ESE 2025
Prelims Solutions

Civil Engineering

Set-D

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Civil Engineering Paper Analysis of ESE 2025 Preliminary Examination		
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UPSC ESE Prelims 2025

CIVIL ENGINEERING

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1. Which one of the following lists identifies the wastes from common manufacturing and industrial process, such as solvents that have been used in cleaning or degreasing operations?

(a) The F-list
(b) The K-list
(c) The P-list
(d) The U-list

Ans. (a)

F-list, according to the EPA, identifies wastes generated from common manufacturing and industrial process, including solvents used in cleaning or degreasing operations. This is because these process can occur in various industries making them non-specific sources.

End of Solution

2. When once a pocket of smoke, containing air pollutants, is released into the atmosphere from a source like an automobile or a factory chimney, it gets dispersed into the atmosphere into various directions depending upon the

1. prevailing winds
2. temperature
3. pressure conditions

Select the correct answer.

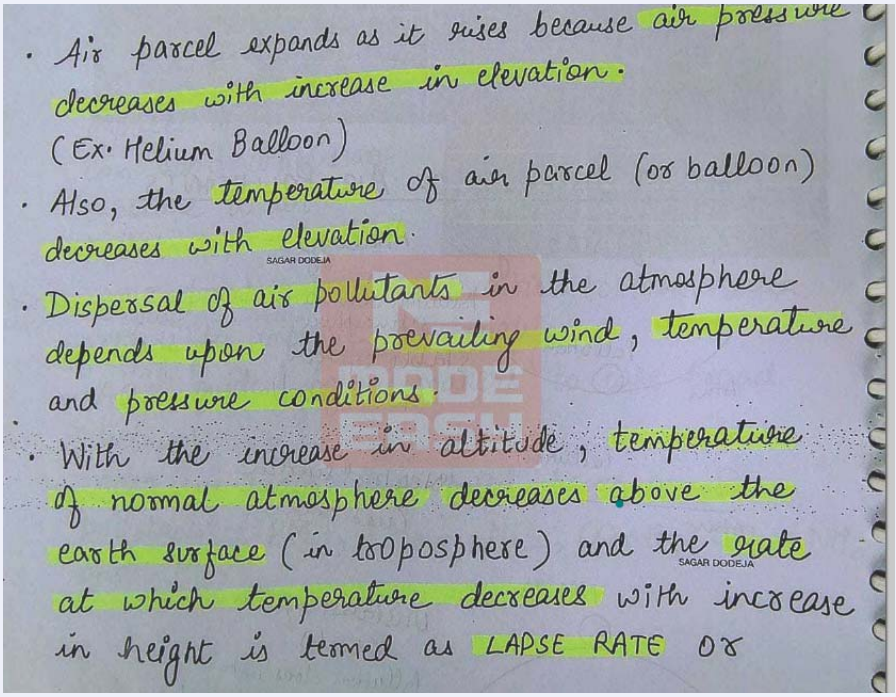
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (d)

Prevailing winds: The direction of the wind significantly influences the movement and dispersion of smoke plumes. Winds can push smoke plumes in different directions, determining where it travels and reaches.

Temperature: Temperature differences create air density variations. Warmer air rises, creating updrafts that can carry smoke plumes higher into the atmosphere. Cooler air is denser and can trap smoke closer to the ground.

Pressure conditions: Pressure differences also play a role. Areas of high pressure tend to push air outward, while areas of low pressure create areas of rising air, which can influence smoke dispersion.



End of Solution

3. During the compaction test, the weight of compacted soil specimen along with mould is 38.2 N. The volume and weight of mould are 0.95×10^{-3} m^3 and 20.5 N respectively and the water content is 12%. The dry unit weight of the compacted specimen will be nearly

(a) 16.6 kN/m^3 (b) 14.4 kN/m^3

(c) 12.6 kN/m^3 (d) 10.4 kN/m^3

Ans. (a)

Given: $W_{soil} + W_{mould} = 38.2$ N

$W_{mould} = 20.5$ N

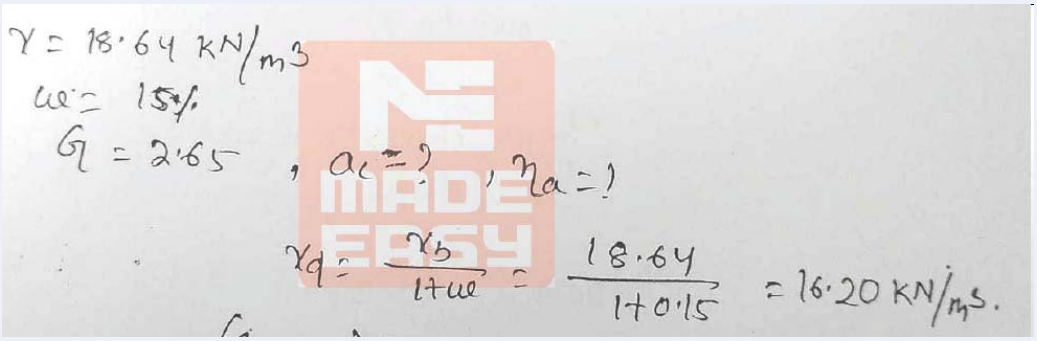
$V_{mould} = 0.95 \times 10^{-3}$ m^3

Water content, $W = 12\%$

$$\therefore \quad \gamma_d = \frac{\gamma_b}{1+w} = \frac{\left(\frac{W_{soil}}{V_{mould}}\right)}{1+w}$$

$$\Rightarrow \quad \gamma_d = \frac{\left(\frac{38.2-20.5}{0.95\times10^{-3}}\right)}{1+0.12}$$

$$\Rightarrow \quad \gamma_d = 16.63 \text{ kN/m}^3$$



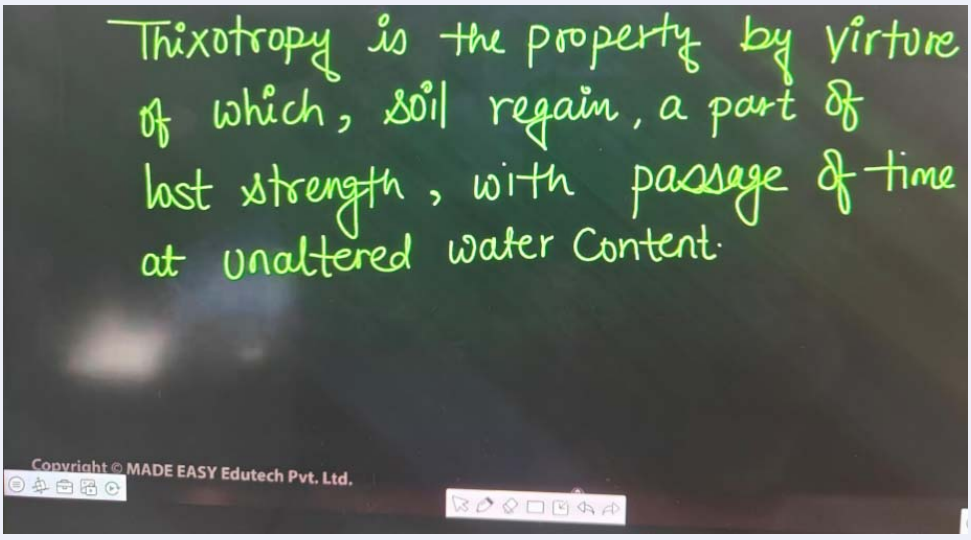
End of Solution

4. Which one of the following is a time-dependent reversible process in which materials under constant composition and volume soften when remolded?

(a) Sensitivity
(b) Hydraulic conductivity
(c) Thixotropy
(d) Elasticity

Ans. (c)

Soil will regain its loss shear strength with time at constant water content this phenomenon is called as thixotropy.



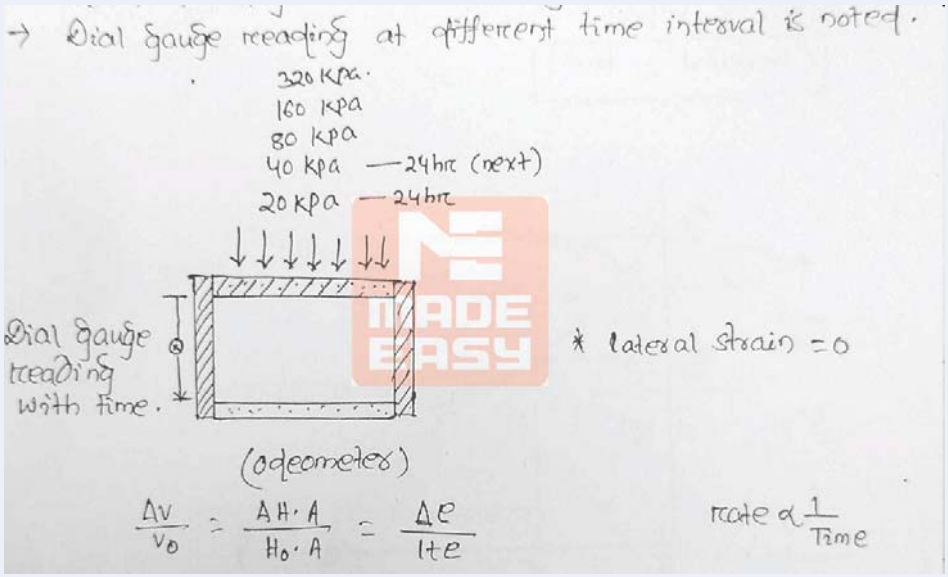
End of Solution

5. The compressibility of a saturated, clay-water system is determined by means of the apparatus devised by Terzaghi known as

(a) Compressometer
(b) Oedometer
(c) Casagrande meter
(d) Azzouz meter

Ans. (b)

The compressibility of a saturated clay water system is determined by 'Oedometer'.



End of Solution

6. In a flow net for a sheet pile wall, the number of flow paths is 5 and the number of equipotential drops is 10. If the coefficient of permeability is 6×10^{-3} mm/s and the head is 4.5 m, the seepage under the wall will be nearly

(a) 1367 L/day (b) 1223 L/day

(c) 1167 L/day (d) 1023 L/day

Ans. (c)

Given:

Number of flow paths, $N_f = 5$

Number of equipotential drops, $N_d = 10$

Permeability, $k = 6 \times 10^{-3}$ mm/sec

$= 6 \times 10^{-6}$ m/sec

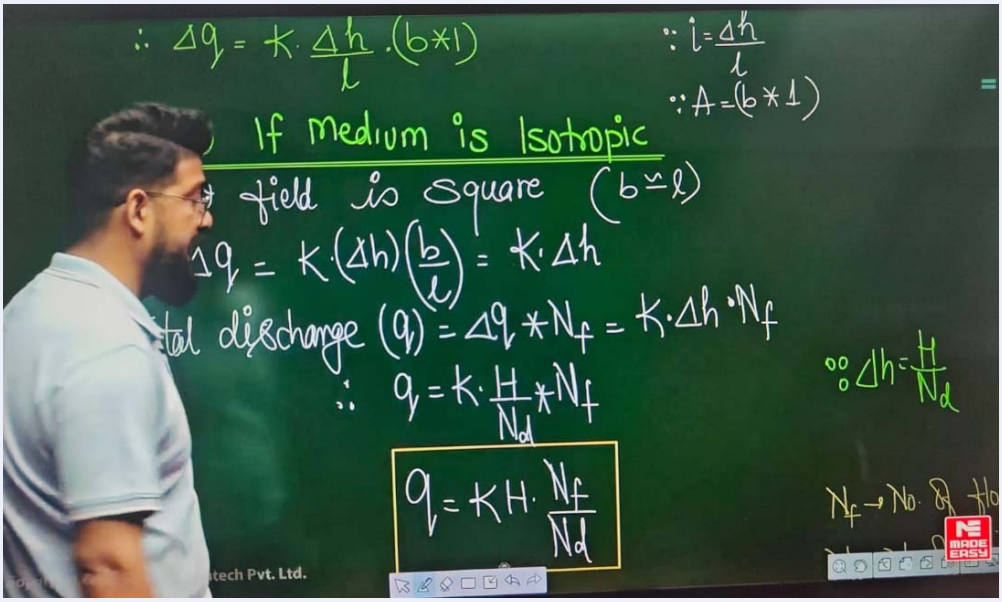
Head, $H = 4.5$ m

Discharge, $q = kH\left(\frac{N_f}{N_d}\right)$

$\Rightarrow \quad q = 6\times10^{-6}\times4.5\times\frac{5}{10}$

$\Rightarrow \quad q = 1.35 \times 10^{-5}\ m^3/day = 1.1664\ m^3/day$

$\Rightarrow \quad q \simeq 1167$ lt/day



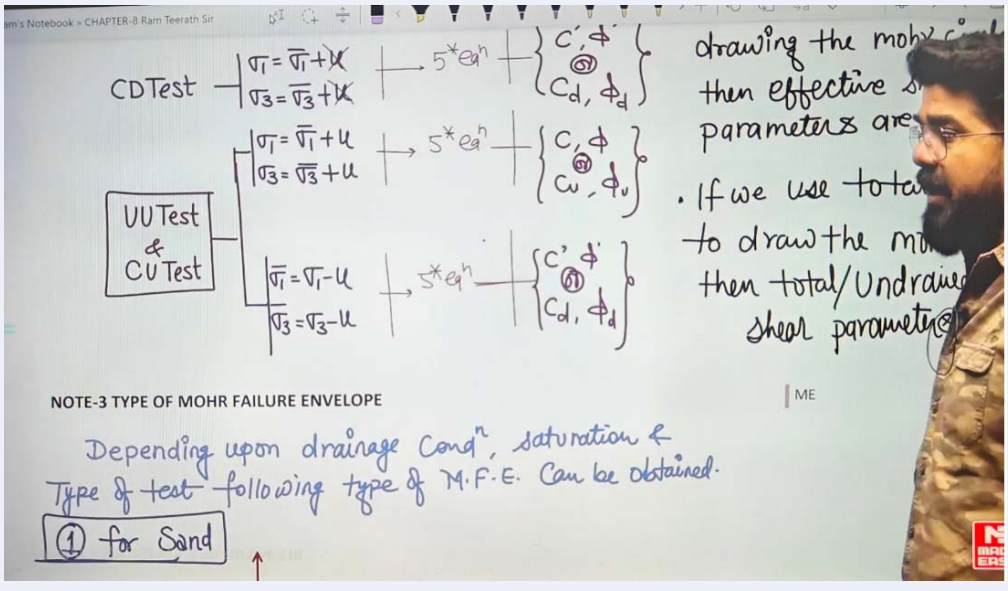
End of Solution

7. Which of the following types of conventional tests will be conducted on clay soils to test the shearing strength?

(a) Undrained or quick tests
(b) Unconsolidated-quick tests
(c) Drained tests
(d) Consolidated-slow tests

Ans. (a)

To determine the shearing strength of clay soil UU-Test (Quick test) is performed.



End of Solution

8. Which of the following are the advantages of reinforced earth structures?
1. These are quite flexible
2. The elements can be transported easily
3. These can be constructed in stages
4. The elements used are not easily available

Select the correct answer.

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

Ans. (c)

- **These are quite flexible** : Reinforced earth structures are known for their flexibility compared to rigid retaining walls. They can tolerate differential settlements and minor seismic movements better.
- **The elements can be transported easily** : The components (like geogrids, metallic strips, wire meshes, and facing panels) are modular and lightweight enough to be transported conveniently.
- **These can be constructed in stages**: One of the key advantages is the ability to build them incrementally, which is especially useful for large projects or when construction is phased.

End of Solution

9. The load on a square footing 2 m × 2 m resting on a deep deposit of clay is 600 kN. If the unconfined compressive strength of clay is 100 kN/m^2, the failure occurs at 20% of strain for Terzaghi's influence factor $I_t = 0.95$, and Poisson's ratio of soil $\nu = 0.5$, the average immediate settlement will be nearly

(a) 34 cm (b) 43 cm
(c) 52 cm (d) 61 cm

Ans. (b)

Given: $Q = 600$ kN, $B = 2$ m

$q = 100$ kN/m^2

$I_t = 0.95$

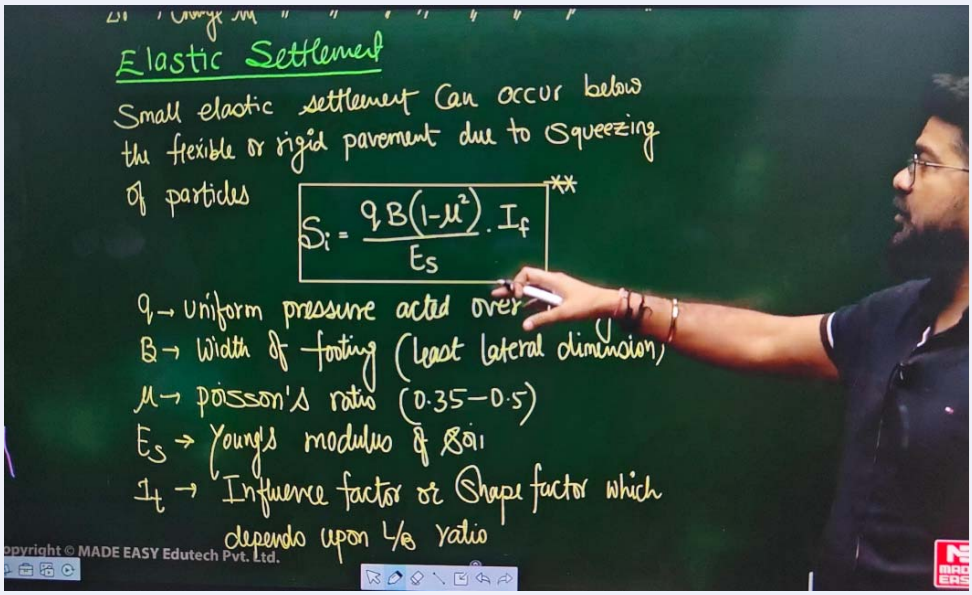
$\nu = 0.5$

$$E_s = \frac{\text{Strength}}{\text{Strain}} = \frac{100}{0.2} = 500 \text{ kN/m}^2$$

$$\therefore \quad S_i = \frac{qB(1-\nu^2)I_t}{E_s}$$

$$\Rightarrow \quad S_i = \frac{\frac{600}{4} \times 2 \times (1-0.5^2) \times 0.95}{500}$$

$$\Rightarrow \quad S_i = 0.4275 \text{ m} \simeq 43 \text{ cm}$$



End of Solution

10. A well foundation of 6 m external diameter and 5 m internal diameter is sunk to a depth of 15 m in a deep deposit of sand. If the average N value of sand is 20, the load that the well can carry by bearing alone will be nearly

(a) 52 MN (b) 44 MN
(c) 38 MN (d) 29 MN

Ans. (d)

Given: SPT number, $N = 20$

Diameter, $D = 6$ m

Ultimate bearing capacity, $q_u = 53\ N$

$q_u = 53 \times 20 = 1060\ kN/m^2$

Ultimate load, $Q_u = q_u \times$ Area

$\Rightarrow \quad Q_u = 1060 \times \frac{\pi}{4} \times 6^2$

$\Rightarrow \quad Q_u = 29968.2\ kN$

$\Rightarrow \quad Q_u \simeq 29\ MN$

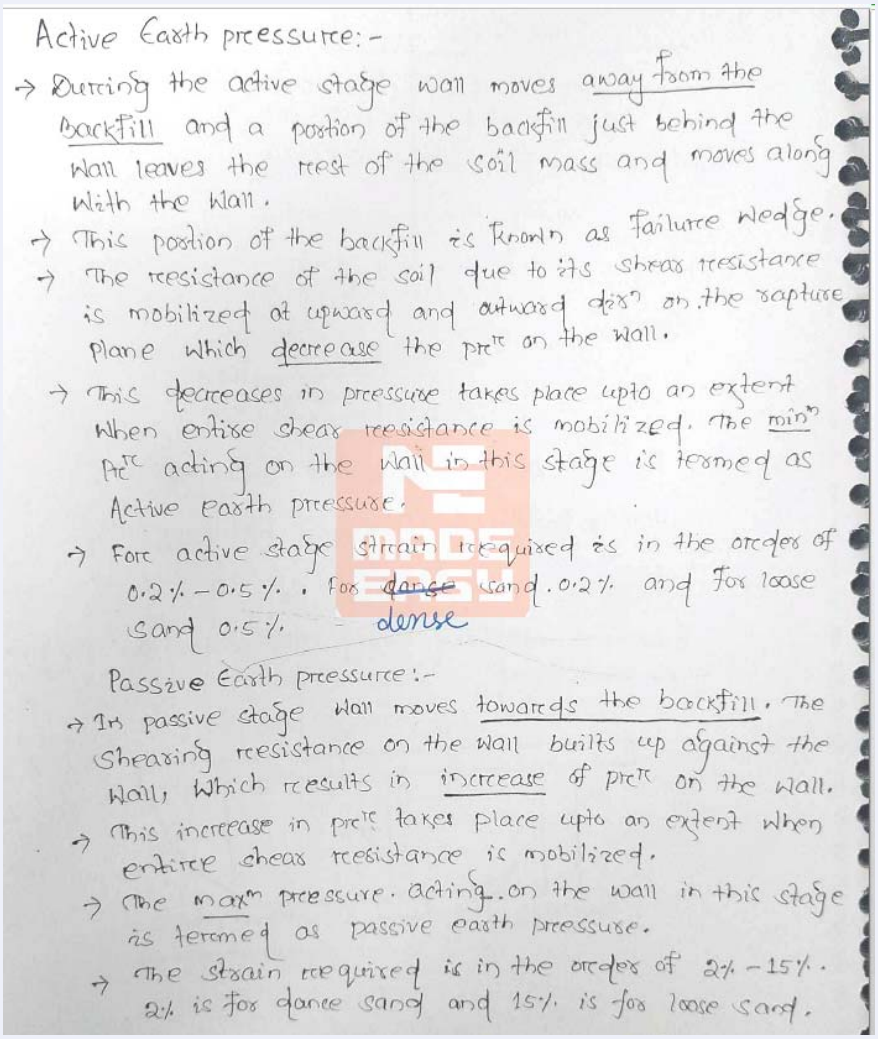
End of Solution

11. A sheet pile wall or bulkhead may be subjected to which one of the following types of lateral pressures?

(a) Active and passive earth pressure
(b) Vertical pressure due to ship impact
(c) Balanced water pressure
(d) Inclined wind pressure

Ans. (a)

A sheet pile wall or bulkhead may be subjected to active and passive earth pressure.



Active Earth pressure:-

→ During the active stage wall moves away from the backfill and a portion of the backfill just behind the wall leaves the rest of the soil mass and moves along with the wall.

→ This portion of the backfill is known as failure wedge.

→ The resistance of the soil due to its shear resistance is mobilized at upward and outward dirn on the rapture plane which decrease the pr on the wall.

→ This decreases in pressure takes place upto an extent when entire shear resistance is mobilized. The min pr acting on the wall in this stage is termed as Active Earth pressure.

→ For active stage strain required is in the orders of 0.2% – 0.5%. For dense sand 0.2% and for loose sand 0.5%

Passive Earth pressure:-

→ In passive stage wall moves towards the backfill. The shearing resistance on the wall builts up against the wall, which results in increase of pr on the wall.

→ This increase in pr takes place upto an extent when entire shear resistance is mobilized.

→ The max pressure acting on the wall in this stage is termed as passive earth pressure.

→ The strain required is in the orders of 2% – 15%. 2% is for dance sand and 15% is for loose sand.

End of Solution

12. What is the maximum depth to which a trench of vertical sides can be excavated in a clay stratum with c = 50 kN/m^2, γ = 16 kN/m^3, $\beta = 90°$, $\phi = 0°$, $F_c = 1$ and N = 0.261?

(a) 12 m (b) 14 m

(c) 16 m (d) 18 m

Ans. (a)

Given: $C = 50$ kN/m^2, $\gamma = 16$ kN/m^3

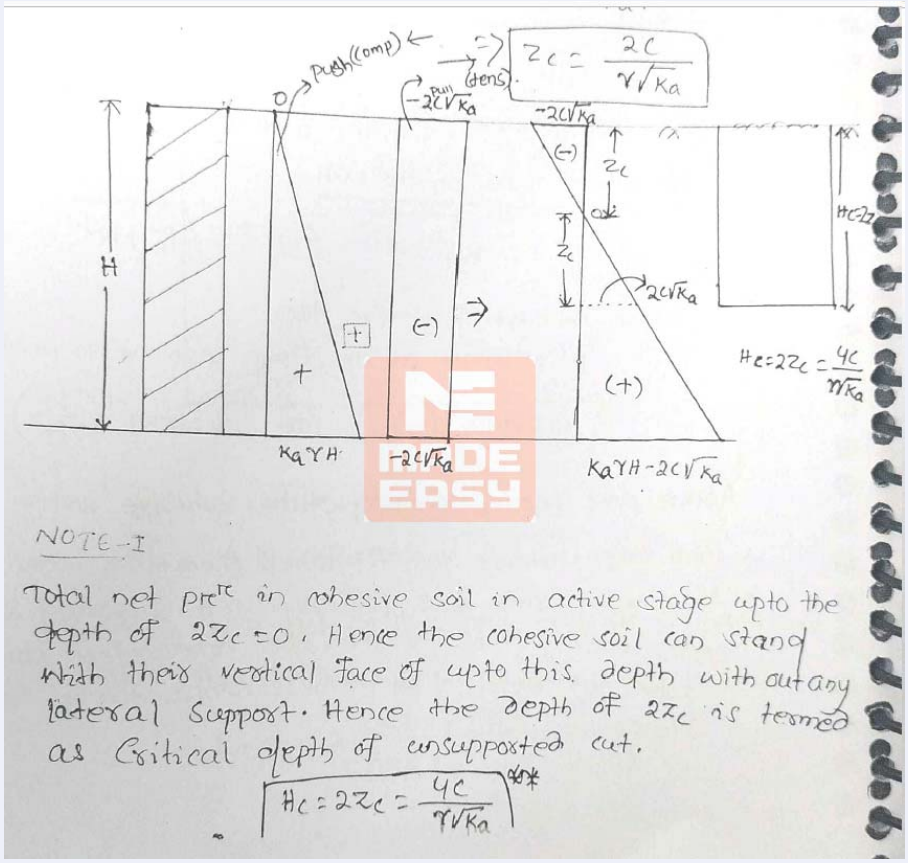
$\beta = 90°$, $\phi = 0°$, $F_c = 1$

Maximum depth of trench of vertical sides is given by

$$H_c = \frac{4C}{\gamma\sqrt{K_a}}$$

$$\Rightarrow \quad H_c = \frac{4\times 50}{16\sqrt{1}}$$

$$\Rightarrow \quad H_c = 12.5 \text{ m}$$



End of Solution

13. The reinforced soil technique/concept is essentially based on the mobilization of the interfacial shearing resistance between the soil and reinforcement, which in turn restrains the

(a) shear force
(b) shearing resistance
(c) lateral deformation of the soil
(d) longitudinal deformation of the soil

Ans. (c)

The concept of reinforced soil relies on the interaction between soil and reinforcement (like geogrids, strips, or mesh). When soil tends to deform laterally (especially under load), the reinforcement resists this movement through interfacial shearing resistance. This mobilized resistance helps stabilize the soil mass by restraining lateral deformation, which is a key factor in improving the strength and stability of the structure (e.g., retaining walls, embankments).

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So, the reinforcement does **not primarily resist longitudinal deformation**, nor does it act simply to resist shear force; it works by mobilizing shearing resistance at the interface, which ultimately restrains lateral soil movement.

End of Solution

14. Which one of the following is an example of a reinforced earth wall?
(a) Facing panel with wire mesh reinforcement
(b) Hollow panel with tieback anchor
(c) Unanchored gabion wall
(d) PFRC wall

Ans. (a)

Reinforced earth walls (also known as mechanically stabilized earth (MSE) walls) are earth retaining structures that consist of:

- Backfill soil
- Reinforcement elements (e.g., steel strips, geogrids, wire mesh)
- Facings (e.g., precast concrete panels, wire mesh panels)

These walls rely on reinforcement embedded in the soil to improve its stability, and the facing panels provide surface stability and aesthetics.

End of Solution

15. To keep the surveying instruments in fit condition
(a) the instrument should be removed from and placed quickly in the box
(b) the tripod legs should be set too close to each other and should be planted firmly on the ground
(c) when the magnetic needle of the instrument is in use, it should be raised off the pivot
(d) the objective and eyepiece lens should not be touched with fingers

Ans. (d)

- Removing and placing the instruments quickly increases the risk of mechanical shock or damage. Instruments should always be handled gently and secured properly in the box.
- Tripod legs set too close will compromise stability.
- When using a magnetic needle, it should be freely suspended to align with magnetic north. Raising it off the pivot would make it non-functional during observation.
- Touching the objective or eyepiece linses with fingers can leave oil, dirt and scratches, impairing visibility and damaging optics.

End of Solution

16. Which one of the following data is not required for the design of a weir or a barrage?
(a) High flood level for the river at the weir site
(b) Maximum flood discharge for the river at the weir site
(c) River cross-section at the weir site
(d) Discharge of the river

Ans. (d)

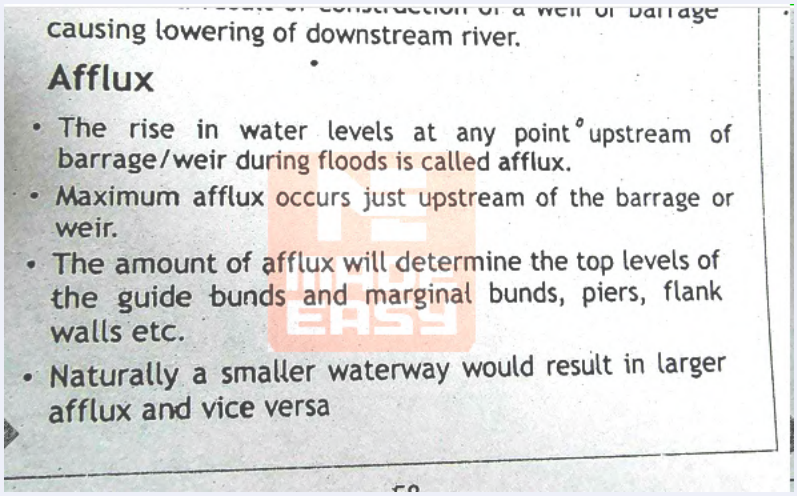
- High flood level is required to determine the crest level and protection works.
- Maximum flood discharge is absolutely essential for hydraulic design.
- Design depends on the width and the cross section of the river.

End of Solution

17. In case of design of a weir or a barrage, by providing a higher afflux, the waterway and, therefore, the length of the weir can be reduced, but it will result in
(a) increased cost of training works
(b) reduced risk of failure by outflanking
(c) reduced scour
(d) reduced discharge intensity

Ans. (a)

- Afflux refers to the rise in the water level or increase in the discharge.
- Higher afflux will increase the risk of outflanking.
- Higher discharge passing capacity per unit length will cause more scour.
- Higher afflux and narrowed section will increase the discharge intensity.
- This increase in erosion and stability will cause increased cost of training works.


causing lowering of downstream river.

Afflux

- The rise in water levels at any point upstream of barrage/weir during floods is called afflux.
- Maximum afflux occurs just upstream of the barrage or weir.
- The amount of afflux will determine the top levels of the guide bunds and marginal bunds, piers, flank walls etc.
- Naturally a smaller waterway would result in larger afflux and vice versa

End of Solution

18. In case of an irrigation canal, the seepage losses depend upon
(a) the condition of the canal; the seepage through a silted canal is more than that from a new canal
(b) amount of silt carried by the canal; the less the silt, the lesser are the losses
(c) velocity of canal water; the more the velocity, the more will be the losses
(d) cross-section of the canal and its wetted perimeter

Ans. (d)

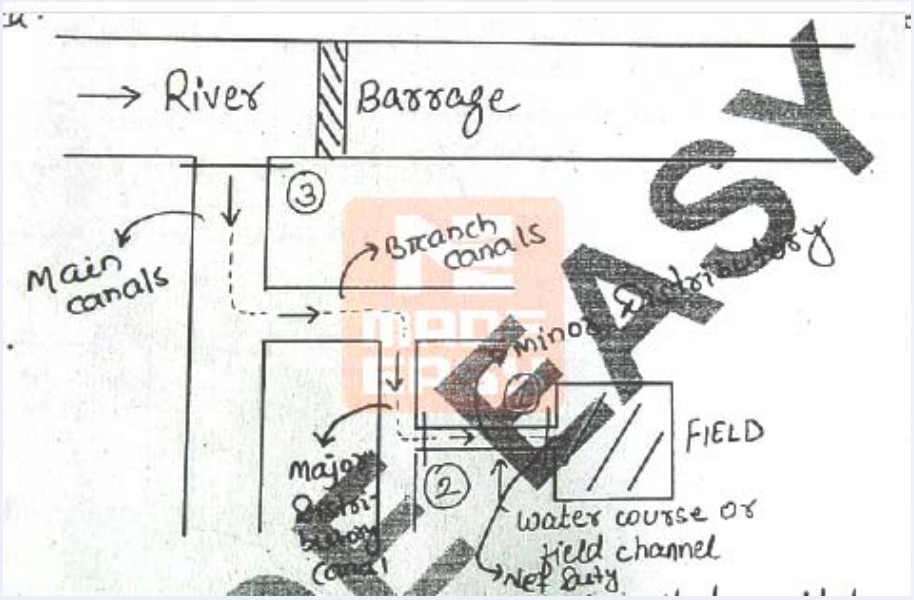
- Seepage losses are directly proportional to wetted perimeter. The more the surface is in contact with the water, the more will be the seepage.
- The seepage through a silted channel will be less than that of from a new canal because of all the silt present at the bed of canal. The less the silt, more are the losses.

End of Solution

19. Which one of the following is not a way of alignment of canals?
(a) Watershed canal (b) Contour canal
(c) Distribution canal (d) Side slope canal

Ans. (c)

- Distribution canals refer to purpose or function of canal not the alignment.
- A distribution canal can be aligned with any alignment technique.



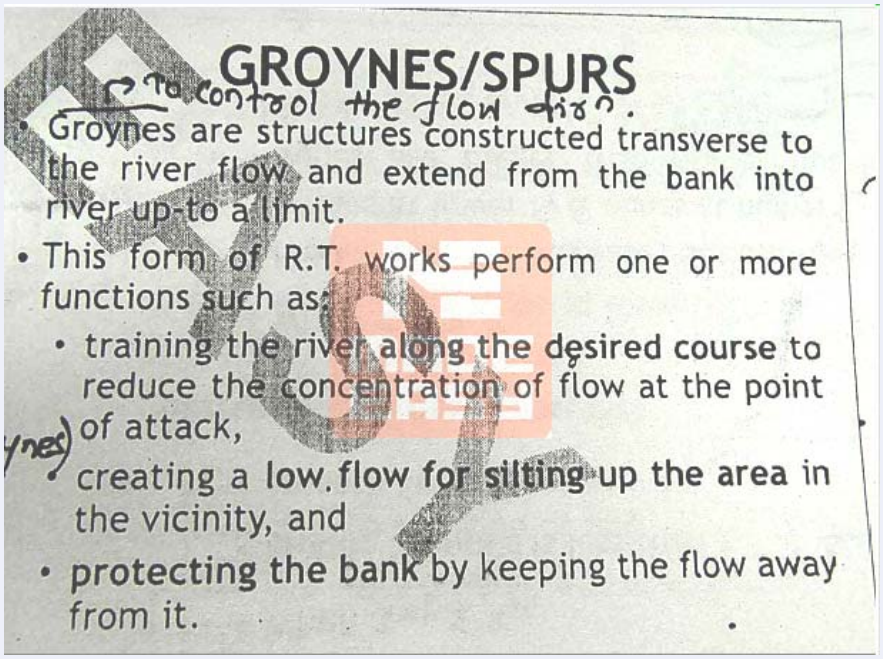
End of Solution

20. Which one of the following is one of the objectives of river training?
(a) To make the river change its course
(b) To protect the river banks by deflecting the river away from the attacked banks
(c) To avoid disposal of sediment load
(d) To avoid providing minimum water depth required for navigation

Ans. (b)

- River training aims to stabilise the river course, not unnecessarily change it.
- Techniques like groynes, spurs and revetments are used to protect the banks from erosion by guiding the flow away from vulnerable sections.
- River training does not avoid disposal of sediment load, instead manages sediment deposition to maintain a stable channel.

- Providing minimum water depth for navigation is one of the objectives of river training.



End of Solution

21. While laying or designing the water distribution system, attempts should be made to keep the
(a) sewer lines and waterlines as far away as possible
(b) sewer lines above the waterlines
(c) sewer lines exactly below the waterlines
(d) sewer lines and waterlines close to each other

Ans. (a)

Water pipelines carry potable (drinking) water, while sewer lines carry wastewater. Any leakage from sewer lines can contaminate nearby water pipelines.
To prevent cross-contamination, preferably atleast 1 m (3 feet) separation is required.
Also, sewer line should be below the water line (never above).

End of Solution

22. Which one of the following factors should be kept in view while fixing the design period for waterworks?
(a) Funds available for the completion of the project; if more funds are available, the design period shall be more
(b) Life of the pipe and other structural materials used in the water supply scheme
(c) As far as possible, the design period should be longer than the life of materials used in the water supply scheme
(d) Rate of interest on the loans taken to complete the project; if it is more, it will be good to keep the design period more

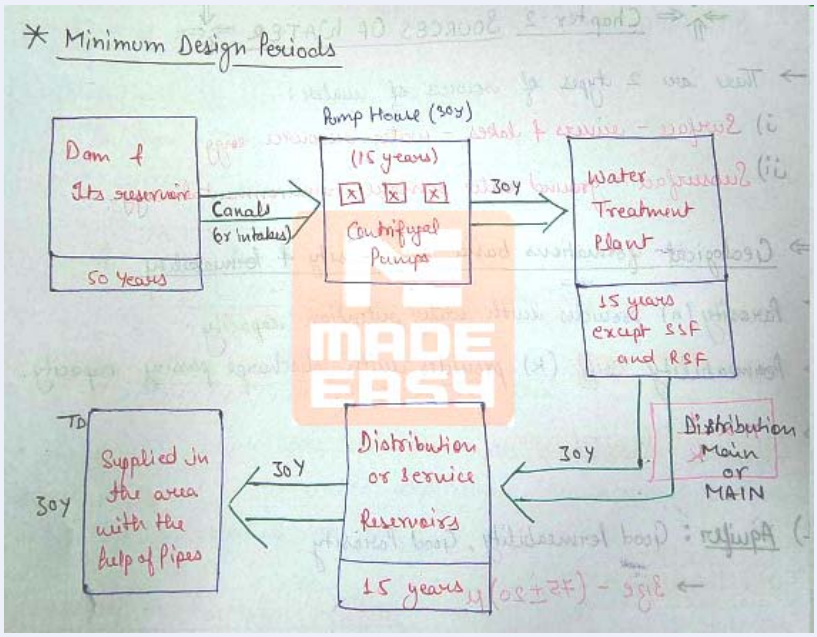
Ans. (b)

Design period is the number of years in the future for which a facility is planned to serve efficiently. According to CPHEEO, the design period should be aligned with the expected life of the component.

Note:

(1) Funds affect capacity but do not determine design period.

(2) Interest rates affect financial viability, not technical design period.



End of Solution

23. Which one of the following is the function of the Central Board set up by the Government of India for water pollution prevention?

(a) To carry out river surveys for classification

(b) To help and provide research facilities in connection with water pollution control

(c) To provide and arrange training facilities to the people connected with water pollution control

(d) To lay down water purification standards

Ans. (b)

As per water (prevention and control of pollution) Act, 1974, functions of CPCB include:

- Advising the central Govt. on water pollution issues.
- Coordinating activities of state boards.
- Providing technical assistance and conducting research.
- Plan and organize the training of persons engaged or to be engaged in water pollution control (that's what option (c) says)
- Collect, compile and publish technical and statistical data relating to water pollution and some other functions.

End of Solution

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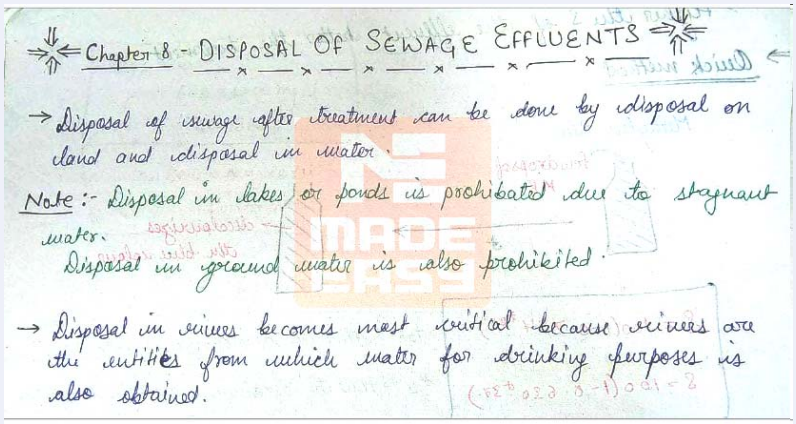
24. Which of the following measures is/are to be adopted against water pollution?
1. The sewage before discharging into the water body may need not to be treated
2. The industrial waste should not be treated before disposing it off.
3. As far as possible, water sources should not be used for discharging the sewage

Select the correct answer.

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

Ans. (c)

A preventive approach to water pollution involves avoiding the use of natural water bodies for sewage disposal altogether, favoring alternative treatment and disposal methods.

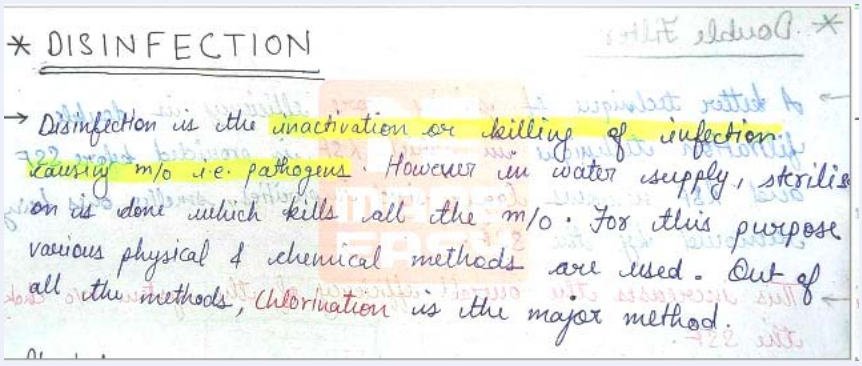


End of Solution

25. Which one of the following is one of the objectives of water treatment?
(a) To detect the dissolved gases, murkiness, and colour of water
(b) To detect the pleasant and objectionable tastes of water
(c) To kill all the pathogenic germs, which are harmful to human health
(d) To detect the tuberculating and corrosive properties of water

Ans. (c)

The objective of water treatment is to act upon removing undesirable physical, chemical, and biological parameters or bring them within some limits. Options (a), (b) and (d) are related to detecting them.



End of Solution

26. Which one of the following aspects should be considered at the time of final selection of a sewage treatment plant?

(a) The site should be safe from floods for all the time
(b) The site should not be situated on the leeward side of the wind
(c) The site should be as far as possible far away from the town
(d) The subsoil water level at the site should not remain low even during monsoon

Ans. (a)

When selecting a site for STP, the following are key considerations as per CPHEEO:

1. STP sites must be above HFL to avoid overflow or change during monsooons.
2. They should be preferably at the leeward side so that odour is carried away from the populated area.
3. It should be close enough to minimize pumping costs. However, there are some minimum distance criteria but is doesn't mean that it should be as far as possible.
4. High subsoil water level is a concern. Hence (d)'s logic is flawed.

End of Solution

27. A completely mixed activated process is to be used to treat a wastewater flow of 500 m^3/hr having soluble BOD_5 of 250 mg/L. If the concentration of soluble BOD_5 escaping treatment is 10 mg/L, the treatment efficiency will be

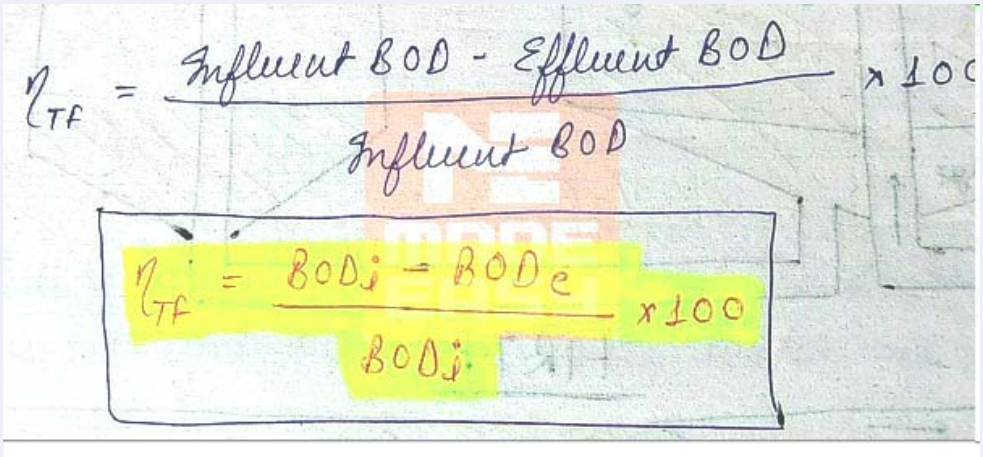
(a) 82% (b) 86%
(c) 92% (d) 96%

Ans. (d)

Given: $BOD_o = 250$ mg/lt
$BOD_e = 10$ mg/lt

$$\text{Efficiency, } \eta_{ASP} = \left(\frac{BOD_o - BOD_e}{BOD_o}\right) \times 100$$

$$\Rightarrow \quad \eta_{ASP} = \left(\frac{250-10}{250}\right) \times 100 = \left(\frac{240}{250}\right) \times 100 = 96\%$$



End of Solution

28. The land treatment of sewage is suitable when
(a) the overall rainfall is very high
(b) there is no river or natural water course
(c) the quantity of sewage is less
(d) rivers usually run full during summer

Ans. (b)

Land treatment or disposal on load or sewage farming is a natural method where sewage is applied to land.

This method is suitable when:

- No nearby water body is available for discharge.
- Large open land is available.
- Soil has good infiltration capacity.
- The area is not prone to heavy rainfall (to avoid waterlagging)

Note: Consider option (d): River availability in fact, helps in disposal of sewage, sometimes even directly if dilution ratios are high.

End of Solution

29. The excessive acidity or alkalinity of the particular wastewater is neutralized by adding alkali or acid, and this is achieved in
(a) the sedimentation tank
(b) the equalization tank
(c) the flocculation tank
(d) the purification tank

Ans. (b)

Equalization tank serves dual purpose:

i. Flow equalization to smoothen variations in flow rate.
ii. Quality equalization to balance out pH or organic loading.

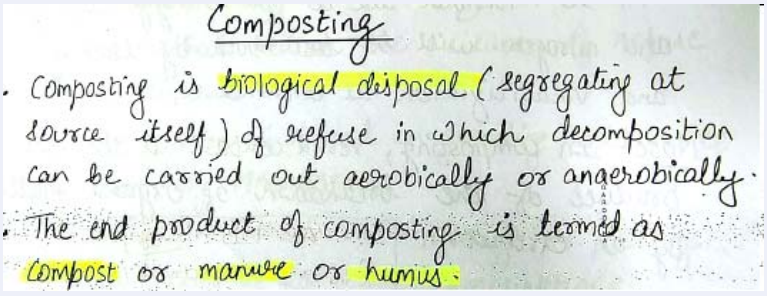
End of Solution

30. Which one of the following is an aerobic method of decomposing solid waste?
(a) Sanitary landfill
(b) Composting
(c) Incineration
(d) Open dumping

Ans. (b)

Composting is a biological process and can be performed both aerobically or anaerobically.

Note: Open dumping is not a method of treatment and can happen aerobically or anaerobically, which is uncontrolled and unhygienc way of disposal.



End of Solution

31. The area of the plan of an old survey plotted to a scale of 15 m to 1 cm now measures 80.2 cm^2 as found by a planimeter. The plan is found to have shrunk, so that a line originally 10 cm long now measures 9.8 cm. The true area of the survey will be nearly

(a) 81.5 m^2 (b) 83.5 m^2

(c) 85.5 m^2 (d) 87.5 m^2

Ans. (*)

Given:

Original scale, OS = 1 cm : 15 m

Area on map, A_m = 80.2 cm^2

Original length = 10 cm

Shrunk length = 9.8 cm

Now, Shrinkage factor, $SF = \dfrac{\text{Shrunk length}}{\text{Original length}}$

$$\Rightarrow \quad SF = \frac{9.8}{10} = 0.98$$

Also, Shrunk scale, $SS = SF \times OS$

$$\Rightarrow \quad SS = 0.98 \times \frac{1\text{cm}}{15\text{m}}$$

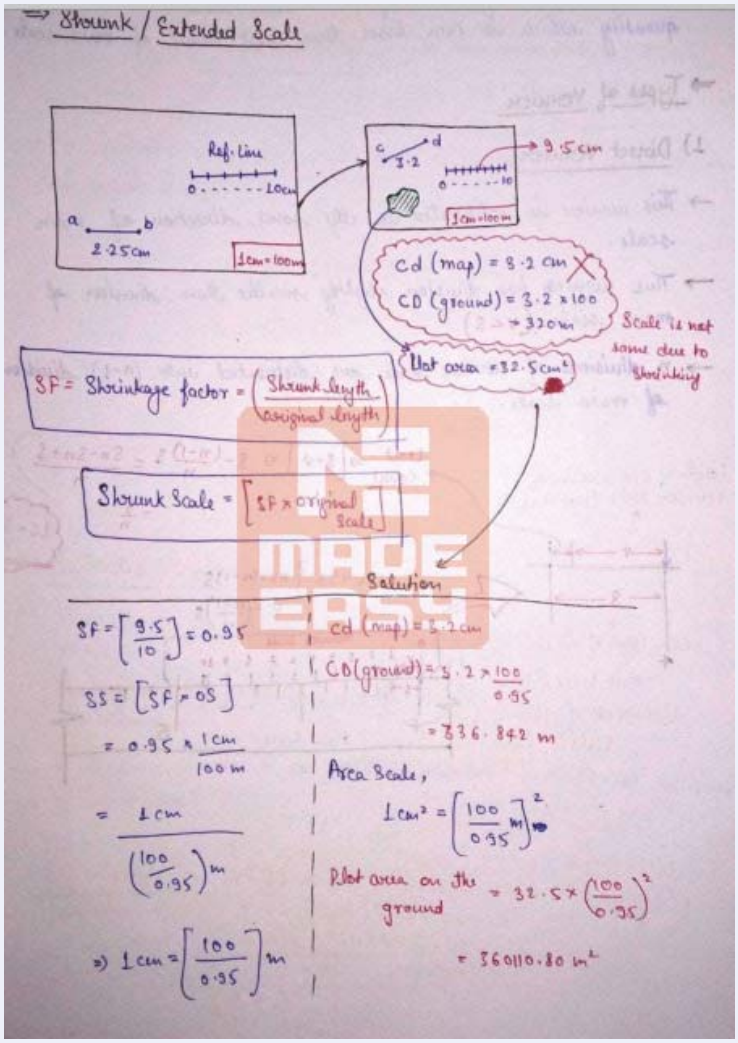
$$\Rightarrow \quad SS = \frac{0.98\text{cm}}{15\text{m}}$$

$$\therefore \quad 1\text{ cm} = \frac{0.98\text{cm}}{15\text{m}}$$

$$\Rightarrow \quad 1\text{ cm}^2 = \left(\frac{15}{0.98}\right)^2 \text{m}^2$$

$$\therefore \quad 80.2\text{ cm}^2 = \left(\frac{15}{0.98}\right)^2 \times 80.2\text{m}^2 = 18789.05\text{ m}^2$$

The true area of the survey = 18789.05 m^2



End of Solution

32. Magnetic declination at a place is
(a) the horizontal angle which a line makes with the true meridian
(b) the horizontal angle which a line makes with the magnetic meridian
(c) the horizontal angle between the true meridian and the magnetic meridian
(d) the horizontal angle which a line makes with an arbitrary meridian

Ans. (c)
Magnetic declination at a place in defined as the horizontal angle between the true meridian and the magnetic meridian.

End of Solution

33. The staff reading with a 4 m staff at a point A is 3.5 m. The top of the staff is 10 cm off the vertical through the bottom of the staff. If the staff is held vertically, the correct reading will be nearly

(a) 3.0 m (b) 3.4 m
(c) 3.8 m (d) 4.2 m

Ans. (b)

Since, ΔABO and ΔMNO are similar,

$$\therefore \quad \frac{MN}{AB} = \frac{OM}{OA}$$

$$\Rightarrow \quad \frac{x}{0.1} = \frac{3.5}{4}$$

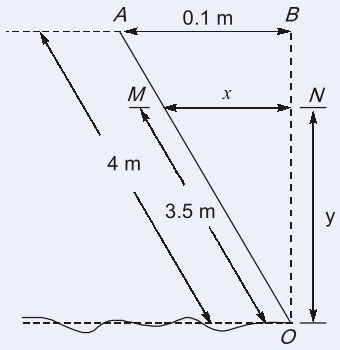
$$\Rightarrow \quad x = 0.0875 \text{ m}$$

From ΔMNO,

$$OM^2 - MN^2 = ON^2$$

$$\Rightarrow \quad 3.5^2 - 0.0875^2 = y^2$$

$$\Rightarrow \quad y = 3.499 \text{ m}$$



End of Solution

34. The circumpolar stars are those having polar distances

(a) equal to the latitude of the place of observation
(b) less than the latitude of the place of observation
(c) twice the latitude of the place of observation
(d) thrice the latitude of the place of observation

Ans. (b)

- A circumpolar star is a star that near sets below the horizon as per the observer's latitude.
- Polar distance is the angular distance of a star from the celestial pole.
- The polar distances of circumpolar stars is always less than the latitude of the place of the observation.

End of Solution

35. In electromagnetic wave theory, the energy Q is

(a) $\frac{hc}{\lambda}$ (b) $\frac{\lambda c}{h}$

(c) $\frac{h}{\lambda c}$ (d) $\frac{\lambda h}{c}$

where h is Planck's constant, λ is wavelength, and c is velocity.

Ans. (a)

In electromagnetic wave theory concept, the energy Q is given by

$$Q = \frac{hc}{\lambda}$$

where, h = Planck's constant
c = Speed of light
λ = Wavelength

End of Solution

36. Which one of the following statements is correct in the case of a map versus an aerial photograph?

(a) A map is an orthogonal projection, whereas an aerial photograph is a central projection.
(b) Both a map and a photograph have a constant scale.
(c) The amount of details on both a map and an aerial photograph is selective.
(d) Due to symbolic representation, the clarity of details is more on a photo than on a map.

Ans. (a)

- A map is created through orthographic (parallel) projection. All features are projected onto a flat plane using parallel lines perpendicular to the map plane.
- An aerial photograph is taken from a camera fixed in an aircraft. All ground features are projected toward a single focal point. This is called central projection.
- A map has a uniform scale but in an aerial photograph the scale is not constant as it varies with terrain elevation and camera tilt.
- Maps include selective and symbolic representation of features while aerial photos capture everything visible at the moment.
- Photos can show more visual detail but not symbolic clarity or thematic information like maps.

End of Solution

37. If the centrifugal ratio is given and comfort conditions hold good, the length of the transition curve L for roads will be

(a) $16.52\sqrt{R}$ (b) $12.80\sqrt{R}$
(c) $8.80\sqrt{R}$ (d) $4.52\sqrt{R}$

Ans. (c)

As per IRC 73, if the centrifugal ratio is given and comfort conditions hold good, the length of transition curve L for roads will be,

$$L = 8.80\sqrt{R}$$

where, R is radius of transition curve.

End of Solution

38. Which one of the following is an advantage of providing the transition curve on a road?
(a) It allows a sudden transition of curvature from the tangent to the circular curve
(b) The radius of curvature increases suddenly
(c) It is provided for the sudden change in superelevation
(d) It eliminates the danger of derailment, overturning, or sideslipping of vehicles and discomfort to passengers

Ans. (d)
- Sudden transition defeats the purpose of transition curves.
- Radius of curvature increases gradually, not suddenly.
- Transition is gradual in superelevation.
- Transition curve reduces the risk of overturning and skidding and the discomfort to passengers.

End of Solution

39. A double-acting reciprocating pump, running at 40 r.p.m., is discharging 1.0 m^3 of water per minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20 m and 5 m, respectively. The theoretical discharge for the double-acting pump is

(a) $\frac{1.6\pi}{300} m^3/s$ (b) $\frac{0.8\pi}{300} m^3/s$

(c) $\frac{2.4\pi}{300} m^3/s$ (d) $\frac{0.4\pi}{300} m^3/s$

Ans. (a)

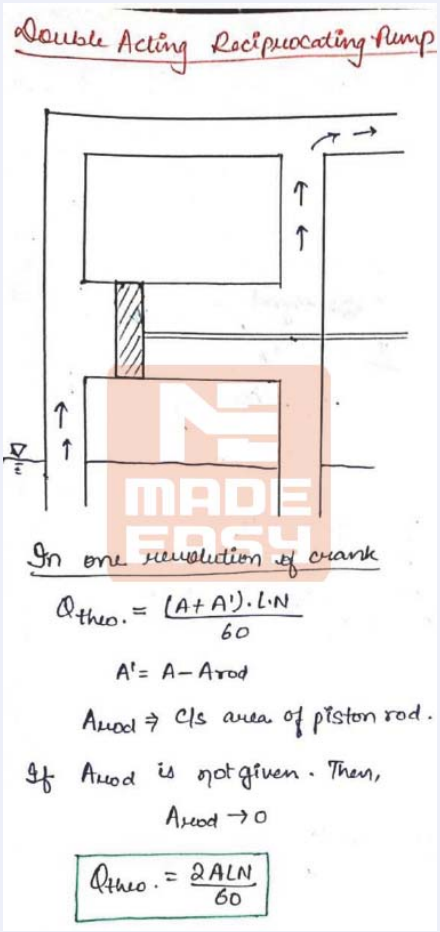
Given: $N = 40$ rpm, $Q = 1$ m^3/min
$D = 200$ mm, $L = 0.4$ m

Theoritical discharge:

$$Q_{theo} = \frac{2ALN}{60}$$

$$= \frac{2 \times \frac{\pi}{4}(0.2)^2 \times 0.4 \times 40}{60}$$

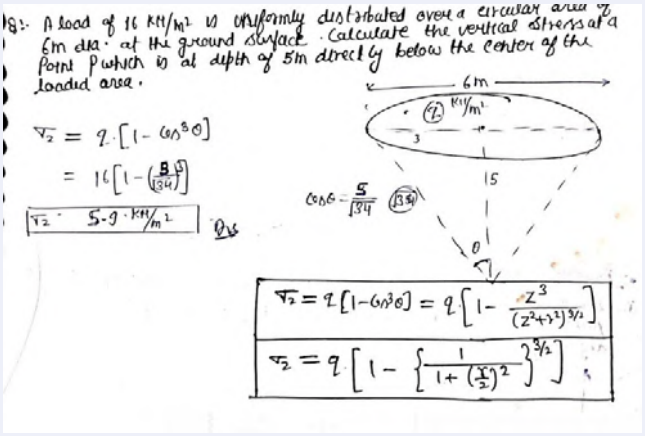
$$Q_{theo} = \frac{1.6\pi}{300} m^3/s$$



End of Solution

40. The plunge of the fold is
(a) a line drawn parallel to the hinge line of a fold
(b) the angle of inclination of the fold axis with the horizontal as measured in a vertical plane
(c) a line representing the intersection of the axial plane of a fold with any bed of the fold
(d) a line drawn vertical to the hinge line of a fold

Ans. (b)
Defined as the angle between the fold axis and the horizontal, measured in a vertical plane.
- If the hinge line is horizontal → non-plunging fold.
- If inclined → plunging fold.



End of Solution

41. A transition curve should satisfy which of the following conditions?

1. It should meet the straight line part of the road tangentially
2. The length of it must be such that the cant or superelevation can be provided conveniently to its maximum value at the beginning of the circular curve
3. The rate of increase of the curvature should be such that it matches with the rate of increase of cant

Select the correct answer.

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

Ans. (d)

- It is the property of transition curve to meet the straight line tangentially.
- The value of superelevation or cant is zero at the start of the transition curve and maximum at its end i.e. beginning of circular curve.
- For vehicle stability and comfort, centrifugal acceleration must increase uniformly. This is ensured if the curvature and cant both increase at the same rate along the transition.

End of Solution

42. The total length L of a valley transition curve for comfort condition is

(a) $2\left[\frac{Nv^3}{C}\right]^{1/2}$ (b) $\frac{1}{2}\left[\frac{Nv^2}{C}\right]^{1/2}$

(c) $2\left[\frac{Nv^2}{C}\right]^{1/2}$ (d) $\frac{1}{2}\left[\frac{Nv^3}{C}\right]^{1/2}$

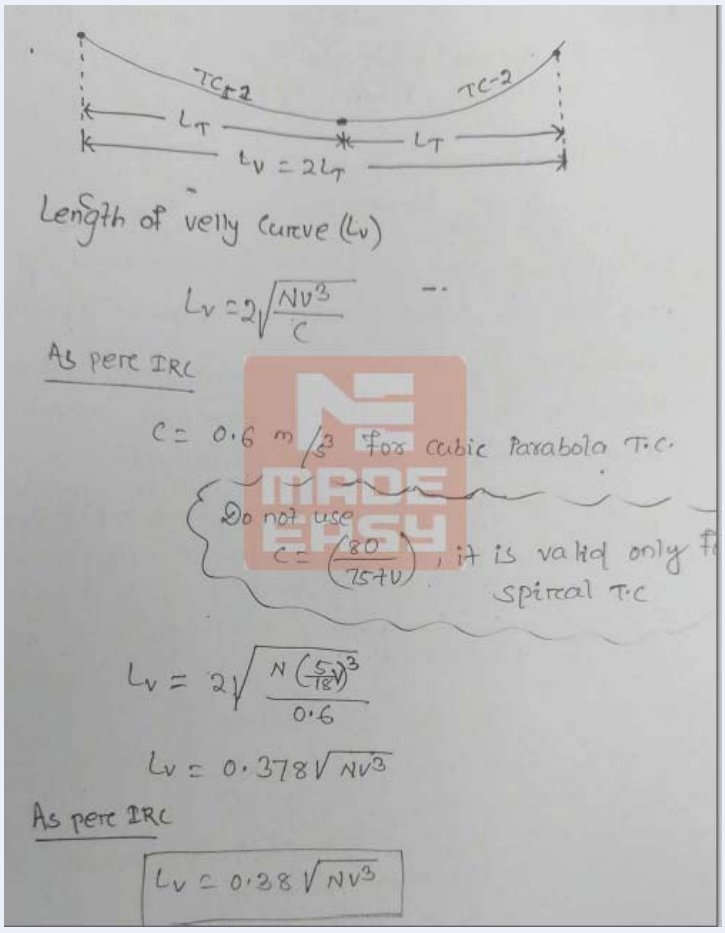
where N is deviation angle v is design speed and C is allowable rate of change of centrifugal acceleration.

Ans. (a)

Length of valley curve for comfort condition,

$$L_v = 2\left[\frac{NV^3}{C}\right]^{1/2}$$

where, L_v is length of valley curve.
N is deviation angle.
V is design speed.
C is allowable rate of change of centrifugal acceleration.



End of Solution

43. For a roadway of 100 km/hr design speed, if the maximum allowable superelevation rate is 0.12 and the maximum friction coefficient is 0.12, the minimum radius of curvature will be

(a) 328 m
(b) 304 m
(c) 288 m
(d) 264 m

Ans. (a)

Maximum radius of curvature, $R_{min} = \dfrac{V^2}{127(e_{max}+f)}$

where,
V is design speed in kmph
e_{max} is maximum allowable superelevation
f is maximum friction coefficient.

$$\Rightarrow \quad R_{min} = \frac{100^2}{127(0.12+0.12)} = 328\text{m}$$

End of Solution

44. The vertical stress σ_z under a uniformly distributed circular load based on Boussinesq's theory is

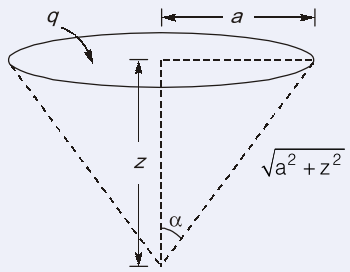
(a) $p\left[1-\dfrac{z^3}{(a^2+z^2)^{3/2}}\right]$ (b) $p\left[1+\dfrac{z^3}{(a^2+z^2)^{3/2}}\right]$

(c) $p\left[1-\dfrac{z^2}{(a^2+z^2)^{3/2}}\right]$ (d) $p\left[1+\dfrac{z^2}{(a^2+z^2)^{3/2}}\right]$

where p is surface pressure, z is depth at which σ_z is computed, and a is the radius of the loaded area.

Ans. (a)

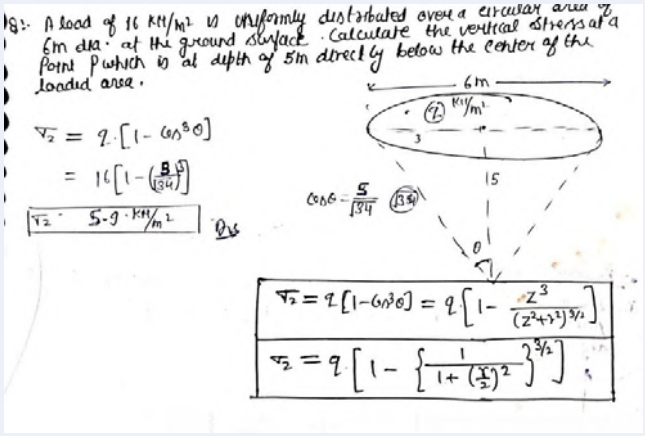
Vertical stress under a uniformly distributed circular load by Boussinesq's theory



$$\sigma_z = q(1 - \cos^3\alpha)$$

$$\Rightarrow \quad \sigma_z = q\left[1-\left(\frac{z}{\sqrt{d^2+z^2}}\right)^3\right]$$

$$\Rightarrow \quad \sigma_z = q\left[1-\frac{z^3}{(a^2+z^2)^{3/2}}\right]$$



End of Solution

45. In the CBR method of pavement design, the mixed commercial vehicles with different axle loads are to be converted in terms of the cumulative number of standard axle load N_S, using the equation

(a) $N_S = \dfrac{365A\left[(1+r)^n - 1\right]}{r} \times F$

(b) $N_S = \dfrac{365A\left[(1+r)^n + 1\right]}{r} \times F$

(c) $N_S = \dfrac{365A\left[(1-r)^n - 1\right]}{r} \times F$

(d) $N_S = \dfrac{365A\left[(1-r)^n + 1\right]}{r} \times F$

where A is the number of vehicles/day for completed construction for the number of lanes, r is the annual growth rate of commercial vehicles, n is the design life of the pavement, and F is the vehicle damage factor.

Ans. (a)

Cumulative number of standard axle loads,

$$N_s = \frac{365\left[(1+r)^n - 1\right]}{r} AF$$

where, r is annual growth rate
A is number of vehicles per day
n is design life of pavement
F is vehicle damage factor

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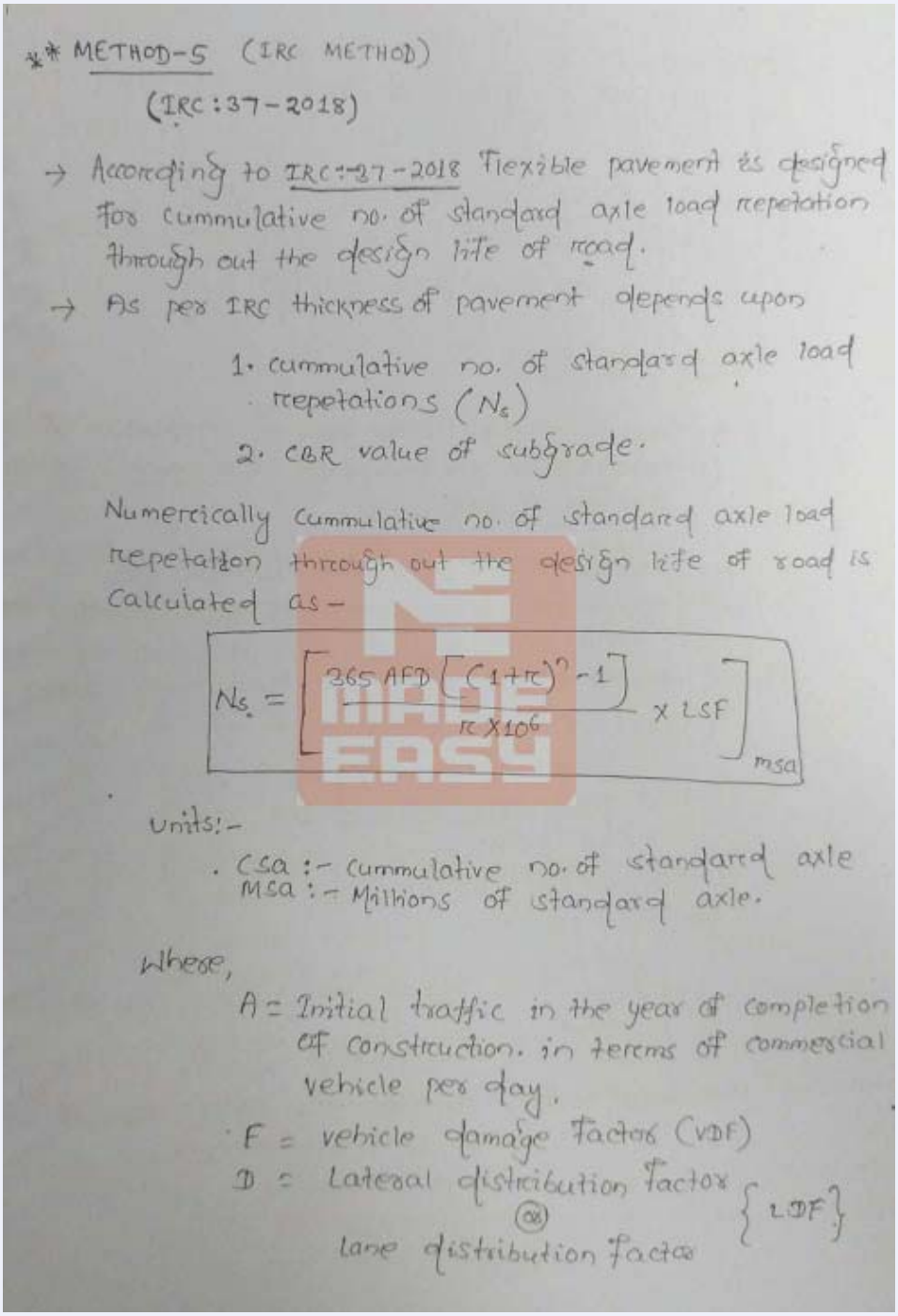


** METHOD-5 (IRC METHOD)

(IRC:37-2018)

→ According to IRC:37-2018 flexible pavement is designed for cummulative no. of standard axle load repetation through out the design life of road.

→ As per IRC thickness of pavement depends upon

1. cummulative no. of standard axle load repetations (N_s)
2. CBR value of subgrade.

Numerically cummulative no. of standard axle load repetation through out the design life of road is calculated as -

$$N_s = \left[\frac{365\,AFD\left[(1+r)^n - 1\right]}{r \times 10^6} \times LSF\right]_{msa}$$

Units:-

- Csa :- Cummulative no. of standard axle
  Msa :- Millions of standard axle.

Where,

A = Initial traffic in the year of completion of construction. in terms of commercial vehicle per day.

F = vehicle damage factor (VDF)

D = Lateral distribution factor (or) lane distribution factor } LDF

End of Solution

46. A circular disc 3 m in diameter is held normal to a 26.4 m/s wind of density 1.2 kg/m^3. If the coefficient of drag of the disc is 1.1, the force required to hold it at rest will be nearly

(a) 1.25 kN (b) 2.5 kN
(c) 3.25 kN (d) 4.2 kN

Ans. (c)

Given: Diameter of disc, D = 3 m
Wind velocity, U_∞ = 26.4 m/sec
Wind density, ρ_{air} = 1.2 kg/m^3
Drag ceofficient, C_D = 1.1

Force required to hold the disc is given by

$$F_D = C_D \frac{1}{2}\rho_{air} A U_\infty^2$$

$$\Rightarrow \quad F_D = 1.1 \times \frac{1}{2} \times 1.2 \times \frac{\pi}{4}(3)^2 \times (26.4)^2$$

$$\Rightarrow \quad F_D = 3.25 \text{ kN}$$

Q: Find the difference in drag force exerted on a flat plate of size 2m x 2m when the plate is moving at a speed of 4 m/sec normal to its plane in (i) water (ii) air of density 1.24 Kg/m^3. Co-efficient of drag is given as 1.15.

Soln Given:

$A = 2 \times 2 = 4 \text{ m}^2$
$U = 4 \text{ m/sec}$
$C_D = 1.15$

(i) Drag force $F_D = C_D \cdot A \cdot \frac{\rho U^2}{2} = 1.15 \times 4 \times \frac{10^3 \times 4^2}{2}$

$\boxed{F_D = 36800 \text{ N}}$ Ans.

(ii) Drag force when the plate is moving in air

$F_D = C_D \cdot A \cdot \frac{\rho U^2}{2} = 1.15 \times 4 \times \frac{1.24 \times 4^2}{2}$

$\boxed{F_D = 45.6 \text{ N}}$

∴ Difference in drag force.
= (i) − (ii)
= 36800 − 45.6 = 36754.4 N.

End of Solution

47. The phenomenon of sudden rise in pressure in the pipe is known as

(a) pressure rise (b) water hammer
(c) stream function (d) hydraulic gradient

Ans. (b)

Water hammer occurs when a flowing liquid in a pipe is abruptly stopped, causing a sudden increase in pressure due to the rapid change in momentum. This pressure surge travels through the pipe, often creating a hammering sound.

End of Solution

48. What is the discharge through the venturi flume built in a rectangular channel 1 m wide and having its throat width 0.4 m? The upstream head is 0.57 m, the measured head in the throat is 0.5 m, and the value of C_d is 1.

(a) 210 L/s (b) 230 L/s
(c) 250 L/s (d) 270 L/s

Ans. (b)

Given:

Upstream head, $H_1 = 0.57$ m

Head at throat, $H_2 = 0.50$ m

Coefficient of discharge, $C_d = 1$

Width of throat = 0.4 m

Area of flow at throat, $A = 0.4 \times H_2 = 0.4 \times 0.5 = 0.2\ m^2$

Discharge through the rectangular venturi-flume is given by

$$Q = C_d A\sqrt{2g(H_1 - H_2)}$$

$$\Rightarrow \quad Q = 1 \times 0.2\sqrt{2 \times 9.81 \times (0.57 - 0.50)}$$

$$\Rightarrow \quad Q = 0.23438\ m^3/sec \simeq 234.3\ lt/sec$$

End of Solution

49. In a long pipe, when the flowing water is suddenly brought to rest by closing the valve or by any similar cause, there will be a sudden rise in pressure. The magnitude of pressure rise depends on

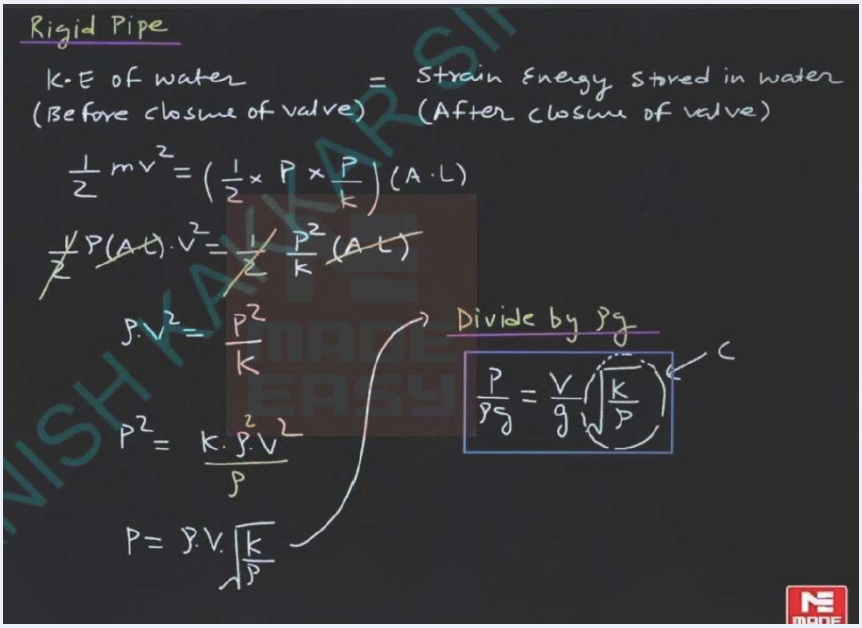
(a) the speed at which the valve is opened
(b) the velocity of flow
(c) the diameter of the pipe
(d) the thickness of the pipe wall

Ans. (b)

$$\therefore \quad \frac{P}{\rho g} = \frac{v}{g}\sqrt{\frac{k}{\rho}}$$

$$\Rightarrow \quad P = \rho V\sqrt{\frac{k}{\rho}}$$

The magnitude of pressure rise depends upon the velocity of flow.



End of Solution

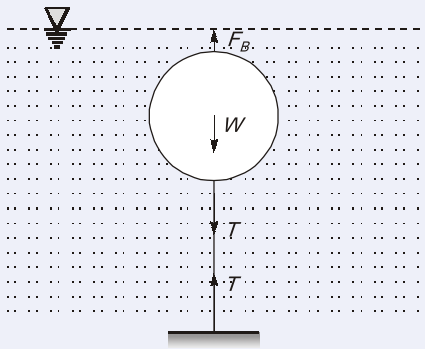
50. A spherical object of 1.45 m diameter is completely immersed in a water reservoir and chained to the bottom. If the chain has a tension of 5.2 kN, the weight of the object when it is taken out of the reservoir into the air will be nearly

(a) 15.5 kN (b) 12.5 kN

(c) 10.5 kN (d) 7.5 kN

Ans. **(c)**

Given: $D = 1.45$ m, $T = 5.2$ kN



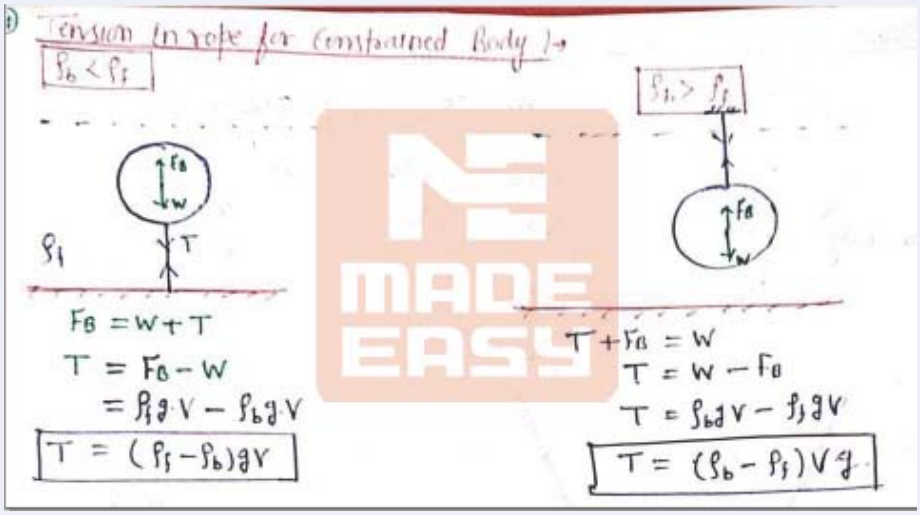
For equilibirum of object.

$$F_B = W + T$$

$$\Rightarrow \quad W = F_B - T$$

$$\Rightarrow \quad W = \frac{10^3 \times \frac{4}{3}\pi\left(\frac{1.45}{2}\right)^3 \times 9.81}{10^3} - 5.2$$

$$\Rightarrow \quad W \simeq 10.5 \text{ kN}$$



End of Solution

51. A double-acting reciprocating pump having a piston area of 0.1 m^2 has a stroke 0.30 m long. If the pump is discharging 2.4 m^3 of water per minute at 45 r.p.m. through a height of 10 m, the power required to drive the pump will be nearly

(a) 4.98 kW (b) 4.86 kW

(c) 4.64 kW (d) 4.42 kW

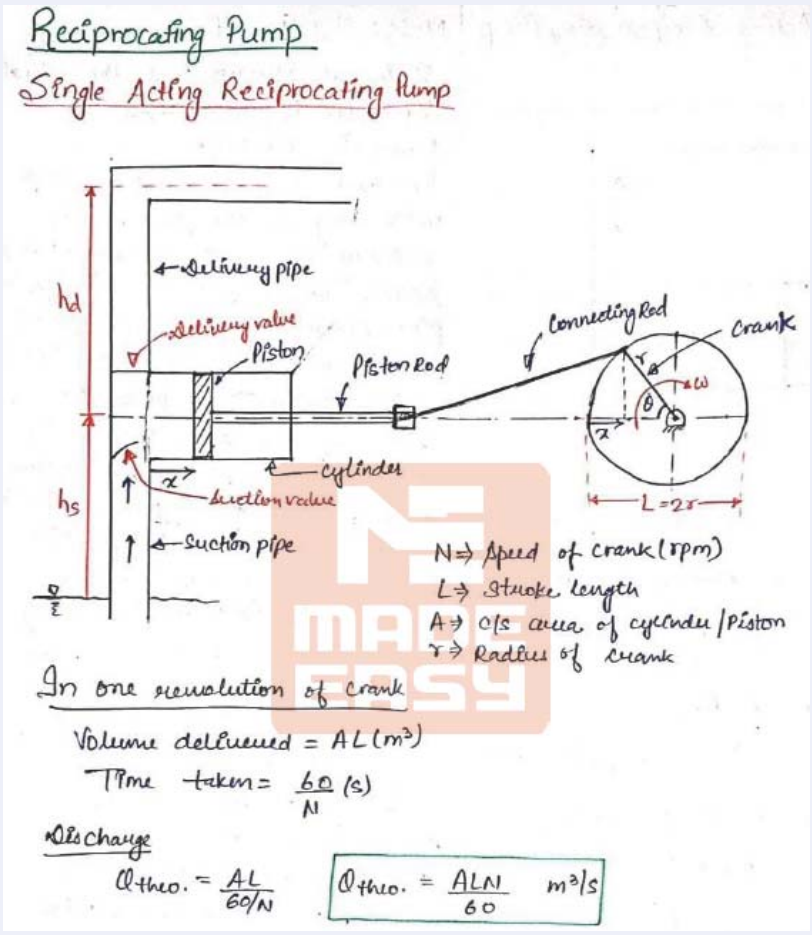
Ans. (d)

$$\text{Power required} = \rho g Q_{theo} \times h$$

$$\Rightarrow P = \rho g\left(\frac{2ALN}{60}\right)h$$

$$\Rightarrow P = 10^3 \times 9.81 \times \left(\frac{2 \times 0.1 \times 0.3 \times 45}{60}\right) \times 10$$

$$\Rightarrow P = 4414.5 \text{ N} \simeq 4.42 \text{ kN}$$



End of Solution

52. A centrifugal pump is required to lift water to a total head of 40 m at the rate of 50 L/s. If its overall efficiency is 62%, the power required for the pump will be

(a) 25.6 kW (b) 28.4 kW

(c) 31.6 kW (d) 34.4 kW

Ans. (c)

Given: Total head, H_m = 40 m

Rate of flow, Q = 50 lt/sec = 0.05 m³/sec

Overall efficiency, η_0 = 62%

$$\therefore \quad \eta_0 = \frac{\rho g Q H_m}{S.P.}$$

$$\Rightarrow \quad 0.62 = \frac{10^3 \times 9.81 \times 0.05 \times 40}{S.P}$$

$$\Rightarrow \quad S.P = 1645.16 \text{ Watt} \simeq 31.6 \text{ kW}$$

End of Solution

53. Full load is supplied by the turbine shaft when the diameter of the jet issuing from the nozzle is 150 mm. If the load suddenly drops to 36% of the full load, the jet diameter to regulate the speed will be

(a) 75 mm (b) 80 mm
(c) 85 mm (d) 90 mm

Ans. (d)

$$\text{Power required} = \rho g Q H$$

$$P \propto Q \propto D^2$$

$$\therefore \quad \frac{P_1}{P_2} = \left(\frac{D_1}{D_2}\right)^2$$

$$\Rightarrow \quad \frac{P}{0.36P} = \left(\frac{0.15}{D_2}\right)^2$$

$$\Rightarrow \quad D_2 = 0.09 \text{ m} = 90 \text{ mm}$$

End of Solution

54. What is the delta for a crop when its duty is 864 hectares/cumec on the field (the base period of this crop is 120 days)?

(a) 100 cm (b) 110 cm
(c) 120 cm (d) 130 cm

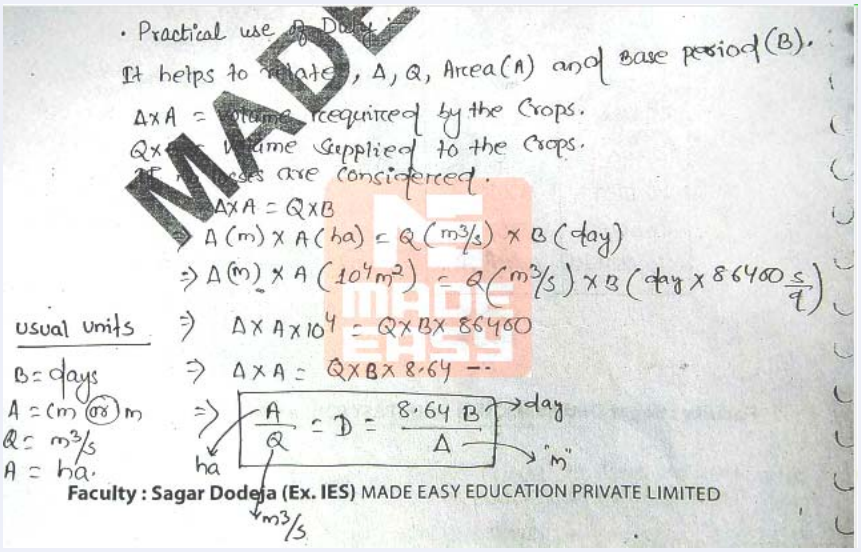
Ans. (c)

Given: Duty, $D = 864$ ha/cumec

Base period, $B = 120$ days

$$\text{Delta for a crop, } \Delta = \frac{864 \times B}{\Delta} \text{cm}$$

$$\Rightarrow \quad \Delta = \frac{864 \times 3120}{864} = 120 \text{cm}$$



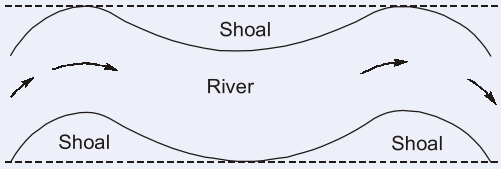
End of Solution

55. Formation of successive bends of reverse order may lead to the formation of a complete 'S' curve called

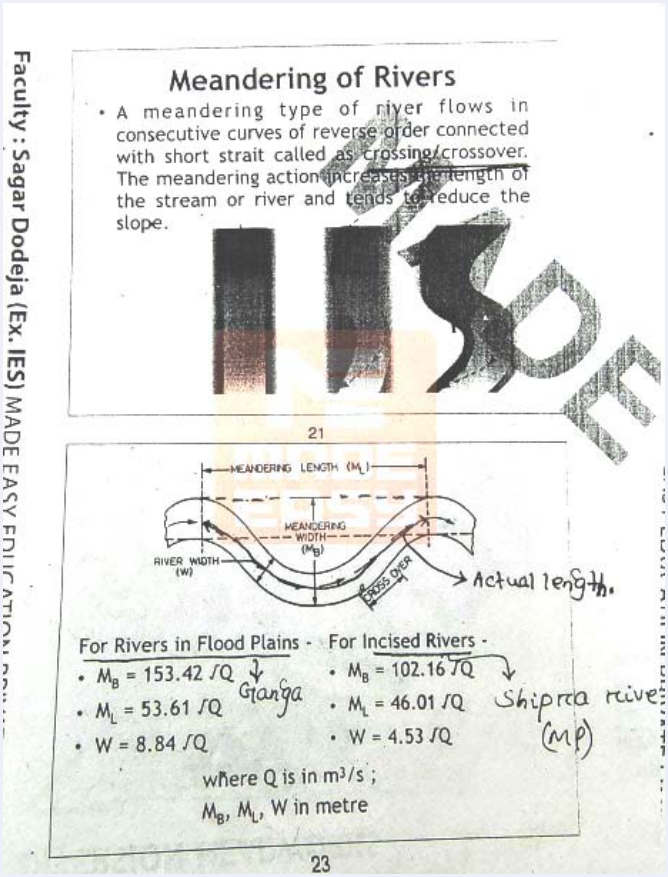
(a) bending
(b) meander
(c) silting
(d) scouring

Ans. (b)

In through stage, the river course takes the shape of a serpentile curve due to the formation of shoals in both the banks in a zig-zag manner which is known as meandering of river.



Meander formation



End of Solution

56. Which one of the following is the pre-construction measure for silting control in reservoirs?
(a) Construction of check dams
(b) Removal of post-flood water
(c) Mechanical stirring of the sediment
(d) Erosion control and soil conservation

Ans. (d)
- Erosion control and soil conservation are preventive measures taken in the catchment area.
- They aim to reduce soil erosion, which is the source of silt, thereby reducing the amount of silt that reaches the reservoir.

End of Solution

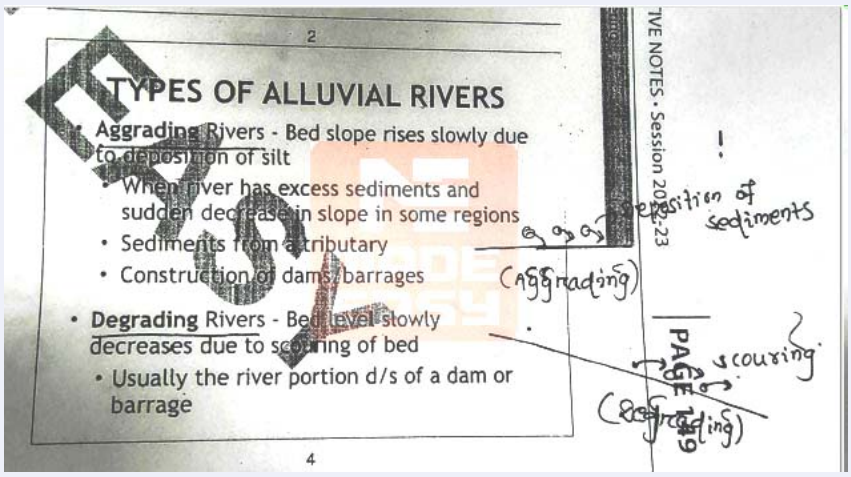
57. Which one of the following is a simple and straightforward analytical procedure for computing reservoir capacity and is used as an excellent alternative to the mass curve method of determining reservoir capacity?
(a) Sequent peak algorithm
(b) Inflow method
(c) Cumulative inflow
(d) First peak

Ans. (a)
- Sequent peak algorithm is a simple and systematic analytical method used to calculate minimum reservoir storage capacity required to meet a given demand.
- It analyzes the difference between cumulative inflow and cumulative demand and identifies the maximum deficit, which corresponds to the required storage.

End of Solution

58. Which one of the following rivers is a silting river?
(a) Aggrading river
(b) Degrading river
(c) Stable type river
(d) Braided river

Ans. (a)
An aggrading river is a river that is building up its bed level over time by depositing more sediment than it is capable of carrying causing silting.

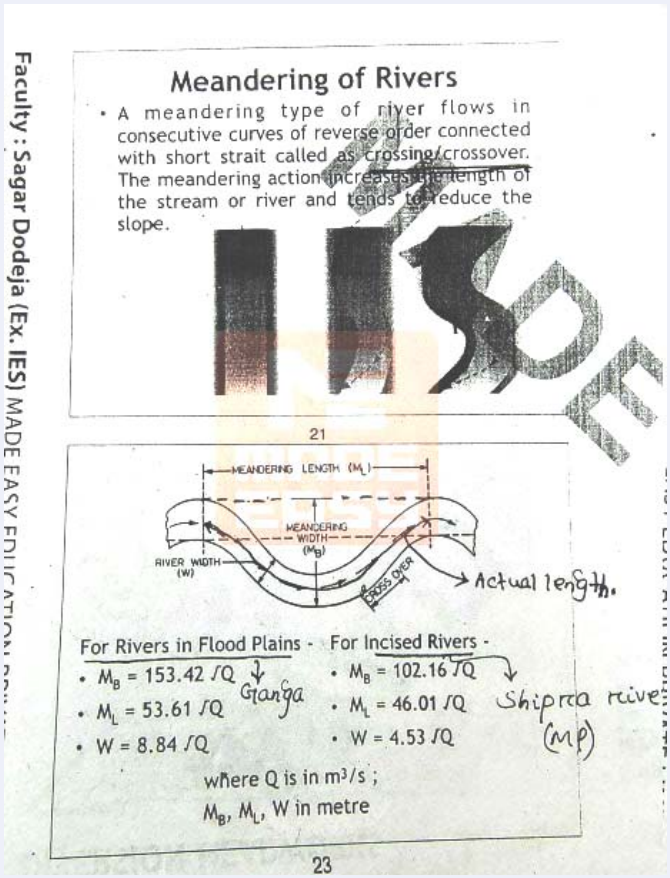


End of Solution

59. Rivers in alluvial flood plains which flow in a zig-zag fashion are called
(a) meandering (b) aggrading
(c) degrading (d) deltaic

Ans. **(a)**

The flow of rivers in zig-zag fashion is known as meandering.



End of Solution

60. All the methods of calculating crop evapotranspiration involve which one of the following relationships?
(a) $ET_c = 2K_cET_o$ (b) $ET_c = K_c\, ET_o$
(c) $ET_c = 4K_cET_o$ (d) $ET_c = \dfrac{K_c}{ET_o}$

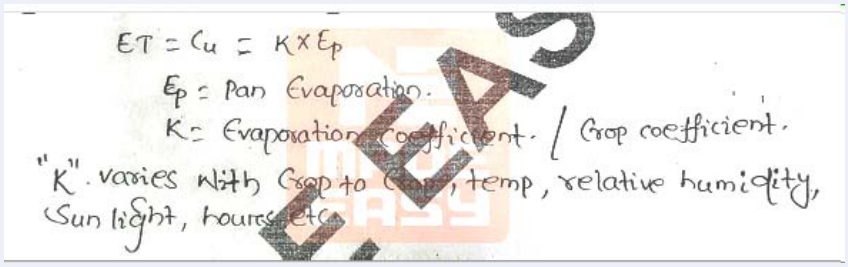
where K_c is crop coefficient, ET_o is potential evapotranspiration and ET_c is evapotranspiration of a specific crop.

Ans. **(b)**

Evapotranspiration is the combined loss of water from soil evaporation and plant transpiration given by,

$$ET = k \times ET_0$$

where, ET is evapotranspiration, k is crop coefficient, ET_0 is potential evapotranspiration.



End of Solution

61. In a district where the rainfall is heavy, a major district road of WBM pavement, 3.8 m wide, is to be constructed. The height of the crown with respect to the edges is

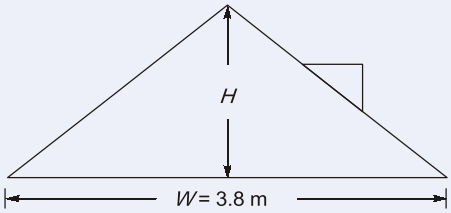
(a) 0.058 m (b) 0.072 m

(c) 0.064 m (d) 0.049 m

Ans. **(a)**

For WBM pavement in heavy rainfall,

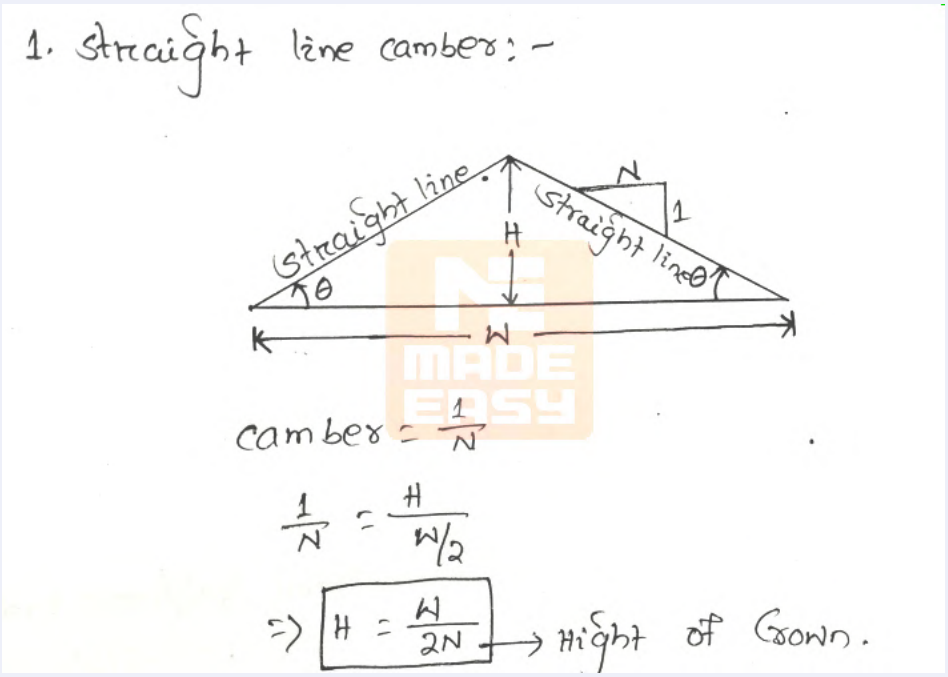
$$\text{Camber} = 3\% = \frac{3}{100} = \frac{1}{(100/3)}$$



Height of the crown with respect to edges,

$$H = \frac{W}{2N}$$

$$\Rightarrow \quad H = \frac{3.8}{2\left(\frac{100}{3}\right)} = 0.057 \text{ m}$$



End of Solution

62. If a crossover occurs between two MG parallel tracks of the same crossing number 1 in 12 with a straight intermediate portion between the reverse curves and the distance between the centres of the track is 3.5 m, the overall length of the crossover will be nearly

(a) 54 m (b) 58 m
(c) 62 m (d) 66 m

Ans. (d)

$$\text{Crossover length} = 4GN + \left(DN - GN - G\sqrt{1+N^2}\right)$$

$N = 12,\ G = 1\text{ m},\ D = 3.5\text{ m}$

$$\Rightarrow \quad N = 4\times1\times12 + \left[3.5\times12 - 1\times12 - 1\sqrt{1+12^2}\right]$$

$$= 48 + [42 - 12 - 12.04] \simeq 66\text{ m}$$

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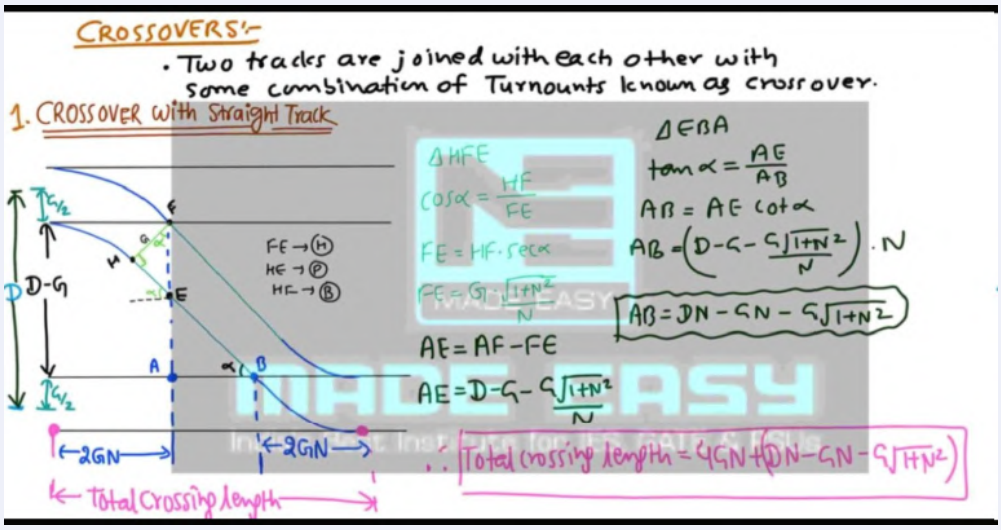


End of Solution

63. A transition curve of 90 m length is to be used to join the ends of a 4° circular curve within a straight and circular curve. The shift value and the offset value at 30 m are respectively, nearly

(a) 0.8 m and 11.6 cm
(b) 0.6 m and 11.6 cm
(c) 0.6 m and 15.4 cm
(d) 0.8 m and 15.4 cm

Ans. (a)

Given: $L_T = 90$ m, $D = 4°$

$$\text{Radius, } R = \frac{180 \times 30}{\pi \times 4°} = 429.7 \text{ m}$$

$$\text{Shift, } S = \frac{L_T^2}{24R} = \frac{90^2}{24 \times 429.7} = 0.8\text{m}$$

$$\text{Offset, } O_T = \frac{x^3}{6RL_T} = \frac{30^3}{6 \times 429.7 \times 90} = 0.1163 \text{ m} \simeq 11.63 \text{ cm}$$

End of Solution

64. Which of the following is/are the correct reason(s) to provide the gradient on the railway track?

1. To provide moderate rise or fall
2. To reach the various stations located at different elevations
3. To reduce the cost of earthwork

Select the correct answer.

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

Ans. (d)

Gradient provided on track:

- to provide a uniform rate of rise or fall as far as possible.
- to reach various station located at different elevation.
- to reduce cost of earthwork like pusher gradient.

End of Solution

65. An exit taxiway for an airport is to be designed. If the turnoff speed is 80 kmph and the coefficient of friction between tire and pavement surface is 0.13, the radius of the central curve will be nearly

(a) 354 m (b) 372 m

(c) 394 m (d) 422 m

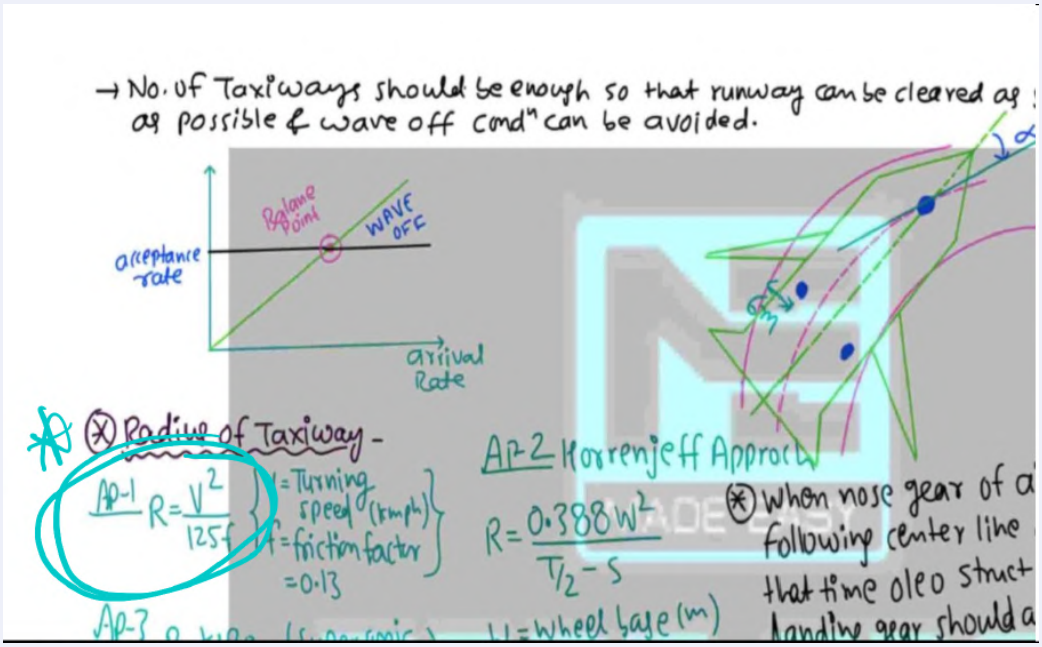
Ans. (c)

Given: turnoff speed, $V = 80$ km/hr

Friction coefficient, $f = 0.13$

Radius of the central curve is given by

$$R = \frac{V^2}{125f} = \frac{80^2}{125 \times 0.13} = 394\text{m}$$



End of Solution

66. Which of the following is/are the correct characteristic(s) of an ideal elastic fastening?
1. It should be able to maintain correct and uniform gauge.
2. It should be of a very particular type.
3. It shall offer elasticity of low level.

Select the correct answer.

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

Ans. (a)

- Elastic fastening should able be to provide enough elasticity to absorb shocks.
- A fastener is provided to hold sleepers in correct position which in turn maintains gauge distance.

End of Solution

67. Which of the following equipment is used for track recording by Indian Railways?
1. Track recording trolley
2. Track recording car
3. Rail-flaw detector
4. Hallade track recorder

Select the correct answer.

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

Ans. (a)

- Hallade track recorder is a track recording car used to measure condition of track by producing graphic record of track parameter like lateral and vertical oscillation, bouncing effect etc.
- Recording trolley is used to record gauge, cant, twist etc.
- Rail flaw detector is used for finding crack, fatigue etc. over rail.

End of Solution

68. Which one of the following is an important point for an efficient airport vehicular circulation and parking system?

(a) Two-way traffic wherever possible
(b) A maximum of driveway intersections
(c) Inadequate driveway width to permit overtaking
(d) Sufficiently and clearly defined parking and circulation routes

Ans. (d)

For most efficient airport vehicular circulation and parking system, the following points are considered:

i. One way traffic wherever possible.
ii. Adequate driveway width to permit overtaking.
iii. Sufficiently and clearly defined parking and circulation route.
iv. A minimum of driveway intersection.
v. Ease of passenger loading and unloading at terminal building.

End of Solution

69. The suitability of an area, as a site for airport terminal building development, is evolved in accordance with
(a) small area of car parking
(b) no direct access to main highways
(c) distant location with respect to runway
(d) sufficient area for the first stage of building development with the possibility of future expansion

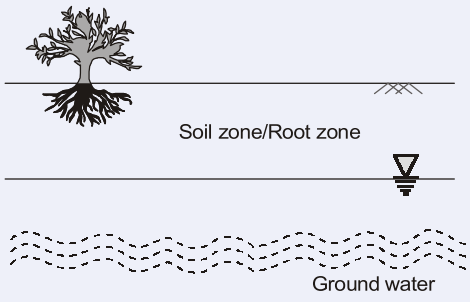
Ans. (d)
Location of building area w.r.t. runway and taxiway should provide adequate space for future expansion. The extent of building area in relation to landing area depends on present and future anticipated use of airport.

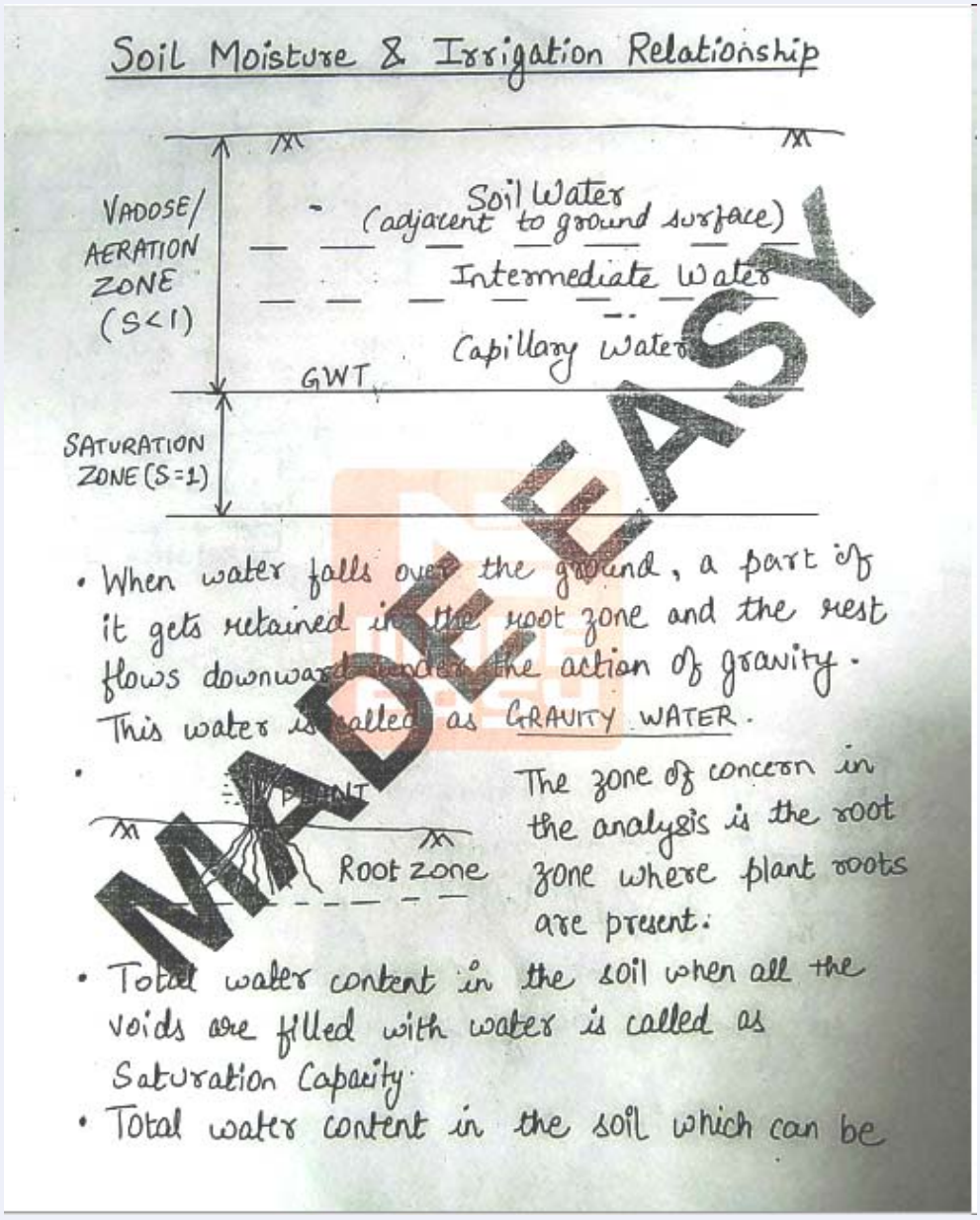
End of Solution

Directions: Each of the following six (06) items consists of two statements, one labeled as 'Statement (I)' and the other as 'Statement (II)'. You are to 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

70. **Statement (I):** The water below the water table is known as soil moisture, and above the water table as groundwater.
Statement (II): Extending down from the ground surface is the soil zone or root zone, which is defined as being the depth of overburden that is penetrated by the roots of vegetation.

Ans. (d)
The water below the water table is known as ground water.





End of Solution

71. **Statement (I):** The rainwater collection for direct use can be practiced by collecting the water coming down from the roof into a storage tank of plastic, RCC, or masonry.

Statement (II): In a campus where sufficient space is not available, the water can be stored in an open excavated pond.

Ans. (b)

- Rainwater downpipes are indeed the primary method for channeling rooftop stormwater into a storage or drainage system.
- In a campus where sufficient space is not available to construct a tank, an open pond can be used to harvest water.

End of Solution

72. **Statement (I):** The soils in nature rarely exist separately as gravel, sand, silt, clay, or organic matter.

Statement (II): The classification or grouping of soils is mainly based on one or two index properties of soil.

Ans. (a)

- In natural diposits, soils are usually a mixture of different particle sizes and components. It is rare ot find a soil deposit that consists of only one type lke pure sand or pure clay.
- Due to this complexity, it becomes essential to adopt a classification system that reflects their mixed behaviour i.e. their index properties.

End of Solution

73. **Statement (I):** During pile driving, heads, helmets, or caps are placed on the top of the pile to receive the blows of the hammer and to prevent damage to the head of the pile.

Statement (II): Piles are ordinarily driven to a resistance measured by the number of blows required for the last 5 cm of penetration.

Ans. (b)

- In pile driving, a helmet (or driving cap) is placed at the top of the pile to:
  a. Transmit hammer energy effectively.
  b. Prevent the pile head from getting damaged.
- In dynamic method (Engineering News record formula), the set or driving resistance is measured in terms of number of blows required to drive the pile a certain distance typically 50 mm (5 cm).

End of Solution

74. **Statement (I):** The critical condition of d/s slope occurs when the reservoir is full and percolation is at its maximum rate.
Statement (II): The direction of seepage forces tends to increase the stability.

Ans. (c)

- The critical condition of d/s slope occurs when the reservoir is full and seeapge (percolation) through the dam body is at its maximum as this can lead to piping or slope failure due to internal erosion or softening of downstream soil.
- Seepage force acts in the direction of water flow. It actually decreases, not increase, the stability.

End of Solution

75. **Statement (I):** Dynamic surveying implies some sort of motion. It allows the user to move during surveying and to collect data on the move.

Statement (II): Rapid static surveying technique, also known as fast static technique, is much like static surveying except that the occupation times are longer.

Ans. (c)

- Dynamic surveying (like kinematic GPS surveying) refers to collecting data while in motion.
- Rapid static surveying technique has shorter occupation times unlike conventional static surveying.

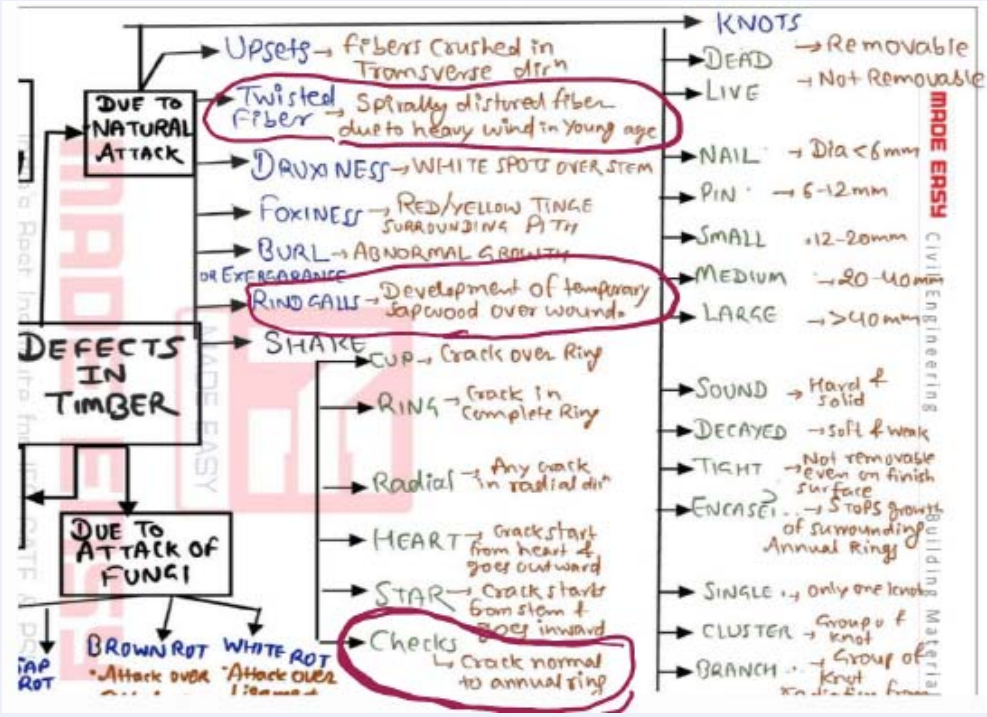
End of Solution

76. 'Rind gall' of sapwood is characterized by
(a) longitudinal cracks normal to annular rings
(b) swelling caused by growth of layers over wounds after the branch has been cut off in an irregular manner
(c) wood with twisted fibers
(d) discoloration

Ans. (b)

Rind galls is a defect due to natural issue i.e. development of temporary sapwood over wound

- Twisted fiber are spirally distorted fiber due to heavy wind/storm in young age of tree
- Longitudinal crack normal to annual rings are "checks"



End of Solution

77. Which one of the following is correct with respect to an incident in the context of construction safety?

(a) Dangerous or unpleasant situation from which someone just manages to escape
(b) Disruption in the normal or smooth flow of work that involves an injury, property loss, damaged equipment, work stoppage, etc.
(c) Unsafe physical condition that could lead to an injury, accident, or loss
(d) Potential for loss resulting from a given action, activity, or inaction

Ans. (b)

In construction safety terminology:

- Incident refers to any unplanned event that disrupts normal operations and may result in injury, property damage, equipment damage, or work stoppage.
- This may include accidents (with injury or damage) or near misses (without injury or damage, but could have caused one).

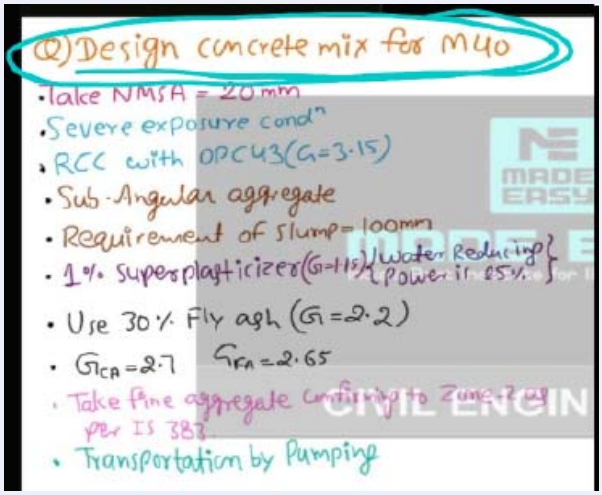
End of Solution

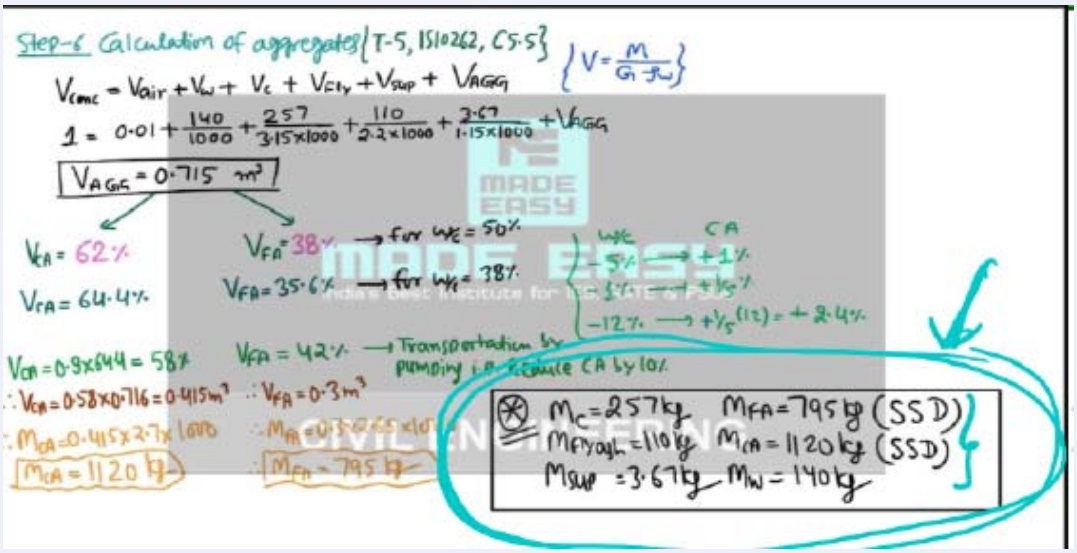
78. For a concrete mix design, an estimation of water content corresponds to

(a) oven-dried aggregates
(b) saturated surface dry aggregates
(c) air-dried aggregates
(d) wet aggregates

Ans. (b)

Concrete mix design is done to find be mass of ingredients required to achieve desired strength in SSD condition only as per IS10262:2019.



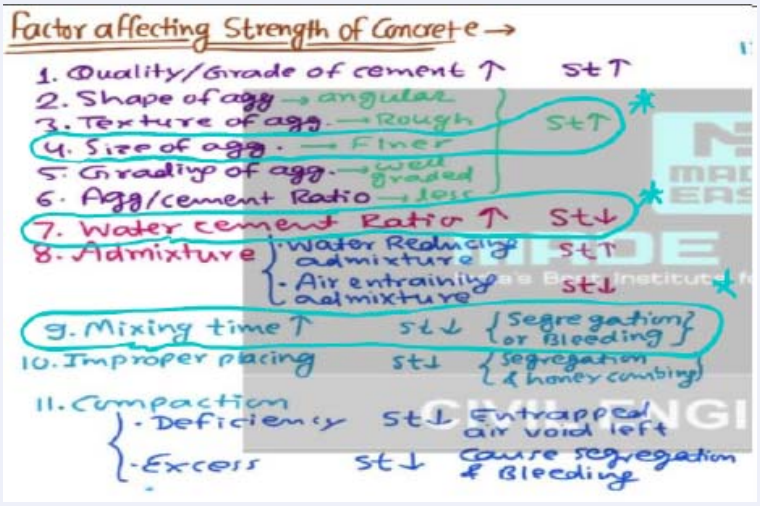


End of Solution

79. For maximum strength, the desired workability of fresh concrete can be attained by which one of the following measures?
(a) The proportion of coarse aggregate may be increased
(b) The proportion of fine aggregate may be reduced
(c) The process of mixing concrete can be repeated a second time by the use of vibrators
(d) The quantity of cement may be increased while the quantity of water may be reduced

Ans. (d)

- Lower W/c ratio leads to higher strength.
- Higher proportion of coarse aggregate i.e. reduction in fine aggregate results into low workability.
- Excess mixing also reduces strength.

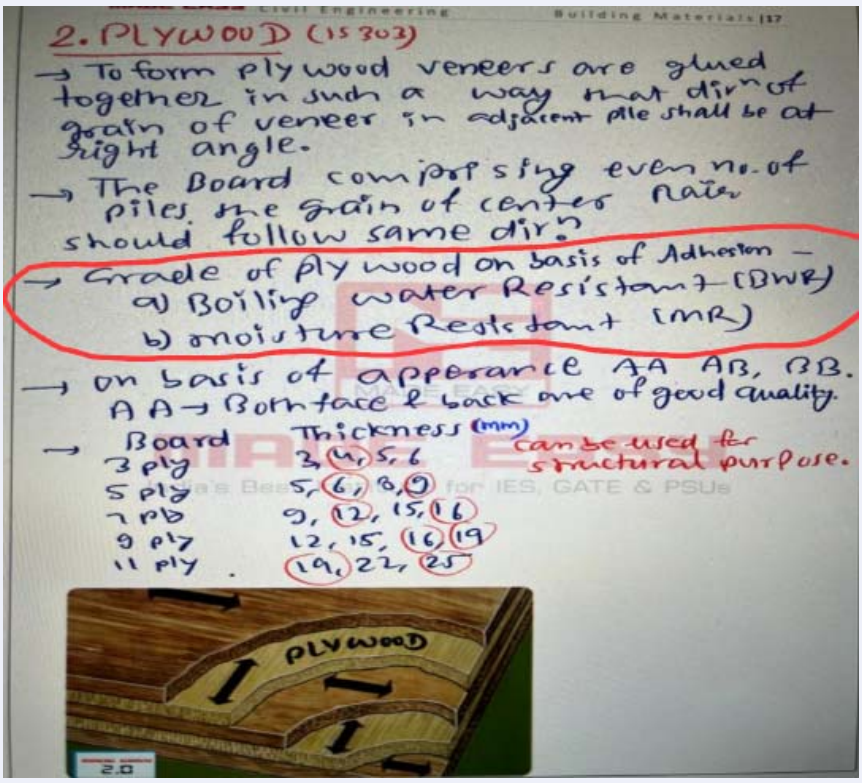


End of Solution

80. Plywoods are classified as Boiling Water Resistant (BWR) grade and Moisture Resistant (MR) grade depending on
(a) appearance of surface
(b) thickness of plywood
(c) density of plywood
(d) bond strength developed by the adhesive used for bonding the veneers

Ans. (d)

- On the basis of bond strength developed by adhesive used for bonding, the veneers/plywood are graded as BWR and MR.
- On the basis of appearance, it will be AA, AB and BB.

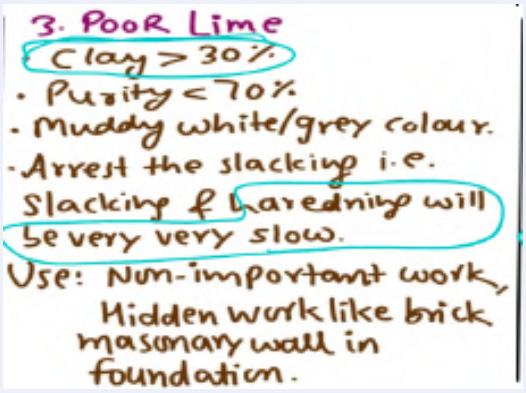


End of Solution

81. A high percentage presence of free silica in lime exhibits
(a) good cementing and quick setting properties
(b) high strength and cementing properties
(c) good cementing and hydraulic properties
(d) poor cementing and hydraulic properties

Ans. (d)

Excess silica which is attached with clay in lime is responsible for reducing hydraulic properties.



End of Solution

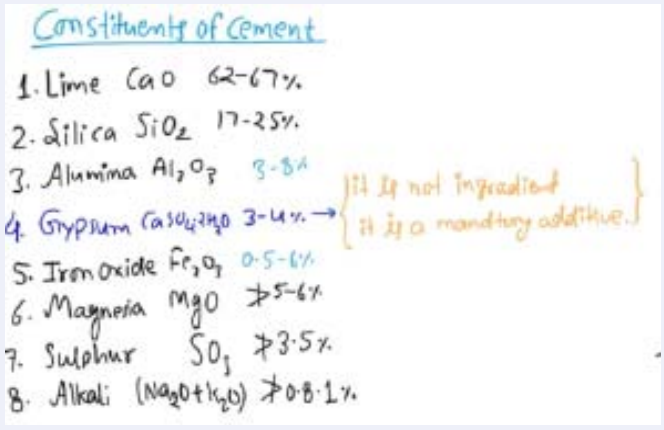
82. Which one of the following is the correct sequence in increasing order for the chemical composition of Portland cement?

(a) Fe_2O_3, Al_2O_3, SiO_2, CaO
(b) Al_2O_3, Fe_2O_3, SiO_2, CaO
(c) Fe_2O_3, Al_2O_3, CaO, SiO_2
(d) Al_2O_3, SiO_2, Fe_2O_3, CaO

Ans. (a)

The chemical composition of Portland cement.

1.	Lime CaO	(62 - 67%)
2.	Silica SiO_2	(17 - 25%)
3.	Alumina Al_2O_3	(3 - 8%)
4.	Gypsum $CaSO_4.2H_2O$	(3 - 4%)
5.	Iron oxide Fe_2O_3	(0.5 - 6%)
6.	Magnesia MgO	(5 - 6%)
7.	Sulphur SO_3	(3.5%)
8.	Alkali (Na_2O + k_2O)	(0.8 - 1%)



End of Solution

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83. As per the straight-line method, what is the annual depreciation value of equipment that has a delivered price of ₹1,00,000 and has a residual value of 10% of the delivered price? Assume the ownership period as 5 years.

(a) ₹18,000/year
(b) ₹2,000/year
(c) ₹20,000/year
(d) ₹9,000/year

Ans. (a)

Given:

$$\text{Initial value} = \text{Rs. } 1,00,000$$
$$\text{Residual value} = 10\% \text{ of } 1,00,000 = \text{Rs. } 10,000$$
$$n = 5 \text{ years}$$

By straight line method,

$$\text{Depreciation value per year} = \frac{\text{Initial value} - \text{residual value}}{n}$$
$$= \frac{100000 - 10000}{5} = \text{Rs. } 18000/\text{year}$$

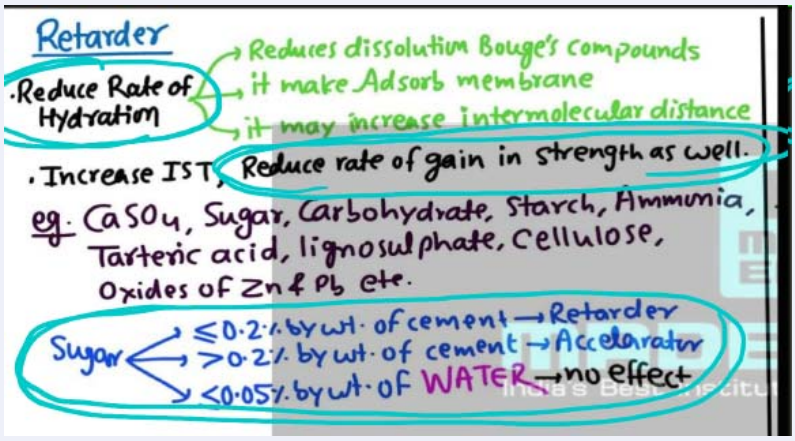
End of Solution

84. Sugar added to cement mortar

(a) accelerates setting time and destroys the early strength
(b) delays setting time and destroys the early strength
(c) accelerates setting time and increases the early strength
(d) delays setting time and increases the early strength

Ans. (b)

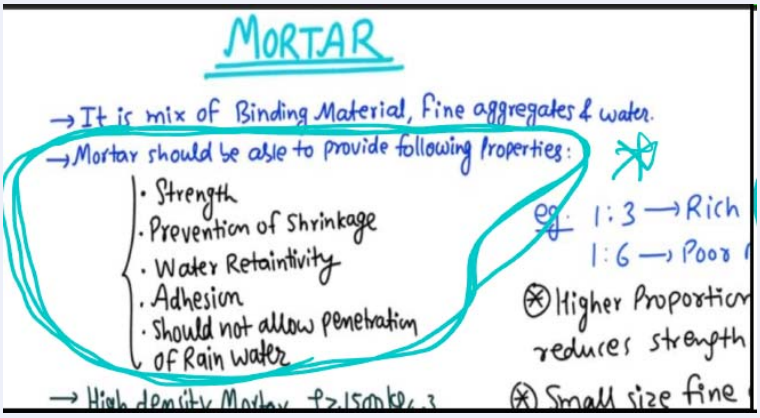
- Sugar is a retarder that delays development of strength as retarders reduce rate of hydration.
- 0.2% sugar by weight of cement is required to impart retardation.



End of Solution

85. Which one of the following is **not** a correct characteristic of an ideal mortar?
(a) Develops good adhesion with building units such as bricks and stones
(b) Withstands the stresses developed
(c) Offers less resistance to water penetration
(d) Durability

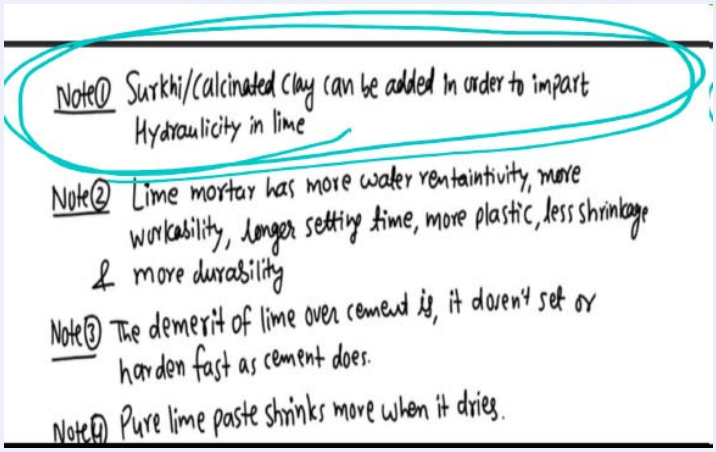
Ans. (c)
Mortar should be able to impart strength, adhesiveness, water retaining for workability, prevention against shrinkage and resistance against penetration of rain water.



End of Solution

86. Surkhi is added to lime mortar for furnishing
(a) hydraulic properties
(b) adhesive properties
(c) solubility properties
(d) cohesive properties

Ans. (a)
Surkhi added to lime imparts hydraulicity in lime which doesn't carry enough clay as an impurity.



End of Solution

87. A power plant has a stack with a diameter of 2 m and emits gases with a stack exit velocity of 15 m/s and a heat emission rate of 4900 kJ/s. The wind speed is 5 m/s. Stability is neutral. If the stack has a geometric height of 40 m, what is the effective stack height, nearly?

(a) 40 m (b) 60 m
(c) 80 m (d) 100 m

Ans. (b)

Given: Stack diameter, $d = 2$ m
Exit velocity of gases, $V_S = 15$ m/sec
Heat emission rate, $Q = 5$ m/sec
Geometric height of stack, $H = 40$ m
By Holland formula,
Effective height of stack is given by

$$H_{eff} = H + \Delta H$$

Where; $$\Delta H = \frac{V_s d}{V_w}\left(1.5 + 0.0096\frac{Q}{V_s d}\right)$$

$$\Rightarrow \Delta H = \frac{15\times 2}{5}\left(1.5 + 0.0096\times\frac{4900}{15\times 2}\right)$$

$$\Rightarrow \Delta H = 18.408 \text{ m}$$

Now, $H_{eff} = 40 + 18.408 = 58.408 \text{ m} \simeq 60 \text{ m}$

End of Solution

88. A steel punch can be stressed to a maximum compressive stress of 800 MN/m^2. If the ultimate shear strength is 300 MN/m^2, the least diameter of the hole that can be punched through a steel plate of 14 mm thickness will be

(a) 41 mm (b) 31 mm
(c) 21 mm (d) 11 mm

Ans. (c)

Given:
Maximum compressive stress $(\sigma_c)_{max} = 800$ MN/m^2
Maximum shear strength $(\tau_s)_{max} = 300$ MN/m^2

$$\Rightarrow \sigma_c = \frac{P}{A} = \frac{P}{\frac{\pi}{4}d^2}$$

$$\Rightarrow 800 = \frac{4P}{\pi d^2}$$

$$\Rightarrow P = 200\pi d^2 \quad \text{...(i)}$$

Now, $$\tau = \frac{P}{\pi d t}$$

$$\Rightarrow 300 = \frac{200\pi d^2}{\pi d\times 14} \quad \text{(From equation (i))}$$

$$\Rightarrow d = 21 \text{ mm}$$

End of Solution

89. A bar of 2500 mm^2 cross-sectional area is subjected to an axial load of 150 kN. The extension over a gauge length of 100 mm is 0.05 mm. If the decrease in each side is 0.00625 mm, the value of Poisson's ratio is

(a) $\frac{1}{5}$ (b) $\frac{1}{4}$

(c) $\frac{1}{3}$ (d) $\frac{1}{2}$

Ans. (b)

Given: $L = 100$ mm, $\Delta L = 0.05$ mm

$\Delta b = -0.00625$ mm

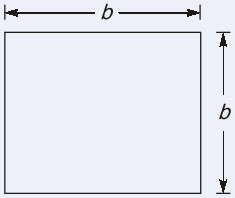
Decrease in each side 0.00625 mm

So cross-section will be square

Cross-section area $A = 2500$ mm^2

$\Rightarrow$ $b^2 = 2500$ mm^2

$\Rightarrow$ $b = 50$ mm

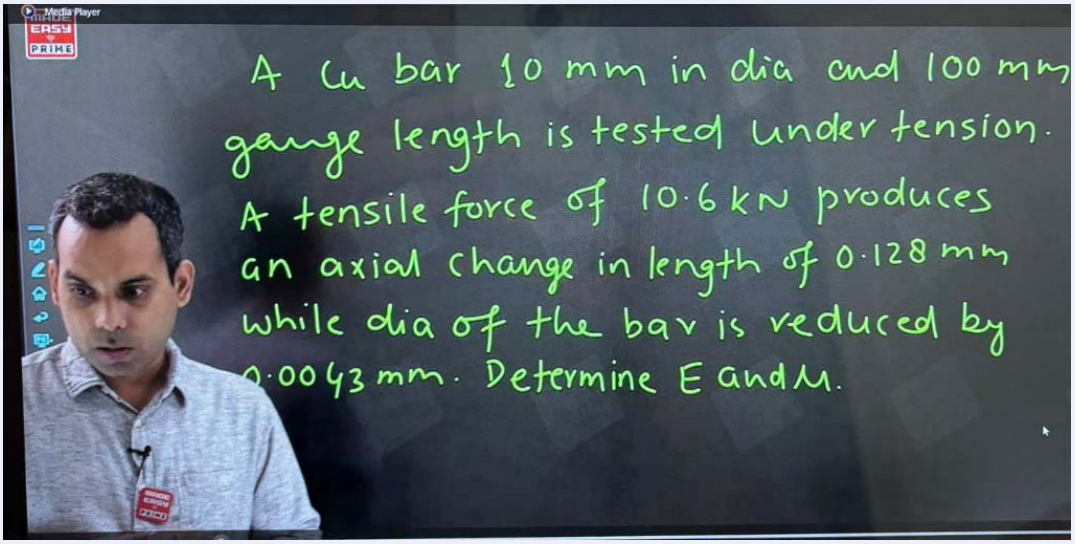


Poisson's ratio

$$\mu = \frac{-\left(\frac{\Delta b}{b}\right)}{\left(\frac{\Delta L}{L}\right)}$$

$$\Rightarrow \quad \mu = -\frac{(-0.00625)}{50} \times \frac{100}{0.05}$$

$$\Rightarrow \quad \mu = \frac{1}{4}$$



End of Solution

90. The resilience in simple tension or compression is

(a) $\frac{\sigma^2}{2E}$ (b) $\frac{\sigma^2}{2A}$

(c) $\frac{\sigma^2}{2AE}$ (d) $\frac{2\sigma^2}{AE}$

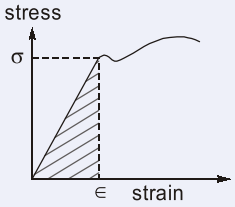
where σ is tensile or compressive stress, A is the area of cross-section, and E is the modulus of elasticity.

Ans. (a)

Resilience = Area of (σ-$\in$) diagram upto elastic limit

$= \frac{1}{2}\sigma \in$

Resilience = $\frac{\sigma^2}{2 \in}$



End of Solution

91. In a fixed beam subjected to downward loads, the maximum bending moment is given by the greater fixing moment. This is true

(a) if the load is only a central point load

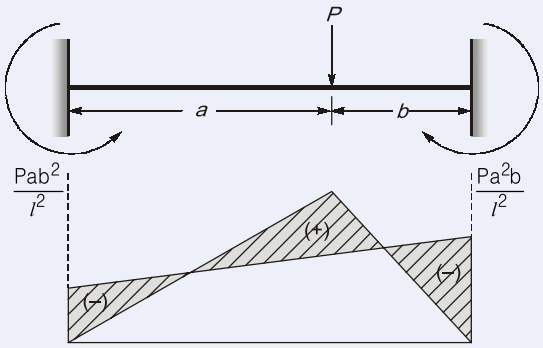
(b) if the load is only an eccentric point load

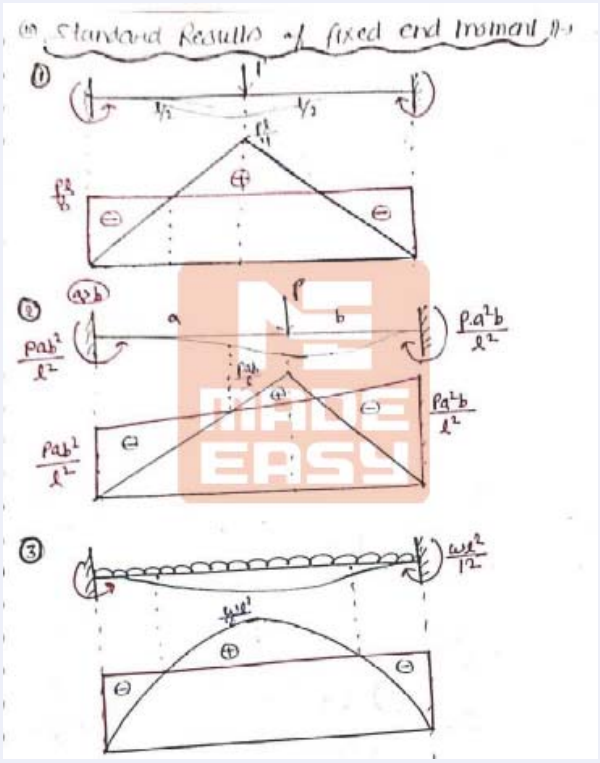
(c) if the load is only a distributed load

(d) for any combination of downward loads

Ans. (b)

The maximum bending moment is given by the greater fixing moment. If load is only eccentric point load





End of Solution

92. The deflection δ at the free end of a cantilever is

(a) $\frac{PL^2}{2EI}$ (b) $\frac{PL^3}{3EI}$

(c) $\frac{PL^3}{2EI}$ (d) $\frac{PL^2}{3EI}$

where P is the point load at the free end, EI is the flexural rigidity, and L is the length of the cantilever.

Ans. (b)

Deflection, $\Delta = \frac{PL^3}{3EI}$

Slope, $\theta = \frac{PL^2}{2EI}$

End of Solution

93. A cantilever beam of span L is subjected to a uniformly distributed load of intensity W. If the flexural rigidity is EI, the slope θ and deflection δ at the free end are respectively

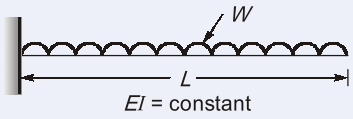
(a) $-\frac{WL^3}{8EL}$ and $-\frac{WL^4}{8EL}$

(b) $-\frac{WL^3}{6EI}$ and $-\frac{WL^4}{6EI}$

(c) $-\frac{WL^3}{8EI}$ and $-\frac{WL^4}{6EI}$

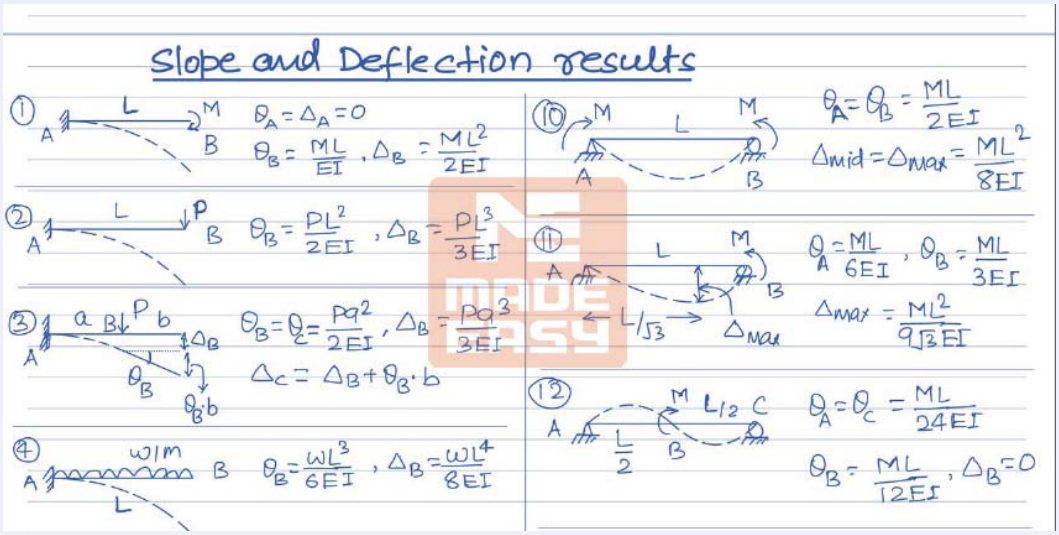
(d) $-\frac{WL^3}{6EI}$ and $-\frac{WL^4}{8EI}$

Ans. (d)



Deflection at free end, $\Delta = \frac{WL^4}{8EI}$

Slope at free end, $\theta = \frac{WL^3}{6EI}$



End of Solution

94. The strain energy U due to bending is

(a) $\int\left(\frac{M^2.dx}{2EI}\right)$

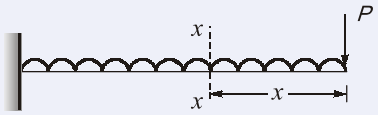
(b) $\int\left(\frac{M.dx}{3EI}\right)^2$

(c) $\int\left(\frac{M^2.dx}{3EI}\right)$

(d) $\int\left(\frac{M.dx}{2EI}\right)^2$

where M is the bending moment, EI is the flexural rigidity, and dx is the short length of the beam.

Ans. (a)



Bending moment at section = M

Strain energy due to Bending moment is given by

$$V = \int \frac{M^2 dx}{2EI}$$

where, EI = flexural rigidity

SE due to AF = $\int \frac{P_x^2 dx}{2AE}$

SE due to BM = $\int \frac{M_x^2 dx}{2EI}$

SE due to TM = $\int \frac{T_x^2 dx}{2GI_p}$

SE due to SF = $\int \frac{S_x^2 dx}{2AG}$

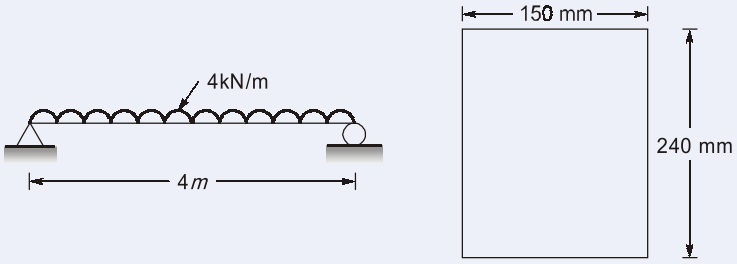
End of Solution

95. A rectangular beam 150 mm × 240 mm deep is simply supported at the ends on a span of 4 m and carries a uniformly distributed load of 4 kN/m on the whole span. What is the point load at the centre it should carry so that the maximum deflection is doubled?

(a) 24 kN (b) 20 kN

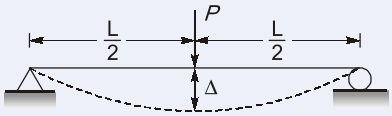
(c) 16 kN (d) 12 kN

Ans. (b)



Maximum deflection occurs at med span of beam

$$\Delta_{max} = \frac{5wL^4}{384EI}$$

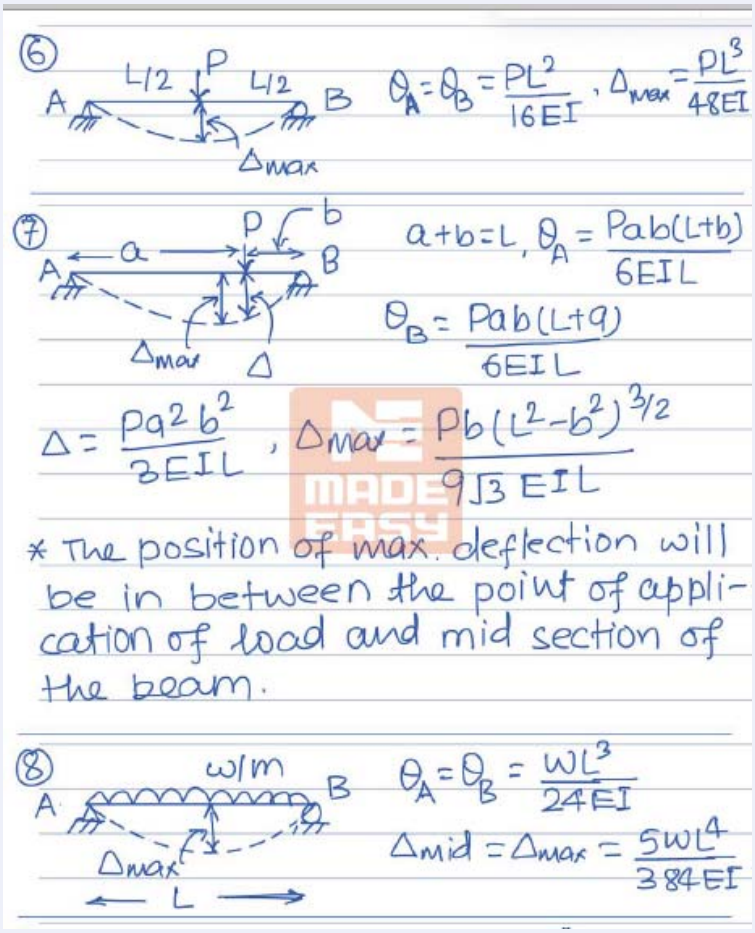


$\because \quad \Delta = 2\,\Delta_{max}$

$\Rightarrow \quad \frac{PL^3}{48EI} = 2\left(\frac{5WL^4}{384EI}\right)$

$\Rightarrow \quad \frac{P}{48} = 2\left(\frac{5\times4\times4}{384}\right)$

$\Rightarrow \quad P = 20\ kN$



End of Solution

96. When a cable is passed over a pulley on the pier and is stayed at the back, the pier will be subjected to a net horizontal force which is given by

(a) $H\,(1 - \sin\alpha\ \mathrm{cosec}\beta)$

(b) $H\,(1 - \sin\beta\ \mathrm{cosec}\alpha)$

(c) $H\,(1 + \sin\alpha\ \mathrm{cosec}\beta)$

(d) $H\,(1 + \sin\beta\ \mathrm{cosec}\alpha)$

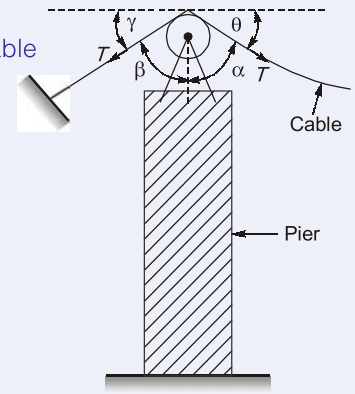
where H is the horizontal tension in the cable, α is the angle made by the cable with the vertical, and β is the angle made by the backstay with the vertical at the pier.

Ans. (b)

Given: H = horizontal tension in the cable

$$H = T\cos\theta = T\sin\alpha$$

$$T = \frac{H}{\sin\alpha} \quad ...(i)$$



Net horizontal force

$$H_{net} = T\sin\alpha - T\sin\beta$$

$$\Rightarrow H_{net} = H - \frac{H}{\sin\alpha}\cdot\sin\beta$$

$$\Rightarrow H_{net} = H(1 - \sin\beta\,\text{cosec}\,\alpha)$$

End of Solution

97. Which one of the following statements is not correct?

(a) In elastic theory of design, stresses in the structures under working load are less than the allowable working stress.

(b) Theory of elasticity will be best suited for structural analysis at the time of failure.

(c) Elastic method does not provide a uniform overload capacity for all parts of the structures.

(d) The ultimate load design method is more economical than the elastic design method.

Ans. (b)

Theory of elasticity will not be best suited for structural analysis at the time of failure.

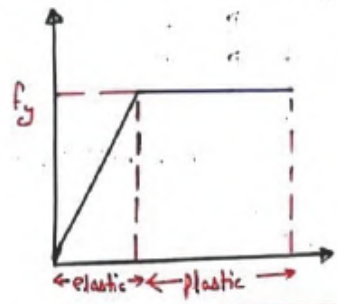
(a) Working Stress Method.

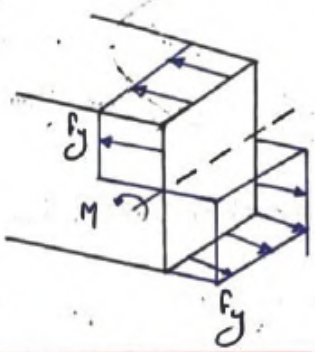
→ It is the traditional method of designing which is based upon elastic theory.

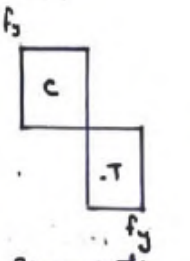
→ Attainment of the initial yielding forms the design critria for the member in this approach.

→ The stresses generated by the applied loading are called working stresses and for the safety, these values of working stress shall never exceed permissible stresses.

(b) Plastic Method of Design.







Stress-profile at Plastic-stage

Ultimate load = Load Factor × Working Load

→ Steel possesses a reserve of strength beyond its yield, which Engineers have tried to utilize in this method.

→ In the plastic method, the design critria is Ultimate strength and hence the behaviour of members beyond the yield stress in plastic range is considered.

→ This method of design is based on failure conditions rather than working load condition.

→ The structure will be design for much higher loads called as Ultimate load or Collapse load.

→ The working loads are multiplied with a factor known as Load factor to obtain Ultimate loads.

• Drawback of Plastic method -

→ Although the members designed by this method were safe and economical but they failed in serviceibility critria. Such as Deflection, vibration et

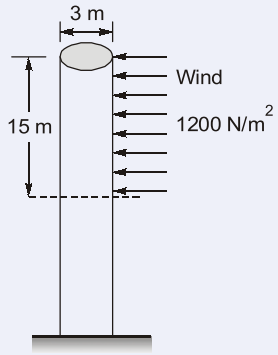
End of Solution

98. A steel chimney 3 m in diameter is situated in a region where the intensity of uniform wind pressure is 1200 N/m^2. If the shape factor is 0.7 and the intensity of wind pressure is uniform, the shear due to wind load at a level of 15 m below the top of the chimney will be

(a) 37.8 kN
(b) 34.6 kN
(c) 31.8 kN
(d) 27.6 kN

Ans. (a)

Given:



Diameter of chimney D = 3 m

Wind pressure, P_0 = 1200 N/m^2

Shape factor K = 0.7

Shear due to wind load at level of 15 m below the top of the chimney

$$V = K(P_0\ D \times H)$$

$$\Rightarrow \quad V = 0.7 \times 1200 \times 3 \times 15 = 37800 \text{ N}$$

$$\Rightarrow \quad V = 37.8 \text{ kN}$$

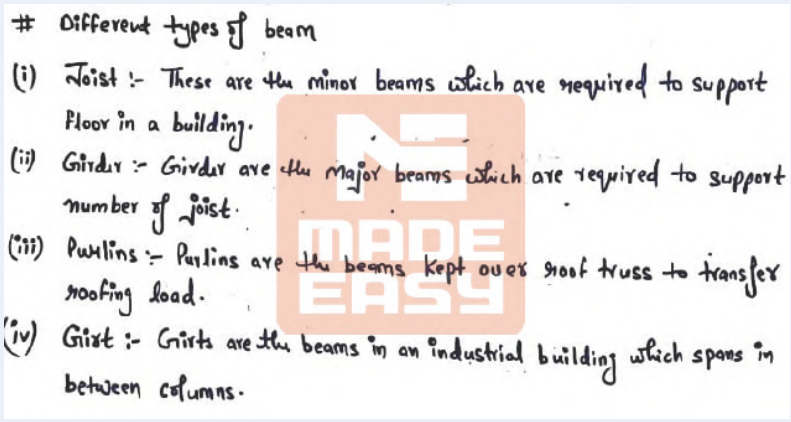
End of Solution

99. With regard to beams in a structure, what are joists?

(a) Usually indicate a major beam frequently at wide spacing that supports small beams
(b) Closely spaced beams supporting the floors and roofs of a building
(c) Roof beams usually supported by trusses
(d) Roof beams usually supported by purlins

Ans. (b)

- **Ginder:** Usually indicate a major beam frequently at wide spacing that support small beams
- **Joists:** Closely spaced beams supporting the floors and roofs of building.
- **Purlins:** Roof beams usually supported by trusses.



End of Solution

100. The design strength of a tension member due to the net section rupture for plates and threaded rods is

(a) $\frac{1.2A_nf_u}{\gamma_{m1}}$ (b) $\frac{0.9A_nf_u}{\gamma_{m1}}$

(c) $\frac{0.6A_nf_u}{\gamma_{m1}}$ (d) $\frac{0.3A_nf_u}{\gamma_{m1}}$

where A_n is the net effective area of cross-section, f_u is the ultimate strength of the material, and γ_{m1} is the partial safety factor.

Ans. (b)

As per IS 800 : 2007 (Cl 6.3.2)

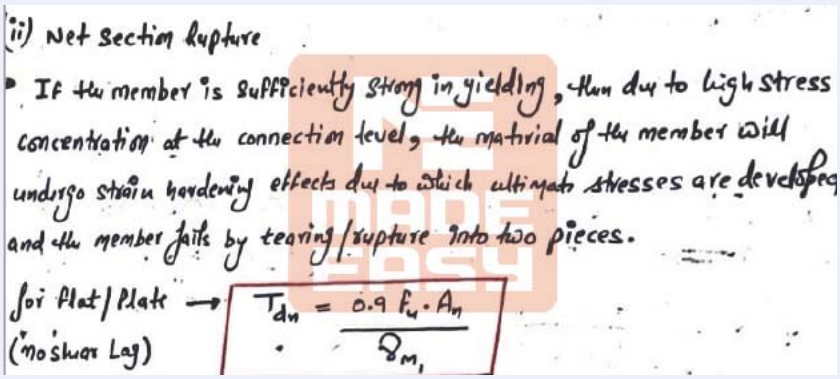
The design strength due to rupture of critical section is given by

$$T_{dn} = \left(\frac{0.9f_u}{\gamma_{m1}}\right)A_n$$

Where, f_u = Ultimate stress of the material

A_n = Net effective area of the member.

γ_{m1} = Partial safety factor



End of Solution

101. Which one of the following checks is necessary in the design of uniaxial bending?

(a) $\frac{\sigma_{at,cal}}{0.6f_y} + \frac{\sigma_{bt,cal}}{0.66f_y} \le 1.0$

(b) $\frac{\sigma_{at,cal}}{0.6f_y} - \frac{\sigma_{bt,cal}}{0.66f_y} \le 1.0$

(c) $\frac{\sigma_{at,cal}}{0.6f_y} + \frac{\sigma_{bt,cal}}{0.66f_y} \ge 1.0$

(d) $\frac{\sigma_{at,cal}}{0.6f_y} - \frac{\sigma_{bt,cal}}{0.66f_y} \ge 1.0$

Ans. (a)

As per IS 800 : 1984 (Cl 7.1.2)

$$\frac{\sigma_{at,cal}}{\sigma_{at,allow}} + \frac{\sigma_{bt,cal}}{\sigma_{bt,allow}} \le 1.0$$

$$\sigma_{at,allow} = 0.60\ f_y$$
$$\sigma_{bt,allow} = 0.66\ f_y$$

End of Solution

102. The maximum slenderness ratio λ for a member normally acting as a tie in a roof truss or a bracing system, but subject to possible reversal of stresses resulting from the action of wind or earthquake forces, is

(a) 430
(b) 350
(c) 250
(d) 180

Ans. (b)

IS 800 : 2007 (Cl 3.8 Table 3)

S.No	Members	λ_{max}
1.	A tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces.	180
2.	A member normally acting as a tie in a roof truss or a bracing system not considered effective when subject to possible reversal of stress into compression resulting from the action of wind or earthquake forces.	350
3.	Members always under tension (other than pre-tensioned members)	400

End of Solution

103. The permissible maximum shear stress τ_{vm} for a steel beam should not exceed
(a) 0.36 f_y (b) 0.45 f_y
(c) 0.65 f_y (d) 0.87 f_y
where f_y is the yield stress of steel.

Ans. (b)

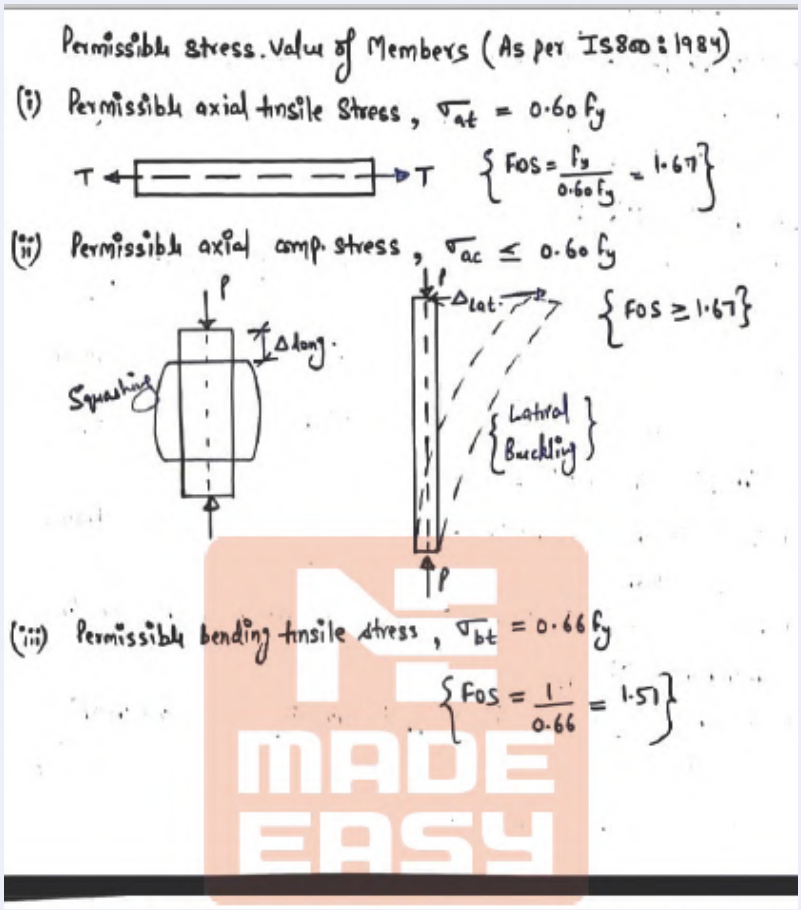
As per IS 800 : 1984 (CL 6.4.1)
The permissible maximum shear stress for a steel beam

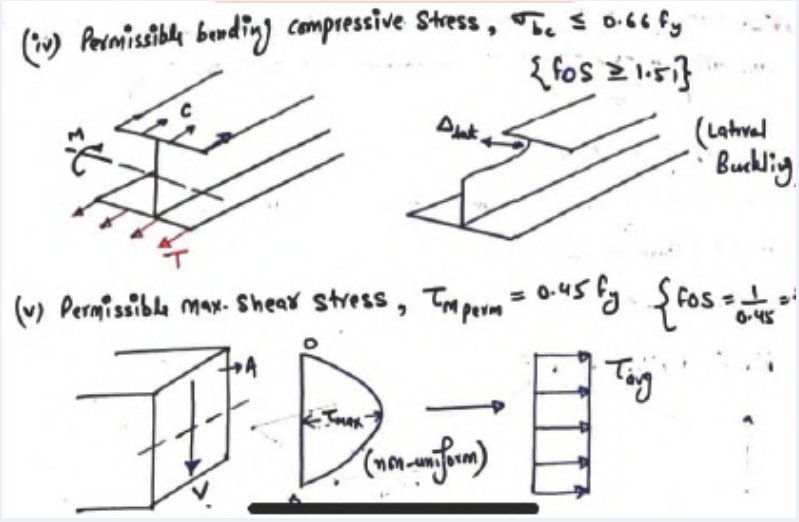
$$\tau_{vm} = 0.45 f_y$$

Permissible average shear stress for a steel beam

$$\tau_{va} = 0.40 f_y$$

where; f_y = yield stress of steel.





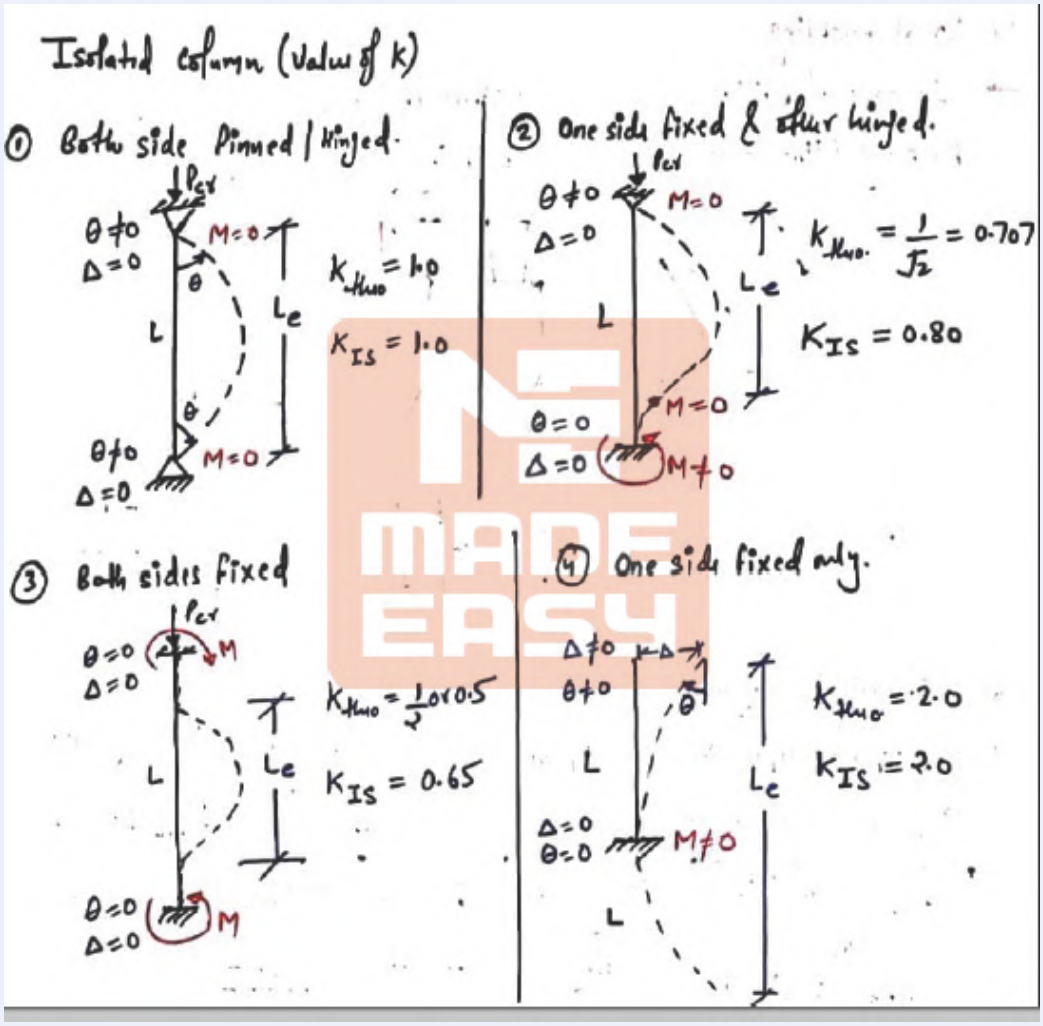
End of Solution

104. As per IS 800 : 2007, the recommended value of an effective length for compression members of constant dimensions effectively held in position at both ends, but not restrained against rotation, is

(a) 1.00 L
(b) 1.20 L
(c) 1.50 L
(d) 2.00 L

Ans. (a)

Refer IS 800 : 2007 (Table 11)



End of Solution

105. Which one of the following is applicable in the case of analysis of portal bracing?

(a) Portal bracings are provided at one end of the truss girder bridge in the plane of end posts

(b) In addition to the lateral force due to wind, the bracings are also designed to carry a lateral shear equal to $1\frac{1}{4}$ percent of the total compressive force in two end posts

(c) The maximum wind load of the loaded span is taken into consideration

(d) Portal bracings are generally provided in more than one plane, located anywhere except in the central transverse plane of end posts

Ans. (b)

In addition to the lateral force due to wind, the bracings are also designed to carry a lateral shear.

End of Solution

106. Consider the following data:

Weight of a dish = 48.6212 g

100 mL of sample is placed in the dish and evaporated. The new weight of the dish and dry solids = 48.6432 *g*

The dish is placed in a 550°C furnace, then cooled. New weight = 48.6300 g

In this case, the total volatile solids are

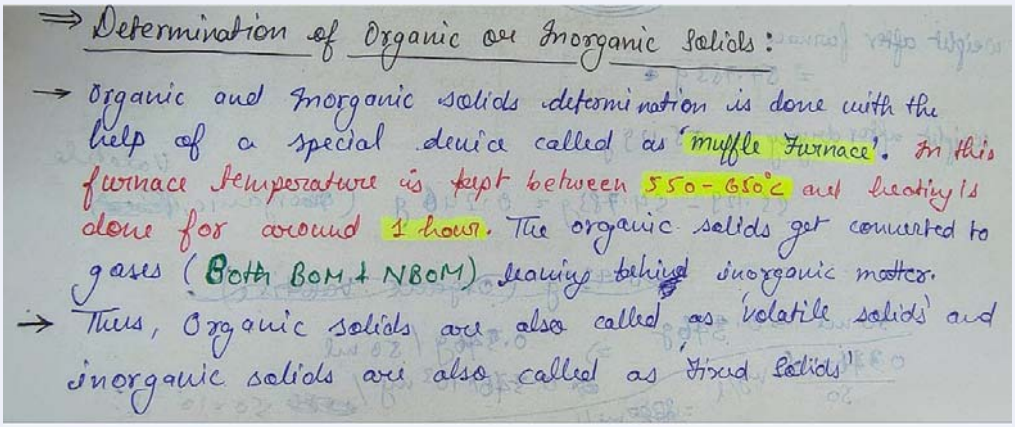
(a) 132 mg/L (b) 220 mg/L

(c) 88 mg/L (d) 308 mg/L

Ans. (a)

$$\text{Total volatile solids} = \frac{(48.6432 - 48.63)\,gm}{100\,ml}$$

$$= \frac{0.0132 \times 10^{+3}}{100 \times 10^{-3}} = 132 \text{ mg/lt}$$



End of Solution

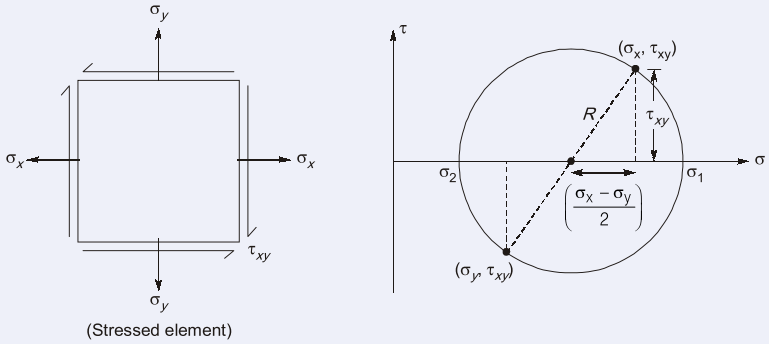
107. The radius of the Mohr's circle of stress is

(a) $\sqrt{\left(\frac{\sigma_x + \sigma_y}{2}\right)^2 - \tau^2}$ (b) $\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$

(c) $\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 - \tau^2}$ (d) $\sqrt{\left(\frac{\sigma_x + \sigma_y}{2}\right)^2 + \tau^2}$

where σ_x and σ_y are normal stresses, and τ is shear stress.

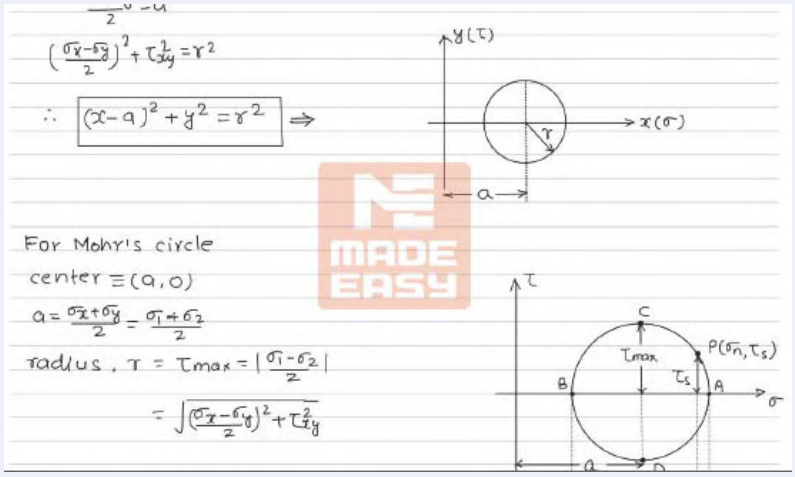
Ans. (b)

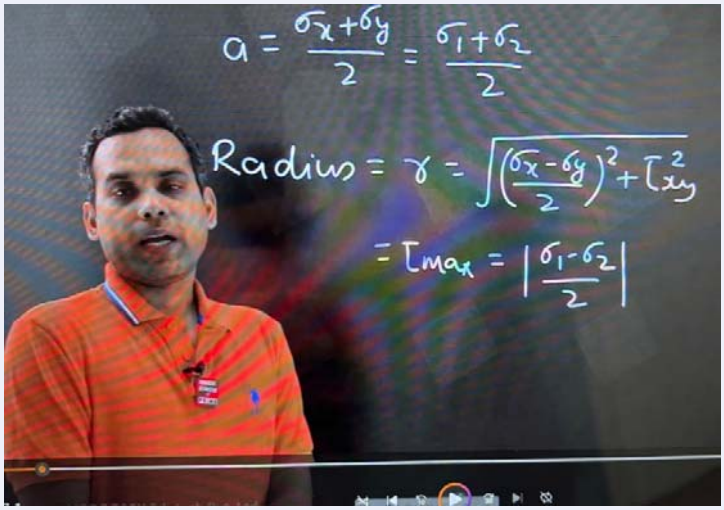


(Stressed element)

Radius of mohr's circle

$$R = \tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$





End of Solution

108. Which one of the following statements is not correct regarding theories of failure?
(a) The cause of failure depends on the properties of the material.
(b) In the case of brittle materials, the maximum principal stress theory should be used.
(c) For ductile materials, the maximum shear stress theory gives a good approximation.
(d) The cause of failure is not dependent on the stress system to which it is subjected.

Ans. (d)
The cause of failure is dependent on the stress system to which it is subjected.

End of Solution

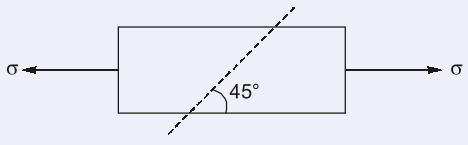
109. The principal stresses at a point in an elastic material are 2σ tensile and σ tensile. If the elastic limit in simple tension is 200 N/mm^2, according to the maximum principal stress theory, the value of σ at failure will be
(a) 108 N/mm^2 (b) 100 N/mm^2
(c) 90 N/mm^2 (d) 80 N/mm^2

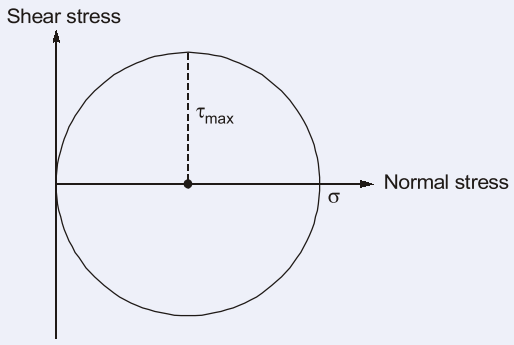
Ans. (b)
Given:
Principal stresses
$\sigma_1 = 2\sigma$ (tensile)
$\sigma_2 = \sigma$ (tensile)
Elastic limit, $\sigma_y = 200$ N/mm^2
As per maximum principal stress theory
$\sigma_1 < \sigma_y$
$\Rightarrow 2\sigma < 200$ N/mm^2
$\Rightarrow \sigma < 100$ N/mm^2

End of Solution

110. In the case of simple tension or compression, the maximum shear stress is equal to
(a) the applied stress and acts on planes at 45° to it
(b) one-half the applied stress and acts on planes at 45° to it
(c) the applied stress and acts on planes at 60° to it
(d) one-half the applied stress and acts on planes at 60° to it

Ans. (b)
Given :
Uniaxial load (tension or compression)





Maximum shear stress

$$\tau_{max} = \frac{\sigma - 0}{2} = \frac{\sigma}{2}$$

It acts on planes at 45°

End of Solution

111. For a general two-dimensional stress system, the maximum principal stress σ_1 is

(a) $\frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x + \sigma_y}{2}\right)^2 + \tau_{xy}^2}$ (b) $\frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 - \tau_{xy}^2}$

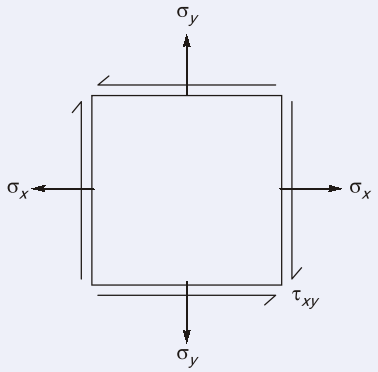
(c) $\frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x + \sigma_y}{2}\right)^2 - \tau_{xy}^2}$ (d) $\frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

where σ_x and σ_y are direct stresses on mutually perpendicular planes, and τ_{xy} is the shear stress on planes.

Ans. **(d)**

Given :

Two-dimensional stress



Principal stress is given by

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

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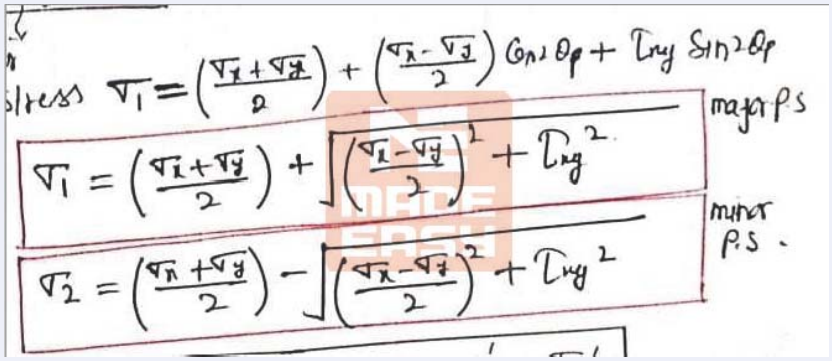
maximum Principal stress

$$\sigma_1 = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

minimum principal stress

$$\sigma_2 = \left(\frac{\sigma_x + \sigma_y}{2}\right) - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

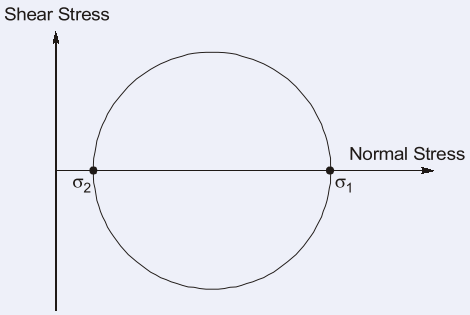


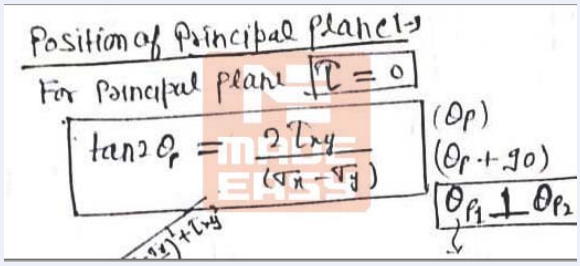
End of Solution

112. On a principal plane, the value of shear stress is
(a) half of the principal stress (b) maximum
(c) zero (d) equal to the principal stress

Ans. (c)

On a principal plane, the value of shear stress is zero.





End of Solution

113. A circular log of timber has diameter d. The ratio of breadth b to depth h ($b : h$) of the rectangular beam that can be cut from a circular log for the strongest section in bending is

(a) 1 : 1 (b) 1 : $\sqrt{2}$

(c) 1 : $\sqrt{3}$ (d) 1 : 2

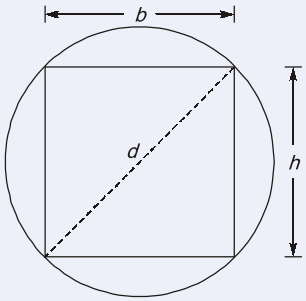
Ans. **(b)**

Given: A circular lag of timber of diameter is 'd'

$\because$ $d^2 = b^2 + h^2$ ...(i)

For strongest section, section modulers should be maximum

$$Z = \frac{bh^2}{6}$$



From equation (i)

$$Z = \frac{b\left(d^2 - b^2\right)}{6}$$

For maximum value of Z.

$$\frac{dZ}{db} = 0$$

$\Rightarrow$ $d^2 - 3b^2 = 0$

$$b = \frac{d}{\sqrt{3}} \text{ and } h = \sqrt{\frac{2}{3}}d$$

$$\text{ratio} = \frac{b}{h} = \frac{\left(\frac{1}{\sqrt{3}}\right)d}{\left(\sqrt{\frac{2}{3}}\right)d} = \frac{1}{\sqrt{2}}$$

7] If a wooden circular log is to be used to make a rectangular cis of strongest beam, then prove that the ratio of depth to width of the beam is $\sqrt{2}$.

End of Solution

114. The torsional stiffness k is given by the relation

(a) $k = \frac{GJ}{l}$ (b) $k = \frac{Gl}{J}$

(c) $k = \frac{lJ}{G}$ (d) $k = \frac{GJ}{l^2}$

where G is the rigidity modulus, J is the polar moment of inertia, and l is the length.

Ans. (a)

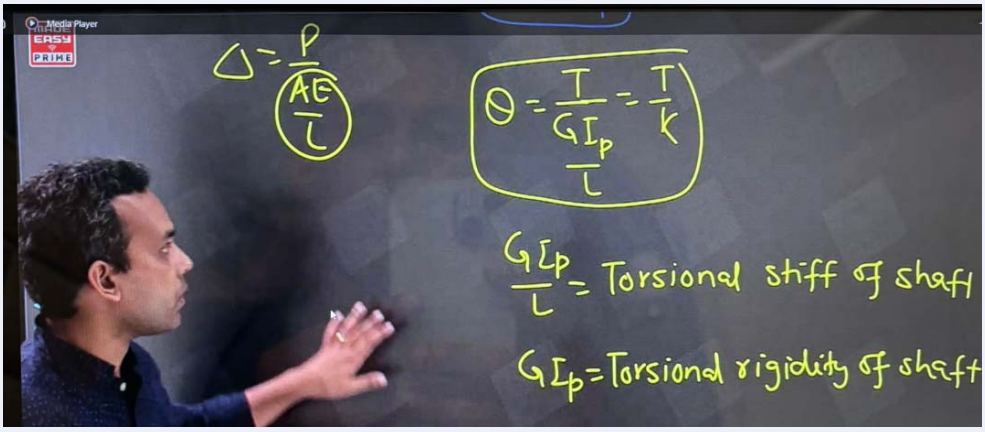
Torsional stiffness : Torque required to produced unit twisting angle.

$$\because \quad \frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

$$T = \left(\frac{GJ}{l}\right).\theta$$

If $\theta = 1$, T = torsional stiffness

$$\therefore \quad \text{Torsional stiffness} = \frac{GJ}{l}$$



End of Solution

115. A cast iron main tube 800 mm in diameter carries water at a pressure head of 100 m. If the maximum permissible tensile stress is 20 MN/m^2 and the weight of water is 10 kN/m^3, the required thickness of the metal will be

(a) 5 mm (b) 10 mm

(c) 15 mm (d) 20 mm

Ans. (d)

Given : diameter, $d = 800$ mm

maximum permissible tensile stress = 20 MN/m^2

Unit weight of water, $\gamma_w = 10$ kN/m^3

Thickness (t) = ?

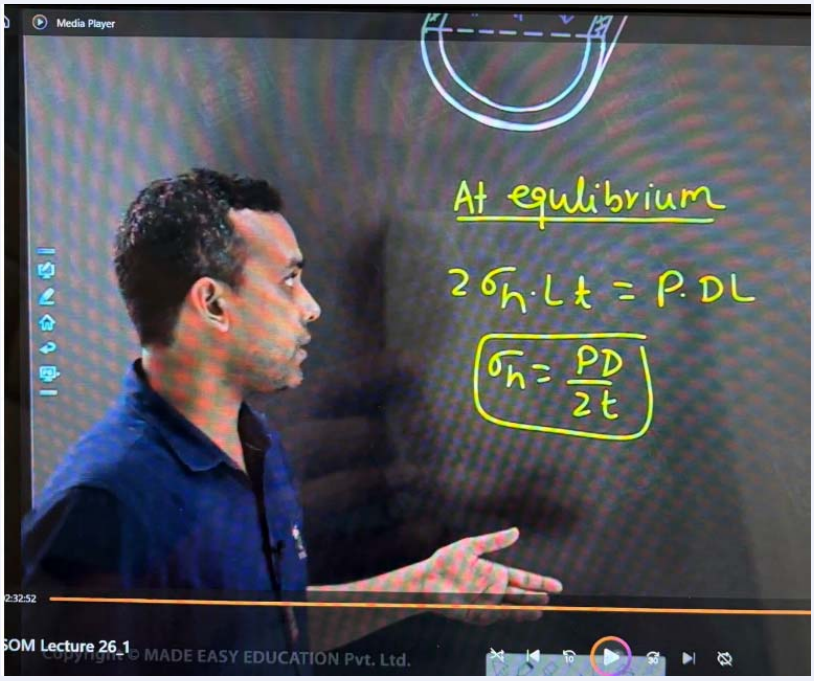
Pressure, $P = \rho gh = \gamma_w h$

$P = 10 \times 1000 = 1$ MN/m^2

Hoop stress. $\sigma_h = \frac{Pd}{2t} \le 20\ MN/m^2$

$$\Rightarrow \quad \frac{1 \times 800}{2 \times t} \le 20$$

$\Rightarrow$ $t \geq 20$ mm



End of Solution

116. A cylindrical air drum is 2.25 m in diameter with plates 1.2 cm thick. The efficiencies of the longitudinal and circumferential joints are 75% and 40%, respectively. If the tensile stress in the plate is limited to 120 MN/m^2, the safe maximum air pressure will be

(a) 0.84 MN/m^2 (b) 0.96 MN/m^2

(c) 1.02 MN/m^2 (d) 1.56 MN/m^2

Ans. (b)

Given: diameter, d = 2.25 m = 2250 mm

Thickness, t = 1.2 cm = 12 mm

Longitudinal joint efficiency, η_L = 75%

Circumferential joint efficiency, η_c = 40%

Permissible tensile stress = 120 MN/m^2.

Hoop stress, $$\sigma_H = \frac{Pd}{2t\eta_L} = \frac{P \times 2250}{2 \times 12 \times 0.75} = 125\,P$$

Longitudinal stress, $$\sigma_l = \frac{Pd}{4t\eta_c} = \frac{P \times 2250}{4 \times 12 \times 0.40} = 117.1875\,P$$

For design $$\sigma_{max} = \max \begin{cases} 125P \\ 117.1875P \end{cases}$$

$\Rightarrow$ 120 MN/m^2 = 125 P

$\Rightarrow$ P = 0.96 MN/m^2

End of Solution

117. The maximum shear stress τ_{max} for a beam of circular section is

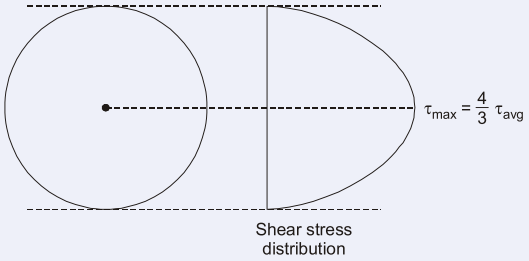
(a) $\frac{5V}{3A}$ (b) $\frac{3V}{4A}$

(c) $\frac{3V}{5A}$ (d) $\frac{4V}{3A}$

where A is the cross-sectional area, and V is the shear force.

Ans. (d)

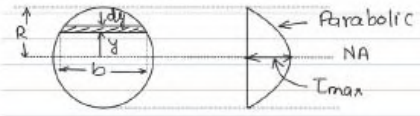
Shear stress distribution for circular section



$$\tau_{max} = \frac{4}{3}\tau_{avg}$$

$$\Rightarrow \quad \tau_{max} = \frac{4}{3}\left(\frac{V}{A}\right)$$

② circular c/s



$$A\bar{y} = \int_y^R b\,dy\,y = \int_y^R 2\sqrt{R^2-y^2}\,y\,dy = \frac{2}{3}(R^2-y^2)^{3/2}$$

$$I = \frac{\pi}{64}(2R)^4 = \frac{\pi}{4}R^4$$

$$\tau = \frac{SA\bar{y}}{Ib} \qquad \frac{(R^2-y^2)^{3/2}}{\frac{\pi}{4}R^4\, 2\sqrt{R^2-y^2}}$$

$$\boxed{\tau = \frac{4S}{3\pi R^4}(R^2-y^2)}$$

$$\tau_{max} = \frac{4S}{3\pi R^2} \text{ at NA}$$

$$\tau_{avg} = \frac{S}{\pi R^2}$$

$$\boxed{\tau_{max} = \frac{4}{3}\tau_{avg}}$$

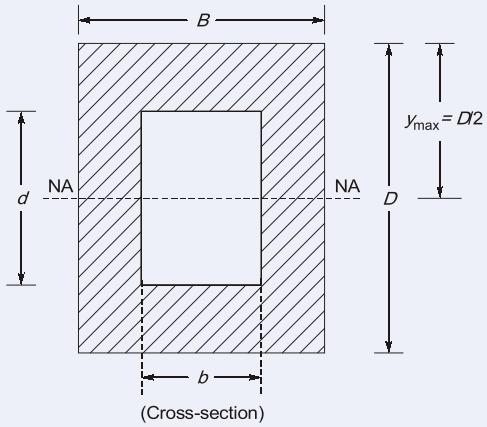
End of Solution

118. Consider a rectangular hollow section having overall width B and overall depth D, and let the width and depth of the symmetrically placed hole be b and d, respectively. Then the section modulus (Z) is

(a) $\dfrac{\left(BD^3 - bd^3\right)}{6d}$ (b) $\dfrac{\left(BD^3 - bd^3\right)}{12D}$

(c) $\dfrac{\left(BD^3 - bd^3\right)}{12d}$ (d) $\dfrac{\left(BD^3 - bd^3\right)}{6D}$

Ans. (d)



Section modulus is given by

$$Z = \frac{I_{NA}}{y_{max}}$$

$$\Rightarrow \quad Z = \frac{\left(\frac{BD^3}{12} - \frac{bd^3}{12}\right)}{\left(\frac{D}{2}\right)}$$

$$\Rightarrow \quad Z = \left(\frac{BD^3 - bd^3}{6D}\right)$$

End of Solution

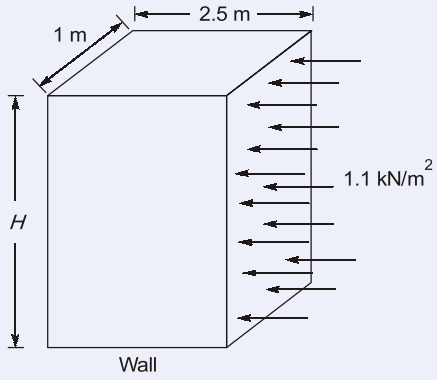
119. A long rectangular wall is 2.5 m wide. The maximum wind pressure on the face of the wall is 1.1 kN/m^2, and the specific weight of masonry is 22 kN/m^3. If the length of the wall is 1 m, the maximum height of the wall so that there is no tension in the base of the wall will be nearly

(a) 52 m (b) 42 m

(c) 32 m (d) 22 m

Ans. (b)

Given: $\gamma_{wall} = 22$ kN/m^3



Weight of wall, $w = \gamma_{wall} \times$ volume

$$\Rightarrow \quad W = 22 \times 1 \times 2.5 \times H$$

$$W = 55\,H \qquad \ldots(i)$$

Four no tension at the base of the wall

Net stress at A, $(\sigma_A)_{Total} = 0$

$$\Rightarrow \quad \frac{55H}{1\times 2.5} - \frac{\left(\frac{1.1\times H^2}{2}\right)}{\left(\frac{1\times 2.5^3}{12}\right)} \times \frac{2.5}{2} = 0$$

$$\Rightarrow \quad H = 41.67 \text{ m} \simeq 42 \text{ m}$$

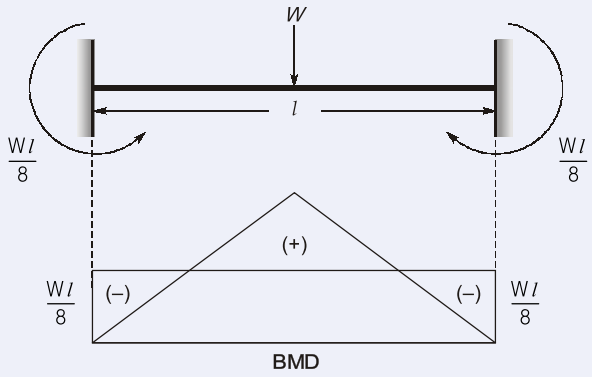
End of Solution

120. A fixed beam of span l is subjected to a central concentrated load W. The bending moment at the supports will be

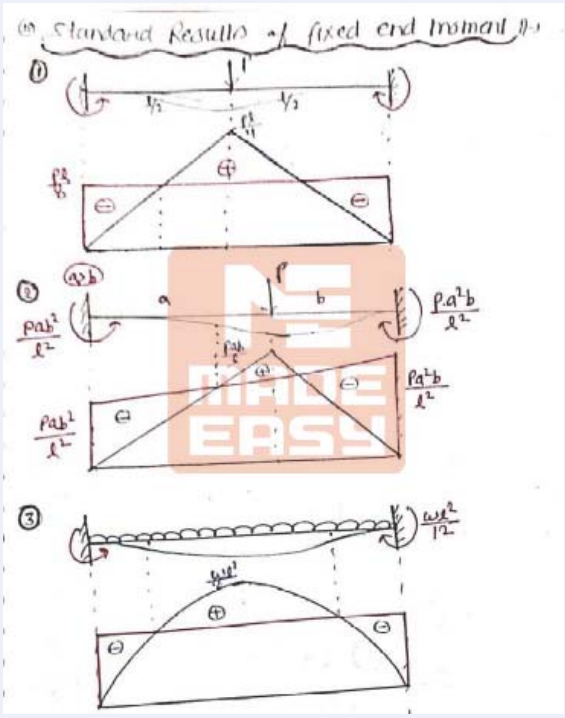
(a) $\frac{Wl}{4}$ (b) $\frac{Wl}{8}$

(c) $\frac{Wl^2}{4}$ (d) $\frac{Wl^2}{8}$

Ans. (b)



Bending moment at support = $\frac{Wl}{8}$



End of Solution

121. What is the time required to grade and finish 30 km of road formation with a width equal to thrice the width of the motor grader, using six passes of the motor grader with speed for each of the successive two passes as 6 km/hr, 8 km/hr, and 10 km/hr, respectively? Assume machine efficiency based on operator's skill, machine characteristics, and work conditions as 75%.

(a) 78 hours
(b) 84 hours
(c) 90 hours
(d) 96 hours

Ans. (*)

Road width, $W = 3 \times$ width of motor grader
$= 3b$

It means there are 3 lane

machine efficiency = 75% = 0.75

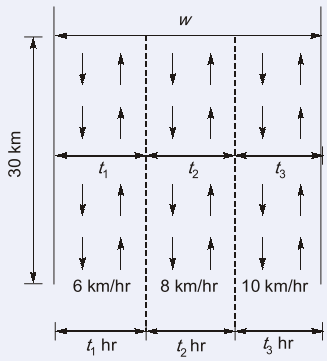
Length of road, $L = 30$ km

$V_{1-2} = 6$ km/hr

$V_{2-4} = 8$ km/hr

$V_{4-6} = 10$ km/hr

Time required for first 2 passes



$$t_1 = \frac{30 \times 2}{6} = 10 \text{ hr}$$

For next 2 passes

$$t_2 = \frac{30 \times 2}{8} = 7.5 \text{ hr}$$

For last 2 passes

$$t_3 = \frac{30 \times 2}{10} = 6 \text{ hr}$$

$$T = t_1 + t_2 + t_3 = 23.5 \text{ hrs}$$

For 75% machine efficiency,

$$\therefore \quad \text{Total times required} = \frac{T}{\eta_{machine}} = \frac{23.5 \text{ hr}}{0.75} = 31.33 \text{hr}$$

End of Solution

122. The factors influencing the output of a machine in construction are
1. physical site conditions
2. condition of the machine
3. method of operation
4. type of soil

Which of the above factors are correct?

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

Ans. (d)

Physical site conditions, conditions of the machine, methods of operation and type of soil all can influence the output of a machine in construction.

End of Solution

123. Which one of the following statements is not correct in respect of the network diagram for time scheduling techniques?

(a) In a network, there must be only a single node, and the initial node must have only outgoing arrows.
(b) A network can have more than one final node.
(c) An event cannot occur twice, i.e., there cannot be any network path looping back to a previously occurred event.
(d) An event cannot occur until all the activities leading to it are completed.

Ans. (b)

A network cannot have more than one final nodes as it will create a dangling error. Practically work should be finalized only one time hence there should be only one final event.

End of Solution

124. An interference float is defined as

(a) the amount of time by which the start of the activity may be delayed without causing a delay in the completion of the project

(b) the amount of time by which the start of the activity may be delayed without delaying the start of a following activity

(c) the difference between total float and free float

(d) the amount of time by which the start of the activity may be delayed without affecting the preceding or the following activity

Ans. (c)

Interference float is the portion of a task's total float that, when used, impacts the start of succeeding tasks. It is the difference between total float and free float.

$$F_{IN} = F_T - F_F$$

End of Solution

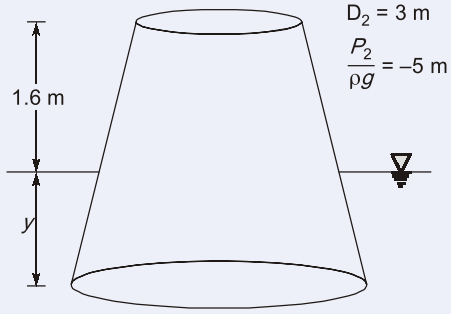
125. What is the approximate efficiency of a Kaplan turbine developing 3000 kW under a net head of 5 m? It is provided with a draft tube with its inlet (diameter 3 m) set 1.6 m above the tailrace level. A vacuum gauge connected to the draft tube indicates a reading of 5 m of water. Assume draft tube efficiency as 68% and acceleration due to gravity as 10 m/s^2. Neglect head losses in the draft tube.

(a) 85% (b) 90%

(c) 80% (d) 95%

Ans. (a)

Apply Bernoulli's equation



$$\frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 = \frac{P_3}{\rho g} + \frac{V_3^2}{2g} + Z_3$$

$$\Rightarrow -5 + \frac{V_2^2}{2g} + (Z_2 - Z_3) = (0 + y) + \frac{V_3^2}{2g}$$

$$\Rightarrow -5 + \frac{V_2^2 - V_3^2}{2g} + (1.6 + y) = y$$

$$\Rightarrow \frac{V_2^2 - V_3^2}{2g} = 3.4 \text{ m}$$

Efficiency of draft tube

$$\eta_{draft} = \frac{\left(\frac{V_2^2 - V_3^2}{2g}\right)}{\left(\frac{V_2^2}{2g}\right)}$$

$$\Rightarrow 0.68 = \frac{3.4}{V_2^2} \times 2 \times 10$$

$$\Rightarrow V_2^2 = 100$$

$\Rightarrow$ $V_2 = 10$ m/sec

Now, efficiency of turbine

$$\eta_0 = \frac{S \cdot P}{W \cdot P} = \frac{S \cdot P}{\rho g Q H}$$

$$\Rightarrow \quad \eta_0 = \frac{3000 \times 10^3}{10^3 \times 10 \times \frac{\pi}{4}(3)^2 \times 10 \times 5}$$

$\Rightarrow$ $\eta_0 = 0.8488$

$\Rightarrow$ $\eta_0 = 84.88\%$

Draft Tube

It is a conical diverging tube which carries water from the exit of runner to the tail race.

It must be air tight and under all conditions of operations its lower end must be submerged below the level of water in the tail race.

Purpose of Draft Tube

It converts a large portion of Kinetic energy rejected from the runner into useful pressure energy. It permits a negative head / suction head to be established at runner exit, thus making it possible to install the turbine above the tail race level.

Apply energy eqn b/w ② & ③ :-

$$\frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 = \frac{P_3}{\rho g} + \frac{V_3^2}{2g} + Z_3 + h_f$$

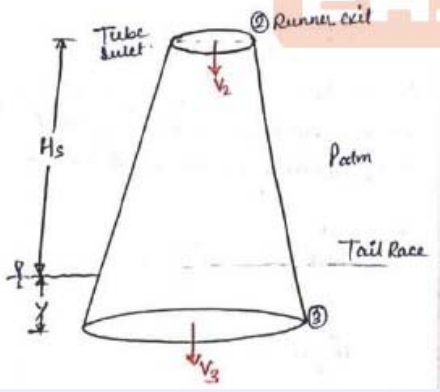
$$\frac{P_2}{\rho g} = \frac{P_3}{\rho g} + \frac{V_3^2 - V_2^2}{2g} + \underbrace{Z_3 - Z_2}_{-(H_s+y)} + h_f$$

$$= \frac{P_{atm}}{\rho g} + y + \frac{V_3^2 - V_2^2}{2g} - (H_s + y) + h_f$$

$$\frac{P_2}{\rho g} = \frac{P_{atm}}{\rho g} - \underbrace{\left[\frac{V_2^2 - V_3^2}{2g} + H_s - h_f\right]}_{+ve}$$

$$\eta_{Draft\ Tube} = \frac{\frac{V_2^2 - V_3^2}{2g} - h_f}{V_2^2/2g}$$

In the presence of draft tube Turbine exit is draft tube exit.



Total length of draft tube $= H_s + y$

$$\left| \frac{P_3}{\rho g} = \frac{P_{atm}}{\rho g} + y \right|$$

End of Solution

126. Any cause which is beyond the control of the contractor or the owner, as the case may be, which they could not foresee or with a reasonable amount of diligence could not have foreseen and which substantially affects the performance of the contract, is called

(a) letter of intent
(b) liquidated damage
(c) force majeure
(d) warranty period

Ans. (c)

Force majeure describes expuorinary events such as natural climateic anomaly like floods, earthquake, fire, covid-19, war etc. that excuses one or both parties from performing ontractual obligations when such events make performance impossible or impracticable.

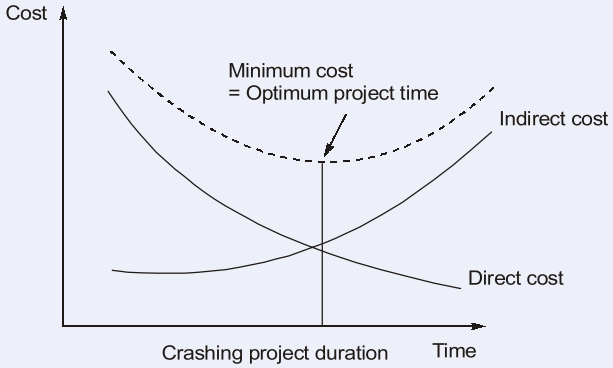
End of Solution

127. A point beyond which the project duration cannot be reduced irrespective of the increase in direct cost is known as

(a) normal duration
(b) optimum duration
(c) pessimistic duration
(d) crash duration

Ans. (d)

Crash duration refers to the minimum time in which a project activity can be completed when additional resources and costs are used to speed up the process, beyond which further reduction will cause an increase in the total cost.



End of Solution

128. Which one of the following models has not been found to be of much practical value in the construction industry?

(a) Game theory model
(b) Friedman's model
(c) Gates model
(d) Cash flow-based model

Ans. (b)

- Friedman's model is not specifically designed for construction or project management.

End of Solution

129. Which one of the following reasons is not correct for low labour productivity?
(a) Unproductive time
(b) Workers' high morale
(c) Poor pre-work preparation by supervisors
(d) Directional failures of the project management

Ans. (b)
Labour productiivty is affected by factors that enhance the efficiency of worker.
In fact worker high morale increase productivity.
High morale among worker is generally associated with better productivity.

End of Solution

130. Consider the following basic causes of accidents in civil engineering works:
1. Persons/materials falling from height
2. Persons being struck or trapped by moving objects
3. Persons stepping on or striking against objects

Which of the above causes are correct?
(a) 1, 2, and 3
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1 and 3 only

Ans. (a)
Persons/materials falling from height, persons being struck or trapped by moving objects and persons stepping on or striking against objects are all basic causes of accidents in civil engineering works.

End of Solution

131. Which one of the following Acts covers provisions for daily working hours, holidays, and overtime payments?
(a) The Minimum Wages Act
(b) The Payment of Wages Act
(c) The Factories Act
(d) The Trade Unions Act

Ans. (c)
The factories Act, 1948 is the primary act that covers prouisious for daily working hours, holidays and overtime payments in India.
1. Daily working hours
2. Weekly holidays
3. Overtime payments
4. Health and safety provisions
5. Welfare of workers in factories

End of Solution

132. What is the depth of a point below the water surface in the sea where pressure intensity is 1.006 MN/m^2 and the specific gravity of seawater is 1.025?
(a) 70 m
(b) 80 m
(c) 90 m
(d) 100 m

Ans. (d)

Given: $G = 1.025$

Let : Pressure intensity at depth h is 1.006 MN/m^2

$\therefore \quad \rho.gh = 1.006 \times 10^6$

$\Rightarrow \quad 1.025 \times 10^3 \times 9.81 \times h = 1.006 \times 10^6$

$\Rightarrow \quad h = 100.05$ m

End of Solution

133. Which one of the following pressure gauges is the most accurate device and is used for precision work and calibrating other pressure gauges?

(a) Deadweight pressure gauge (b) Diaphragm pressure gauge

(c) Bourdon tube pressure gauge (d) Vacuum pressure gauge

Ans. (a)

Deadweight pressure gauges are considered the most accurate pressure measurement devices due to their simple design based on the principle of applying known weights to a piston to generate a precise pressure. They are often used as the primary standard for calibrating other pressure gauges.

- **Diaphragm pressure gauge:** While relatively accurate for low-pressure applications, diaphragm gauges are less precise than deadweight testers and are susceptible to temperature fluctuations.
- **Bourdon tube pressure gauge:** Bourdon tube gauges are widely used for a variety of pressure measurements but are less accurate than deadweight testers. They can be affected by factors like temperature and pressure variations.
- **Vacuum pressure gauge:** Vacuum pressure gauges are designed specifically for measuring very low pressures and are not typically used for general pressure calibration or high-accuracy work.

End of Solution

134. Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with a mean velocity of 2 m/s. What is the total head of the water at a cross-section, which is 5 m above the datum line? Take the density of water as 1000 kg/ml.

(a) 38.2 m (b) 35.2 m

(c) 32.6 m (d) 28.6 m

Ans. (b)

Given: Diameter of pipe, $d = 5$ cm

Pressure, $P = 29.43$ N/cm^2 (gauge)

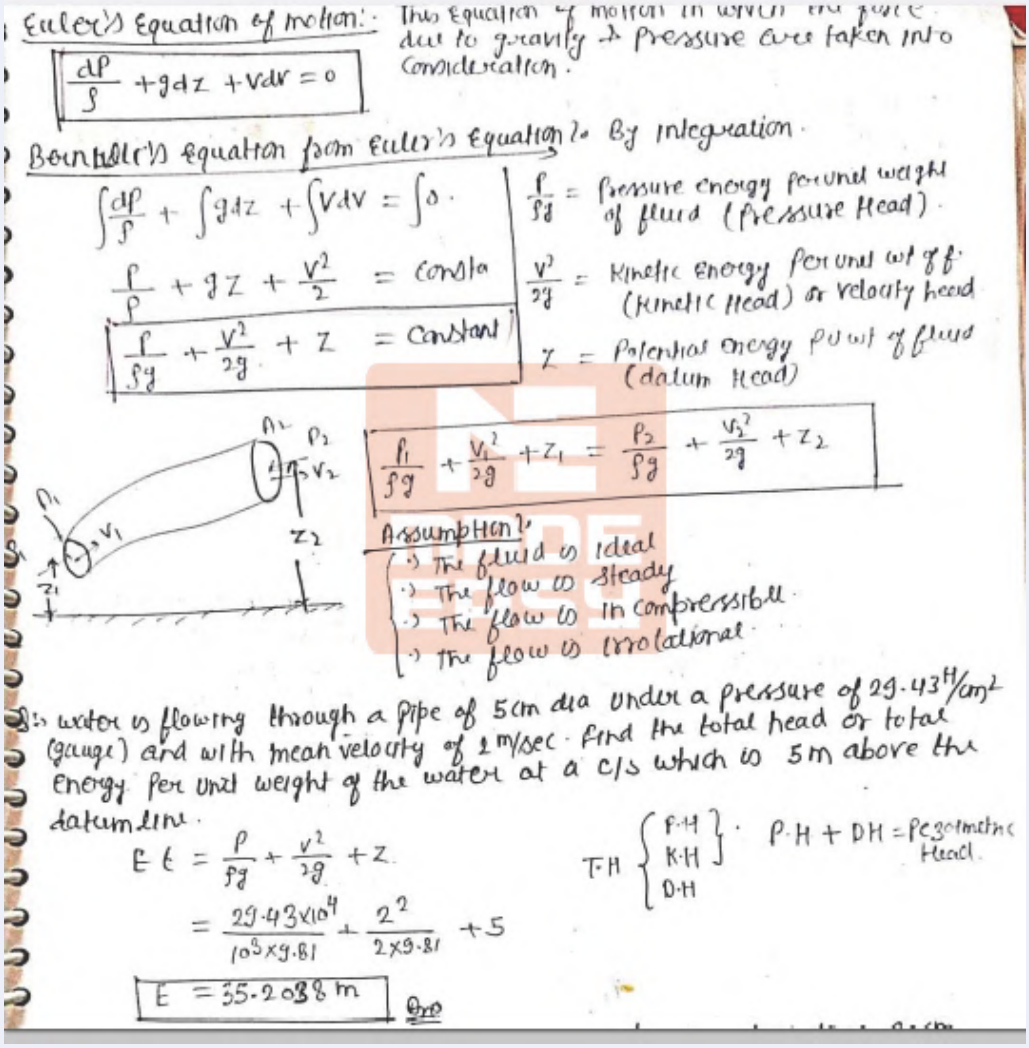
Velocity, $v = 2$ m/sec

Datum head, $z = 5$ m

$$\text{Total head} = \frac{P}{\rho g} + \frac{v^2}{2g} + z$$

$$\Rightarrow \quad H_{\text{Total}} = \frac{29.43 \times 10^4}{10^3 \times 9.81} + \frac{2^2}{2 \times 9.81} + 5$$

$$\Rightarrow \quad H_{\text{Total}} = 35.20 \text{ m}$$

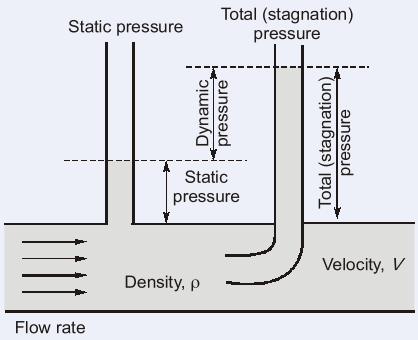


End of Solution

135. Pitot tube is one of the most accurate devices for
(a) pressure measurement
(b) velocity measurement
(c) density measurement
(d) surface tension measurement

Ans. (b)

A Pitot tube measures the velocity of a fluid by converting the kinetic energy of the flow into pressure energy at a stagnation point, allowing for the calculation of the fluid velocity based on the pressure difference.

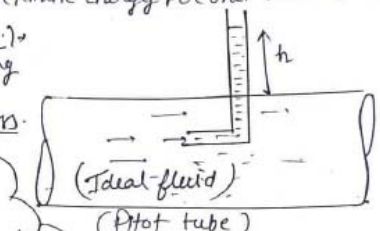


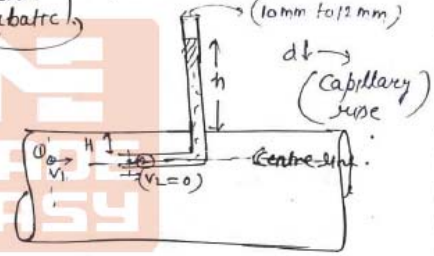
(3) Pitot tube :-

- It measure velocity of fluid.
- It converted Kinetic head to Potential head (Pressure head) (Based on conservation of energy).

→ Static Pressure · (thermodynamics · Pressure)
→ Dynamic Pressure (Kinetic energy Per unit volume) $\frac{1}{2}\frac{\rho v^2}{v}$
→ Stagnation Pressure :-
- When a fluid is moving
(KE → Pressure head)
In an isentropic Process.

Total KEnergy converted into Pressure head Here no loss will occure. It is possible only Reversible adiabatic Process





Calculation :-

B.E b/w ① & ②

$$\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2 \quad (Z_1=Z_2)$$

$\frac{P_1}{\rho g}$ = Pressure head above ① = H

$\frac{P_2}{\rho g}$ = Pressure head above ② = H+h

Now $H+\frac{V_1^2}{2g}=H+h+0$.

$h=\frac{V_1^2}{2g}$ = reading

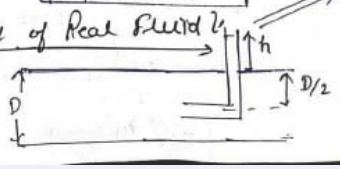
$(V_1)_T=\sqrt{2gh}$

Co-efficient of velocity $C_v=\frac{(V_1)_{act}}{(V_1)_{the}}$

$(V_1)_{act}=C_v(V_1)_T$

$0<C_v<1$

⇒ Velocity of Real fluid :-



$(V_1)_T=\sqrt{2gh}$

$(V_1)_T > (V_1)_{actual\ velocity}$.

End of Solution

136. The buckling of the web by diagonal compression can be prevented by which of the following?

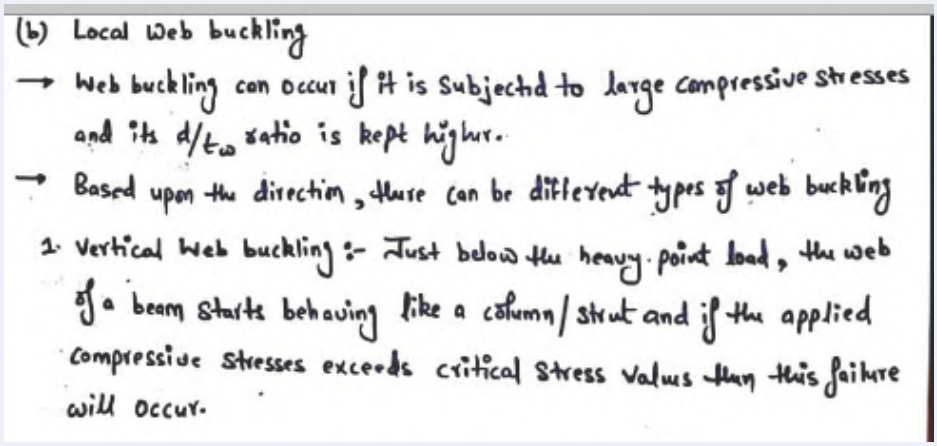
1. The depth-to-thickness ratio of the web can be increased
2. Web stiffness may be provided by forming panels to increase the shear resistance of the web
3. Web stiffness may be provided by forming panels in such a way as to create tension field action in the web to resist diagonal compression

Select the correct answer.

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

Ans. (b)

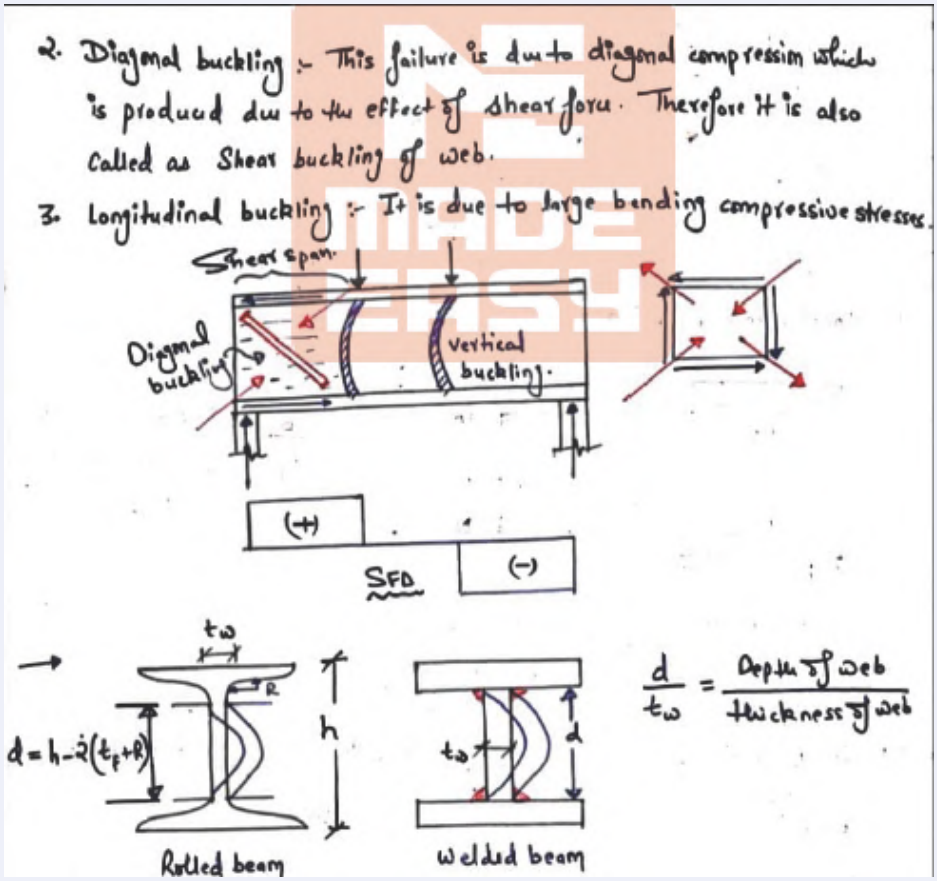
The buckling of the web by diagonal compression can be prevented by decreasing depth to thickness ratio.


(b) Local web buckling

→ Web buckling can occur if it is subjected to large compressive stresses and its d/t_w ratio is kept higher.

→ Based upon the direction, there can be different types of web buckling

1. Vertical web buckling :- Just below the heavy point load, the web of a beam starts behaving like a column/strut and if the applied compressive stresses exceeds critical stress values then this failure will occur.



End of Solution

137. It is proposed to design an industrial building 12 m high for a 50-year life. The building size is in the range of 20 m to 50 m, the topography of the site is practically plain, and the terrain is in the city industrial area. If the risk coefficient $k_1 = 1$, terrain factor $k_2 = 0.9$, topography factor $k_3 = 1$, and wind speed $V_b = 47$ m/s, the design wind pressure at the site will be nearly

(a) 0.6 kN/m^2 (b) 1.1 kN/m^2

(c) 2.1 kN/m^2 (d) 2.6 kN/m^2

Ans. (b)

Given: wind speed $V_b = 47$ m/sec

Risk factor $K_1 = 1$

Terrain factor $K_2 = 0.9$

topography factor $K_3 = 1$

Design wind velocity $V_d = K_1 K_2 K_3 V_b$

$= 1 \times 0.9 \times 1 \times 47$

$V_d = 42.3$ m/sec

Now, Design wind pressure,

$$P_z = 0.6\,(V_d)^2$$

$\Rightarrow$ $P_z = 0.6\,(42.3)^2 = 1.074\ \text{kN/m}^2$

$\Rightarrow$ $P_z \simeq 1.1\ \text{kN/m}^2$

(iii) Wind load [IS875 (Part-3)]

→ The most important parameter in quantifying wind load is the wind speed.

→ As per IS 875, the intensity of the wind pressure can be related to the max. wind speed which is calculated over a short interval of 3 seconds, at a height of 10 m from the mean G.L with a 50 yrs return period.

→ The basic wind speed (V_b) for any location can be obtained from wind map of the country.

→ This basic wind speed is now modified as per our structure requirement

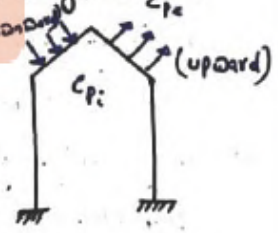
$$V_z = K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot V_b$$

where K_1 → Risk coeffecient.

K_2 → Terrain, Height and Structure size factor.

K_3 → Topography factor.

K_4 → Importance factor



→ Design Wind Pressure, $p_z = 0.6(V_z)^2$ → N/m²

→ Wind load on Roof or Wall $= (C_{pe} - C_{pi}) \cdot p_z \times A_e$

where C_{pe} → Coeff of external pressure.

C_{pi} → Coeff. of internal pressure.

A → Surface area of the member.

End of Solution

MADE EASY students top in ESE 2024

• 4 Streams 4 Toppers all 4 MADE EASY Students • 40 out of 40, in Top 10 • 197 out of total 206 Vacancies (95% Selections)

CE 10 in Top 10

AIR	Name	Course
1	ROHIT DHONDGE	CLASSROOM COURSE
2	HARSHIT PANDEY	CLASSROOM COURSE
3	LAXMIKANT	CLASSROOM COURSE
4	D MADHANKUMAR	CLASSROOM COURSE
5	AMAN PRATAP SINGH	CLASSROOM COURSE
6	SANCHIT GOEL	CLASSROOM COURSE
7	SUNIL SEERVI	CLASSROOM COURSE
8	ROHIT KUMAR	CLASSROOM COURSE
9	ANKIT MEENA	TEST SERIES & IGP
10	BADUGU RAJESH	ONLINE COURSE

ME 10 in Top 10

AIR	Name	Course
1	MUNISH KUMAR	TEST SERIES & IGP
2	RAJESH KASANIYA	ONLINE COURSE
3	GOLLANGI SATEESH	TEST SERIES & IGP
4	D. AJINKYA RADHAKISAN	CLASSROOM COURSE
5	BANKURU NAVEEN	CLASSROOM COURSE
6	CHANDAN JOSHI	ONLINE COURSE
7	DINESH KR. SHARMA	CLASSROOM COURSE
8	SHAILENDRA SINGH	CLASSROOM COURSE
9	KRISHNA K. DWIVEDI	CLASSROOM COURSE
10	V. AKSHAY SANTOSH	IGP

EE 10 in Top 10

AIR	Name	Course
1	RAJAN KUMAR	CLASSROOM COURSE
2	SATYAM CH. KHAIRNAR	CLASSROOM COURSE
3	PRIYANSHU MUDGAL	ONLINE COURSE
4	NAMAN AGARWAL	ONLINE COURSE
5	MAYANK KUMAR SINGH	CLASSROOM COURSE
6	RITVIK KOK	ONLINE COURSE
7	MANTHAN SHARMA	CLASSROOM COURSE
8	MAYANK JAIMAN	ONLINE COURSE
9	ANMOL SINGH	ONLINE COURSE
10	AKSHIT PARASHARI	ONLINE COURSE

E&T 10 in Top 10

AIR	Name	Course
1	HIMANSHU THAPLIYAL	CLASSROOM COURSE
2	YASHASVI VIJAYVARGIYA	CLASSROOM COURSE
3	UNNATI CHANSORIA	ONLINE COURSE
4	RAJIV RANJAN MISHRA	CLASSROOM COURSE
5	PARAG SAROHA	ONLINE COURSE
6	CHANDRIKA GADGIL	CLASSROOM COURSE
7	DEBARGHYA CHATTERJEE	CLASSROOM COURSE
8	VIDHU SHREE	ONLINE COURSE
9	T. PIYUSH DAYANAND	CLASSROOM COURSE
10	RAJVARDHAN SHARMA	CLASSROOM COURSE

MADE EASY students top in GATE 2025

• 10 All India Rank 1 (CE, ME, IN, ES & EE) • 46 Selections in Top 10 • 401 Selections in Top 100

CE 10 in Top 10

AIR	Name	Course
CE 1	ABHAY SINGH	CLASSROOM COURSE
CE 2	HARSHVARDHAN SINGH	CLASSROOM COURSE
CE 3	PANKAJ MEENA	CLASSROOM COURSE
CE 4	HARSHIL MAHESHWARI	ONLINE COURSE
CE 5	KARTIK POKHRIYAL	CLASSROOM COURSE
CE 6	SHIVANAND CHAURASIA	ONLINE COURSE
CE 6	NIMISH UPADHYAY	ONLINE COURSE
CE 9	TARUN YADAV	CLASSROOM COURSE
CE 10	ADNAN QUASAIN	CLASSROOM COURSE
CE 10	RAHUL SINGH	ONLINE COURSE

ME+PI 14 in Top 10

AIR	Name	Course
ME 1	RAJNEESH BIJARNIYA	CLASSROOM COURSE
ME 2	GOLLANGI SATEESH	ONLINE COURSE
ME 3	NIMESH CHANDRA	CLASSROOM COURSE
PI 3	ADITYA KUMAR PRASAD	CLASSROOM COURSE
PI 5	KULDEEP SINGH NARUKA	CLASSROOM COURSE
PI 6	KAUSHAL KUMAR KAUSHIK	ONLINE COURSE
PI 7	WALEED SHAIKH	TEST SERIES
ME 7	ABHINN	CLASSROOM COURSE
ME 8	GOUTAM KUMAR	TEST SERIES
ME 10	ASHUTOSH KUMAR	CLASSROOM COURSE
ME 10	JETTI GANATEJA	TEST SERIES
ME 10	MUHAMMED SINAN K	TEST SERIES
ME 10	PITCHIKA KUMAR VASU	ONLINE COURSE
PI 10	M GOPU GANESH	TEST SERIES

EE+CS 6 in Top 10

AIR	Name	Course
EE 1	PRADIP CHAUHAN	TEST SERIES
EE 2	KAILASH GOYAL	CLASSROOM COURSE
EE 6	PUNEET SONI	TEST SERIES
EE 6	SHIVAM KUMAR GUPTA	TEST SERIES
CS 9	OMHARI	TEST SERIES
EE 10	NEELAVA MUKHERJEE	POSTAL PACKAGE & TEST SERIES

IN+EC 9 in Top 10

AIR	Name	Course
IN 1	KAILASH GOYAL	CLASSROOM COURSE
EC 2	ANKUSH PHILIP JOHN	POSTAL PACKAGE & TEST SERIES
IN 2	S. BHATTACHARYA	TEST SERIES
IN 5	SACHIN YADAV	TEST SERIES
EC 5	M. M. NAFEEZ	TEST SERIES
EC 6	PENTELA BHAVANI	TEST SERIES
IN 6	UTKARSH PATIL	CLASSROOM COURSE
IN 7	DEV J. PATEL	TEST SERIES
EC 9	CHILUKURI S. CHARAN	TEST SERIES

ES+XE 7 in Top 10

AIR	Name	Course
ES 1	YASH JAIN	CLASSROOM COURSE
ES 2	JITESH CHOUDHARY	CLASSROOM COURSE
ES 2	TARUN YADAV	CLASSROOM COURSE
XE 3	ROHAN KUMAR BISWAL	TEST SERIES
ES 5	SACHIN KUMAR	CLASSROOM COURSE
ES 7	ANKIT KUMAR	CLASSROOM COURSE
XE 9	APAR HARSH CHANDRA	CLASSROOM COURSE

For complete results of ESE & GATE, visit : www.madeeasy.in

138. The ultimate tensile strain in steel is
(a) 5-15 times more strain than concrete at collapse
(b) 15-25 times more strain than concrete at collapse
(c) 25-35 times more strain than concrete at collapse
(d) 35-45 times more strain than concrete at collapse

Ans. (d)
Ultimate tensile strain in steel and concrete at the time of failure.

$$(\epsilon_{steel})_{failure} = 15\%$$
$$(\epsilon_{concrete})_{failure} = 0.0035 = 0.35\%$$
$$\text{ratio} = \frac{15}{0.35} = 43 \text{ times}$$

$\therefore$ Strain in steel is 35 to 45 times more strain than concrete at the time of collapse.

End of Solution

139. The long-term deflections of reinforced concrete members under sustained loads are mainly due to
1. differential shrinkage
2. creep under sustained loading
3. temperature effects

Select the correct answer.
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2, and 3

Ans. (d)
It mainly due to
- differential shrinkage
- creep under sustained loading
- temperature effects

End of Solution

140. The maximum spacing of vertical stirrups at beam ends (plastic hinge locations) as per IS 13920 is the lesser of
(a) 0.75 d or 300 mm
(b) 0.55 d or 250 mm
(c) 0.35 d or 200 mm
(d) 0.15 d or 150 mm

Ans. (*)
As per IS 13920
- $\frac{d}{4} = 0.25d$
- $6\phi_m$
- 100 mm

As per IS 456 : 2000
- 0.75 d or 300 mm

End of Solution

141. Which of the following are the design steps of restrained slabs?

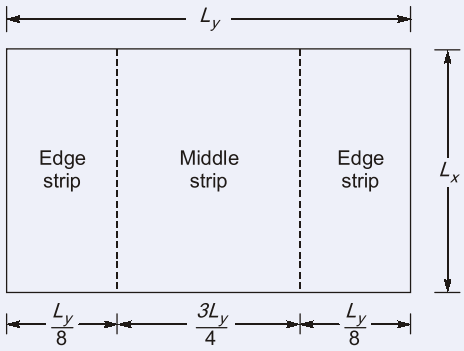
1. Slabs are considered as divided in each direction into middle strips and edge strips
2. The middle strips are one-fourth of the width, and edge strips are three-quarters of the width
3. Tension reinforcement provided at mid-span in the middle strip shall extend in the lower part of the slab to within 0.25l of a continuous edge or 0.15l of a discontinuous edge, where l is the length of the span

Select the correct answer.

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

Ans. (a)

Refer IS 456 : 2000 (Cl 1.2 and Cl 1.4)



End of Solution

142. Which of the following are the correct design requirements regarding underground water tanks?

1. Walls are to be designed for saturated soil up to the extent of water above the base slab
2. The base slab is to be designed for the net uplift pressure of water (less the weight of the slab for the tank empty)
3. A check has to be applied for the stability of the tank as a whole against uplift

Select the correct answer.

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

Ans. (d)

All statements are correct.

End of Solution

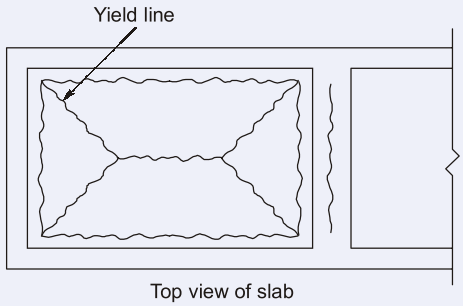
143. Which of the following characteristics are useful in the yield line patterns for slabs with various boundary conditions?

1. Yield lines are curvilinear lines so that they may act as plastic hinges
2. Yield lines terminate at the slab boundary or at the intersection of other yield lines
3. Yield lines may form along the support if an edge is fixed or continuous

Select the correct answer.

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

Ans. (c)



- Yield lines are straight line so that they may act plastic hinges.
- Yield lines terminate at the slab boundary or at intersection of other yield lines.
- Yield lines may form along the support if an edge is fixed or continuous.

End of Solution

144. For cohesionless sand at a depth of 6 m and with an angle of internal friction of 30°, the active lateral pressure intensity will be (take the unit weight of dry sand as 19600 N/m^3)

(a) 43.4 kN/m^2 (b) 39.2 kN/m^2
(c) 36.4 kN/m^2 (d) 33.2 kN/m^2

Ans. (b)

Given: depth, $H = 6$ m, $\phi = 30°$

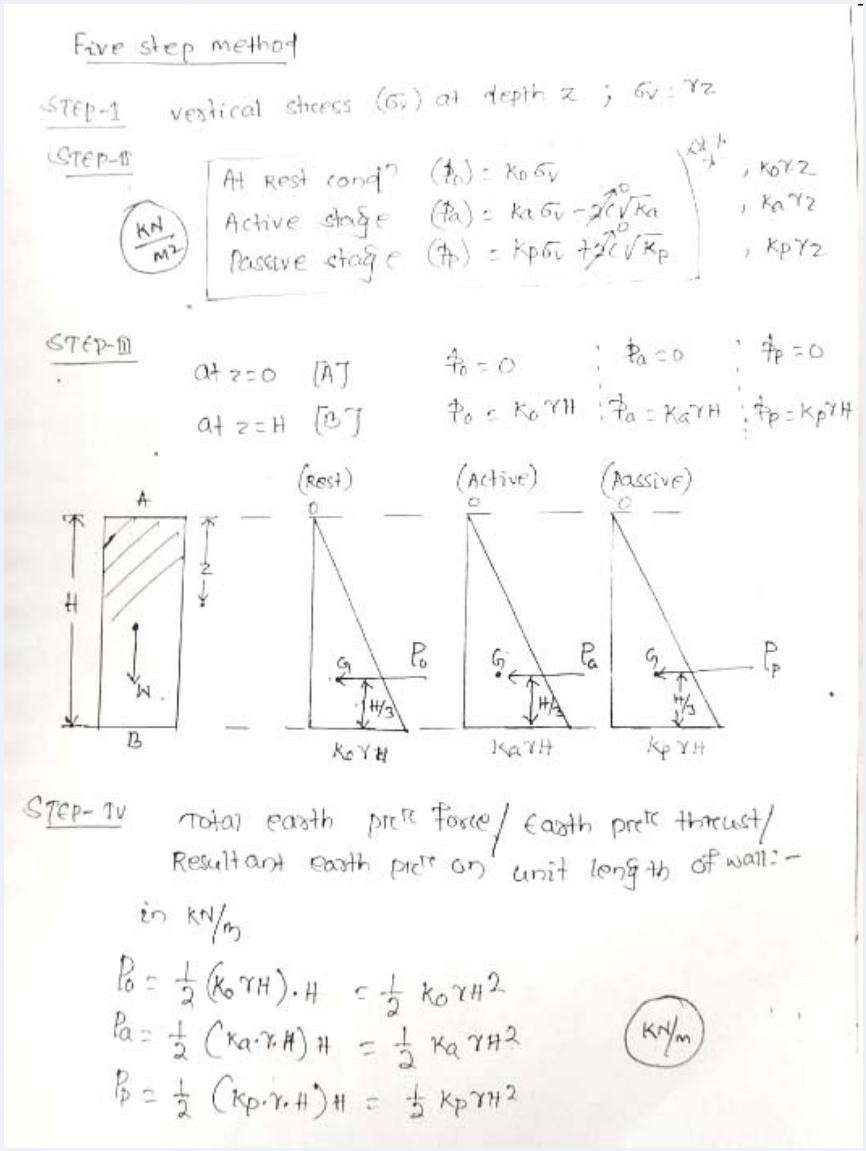
$\gamma = 19.6$ kN/m^3

Now, $$K_a = \frac{1-\sin 30°}{1+\sin 30°} = \frac{1}{3}$$

Active lateral pressure intensity.

$$P_a = K_a \gamma H$$

$$= \frac{1}{3} \times 19.6 \times 6 = 39.2 \text{ kN/m}^2$$



End of Solution

145. A slab having a total thickness of 120 mm is provided with reinforcement bars of the following diameters. The permissible diameter is

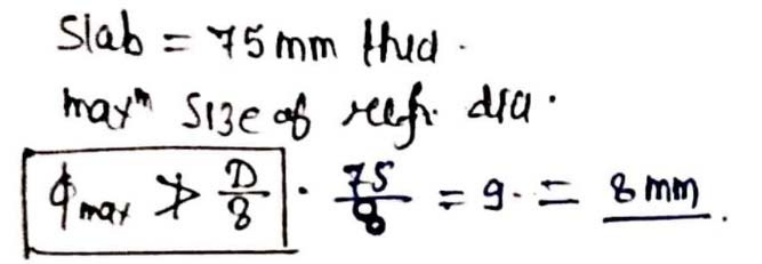
(a) 15 mm (b) 16 mm

(c) 18 mm (d) 19 mm

Ans. **(a)**

As per IS 456 : 2000 (CL 26.5.2.2)

$$\phi_{max} = \frac{D}{8} = \frac{120}{8} = 15 \text{ mm}$$



End of Solution

146. The correct sequence of the stages for dressing of stone is
(a) planning, sizing, shaping, finishing, polishing
(b) sizing, planning, shaping, finishing, polishing
(c) planning, shaping, sizing, finishing, polishing
(d) sizing, shaping, planning, finishing, polishing

Ans. **(a)**
Dressing of stone is process of giving proper size, shape and finishing to roughly broken stone.
To make it more decorative polishing machine impart appealing finishing.
Note: If it is plainshing or plaining i.e. using chisels to create a smooth even surface than answer would be d.

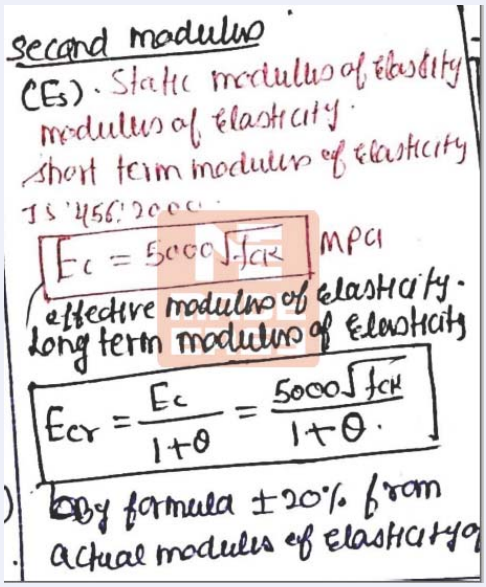
End of Solution

147. The short-term static modulus of elasticity E_C for structural concrete defining the slope of the tangent to the stress-strain diagram may be estimated from
(a) $2000\sqrt{f_{ck}}$ MPa (b) $3000\sqrt{f_{ck}}$ MPa
(c) $4000\sqrt{f_{ck}}$ MPa (d) $5000\sqrt{f_{ck}}$ MPa
where f_{ck} is the characteristic compressive strength of concrete.

Ans. **(d)**
Short-term static modulus of elasticity

$$E_C = 5000\sqrt{f_{ck}}\ \text{MPa}$$

where, f_{ck} = Characters strength of concrete (in MPa)



End of Solution

148. The stone masonry construction is superior to brick masonry construction under which of the following circumstances?

1. Stone masonry construction can be developed aesthetically more sound than brickwork
2. Stone masonry is more watertight than brick masonry because bricks absorb moisture from the atmosphere
3. For public buildings and monumental structures, stone masonry provides a solid appearance and is found to be more useful than brick masonry

Select the correct answer.

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

Ans. (d)

All statements are correct.

End of Solution

149. Consider the following statements:
The wall thickness depends upon
1. the anticipated load to come on the wall
2. the quality of wall material
3. the overall height of the wall
4. the height between floors
5. the spacing between buttress and cross-wall

Which of the above statements are correct?

(a) 1, 2, 3, 4, and 5 (b) 1, 2, 3, and 4 only
(c) 1, 2, 3, and 5 only (d) 2, 3, 4, and 5 only

Ans. (a)
All statement are correct.

End of Solution

150. A grader may be used for the following works, **except**

(a) finishing or levelling earthwork (b) shaping bank slopes
(c) heavy excavation (d) dirt road maintenance

Ans. (c)
Graders are primarily used for shaping and leveling surfaces, direction road maintenance etc. but not for heavy excavation.

End of Solution