SMART EDITION

1
VOLUME

CIVIL ENGINEERING

MCQ

Assistant Engineer & Junior Engineer

Strength of Materials • Structure Analysis
Design of Steel Structure • RCC Design

Complete in-Depth Solutions of All Question | Topic-wise Bifurcation of Questions
Also Useful for State-AE/JE, PSUs and PSCs Exams

ENGINEERS ACADEMY®
Your GATEway to Professional Excellence
IES • GATE • PSUs • JTO • IAS • NET

www.eapublications.org   + 91-80944 41777

Published by ENGINEERS ACADEMY®
Your GATEway to Professional Excellence
IES • GATE • PSUs • JTO • IAS • NET

Corporate Office: # 100-102, Ram Nagar, Bambala Puliya, Toll Tax,
Tonk Road, Pratap Nagar, Jaipur (Rajasthan)-302033
E-Mail : engineers.academy.india@gmail.com
Website : www.engineersacademy.org
Helpline Number : +91 8094441777

ISBN : 978-93-93531-23-0

First Edition : 2020
Second Edition : 2021
Third Edition : 2023

Price : ₹1000.00

Preface

This book has been written to meet the growing requirements of candidates appearing for State Engineering Service Examination, Junior Engineer, Public Sector Units, RRB-JE and Metro Exams. Though every candidate has ability to succeed but competitive environment, in-depth knowledge, quality guidance, time management and good source of study is required to achieve goals.

This book includes Multiple Choice Questions (MCQ Volume-I) which works as a mock exam practice for the reader. Questions of all the subject have been organized in systematic, concepts oriented and error less manner so that it become easy and interesting for even a beginner to understand. It is a very convenient book and must be solved by candidate aiming for competitive exams.

After solving this booklet students can feel encouraged and develop confidence to attempt each and every type of numerical as well as theoretical problems. Each problems explains solving approach so that at the end, so the reader is well equipped to be able to apply any type of problem solving requirement and distinctly choose one strategy or type from the other.

We hope this book will be proved an important tool to succeed in State Engineering Service Examination, Junior Engineer, Public Sector Units, RRB-JE and Metro Exams.

It is earnestly hoped that with the extensive additions and revisions, the present edition will facilitate the students not only in preparing themselves for competitive examinations but also in preparing for their regular examinations and prove more useful to the students than the earlier editions.

Even though, enough readings were given for correcting the error and printing mistakes, due to human tendency there could be some minor typos in the book. If any such typos found, they will be highly appreciated and incorporated in the next edition. Also, please provide your valuable suggestions at :engineers.academy.india@gmail.com

All the Best!

Engineers Academy Editorial Board

CONTENTS

S.No.	TOPIC	Page No.
1.	Strength of Materials	01 – 154
2.	Structure Analysis	155 – 242
3.	Design of Steel Structure	243 – 362
4.	RCC Design	363 – 510

UNIT-I

STRENGTH OF MATERIALS

1. Basic Properties and Stresses .... 03 – 33
2. Complex Stresses .... 34 – 47
3. SFD & BMD .... 48 – 71
4. Centroids and Moment of Inertia .... 72 – 79
5. Shear Stress in Beams .... 80 – 84
6. Torsion and Shear Centre .... 85 – 95
7. Slopes and Deflections .... 96 – 117
8. Thin and Thick Cylinders .... 118 – 122
9. Columns and Struts .... 123 – 134
10. Strain Energy and Spring .... 135 – 140
11. Bending and Combined Stresses 141– 154

NOTES

Basic Properties and Stresses

CHAPTER 1

OBJECTIVE QUESTIONS

1. Actual rupture stress is
(a) Breaking stress
(b) Maximum load/original cross-sectional area
(c) Load at breaking point/original cross-sectional area
(d) Load at breaking point/neck area

2. Elasticity of various materials is controlled by its
(a) Ultimate tensile stress
(b) Proof stress
(c) Stress at yield point
(d) Stress at elastic limit

3. Which of the following is proper sequence
(a) Proportional limit, elastic limit, yielding, failure
(b) Elastic limit, proportional limit, yielding, failure
(c) Yielding, proportional limit, elastic limit, failure
(d) None of the above

4. Ratio of direct stress to volumetric strain in case of a body subjected to three mutually perpendicular stress of equal intensity, is
(a) Young's modulus
(b) Bulk modulus
(c) Modulus of rigidity
(d) None of the above

5. If a material expands freely due to heating it will develop
(a) Thermal stresses (b) Tensile stress
(c) No stress (d) Bending

6. Unit of modulus of elasticity is same as those of
(a) Stress, strain and pressure
(b) Stress, force and modulus of rigidity
(c) Strain, force and pressure
(d) Stress, pressure and modulus of rigidity

7. Impact test enables one to estimate the property of
(a) Hardness (b) Toughness
(c) Strength (d) Creep

8. Proof stress
(a) Is the safest stress
(b) Causes a specified permanent deformation in a material, usually 0.1% or less
(c) Is used in connection with materials like mild steel
(d) Does not exist

9. In compression test, the fracture in cast iron specimen would occur along
(a) The axis of load
(b) An oblique plane
(c) At right angle to axis of specimen
(d) Would not occur

10. The extension of a bar of diameter d, length L and unit weight γ under the action of self weight is given by

(a) $\dfrac{\gamma L^3}{2E}$ (b) $\dfrac{6\gamma L^2}{E}$

(c) $\dfrac{\gamma L^2}{2E}$ (d) $\dfrac{\gamma L^4}{2E}$

11. A material subjected to reversal stresses does not fail at a stress known as
(a) Fatigue stress (b) Proof stress
(c) Safe stress (d) Endurance stress

12. The Bulk modulus K, the modulus of rigidity N and poisson's ratio 1/m are related by

(a) $\frac{1}{m}=\frac{9KN}{3K+N}$ (b) $\frac{1}{m}=\frac{3K-2N}{6K+2N}$

(c) $\frac{1}{m}=\frac{6K+2N}{3K-2N}$ (d) None of the above

13. The point at which extension of the material takes place more quickly as compared to the increase in load is called

(a) Elastic point of the material

(b) Ultimate point of the material

(c) Breaking point of the material

(d) Yield point of the material

14. Which of the following material is expected to have the least value of young's modulus of elasticity

(a) Wood (b) Copper

(c) Glass (d) Aluminium

15. A cube subjected to three mutually perpendicular stress of equal intensity p expenses a volumetric strain

(a) $\frac{3p}{E}\left(\frac{2}{m}-1\right)$ (b) $\frac{3p}{E}(2-m)$

(c) $\frac{3p}{E}\left(1-\frac{2}{m}\right)$ (d) $\frac{E}{3p}\left(\frac{2}{m}-1\right)$

16. Volumetric strain for a rectangular specimen of length l, breadth b and thickness t subjected to a pull of P is given by

(a) e(1 − 2m) (b) $e\left(1-\frac{2}{m}\right)$

(c) e(m − 2) (d) $e\left(\frac{2}{m}-1\right)$

Note : Notations have usual meaning

17. The intensity of stress which causes unit strain is called

(a) Unit stress (b) Modulus of rigidity

(c) Bulk modulus (d) Modulus of elasticity

18. A composite bar fixed at both ends made up of steel and copper bars of equal lengths are heated through 100°C. The stresses developed shall be

(a) Tensile in both the materials

(b) Tensile in steel and compressive in copper

(c) Compressive in steel and tensile in copper

(d) Compressive in both the materials

19. Limit of proportionality depends on

(a) Area of cross-section

(b) Type of loading

(c) Type of material

(d) All of the above

20. Percentage reduction of area in performing tensile test on cast iron may be of the order of

(a) 50% (b) 25%

(c) 0% (d) 15%

21. Ductility of which of the following is maximum?

(a) Mild steel (b) Cast iron

(c) Wrought iron (d) Pig iron

22. Elasticity of a M.S. specimen is defined by

(a) Hooke's law (b) Yield point

(c) Plastic flow (d) Proof stress

23. In a uniform bar supported at one end in position, the maximum stress under self weight of bar shall occur at the

(a) Middle of bar (b) Supported end

(c) Bottom end (d) None of the above

24. Temperature at which uncontrollable creep occurs is called

(a) Homologous temperature

(b) Homophobic temperature

(c) Halophobic temperature

(d) None of these

25. During the tensile test of a glass rod the nature of stress-strain curve is

(a) Straight and dropping

(b) Sudden break

(c) Straight line

(d) Parabolic

26. Order of strength in ductile material

(a) Tensile < shear < compressive

(b) Shear < Tensile < Compressive

(c) Compressive < Shear < Tensile

(d) Shear < Compressive < Tensile

27. Strain Rossettes are used to

(a) Produce strains for testing purpose

(b) Relieve strain in heavily loaded components

(c) Measure strain

(d) Analyse property of materials

28. Poisson's ratio for cork is

(a) 0 (b) 0.2

(c) 0.25 (d) None of the above

29. Longitudinal strain for a specimen is 0.01 and $\mu = 0.25$ it is found to undergo 1 mm change in its thickness. Its thickness will be

(a) 100 mm (b) 200 mm

(c) 400 mm (d) 800 mm

30. Tensile test is carried on _____ materials.

(a) Brittle (b) Malleable

(c) Ductile (d) Plastic

31. Ratio of elongation in a prismatic bar due to its own weight (W) as compared to another similar bar carrying an additional weight (W) will be

(a) 1 : 2 (b) 1 : 3

(c) 1 : 4 (d) 1 : 25

32. A vertical hanging bar of length l weight w kg/unit length and carries a load W at bottom. Tensile force at distance y from the support in the bar will be

(a) $W + w(l - y)$ (b) W

(c) $W + wl$ (d) $(w + W)\frac{y}{l}$

33. A non-yielding support implies that the

(a) Support is frictionless

(b) Support can take any amount of reaction

(c) Support holds member firmly

(d) Slope of the beam at the support is zero

34. Material which exhibit the same elastic properties at two different position is called

(a) Homogeneous (b) Inelastic

(c) Isotropic (d) Anisotropic

35. If a part is constrained to move and heated, it will develop

(a) Principal stress

(b) Tensile stress

(c) Compressive stress

(d) Shear stress

36. Most elastic material is

(a) Rubber (b) Plastic

(c) Brass (d) Steel

37. The value of modulus of elasticity for mild steel is of the order of

(a) 2.1×10^6 kg/cm^2

(b) 2.1×10^8 kg/cm^2

(c) 2.1×10^7 kg/cm^2

(d) 0.1×10^6 kg/cm^2

38. Number of independent elastic constant for an isotropic, homogeneous and elastic material obeying Hooke's law is

(a) 1 (b) 2

(c) 5 (d) 6

39. Two bars of copper and steel are heated. The ratio of expansion in copper and steel will be

(a) 1.33 (b) 0.5

(c) 2.0 (d) 2.5

40. Two bars have same width but one bar has double the depth of the other. The elastic stress of double depth bar compared to the other bar will be

(a) Four times (b) Half

(c) Eight times (d) Same

41. Proof resilience per unit volume of a material is known as

(a) Resilience (b) Proof resilience

(c) Toughness (d) Modulus of resilience

42. The elongation produced in a tapered shaft with end diameters d_1 and d_2 due to tensile or compressive axial load is proportional to

(a) $d_1 + d_2$ (b) $\frac{1}{d_1 + d_2}$

(c) $d_1 d_2$ (d) $\frac{1}{d_1 d_2}$

43. The deformation per unit length is called

(a) Tensile stress

(b) Compressive stress

(c) Shear stress

(d) Strain

[KPSC-JE, Punjab JE. - 2014]

44. A rectangular bar having cross section A, length L, modulus of elasticity E and Poisson's ratio 1/m, is subjected to axial pull of P. The volumetric strain will be given by :

(a) $\frac{PL}{AE}\left(1-\frac{2}{m}\right)$ (b) $\frac{P}{AE}\left(1-\frac{2}{m}\right)$

(c) $\frac{PL}{AE}\left(1-\frac{1}{m}\right)$ (d) $\frac{P}{AE}\left(1-\frac{1}{m}\right)$

[RPSC-VPITI - 2016]

45. The value of Poisson's ratio of the materials lie between: –

(a) 1 and 2 (b) 0 and 1/2

(c) 0 and 1 (d) 2 and 3

[RPSC-VPITI - 2016]

46. The value of stress up to which a member regains its original shape or size after load removal is called :

(a) Elastic limit (b) Proportional Limit

(c) Yield stress (d) Plastic limit

[RPSC-VPITI - 2016]

47. The stress above which a material fractures under large number of reversals of stress is called

(a) Creep (b) Ultimate strength

(c) Endurance limit (d) Residual stress

[RPSC, HPSC - 2014]

48. In a simple tension test, Hooke's law is valid up to the :

(a) Limit of proportionality

(b) Breaking point

(c) Ultimate point

(d) Yield point

[RPSC ACF - 2011, PEB-SUB ER. - 2017]

49. The ratio of young's modulus to modulus of rigidity for a material having poisson's ratio 0.2 is

(a) 2 (b) 2.4

(c) 2.8 (d) 3

50. The ratio of maximum load to the original area of cross-section is

(a) Strain (b) Ultimate stress

(c) Young's modulus (d) Unit stress

51. Choose the correct answer :

The ratio of shear stress and shear strain of an elastic material is

(a) Modulus of rigidity

(b) Shear modulus

(c) Young's modulus

(d) Both (a) and (b)

52. The ratio of longitudinal stress to longitudinal strain within elastic limit is known

(a) Target modulus of elasticity

(b) Bulk modulus of elasticity

(c) Shear modulus of elasticity

(d) Modulus of elasticity

[PEB-SUB ER. - 2017]

53. Proof Resilience is the

(a) Maximum energy stored at elastic limit of a material

(b) Minimum energy stored at elastic limit of a material

(c) Average energy stored at elastic limit of a material

(d) None of these

[GESCOM - AE]

54. Some structural members subjected to long time sustained loads deform progressively with time especially at elevated temperatures. What is such a phenomenon called?

(a) Fatigue (b) Creep

(c) Creep relaxation (d) Fracture

[KPSC - AE]

55. The ratio of total elongation of a bar of uniform cross-section produced under its own weight to the elongation produced by an external load equal to the weight of the bar is

(a) 1/4 (b) 1/2

(c) 1 (d) 2

[KPSC - AE]

56. Compressive test is carried on

(a) Ductile (b) Brittle

(c) Plastic (d) Malleable

57. The length, coefficient of thermal expansion and Young's modulus of bar 'A' are twice that of bar 'B' if the temperature of both bars is increased by the same amount while preventing any expansion, then the ratio of stress developed in bar A to that in bar B will be

(a) 2 (b) 4

(c) 8 (d) 16

[KPSC - AE]

58. A composite system where the components are of equal lengths is subjected to temperature rise. Which one of the following stresses will be developed in the component having highest coefficient of linear expansion?

(a) Compressive stress

(b) Tensile Stress

(c) Shear stress

(d) Zero stress

[KPSC - AE]

59. The stress necessary to initiate yielding is significantly

(a) Higher than that necessary to continue the same

(b) Lesser than that necessary to continue the same

(c) Higher than that necessary to stop the same

(d) Lesser than that necessary to stop the same

[KPSC - AE]

60. The value of the stress induced in a body, when it is suddenly loaded, is ______ times the stress induced when the same load is applied gradually.

(a) Equal to zero (b) One half

(c) Twice (d) Six times

[KPSC - JE, ISRO - 2013]

61. Hooke's law refer to stress and strain in the body holds true upto

(a) Elastic limit (b) Yield point

(c) Plastic limit (d) Breaking point

[KPSC - JE]

62. Ratio of lateral strain to linear strain is called _____

(a) Modulus of elasticity

(b) Modulus of rigidity

(c) Bulk modulus

(d) Poisson's ratio

[MPSC - 2012, KPSC-JE, GETCL - 2015]

63. Volumetric strain is defined as _________.

(a) $\frac{\partial V}{V}$ (b) $\frac{U}{\delta V}$

(c) $\frac{m}{\delta V}$ (d) $\frac{\delta V}{m}$

[KPSC-JE]

64. All forces meeting at a point are ________

(a) Concurrent (b) Non-concurrent

(c) Coplanar (d) Non-coplanar

[KPSC-JE]

65. Which of the following statements is true?

(a) Poisson's ratio of a metal is 1.2

(b) Unit of strain is mm.

(c) Product of modulus of elasticity and moment of inertia is flexural rigidity.

(d) For safety, factor of safety is less than 1.

[KPSC-JE]

66. When is the stress caused by a load transferred through one surface to another surface in contact called?

(a) Tensile stress (b) Transitive stress

(c) Shearing stress (d) None of the above

[KPSC-JE]

67. Stress is defined as

(a) Force per unit area

(b) Force per unit length

(c) Force per unit volume

(d) None of the above

[KPSC-JE]

68. What is the phenomenon of slow extension of materials having constant load, i.e. Increasing with the time called?

(a) Creeping (b) Yielding

(c) Breaking (d) None of these

[KPSC-JE]

69. The relationship between modulus of elasticity (E) and Bulk Modulus (k) and Poisson's ratio (μ) is

(a) E = 3k(1–2μ) (b) E = 3k(1+2μ)

(c) E = 3k(1–μ) (d) E = 3k(1+μ)

[PHED-RAJ., LMRC - 2018]

70. The material that has same properties in all directions is called

(a) Homogenous (b) Isotropic

(c) Elastic (d) Orthotropic

[RPSC ACF - 2011, PHED-RAJ.]

71. The relation between, E, G and K is where E-Young's modulus, G - modulus of rigidity, K - bulk modulus

(a) $E = \frac{G+3K}{3GK}$ (b) $E = \frac{3G+K}{9GK}$

(c) $E = \frac{G+3K}{9GK}$ (d) $E = \frac{9GK}{G+3K}$

72. Materials are generally classified as brittle if the percentage of elongation is less than

(a) 5% (b) 15%

(c) 25% (d) 40%

73. Energy stored in a material during its deformation is known as

(a) Elastic energy (b) Plastic energy

(c) Strain energy (d) Potential energy

74. If a composite bar of steel and brass is heated, then the brass bar will be under

(a) Tension (b) Compression

(c) Shear (d) Torsion

75. When a tensile or compressive force (P) acts on a body. If E is the young's modulus, A is cross-sectional area and l is the length, then the change in its length is given by

(a) $\frac{Pl}{AE}$ (b) $\frac{AE}{Pl}$

(c) $\frac{PE}{Al}$ (d) $\frac{PA}{lE}$

76. The rigidity modulus G, in terms of modulus of elasticity E and Poisson's ratio $\frac{1}{m}$ is given by

(a) $G = \frac{E}{2\left(1+\frac{1}{m}\right)}$ (b) $G = \frac{2E}{\left(1+\frac{1}{m}\right)}$

(c) $G = \frac{E}{2\left(1-\frac{1}{m}\right)}$ (d) $G = \frac{E}{\left(1-\frac{1}{m}\right)}$

193. A cylindrical bar of L meter deform axially by 'l' mm. the strain of bar is .

(a) $\frac{\ell}{L}$ (b) $0.1\frac{\ell}{L}$

(c) $0.001\frac{\ell}{L}$ (d) $100\frac{\ell}{L}$

[APPSC JE 2009]

194. A Load of 20,000 N is applied to a cylinder, 40m long and 10 mm diameter caused an extension of 0.8m and the diameter to decrease by 0.05m the Poisson's ratio of the material is

(a) 2.5 (b) 0.4

(c) 0.0625 (d) 0.25

[UPPSC JE 2009]

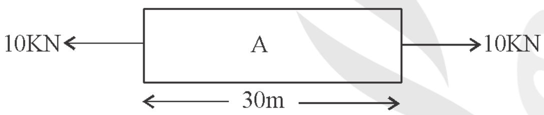
195. The ratio of ultimate creep strain to elastic strain is known as

(a) Creep - modules (b) Creep coefficient

(c) Creep - strain ratio (d) Territory creep

[DRDO 2009]

196. The total extension of the bar loaded as shown in the Figure is-



A = Area of cross section

E = Modulus of elasticity

(a) 10 × 30/AE (b) AE / 10 × 30

(c) 10/30 AE (d) 30/10 AE

[DRDO 2009]

197. A solid uniform bar of dia 'd' and length l is hanging vertically from it's free end. Elongation of the bar due to self weight is-

(a) Proportional to l and inversely proportional of d^2

(b) Proportional to l^2 and inversely proportional of d^2

(c) Proportional to l but independent of d

(d) Proportional to l^2 but independent of d

[DRDO 2009]

198. The independent elastic constants for a homogenous and isotropic material are.

(a) E,G, K, μ (b) E,G,K

(c) E,G, μ (d) E,G

[DRDO 2009]

199. A cable is cut to half of its original length. The maximum load which the cable can support would.

(a) Get reduced to half the value

(b) Become two - fold

(c) Remain unchanged.

(d) Data insufficient to make any comment

[DRDO 2009]

200. A square block is subjected to a state of simple shear the linear strain of the diagonal shall be equal to

(a) Two times the shear strain

(b) Thrice shear strain

(c) Half the shear strain

(d) One - fourth the shear strain

[HPPSC JE 2011]

201. A pull of 10 tonnes has been suddenly applied to rod of 10 cm^2 cross - sectional area. The maximum stress produced in the rod will be —

(a) 0.5 tonne/cm^2 (b) 1.0 tonne/cm^2

(c) 1.5 tonne/cm^2 (d) 2.0 tonne/cm^2

[DRDO 2009]

202. In the case of nailed laminated beam the maximum depth of the plank is limited to

(a) 0.2 cm (b) 2.5 cm

(c) 3.0 cm (d) 4.0 cm

[HP SSC JE 2015]

203. Which of the following is indeterminate

(a) Simply supported beam

(b) A propped cantilever with internal hinge

(c) Cantilever

(d) Beam with both ends fixed

[ISRO 2015]

204. If a ductile material is subjected to a unidirectional tensile force, then to avoid shear failure, the material should have its shear strength at least equal to

(a) Its tensile strength

(b) Half the tensile strength

(c) Its compressive strength

(d) Twice the tensile strength

[Rajasthan JE 2015]

205. Find the tensile stress of a mild steel rod of 18mm diameter. Given: ultimate load = 9.0 ton.

(a) 0.03 Ton/sq. mm (b) 0.02 Ton sq. mm

(c) 0.05 Ton /sq. mm (d) 0.06 Ton /sq. mm

[M.P. Sub Eng 2016]

206. Find the intensity of stress if a steel rod of 26.9 mm diameter and 4.5 m long is subjected to an axial pull of 55 kN :

(a) 96.77 N/mm^2 (b) 97.77 N/mm^2

(c) 98.77 N/mm^2 (d) 99.77 N/mm^2

[MP Sub Engg. 2016]

❑❑❑

ANSWERS AND EXPLANATIONS

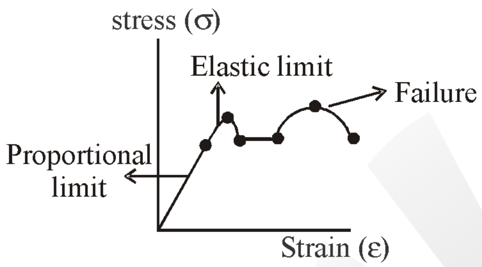
1. ***Ans. (d)***

Rupture stress is defined as the ratio of load at breaking point/neck area.

2. ***Ans. (d)***

Elasticity of various materials is controlled by its stress at elastic limit.

3. ***Ans. (a)***



4. ***Ans. (b)***

$$\text{Bulk modulus} = \frac{\text{direct stress}}{\text{volumetric strain}}$$

5. ***Ans. (c)***

If a material expands freely due to heating it will develop no stress because there is no resistive force.

6. ***Ans. (d)***

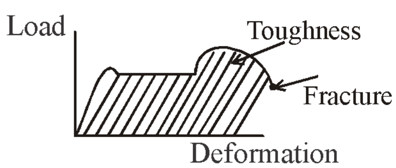
Unit of modulus of elasticity = N/mm^2

Stress unit $\rightarrow N/mm^2$

Pressure unit $\rightarrow N/mm^2$

Modulus of rigidity unit $\rightarrow N/mm^2$

7. ***Ans. (b)***



8. ***Ans. (b)***

9. ***Ans. (b)***

10. ***Ans. (c)***

11. ***Ans. (d)***

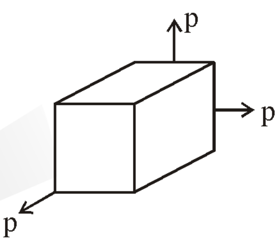
12. ***Ans. (b)***

$$E = 3K(1 - 2\mu)$$
$$E = 2G(1 + \mu)$$
$$3K(1 - 2\mu) = 2G(1 + \mu)$$
$$3K - 2G = \mu(2G + 6K)$$
$$\frac{3K-2G}{2G+6K} = \mu = \frac{1}{m}$$

13. ***Ans. (d)***

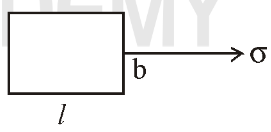
14. ***Ans. (a)***

15. ***Ans. (c)***



$$\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z \quad [\because \varepsilon_x = \varepsilon_y = \varepsilon_z]$$
$$= 3\left[\frac{p}{E} - \frac{\mu p}{E} - \frac{\mu p}{E}\right]$$
$$= 3\left[\frac{p}{E} - 2\mu\frac{p}{E}\right]$$
$$= \frac{3p}{E}[1 - 2\mu]$$

16. ***Ans. (b)***



$$\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$$
$$= \frac{\sigma}{E} - \frac{\mu\sigma}{E} - \frac{\mu\sigma}{E}$$
$$= \frac{\sigma}{E} - \frac{2\mu\sigma}{E}$$
$$= \varepsilon(1 - 2\mu)$$

17. ***Ans. (d)***

$$E = \frac{\sigma}{\varepsilon}$$

When, $\varepsilon = 1 \Rightarrow \sigma = E$

18. ***Ans. (b)***

19. ***Ans. (c)***

20. ***Ans. (c)***

21. ***Ans. (a)***

22. ***Ans. (a)***

23. ***Ans. (b)***

24. ***Ans. (a)***

25. ***Ans. (b)***

26. ***Ans. (b)***

27. ***Ans. (c)***

28. ***Ans. (a)***

29. ***Ans. (c)***

$$\mu\varepsilon_L = \varepsilon_t$$

$$0.25 \times 0.01 = \frac{1}{t}$$

$$t = \frac{1}{0.25 \times 0.01} = 400 \text{ mm.}$$

30. ***Ans. (c)***

31. ***Ans. (b)***

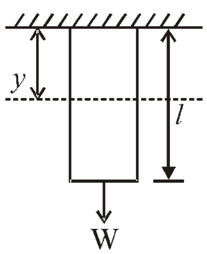
$$\Delta_1 = \Delta_{\text{self weight}} = \frac{\gamma L^2}{2E} = \frac{WL}{2AE}$$

$$\Delta_2 = \Delta_{\text{self weight}} + \Delta_{\text{additional weight}}$$

$$= \frac{WL}{2AE} + \frac{WL}{AE} = \frac{3}{2}\frac{WL}{AE}$$

$$\frac{\Delta_1}{\Delta_2} = \frac{\frac{WL}{2AE}}{\frac{3}{2}\frac{WL}{AE}} = \frac{1}{3}$$

32. ***Ans. (a)***



$F_T = W + w(l - y)$

33. ***Ans. (c)***

34. ***Ans. (a)***

35. ***Ans. (c)***

36. ***Ans. (d)***

37. ***Ans. (a)***

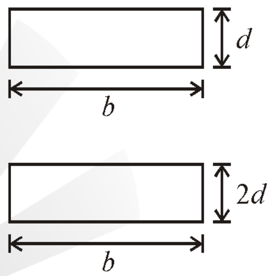
38. ***Ans. (b)***

No. of independent elastic constant = 2

39. ***Ans. (a)***

$$\frac{\Delta_C}{\Delta_S} = \frac{L\alpha_C \Delta T}{L\alpha_S \Delta T} = \frac{\alpha_C}{\alpha_S} = \frac{17 \times 10^{-6}}{13 \times 10^{-6}} = 1.31$$

40. ***Ans. (b)***



$P = \sigma_1 \times A_1$

$P = \sigma_2 \times A_2$

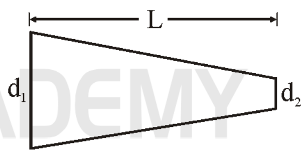
$$\sigma_1 \times \cancel{b} \times \cancel{d} = \sigma_2 \times \cancel{b} \times 2\cancel{d}$$

$$\boxed{\frac{1}{2} = \frac{\sigma_2}{\sigma_1}}$$

41. ***Ans. (d)***

Proof resilience per unit volume of a material is known as modulus of resilience.

42. ***Ans. (d)***



Elongation (δl) $= \dfrac{4PL}{\pi E d_1 d_2}$

43. ***Ans. (d)***

The deformation per unit length is called strain,

$$\text{strain} = \frac{\Delta}{L}$$

44. ***Ans. (b)***

45. ***Ans. (b)***

For engineering material $\rightarrow 0 \le \mu \le 0.5$

46. ***Ans. (a)***

47. ***Ans. (c)***

48. ***Ans. (a)***

49. ***Ans. (b)***

$$E = 2G \times (1 + \mu)$$

$$\frac{E}{G} = 2 \times (1 + \mu)$$

$$= 2 \times (1 + 0.2)$$

$$= 2.4$$

50. ***Ans. (b)***

51. ***Ans. (d)***

$$\text{Modulus of rigidity} = \frac{\text{Shear stress}}{\text{Shear strain}}$$

52. ***Ans. (d)***

$$\text{Modulus of elasticity} = \frac{\text{longitudinal stress}}{\text{longitudinal strain}}$$

53. ***Ans. (a)***

54. ***Ans. (b)***

55. ***Ans. (b)***

$$\frac{\frac{WL}{2AE}}{\frac{WL}{AE}} = \frac{1}{2}$$

56. ***Ans. (b)***

57. ***Ans. (b)***

$$\text{Strain}_A = \alpha_A \Delta T$$

$$\text{Strain}_B = \alpha_B \Delta T$$

$$\sigma_A = E_A \times \text{strain}_A$$

$$= E_A \times \alpha_A \times \Delta T$$

$$\sigma_B = E_B \times \alpha_B \times \Delta T$$

$$\frac{\sigma_A}{\sigma_B} = \frac{E_A \times \alpha_A \times \Delta T}{E_B \times \alpha_B \times \Delta T}$$

Since, $\alpha_A = 2\alpha_B$ and $E_A = 2E_B$

$$= \frac{2E_B \times 2\alpha_B \times \Delta T}{E_B \times \alpha_B \times \Delta T} = 4$$

58. ***Ans. (a)***

59. ***Ans. (a)***

60. ***Ans. (c)***

The value of the stress induced in a body, when it is suddenly loaded is two times the stress induced when the same load is applied gradually.

61. ***Ans. (a)***

Hooke's law holds true upto elastic limit

62. ***Ans. (d)***

$$\text{Poisson's ratio} = -\frac{\text{lateral strain}}{\text{linear strain}}$$

63. ***Ans. (a)***

$$\text{Volumetric strain} = -\frac{\text{Change in volume}}{\text{Original volume}}$$

64. ***Ans. (a)***

65. ***Ans. (c)***

66. ***Ans. (c)***

67. ***Ans. (a)***

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

68. ***Ans. (a)***

69. ***Ans. (a)***

70. ***Ans. (b)***

71. ***Ans. (d)***

$$E = 2G(1 + \mu)$$

$$E = 3K(1 - 2\mu)$$

$$2G(1 + \mu) = 3K(1 - 2\mu)$$

$$2G + 2G\mu = 3K - 6K\mu$$

$$2G - 3K = (-2G - 6K)\mu$$

$$\mu = \frac{2G - 3K}{-(2G + 6K)} = \frac{3K - 2G}{6K + 2G}$$

$$E = 2G\left(1 + \frac{3K - 2G}{6K + 2G}\right)$$

$$= 2G\left[\frac{6K + \cancel{2G} + 3K - \cancel{2G}}{6K + 2G}\right]$$

$$= \frac{\cancel{2}G(9K)}{\cancel{2}(3K + G)} = \frac{9KG}{3K + G}$$

72. ***Ans. (a)***

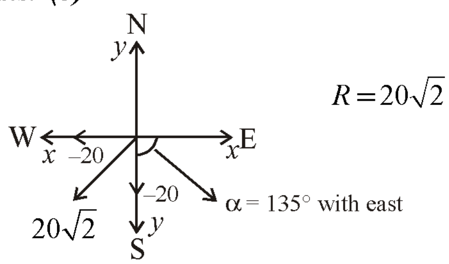
73. ***Ans. (c)***

74. ***Ans. (b)***

75. ***Ans. (a)***

76. ***Ans. (a)***

77. ***Ans. (b)***



78. ***Ans. (c)***

$$\text{Strain energy} = \frac{\sigma^2}{2\times E}\times\text{Volume}$$

$$= \frac{10^2}{2\times1\times10^5}\times10^5$$

$$= 100 \text{ N-mm}$$

79. ***Ans. (d)***

80. ***Ans. (a)***

$$\Sigma f_x = 0$$

$$P_1 + P_3 = P_2 + P_4$$

$$P_3 = 530 \text{ kN}$$

Net load at section of P_2 = 445 – 45

= 400 kN

$$\text{Maximum stress} = \frac{400\times1000}{200\times100}$$

$$= 20 \text{ N/mm}^2$$

81. ***Ans. (a)***

82. ***Ans. (c)***

83. ***Ans. (a)***

84. ***Ans. (a)***

85. ***Ans. (a)***

86. ***Ans. (a)***

87. ***Ans. (d)***

88. ***Ans. (a)***

$$D = 26.9 \text{ mm}$$

$$L = 4.5 \text{ m}$$

$$\text{Axial pull} = 55 \text{ kN}$$

$$\text{Tension intensity} = \sigma = \frac{55000}{\frac{\pi}{4}\times(26.9)^2}$$

$$= 96.7761$$

89. ***Ans. (b)***

90. ***Ans. (c)***

91. ***Ans. (a)***

92. ***Ans. (b)***

93. ***Ans. (a)***

94. ***Ans. (d)***

$$\text{Modulus of rigidity} = \frac{\text{shear stress}}{\text{shear strain}}$$

95. ***Ans. (c)***

$$\frac{\Delta L_1}{\Delta L_2} = \frac{3}{5}$$

$$\frac{\frac{PL}{AE_1}}{\frac{PL}{AE_2}} = \frac{3}{5}$$

$$\frac{E_2}{E_1} = \frac{3}{5}$$

$$\frac{E_1}{E_2} = \frac{5}{3}$$

96. ***Ans. (c)***

97. ***Ans. (c)***

$$G = \frac{E}{2(1+\mu)} = \frac{150}{2\times(1+0.25)}$$

$$= 60 \text{ GPa}$$

98. ***Ans. (b)***

99. ***Ans. (d)***

100. ***Ans. (b)***

$$\frac{\Delta d}{d} = \mu\frac{\Delta L}{L}$$

$$\frac{0.00018}{40} = \mu\times\frac{0.003}{200}$$

$$\mu = 0.30$$

101. ***Ans. (a)***

$$G = k$$

$$\Rightarrow \quad \frac{E}{2(1+\mu)} = \frac{E}{3(1-2\mu)}$$

$$\Rightarrow \quad 2 + 2\mu = 3 - 6\mu$$

$$\Rightarrow \quad 8\mu = 1$$

$$\Rightarrow \quad \mu = \frac{1}{8}$$

102. ***Ans. (b)***

103. ***Ans. (c)***

104. ***Ans. (d)***

105. ***Ans. (a)***

$$G = \frac{E}{2(1+\mu)}$$

$$G = \frac{2\times10^5}{2(1+0.3)}$$

$$G = 76923.07 \text{ N/mm}^2$$

106. ***Ans. (c)***

$$\Delta l_1 = \frac{T\times l}{\frac{\pi}{4}\times(2)^2\times E},$$

$$\Delta l_2 = \frac{T\times l}{\frac{\pi}{4}\times(3)^2\times E}$$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{\dfrac{Tl}{\frac{\pi}{4}\times E\times 2^2}}{\dfrac{Tl}{\frac{\pi}{4}\times E\times 3^2}}$$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{9}{4}$$

107. ***Ans. (c)***

$$\delta = \frac{PL}{AE}$$

$$\Rightarrow \quad E = \frac{PL}{A\delta}$$

108. ***Ans. (a)***

109. ***Ans. (d)***

$$E = 2G(1+\mu)$$

$$200 = 2\times 80(1+\mu)$$

$$\mu = \frac{200}{2\times80} - 1$$

$$\mu = 0.25$$

110. ***Ans. (d)***

$$U = \frac{1}{2}\times W\times\delta$$

$$U = \frac{1}{2}\times W\times\frac{WL}{AE}$$

$$U = \frac{W^2L}{2AE}$$

111. ***Ans. (b)***

112. ***Ans. (b)***

113. ***Ans. (b)***

$$\Delta_{\text{self weight}} = \frac{WL}{2AE}$$

$$\Delta_{\text{load}} = \frac{PL}{AE}$$

$$\text{Total elongation} = \frac{WL}{2AE} + \frac{PL}{AE}$$

114. ***Ans. (c)***

115. ***Ans. (c)***

116. ***Ans. (c)***

117. ***Ans. (d)***

118. ***Ans. (c)***

119. ***Ans. (d)***

120. ***Ans. (c)***

121. ***Ans. (c)***

122. ***Ans. (d)***

123. ***Ans. (c)***

124. ***Ans. (d)***

125. ***Ans. (a)***

The thermal stress developed is = αtE

126. ***Ans. (c)***

$$\text{Permanent Strain} = 0.0080 - 0.0015$$
$$= 6.5 \times 10^{-3}$$

$$\text{Modulus of Elasticity} = \frac{\text{Stress}}{\text{Strain}}$$

$$= \frac{450}{6.5\times10^{-3}}$$

$$= 0.692 \times 10^{5}\ \text{N/mm}^2$$

127. ***Ans. (d)***

According to Hooke's law

$$\text{Stress} \propto \text{Strain}$$
$$\sigma = \varepsilon E$$

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

Maximum Shear Stress

$$= \frac{\sigma_1 - \sigma_2}{2} = \frac{\sigma_0}{2}$$

$$\begin{Bmatrix} \sigma_2 = 0 \\ \sigma_1 = \sigma_0 \end{Bmatrix}$$

$$\text{Strain Energy} = \frac{1}{2}\times\text{Stress}\times\text{Strain}\times\text{Volume}$$

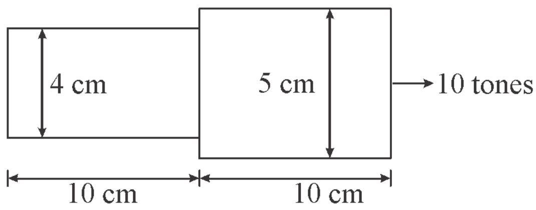
$$= \frac{1}{2}\times\frac{\sigma_0}{E}\times\sigma_0\times\text{Volume}$$

$$= \frac{\sigma_0^2}{2E}\times\text{Volume}$$

128. ***Ans. (d)***

$$E = 2G \quad \text{(Given)}$$
$$E = 2G(1+\mu)$$
$$2G = 2G(1+\mu)$$
$$\mu = 0$$

129. ***Ans. (b)***



$$\Delta = \Delta_1 + \Delta_2$$

$$= \left(\frac{PL}{AE}\right)_1 + \left(\frac{PL}{AE}\right)_2$$

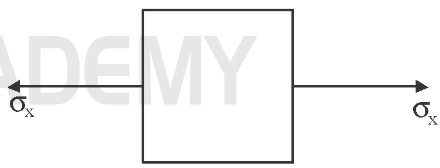
$$= \frac{10\times10^3\times10}{\frac{\pi}{4}(4)^2\times2\times10^6} + \frac{10\times10^3\times10}{\frac{\pi}{4}(5)^2\times2\times10^6}$$

$$= \frac{10^5}{10^6\times\frac{\pi}{4}\times2}\left[\frac{1}{16}+\frac{1}{25}\right]$$

$$= \frac{2}{10\pi}\left[\frac{1}{16}+\frac{1}{25}\right]$$

130. ***Ans. (b)***

(i)



$$\varepsilon_x = \frac{\sigma_x}{E}$$

$$\varepsilon_y = -\mu[\varepsilon_x] = -\mu\frac{\sigma_x}{E}$$

$$\varepsilon_z = -\frac{\mu\sigma_x}{E}$$

(ii) $\varepsilon_x + \varepsilon_y + \varepsilon_z = \varepsilon_v$

131. ***Ans. (d)***

Since brittle materials have minimum tensile strength. Hence, brittle materials fail in tension.

Hence brittle material subjected to torsion fails at 45° Plane (Helicoidal failure).

132. ***Ans. (a)***

$$\text{Stress} = \frac{P}{A} = \frac{100}{20\times20\times10^{-3}\times10^{-3}}$$

$$= 2{,}50{,}000 \text{ kN/m}^2$$

133. ***Ans. (c)***

Hooke's law holds up to the proportional limit.

$$\text{Stress} \propto \text{Strain}$$

$$\sigma = E\varepsilon$$

So, Hooke's law equally holds good for tension as well as compression.

134. ***Ans. (a)***

$$\Delta = \frac{PL}{AE}$$

$$A = \frac{PL}{\Delta E}$$

$$= \frac{20\times10^3\times1}{10^{-3}\times1.5\times200\times10^9}$$

$$= 6.67\times10^{-8} \text{ m}^2$$

$$= 66.67 \text{ mm}^2$$

135. ***Ans. (c)***

$$\sigma = \frac{P}{A}$$

$$= \frac{40\times10^3}{100\pi}\frac{N}{mm^2}$$

$$= 127.32 \text{ MPa}$$

136. ***Ans. (d)***

$$a^2 = 2500$$

$$a = 50 \text{ mm}$$

$$\mu = \frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$

$$= \frac{0.00625\times100}{50\times0.05}$$

$$= 0.25$$

137. ***Ans. (a)***

The young's modulus of high tensile steel and mild steel is same i.e. 200 GPa.

$$\frac{E_{\text{high tensile steel}}}{E_{\text{mild steel}}} = 1$$

138. ***Ans. (b)***

139. ***Ans. (d)***

$$\Delta = \frac{PL}{AE}$$

$$= \frac{250000\times40\times10^3\times10^3}{2.14\times10^8\times(10^3)^2}$$

$$= 0.0467 \text{ mm}$$

140. ***Ans. (a)***

- To define the yield strength, stress at the point of unloading that corresponds to a strain of 0.002 is used.
- This method of determining the yield strength is called the 0.2% offset method.

141. ***Ans. (a)***

Extensometer is a device that is used to measure changes in the length of an object.

142. ***Ans. (b)***

If the deforming force acts tangentially or parallel to the surface of the body, then it is known as shearing resistance.

143. ***Ans. (a)***

If a material is loaded beyond elastic limit, it will undergo permanent deformation. After unloading the material, the elastic strain will be recovered but the plastic strain will remain. This is called a permanent set.

144. ***Ans. (a)***

145. ***Ans. (c)***

$$\text{Stress} = \frac{P}{A}$$

$$95 \times 10^6 \frac{N}{m^2} = \frac{4000N}{\frac{\pi}{4}(d)^2}$$

$$d = 7.32 \text{ mm}$$

146. ***Ans. (b)***

When the tensile force is subjected to the body, it gets elongated and its strain is positive.

147. ***Ans. (c)***

$$E = \frac{PL}{A\Delta\ell}$$

$$\frac{\Delta\ell}{L} = \alpha\Delta T$$

$$E = \frac{P}{A\alpha\Delta T}$$

$$P = EA\alpha\Delta T$$

$$E_1 A\ \alpha_1\ \Delta T = E_2 A\ \alpha_2\ \Delta T$$

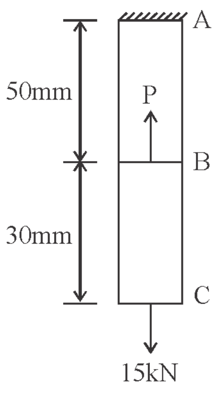
$$\frac{2}{3} = \frac{E_2}{E_1}$$

$$\frac{E_1}{E_2} = \frac{3}{2}$$

148. ***Ans. (d)***

The factors to determine the deformations produced by a stress system acting on the material with in elastic limits are constants so, the stress developed due to external force in an elastic material does not depend on the elastic constant.

149. ***Ans. (a)***



$$\delta_{AB} + \delta_{BC} = 0$$

$$\frac{-(P-15)\times 50}{AE} + \frac{15 \times 30}{AE} = 0$$

$$-5P + 75 + 45 = 0$$

$$5P = 120$$

$$P = 24 \text{ kN}$$

150. ***Ans. (d)***

$$\Delta = \frac{PL}{AE} = \frac{40 \times 10^3 \times 1000}{100 \times 2 \times 10^5}$$

$$= 2 \text{ mm}$$

151. ***Ans. (d)***

$$\text{Compressive strain} = \frac{-\delta\ell}{\ell}$$

152. ***Ans. (a)***

$$\mu = \frac{\text{lateral strain}}{\text{longitudinal strain}}$$

$$= \frac{\frac{\Delta D}{D}}{\frac{\Delta\ell}{\ell}} = \frac{\frac{0.0045}{30}}{\frac{0.09}{200}}$$

$$= 0.33$$

153. ***Ans. (a)***

154. ***Ans. (a)***

The endurance limit of a material is defined as the stress below which a material can endure an infinite number of repeated load cycles without exhibiting failure.

155. ***Ans. (c)***

$$\Delta = \frac{PL}{AE}$$

$$\frac{\Delta}{L} = \text{Strain} = S$$

$$E = \frac{PL}{A\Delta} = \frac{P}{AS} = \frac{W}{AS}$$

156. ***Ans. (b)***

The order will be proportional limit, elastic limit, upper yield point, lower yield point, ultimate tensile strength, failure.

157. ***Ans. (b)***

We can find the change in length or longitudinal elongation by the formula

$$\Delta L = \frac{PL}{AE}$$

For this we required E. and to find a decrease in the diameter of rod we need to know Poission's ratio. From the relation E = 2G (1 + μ)

We can calculate Poission's ratio if we know shear modulus and young's modulus.

158. ***Ans. (a)***

Hooke's law is valid upto the limit of proportionality.

159. ***Ans. (b)***

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

Stress = $50 \times 10^3 \times 10 \times 10^{-4} = 50$ MPa

160. ***Ans. (b)***

$$\text{Stress} = \frac{P}{A} = \frac{58 \times 10^3}{\frac{\pi}{4}\left(7 \times 10^{-2}\right)^2}$$

$$= 15.07 \text{ Mpa}$$

161. ***Ans. (b)***

$$\text{Strain} = \frac{\Delta}{L} = \frac{11.5 - 10}{10} = 0.15$$

162. ***Ans. (d)***

163. ***Ans. (a)***

Extension of bar,

$$\delta l = \frac{PL}{tE\left(b_1 - b_2\right)} \log_e\left(\frac{b_1}{b_2}\right)$$

$$= \frac{40 \times 10^3 \times 2.8 \times 1000}{15 \times 2 \times 10^6 \times (75 - 30)} \log_e\left(\frac{75}{30}\right)$$

$$= 0.076 \text{ mm}$$

164. ***Ans. (a)***

$$\frac{\Delta V}{V} = \epsilon_x + \epsilon_y + \epsilon_z$$

165. ***Ans. (a)***

166. ***Ans. (a)***

167. ***Ans. (a)***

168. ***Ans. (d)***

169. ***Ans. (c)***

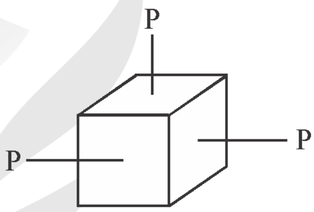
$$\Delta_T = \Delta_1 + \Delta_2 + \Delta_3$$

$$= \frac{PL}{AE} + \frac{PL}{2AE} + \frac{PL}{AE}$$

$$= \frac{2PL}{AE} + \frac{1}{2}\frac{PL}{AE}$$

$$= \frac{5}{2}\frac{PL}{AE}$$

170. ***Ans. (c)***



$$\epsilon_V = \epsilon_x + \epsilon_y + \epsilon_z$$

$$= 3\epsilon_x$$

171. ***Ans. (d)***

According to Hooke's low

Stress μ Strain

$$\sigma \propto \varepsilon$$

$$\sigma = E\varepsilon$$

$$E = \frac{\sigma}{\varepsilon} = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta l/l},$$

or $$\Delta l = \frac{F\ell}{AE}$$

172. ***Ans. (b)***

Young's modulus depends upon the composition of material. It does not depend upon type of loading.

173. ***Ans. (b)***

The elastic limit of brittle materials is comparatively low, there is no yield point in brittle materials.

174. ***Ans. (b)***

The phenomenon of necking is found in ductile materials like mild steel.

175. ***Ans. (a)***

When change in length occurs in the direction of applied load, the strain is known as linear strain/ longitudinal strain and if change in length takes place perpendicular (normal) to the direction of applied load. The strain is called lateral strain

176. ***Ans. (b)***

Longitudinal strain

$$\varepsilon_1 = \frac{\Delta l}{l} = \frac{l_2 - l_1}{l_1}$$

$\because$ $l_2 = 2l_1$

$$\varepsilon_1 = \frac{2l_1 - l_1}{l_1} = 1.0$$

177. ***Ans. (c)***

Poisson's ratio $= -\dfrac{\text{lateral strain}}{\text{linear strain}}$

lateral strain = strain normal to applied load = e_y

linear strain = strain in the direction of applied load = e_x

$\therefore$ $$\mu = -\frac{e_y}{e_x}$$

178. ***Ans. (c)***

$$\Delta l = \frac{Pl}{AE}, \; E = \frac{Pl}{A \times \Delta l}$$

$\because$ $P/A = \sigma$ = stress

$\because$ $$e = \frac{\Delta l}{l} = \text{strain}$$

$\because$ $$E = \frac{P}{A \times e} = \frac{\text{Force}}{\text{Area} \times \text{strain}}$$

179. ***Ans. (b)***

$$\Delta l = (\Delta l)_1 + (\Delta l)_2 + (\Delta l)_3$$

$$\Delta l = \frac{P_1 l_1}{A_1 E_1} + \frac{P_2 l_2}{A_2 E_2} + \frac{P_3 l_3}{A_3 E_3}$$

$P_1 = 10T$, $P_2 = 7T$ $P_3 = 9T$

$A_1 = A_2 = A_3 = A$,

$E_1 = E_2 = E_3 = E$

$$\Delta l = \frac{1}{AE}(P_1 l_1 + P_2 l_2 + P_3 l_3)$$

$$\Delta l = \frac{1}{AE}(10\times10 + 7\times10 + 9\times10)$$

$$\Delta l = \frac{26\times10}{AE}\text{m.m}$$

180. ***Ans. (c)***

For composite bar

(A) $P_{total} = P_{steel} + P_{Al}$

$1200 = \sigma_{steel} \times A_{steel} + \sigma_{Al} \times A_{Al}$

$\because$ $A_{steel} = A_{Al} = 3cm^2 = 300mm^2$

$\therefore$ $1200 = 300\,(\sigma_{steel} + \sigma_{Al})$ - (1)

(B) $(\Delta l)_{steel} = (\Delta l)_{Al}$

$$\frac{\sigma_{steel} l_{steel}}{E_{steel}} = \frac{\sigma_{Al} \times l_{Al}}{E_{Al}}$$

$(\because l_{steel} = l_{Al})$ $$\frac{\sigma_{steel}}{E_{steel}} = \frac{\sigma_{Al}}{E_{Al}}$$

$$\sigma_{steel} = \frac{\sigma_{Al}}{e_{Al}} \times E_{steel} = \frac{\sigma_{Al}}{E_{Al}} \times 3E_{Al}$$

$$\sigma_{steel} = 3\sigma_{Al} \qquad \ldots(2)$$

Substituting in (1)

$$\frac{12000}{300} = 3\sigma_{steel} + \sigma_{Al}$$

$$\sigma_{A1} = \frac{12000}{300\times4}, \quad \sigma_{A1} = 10\frac{N}{mm^2}$$

Substituting in (2)

$$\sigma_{steel} = 3\times10 = 30\frac{N}{mm^2}$$

181. ***Ans. (b)***

$$\Delta l = \frac{4Wl}{\pi E d_1.d_2}$$

$$E = \frac{4Wl}{\Delta l\times\pi\, d_1 d_2}$$

$$= \frac{4\times5.5\times10^3\times350}{0.025\times3.14\times30\times15}$$

$$E = 2.18\times10^5\ N/mm^2$$

182. ***Ans. (d)***

No stress is developed because stress is resistance per unit area and there is no resistance.

183. ***Ans. (d)***

Thermal stress $\boxed{\sigma_{th} = f(\alpha, \Delta t, E)}$

184. ***Ans. (a)***

185. ***Ans. (d)***

186. ***Ans. (a)***

$$\text{Bulk modulus (K)} = \frac{\text{Normal stress}}{\text{Volumetric strain}}$$

187. ***Ans. (a)***

$$E = 2G(1+\mu)$$

$$200 = 2G(1+0.25)$$

$$G = \frac{200}{2\times1.25}, \quad G = 80\ kN/m^2$$

188. ***Ans. (d)***

$$E = 2G(1+\mu)$$

$$E = 2\times100(1+0.25) = 200\times1.25$$

$$E = 250\ GPa$$

189. ***Ans. (c)***

$$E = 2G(1+\mu)$$

$$E = \frac{E}{G}2(1+0.4) = 2\times1.4 = 2.8$$

$$\frac{E}{G} = 2.8 = \frac{14}{5}$$

190. ***Ans. (c)***

191. ***Ans. (b)***

$$\Delta l = \frac{Wl}{2AE} = \frac{wl^2}{2E}$$

$\because$ $w = \text{specific weight} = \rho g = \frac{W}{V}$

$\because$ $W = w\times V$

$\therefore$ $\Delta l = \frac{w\times Vl}{2AE} = \frac{(\rho g)\times(A\times l)\times l}{2AE}$

$$\Delta l = \frac{\rho g l^2}{2E}, \quad g = 9.81\frac{m}{sec^2}$$

$$\Delta l = \frac{9.8 l\rho l^2}{2E}$$

192. ***Ans. (c)***

In a rigid body modulus of elasticity is equal infinite because in it value of strain is zero.

193. ***Ans. (c)***

Length of cylindrical bar = L meter deformation due to axially load = l mm.

$$\text{Then strain} = \frac{\text{elongatinon in length}}{\text{Initial length of Rod}}$$

$$= \frac{\ell\ mm}{L\ m} = \frac{\ell}{1000L}\ \text{OR}\ 0.001\left(\frac{\ell}{L}\right)$$

194. ***Ans. (d)***

$$\text{lateral strain} = \Delta d/d = \left(\frac{0.05}{10}\right) = 0.005$$

Longitudinal strain $= \Delta l/l = (0.8/40) = 0.02$

$$\text{Poisson ratio} = \frac{\text{lateral strain}}{\text{longitudnal strain}}$$

$$\mu = \frac{0.005}{0.02} = 0.25$$

195. ***Ans. (b)***

196. ***Ans. (a)***

197. ***Ans. (d)***

198. ***Ans. (d)***

199. ***Ans. (c)***

200. ***Ans. (c)***

201. ***Ans. (d)***

Maximum stress induced due to suddenly applied load

$$\sigma = 2\frac{W}{A}, \sigma = \frac{2\times10}{10},$$

$$\sigma = 2\frac{\text{tonne}}{\text{cm}^2}$$

202. ***Ans. (b)***

203. ***Ans. (d)***

204. ***Ans. (b)***

205. ***Ans. (a)***

206. ***Ans. (a)***

❑❑❑