Effects of Surface Roughness on Stress-Strain curve

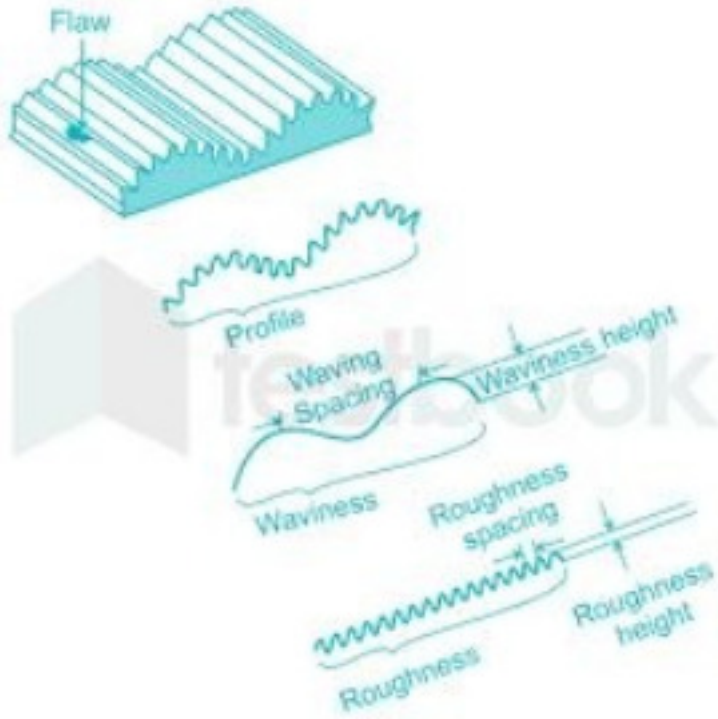
OBJECTIVE

Theme of the experiment is to demonstrate the effect of roughness in material properties such as ductility, yield point , modulus etc.. and to understand it's important

OVERVIEW

- THEME AND THEORY ON HOW SURFACE ROUGHNESS AFFECTS STRESS STRAIN
- PARAMETERS

Variations in surface roughness alter the material's mechanical response under loading.



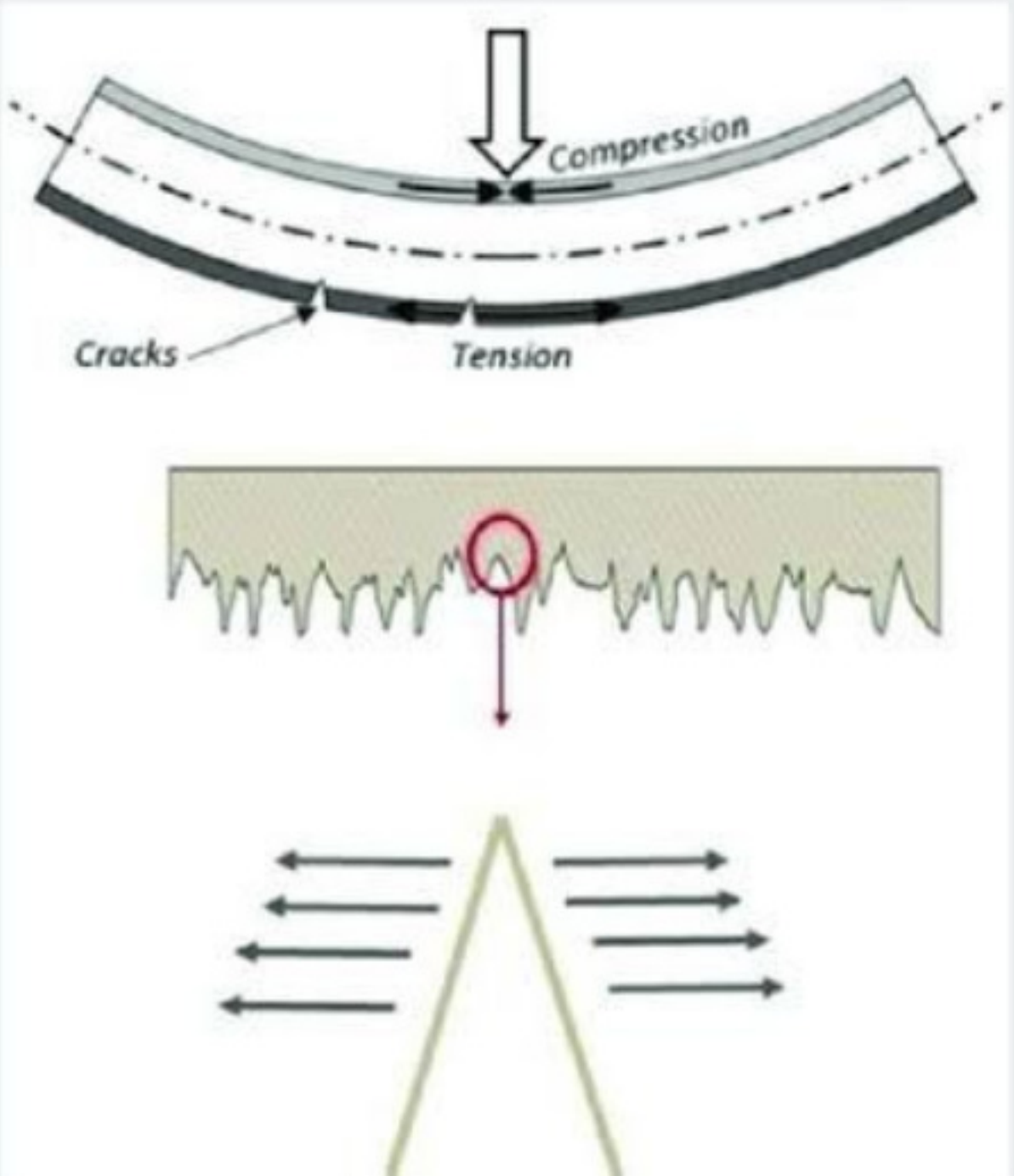
HOW IT AFFECTS THE MATERIAL

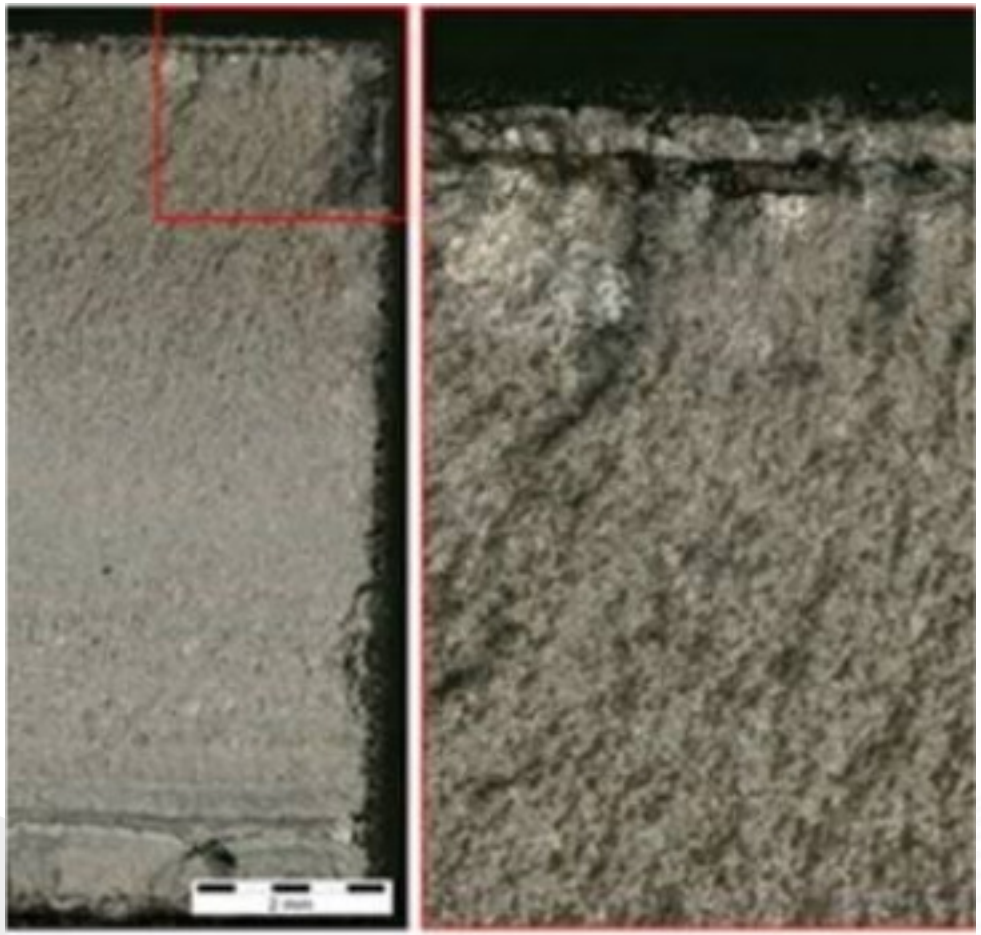
Stress Concentration

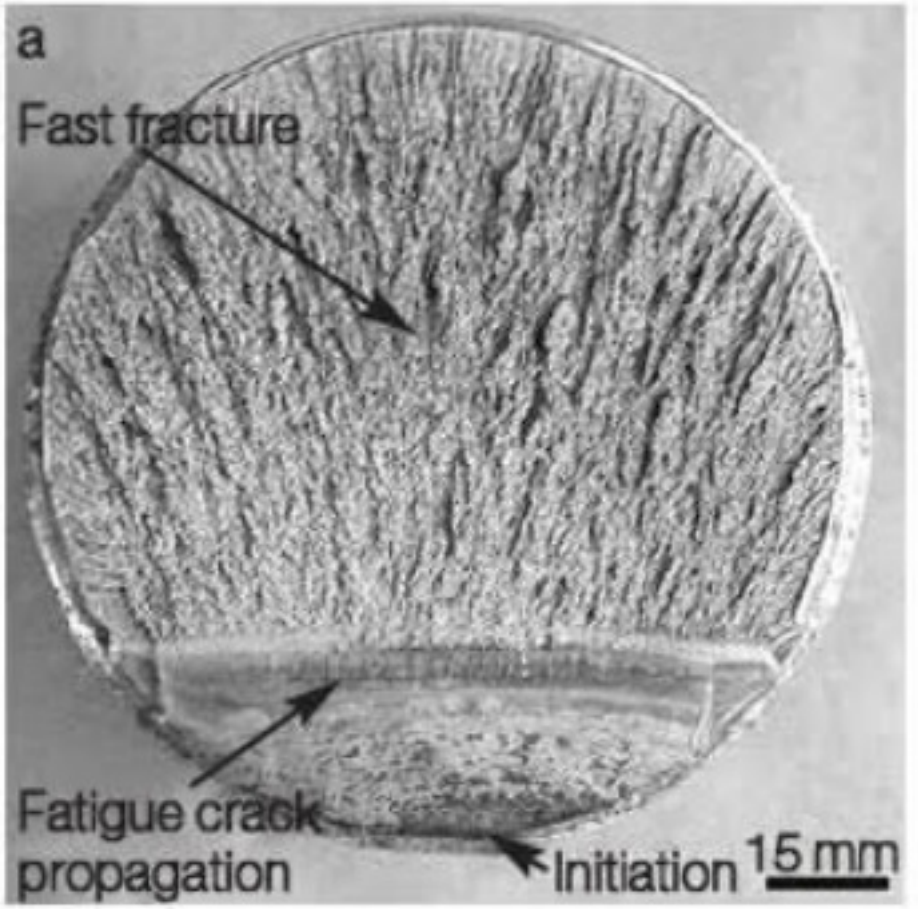
Surface roughness, characterized by micro-scale irregularities, creates geometric discontinuities. When a material is stressed, these discontinuities cause the lines of force to concentrate at the peaks and valleys of the roughness profile, resulting in higher stresses in those areas.

HOW IT AFFECTS THE MATERIAL

Surface roughness can significantly reduce **crack initiation** life in materials s
cyclic loading because it increases stress concentrations and creates localize
fields that can facilitate crack initiation. A rougher surface tends to shorten th
compared to a smoother surface. Yield or fracture at lower strains, since micr
grow more easily from rough features.


Compression
Cracks
Tension




a
Fast fracture
Fatigue crack
propagation
Initiation
15 mm

HOW IT AFFECTS THE MATERIAL

Wear and Tear

Real contact area is much smaller than the apparent contact area due to surface roughness .As a result, local pressures are higher, increasing wear and plastic deformation in those spots.

HOW IT A ATERIAL

HOW IT AFFECTS THE MATERIAL

Measurement Inaccuracy

EXTENT OF IT'S EFFECTS

MAXIMUM EFFECTS

- Thickness of specimen is low
- The surface roughness parameters are high
- Surface Roughness effects are more pronounced when fatigue failure is involved.Damage accumulation from wear and roughness, materials Show lower stiffness (modulus) in repeated loading cycles.

MINIMUM EFFECTS

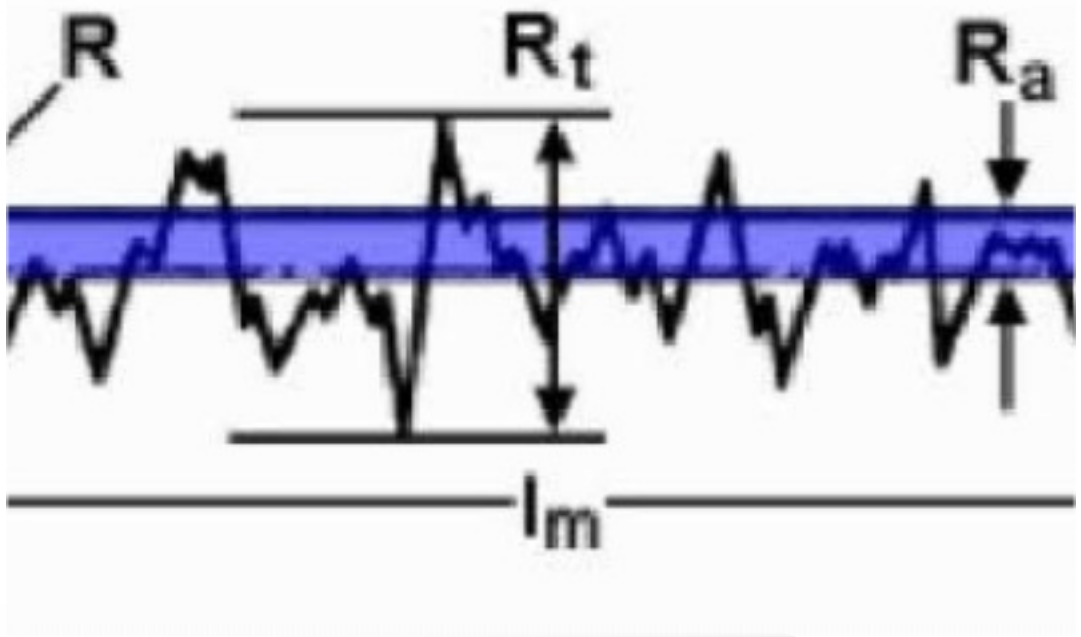
- If thickness of specimen is high the effects will be minimum in the interior region
- Surface roughness parameters are not high enough the effects will be negligible
- Slight roughening (light sanding or machining) may induce residual compressive stresses or strain-harden the surface which minimize surface roughness effects and sometimes even inverting the effects

PARAMETERS

- Parameters are crucial in experiments because they define the specific conditions and measurable factors used to evaluate the impact of treatments or substances
  - For Roughness
  - For Stress Strain Curve

PARAMETERS

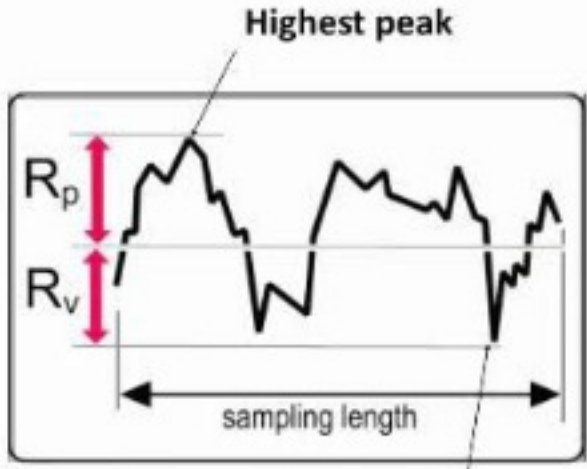
- For Roughness



- Ra – Roughness Average
- Rq – Root Mean Square Roughness
- Rz – Average Maximum Height of the Profile
- Rt – Total Height of the Profile
- Rv – Maximum Valley Depth

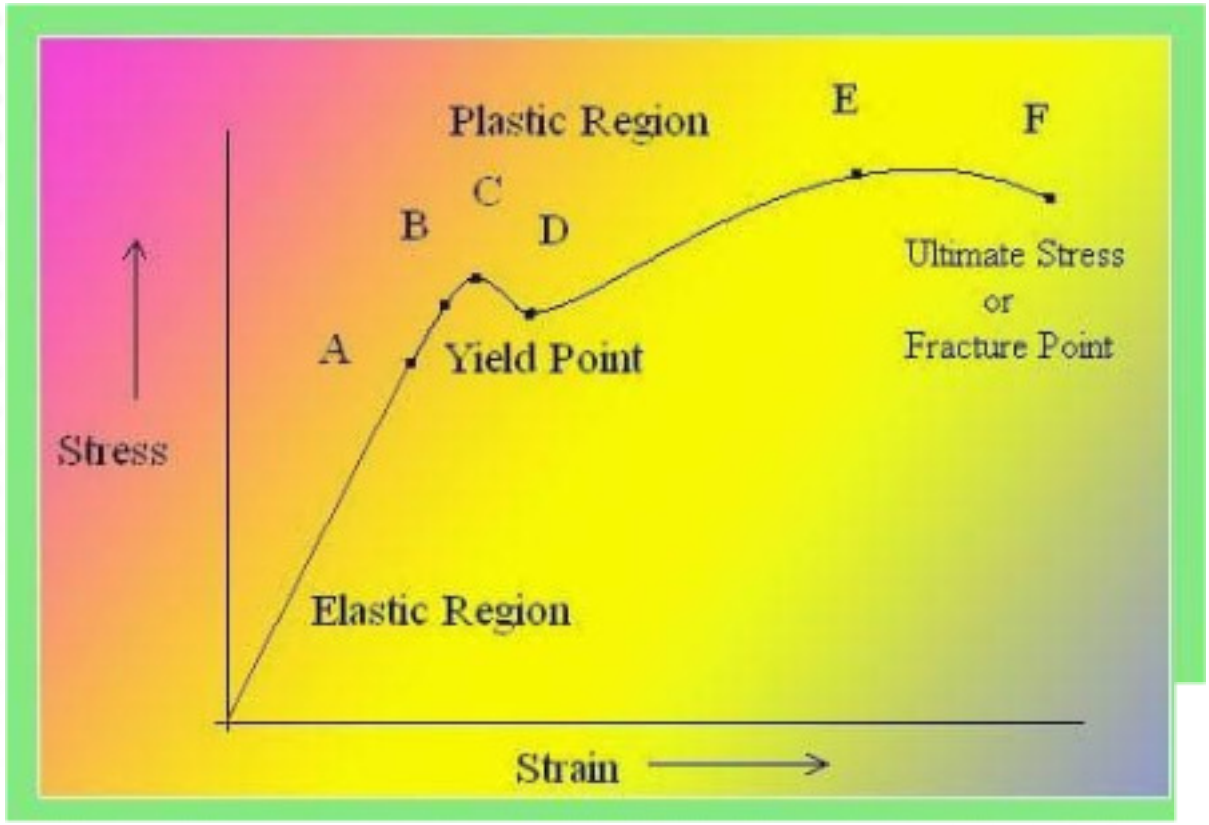
Rp (Peak)
Highest peak. The maximum distance between the mean line and the highest point within the sample. It is the maximum data point height above the mean line through the entire data set.

Rv (Valley)
Lowest valley. The maximum distance between the mean line and the lowest point within the sample. It is the maximum data point height below the mean



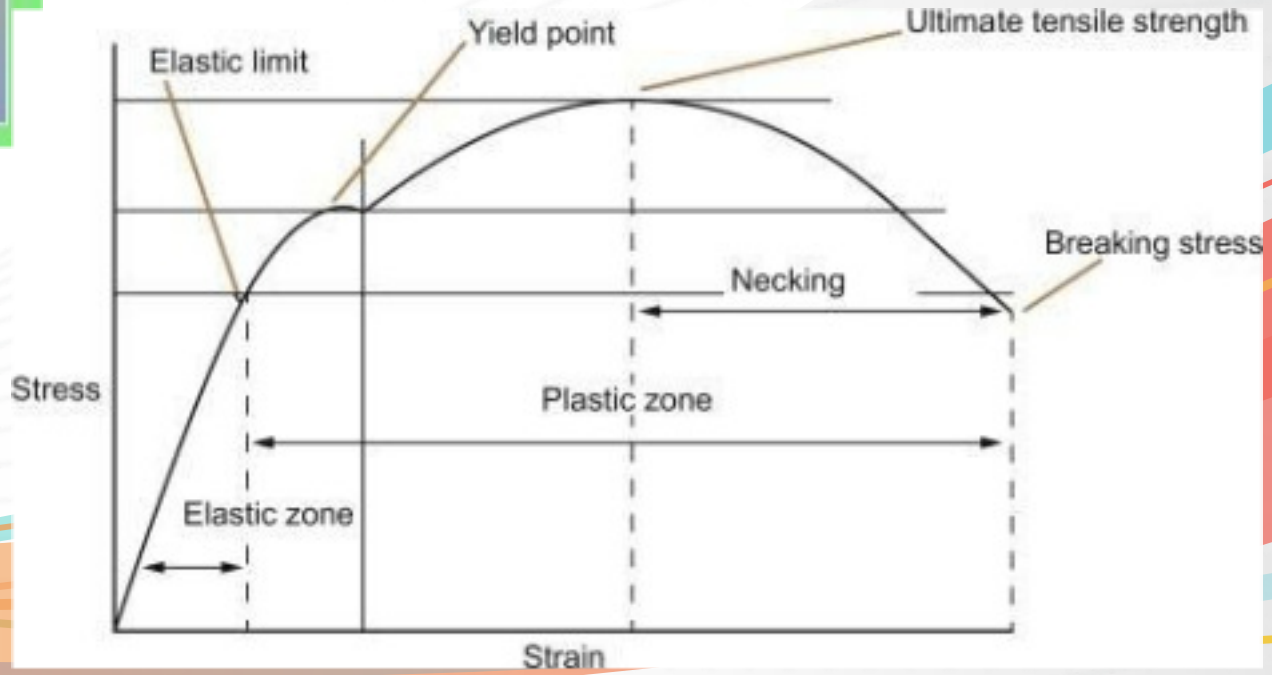
Ra- ROUGHNESS AVERAGE

- It's a crucial parameter in manufacturing because it directly reflects the surface's overall condition, influencing factors like friction, adhesion, and wear. A lower Ra value indicates a smoother surface, while a higher value signifies a rougher surface
- A lower Ra-value indicates a smoother surface, and a higher value indicates a rougher one.



Steel Stress Strain Curve

Aluminium Stress Strain Curve



- Proportional Limit-Material behaves elastically, meaning it returns to its original shape when the load is removed. The slope of this region represents the material's Young's modulus
- Yield Point-This point marks the transition from elastic to plastic behavior. It's where the material begins to deform permanently under load
- Elastic Limit-Maximum stress it can withstand without undergoing permanent deformation
- Ultimate Stress Point-This is the highest point on the stress-strain curve, indicating the maximum stress the material can withstand before it starts to fracture
- Fracture or Breaking Point-This is the point where the material breaks or fails.

Zoho Show

THEME AND THEORY .pdf

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