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# POSTAL BOOK PACKAGE 2025

# CONTENTS

# CIVIL ENGINEERING

**Objective Practice Sets**

## Strength of Materials

# 1 CHAPTER
# Properties of Materials

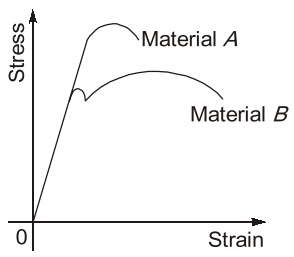
**Q.1** In a tensile test, near the elastic limit zone
(a) tensile stress increases at a faster rate
(b) tensile stress decreases at a faster rate
(c) tensile stress increases in linear proportion to the strain
(d) tensile stress decreases in linear proportion to the strain

**Q.2** Consider the following statements:
1. Mild steel is more elastic than rubber.
2. Young's modulus of a material is used to represent the elasticity of the material.
3. Greater the Young's modulus, greater the elasticity.

Which of the above statement(s) is/are correct?
(a) Only 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

**Q.3** Which of the following properties is more sensitive to increase in strain rate?
(a) Yield strength
(b) Elastic limit
(c) Proportional limit
(d) Tensile strength

**Q.4** The stress-strain diagram for two materials *A* and *B* is shown below:




The following statements are made based on this diagram:
I. Material *A* is more brittle than material *B*.
II. The ultimate strength of material *B* is more than that of *A*.

With reference to the above statements, which of the following applies?
(a) Both the statements are false
(b) Both the statements are true
(c) I is true but II is false
(d) I is false but II is true

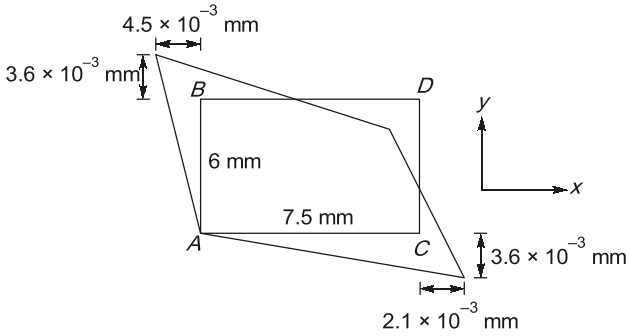
**Q.5** As soon as the external forces causing deformation in a perfectly elastic body, are withdrawn, the elastic deformation disappears
(a) only partially
(b) completely over a prolonged period of time
(c) completely and instantaneously
(d) completely after an initial period of rest

**Q.6** Which one of the following favours brittle fracture in a ductile material?
(a) Elevated temperature
(b) Slow rate of straining
(c) Presence of notch
(d) Circular cross-section

**Q.7** Consider the following statements:
1. Strain-softening region in stress strain curve is also known as post ultimate stress.
2. Logarithmic strain given as $\bar{\varepsilon} = \ln\left(\frac{L_f}{L_0}\right)$ is same as true strain.
3. Value of elastic modulus is a definite property of a material.

Which of the above statements is(are) INCORRECT?
(a) 1 and 3 (b) 2 only
(c) 1 only (d) None of these

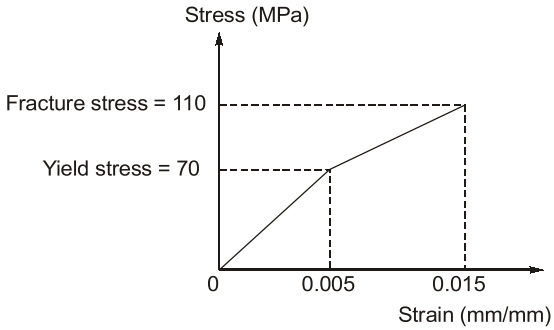
**Q.8** An initially rectangular element of a material is deformed as shown in figure. The shear strain for the element ($\gamma_{xy}$), will be




(a) $1370 \times 10^{-6}$ (b) $1500 \times 10^{-6}$
(c) $1230 \times 10^{-6}$ (d) $900 \times 10^{-6}$

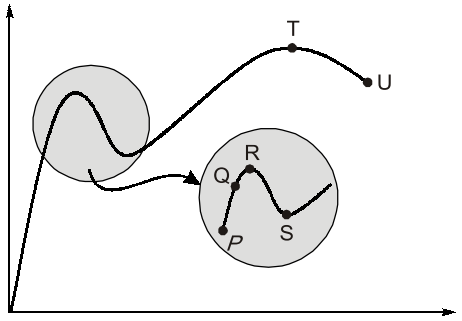
**Q.9** If $\in$ is engineering strain in a tensile specimen. The value of true strain ($\in_t$) is given as
(a) $\in$ (b) $e^{\in} - 1$
(c) $ln(1 + \in)$ (d) $\left(\frac{1-\in}{6}\right)$

**Q.10** The stress stain behaviour of a material is as shown in figure below. Its modulus of resilience and toughness in Nm/m$^3$ are respectively:




(a) $20 \times 10^4$ and $107.5 \times 10^4$
(b) $17.5 \times 10^4$ and $107.5 \times 10^4$
(c) $17.5 \times 10^4$ and $120 \times 10^4$
(d) $35 \times 10^4$ and $140 \times 10^4$

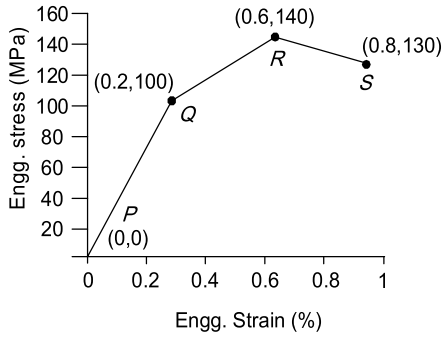
**Q.11** The stress-strain curve for mild steel is shown in figure given below. Choose the correct option referring to both figure and table.




| Point on the graph | Description of the point |
|---|---|
| P. | 1. Upper yield point |
| Q. | 2. Ultimate tensile strength |
| R. | 3. Proportionality limit |
| S. | 4. Elastic limit |
| T. | 5. Lower yield point |
| U. | 6. Failure |

(a) P–1, Q–2, R–3, S–4, T–5, U–6
(b) P–3, Q–1, R–4, S–2, T–6, U–5
(c) P–3, Q–4, R–1, S–5, T–2, U–6
(d) P–4, Q–1, R–5, S–2, T–3, U–6

**Q.12** A hypothetical engineering stress-strain curve shown in the figure has three straight lines *PQ*, *QR*, *RS* with coordinates *P*(0, 0), *Q*(0.2, 100), *R*(0.6, 140) and *S*(0.8, 130). *Q* is the yield point, *R* is the UTS point and *S* the fracture point.




The toughness of the material (in MJ/m$^3$) is_____.

**Q.13** Which of the following are incorrect statements?
1. Linear elastic range in compression in larger as compared to that in tension for most brittle materials.
2. The brittle fracture is performed by separation and is not accompanied by noticeable plastic deformation.

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

**Q.14** Which of the following pairs is not correctly matched?
(a) Visco-elastic: Small plastic zone
(b) Orthotropic material: Different properties in their perpendicular directions

(c) Strain hardening material: Stiffening effect at some stage
(d) Isotropic material: Same physical property in all direction at a point

**Q.15** Assuming a force of 18 kN is applied to a round metal test specimen with diameter of 9.6 mm. The original length of test specimen is 400 mm. Determine the engineering stress and strain at 401.5 mm

(a) $\sigma = 280$ MPa, $\varepsilon = 0.0037$ (b) $\sigma = 350$ MPa, $\varepsilon = 0.018$
(c) $\sigma = 200$ MPa, $\varepsilon = 0.002$ (b) $\sigma = 249$ MPa, $\varepsilon = 0.0037$

**Q.16** Which of the following pairs are correctly matched?

1. Resilience ... Resistance to deformation
2. Malleability ... Deformation under compressive load
3. Creep ... Progressive deformation
4. Plasticity.... Permanent deformation

Select the correct option using the codes below:

(a) 2, 3 and 4 (b) 1, 2 and 3
(c) 1, 3 and 4 (d) 3 and 4

**Q.17** Fatigue test is carried out for

(a) Stresses varying between two limits of equal value, but of opposite sign
(b) Stresses varying between two limits of unequal value but of opposite sign
(c) Stresses varying between two limits of unequal value but of same sign
(d) All are the correct

**Q.18** When plastic deformation occurs, then volume of a ductile specimen is essentially constant. If the initial radius of the specimen is $\frac{d_0}{2}$, then what will be the true strain when radius is $\frac{d}{2}$?

(a) $\varepsilon_t = 2\ln\left(\frac{d}{d_0}\right)$ (b) $\varepsilon_t = 2\ln\left(\frac{d_0}{d}\right)$
(c) $\varepsilon_t = \frac{1}{2}\ln\left(\frac{d_0}{d}\right)$ (d) $\varepsilon_t = \frac{1}{2}\ln\left(\frac{d}{d_0}\right)$

**Q.19** Steel has its yield strength of 400 N/mm$^2$ and modulus of elasticity of $2 \times 10^5$ MPa. Assuming the material to obey Hooke's law up to yielding, what is its proof resilience?

(a) 0.8 N/mm$^2$ (b) 0.4 N/mm$^2$
(c) 0.6 N/mm$^2$ (d) 0.7 N/mm$^2$

**Directions:** Each of the next items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

**Codes:**

(a) Both Statement (I) and Statement (II) are individually true; and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true; but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true; but Statement (II) is false
(d) Statement (I) is false; but Statement (II) is true

**Q.20** **Statement (I):** Strain is a fundamental behaviour of the material, while stress is a derived concept.

**Statement (II):** Strain does not have a unit while stress has a unit.

**Q.21** **Statement (I):** When a material is subjected to repeated tensile stress within elastic range, it is found that the material deteriorates and fractures after many but finite number of repeated application of stress.

**Statement (II):** The critical stress below which fluctuating stresses cannot cause a fatigue failure is termed as 'endurance limit'.

**Q.22** **Statement (I):** For a given mean stress, there is a limiting value of stress below which failure will not take place for infinite number of cycles, known as endurance limit.

**Statement (II):** When a structure is subjected to fluctuating stresses, the fracture occurs at value of stress much lower than that in case of static loading.

**Q.23** In mild steel specimens subjected to tensile test cycle, the elastic limit in tension is raised and the elastic limit in compression is lowered. This is called

(a) Annealing effect
(b) Bauschinger effect
(c) Strain rate effect
(d) Fatigue effect

**Q.24** The following observation refer to two metal specimens 'A' and 'B' of the same size subjected to uni-axial tension test upto failure.

1. The elastic strain energy of A is more than that of B.
2. Area under stress strain curve of A is less than that of B.
3. The yield strength of A is more than that of B.
4. The percentage elongation of A and B at elastic limit are equal.

Which of the following statements is true in this regard?

(a) Specimen A is more ductile than specimen B.
(b) Specimen B is more ductile than specimen A.
(c) The ductility of two specimens are equal.
(d) The data is insufficient to compare the ductilities of the two specimens.

**Q.25** A steel bar of length 3 m has yield stress 250 MPa and the slope of linear part of stress-strain curve is 190 GPa. The bar is loaded axially until it elongates 6 mm and then the load is removed. What is the residual strain in bar?

(a) 0.002 (b) 0.00131
(c) 0.00069 (d) None of these

**Q.26** Consider the following statements regarding tension test of a specimen:

1. Gauge length for specimen is $5.65\sqrt{A}$, where $A$ is cross-sectional area of specimen.
2. True rupture stress is much more than nominal rupture stress in specimen.
3. For steel specimen, proportionality limit is more than elastic limit.
4. Steel specimen breaks at ultimate stress.

Which of the above statements are CORRECT?

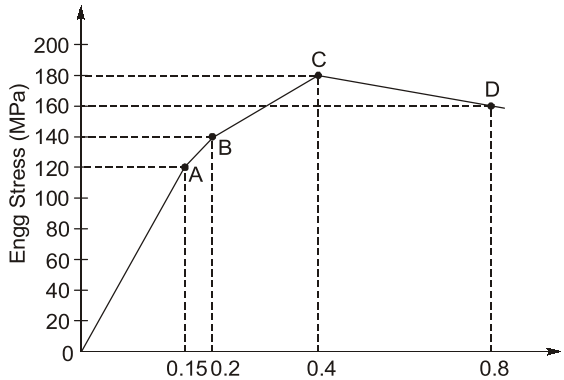
(a) 1 and 2 (b) 1 and 3
(c) 2, 3 and 4 (d) 3 and 4

## Multiple Select Questions (MSQ)

**Q.27** Consider the following statements with reference to ductile materials and choose the correct statement(s) :

(a) Large deformation is possible before absolute failure by rupture takes place.
(b) In ductile material, elastic deformation is more predominant than plastic one.
(c) Drawn permanently with great changes of shape without rupture.
(d) It can be beaten or rolled into plates.

**Q.28** A hypothetical engineering stress-strain curve is shown in figure below :




A → Elastic Limit; B → Yield Point
C → UTS Point; D → Fracture Point

With reference to the information given above, the correct statement(s) is/are :

(a) The resilience of the material is 0.09 MJ/m$^3$.
(b) The resilience of the material is 0.140 MJ/m$^3$.
(c) The toughness of the material is 1.14 MJ/m$^3$.
(d) The toughness of the material is 0.46 MJ/m$^3$.

**Q.29** Which of the following statement(s) is/are correct?

(a) The greatest strain energy stored in a body is called proof resilience.
(b) The quantity of strain energy stored in a body when strained upto elastic limit is called proof resilience.
(c) The least energy stored in a body is called proof resilience.
(d) Ability to absorb mechanical energy upto failure is called toughness.

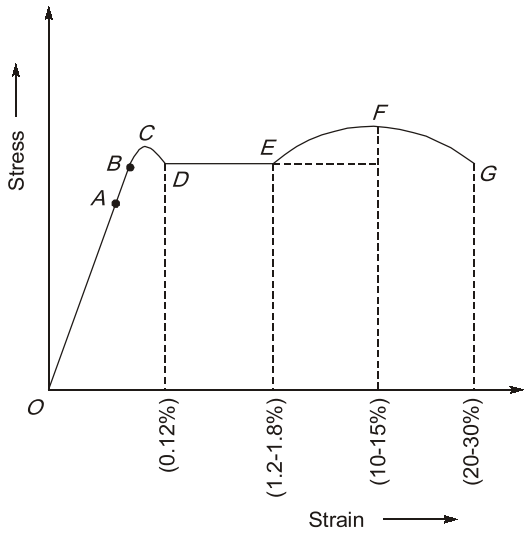
■■■■

## Answers Properties of Materials

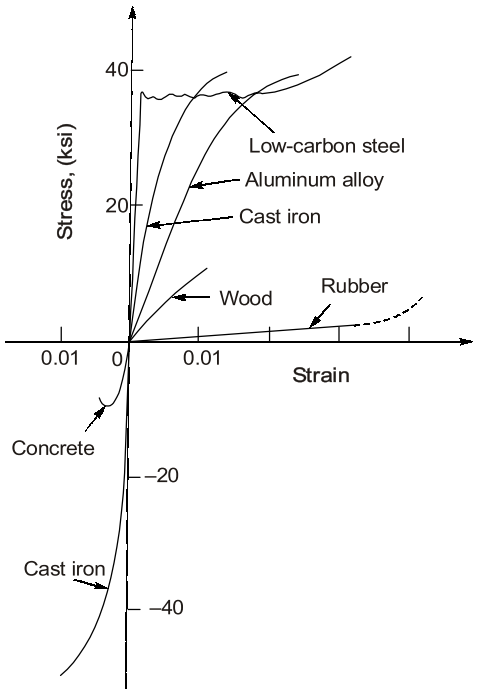
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. (c) | 2. (d) | 3. (b) | 4. (c) | 5. (c) | 6. (c) | 7. (c) | 8. (c) | 9. (c) | 10. (b) |
| 11. (c) | 12. 0.85 | 13. (d) | 14. (a) | 15. (d) | 16. (a) | 17. (d) | 18. (b) | 19. (b) | 20. (b) |
| 21. (b) | 22. (b) | 23. (b) | 24. (b) | 25. (c) | 26. (a) | 27. (a, c) | | 28. (a, c) | |
| 29. (a, b, d) | | | | | | | | | |

## Explanations Properties of Materials

1. (c)




2. (d)




4. (c)

Since strain in material *B* is more, hence it is more ductile than material *A* i.e., material *A* is more brittle than material *B*. Hence **statement I is true**. Material *A* can reach upto higher stress level hence ultimate strength of material *A* is more than that of material *B*. Hence **statement II is false**.

5. (c)

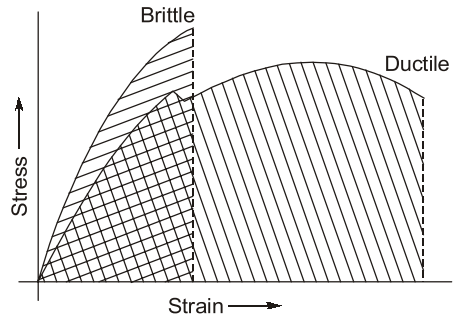
For perfectly elastic body, ideal deformation takes place. Ideal deformation means that the deformation takes place instantaneously upon application of force and disappears completely and instantaneously on the removal of force.

6. (c)

- When an elastic body of ductile material with a local geometrical irregularity such as on oil hole, a keyway or a notch is stressed, usually there is a localised variation in the stress state in the immediate neighbourhood of the irregularity.
- The peak stress level at the irregularity may be several times higher than the nominal stress levels in the bulk of the body.
- Under these circumstances the irregularity is said to cause a stress concentration. This leads to brittle fracture in the material.
- Also, the lower the temperature for a given steel, the greater the possibility that brittle fracture will occur.

**Key Points:**

- **Fracture :** The separation of a material into two or more pieces under the action of stress.
- Whether a material undergoes ductile fracture or a brittle fracture, it depends on the ability of the material to undergo plastic deformation before the fracture.




- **Brittle Fracture :** It is the sudden and rapid cracking of material under stress.
  - The material does not exhibits (or very little) evidence of ductility or plastic deformation.
  - It is often caused by low temperatures. If the steel temperature is at or below its brittle-to-ductile transition temperature, it will be susceptible to brittle fracture.
- **Ductile Fracture :** It is characterized by extensive plastic deformation or necking.
  - There is absorption of massive amounts of energy before fracture, unlike brittle fracture.

**7. (c)**

Strain-softening region in stress strain curve is also known as post ultimate stress.

**8. (c)**

The shear strain is angle of distortion (change in angle of a corner of element) measured in radian.

For corner A,

$$\gamma_{xy} = \frac{3.6\times10^{-3}}{7.5} + \frac{4.5\times10^{-3}}{6} = 1230\times10^{-6}$$

**9. (c)**

True strain for finite increment of loading such that length changes from $L_0$ to $L$ is given by

$$\in_t = \int_{l_0}^{L} \frac{dL}{L} = \ln\left(\frac{L}{L_0}\right)$$

$$\in_t = \ln\left(\frac{L_0+\delta}{L}\right) = \ln\left[1+\frac{\delta}{L_0}\right]$$

$$\in_t = \ln(1+\in)$$

**10. (b)**

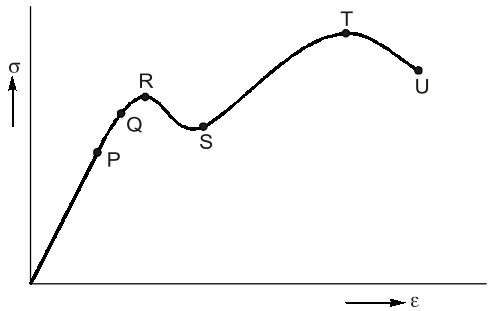
$$\text{Resilience} = \frac{1}{2}\times70\times0.005\times10^6$$

$$= 7.5\times10^4 \text{ Nm/m}^3$$

$$\text{Toughness} = 17.5\times10^4 + \left\{\frac{(70+110)}{2}\right\}\times0.01\times10^6$$

$$= 107.5\times10^4 \text{ Nm/m}^3$$

**11. (c)**




P : Proportional limit Q : Elastic limit
R : Upper Yield Point S : Lower Yield Point
T : Ultimate Tensile Strength
U : Failure/Rupture

**12. (0.85)**

Toughness is area of curve upto *S* on strain axis

$$\left[\frac{1}{2}\times\frac{0.2}{100}\times100\right] + \left\{\frac{[100+140]}{2}\times\frac{0.4}{100}\right\} + \left\{\frac{140+130}{2}\right\}\times\frac{0.2}{100}$$

= 0.1 + 0.48 + 0.27 = **0.85 MJ/m³**

**13. (d)**

**Brittle materials (in compression test):** Brittle material in compression typically an initial linear region followed by a region in which the shortening increases at a higher rate than does the load for cast iron, the shape may be like this: