CHAPTER - 1
EQUILIBRIUM OF FORCES

1.1 MECHANICS

Mechanics is a branch of the physical sciences that is concerned with the state of rest or motion of bodies that are subjected to the action of forces. In general, this subject can be subdivided into three branches: rigid-body mechanics, deformable-body mechanics, and fluid mechanics.

Rigid-body mechanics is divided into two areas: statics and dynamics. *Statics* deals with the equilibrium of bodies, that is, those that are either at rest or move with a constant velocity; whereas dynamics is concerned with the accelerated motion of bodies.

1.1.1 Matter

Anything which has mass and occupy space is called matter. Generally, it has three phases

1. Solid
2. Liquid
3. Gas

$$\text{Solid} \xrightarrow[\text{Heat}]{} \underbrace{\text{Liquid} \xrightarrow[\text{Heat}]{} \text{Gas} \xrightarrow[\text{Heat}]{} \text{Plasma}}_{\text{Fluid Mechanics}}$$

1.1.2 Particle

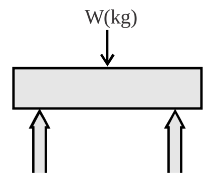
A particle has a mass, but a size that can be neglected. For example, the size of the earth is insignificant compared to the size of its orbit, and therefore the earth can be modeled as a particle when studying its orbital motion. When a body is idealized as a particle, the principles of mechanics reduce to a rather simplified form since the geometry of the body will not be involved in the analysis of the problem.

1.1.3 Rigid Body

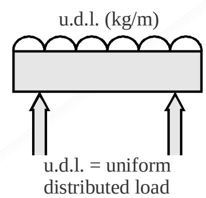
A rigid body can be considered as a combination of a large number of particles in which all the particles remain at a fixed distance from one another, both before and after applying a load. This model is important because the material properties of anybody that is assumed to be rigid will not have to be considered when studying the effects of forces acting on the body. In most cases the actual deformations occurring in structures, machines, mechanisms, and the like are relatively small, and the rigid-body assumption is suitable for analysis.

1.1.4 Concentrated Force A concentrated force represents the effect of a loading which is assumed to act at a point on a body. We can represent a load by a concentrated force, provided the

(i) Concentrated Force

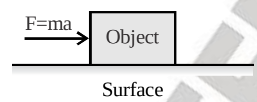


(ii) Distributed Force

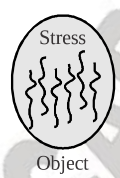


3. According to the Effect produced by the Force

(i) External Forces



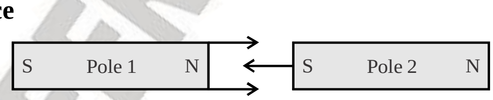
(ii) Internal Forces



4. Classification According to Application of Force

(i) Contacting Force

(ii) Non Contacting Force

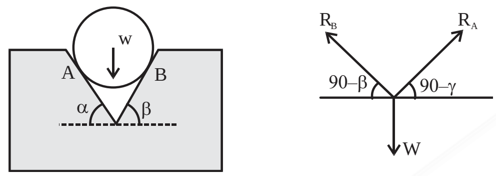


5. Classification According to Nature of Stress Produced

(i) Tensile Force

(ii) Compressive Force

(iii) Shearing Force



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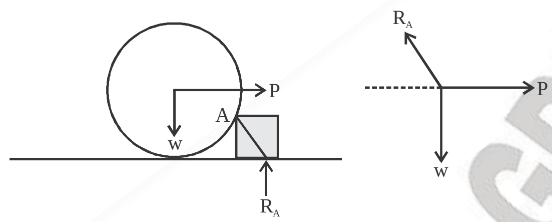

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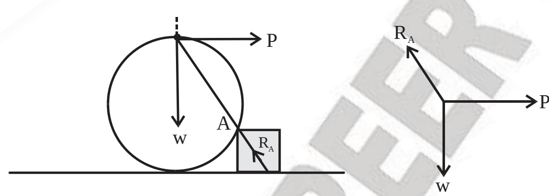


1.3.6 Principle of Physical independence of Forces

Each force is having its own effect and is independent of the presence of other forces. This principle is applicable in all engineering problems in which a number of forces are acting on a body.

1.3.7 Equilibrium of Forces

1. Equal in magnitude
2. Act along the same straight line
3. Are opposite in direction
4. Resultant force is zero.

1.3.8 Law of Super Position

According to this law there will be no effect on the action of a given system of forces acting on a rigid body if added or subtracted from them another system of forces which is also in equilibrium.

1.3.9 Principle of Transmissibility of Forces

Principle of Transmissibility of forces may be stated in other words as; A force acting at any point of a rigid body may be considered to act at any other point in its line of action provided the latter point is either one of the points of the body or rigidly connected with it.

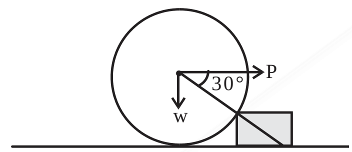
1.3.10 Laws of Forces

1. Resultant of Coplanar Forces

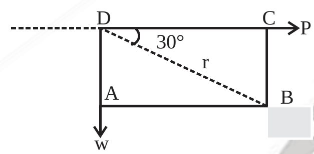
$$\frac{F_A}{\sin\alpha} = \frac{F_B}{\sin\beta} = \frac{F_C}{\sin\gamma}$$

1.8 NUMERICALS

Example. For the given configuration, force P acting horizontally is pulling out a roller out of ditch. Find the minimum force P in terms of W.



Solution.



AB = r cos θ

BC = r sin θ

$\Sigma M_B = 0$

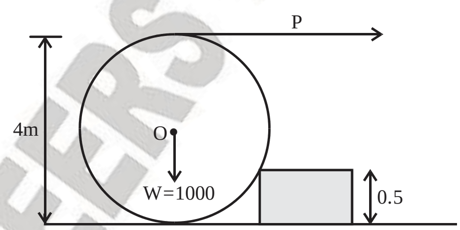
$W (r \cos\theta) - P (r \sin\theta) + R_B (0) = 0$

$W r \cos\theta = P (r) \sin\theta$

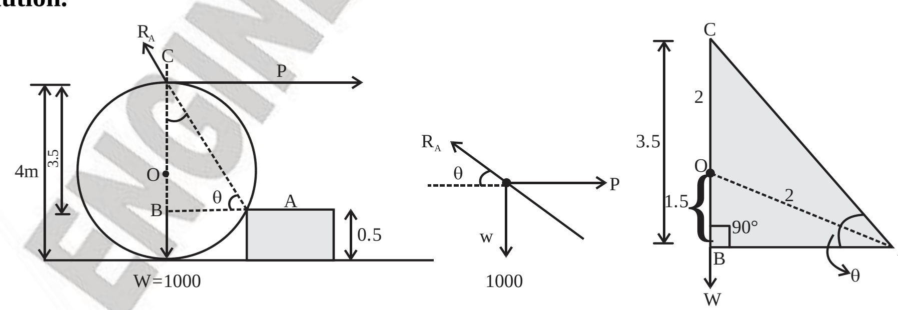
W cot 30 = P

$P = \sqrt{3}W$

Example. For the given configuration, force P acting horizontally is pulling out a roller out of ditch. Find the minimum force P to take out the roller out of ditch.



Solution.



4. Square c/s with diagonal horizontal, $Z = \frac{a^3\sqrt{2}}{6}$

5. Circular c/s of diameter "d", $Z = \frac{\pi d^3}{32}$

A long diameter "d" is available. It is proposed to cut out a strongest beam from it. Then

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

Therefore,

$$Z_{max} = \frac{bd^3}{9} \quad for \;\; b = \frac{d}{\sqrt{3}}$$

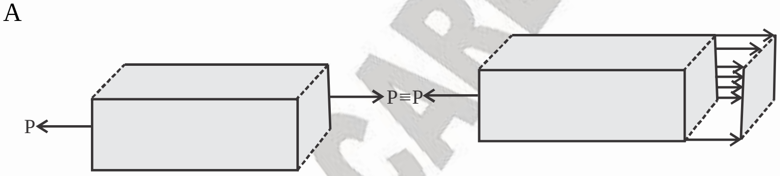
2.3 SIMPLE STRESS STRAIN RELATIONSHIPS

2.3.1 Stress

When a material is subjected to an external force, a resisting force is set up within the component. The internal resistance force per unit area acting on a material or intensity of the forces distributed over a given section is called the stress at a point.

(i) It uses original cross section area of the specimen and also known as engineering stress or conventional stress.

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



Where P is expressed in Newton (N) and A, original area, in square meters (m), the stress σ will be expressed in N/m^2. This unit is called Pascal (Pa).

(ii) As Pascal is a small quantity, in practice, multiples of this unit is used.

$1\text{kPa} = 10^3\,\text{Pa} = 10^3\,\text{N/m}^2$ (kPa = Kilo Pascal)

$1\text{MPa} = 10^6\,\text{Pa} = 10^6\,\text{N/m}^2 = 1\text{N/mm}^2$ (MPa = Mega Pascal)

$1\text{GPa} = 10^9\,\text{Pa} = 10^9\,\text{N/m}^2$ (GPa = Giga Pascal)

Let us take an example: A rod 10 mm × 10 mm cross-section is carrying an axial tensile load 10 kN. In this rod the tensile stress developed is given by

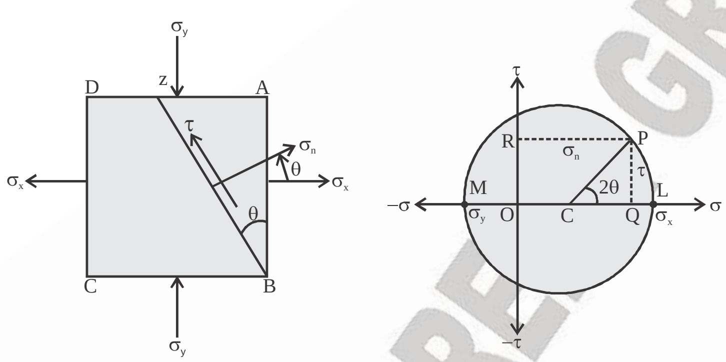
$$(\sigma_1) = \frac{P}{A} = \frac{10\text{kN}}{(10\text{mm} \times 10\text{mm})} = \frac{10 \times 10^3\,\text{N}}{100\text{mm}^2} = 100\text{N/mm}^2 = 100\text{MPa}$$

The resultant of the internal forces for an axially loaded member is normal to a section cut perpendicular to the member axis.

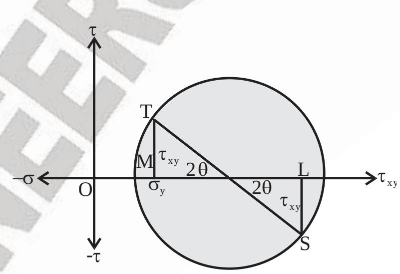
The force intensity on the shown section is defined as the normal stress.

In the examination you only draw final figure (which is in Step-V) and follow the procedure step by step so that no mistakes occur.

Construction of Mohr's circle for unlike stresses (when σ_x and σ_y) are opposite in sign)
Follow the same steps which we followed for construction for 'like stresses' and finally will get the figure shown below



For construction of Mohr's circle for principal stresses when (σ_1 and σ_2 is known) then follow the same steps of constant of Mohr's circle for Bi-axial stress (when only σ_x and σ_y known) just change the $\sigma_x = \sigma_1$ and $\sigma_y = \sigma_2$

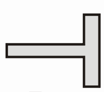
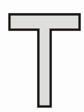
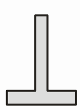


(d) Is supported on all sides throughout its length

144. Which of the following is a dimensionless quantity?
(a) Shear force
(b) Stress
(c) Strain
(d) Modulus of elasticity

145. In a simply supported beam of span, L subjected to Uniformly Distributed Load (UDL) of intensity W kN/m over it's entire length the maximum bending is given by the expression:
(a) $\frac{WL^2}{8}$ (b) $\frac{WL}{2}$
(c) $\frac{WL^2}{2}$ (d) WL

146. A simply supported beam of span 'L' is loaded with downward uniformly distributed load of intensity W/m over it's entire length. Which of the following orientation of T-beams is preferred to resist bending

(a)  (b) 
(c)  (d) 

147. The ratio of normal stress to normal strain within elastic limits is called:
(a) Young's Modulus (b) Shear Modulus
(c) Poisson's Ratio (d) Bulk Modulus

148. The shape of bending Moment Diagram in a beam subjected to only Uniformly Distributed Load (UDL) is:
(a) Constant (b) Cubic parabola
(c) Parabola (d) Triangular

149. Compression members always tend to buckle in the direction of the:
(a) Least radius of gyration
(b) Axis of load
(c) Perpendicular
(d) Minimum cross-section

150. The permanent deformation of concrete with time under steady load is called:
(a) Visco-elasticity (b) Vicidity
(c) Creep (d) Relaxation

151. Unit of second moment of area is;
(a) mm (b) mm^4
(c) mm^3 (d) mm^2

152. In case of biaxial stress, the maximum value of shear stress is given by
(a) Difference of the normal stressed
(b) Half the difference of the normal stresses
(c) Sum of the normal stresses
(d) Half the sum of the normal stresses

153. From a circular plate of diameter 6.0 cm , a circle is cut out whose diameter is a radius of the plate. The distance of centre of gravity of the remainder from the centre of circular plate is
(a) 2.0 cm (b) 1.5 cm
(c) 1.0 cm (d) 0.5 cm

154. In a section undergoing pure bending, the neutral surface is subjected to
(a) Compression strain (b) Tensile strain
(c) Zero strain (d) None of the above

155. The ability of a material to absorb energy till the breaking or rupture takes place is known as
(a) Hardness (b) Toughness
(c)Brittleness (d) Softness

156. At the point of contraflexure
(a) Bending moment is minimum
(b) Bending moment is maximum
(c) Bending moment is zero
(d) Bending moment is zero and its sign changes

157. The shear diagram for a cantilever beam subjected to a concentrated loads at the free end is given by a/an
(a) Triangle (b) Rectangle

230. An open ended thin cylindrical shell, subjected to a uniform internal pressure will be subjected to
(a) Hoop stress only
(b) Longitudinal stress only
(c) Both hoop stress and longitudinal stress
(d) None of the above

231. Moment of inertia is a concept applicable in case of
(a) A rotating body
(b) A body moving in a straight line
(c) A body at rest
(d) both (a) and (b) (Column setting not proper)

232. When slenderness ratio in a column lies between 32 to 120, it is known as
(a) Long column (b) Short column
(c) Medium column (d) Stocky column

233. Every material obeys. Hooke's law within its
(a) Elastic limit
(b) Plastic limit
(c) Limit of proportionality
(d) None of the above

234. If a uniform bar is supported at one end in a vertical direction and loaded at the bottom end by a load equal to the weight of the bar, the strain energy as compared to that due to self weight will be
(a) Same (b) Half
(c) Twice (d) Thrice

235. For a given material, if E, N and $\frac{1}{m}$ are young's Modulus, modulus of Rigidity and Poisson's Ratio then
(a) $E = 2N\left(1+\frac{1}{m}\right)$ (b) $E = 2N\left(1-\frac{1}{m}\right)$
(c) $E = \frac{2N}{\left(1+\frac{1}{m}\right)}$ (d) $E = \frac{1}{2N\left(1+\frac{1}{m}\right)}$

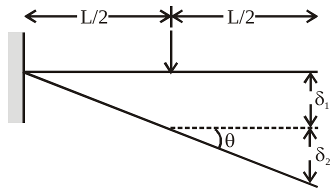
236. A cantilever of span 'ℓ' has a load P acting at the free end. The bending moment at free end will be
(a) 0 (b) P
(c) – P (d) $\frac{P}{2}$

237. Consider the following statements:
A simply supported beam is subjected to a couple somewhere in the span. It would produce
1. A rectangular SF diagram
2. Parabolic B < diagrams
3. Both + ve and –ve BM which are maximum at the point of application of the couple.
Of these statements:
(a) 1, 2 and 3 are correct
(b) 1 and 2 are correct
(c) 2 and 3 are correct
(d) 1 and 3 are correct

238. A beam simply - supported at both the ends, of length 'L' carries two equal unlike couples 'M' at two ends. If the flexural rigidity EI is constant, then the central deflection of beam is given by
(a) $\frac{ML^2}{4EI}$ (b) $\frac{ML^2}{16EI}$
(c) $\frac{ML^2}{64EI}$ (d) $\frac{ML^2}{8EI}$

239. Euler's crippling load for a column of length with one end fixed and the other hinged is
(a) $\frac{\pi^2 EI}{L^2}$ (b) $\frac{4\pi^2 EI}{L^2}$
(c) $\frac{\pi^2 EI}{4L^2}$ (d) $\frac{2\pi^2 EI}{L^2}$

240. A circular shaft can transmit a torque of 5 kNm. If the torque is reduced to 4 kNm, then the maximum Value of bending moment that can be applied to the shaft is
(a) 1 kNm (b) 2 kNm
(c) 3 kNm (d) 4 kNm



$$\delta_1 = \frac{w\left(\frac{L}{2}\right)^3}{3EI}$$

$$\delta_2 = \frac{L}{2}.\frac{w\left(\frac{L}{2}\right)^2}{2EI} \Rightarrow \frac{w\left(\frac{L}{2}\right)^3}{3EI} + \frac{L}{2}.\frac{w\left(\frac{L}{2}\right)^2}{2EI}$$

$$= \frac{wL^3}{24EI} + \frac{wL^3}{16EI}$$

$$= \frac{5}{48}\frac{wL^3}{EI}$$

Sol. 159.(c)

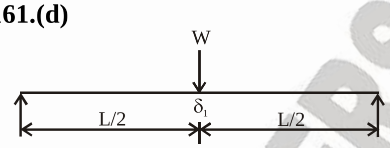
Permissible stress → τ_{per}

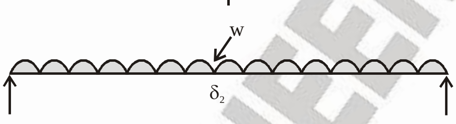
Stress produced,

$$\sigma = \frac{M}{I}.y = \frac{M}{z}$$

Sol. 160.(c)

Sol. 161.(d)



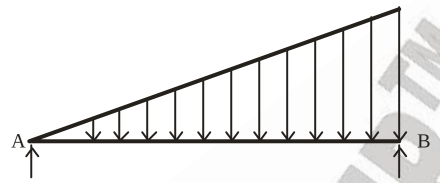


$$\delta_1 = \frac{WL^3}{48EI}$$

$$\delta_2 = \frac{5WL^4}{384} = \frac{5WL^3}{384} \qquad (WL = W)$$

$$\frac{\delta_1}{\delta_2} = \frac{8}{5} = 1.6$$

Sol. 162.(c)



Since the load is of 1° = n

BMD is n + 2° = 1° + 2° = 3°

The shape of BMD will be cubic parabola.

Sol. 163.(d)

Sol. 164.(b)

$$\delta_1 = \frac{WL}{4}$$

$$\delta_2 = \frac{wL^2}{8} = \frac{WL}{8} \qquad (wL = W)$$

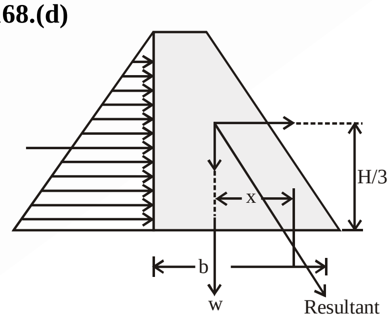
$$\frac{\delta_1}{\delta_2} = \frac{\frac{WL}{4}}{\frac{WL}{8}} = 2$$

Sol. 165.(a)

Sol. 166.(d)

Sol. 167.(b)

Sol. 168.(d)

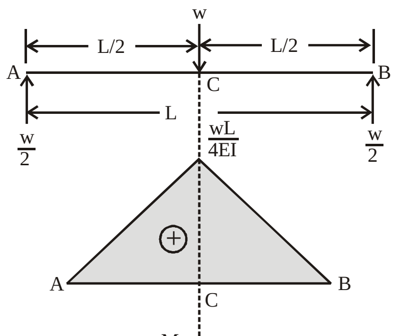


$$x = \frac{b}{6}$$

For no tension.

Compressive stress = $\frac{w}{A}$

Tensile stress = $\frac{+M}{I}.y$



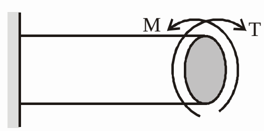
$\frac{M}{EI}$ Diagram

From slope area method
Slope at corner
= Area between A & C

$= \frac{1}{2} \times \frac{wL}{4EI} \times \frac{L}{2}$

$= \frac{wL^2}{16EI}$

Sol. 184.(c)



Maximum stress due to torque

$\tau = \frac{16T}{\pi d^3}$

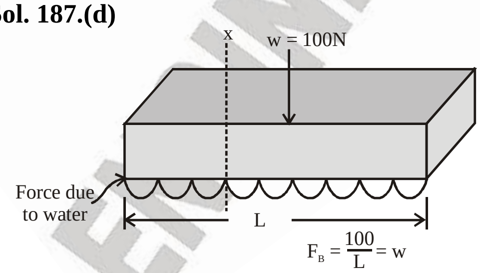
Maximum stress due to B.M.

$\sigma = \frac{32M}{\pi d^3} \Rightarrow \frac{\sigma}{\tau} = \frac{32M}{16T} = \frac{2M}{T}$

Sol. 185.(d)

Sol. 186.(d)

Sol. 187.(d)



So, shear force at section x – x

$F_x = wx$

At support

$F|_{x=0} = 0$

At centre

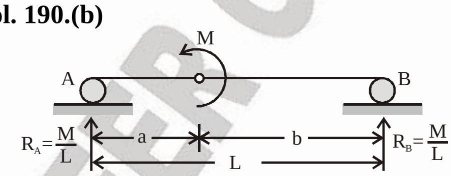
$F|_{x=\frac{L}{2}} = w \times \frac{L}{2}$

$= \frac{100}{L} \times \frac{L}{2} = 50N$

Sol. 188.(b)

Sol. 189.(c)

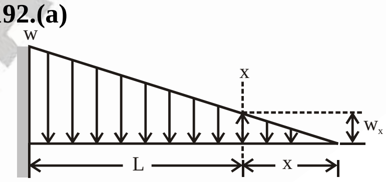
Sol. 190.(b)



Shear force Diagram

Sol. 191.(c)

Sol. 192.(a)



$w_x = \frac{w}{L} \times x$

$M_x = EI \frac{d^2y}{dx^2}$

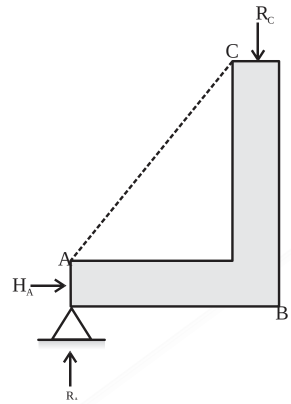
$= -\left(\frac{1}{2} \times w_x \times x\right) \times \frac{2}{3} x$

$EI \frac{d^2y}{dx^2} = -\frac{1}{6}\left(\frac{w}{L}\right) x^3$

$EI \frac{dy}{dx} = \frac{1}{6} \times \frac{w}{L} \times \frac{x^4}{4} + C_1$

Slope at x = l will be zero

$\Rightarrow C_1 = \frac{wL^4}{24EI}$



Unstable because all reaction are concurrent

3.5 METHOD OF ANALYSIS(STATICALLY DETERMINATE AND STABLE TRUSS)

There are two methods of analysis for statically determinate and stable trusses. They are:

1. Method of Joint
2. Method of Section

1. Method of Joint

In a planer-truss, at every joint there are two conditions of equilibrium

$$\Sigma F_x = 0$$
$$\Sigma F_y = 0$$

Since all the members at a joint are assumed to pass through a single point, moment about the joint will always be zero. Hence $\Sigma M = 0$ will not be of any consequence.

Sign Convention: Tension (+) ve. Compression (-)ve.

In Method of Joint

Analysis should start at joint having at least one known force and at most two unknown forces. For example in the following figure, if we take joint A then free body diagram of joint A can be drawn as in Figure (ii)

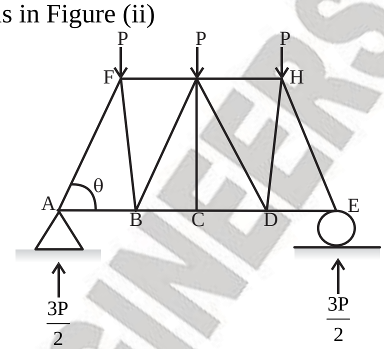


Fig. (i)

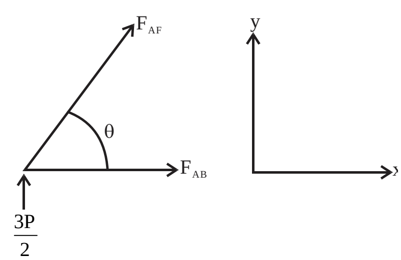
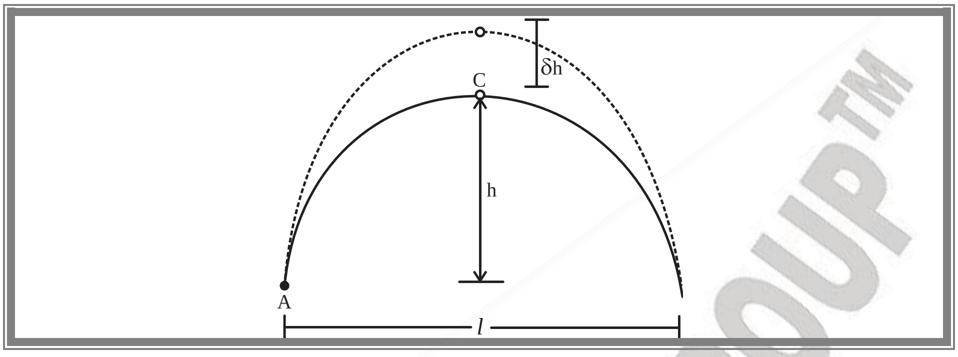


Fig. (ii)

Now from the equilibrium of forces we have

$$\Sigma F_x = 0 \Rightarrow F_{AB} + F_{AF}\cos\theta = 0$$



3.6.3 ANALYSIS OF STATICALLY DETERMINATE CABLES

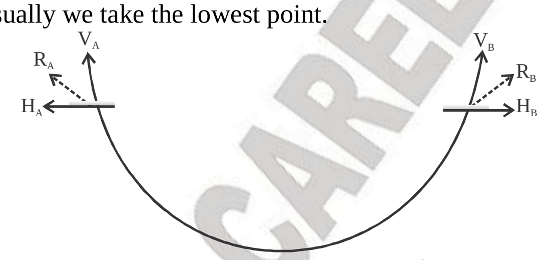
Cable is assumed to have zero self weight and BM at every, section is zero.

Steps to Analyse Cable with 2 Supports at Same Level.

i. Find the vertical reaction V_A and V_B by taking moment about one support, similar to that of a simply supported beam.

ii. If there is only vertical loads, then $H_A = H_B$.

iii. If position of any point of chord is known, take $\Sigma M = 0$ about this point to calculate horizontal reaction at supports. Usually we take the lowest point.



iv. Tension at the segments near to supports equal to resultant forces at support.

> We can analyse cable with support at two levels similar to that of 3 hinged arch with support at different levels.

Analysis of cable with UDL all over is length.

$$V_A = V_B = \frac{w\ell}{z}$$

$$H_A = H_B = \frac{w\ell^2}{8h}$$

ASSIGNMENT

1. A truss containing 'J' joints and 'm' members, will be a simple truss if

(a) j = 2m–3 (b) m = 2j–3

(c) m = 3j–2 (c) n = 3m –2

2. In a statically indeterminate structure, the formation of first plastic hinge will reduce the number of redundancy by

(a) 0 (b) 1

(c) 2 (d) 3

3. The influence lines for any stress function are used for obtaining the maximum value due to______

(a) A single point load only

(b) Uniform live load only

(c) Several point loads

(d) All options are correct

4. What does the influence line for Bending Moment indicate?

A.Bending Moment at any section on the structure for a given positions of load

B.Bending Moment at a given section for any position of a point load

(a) Only A (b) Only B

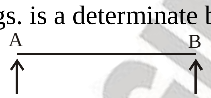
(c) Both A and B (d) Neither A nor B

5. A truss containing j joints and m members will be a simple truss if ____

(a) m=2j3 (b) j=2m–3

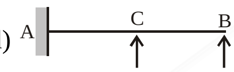
(c) m=3j–2 (d) j=3m–2

6. Which of the beams given in the following Figs. is a determinate beam?

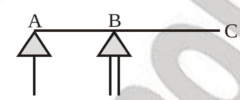
(a) 

(b) 

(c) 

(d) 

7.



The beam shown in fig is:

(a) Free cantilever beam

(b) Single overhanging beam

(c) Double overhanging beam

(d) Proper cnatiliver beam

8. In a structure, cables and wired are used generally as:

(a) To resist shear stress

(b) Tension member

(c) Compression member

(d) Flexural member

9. The lintels are preferred to arches because

(a) Arches require more headromm toe span the openings like doors, windows, etc.

(b) Arches require strong abutement to withstans arch thrust

(c) Arches are difficult in construction

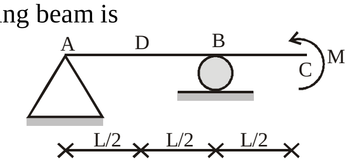
(d) All of the above

10. A beam fixed at both ends carries uniformly distributed load on entire length. The ratio of bending moment at the support to the bending moment at mid span is given by

(a) 0.5 (b) 1.0

(c) 1.5 (d) 2.0

11. Shear force at the mid - span point D in the following beam is



(a) Zero (b) 2 M/L

(c) M/L (d) 3M/L

SOLUTIONS

Sol. 1. (b)

Sol. 2. (b)

Sol. 3. (d)

Sol. 4. (b)

Sol. 5. (a)

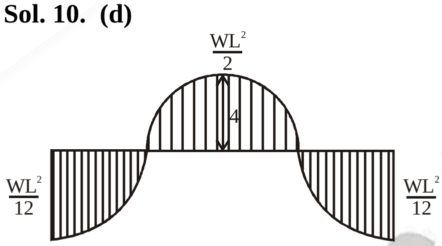
Sol. 6. (a)

Sol. 7. (b)

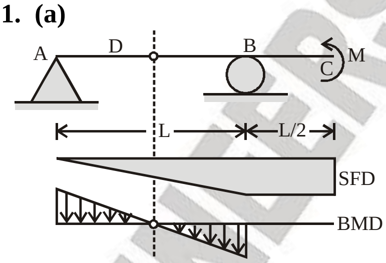
Sol. 8. (b)

Sol. 9. (d)

Sol. 10. (d)



Sol. 11. (a)



$R_A + R_B = 0$
$\Sigma M_A = 0$
$R_B.L + M = 0$

$\Rightarrow R_B = -\frac{M}{L}$

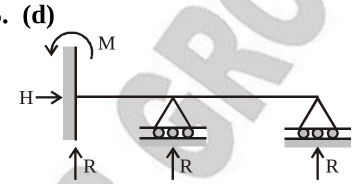
$R_A = \frac{M}{L}$

Sol. 12. (d)

Sol. 13. (a)

Sol. 14. (c)

Sol. 15. (d)



Number of Reaction = 5
Number of equilibrium condition = 3
Degree of indeterminacy
= 5 – 3 = 2

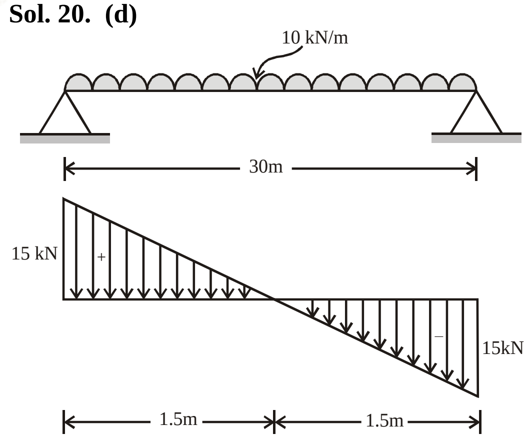
Sol. 16. (d)

Sol. 17. (c)

Sol. 18. (d)

Sol. 19. (c)

Sol. 20. (d)



S.F.D of given loading

$$A_u = \frac{T_u S_1}{b_1 d_1 (0.87 f_x)} + \frac{V_u S_1}{2.5 d_1 (0.87 f_y)} \qquad \text{i.e. } (\tau_{ce} - \tau) bd > \frac{0.87 f_y A_{st} d}{S_1}$$

But the total transverse reinforcement shall not be less than $A_{SV} < \frac{(\tau_{ce} - t_v) b.S_1}{0.87 f_y}$

Where,

T_u = Ultimate tensional moment

V_u = Ultimate shear force

S_v = Spacing of the stirrup reinforcement

b_1 = c/c distance between corner bars in the direction of width

d_1 = c/c distance between corner bars in the direction of width

B = Breadth of the member

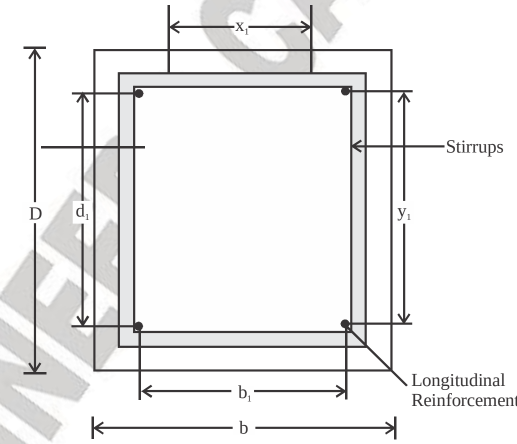
f_y = Characteristic strength of shear reinforcement $\leq$ 415 N/mm^2

$\tau_{ve} = \frac{V_e}{bd}$ = Equivalent shear stress

τ_c = Shear strength of concrete as in table 19 of IS 456.

The transverse reinforcement for torsion shall be rectangular closed stirrups placed perpendicular to the axis of the member. The spacing of the stirrups shall not exceed the least of $x_V \frac{x_1 + y_1}{4}$ and 300 mm, where x_1 and y_1 are the short and long dimensions of the stirrups as shown in figure shown below.

Where b_1= c/c distance between corner bars in the direction of the width.



$$= b = \text{clear cover - 2 diameter of stirrup } 2\left(\frac{\text{diameter of longitudinal bar}}{2}\right)$$

$$d_1 = c/c \text{ distance 2 diameter of stirrup } 2\left(\frac{\text{diameter of longtitudinal bar}}{2}\right)$$

(c) Cement provides strength, durability and water tightness to the concrete
(d) All options are correct

156. The produce impermeable concrete_______.
(a) Thorough mixing of concrete is required
(b) Proper compaction of concrete is required
(c) Proper curing of concrete is required
(d) All options are correct

157. The entrained air in concrete________.
(a) Increase workability
(b) Decreases workability
(c) Decreases resistance to weathering
(d) Increase strength

158. The neutral axis of a T-beam exists_____
(a) Within the flange
(b) At the bottom edge of the slab
(c) Below the slab
(d) All options are correct

159. The width of the rib of a T-beam is generally kept between______
(a) 1/7 to 1/3 of rib depth
(b) 1/3 to ½ of rib depth
(c) ½ to ¾ of rib depth
(d) 1/3 to 2/3 of rib depth

160. For the design of a simply supported T-beam the ratio of the effective span to the overall depth of the beam is limited to______
(a) 10 (b) 15
(c) 20 (d) 25

161. Though the effective depth of a T-beam is the distance between the top compression edge to the centre of the tensile reinforcement for heavy loads it is taken as _____.
(a) $1/8^{th}$ of span (b) $1/10^{th}$ of span
(c) $1/12^{th}$ of span (d) $1/16^{th}$ of span

162.A part of the slab may be considered as the flange of the T-beam if ______
(a)Flange has adequate reinforcement transverse to beam
(b)It is built integrally with the beam
(c)It is effectively bonded together with the beam
(d)All options are correct

163. Pickup the incorrect statement from the following: Tensile reinforcement bars of a rectangular beam____.
(a)Are curtailed if not required to resist the bending moment
(b)Are bent up at suitable places to serve as shear reinforcement
(c)Are bent down at suitable places to serve as shear reinforcement
(d)Are maintained at bottom to provide at least local bond stress

164. In a single reinforced beam, if the permissible stress in concrete reaches earlier than that in steel, the beam section is called____
(a) Under-reinforced section
(b) Over reinforced section
(c) Economic section
(d) Critical section

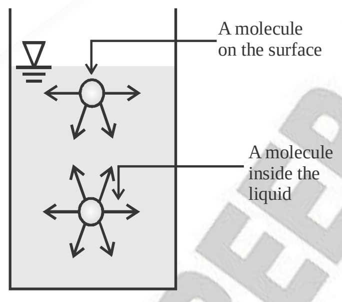
165. The width of the flange of a T-beam, which may be considered to act effectively with the rib depends upon____
(a) Breadth of the rib
(b) Overall thickness of the rib
(c) Centre to centre distance between T-beam
(d) All options are correct

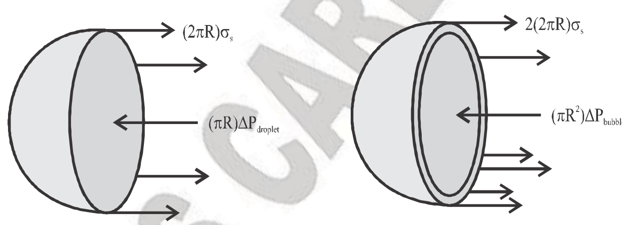
166. The minimum thickness of the cover at the end of a reinforcing bar should not be less than twice the diameter or the bar subject to a minimum of _____
(a) 10mm (b) 15mm
(c) 20mm (d) 25mm

167. Minimum spacing between horizontal parallel reinforcement of different sizes, should not be less than _____
(a)One diameter of thinner bar
(b)One diameter of thicker bar

force that causes this tension acts parallel to the surface and is due to the attractive forces between the molecules of the liquid. The magnitude of this force per unit length is called surface tension or coefficient of surface tension σ_s and is usually expressed in the unit N/m. This effect is also called surface energy (per unit are) and is expressed in the equivalent unit of $N.m/m^2$.

The attractive forces applied on the interior molecule by the surrounding molecules balance each other because of symmetric, and the attractive forces applied by the gas molecules above are usually very small. Therefore, these is a net attractive force acting on the molecule at the surface of the liquid, which tends to pull the molecules on the surface toward the interior of the liquid. This force is balanced by the repulsive forces from the molecules below the surface that are trying to be compressed. The result is that the liquid minimizes its surface area. This is the reason for the tendency of liquid droplets to attain a spherical shape. Which has the minimum surface area for a given volume.





(a) Half of a droplet or air bubble (a) Half of a soap bubble

The free – body diagram of half of a droplet or air bubble and half of a soap bubble.

Attractive forces acting on a liquid molecule at the surface and deep inside the liquid.

Droplet $(2\pi R)\sigma_s = (\pi R^2)\Delta P_{droplet}$

$$\Delta P_{droplet} = P_i - P_o = \frac{2\sigma_s}{R}$$

Soap bubble: $2(2\pi R)\sigma_s = (\pi R^2)\Delta P_{bubble}$

$$\Delta P_{bubble} = P_i - P_o = \frac{4\sigma_s}{R}$$

5.1.5 Capillary Effect

Another interesting consequence of surface tension is the capillary effect, which is the rise or fall of a liquid in a small-diameter tube inserted into the liquid. Such narrow tubes or confined flow channels are called capillaries. The rise of kerosene through a cotton wick inserted into the reservoir of a kerosene lamp is due to this effect. The capillary effect is also partially responsible

1. When body is displaced from its original position, and it ends to come back to its original position
2. When body is displaced from its original position, it remains in that new position
3. When a body is displaced from its original position, it continues to move away

5.2.2 Kinematics of Fluid Flow

The Science which deals with the geometry of motion of fluids without reference to the forces causing the motion is known as hydro kinematics or simply kinematics. Thus kinematics involves merely the description of the motion of fluids in terms of space-time relationship. One the other hand the science which deals with the action of the forces in producing or changing motion of fluids is known as hydro kinematics or simply kinetics.

There are in general two methods by which the motion of a fluid may be described. These are the Lagrangian method and the Eulerian method.

In the Lagrangian method any individual fluid particle is selected, which is pursued throughout its course of motion and the observation is made about the behavior of this particle during its course of motion through space. In the Eulerian method any point in the space occupied by the fluid is selected and observation is made of whatever changes of velocity, density and pressure which take place at that point. Out of these two methods the Eulerian method is commonly adopted in fluid mechanics and therefore the same is used in the following analysis.

5.3 TYPES OF FLUID FLOW

1. Steady Flow

Fluid flow is said to be steady if at any point in the flowing fluid various characteristics such as velocity, pressure, density, temperature etc., which described the behaviors of the fluid in motion, do not change with time.

Thus the steady flow may be expressed mathematically by the following expression at any point in the flowing fluid.

$$\left(\frac{\partial u}{\partial t}\right)=0;\left(\frac{\partial v}{\partial t}\right)=0;\left(\frac{\partial w}{\partial t}\right)=0;\left(\frac{\partial p}{\partial t}\right)=0;\left(\frac{\partial \rho}{\partial t}\right)=0$$

(i) Unsteady Flow

Fluid flow is said to be unsteady if at any point in the flowing fluid any one or all the characteristics which describe the behavior of the fluid in motion change with time. Thus a flow of fluid is unsteady, if at any point in the flowing fluid

$$\left(\frac{\partial V}{\partial t}\right)\neq 0;\ \text{and or}\ \left(\frac{\partial p}{\partial t}\right)\neq 0\ \text{etc.}$$

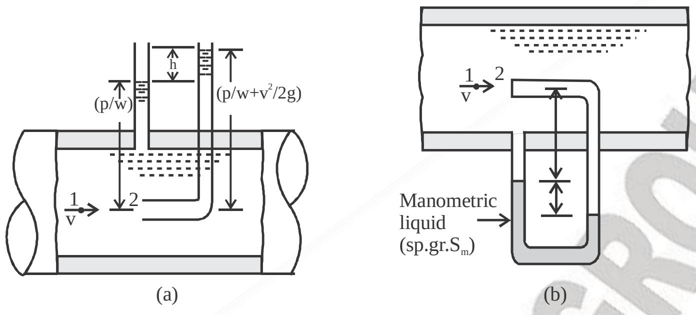
2. Uniform Flow

When the velocity of flow of fluid does not change, both in magnitude and direction, from point to point in the flowing fluid, for any given instant of time, the flow is said to be uniform. In the mathematical form a uniform flow may therefore be expressed as $\left(\frac{\partial V}{\partial s}\right)=0$

(i) Non-Uniform Flow

If the velocity of flow of fluid changes from point to point in the flowing fluid at any instant, the flow is said to be non-uniform. In the mathematical form a non-uniform flow may be expressed as

$$\frac{V^2}{2g} = h \qquad \text{Or} \quad V = \sqrt{2gh}$$



Pilot tube used for measuring velocity in pipes

Consider point 1 slightly upstream of the stagnation point 2 as shown in fig. Applying Bernoullis equation between the points 1 and 2, we get

$$\frac{p_1}{w} + \frac{V^2}{2g} = \frac{p_2}{w}$$

The equation for the pressure through the manometer in meters of water may be written as

$$\frac{p_1}{w}S + yS + xS_m = (y+x)S + \frac{p_2}{w}S$$

Where S and S_m are the specific gravities of the fluid flowing in the pipe and the manometric liquid respectively. By simplifying

$$\frac{p_2}{w} - \frac{p_1}{w} = x\left(\frac{S_m}{S} - 1\right)$$

After substituting for $[(p_2/w) - (p_1/w)]$ in Eq. (i) and solving for V,

$$V = \sqrt{2gx\left(\frac{S_m}{S} - 1\right)}$$

Again introducing the coefficient of the pitot tube C, the actual velocity of flow is given by

$$V = C\sqrt{2gx\left(\frac{S_m}{S} - 1\right)}$$

4. Orifice Meter

1. It is used to measure discharge through a pipe
2. In this case a circular plate with concentric sharp edged hole is installed in a pipe such that the plate is perpendicular to the axis of pipe
3. Concept of discharge measurement is same as that in venturimeter but it is a cheaper arrangement as compared to venturimeter
4. In this case, only a small length of pipe is affected hence if there is space restriction, orificemeter can be used in place of venturimeter
5. However, the disadvantage is that the head loss in more in this case due to flow operation. The region where flow area is minimum is called venna –contracta

a_1 is x –sectional area of section (1)-(1)

Thus for a side slope of 60^o, the length of sloping side is equal to the base width of the trapezoidal.

4. Most Economical Triangular Channel Section

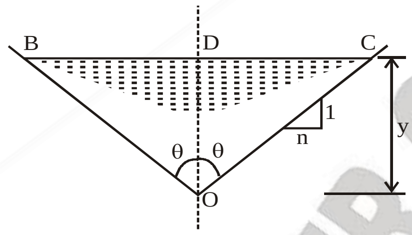
As shown in a figure a triangular channel. The side sides are n(horizontal) to 1(vertical)

Let, y = Depth of flow, and

θ = Angle made by the sides with the vertical

From ΔODC, $\frac{CD}{DO} = \tan\theta$ or $\frac{CD}{y} = \tan\theta$

or, CD = y tanθ



Triangular channel

Also, $\frac{DO}{CO} = \cos\theta$ or $\frac{y}{CO} = \cos\theta$

Or, CO = y sec θ

Area of flow,

$$A = \frac{1}{2}\times BC\times DO = \frac{1}{2}\times 2CD\times DO = \frac{1}{2}\times 2y\tan\theta\times y = y^2\tan\theta$$

i.e., $A = y^2 \tan\theta$ …(i)

Perimeter, P = BO + OC = 2OC = 2y sec θ (∵ BO=OC) …(ii)

Substituting the value of $y\left(=\sqrt{\frac{A}{\tan\theta}}\right)$ from equation (i) in equation. (ii), we get

$$P = 2\sqrt{\frac{A}{\tan\theta}}\sec\theta = 2\frac{\sqrt{A}}{\sqrt{\tan\theta}}(\sec\theta) \quad \text{…(iii)}$$

Assuming the area to be constant, eqn. (iii) can be differentiated with respect to θ and equated to zero for obtaining the condition for minimum P.

i.e., $\frac{dP}{d\theta} = \frac{d}{d\theta}\left[2\frac{\sqrt{A}}{\sqrt{\tan\theta}}(\sec\theta)\right] = 0$

$$= 2\sqrt{A}\left[\frac{\sqrt{\tan\theta}\times\sec\theta\cdot\tan\theta - \sec\theta\times\frac{1}{2}(\tan\theta)^{-1/2}\sec^2\theta}{\tan\theta}\right] = 0$$

$$= 2\sqrt{A}\left[\frac{\sec\theta\tan\theta}{\sqrt{\tan\theta}} - \frac{\sec^3\theta}{2(\tan\theta)^{3/2}}\right] = 0$$

or, $\sec\theta(2\tan^2\theta - \sec^2\theta) = 0$

Since $\sec\theta \neq 0$,

$\therefore 2\tan^2\theta - \sec^2\theta = 0$ or $2\tan^2\theta = \sec^2\theta$

12. The runway speed of a turbine is ______.
(a) The actual running speed at design load
(b) The synchronous speed of the generator
(c)The speed attained by the turbine under no load condition
(d)The speed of the wheel when governor fails

13. In the selection of turbine by specific speed or head, which one of the following statements in not correct?
(a) For specific speed 10-35, Kaplan turbines
(b) For specific speed 60-300, Francis turbines
(c) For head 50-150m, Francis turbine
(d) For head above 300m, Pelton wheel

14. Which of the following fluids can be classified as non-Newtonian?
(a) Kerosene oil and Diesel oil
(b) Human blood and Toothpaste
(c) Diesel oil and water
(d) Kerosene and water

15. When an ideal fluid flows past a sphere_____.
(a)Highest intensity of pressure occurs around the circumference at right angles to direction of flow.
(b)Lowest pressure intensity occurs at front stagnation point
(c)Lowest pressure intensity occurs at rear stagnation point
(c)Total drag is zero

16. Apart from inertial force, which of the following forces is most important in motion of submarines under water?
(a) Viscous force
(b) Gravity force
(c) Compressive force
(d) Surface tension force

17. The motion of air mass in a tornado is a ______.
(a) Free vortex motion
(b) Forced vortex motion
(c)Free vortex at center and forced vortex outside
(d)Forced vortex at centre and free vortex outside

18. Flow at constant rate through a tapering pipe is ______.
(a) Steady and uniform flow
(b) Steady and non-uniform flow
(c) Unsteady and uniform flow
(d) Unsteady and non-uniform flow

19. The pressure intensity is same in all directions at a point in a fluid______.
(a)Only when fluid is frictionless and incompressible
(b)Only when fluid is frictionless and is at rest
(c)Only when fluid is frictionless
(d)When there is no relative motion of one fluid layer relative to other

20. If the capillary rise of water in 1mm diameter tube in 3cm, the height of capillary rise of water in a 0.2mm diameter tube in centimeter will be_____.
(a) 1.5 (b) 7.5
(c) 15 (d) 75

21. A ship's model of scale 1: 100 had a wave resistance of 1N at its design speed. The corresponding wave resistance (in N) in prototype will be ______.
(a) 100 (b)1000
(c) 1000000 (d) 1000

22. An old shaped body weighing 7.5kg and occupying 0.01 cubic meter volume will be

47. The depth of water below the spillway and after hydraulic jump are 1 m and 6 m respectively. The head loss will be _________.

(a) 1.74 m (b) 6 m

(c) 1.7 m (d) None of these

48. A body floats in stable equilibrium

(a)When its metacentric height is zero

(b)When metacentre is above centre of gravity

(c) When is centre of gravity is below its centre of buoyancy

(d) None of these

49. A one dimensional flow is one which _______.

(a) Is uniform

(b)Becomes negative

(c) I steady uniform

(d) Take place in straight lines

50. Separation of flow occurs when pressure gradient _______.

(a) Tends to approach zero

(b) Becomes negative

(c) Changes abruptly

(d) Reduces to a value when vapour formation starts

51. Centre of pressure on an inclined plane is _______.

(a) All the centroid

(b) Above the centroid

(c) Below the centroid

(d) At metacentre

52. Bluff body surface_________.

(a) Is smooth so that friction can be neglected

(b) Coincides with streamlines

(c) Does not coincide with streamlines

(d) Perpendicular to streamlines

53. Gradually varied flow is ________.

(a) Steady uniformed flow

(b) Steady non – uniform flow

(c) Unsteady uniform flow

(d) Unsteady non – uniform flow

54. The ratio of hydrostatic stress to the volumetric strain within the elastic range is called _____.

(a) Modulus of elasticity

(b) Shear modulus of elasticity

(c)Both modulus of elasticity and shear modulus of elasticity

(d) None of these

55. The resultant upward pressure of a fluid on a floating body is equal to the weight of the fluid displayed by the body. This definition is according to_______.

(a) Buoyancy

(b) Equilibrium of a floating body

(c) Archimedes principle

(d) Bernoulli's theorem

56. A liquid would wet the solid, if adhesion forces as compared to cohesion forces are________.

(a) Less

(b) More

(c) Equal

(d) Less at low temperature and more at thigh temperature

57. If 850 kg liquid volume of one cubic meter, then 0.85 represents its

(a) Specific weight (b) Specific mass

(c) Specific gravity (d) Specific density

58. Which of the following is the unit of kinematic viscosity_______.

(a) Pascal (b) Poise

(c) Stoke (d) Faraday

In this type of survey horizontal and vertical angles are -measured with the help of theodolite. A theodolite is a very precise instrument used for measuring horizontal and vertical angles.

The theodolite surveys can be broadly classified into two types:

(i) Traverse survey

In traverse survey, the various stations form a polygon. The horizontal angles are measured with the help of a theodolite, whereas the linear measurements are made with a tape.

(ii) Triangulation survey

In triangulation survey, the lines form a system of triangles. The base line is measured accurately and the lengths of all other lines are computed from the measured angles.

Triangulation is used for establishing control points over extensive areas.

> Theodolite surveys are quite accurate.

6. Tacheometric Surveys

(i) In this type of survey a special type of theodolite called as Tacheometer is used, which is fitted with a stadia diaphragm having two horizontal cross hairs in addition to the central horizontal hair.

(ii) In tacheometric surveying, horizontal angles, horizontal distances and vertical distances (elevation) are measured with tacheometer.

(iii) Although tacheometric surveys are not very accurate in plane areas, but these are extremely convenient and gives better result then the-theodolite surveys in rough terrain.

7. Photogrammetric Surveys

(i) Photogrammetry is the science of taking measurements with the help of photographs.

(ii) Photogrammetric surveys are generally used for Topographic mapping of large areas.

(iii) These are extremely usefull for obtaining Topographical details of areas which are difficult to access.

(iv) Photographs are generally taken from an aeroplane. However, for certain areas where suitable sites exist, photographs can be taken from ground-based cameras.

8. EDM Surveys

(i) Trilateration is a type of triangulation in which all the three sides of each triangle are measured accurately with the help EDM instruments.

(ii) Then angles are computed indirectly form the known sides of the triangles. Hence all the sides and angles are determined.

> Trilateration is also used for fixing the position of control points like triangulation. With the help of modern EDM instruments, the trilateration is more convenient in. comparison to triangulation and is a major means of control surveys

6.3 PRINCIPLES OF SURVEYING

There are two basic principles of surveying.

The best way to over come the effect of mistake is to compare several measurements of the same quantity and discard the odd measurement which does not follow any law.

Error

This does not arise due to mistake. Rather, it is due to physical condition of instruments like temperature at the time of measurements of the length of a line & limitations of human eye etc.

1. Error = Measured Value – True Value
2. Correction = True Value – Measured Value

Hence, Measured Value + Correction = True Value

Measured Value – Error = True Value

Thus, Correction = (–) Error

6.4.4 Errors are classified as

(i) Systematic error (ii) Random error

(i) Systematic Error

(a) Systematic error arises from the source that act in a similar manner on servations.

(b) The method of measurement, the instrument used and the physical conditions at the time of measurement causes systematic error

(c) Expansion of steel tapes, frequency change in electro megnatic distance measurement (EDM) instruments and **collimation in a level**, are few examples of possible source of systematic errors.

(d) Systematic errors are **cumulative in nature**.

(e) The errors caused by systematic error are eliminated by applying corrections.

(f) Systematic errors are not revealed by taking the same measurement again with the same instruments. The only proper way to check systematic error is remeasure the quantity by an entirely different method using different instruments.

(ii) Random Error

1.Random errors are really all those discrepancies remaining, after the mistakes and systematic errors are removed.

2.It is mainly caused by limitations of observer and instruments, and are random in nature.

Important characteristics of Random Error

(i)Small errors occur more frequently than larger ones.

(ii)Positive and negative errors are equally likely.

(iii)Very large error seldom occurs.

(iv)The characterstics described above are the characteristics of normal distribution curve. Hence mathematical equations based on normal probability distribution are used for such errors.

(v)Random errors are not of much significance for ordinary surveys. However, they are quite important in precise, control surveys.

(vi)Random error of mean is directly proportional to $1/\sqrt{N}$,

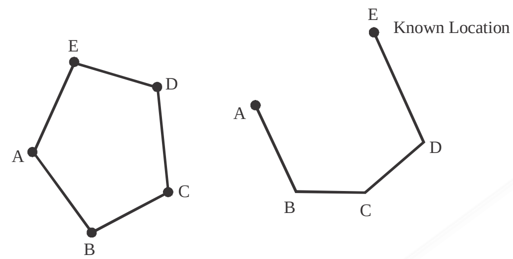
Where N is the no. of observations made.

(vii)For leveling, random error $\propto \sqrt{L}$

Where, L is horizontal length of route.

Units of Measurement

1 ft = 0.3048 m	1 mile = 5280 ft
1 yard = 3 ft	1 mile = 1.609 km
1 sq mile = 2.590 km^2	1 sq mile = 640 acres
1 acre = 43,560 sq ft	1 hectare = 2,471 acres



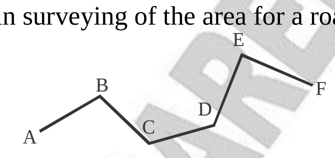
(a) Loop Traverse (b) Link Traverse

Closed Traverse

An error in a closed traverse can be easily detected and the traverse can be adjusted and balanced.

6.5.2 Open Traverse

1. An open traverse starts from a station A and closes at another station F whose location is neither known nor established.
2. It consists of a series of connected lines.
3. An open traverse is generally used in surveying of the area for a road, railway line, canal, etc.



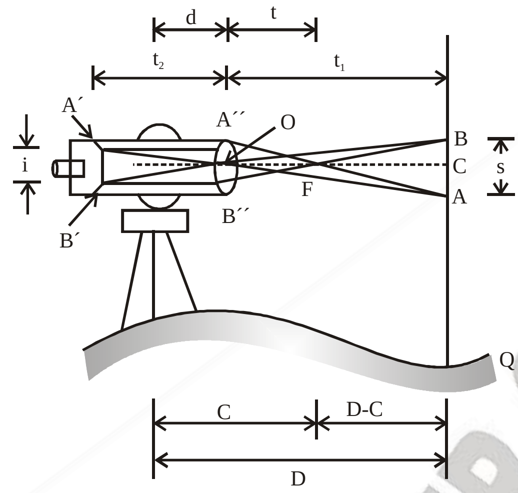
Open Traverse

An open traverse cannot be properly checked and adjusted. As far as possible, it should be avoided.

6.5.3 Difference between Traverse Surveying & Chain Surveying

Chain Surveying	Traverse Surveying
1.Requires only linear measurements hence relatively easier	1.Requires both linear and angular measurements. Hence requires trained personnel.
2.The frame work consists of triangles	2.Frame work consists of a series of connected lines froming an open or closed polygon. As the directions of lines are measured, the polygon can be plotted without constructing triangles.
3. Check lines are required in chain Surveying	3. Check lines are not required because accuracy of the framework can be-checked by the methods of adjustments.

d is Horizontal distance between optical center O and vertical axis of tacheometer.
D is Horizontal distance between staff and vertical axis of tacheometer.



$f_1 f_2$ is conjugate focal lengths of the lens, and are the distances between the optical centre O and staff, and optical centre O and the image of staff, respectively.

In triangles AOB and A′OB′

$$\frac{AB}{A'B'} = \frac{OC}{OC''} = \frac{f_1}{f_2} \quad ...(i)$$

$$\frac{s}{i} = \frac{f_1}{f_2}$$

From the lens formula

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} \quad ...(ii)$$

$$\frac{f_1}{f} = 1 + \frac{f_1}{f_2}$$

Substituting for $\frac{f_1}{f_2}$ in eq.(i)

$$\frac{s}{i} == \frac{f_1}{f} - 1 \qquad f_1 = \frac{f}{i}s + f \qquad f_1 + d = \frac{f}{i}s + f + d \qquad D = \left(\frac{f}{i}\right)s + (f+d)$$

$D = Ks + C$

1.Above equation is Tacheometric Distance Equation, K and C are the multiplying and additive constants respectively.

2.The multiplying constant $K = \left(\frac{f}{i}\right)$ is also called as stadia interval factor

3.For ease of calculation of distances, the stadia wires are spaced such that the multiplying constant K = 100.

4.The additive constant C = (f + d). Practically speaking, it is a constant value for a tacheometer, because the value of d varies by only a small and negligible amount when focusing the telescope on different objects.

$$R = \frac{15}{\sin D/2}$$

Since for flat curve, D is very small, therefore, $\sin\frac{D}{2} \approx \frac{D}{2}$

$$R = \frac{15}{(D/2)\times\pi/180^\circ}; \quad R = \frac{15\times 2\times 180^\circ}{D\times\pi}$$

R = 1718.9/D ≈ 1719/D

Similarly, for a 20m chord, $\sin\frac{D}{2} = \frac{10}{R}$

$$R = \frac{10}{\sin D/2}$$

Since for flat curve, D is very small, therefore $\frac{\sin D}{2} \approx \frac{D}{2}$

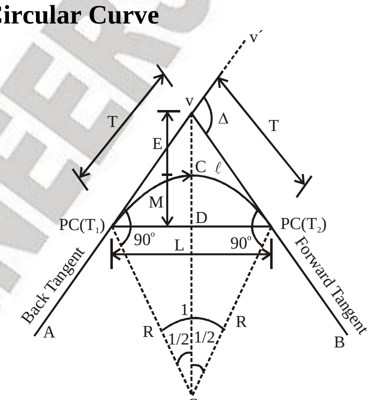
$$R = \frac{10}{(D/2)\times(\pi/180^\circ)}$$

$$R = \frac{10\times 2\times 180^\circ}{D\times\pi}$$

$$R = \frac{1145.9}{D} \approx \frac{1146}{D}$$

For flat curves, a the degree of curve is small, the arc definition and the chord definition given identical results. However, for sharp curves, the two definitions give slightly different results.

6.13.5 Elements of a Simple Circular Curve



1. Length of Curve (ℓ)

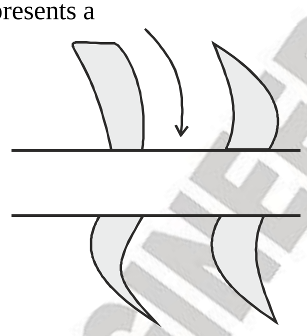
The length of curve T_1CT_2 is given by of peg A to the centre of the eye-piece is 1.540 m and the reading on peg B is 0.705m. The level is then setup over B. The height of he eye-piece above peg B is 1.490m and a reading on A is 2.195m. The difference in level between A and B is _____.

(a) 2.900m (b) 3.030m
(c) 0.770m (d) 0.785m

24. An internal focusing type surveying telescope may be focused by the movement of ______.
(a) Objective glass of the telescope
(b) Convex-lens in the telescope
(c) Concave lens in the telescope
(d) Plano-convex lens in the telescope

25. In an adjusted level when the bubble is central, the axis of the bubble tube becomes parallel to ______.
(a) Line of sight
(b) Line of collimation
(c) Axis of the telescope
(d) None of these

26. The conventional sign shown in the figure below represents a



(a) Road bridge (b) Railway bridge
(c) Canal bridge (d) Aquaduct

27. For taking offsets with an optical square on the right hand side of the chain line it is held_____.
(a) By right hand upside down
(b) By left hand upright
(c) By right hand upright
(d) By left hand upside down

28. Check lines (or proof lines) in Chain Surveying are essentially required______.
(a) To plot the chain lines
(b) To plot the offsets
(c) To indicate the accuracy of the survey work
(d) To increase the out-turn

29. Correction per chain length of 100 links along a slope of a radians is _______.
(a) $100a^2$ (b) 100a
(c) $100a^3$ (d) $100\ a^{(-1)}$

30. If h is the difference in height between end points of a chain of length I the required slope correction is ______.
(a) $h^2/(2I)$ (b) $h/(2I)$
(c) h^2/I (d) $h^2/(4I)$

31. Positive error is caused if_____.
(a)Length of chain is shorter than the standard
(b)Slope and sag corrections is not applied
(c)Measurements are made along the incorrectly aligned line
(d)All options are correct

32. Prolongation of chain line across an obstruction in chain surveying is done by:
(a) Marking angular measurement
(b) Drawing perpendiculars with a chain
(c) Solution of triangle
(d) All options are correct

33. Number of links in a 30m metric chain is_____.
(a) 100 (b) 150
(c) 180 (d) 200

(c)Bridge carrying road and railway at the same level

(d)A level crossing

69. If the chain line which runs along N-S direction is horizontal and the ground in E-W direction is sloping______.

(a)It is possible to set off sects correctly on east side

(b)It is possible to set off sets correctly on east side

(c)It is not possible to set off sets correctly on west side

(d)It is possible to set off sets correctly on both sides

70. What is the psychological widening of a pavement on horizontal curve of radius 230 m for ruling speed 80kmph?

(a) 0.455m (b) 0.555

(c) 0.186m (d) 0.136

71. If the bearing of AB = N40°W, bearing of BC = S70°E, then the value of ∠ABC is

(a) 30 degree (b) 70 degree

(c) 100 degree (d) None of these

72. Point of tangency is the ______

(a) Beginning of the curve

(b) End of the curve

(c) Common point where the radius changes

(d)Common point where the radius and direction changes

73. Left wwing is not much favoured in theodolite survey, because

(a)Most of surveyors are accustomed to right hand

(b)It is inconvenient to turn the telescope anti-clockwise

(c) The readings increase clockwise

(d)Vertical scale comes to an inconvenient position to be read

74. The telescope of a dumpy level_____

(a)Is rigidly fixed to the leveling head

(b)Can be titled in a vertical plane

(c)Can be taken out of its supports and reversed

(d)Permits interchange of eye piece and object glass

75. The representation of general topography of a very flat terrain is possible only by:

(a) Drawing contours at large interval

(b) Drawing contours at small interval

(c) Giving spot levels at large interval

(d) Giving spot levels to salient features at close interval

76. Which of the following are the required corrections for runway length?

(a) Correction for elevation

(b) Correction for gradient

(c) Correction for temperature

(d) All options are correct

77. A contour canal is ____

(a) Irrigate only on one side

(b) Does not needs bank on higher side

(c) Is generally aligned parallel to the counter of the area

(d)All options are correct

78. Which of the following would represent the surface of the water level of a still lake?

(a) Level surface (b) Contour surface

(c) Horizontal surface (d) None of these

79. Which of the following leveling is carried out to determine the elevation difference between two points on the surface of earth?

(a) Reciprocal leveling

Sol. 105.(d)

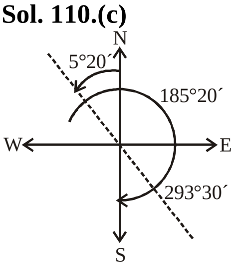
Sol. 106.(d)

Sol. 107.(d)

Sol. 108.(a)

Sol. 109.(d)

Sol. 110.(c)



The sun at noon is 185°20′, the magnetic declination will be 5°20′ west .

Sol. 111.(b)

Sol. 112.(d)

Sol. 113.(c)

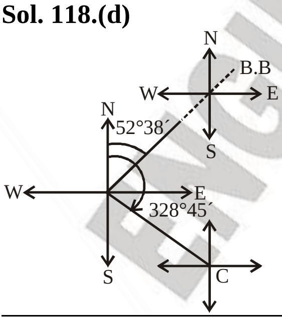
Sol. 114.(c)

Sol. 115.(b)
L = 6 – 0.8 = 5.2
B = 4 – 0.8 = 3.2
= 0.80 × 0.60 × [2 × (5.2 + 3.2)]

Sol. 116.(d)

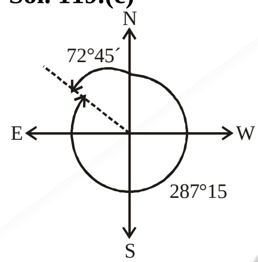
Sol. 117.(b)

Sol. 118.(d)



LA = 328°45′ – 52°30′ = 276°15′
Since it is exterior angle, hence correct answer is (360 – 276°15′)

Sol. 119.(c)



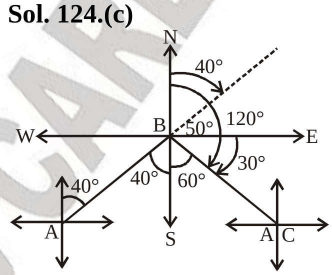
Sol. 120.(a)

Sol. 121.(d)

Sol. 122.(a)

Sol. 123.(a)

Sol. 124.(c)



50° + 30° = 80°
The included angle between AB and BC is 80°.

Sol. 125.(a)
$\Sigma Lat_{north} - \Sigma Lat_{south} = 1m$
$\Sigma Departures_{east} - \Sigma Departures_{wet} = 1m$
Resulting closing line in (South West) direction with latitude and departure = 1m
Length = $\sqrt{1^2 + 1^2} = \sqrt{2}m$

Sol. 126.(a)
$\Sigma Lat_{north} > \Sigma Lat_{south}$
$\Sigma Departures_{west} > \Sigma\ Departures_{east}$
Closing line must be in South and East.
As ΣL = ΣD = 0 for closed traverse