

Lecture Notes on “Fracture Mechanics”

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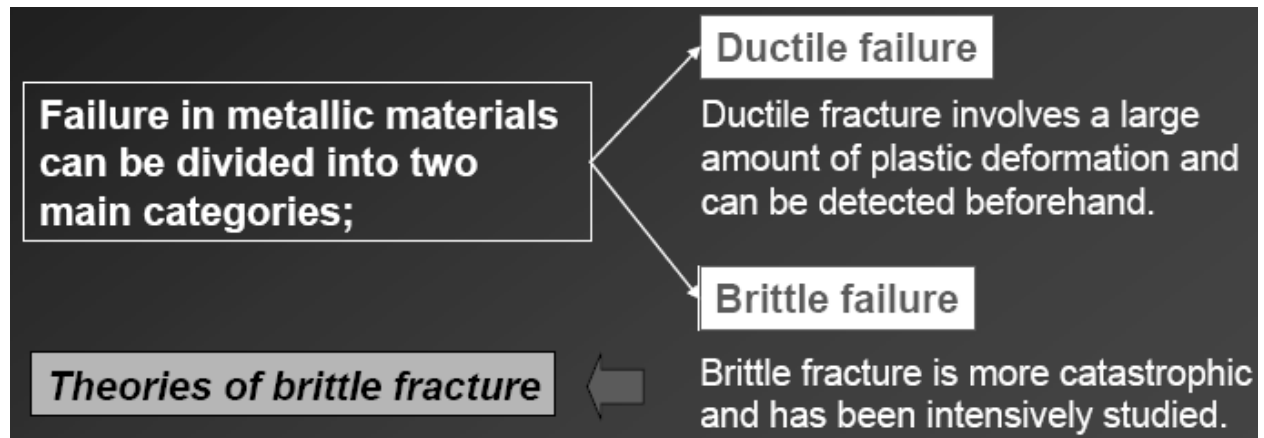
OBJECTIVE:

This topic provides brief introduction about the fundamentals and types of fractures; together with development in the theories of brittle fractures mechanisms

INTRODUCTION:

Failure in structures leads to lost of properties and sometimes lost of human lives unfortunately.

The concept of material strength and fractures has long been studied to overcome failures. The introduction of malleable irons during the revolution of material construction led to the perception of brittle and ductile fractures as well as fatigue failure in metals



PARAMETER AFFECTING FRACTURE:

- Load Rate
- Nature of Loading
- Triaxiality
- Cyclic
- Material
- Temperature
- Corrosion
- Fabrication Cracks
- Design Features
 - ✓ Notches
 - ✓ Holes
 - ✓ Fillets
 - ✓ Uneven surface Roughness

TYPES OF FRACTURE:

1. Brittle fracture
2. Ductile fracture

Brittle fracture:

- Under uniaxial tension loading, fracture occurs at 90 degrees with the axis of loading.
- There is no plastic deformation (i.e. there is no necking).
- The failure plane has a granular appearance

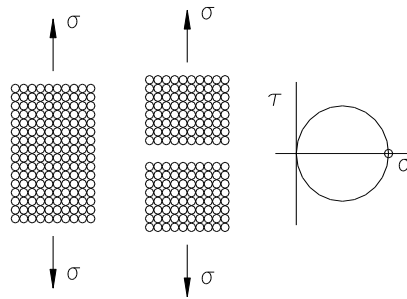


Fig: Mechanism of brittle fracture

Ductile fracture:

- Necking in round specimens:
- As necking occurs, a **tri**-axial state of stress develops in the region of necking. This is most popular in round specimens.
- Failure begins when micro-cracking causing a fibrous surface to develop. This is followed by a rapid fracture oriented **at 45°** with the axis of loading.

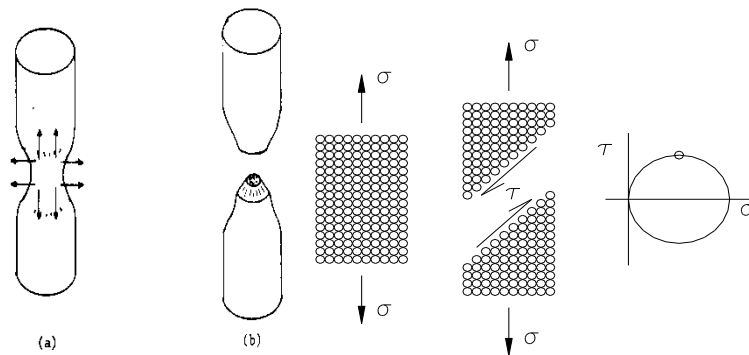


Fig: Mechanism of ductile fracture

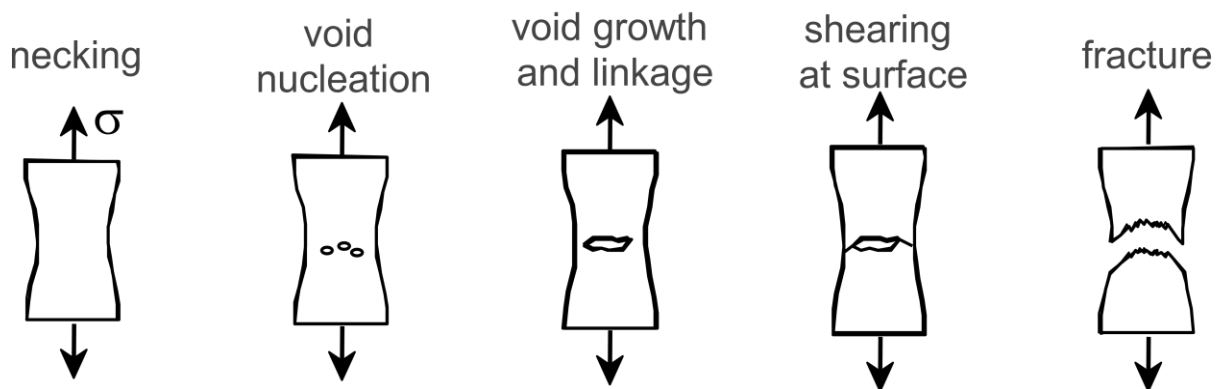


Fig: Evolution of ductile fracture

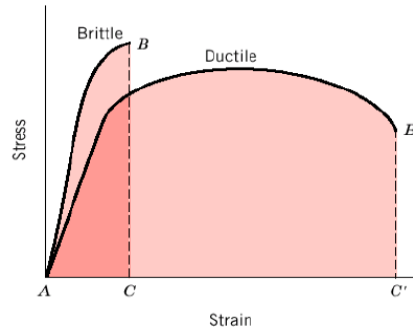


Fig: Ductile Vs. Brittle fracture

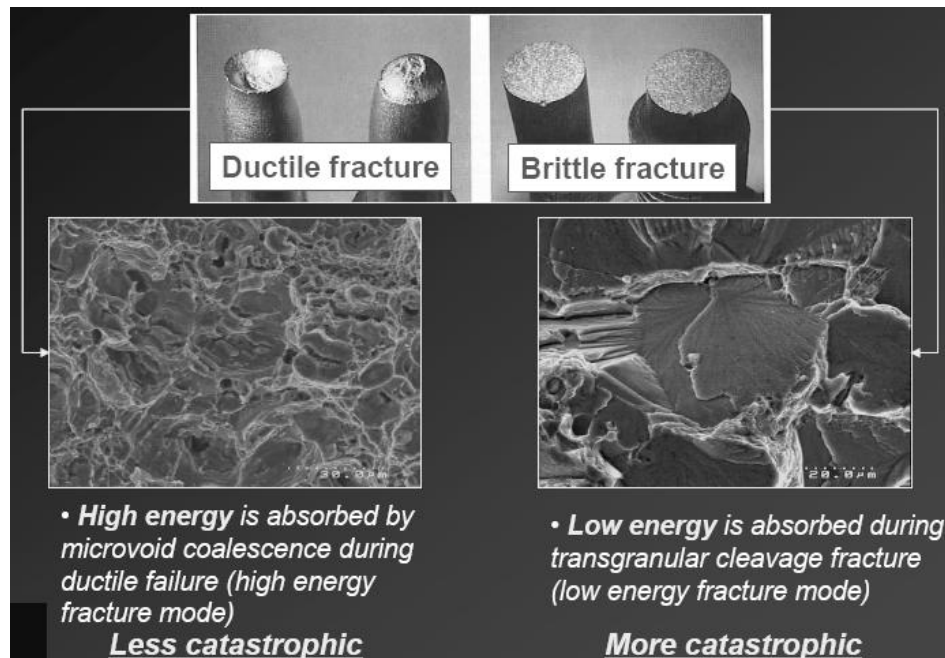


Fig: Microscopic comparison between ductile and brittle fracture

FRACTURE IN SINGLE CRYSTAL:

The brittle fracture of single crystals is related to the resolved normal stress on the cleavage plane. Schmid's law states that fracture occurs when the resolved normal stress reaches a critical value.

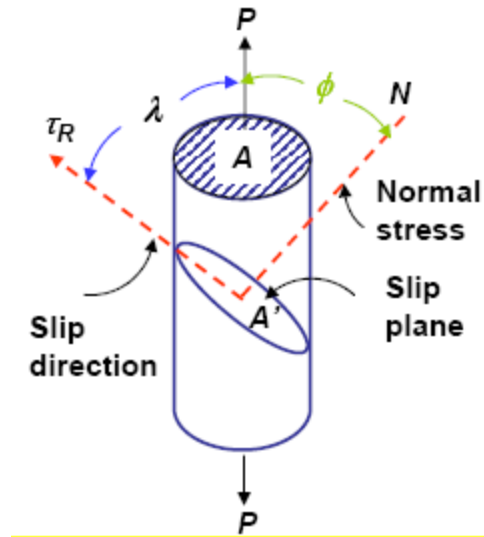


Fig: Critical resolved shear stress

GRIFFITH'S THEORY OF BRITTLE FRACTURE:

This theoretical cohesive strength is exceptionally higher than the fracture strength of engineering materials. This difference between cohesive and fracture strength is due to inherent flaws or defects in the materials which lower the fracture strength in engineering materials. Griffith explained the discrepancy between the fracture strength and theoretical cohesive strength using the concept of energy balance

The first analysis on cleavage fracture was initiated by Griffith using the concept of energy balance in order to explain discrepancy between the theoretical cohesive strength and observed fracture strength of ideally brittle material.