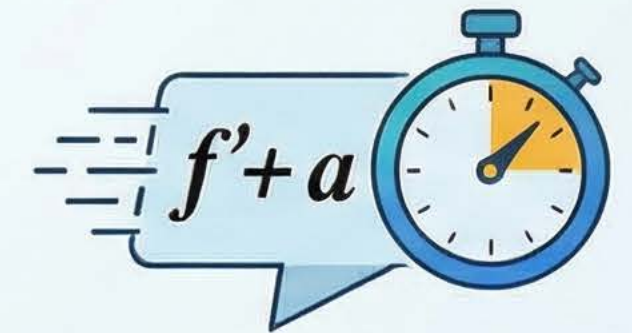
MODE I vs MODE II LOADING

Crack initiation angles decrease from 83° to 0° as loading shifts modes.



THE GMPZR CRITERION

A new 3rd-order polynomial allows crack angle prediction without complex FEA.



RAPID ANALYTICAL ESTIMATION

A new 3rd-order polynomial allows quick crack angle prediction without complex FEA.