



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

Failure Analysis and Prevention

General Procedure of Failure Analysis: DT for Failure Analysis

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Purpose

- Measure the load carrying capability under different types of loads
- Each destructive test reveals a unique behavior of metal
- To assess the suitability for a given application
- Evaluating the effect of service conditions



Types of tests

- Harness: resistance to indentation, abrasion
- Tensile: yield & ultimate strength, ductility
- Toughness: resistance to impact loading
- Fatigue: resistance to fluctuating and varying load
- Fracture Toughness: Resistance to crack growth
- Creep: Resistance to strain/fracture at elevated temperature
- Bend: Ductility, soundness, bending capability

Hardness test

- Identify / confirm the manufacturing process used for developed the component under investigation,
- Confirm if a particular heat treatment was performed properly.
- Estimating ultimate tensile strength and
- Determines the extent of work hardening or decarburization occurred on the fractured component during the service, if any.
- No major sample preparation except for micro-hardness test



High low/temperature tests to simulate condition

- To determine how structure and property variation occurs due to exposure other than room temperature
- Thermal of steel about 1h prior to impact test for temper/blue embrittlement tendency
- Mechanical treatment of steel about 1h prior to impact test for strain age embrittlement tendency
- DBTT for steel in case of brittle fracture of LCS



Interpretation of mechanical tests

- Little (5-10%) lower strength than minimum specified does not necessarily indicate as primary cause of failure in service
- Further, lab test data on small samples may not adequately represent the metal behavior of large structures.
- For example, brittle fracture of large structures at room / near room temperature can occur despite of lab DBTT data show -18°C .
- Effect of size however is not full understood however, in general resistance to fatigue, corrosion fatigue and hydrogen embrittlement decreases with increase of size.



Limitation of tensile data

- In majority of cases tensile data don't provide much information as very few failures occur due to deficient metal strength (loading till rupture).
- Also, components failed in brittle manner generally show adequate ductility under standard tensile test.
- Its good for routine quality test of lot at manufacturing stage.
- In FA, it helps to eliminate possibility of poor quality of materials as cause of failure.



Limitation of tensile data

- Approximation of tensile strength is also possible from hardness test so as to avoid time consuming sample preparation and testing.
- Ductility in %elongation doesn't relate with behavior of metal in service. A crank shaft metal with 20% elo. Failed in brittle manner.
- Bend test indicates better ability to facilitate local yield at notch so as relieve stress and resist crack growth.
- Bend test offer better indication than ductility of tensile test.

Interpretation of Mechanical Tests

- Minor discrepancy in properties after service wrt new component should not be interpreted as major cause of failure.
- Directionality in deformed products (longitudinal/transverse) should be considered owing anisotropy in rolling /forging
- Such variations may arise from difference in
 - deformation during hot/cold working
 - Heat treatment differences changing section thickness

