GATE SOLUTIONS
CIVIL ENGINEERING

IES MASTER PUBLICATION

Office: F-126, (Lower Basement), Katwaria Sarai, New Delhi-110 016
Phone: 011-26522064 ▪ **Mobile:** 81309 09220, 97118 53908
Email: info.publications@iesmaster.org, info@iesmaster.org
Web: iesmasterpublications.com, iesmaster.org

IES MASTER PUBLICATION

F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016

Phone : 011-26522064, **Mobile :** 8130909220, 9711853908

E-mail : info.publications@iesmaster.org

Web : iesmasterpublications.com

First Edition : 2016

Second Edition : 2017

Third Edition : 2018

Fourth Edition : 2019

Fifth Edition : 2020

Sixth Edition : 2021

Seventh Edition : 2022

Typeset at : IES Master Publication, New Delhi-110016

PREFACE

The Graduate Aptitude Test in Engineering (GATE) is an All-India examination administered and conducted in eight zones across the country by the GATE Committee comprising of Faculty members from IISc, Bangalore and other seven IITs on behalf of the National Coordinating Board, Department of Education, Ministry of Human Resources Development.

The GATE score/rank is used for admissions to Post Graduate Programmes (ME, M.Tech, MS, direct PhD) in institutes like IIT and IISc, etc. with financial assistance offered by the Ministry of Human Resource Development. PSUs too use the GATE scores for recruiting candidates for various prestigious jobs with attractive remuneration.

The door to GATE exam is through previous year question papers. If you are able to solve question papers in access of 10 years, you are sure to clear the GATE exam, and open new vistas of career and learning.

The **Civil Engineering GATE 2023** book from IES Master offers detailed topic-wise solutions for the past **36 years** question papers. The emphasis is clearly on the understanding of concepts and building upon a holistic picture. So as you finish a topic, for instance, Strength of Materials, you will find all the previous years' question papers with detailed explanation under that particular topic.

The approach has been to provide explanation in such a way that just by going through the solutions, students will be able to understand the basic concepts and will apply these concepts in solving other questions that might be asked in future exams.

Every care has been taken to bring an error-free book. However, comments, suggestions, and feedback for improvement in the future editions are most welcome.

IES Master Publication
New Delhi

CONTENT

1 STRENGTH OF MATERIAL

1– Mark

1. For a linear elastic and isotropic material, the correct relationship among Young's modulus of elasticity (E), Poisson's ratio (v), and shear modulus (G) is

(a) $G = \frac{E}{2(1+v)}$ (b) $G = \frac{E}{2(1+2v)}$

(c) $E = \frac{G}{2(1+v)}$ (d) $E = \frac{G}{2(1+2v)}$

[GATE–2022 SHIFT-II]

2. Strain hardening of structural steel means.

(a) decrease in the stress experienced with increasing strain

(b) Experiencing higher stress than yield stress with increased deformation

(c) strain occurring before plastic flow of steel material

(d) Strengthening steel member externally for reducing strain experienced.

[GATE–2021 SHIFT-II]

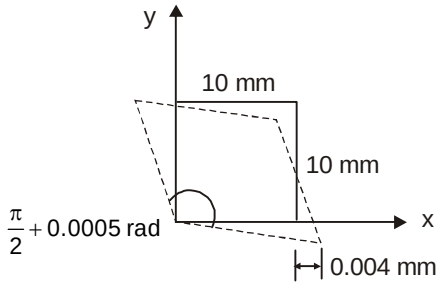
3. An elastic bar of length L, uniform cross sectional area A, coefficient of thermal expansion α and Young's modulus E is fixed at the two ends. The temperature of the bar is increased by T, resulting in an axial stress σ. Keeping all other parameters unchanged, if the length of the bar is doubled, the axial stress would be

(a) σ (b) 2σ

(c) 0.5σ (d) $0.25\ \alpha\sigma$

[GATE–2017 SHIFT-I]

4. In a material under a state of plane strain, a 10 × 10 mm square centred at a point gets deformed as shown in the figure.



If the shear strain γ_{xy} at this point is expressed as 0.001 k (in rad.) the value of k is

(a) 0.50 (b) 0.25

(c) –0.25 (d) –0.50

[GATE–2017 SHIFT-II]

5. The creep strains are

(a) caused due to dead loads only

(b) caused due to live loads only

(c) caused due to cyclic loads only

(d) independent of loads

[GATE–2013]

6. The Poisson's ratio is defined as

(a) $\left|\frac{\text{axial stress}}{\text{lateral stress}}\right|$ (b) $\left|\frac{\text{lateral strain}}{\text{axial strain}}\right|$

(c) $\left|\frac{\text{lateral stress}}{\text{axial stress}}\right|$ (d) $\left|\frac{\text{axial strain}}{\text{lateral strain}}\right|$

[GATE–2012]

7. The number of independent elastic constant for a linear elastic isotropic and homogeneous material is

(a) 4 (b) 3

(c) 2 (d) 1

[GATE–2010]

8. A mild steel specimen is under uniaxial tensile stress. Young's modulus and yield stress for mild

steel are 2×10^5 MPa and 250 MPa respectively. The maximum amount of strain energy per unit volume that can be stored in this specimen without permanent set is

(a) 156 Nmm/mm^3

(b) 15.6 Nmm/mm^3

(c) 1.56 Nmm/mm^3

(d) 0.156 Nmm/mm^3

[GATE–2008]

9. For an isotropic material, the relationship between the young's modulus (E), shear modulus (G) and Poisson's ratio (μ) is given by

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

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

[GATE–2007]

10. The necessary and sufficient condition for a surface to be called as a free surface is

(a) no stress should be acting on it
(b) tensile stress acting on it must be zero
(c) shear stress acting on it must be zero
(d) no point on it should be under any stress

[GATE–2006]

11. The components of strain tensor at a point in the plane strain case can be obtained by measuring longitudinal strain in following directions?

(a) along any two arbitrary directions
(b) along any three arbitrary directions
(c) along two mutually orthogonal directions
(d) along any arbitrary direction

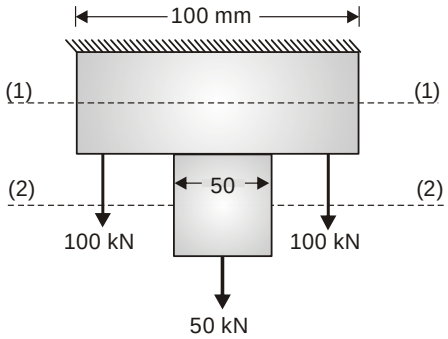
[GATE–2005]

12. The symmetry of stress tensor at a point in the body under equilibrium is obtained from

(a) conservation of mass
(b) force equilibrium equations
(c) moment equilibrium equations
(d) conservation of energy

[GATE–2005]

13. A bar of varying square cross-section is loaded symmetrically as shown in the figure. Loads shown are placed on one of the axes of symmetry of cross-section. Ignoring self weight, the maximum tensile stress in N/mm^2 anywhere is



(a) 16.0 (b) 20.0
(c) 25.0 (d) 30.0

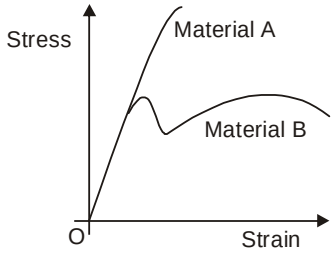
[GATE–2003]

14. The shear modulus (G), modulus of elasticity (E) and the Poisson's ratio (v) of a material are related as,

(a) G = E/[2(1 + v)] (b) E = G/[2(1 + v)]
(c) G = E/[2(1 – v)] (d) G = E/[2(1 – v)]

[GATE–2002]

15. 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

[GATE–2000]

16. In a linear elastic structural element

(a) Stiffness is directly proportional to flexibility
(b) Stiffness is inversely proportional to flexibility
(c) Stiffness is equal to flexibility
(d) Stiffness and flexibility are not related

[GATE–1991]

17. A cantilever beam of tubular section consists of 2 materials, copper as outer cylinder and steel

ANSWER KEY

1 Mark : –

1.	**(a)**	**9.**	(b)	**18.**	(b)	**26.**	(c)
2.	(b)	**10.**	(c)	**19.**	(b)	**27.**	(15)
3.	(a)	**11.**	(b)	**–: 2 Marks : –**		**28.**	(a)
4.	(d)	**12.**	(c)	**20.**	**(50)**	**29.**	(1200 kN/m^2)
5.	(a)	**13.**	(c)	**21.**	(2.5)	**30.**	(a)
6.	(b)	**14.**	(a)	**22.**	(130)	**31.**	(c)
7.	(c)	**15.**	(c)	**23.**	(a)	**32.**	(c)
8.	(d)	**16.**	(b)	**24.**	(35)	**33.**	(c)
		17.	(c)	**25.**	(15707.96)	**34.**	(c)

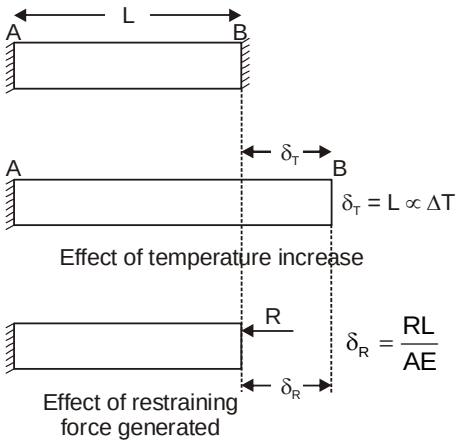
EXPLANATIONS

1– Mark

1. (a)

2. (b) Strain hardening means increased resistance (stress) against further deformation due to change in crystalline structure of steel.

3. (a)



From compatibility

$$\delta_T = \delta_R = 0$$

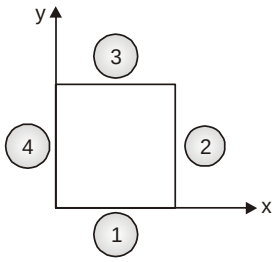
$$\Rightarrow \quad L\alpha\Delta T = \frac{RL}{AE}$$

$$\Rightarrow \quad \sigma = \frac{R}{A} = \text{Stress} = E\alpha\Delta T$$

Hence stress is independent of length of bar.

4. (d) Shear strain in an element is positive when the angle between two positive faces (or two negative faces) is reduced.

The strain is negative when the angle between two positive (or two negative) faces increase.



Face (2) & (3) are +ve face

Face (1) & (4) are –ve face.

Angle between (1) & (4) is increased by 0.0005 rad.

$\therefore \quad \gamma_{xy} = -0.0005 = 0.001\ K$

$\therefore \quad K = -0.5$

5. (a) Creep strains are those which occur due to prolonged stress. Thus, these occur due to