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Properties of solids and liquids

1. SOLID & ELASTICITY

Overview:

Solid mechanics deals with the study of the behavior of solid materials under different conditions. Elasticity is a fundamental concept in solid mechanics that describes how materials deform when subjected to external forces.

Application:

Used in engineering to design structures and components, ensuring they can withstand various loads without permanent deformation.

Formulas:

$Stress = \frac{Force}{Area}$
$Strain = \frac{Changeinlength}{Originallength}$
$Young'sModulus(E) = \frac{Stress}{Strain}$
$ShearModulus(G)$
$BulkModulus(K)$

2. YOUNG'S MODULUS

Overview:

Young's Modulus is a measure of the stiffness of a material. It quantifies how much a material will stretch (or compress) under a given force.

Application:

Used in material science and engineering to predict how a material will deform under load.

Formula:

$E = \frac{\text{Stress}}{\text{Strain}}$

3. SHEAR MODULUS

Overview:

Shear Modulus describes the material's response to shear stress, which results in deformation by slippage along planes parallel to the stress.

Application:

Used in predicting material behavior under shear forces.

Formula:

$$G = \frac{\text{Shear Stress}}{\text{Shear Strain}}$$

4. BULK MODULUS

Overview:

Bulk Modulus measures the response of a material to uniform pressure.

Application:

Important in studying fluid mechanics and compressibility of materials.

Formula:

$$K = -V \frac{\Delta P}{\Delta V}$$

5. DENSITY AND PRESSURE

Overview:

Density is the mass per unit volume of a substance. Pressure is the force per unit area exerted on an object.

Application:

Used in fluid dynamics, atmospheric science, and engineering.

Formulas:

$$Density = \frac{Mass}{Volume}$$
$$Pressure = \frac{Force}{Area}$$

6. SPECIFIC GRAVITY

Overview:

Specific Gravity compares the density of a substance to the density of a reference substance (usually water).

Application:

Commonly used in industries like brewing and metallurgy.

Formula:

$$SpecificGravity = \frac{\text{Density of Substance}}{\text{Density of Reference Substance}}$$

7. PRESSURE

Overview:

Pressure is the force applied perpendicular to the surface of an object per unit area.

Application:

Crucial in fluid dynamics, hydraulics, and pneumatics.

Formula:

$$Pressure = \frac{Force}{Area}$$

8. VARIATION OF PRESSURE WITH DEPTH

Overview:

In a fluid, pressure increases with depth due to the weight of the fluid above.

Application:

Used in understanding oceanography, hydraulic engineering.

Formula:

$$P = P_0 + \rho g h$$

9. PASCAL'S LAW

Overview:

Pascal's Law states that a change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid.

Application:

Foundation for hydraulic systems.

Formula:

$$P_1 = P_2$$

10. BUOYANCY

Overview:

Buoyancy is the upward force exerted by a fluid on a submerged object.

Application:

Crucial in ship design, understanding the behavior of floating objects.

Formula:

$$BuoyantForce = \rho g V_{\text{submerged}}$$

11. ARCHIMEDES' PRINCIPLE

Overview:

Archimedes' Principle states that the buoyant force on an object is equal to the weight of the fluid displaced by the object.

Application:

Used in designing ships, submarines, and hot air balloons.

Formula:

$$BuoyantForce = \rho g V_{\text{displaced}}$$

12. EQUATION OF CONTINUITY

Overview:

The equation of continuity states that the mass flow rate of a fluid is constant in a steady-flow process.

Application:

Used in fluid dynamics, pipe flow, and aerodynamics.

Formula:

$A_1 v_1 = A_2 v_2$

13. BERNOULLI'S EQUATION

Overview:

Bernoulli's Equation relates the pressure, velocity, and height of a fluid in steady, incompressible flow.

Application:

Used in aerodynamics, fluid dynamics.

Formula:

$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$

14. SURFACE TENSION

Overview:

Surface tension is the force that acts at the surface of a liquid, minimizing its area.

Application:

Important in understanding capillarity, fluid dynamics.

Formula:

$\text{Surface Tension} = \frac{\text{Force}}{\text{Length}}$

15. INTERATOMIC COHESIVE AND ADHESIVE FORCES

Overview:

Interatomic forces are attractions or repulsions between atoms in a molecule. Cohesive forces act between similar molecules, while adhesive forces act between different molecules.

Application:

Critical in material science, chemistry.

Formula:

$F = -kx$

16. SURFACE ENERGY

Overview:

Surface energy is the work done to increase the surface area of a liquid.

Application:

Crucial in understanding wetting, adhesion.

Formula:

$\text{Surface Energy} = \frac{\text{Work}}{\text{Area}}$

17. ANGLE OF CONTACT

Overview:

The angle of contact is the angle between the solid surface and the tangent to the liquid surface at the point of contact.

Application:

Influences capillary action.

Formula:

$\cos\theta = \frac{\text{Adhesive Force}}{\text{Cohesive Force}}$

18. CAPILLARITY

Overview:

Capillarity is the ability of a liquid to flow in narrow spaces against gravity.

Application:

Crucial in understanding groundwater movement, ink pens.

Formula:

$h = \frac{2T \cos \theta}{\rho g r}$

19. VISCOSITY

Overview:

Viscosity is a measure of a fluid's resistance to flow.

Application:

Important in fluid dynamics, oil industry.

Formula:

$\tau = \eta \frac{du}{dy}$

20. THERMAL EXPANSION

Overview:

Thermal expansion is the tendency of matter to change its shape, area, and volume due to a change in temperature.

Application:

Critical in construction, engineering.

Formula:

$\Delta L = \alpha L_0 \Delta T$

21. SPECIFIC HEAT AND HEAT CAPACITY

Overview:

Specific heat is the amount of heat energy required to raise the temperature of a unit mass of a substance by one degree Celsius.

Application:

Used in thermodynamics, cooking.

Formula:

$Q = mc\Delta T$

22. HEAT CONDUCTION

Overview:

Heat conduction is the transfer of heat through a material without any movement of the material itself.

Application:

Critical in designing thermal insulations, understanding material behavior.

Formula:

$Q = \frac{kA\Delta T}{d}$

23. HEAT RADIATION

Overview:

Heat radiation is the transfer of heat energy in the form of electromagnetic waves.

Application:

Crucial in understanding planetary temperatures, designing space equipment.

Formula:

$P = \varepsilon\sigma AT^4$

24. BASIC DEFINITIONS

Perfectly Black Body:

A theoretical object that absorbs all incident electromagnetic radiation.

Absorptive Power of a Surface:

Ratio of radiation absorbed by a surface to the incident radiation.

Kirchhoff's Law:

For a body in thermal equilibrium, its emissivity is equal to its absorptivity.

Stefan's Law:

Describes the power radiated by a black body in terms of its temperature.

Newton's Law of Cooling:

Rate of heat loss of a body is directly proportional to the temperature difference.

25. WIESEN DISPLACEMENT LAW

Overview:

Wien's Displacement Law relates the temperature of a black body to the peak wavelength of its emitted radiation.

Application:

Used in astrophysics, understanding the spectra of stars.

Formula:

$$\lambda_{\max} T = \text{constant}$$

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