Solutions of

of

Civil Engineering

GATE-2016

Session 7 | Set-2

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Section - I (Civil Engineering)

Q.1 If I were you, I _____ that laptop. It's much too expensive.

(a) won't buy (b) shan't buy

(c) wouldn't buy (d) would by

Ans. **(c)**

Q.2 He turned at deaf ear to my request.
What does the underlined pharasal verb mean?

(a) ignored (b) appreciated

(c) twisted (d) returned

Ans. **(a)**

Q.3 Choose the most appropriate set of words from the options given below to complete the following sentence.

_____ _____ is a will, _____ is a way.

(a) wear, there, their (b) were, their, there

(c) where, there, there (d) were, their, their

Ans. **(c)**

Q.4 (x% of y) + (y% of x) is equivalent to ____ .

(a) 2% of xy (b) 2% of (xy/100)

(c) xy% of 100 (d) 100% of xy

Ans. **(a)**

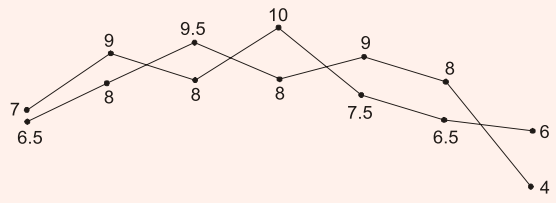
Q.5 The sum of the digits of a two digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number.

(a) 39 (b) 57

(c) 66 (d) 93

Ans. **(a)**

Q.6 Two finance companies, P and Q declared fixed annual rates of interest on the amounts invested with them. The rates of interest offered by these companies may differ from year to year. Year-wise annual rates of interest offered by these companies are shown by the line graph provided below.



If the amounts invested in the companies, P and Q in 2006 are in the ratio 8 : 9, then the amounts received after one year as interest from companies P and Q would be the ratio

(a) 2 : 3 (b) 3 : 4

(c) 6 : 7 (d) 4 : 3

Ans. **(d)**

Q.7 Today we consider, Ashoka as a great ruler because of the copious evidence he left behind in the form of stone carved edicts. Historians tend to correlate greatness of a king at his time with the availability of evidence today.
Which of the following can be logically inferred from the above sentences?

(a) Emperors who do not leave significant sculpted evidence are completely forgotten.

(b) Ashoka produced stone carved edicts to ensure that later historians will respect him.

(c) Statues of kings are a reminder of their greatness.

(d) A king's greatness, as we know him today, is interpreted by historians.

Ans. **(d)**

Q.8 Fact 1 : Humans are mammals.
Fact 2 : Some humans are engineers.
Fact 3 : Engineers build hours.
If the above statements are facts, which of the following can be logically inferred?

I. All mammals build houses.
II. Engineers are mammals.
III. Some humans are not engineers.

(a) II only (b) III only

(c) I, II and III (d) I only

Ans. **(b)**

Q.9 A square pyramid has a base perimeter x and the slant height is half of the perimeter. What is the lateral surface area of the pyramid?

(a) x^2 (b) $0.75\ x^2$

(c) $0.50\ x^2$ (d) $0.25\ x^2$

Ans. **(d)**

Q.10 Ananth takes 6 hours and Bharath takes 4 hours to read a book. Both started reading copies of the book at the same time. After how many hours is the number of pages to be rad by Ananth, twice that to be read by Bharath? Assume Ananth and Bharath read all the pages with constant pace.

(a) 1 (b) 2

(c) 3 (d) 4

Ans. **(c)**

Section - II (Civil Engineering)

Q.1 The spot speeds (expressed in km/hr) observed at a road section are 66, 62, 45, 79, 32, 51, 56, 60, 53, and 49. The median speed (expressed in km/hr) is _____. (Note : answer with one decimal accuracy)

Ans. **(54.5)**

Q.2 The optimum value of the function $f(x) = x^2 - 4x + 2$ is

(a) 2 (maximum) (b) 2 (minimum)

(c) –2 (maximum) (d) –2 (minimum)

Ans. **(d)**

Q.3 The Fourier series of the function,

$$f(x) = 0, \quad -\pi < x \le 0$$
$$= \pi - x, \quad 0 < x < \pi$$

in the interval $[-\pi, \pi]$ is

$$f(x) = \frac{\pi}{4} + \frac{2}{\pi}\left[\frac{\cos x}{1^2} + \frac{\cos 3x}{3^3} + \ldots\right] + \left[\frac{\sin x}{1} + \frac{\sin 2x}{2} + \frac{\sin 3x}{3} + \ldots\right]$$

The convergence of the above Fourier series at $x = 0$ gives

(a) $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$ (b) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2} = \frac{\pi^2}{12}$

(c) $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^2} = \frac{\pi^2}{8}$ (d) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{2n-1} = \frac{\pi}{4}$

Ans. **(c)**

Q.4 X and Y are two random independent events. It is known that $P(X) = 0.40$ and $P(X \cup Y^C) = 0.7$. Which one of the following is the value of $P(X \cup Y)$?

(a) 0.7 (b) 0.5

(c) 0.4 (d) 0.3

Ans. **(a)**

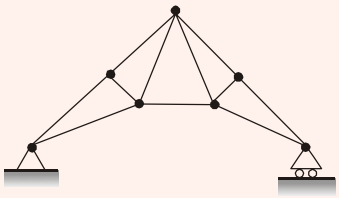
Q.5 What is the value of $\lim_{\substack{x\to 0 \\ y\to 0}} \frac{xy}{x^2 + y^2}$?

(a) 1 (b) –1

(c) 0 (d) Limit does not exit

Ans. **(d)**

Q.6 The kinematic indeterminacy of the plane truss shown in the figure is



(a) 11 (b) 8

(c) 3 (d) 0

Ans. **(a)**

Kinematic indeterminacy,

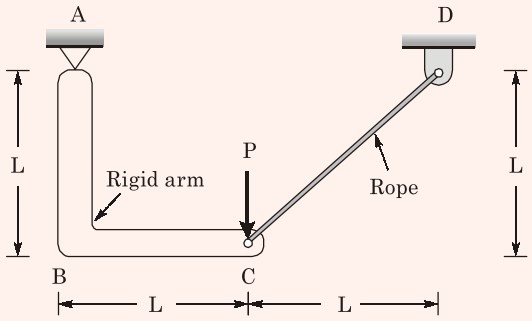
$$D_k = 2j - r_e$$
$$= 2 \times 7 - 3 = 11$$

Q.7 As per IS 456 - 2000 for the design of reinforced concrete beam, the maximum allowable shear stress (τ_{cmax}) depends on the

(a) grade of concrete and grade of steel
(b) grade of concrete only
(c) grade of steel only
(d) grade of concrete and percentage of reinforcement

Ans. **(b)**

Q.8 An assembly made of a rigid arm *A-B-C* hinged at end *A* and supported by an elastic rope *C-D* at end *C* is shown in the figure. The members may be assumed to be weightless and the lengths of the respective members are as shown in the figure

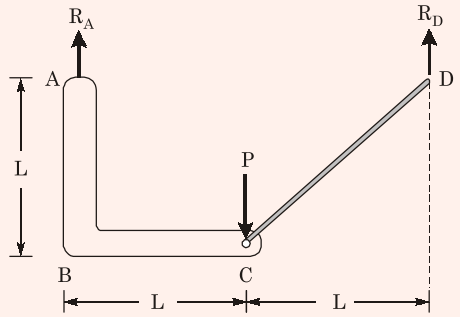


Under the action of a concentrated load *P* at *C* as shown, the magnitude of tension developed in the rope is

(a) $\frac{3P}{\sqrt{2}}$ (b) $\frac{P}{\sqrt{2}}$

(c) $\frac{3P}{8}$ (d) $\sqrt{2}P$

Ans. **(b)**



$$\Sigma M_A = 0$$

$$\Rightarrow R_D \times 2L - P \times L = 0$$

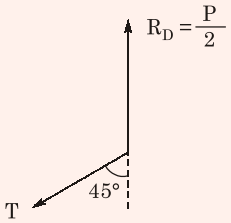
$$\Rightarrow R_D = \frac{P}{2}$$

At joint D :

$$\Sigma F_y = 0$$

$$\Rightarrow T\cos 45^\circ = \frac{P}{2}$$

$$\therefore T = \frac{P}{\sqrt{2}}$$



Q.9 As per Indian standards for bricks, minimum acceptable compressive strength of any class of burnt clay bricks in dry state is

(a) 10.0 MPa (b) 0.75 MPa

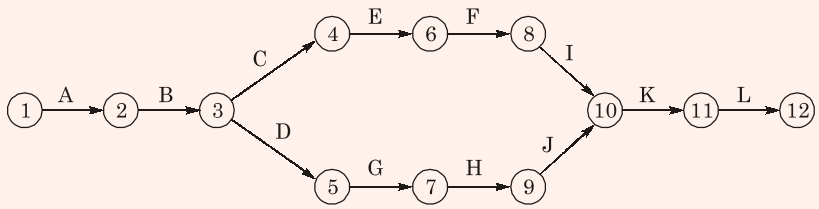
(c) 5.0 MPa (d) 3.5 MPa

Ans. **(d)**

As per **IS 1077-1992 clause 4.1**, minimum strength of burnt clay bricks is 3.5 MPa.

Q.10 A construction project consists of twelve activities. The estimated duration (in days) required to complete each of the activities along with the corresponding network diagram is shown below.

Activity		Duration (days)	Activity		Duration (days)
A	Inauguration	1	G	Flooring	25
B	Foundation work	7	H	Electrification	7
C	Structural Construction-1	30	I	Plumbing	7
D	Structural construction-2	30	J	Wood work	7
E	Brick masonry work	25	K	Coloring	3
F	Plastering	7	L	Handing over function	1



Total floats (in days) for the activities 5-7 and 11-12 for the project are, respectively,

(a) 25 and 1 (b) 1 and 1

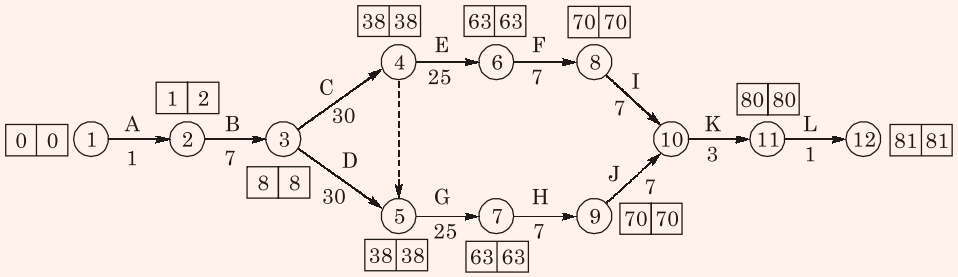
(c) 0 and 0 (d) 81 and 0

Ans. **(c)**

Total float can be determined once the activity times i.e. EST, EFT, LST and LFT are known.

Total float, F_T = LST – EST

= LFT – EFT



For activity 5-7, EST = 38

EFT = 63

LFT = 63

LST = 38

F_T = 0

For activity 11-12, EST = 80

EFT = 81

LFT = 81

LST = 80

F_T = 0

Note: It can be seen directly that since the slack of all events are zero, there is not margin left for the occurence of events and therefore.

Maximum available line = Time required for completion of activity

∴ F_T for all activities is zero.

Q.11 A strip footing is resting on the surface of a purely clayey soil deposit. If the width of the footing is doubled, the ultimate bearing capacity of the soil

(a) becomes double (b) becomes half

(c) becomes four-times (d) remains the same

Ans. **(d)**

In case of clay ultimate bearing capacity is independent of width of footing.

Q.12 The relationship between the specific gravity of sand (G) and the hydraulic gradient (i) to initiate quick condition in the sand layer having porosity of 30% is

(a) $G = 0.7i + 1$ (b) $G = 1.43i - 1$

(c) $G = 1.43i + 1$ (d) $G = 0.7i - 1$

Ans. **(c)**

$$i_c = \frac{G-1}{1+e} = (G-1)(1-n) \qquad \because \frac{1}{1+e} = 1-n$$

$$i_c = (G-1)(1-0.3) = (G-1)\times 0.7$$

$$G = \frac{i_c}{0.7} + 1 = 1.43 i_c + 1$$

Q.13 The results of a consolidation test on an undisturbed soil, sampled at a depth of 10 m below the ground level are as follows :

Saturated unit weight : 16 kN/m^3

Pre-consolidation pressure : 90 kPa

The water table was encountered at the ground level. Assuming the unit weight of water as 10 kN/m^3, the over-consolidation ratio of the soil is

(a) 0.67 (b) 1.50

(c) 1.77 (d) 2.00

Ans. **(b)**

$$\text{OCR} = \frac{\text{Maximum effective stress in past}}{\text{Maximum effective stress in present}}$$

Maximum effective stress in present = $10\,\gamma_{sat} - 10\,\gamma_w$

$= 10 \times 16 - 10 \times 10 = 60$ kN/m^2

$\therefore$ $$\text{OCR} = \frac{90}{60} = 1.5$$

Q.14 Profile of a weir on permeable foundation is shown in figure I and an elementary profile of upstream pile only case' according to Khosla's theory is shown in figure II. The uplift pressure heads at key points Q, R and S are 3.14 m, 2.75 m and 0 m, respectively (refer figure II)

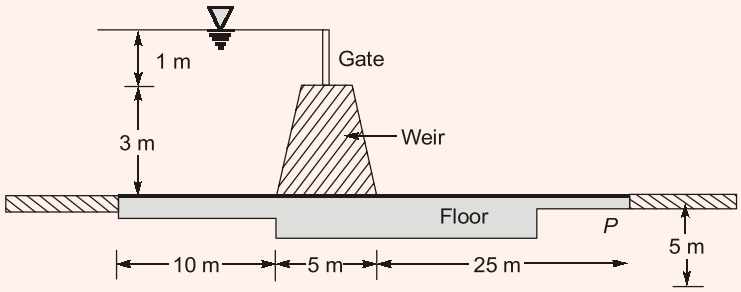


Figure I

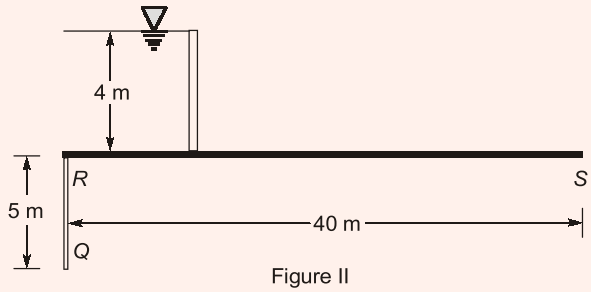


Figure II

What is the uplift pressure head at point *P* downstream of the weir (junction of floor and pile as shown in the figure I)?

(a) 2.75 m (b) 1.25 m
(c) 0.8 m (d) Data not sufficient

Ans. **(b)**

$$\phi_R = \frac{2.75}{4} \times 100 = 68.75\%$$

$$\phi_P = 100 - \phi_R = 31.25\%$$

Now, $$\phi_P = \frac{\text{Pressure head at point P}}{\text{Total head}} \times 100$$

$$31.25 = \frac{h}{4} \times 100$$

$\therefore$ $$h = 1.25 \text{ m}$$

Q.15 Water table of an aquifer drops by 100 cm over an area of 1000 km^2. The porosity and specific retention of the aquifer material are 25% and 5%, respectively. The amount of water (expressed in km^3) drained out from the area is_____.

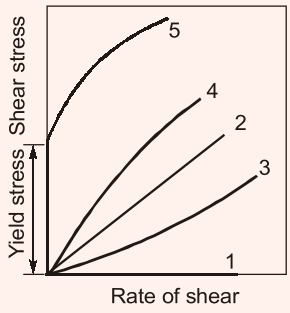
Ans. **(0.2)**

$$S_r + S_y = n$$

$$\frac{5}{100} + \frac{V_w}{10^3 \times 10^6 \times 1} = \frac{25}{100}$$

$$V_w = 0.2 \times 10^9 \text{ m}^3 = 0.2 \text{ km}^3$$

Q.16 Group I contains the types of fluids while Group II contains the shear stress-rate of shear relationship of different types of fluids, as shown in the figure



	Group I	Group II
P.	Newtonian fluid	1. Curve 1
Q.	Pseudo plastic fluid	2. Curve 2
R.	Plastic fluid	3. Curve 3
S.	Dilatant fluid	4. Curve 4
		5. Curve 5

The correct match between Group I and Group II is

(a) P-2, Q-4, R-1, S-5 (b) P-2, Q-5, R-4, S-1

(c) P-2, Q-4, R-5, S-3 (d) P-2, Q-1, R-3, S-4

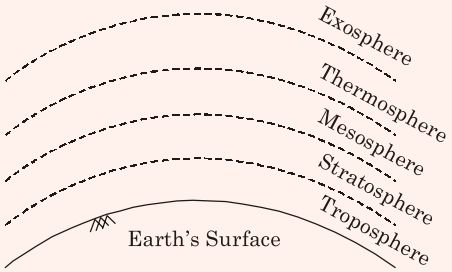
Ans. **(c)**

Q.17 The atmospheric layer closest to the earth surface is

(a) the mesosphere (b) the stratosphere

(c) the thermosphere (d) the troposphere

Ans. **(d)**



Q.18 A water supply board is responsible for treating 1500 m^3/day of water. A settling column analysis indicates that an overflow rate of 20 m/day will produce satisfactory removal for a depth of 3.1 m. It is decided to have two circular settling tanks in parallel. The required diameter (expressed in m) of the settling tanks is_____.

Ans. **(6.91)**

Discharge to be treated by one tank,

$$Q = \frac{1500}{2} = 750 \text{ m}^3/\text{day}$$

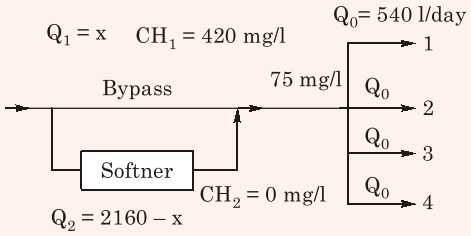
$$\text{Surface area, } A = \frac{Q}{OFR} = \frac{750}{20} = 37.5 \text{ m}^2$$

$$\Rightarrow \quad 37.5 = \pi \times \frac{d^2}{4}$$

$$\Rightarrow \quad d = 6.91 \text{ m}$$

Q.19 The hardness of a ground water sample was found to be 420 mg/L as $CaCO_3$. A softener containing ion exchange resins was installed to reduce the total hardness to 75 mg/L as $CaCO_3$ before supplying to 4 households. Each household gets treated water at a rate of 540 L/day. If the efficiency of the softener is 100%, the bypass flow rate (expressed in L/day) is_____.

Ans. **(385.7)**



Total water to be treated

$$= 540 \times 4 = 2160\ l/\text{day}$$

Resultant hardness required

$$= 75\ \text{mg}/l$$

Let bypass rate be x l/day having hardness of 420 mg/l

Resultant hardness required

$$= 75\ \text{mg}/l$$

$$CH_{mix} = \frac{CH_1Q_1 + CH_2Q_2}{Q}$$

$$75 = \frac{x \times 420 + (2160 - x)0}{2160}$$

$$x = \frac{2160 \times 75}{420} = 385.7 \text{ l/day}$$

Q.20 The sound pressure (expressed in μPa) of the faintest sound that a normal healthy individual can hear is

(a) 0.2 (b) 2

(c) 20 (d) 55

Ans. **(c)**

The sound pressure of the faintest sound that a normal healthy individual can hear is 20 μPa. It is taken as reference sound pressure level.

A 20 μPa pressure is 0dB on the sound pressure level scale.

Q.21 In the context of the IRC 58-2011 guidelines for rigid pavement design, consider the following pair of statements.

I. Radius of relative stiffness is directly related to modulus of elasticity of concrete and inversely related to Poisson's ratio.

II. Radius of relative stiffness is directly related to thickness of slab and modulus of subgrade reaction.

Which one of the following combinations is correct?

(a) I. True; II. True (b) I. False; II. False

(c) I. True; II. False (d) I. False; II. True

Ans. **(b)**

Radius of relative stiffness,

$$l = \left[\frac{Eh^3}{12k\left(1-\mu^2\right)}\right]^{1/4}$$

∴ Statement 1 is wrong.

Modulus of subgrade reaction,

$$k = \frac{P}{\Delta}$$

Statement 2 is also wrong.

∴ Option (b) is correct.

Q.22 If the total number of commercial vehicles per day ranges from 3000 to 6000, the minimum percentage of commercial traffic to be surveyed for axle load is

(a) 15 (b) 20

(c) 25 (d) 30

Ans. **(a)**

Q.23 Optimal flight planning for a photogrammetric survey should be carried out considering

(a) only side-lap

(b) only end-lap

(c) either side-lap or end-lap

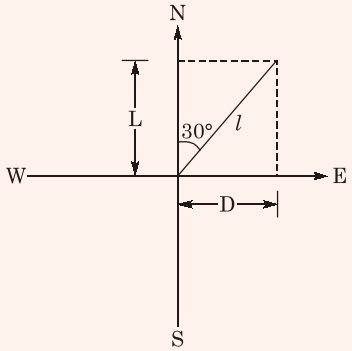
(d) both side-lap as well as end-lap

Ans. **(d)**

Q.24 The reduced bearing of a 10 m long line is N30°E. The departure of the line is

(a) 10.00 m (b) 8.66 m

(c) 7.52 m (d) 5.00 m



Ans. **(d)**

The departure of the line,

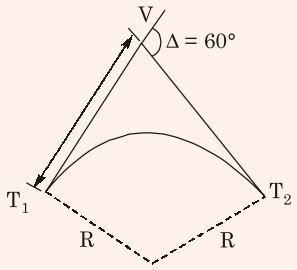
$$D = l \sin\theta$$
$$= 10 \sin 30°$$
$$= \frac{10}{2} = 5 \text{ m}$$

Q.25 A circular curve of radius R connects two straights with a deflection angle of 60°. The tangent length is

(a) 0.577 R (b) 1.155 R

(c) 1.732 R (d) 3.464 R

Ans. **(0.577)**



$$\text{Tangent length, } VT_1 = R\tan\frac{\Delta}{2}$$

$$= R\tan 30^\circ = 0.577\ R$$

Q.26 Consider the following linear system.

$x + 2y - 3z = a$

$2x + 3y + 3x = b$

$5x + 9y - 6z = c$

This system is consistent if a, b and c satisfy the equation

(a) $7a - b - c = 0$ (b) $3a + b - c = 0$

(c) $3a - b + c = 0$ (d) $7a - b + c = 0$

Ans. **(b)**

Q.27 If $f(x)$ and $g(x)$ are two probability density functions,

$$f(x) = \begin{cases} \frac{x}{a} + 1 & : \ -a \le x < 0 \\ -\frac{x}{a} + 1 & : \ 0 \le x \le a \\ 0 & : \ \text{otherwise} \end{cases}$$

$$g(x) = \begin{cases} -\frac{x}{a} & : \ -a \le x < 0 \\ \frac{x}{a} & : \ 0 \le x \le a \\ 0 & : \ \text{otherwise} \end{cases}$$

Which one of the following statements is true?

(a) Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are same

(b) Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are different

(c) Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are same

(d) Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are different

Ans. **(b)**

Q.28 The angle of intersection of the curves $x^2 = 4y$ and $y^2 = 4x$ at point (0, 0) is

(a) 0° (b) 30°

(c) 45° (d) 90°

Ans. **(d)**

Q.29 The area between the parabola $x^2 = 8y$ and the straight line y = 8 is_____.

Ans. **(85.33)**

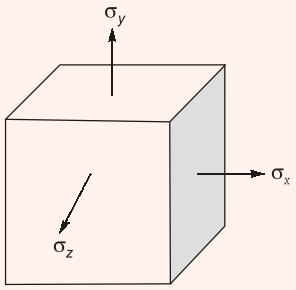
Q.30 The quadratic approximation of $f(x) = x^3 - 3x^2 - 5$ a the point $x = 0$ is

(a) $3x^2 - 6x - 5$ (b) $-3x^2 - 5$

(c) $-3x^2 + 6x - 5$ (d) $3x^2 - 5$

Ans. **(b)**

Q.31 An elastic isotropic body is in a hydrostatic state of stress as shown in the figure. For no change in the volume to occur, what should be its Poisson's ratio?



(a) 0.00 (b) 0.25

(c) 0.50 (d) 1.00

Ans. **(c)**

Volumetric strain,

$$\in_V = \left(\frac{\sigma_x + \sigma_y + \sigma_z}{3}\right)(1 - 2\mu)$$

$$\Rightarrow \quad \frac{\delta V}{V} = \left(\frac{\sigma_x + \sigma_y + \sigma_z}{3}\right)(1 - 2\mu)$$

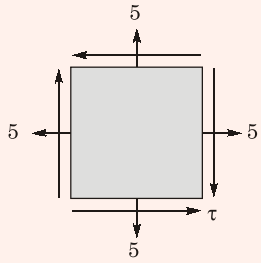
As $\Delta V = 0$

$\Rightarrow$ Either $\sigma_x + \sigma_y + \sigma_z = 0$ or $1 - 2\mu = 0$

$\Rightarrow$ $1 - 2\mu = 0$

$\mu = 0.5$

Q.32 For the stress state (in MPa) shown in the figure, the major principal stress is 10 MPa.

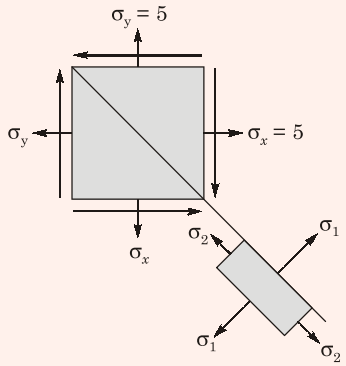


The shear stress τ is

(a) 10.0 MPa (b) 5.0 MPa

(c) 2.5 MPa (d) 0.0 MPa

Ans. **(b)**



$$\sigma_x + \sigma_y = \sigma_1 + \sigma_2$$

$$\Rightarrow \quad 5 + 5 = 10 + \sigma_2$$

$$\Rightarrow \quad \sigma_2 = 0$$

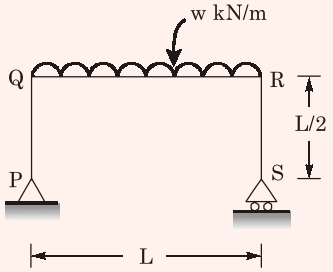
Now, $$\sigma_{1/2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\therefore \quad \sigma_1 = \frac{5+5}{2} + \sqrt{\left(\frac{5-5}{2}\right)^2 + \tau_{xy}^2}$$

$$\Rightarrow \quad 10 = 5 + \tau_{xy}$$

$$\therefore \quad \tau_{xy} = 5 \text{ MPa}$$

Q.33 The portal frame shown in the figure is subjected to a uniformly distributed vertical load w (per unit length).



The bending moment in the beam at the join 'Q' is

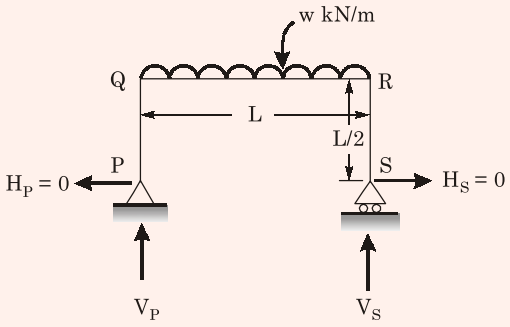
(a) zero

(b) $\frac{wL^2}{24}$(hogging)

(c) $\frac{wL^2}{12}$(hogging)

(d) $\frac{wL^2}{8}$(sagging)

Ans. **(a)**



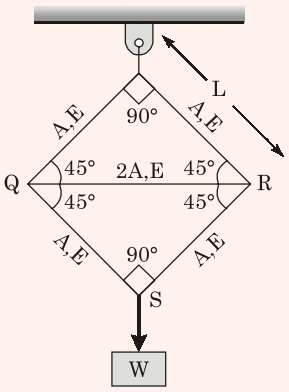
As there is no horizontal force,

Hence $H_P = H_S = 0$

$$\Sigma M_Q = H_P \times \frac{L}{2} = 0$$

$\therefore$ BM at Q = 0

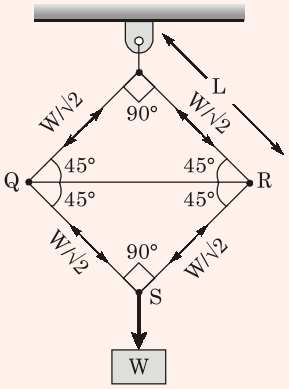
Q.34 Consider the structural system shown in the figure under the action of weight W. All the joints are hinged. The properties of the members in terms of length (L), are (A) and the modulus of elasticity (E) are also given in the figure. Let L, A and E be 1 m, 0.05 m^2 and 30×10^6 N/m^2, respectively, and W be 100 kN.



Which one of the following sets gives the correct values of the force, stress and change in length of the horizontal member QR?

(a) Compressive force = 25 kN; Stress = 250 kN/m^2 ; Shortening = 0.0118 m
(b) Compressive force = 14.14 kN; Stress = 141.4 kN/m^2; Extension = 0.0118 m
(c) Compressive force = 100 kN; Stress = 1000 kN/m^2; Shortening = 0.0417 m
(d) Compressive force = 100 kN; Stress = 1000 kN/m^2; Extension = 0.0417 m

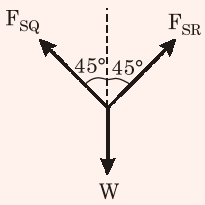
Ans. **(c)**



Given data:

$$L = 1m,\ A = 0.05\ m^2,\ E = 30 \times 10^6\ N/m^2$$

Consider joint 'S'



$$F_{SQ} = F_{SR}$$

$$2F_{SQ}\cos 45° = W$$

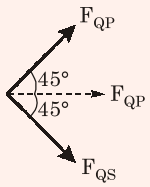
$$\Rightarrow \quad F_{SQ} = \frac{W}{2}\times\sqrt{2} = \frac{W}{\sqrt{2}}$$

$$\therefore \quad F_{SQ} = \frac{W}{\sqrt{2}}$$

As the truss is symmetrical

$$\therefore \quad F_{QP} = F_{PR} = \frac{W}{\sqrt{2}} \qquad \text{(Tensile)}$$

Now consider joint 'Q'



$$F_{QP} = F_{QS} = \frac{W}{\sqrt{2}}$$

$$\Sigma F_x = 0$$

$$\Rightarrow \quad \frac{F_{QP}}{\sqrt{2}} + \frac{F_{QS}}{\sqrt{2}} + F_{QR} = 0$$

$$\Rightarrow \quad F_{QR} = W \qquad \text{(Compressive)}$$

$$\therefore \quad F_{QR} = 100 \text{ kN} \qquad \text{(Compressive)}$$

Stress in member QR,

$$\sigma_{QR} = \frac{F_{QR}}{2\Delta}$$

$$\Rightarrow \quad \sigma_{QR} = \frac{100}{2\times 1.05} = \frac{100\times 100}{2\times 5} = 1000 \text{ kN/m}^2$$

$$\therefore \quad \sigma_{QR} = 1000 \text{ kN/m}^2$$

As the member QR consist compressive tone so it will go under shortening.

$$\therefore \quad \text{Shortening, } \Delta = \frac{P(\text{Length})}{2AE} = \frac{F_{QR}\cdot L_{QR}}{2AE}$$

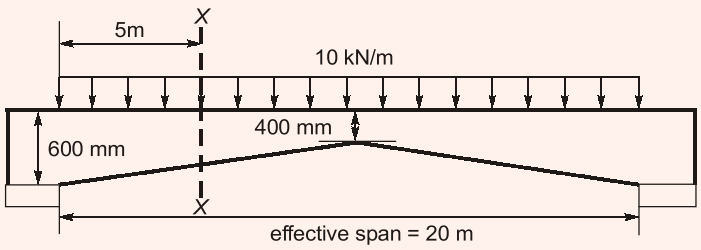
$$L_{QR} = \sqrt{L^2 + L^2} = \sqrt{2}\,L$$

$$\therefore \quad \Delta = \frac{100\times 10^3 \times \sqrt{2}\times 1}{2\times 0.05\times 30\times 10^6}$$

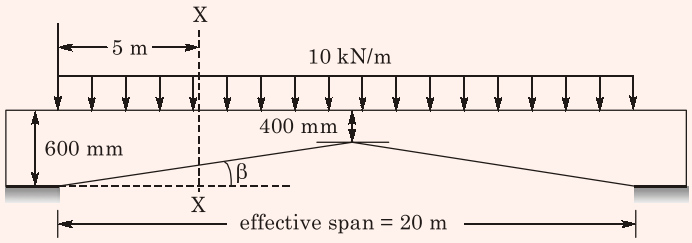
$$= \frac{100\times 10^3\times\sqrt{2}}{0.1\times 30\times 10^6} = \frac{\sqrt{2}}{30}$$

$$\therefore \quad \Delta = 0.471$$

Q.35 A haunched (varying depth) reinforced concrete beam is simply supported at both ends, as shown in the figure. The beam is subjected to a uniformly distributed factored load of intensity 10 kN/m. The design shear force (expressed in kN) at the section X-X of the beam is___



Ans. **(65)**



Shear force at section X-X,

$$V_u = 100 - 5 \times 10 = 50 \text{ kN}$$

Depth at section X-X,

$$d = 400 + \frac{200}{10} \times 5 = 500 \text{ mm} = 0.5 \text{ m}$$

Moment at section X-X,

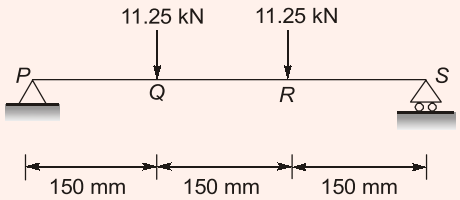
$$M_u = 100 \times 5 - 10 \times 2.5 \times 5 = 375 \text{ kNm}$$

Design shear force at section X-X,

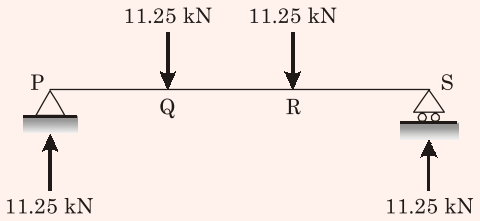
$$V_{u,design} = V_u + \frac{M_u}{d}\tan\beta$$

$$= 50 + \frac{375}{0.5} \times \frac{200}{10000} = 65 \text{ kN}$$

Q.36 A 450 mm long plain concrete prism is subjected to the concentrated vertical loads as shown in the figure. Cross section of the prism is given as 150 mm × 150 mm. Considering linear stress distribution across the cross-section, the modulus of rupture (expressed in MPa) is ____



Ans. **(3)**



$$BM_Q = 11.25 \times 150 = 1.6875 \times 10^6 \text{ N-mm}$$

$$\Rightarrow \quad \frac{\sigma}{y} = \frac{M_Q}{I}$$

where, $\quad y = \frac{150}{2} = 75 \text{ mm and } I = \frac{(150)^4}{12}$

$$\Rightarrow \quad \sigma = \frac{1.6875 \times 10^6 \times 75}{(150)^4/12} = 3 \text{ MPa}$$

Q.37 Two bolted plates under tension with alternative arrangement of bolt holes are shown in figures 1 and 2. The hole diameter, pitch, and gauge length are d, p and g, respectively.

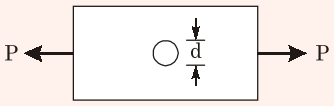


Figure 1

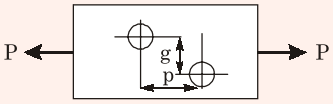


Figure 2

Which one of the following conditions must be ensured to have higher net tensile capacity of configuration shown in figure I?

(a) $p^2 > 2gd$ (b) $p^2 < \sqrt{4gd}$

(c) $p^2 > 4gd$ (d) $p > 4gd$