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VOLUME-II

CIVIL ENGINEERING

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Civil Engineering

(Previous Year Questions With Detailed Solutions)

Volume - II

Edition
May 2022

IITian's Publication

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Previous Year Question Paper

MPSC Maharashtra Public Service Commission

GPSC Gujarat Public Service Commission

BPSC Bihar Public Service Commission

WBPSC West Bengal Public Service Commission

Previous Year Question Paper

TNPSC Tamilnadu Public Service Commission

MPPSC Madhya Pradesh Public Service Commission

RPSC Rajasthan Public Service Commission

KPSC Karnataka Public Service Commission

UKPSC Uttarakhand Public Service Commission

OPSC Odisha Public Service Commission

Kerala PSC Kerala Public Service Commission

APPSC Andra Pradesh Public Service Commission

INDEX

CIVIL ENGINEERING
Volume - II

1. Surveying

Syllabus

Classification of surveys, measurement of distances-direct and indirect methods, optical and electronic devices, prismatic compass, local attraction; plane table surveying, levelling, calculations of volumes, contours, theodolite, theodolite traversing, omitted measurements, trigonometric levelling, tacheometry, curves, photogrammetry, geodetic surveying, hydrographic surveying.

Content **Page No.**

1 Introduction to Surveying & Linear Measurements

MPSC

1. The representation fraction of a map scale 1cm = 5km is
(1) 1/500000 (2) 1/500
(3) 1/5000 (4) 1/50000
[MPSC : 2011]

2. The representative fraction (R.F) of scale 1cm = 500m is :
(1) 1:500 (2) 1:5000
(3) 1:50000 (4) 1:50
[MPSC : 2011]

3. A survey which consists of observations of the heavenly bodies such as sun or any fixed star, is known as
(1) Celestial Survey
(2) Astrologicaly Survey
(3) Heaven Survey
(4) Astronomical Survey
[MPSC : 2012]

4. The process of establishing number of intermediate points between two fixed end points on ground is known as
(1) Ranging (2) Offsets
(3) Station points (4) Auxillary points
[MPSC : 2012]

5. Measurement of discharge of river usually forms a part of
(1) Topographic surveying
(2) Hydrographic surveying
(3) Geodetic surveying
(4) Route surveying
[MPSC : 2012]

6. In chain surveying, perpendiculars to the chain line are set out by :
(1) A theodolite (2) A prismatic compass
(3) A clinometers (4) An optical square
[MPSC : 2016]

7. A triangulation station selected close to the main station for avoiding intervening obstruction is called
(1) Tie station (2) Eccentric station
(3) Pivot station (4) Satellite station
[MPSC : 2017]

8. The maximum tolerances in overall length of a 20 m and 30 m metric chain should be respectively
(1) ± 2 mm, ± 8 mm (2) ± 3 mm, ± 5 mm
(3) ± 5 mm, ± 8 mm (4) ± 8 mm, ± 5 mm
[MPSC : 2017]

9. If the intercept on a vertical staff is abserved as 0.75 m from a tacheometer with the line of sight horizontal, fitted with anallatic lens, the horizontal distance between the tacheometer and the staff station is
(1) 0.75 m (2) 75 m
(3) 75 m (4) 750 m
[MPSC : 2017]

10. An alidade in which one edge is bevelled is called as
(1) Soft edge (2) Fiducial edge
(3) Telescopic edge (4) Swivel edge
[MPSC : 2018]

11. A rectangular plot of land of area 0.45 hectare is represented on a map by a similar rectangle of area 5 cm^2. Calculate R.F. of the scale of the map. Draw a scale to read upto a single metre from the map.
(1) 1 : 5000 (2) 1 : 8000
(3) 1 : 9000 (4) 1 : 3000
[MPSC : 2019]

12. The correction for sag is_____.
(1) Always additive
(2) Always subtractive
(3) Always zero
(4) Sometimes additive and sometimes subtractive
[MPSC : 2020]

13. The purpose of making a hydrographic survey is :
(1) To determine the quantities of subaqueous excavations.
(2) To measure areas subjected to scouring and silting in harbours.
(3) To measure sounding and preparing navigation charts.
(4) All of the above.
[MPSC : 2020]

GPSC

1. A plan drawn to a scale of 1 : 4000 was measured by a scale of 1 : 5000. The %error in the length measured will be :
(1) 10 (2) 1000
(3) 25 (4) 1.25
[GPSC : 2018]

2. Basic principle of Surveying "working from whole to part" is :
(1) To complete the work rapidly
(2) To prevent accumulation of errors
(3) To avoid mistakes in work
(4) All of the above
[GPSC : 2018]

3. The type of survey in which the curvature of the earth's surface is neglected, is called :
(1) Plane survey (2) Geodetic survey
(3) Preliminary survey (4) Aerial survey
[GPSC : 2018]

4. In surveying, the correction due to sag of a tape is
(1) Always positive
(2) Always negative
(3) Sometimes negative sometimes positive
(4) Dependent on temperature conditions
[GPSC : 2018]

5. The descending order of precision among the following types of survey is
a. Chain
b. Compass
c. Theodolite
d. Micro-optic theodolite
(1) a, b, c, d (2) d, a, b, c
(3) d, c, b, a (4) d, c, a, b
[GPSC : 2018]

6. Pick the incorrect pair :
(1) Butt Rod : Measuring offsets
(2) Invar Tape : Baseline Measurement
(3) Plasters laths : Marking terminal points
(4) Prism square : Setting right angles
[GPSC : 2018]

7. Systematic errors in surveying are
(1) Self Compensating
(2) Always Positive
(3) Always Negative
(4) Cumulative
[GPSC : 2018]

8. The length of a line measured with a 20 m chain was found to be 250 m. Calculate the true length of the line if the chain was 10 cm longer.
(1) 252.25 m (2) 251.25 m
(3) 225.25 m (4) 221.25 m
[GPSC : 2019]

9. 'Representative Fraction' (RF) is defined as
(1) Length of an object in the drawing/Actual length of the object
(2) Length of an object in the drawing/Isometric length of the object
(3) Actual length of the object/Length of an object in the drawing
(4) Isometric length of the object/Length of an object in the drawing
[GPSC : 2019]

10. The type of surveying where in curvature of earth is also accounted for is known as
(1) Geodetic surveying
(2) Hydrographic surveying
(3) Aerial surveying
(4) Great Trigonometric surveying
[GPSC : 2019]

11. The plan of a map was photocopied to a reduced size such that a line originally 120mm, measures 90 mm. The original scale of plan was 1 : 1000. What will be the revised scale?
(1) 1 : 1200 (2) 1 : 1232
(3) 1 : 1333 (4) 1 : 1121
[GPSC : 2019]

12. The total length of eight links in a 'Revenue chain' is
(1) 16.5 feet (2) 33 feet
(3) 26 feet (4) 13 feet
[GPSC : 2019]

13. 10 division of the Vernier scale will have the same length as
(1) 1 division of the Main Scale
(2) 5 division of the Main Scale
(3) 9 division of the Main Scale
(4) 11 division of the Main Scale
[GPSC : 2019]

14. A scale of 1 cm = 3 km is represented as a Representative Fraction as
(1) 1 : 3000 (2) 1 : 30000
(3) 1 : 300000 (4) 1 : 3000000
[GPSC : 2019]

15. A diagonal scale is used for measuring
(1) Units and one-tenths of units
(2) Units, tenths and hundredths of units
(3) Diagonals of a closed polygons
(4) Angles between lines in plan
[GPSC : 2019]

16. A vernier is made using a main scale of one meter to read mm. If the vernier scale is divided into cm divisions, the vernier will have
(1) 10 divisions for 9 main scale divisions
(2) 11 divisions for 10 main scale divisions
(3) 20 divisions for 19 main scale divisions
(4) 21 divisions for 20 main scale divisions
[GPSC : 2019]

17. If the actual length of a 20 m chain is found to be 19.8 m, then the actual length of a line measured as 100 m with that chain will be
(1) 98 m (2) 99 m
(3) 101 m (4) 102 m
[GPSC : 2019]

18. Correction due to sag of a tape is
(1) Always positive
(2) Always negative
(3) Sometimes negative and sometimes positive
(4) Dependent on the temperature conditions
[GPSC : 2019]

19. In an optical square, the two mirrors are placed at an angle of
(1) 30^0 (2) 45^0
(3) 60^0 (4) 90^0
[GPSC : 2019]

WBPSC

1. The survey in which the curvature of earth is ignored, is called as
(1) Plane survey (2) Geodetic survey
(3) Geological survey (4) Acrial survey
[WBPSC : 2012]

2. When a chain of designated length L and actual length L' is used for measuring a line, the true length of the line will be
(1) $\frac{L}{L'} \times$ measured length
(2) $\frac{L'}{L} \times$ measured length
(3) $(L' - L) \times$ measured length
(4) $(L - L') \times$ measured length
[WBPSC : 2020]

Answers 2. Compass surveying

MPSC	**1.**	(1)	**2.**	(2)	**3.**	(4)	**4.**	(1)	**5.**	(4)	**6.**	(2)	**7.**	(1)						
GPSC	**1.**	(2)	**2.**	(3)	**3.**	(3)	**4.**	(2)	**5.**	(3)	**6.**	(3)	**7.**	(3)	**8.**	(4)	**9.**	(2)	**10.**	(3)
	11.	(2)	**12.**	(4)	**13.**	(1)	**14.**	(3)	**15.**	(3)	**16.**	(1)	**17.**	(3)	**18.**	(2)				
WBPSC	**1.**	(1)	**2.**	(2)	**3.**	(3)	**4.**	(3)												
TNPSC	**1.**	(4)	**2.**	(3)	**3.**	(1)	**4.**	(2)	**5.**	(3)										
RPSC	**1.**	(4)	**2.**	(3)	**3.**	(2)														
KPSC	**1.**	(2)	**2.**	(3)	**3.**	(3)	**4.**	(4)												
OPSC	**1.**	(2)	**2.**	(2)	**3.**	(2)	**4.**	(4)												
Kerala	**1.**	(1)	**2.**	(2)	**3.**	(3)	**4.**	(3)	**5.**	(4)	**6.**	(2)	**7.**	(2)	**8.**	(4)				
APPSC	**1.**	(2)	**2.**	(3)																

Explanations 2. Compass surveying

MPSC

1. Ans : 1

1) Magnetic bearing :
Is bearing of line measured with respect to magnetic meridian. And magnetic meridian is the direction indicated by freely suspended magnetic needle.

2) True Meridian :
It the line missing through geographic north and geographic south poles which does not change with time. Generally magnetic meridian and true meridian does not coincide with each other and horizontal angle between these two meridian is called magnetic declination.

- At noon true meridian is zero or 180^0.
- At noon compass should show 180^0 but instead its showing 170^0, from this we conclude that magnetic meridian is shifted toward East or may say clockwise by 10^0 hence magnetic declination is 10^0E.
- East declination is positive.
- West declination is taken negative.

2. Ans : 2

1) True meridian :
True meridian at a point on earth's surface is the line joining geographic north and geographic south poles.

2) True Bearing :
Bearing of line measured with respect to true meridian.

3) Arbitary Medidian :
Meridian taken in any arbitrary direction is known as arbitrary meridian. It is taken for corresponding survey work.

3. Ans : 4

Magnetic declination is horizontal angle between true meridian and magnetic meridian.

- If it is eastward then taken positive and vice versa.

True meridian = Magnetic meridian $\pm$ Magnetic declination

$= 54^0 30' + 5^0 30'$

$= 60^0$

+ve when Eastward

-ve when westward

4. Ans : 1

- At noon true meridian is zero or 180^0. But magnetic meridian may or may not be 180^0 the difference between these two is called magnetic declination.

- At noon compass should show 180^0 but its showing 186^0 means magnetic meridian is shifted toward west or anticlockwise by 6^0.

5. Ans : 4

1) Isoclinic lines :

These are the line which joins points on earth with same value of dip.

2) Dip :

Vertical angle between magnetic needle and earth surface is called as angle of dip.

3) Aclinic lines :

Lines joining the point of zero dip are called as aclinic lines.

6. Ans : 2

2^0E

- At noon true meridian is zero or 180^o.
- Magnetic declination is horizontal angle between true meridian and magnetic meridian.
- At noon compass should show 180^0 but its showing 178^0, that means magnetic meridian is shifted towards East or clockwise by 2^0. Hence magnetic declination is 2^0E.

7. Ans : 1

The bearing of line is designated in the following systems :

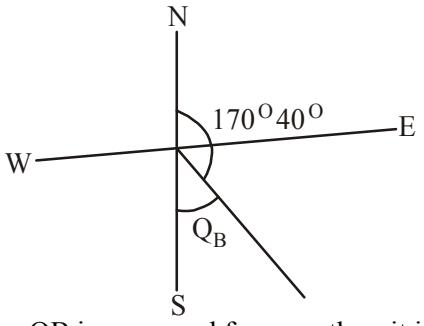
1) Whole circle bearing (WCB) system :

The W.C.B. of a line is the horizontal angle between the line and the north end of he reference meridian in the clockwise direction. The WCB of a line may vary from 0^o to 360^o. It is also called as azimuth & is measured with a prismatic compass.

2) Quadrantal bearing (QB) system :

The QB of a line is the acute angle which the line makes with the meridian. It is measured from the north point or south point, whichever is closer therefore the quadrantal bearing of a line cannot be greater than 90^o. It is measured using surveyor's compass.

Given,



The QB is measured from south as it is nearer.

Therefore,

QB $= 180 - 170^o40^o$

$= 59^o\ 20'E$

GPSC

1. Ans : 2

1) Agonic Line :

These are special case and isogonic lines and related to magnetic declination. These are the line which are passing through point of zero declination. or

In other words at all points true meridian & magnetic meridian coincide on agonic line.

2) Isogonic line :

These are the lines passing through the points on earth surface at which declination is same at a given time.

Magnetic declination changes from place to place and also varies with time at same place.

2. Ans : 3

1) Magnetic declination :

It is horizontal angle between true meridian and magnetic meridian. Generally magnetic meridian and true meridian do not coincide with each other.

2) Dip :

Vertical angle which magnetic needle make with horizontal earth surface.

3) Bearing :

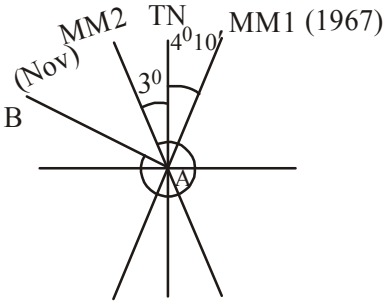
It is angle which survey line makes with reference to N.S. direction.

3. Ans : 3

See following Table :

WCB	Quadrant	Reduced bearing (R.B)
0^0 to 90^0	I or NE	R.B. = WCB
90^0 to 180^0	II or SE	R.B. = 180^0 - WCB
180^0 to 270^0	III or SW	R.B. = WCB - 180^0
270^0 to 360^0	IV or NW	R.B. = 360^0 - WCB

4. Ans : 2



In 1967, in NW quadrant R.B. = 360^0 - WCB

$\therefore$ WCB = 360^0 - RB

= $360^0 - 59^0 30'$

= $300^0 30'$

True bearing = WCB or magnetic + East bearing dedination

= $300^0 30' + 4^0 10'$

= $304^0 40'$

New we want to find WCB with current magnetic meridian which is 3^0 westward.

$\therefore$ Magnetic baring = $304^0 40' + 3^0$

= $307^0 40'$.

5. Ans : 3

Optical square :

- It is instrument used for setting out right angle.
- There are two mirror placed vertically above the base at 45^0 to each other, which are used for offsetting.

6. Ans : 3

In the same direction of bubble moved.

Theodolite is mounted on tripod legs. At lower end there are pointed steel shoes to push then into around. Bubble or instrument is approximately levelled by tripod legs and thin by foot screw.

7. Ans : 3

Cylindrical Projection :

Mercator projection is cylindrical projection (map projection) presented by flerrish geographer and cartographer gerardus mercator in 1569. It is standard map projection for navigation because it is unique in representing north as up and south as town every where while preserving local direction and shapes.

8. Ans : 4

Isogonic line and agonic lines are concept related to magnetic declination.

1) Isogonic line :

These are the line passing through the points on earth surface at which declination is same at given time.

2) Agonic line :

These are special case of isogonic line and related to magnetic declination. These are the line passing through point of zero declination.

9. Ans : 2

1) True meridian :

True meridian at a point on earth surface is the line passing through of joining geographic north & geographic south poles.

2) Magnetic meridians :

Magnetic meridian at a point is the direction indicated by freely suspended magnetic needle provided. It shoud not be affeted by magnetic forces other than of earth.

3) Arbitrary Meridian :

It is meridian taken in any arbitrary direction. Depend upon given type of survey and location.

4) Arid Meridian :

For survey of country the true meridian passing through central place is taken as reference meridian for whole country and such a reference meridian is called grid meridian.

10. Ans : 3

01^0E

True bearing of sun at noon is zero degree or 180^0. Its showing 179^0. means at noon compass should show 180^0 but its showing 179^0, means magnetic meridian is shifted toward east or clockwise by angle 1^0, hence magnetic declination is 1^0E.

11. Ans : 2

1) **Isoclinic line :**
These are the line joining points on earth with same value of dip.
2) **Aclinic line :**
Line joining the points of zero dip are called as aclinic line.

12. Ans : 4

1) **Hour angle :**
In astronomy, the angle between observer meridian and hour circle on which some celestial body lies.
2) **Observer meridian :**
A great circle passing over his head and through celestial poles.
3) **Hour circle :**
Any other great circle passing through poles.
It is measured in degrees or time.
$24h = 360^0$

13. Ans : 1

If difference between FB & BB of survey line is not exactly 180^0 then, one of the both or both station or end point of survey line are said to be affected & If its exactly 180^0 then none of them or both of them are affected with equal local atraction.
Here difference in FB of survey line AB and DE is exactly 180^0 and difference between FB BB of survey line BC and CD is not exactly 180^0 from this we can conclude that station 'c' is most likely affected by local attraction.

14. Ans : 3

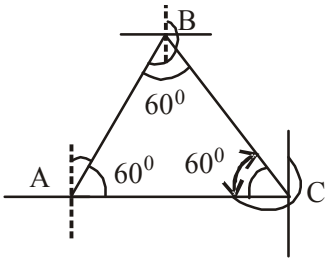
Here SE quadrant given
WCB
$= 180 + 52^030'$
$= 232^o\ 30' - 4^013'$
$= 228^015'$
$RB = 228^015' - 180^00'$
$= S48^015'W$

15. Ans : 3

Dip of horizon :
It is angle between line of sight of tangent to the level surface.
or Angle at an eye of observer between horizontal line and tangent drawn from eye to the surface of ocean.

16. Ans : 1

See following figure



FB of line AB = $38^045'$
Then BB of AB = $38^045' + 180^0 = 218^045^0$
FB of BC = BB of AB - $\angle$B
$= 218^0\ 45' - 60^0$
$= 158^045'$
BB of BC = $158^045' + 180^0$
$= 338^045'$
FB of CA = BB of CB - $\angle$C
$= 338^045' - 60^0$
FB of CA = $278^045'$
or WCB of CA = $278^045'$

17. Ans : 3

Magnetic declination :
It is angle between true meridian and magnetic meridian.
Generally true meridian and magnetic meridian does not coincide with each other and angle between them is magnetic declination.

- Brick work shall be measured in cubic metres unless otherwise specified.
- Single scaffolding may be provided where plastering, pointing and other finishing has been indicated.
- Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm.

3. Ans : 4

1) Tender notice :

The notice inviting tender papers is very important document on which tenders and subsequent agreements with the contractors are based.

2) Specifications :

Specification specifies or describes the nature and the class of the work, materials to be used in the work, workmanship, etc and is very important for execution of work.

The detailed specifications form an important part of contract document.

3) Security Deposit Receipt :

Security deposit is an amount of money which shall be deposited by the contractor whose tender has been accepted in order to tender himself liable to the department to pay compensation amounting to the part or whole of his security deposit if the work is not carried out according to the specification.

The receipt given by department after depositing security deposit is known as security deposit receipt, and it does not contain any contract document.

TNPSC

1. Ans : 4

- In no circumstances forms shall be struck until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of striking.
- In normal circumstances (where temp > 20^0C) and where ordinary cement is used, forms may be struck after expiry of following periods.

	Type of formwork	Minimum Period before Striking Formwork
a)	Vertical formwork to columns, walls, beams	16 - 24 h
b)	Soffit formwork to slabs (Props to be refixed immediately after, removal of formwork)	3 days
c)	Soffit formwork to beams (Props to be refixed immediately after removal of formwork)	7 days
d)	Props to slabs : 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	 7 days 14 days
e)	Props to beams and arches : 1) Spanning up to 6 m 2) Spanning over 6 m	 14 days 21 days

Note :

For rapid hardening cement, $\frac{3}{7}^{th}$ of the periods will be sufficient except (a) which should be retained for at least one day.

2. Ans : 2

1) Specification :

Specification describes the nature and the class of the work, materials, to be used in the work, workmanship etc. and is very important for the execution of the work.

Drawings do not furnish the details of different items of work, the quantity of materials, proportion of mortar and workmanship which are described in specifications.

Thus the combinations of drawings and specifications defines completely the structure and they form important parts of contract document.

2) General / brief Specification :

It is a short description of different parts of the work specifying materials, proportions, qualities etc.

General specifications give general idea of the whole work and are useful for preparing the estimate.

It does not form the part of contract document.

3) Detailed/Thorough specifications :

It specifies the qualities and quantities of materials, the proportion of mortar, workmanship, the method of preparation and execution and the methods of measurement.

They are very helpful for the execution of work.

They form an important part of contract document.

3. Ans : 4

Stages in execution of works :

It is essential to keep in mind that the normal work shall be commenced or liability incurred in connection with it unless the formalities shown below have been completed.

1) Administrative approval :

Administrative approval denotes the formal acceptance by the department concerned of the proposal, and after the administrative approval is given the Engineering department take up the work and prepares detailed designs, plans and estimates and then executes the work.

2) Expenditure sanction :

It means the concurrence of the Government of the expenditure proposed and represent the allotment of the money to meet the expenditure.

3) Technical sanction :

Technical sanction means the sanction of the detailed estimate, design calculations, quantities of works, rates and cost of the work by the competent authority of the Engg. department.

4. Ans : 4

The cost of a particular project depends on the following :

1) Specifications of work and materials, quality of materials, method of constructional operation etc.
2) Quantities of materials and their rates, number of different types of labourer and their rates.
3) Location of the site of work and its distances from the sources of materials.
4) Profits and miscellaneous and overhead expenses of contractor.

KPSC

1. Ans : 1

1) Scaffolding :

When the height of wall or column or other structural member of a building exceeds about 1.5 m, temporary structures are needed to support the platform over which the workmen can sit and carry on the constructions.

These temporary structures constructed very close to wall, is in the form of timber or steel framework commonly called scaffolding.

2) Types of scaffolding :

a) Single scaffolding :

(Brick-layer's scaffolding)

Such scaffolding is commonly used for bricklaying and is also called putlog scaffolding.

b) Double or Mason's Scaffolding :

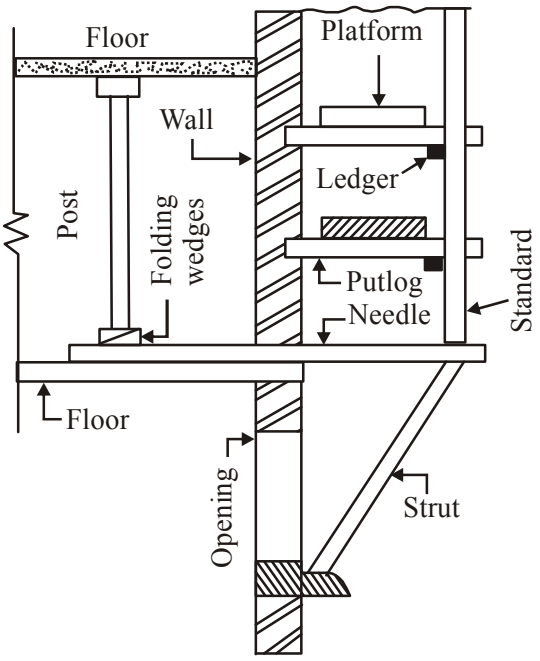
When it becomes very difficult to provide holes in the wall to support putlogs i.e. case of stone masonary, this type of scaffolding is used.

It is also known as Independent scaffolding.

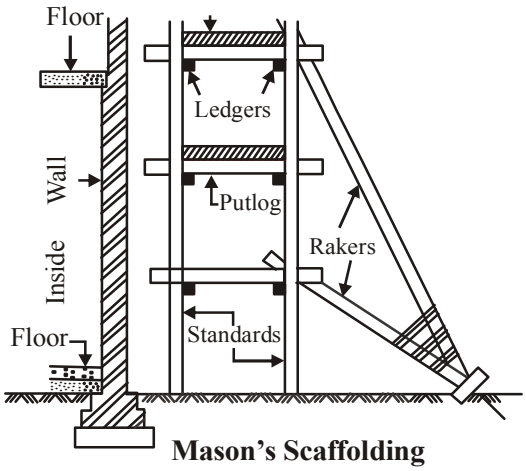
3) Cantilever or needle scaffolding :

It is used under following circumstances :

i) Ground is weak to support standards (vertical members are called as standards and horizontal members are called as ledgers)
ii) Construction of upper part of the wall is to be carried out.
iii) It is required to keep the ground, near wall, free for traffic etc.



Single Frame



Mason's Scaffolding

4) Suspended scaffolding :

This is a light weight scaffolding used for repair works such as pointing, painting etc.

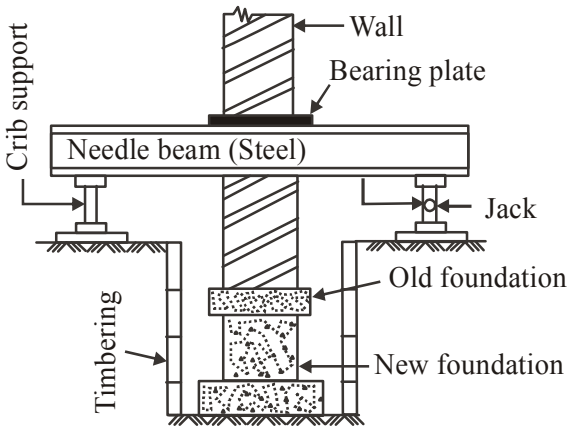
5) Trestle scaffolding :

Such type of scaffolding is used for painting and repair works inside the room, up to a height of 5m.

Note :

a) Underpinning :

The process of placing a new foundation under an existing one or strengthening an existing foundation is called underpinning of foundations.



Vertical section

Underpinning may be required to serve following purposes :

a) To strengthen the existing foundation
b) To deepen the existing foundation
c) To construct a basement in the existing building.

Underpinning can be carried out by the following methods.

a) Pit method
b) Pile method

b) Shoring :

Shoring is a construction of a temporary structure to support temporarily an unsafe structure.

These render lateral support to walls and are used under the following circumstances.

a) When the wall shows signs of bulging out.
b) When an adjacent structure is to be dismantled.
c) When openings are to be made or enlarged in the wall.
d) When a wall cracks due to unequal settlement.

Types of shores :

a) Raking shores.
b) Flying or horizontal shores.
c) Dead or vertical shores.

2. Ans : 4

1) Batching :

Batching is the process of measurement of concrete ingredients for uniformity of proportion.

3. Soil Mechanics

Syllabus

Geotechnical properties, stresses in soil, shear resistance, compaction, consolidation and earth pressure, stability of slopes, bearing capacity, settlements, shallow and deep foundations, cofferdams, ground water control.

1 Properties of Soils

MPSC

1. Residual soil is a soil
(1) Which stays at the place of its formation
(2) Which deposits at a place away from place of its origin
(3) Both 1 and 2
(4) Neither 1 nor 2

[MPSC : 2011]

2. Match the following :

A. Plasticity Index **1.** $\frac{(w_l - w)}{I_p}$

B. Consistency Index **2.** $\frac{(w - w_p)}{I_p}$

C. Liquidity Index **3.** $\frac{(w_l - w_p)}{I_f}$

D. Toughness Index **4.** $(w_L - w_p)$

	A	B	C	D
(1)	4	2	1	3
(2)	2	1	4	3
(3)	4	3	2	1
(4)	4	1	2	3

[MPSC : 2011]

3. Find the specific gravity of soil grains with the help of a pycnometer if, weight of solids = 100g, weight of pycnometer + soil + water =610 g, weight of pycnometer + water = 550 g.
(1) 2.40 (2) 2.50
(3) 2.60 (4) 2.70

[MPSC : 2013]

4. If the porosity of a soil sample is 40%, its void ratio is :
(1) $\frac{2}{3}$ (2) $\frac{1}{3}$
(3) $\frac{1}{2}$ (4) 1

[MPSC : 2016]

5. A cube of soil specimen having dimension 2 cm × 2 cm × 2 cm weight 16 gm when it is fully saturated. If void ratio of the specimen is 1.0, the dry density of the specimen will be :
(1) 2000 kg/m^3 (2) 1500 kg/m^3
(3) 1200 kg/m^3 (4) 1600 kg/m^3

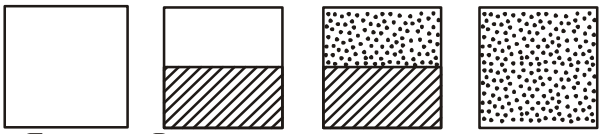
[MPSC : 2016]

6. The void ratio and porosity of a soil sample having equal volume of solids and volume of voids are

	Void ratio	Porosity
(1)	1-0	100%
(2)	0-5	50%
(3)	1-0	50%
(4)	0-5	100%

[MPSC : 2018]

7. The given figure indicate the weights of different pycnometers.



Empty Pycnometer (W_1) | Pycnometer + Dry Soil (W_2) | Pycnometer + Soil + Water (W_3) | Pycnometer + Water (W_4)

For this, the specific gravity of the solids is given by
(1) $\frac{W_2}{W_4 - W_2}$
(2) $\frac{W_1 - W_2}{(W_3 - W_4) - (W_2 - W_1)}$

(3) $\frac{W_2}{W_3 - W_4}$

(4) $\frac{W_2 - W_1}{(W_2 - W_1) - (W_3 - W_4)}$

[MPSC : 2020]

8. A clay sample has a void ratio 0.54 in dry state. The specific gravity of soil solids is 2.7. What is the shrinkage limit of the soil ?
(1) 8.5% (2) 10.0%
(3) 17.0% (4) 20.0%
[MPSC : 2020]

9. For a soil having $\gamma_{sat} = 22$ kN/m^3, how much will γ_{sub} be ? (Take $\gamma_w = 10$ kN/m^3)
(1) 21 kN/m^3 (2) 12 kN/m^3
(3) 22 kN/m^3 (4) None of the above
[MPSC : 2020]

10. A cohesive soil was tested in natural state and in remoulded state. If the cohesion of soil in natural state is 40 kN/m^2 and in remoulded state is 20 kN/m^2, then the sensitivity of the cohesive soil is_____.
(1) 0.5 (2) 1.0
(3) 2.0 (4) 3.0
[MPSC : 2020]

GPSC

1. The ratio of volume of voids to the total volume of soil mass is called
(1) Air content
(2) Porosity
(3) Percentage in voids
(4) Voids ratio
[GPSC : 2017]

2. If the plasticity index of a soil mass is zero, the soil is
(1) Sand (2) Silt
(3) Clay (4) Clayey Silt
[GPSC : 2017]

3. When the water content in a soil at which just shear strength develops is called
(1) Liquid Limit (2) Plastic Limit
(3) Elastic Limit (4) Shrinkage Limit
[GPSC : 2017]

4. When the plastic limit is equal to or greater than the liquid limit, then plasticity index is
(1) Negative (2) Zero
(3) One (4) More than one
[GPSC : 2017]

5. The plastic limit exists in
(1) Sandy soils (2) Gravel soil
(3) Silty soil (4) Clay
[GPSC : 2017]

6. The soil transported by running water is called
(1) Aeolian soil (2) Marine soil
(3) Alluvial soil (4) Lacustrine soil
[GPSC : 2017]

7. A soil having particles of nearly the same size of known as
(1) Well graded
(2) Poorly graded
(3) Uniformly graded
(4) Gap graded
[GPSC : 2017]

8. Inorganic clays have specific gravity usually between following range
(1) 2.70 to 2.80 (2) 1.65 to 2.65
(3) 2.40 to 2.50 (4) 2.90 to 3.00
[GPSC : 2018]

9. When liquidity index is between 0 and 1 the soil will behave like
(1) Liquid (2) Plastic
(3) Solid (4) Sand
[GPSC : 2018]

10. If the water content of a fully saturated soil mass is 100% then the voids ratio of the sample is
(1) Less than specific gravity of soil
(2) Equal to specific gravity of soil

(3) Greater than specific gravity of soil
(4) Independent of specific gravity of soil

[GPSC : 2018]

11. Submerged unit weight is based on principle of
(1) Darcy (2) Terzaghi
(3) Archimedis (4) Reynolds

[GPSC : 2018]

12. The specific gravity of soil sample is 2.7 and its void ratio is 0.945. When it is fully saturated, the moisture content of the soil will be
(1) 2.8% (2) 25%
(3) 35% (4) 95%

[GPSC : 2018]

13. The admixture of sand or silt to clay causes
(1) Decrease in liquid limit and increase in plasticity index
(2) Decrease in liquid limit and no change in plasticity index
(3) Decrease in both liquid limit and plasticity index
(4) Increase in both liquid limit and plasticity index

[GPSC : 2018]

14. Lacustrine soils are soils
(1) Transported by rivers and streams
(2) Transported by glaciers
(3) Deposited in sea beds
(4) Deposited in lake beds

[GPSC : 2018]

15. The maximum water content at which a reduction in water content will not cause a decrease in the volume of a soil
(1) Plastic limit (2) Liquid limit
(3) Shrinkage limit (4) Consistency Index

[GPSC : 2019]

16. The minimum water content at which soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter is known as
(1) Plastic limit (2) Liquid limit
(3) Shrinkage limit (4) Plasticity Index

[GPSC : 2019]

17. Identify the true statements from the following :
(1) Laterite soil is a category of organic soil
(2) Water held firmly to the clay particles has the same properties as ordinary water
(3) A soil transported by gravitational force is called talus
(4) A clay deposit which exhibits no evidence of fissuring is described as intact

[GPSC : 2019]

18. **Assertion (A) :** Black cotton soils are clay and exhibit characteristic property of swelling.
Reason (R) : These clays contain Montmorillonite which attracts external water into its lattice structure.
(1) Both A and R are true and R is not the correct explanation of A
(2) Both A and R are true and R is the correct explanation of A
(3) A is false but R is true
(4) A is true but R is false

[GPSC : 2019]

19. A soil has a liquid limit of 40% and plastic limit of 30%. If its flow index is 20%, the corresponding toughness index would be
(1) 0.25 (2) 0.50
(3) 0.75 (4) 1.00

[GPSC : 2019]

20. The liquid limit and plastic limit of sample are 40% and 30% respectively. If 20% of the soil is finer than 0.002 mm then the activity ratio of the soil sample would be
(1) 0.5 (2) 1.0
(3) 1.5 (4) 2.0

[GPSC : 2019]

21. The correct sequence of plasticity of minerals in soil in an increasing order is
(1) Kaolinite, silica, illite, montmorillonite
(2) Silica, kaolinite, illite, montmorillonite
(3) Silica, kaolinite, montmorillonite, illite
(4) Kaolinite, Silica, montmorillonite, illite

[GPSC : 2019]

Answers 1. Properties of Soil

MPSC	**1.**	(1)	**2.**	(4)	**3.**	(3)	**4.**	(1)	**5.**	(2)	**6.**	(3)	**7.**	(4)	**8.**	(2)	**9.**	(2)	**10.**	(3)	
GPSC	**1.**	(2)	**2.**	(1)	**3.**	(1)	**4.**	(2)	**5.**	(4)	**6.**	(3)	**7.**	(3)	**8.**	(1)	**9.**	(2)	**10.**	(2)	
	11.	(3)	**12.**	(3)	**13.**	(3)	**14.**	(4)	**15.**	(3)	**16.**	(1)	**17.**	(3)	**18.**	(2)	**19.**	(2)	**20.**	(1)	
	21.	(2)	**22.**	(1)	**23.**	(2)	**24.**	(1)	**25.**	(2)	**26.**	(4)	**27.**	(1)	**28.**	(3)	**29.**	(1)	**30.**	(2)	
	31.	(2)	**32.**	(2)	**33.**	(1)	**34.**	(3)	**35.**	(3)	**36.**	(3)									
BPSC	**1.**	(3)	**2.**	(1)	**3.**	(1)	**4.**	(3)	**5.**	(4)	**6.**	(3)									
WBPSC	**1.**	(3)	**2.**	(3)	**3.**	(2)	**4.**	(2)	**5.**	(2)	**6.**	(1)	**7.**	(4)	**8.**	(#)					
TNPSC	**1.**	(2)	**2.**	(1)	**3.**	(4)	**4.**	(3)	**5.**	(2)	**6.**	(3)	**7.**	(4)	**8.**	(1)	**9.**	(3)	**10.**	(1)	
	11.	(1)	**12.**	(1)	**13.**	(4)	**14.**	(4)	**15.**	(3)	**16.**	(1)	**17.**	(4)							
MPPSC	**1.**	(4)	**2.**	(1)	**3.**	(3)	**4.**	(2)	**5.**	(2)	**6.**	(3)	**7.**	(2)							
RPSC	**1.**	(1)	**2.**	(2)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(1)	**7.**	(4)	**8.**	(1)	**9.**	(1)	**10.**	(4)	
	11.	(3)	**12.**	(3)																	
KPSC	**1.**	(4)	**2.**	(2)	**3.**	(3)	**4.**	(4)	**5.**	(2)	**6.**	(2)	**7.**	(3)	**8.**	(2)	**9.**	(1)	**10.**	(1)	
	11.	(4)																			
UKPSC	**1.**	(3)	**2.**	(3)	**3.**	(1)	**4.**	(4)	**5.**	(2)	**6.**	(1)	**7.**	(3)	**8.**	(1)	**9.**	(4)			
OPSC	**1.**	(1)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(3)	**6.**	(1)	**7.**	(4)	**8.**	(3)	**9.**	(4)	**10.**	(3)	
	11.	(1)																			
Kerala	**1.**	(1)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(3)	**6.**	(1)	**7.**	(2)	**8.**	(2)	**9.**	(2)	**10.**	(4)	
	11.	(2)	**12.**	(2)	**13.**	(2)	**14.**	(1)	**15.**	(1)											
APPSC	**1.**	(2)	**2.**	(4)	**3.**	(4)	**4.**	(2)													

Explanations 1. Properties of Soil

MPSC

1. Ans : 1

- The rock is formed due to weathering of rocks, which may be carried out either physically or chemically.
- If the weathered rock material is retained over same parent rock, then soil is called residual soil & if it is transported then it is called transported soil.

2. Ans : 4

It is the range of consistency in which soil shows plastic properties or behaves as plastic material.

$I_P = W_L - W_P$

Where,

W_L = Liquid limit

W_P = Plastic limit

Consistency Index & liquidity index

These indices represents the degree of firmness of soil or in-situ behaviour of soil depending upon natural water content of soil.

$$\text{Consistency index } (I_C) = \frac{W_L - W_n}{I_P}$$

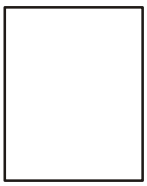
$$\text{Liquidity index } (I_L) = \frac{W_n - W_P}{I_P}$$

Toughness index

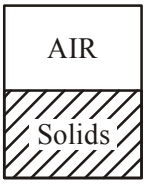
If represents the shear strenght of soil at it's plastic limit.

$$I_T = \frac{I_P}{I_f} = \frac{\text{Plasticity index}}{\text{flow index}}$$

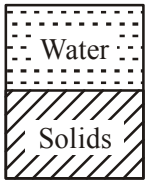
3. Ans : 3



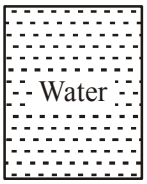
W_1
Empty pycnometer



W_1 + wt.of soil = W_2



W_2 + wt. of water filling in remaining volume = W_3



wt. of (pycnometer + water fully filled in pychometer = W_4

Given,

$W_2 - W_1$ = wt. of solids = 100 gm

W_3 = wt. of pycnometer = 610 gm + soil + water

W_4 = wt. of pycnometer = 550 gm + water

$$\therefore \quad G = \frac{\text{wt.of solids in a given volume}}{\text{wt.of water having same volume}\left(V_s\right)}$$

$$G = \frac{\left(W_2 - W_1\right)}{W_4 - W_3 + W_2 - W_1}$$

$$= \frac{100}{550 - 610 + 100}$$

$$G = 2.5$$

4. Ans : 1

Given,

n = 40% = 0.4

The relation between void ratio and porosity is given by

$$e = \frac{n}{1-n} = \frac{0.4}{1-0.4} = \frac{2}{3}$$

5. Ans : 2

Given,

Soil specimen dimension = 2 cm × 2 cm × 2 cm

wt. of specimen = 16 gm

Degree of saturation (S) = 1

Void ratio = e = 1

$$\text{As } \gamma_{bulk} = \gamma_{sat} = \frac{\text{wt.of soil}}{\text{volume of soil}} = \frac{16}{8} = \text{gm/cm}^3$$

$$= 2 \text{ gm/cm}^3$$

$$\therefore \quad \gamma_{sat} = \frac{\left(G + S.e\right)}{1+e}.\gamma_w$$

$$2 = \frac{\left(G+1\right)\times 1}{1+1}$$

$$\therefore \quad G = 3$$

$$\text{So, } \gamma_d = \frac{G.\gamma_w}{1+e} = \frac{3\times 1}{1+1} = 1.5 \text{gm/cm}^3$$

$$= 1500 \text{ kg/m}^3$$

6. Ans : 3

Given,

Condition is

Volume of solids = volume of voids

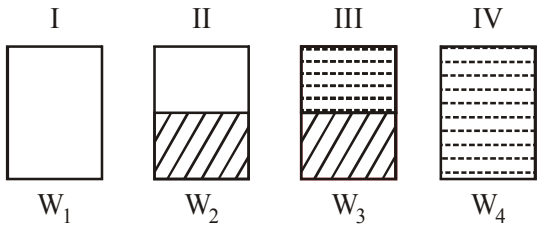
$$V_s = V_v$$

1) $$\text{Void ratio} = \frac{V_v}{V_s} = 1$$

2) $$\text{Porosity, } n = \frac{e}{1+e} = \frac{1}{1+1} = 0.5$$

$$= 50\%$$

7. Ans : 4



Specific gravity,

$$G = \frac{\text{wt. of soil solids}}{\text{wt. of water for same volume}}$$

wt. of solids = $W_2 - W_1$
wt. of water = $W_3 - W_2$ in III
wt. of water in IV = $W_4 - W_1$
Wt. of water whose volume is same as solids
= $(W_4 - W_1) - (W_3 - W_2)$

$$G = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$$

$$= \frac{W_2 - W_1}{W_4 - W_1 - W_3 - W_2}$$

$$G = \frac{W_2 - W_1}{(W_2 - W_1) - (W_3 - W_4)}$$

8. Ans : 2

Shrinkage limit : (Wsr%)

- It is the maximum water content beyond which if water content of soil is reduced then there is no decrease in volume of soil.
- Shrinkage limit may also be defined as minimum water content at which soil is completely saturated.

$$Wsr = \frac{\gamma_w}{\gamma_{dry}} - \frac{1}{G}$$

G = 2.7, e = 0.54

$$\gamma_{dry} = \frac{G\gamma_w}{1+e}$$

$$= \frac{2.7 \times 10}{1.54} = \frac{27}{1.54} = 17.53 kN/m^3$$

$$W_{sr} = \frac{10}{17.53} - \frac{1}{2.7}$$

= 0.58 - 0.37
= 0.21
= 21%

9. Ans : 2

$$\gamma_{submerged} = \gamma_{sat} - \gamma_w$$

= 22 - 10
= 12 kN/m^3

10. Ans : 3

Sensitivity :

The degree of disturbance achieved on remoulding is represented by sensitivity. The loss in strength of soil is represented in terms of its sensitivity at same water content. Sensitivity is defined as ratio is undisturbed state compressive strength of soil is undisturbed state to the unconfined compressive strength of soil in its remoulded strate.

$$St = \frac{q_o(\text{undisturbed})}{q_u(\text{disturbed})} = \frac{40}{20} = 2$$

Note :

1) For most clays sensitivity lies between 2 to 4.
2) More sensetivity of soil is not suitable for engineering construction.
3)

Sensitivity	Description of soil
1	Insensetive
1 - 4	Normal/less sensetive
4 - 8	Sensetive soil
8 - 16	Extra sensetive
7 - 16	quick (unstable)

GPSC

1. Ans : 2

The porosity (n) of a soil is defined as the ratio of volume of voids to the total volume of soil.

$$n = \frac{V_v}{V}$$

Where,
V_v = volume of voids
V = Total volume of soil

- It is expressed in percentage.
- In porosity, total volume of soil is used which includes volume of voids.
- Hence porosity (n) of soil cannot exceed 100%.
- The range of porosity is 0 <n< 100%.

2. Ans : 1

Silt and Clay are considered to be smaller family members of soil group. Clays are plastic fine-grained soils while silts & sand are non-plastic fines.

We have, Plasticity index

$$Ip = W_L - W_p$$

where,

W_L = Water content at liquid limit

W_p = Water content at PL This is due to presence of clay minerals.

As given Plasticity index is zero means soil is non plastic.

3. Ans : 1

- It is that minimum water content at which soil has tendency to flow. At liquid limit, consistency of soil changes from plastic state to liquid state.
- At liquid limit all soil have nearly negligible shear strength of 2.7 kN/m² approximately.

4. Ans : 2

- Plasticity index (PI) is the range of water content over which the soil remains in the plastic state. Mathematically defined as,
- Plasticity Index = Liquid Limit - Plastic Limit.
- This parameter cannot be negative if plastic limit, in some exceptions, is larger than the liquid limit, it is considered to be zero and soil is considered non-plastic.
- The plasticity of a soil is its ability to undergo deformation without cracking. It is an important index property of fine-grained soil, especially for clayey soils.

5. Ans : 4

Silt and Clay are smaller family members of soil group. Clays are plastic fine-grained soils while silts & sand are non-plastic fines. Soils containing large quantities of silt and clay are most troublesome to engineers. Clays have medium to high plasticity while silt have very low to no plasticity.

6. Ans : 3

Different types of soil deposit according to transportation agency and method of deposition

Alluvial deposit: Soils that have been deposited from suspension in running water

1) **Lacustrine deposit :**
Soils that have been deposited from suspension in still, fresh water of lakes
2) **Marine deposit :**
Soils that have been deposited from suspension in sea water
3) **Aeolian deposit :**
Soils that have Transported by wind.
4) **Glacial deposit :**
deposits that have been Transported by ice.

7. Ans : 3

Gradation of Soil :

Gradation describes the distribution of different sizes of individual particles within a soil sample. The particle size distribution curve is used to define the grading of soil.

A soil sample may be either :

1) **Well graded :**
A soil sample is said to be well graded if it has all sizes of materials present in it.
2) **Uniformly graded :**
Uniformly graded soil is a soil sample in which most of the particles are approximately of the same size.
3) **Gap graded :**
A soil sample is said to be gap graded if at least one particle size is completely missing in it. Gap graded soils are sometimes considered a type of poorly graded soil.

8. Ans : 1

Different types of soil and their respective specific gravities are as given below

1) **Sand and gravel :** 2.65 - 2.68.
2) **Silt and silty sand :** 2.66 - 2.70.
3) **Inorganic clay :** 2.70 - 2.80.
4) **Soil high in mica and iron :** 2.75 - 2.85.
5) **Organic soil :** 1 - 2.

4 Design of Gravity Dam

MPSC

1. The eccentricity of the resultant permitted on either side of centre of base in gravity dam is given as
(1) e = 6B
(2) e = 6/B
(3) e = B/6
(4) None of above

[MPSC : 2011]

2. The uplift pressure is reduced…….. in a gravity dam when a drainage gallery with its drainage pipe system is provided.
(1) At all levels below the upstream level
(2) At all levels below the drainage gallery
(3) At all levels below the downstream level
(4) At the foundation level only

[MPSC : 2012]

3. Uplift pressure on the dam
(1) Virtually increases the downward weight of the body of the dam
(2) Increases the stability of dam
(3) Virtually decreases the downward weight of the body of the dam
(4) Has no effect on the stability of dam

[MPSC : 2013]

4. What does an earthquake acceleration of 0.15g acting vertically downward in a gravity dam cause ?
(1) An increase in the weight of dam by 15%
(2) Reduction in weight of concrete only by 15%
(3) Decrease in unit weight of concrete and water by 15%
(4) Increase in uplift pressure by 15%

[MPSC : 2013]

5. Elementary profile of a gravity dam will be right-angled triangle haying zero with at the water level a base width (B) at bottom :
(1) When subjected to water pressure on upstream side only
(2) When subjected to water pressure and silt pressure
(3) When subjected to silt pressure on upstream side only
(4) When subjected to ice pressure on upstream side only

[MPSC : 2013]

6. At the base of a gravity dam section, the vertical stress at the toe is 4Mpa. The slope of downstream face of dam is 0.707 horizontal : 1 vertical. If there is no tail water, the major principal stress at the toe is :
(1) 4MPa (2) 5MPa
(3) 6MPa (4) 8MPa

[MPSC : 2013]

7. …… is an example of a non-rigid dam.
(1) Arch dam (2) Timber dam
(3) Steel dam (4) Rockfill dam

[MPSC : 2017]

8. 'Bank storage' in a dam reservoir
(1) Decreases the computed reservoir capacity
(2) Increases the computed reservoir capacity
(3) Sometimes decreases and sometimes increases the computed reservoir capacity
(4) Has no effect on reservoir capacity

[MPSC : 2017]

9. In case of gravity dams, the factor of safety against over turning should not be less than
(1) 1.00 (2) 1.10
(3) 1.25 (4) 1.50

[MPSC : 2017]

GPSC

1. In Gravity dam, the ..... acts in a direction opposite to the acceleration imparted by earthquake forces and is equal to the product of the mass and the acceleration
(1) Inertia force
(2) Hydrodynamic force
(3) Uplift force
(4) Wave pressure

[GPSC : 2017]

2. In Gravity dam, the factor of safety against overturning should not be less than
(1) 1.15
(2) 1.5
(3) 1.8
(4) 2

[GPSC : 2017]

3. Which of the following is not be mode of failure of a gravity dam
(1) Overturning failure
(2) Sliding failure
(3) Tension failure
(4) Seepage failure

[GPSC : 2017]

4. Uplift on the base is not an important design factor in case of
(1) Arch dams
(2) Gravity dams
(3) Earthen dams
(4) Buttress dams

[GPSC : 2017]

5. 'Economical Height of a Dam' is that height for which
(1) Cost per unit of storage is minimum
(2) Benefit cost ratio is maximum
(3) Net benefits are maximum
(4) None of these

[GPSC : 2018]

6. The force considered for the analysis of an elementary profile of a gravity dam under empty reservoir condition is
(1) Uplift pressure
(2) Water pressure
(3) Self weight
(4) Earthquake pressure

[GPSC : 2018]

7. A channel designed by Lacey's theory has a mean velocity of 1m/sec. If slit factor is unity, then hydraulic mean radius will be
(1) 1.5 m
(2) 2 m
(3) 2.5 m
(4) 1 m

[GPSC : 2018]

8. Economical height of a dam is that height, for which the
(1) Cost per unit storage is minimum
(2) Cost benefit ratio is minimum and net benefits are maximum
(3) Cost benefit ratio is maximum and net benefits are maximum
(4) Net benefits are maximum

[GPSC : 2019]

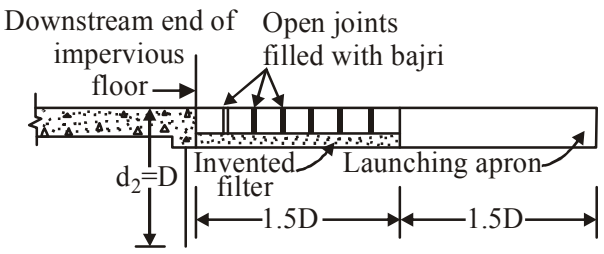
BPSC

1. Shear failure indicates :
(1) Lateral-displacement of soil
(2) Upward displacement of soil
(3) Both lateral and upward displacement
(4) None of these

[BPSC : 2006]

2. The main overturning force in gravity dam is the
(1) Weight of the dam
(2) Water pressure
(3) Wind pressure
(4) Uplift pressure

[BPSC : 2012]



(b) Downstream protection works

2) Launching apron :

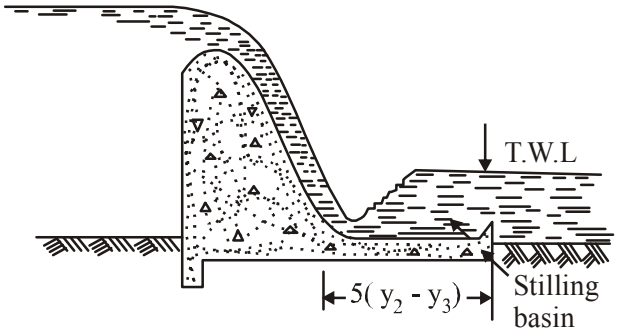
A launching apron is an apron of loosely packed stones. After the inverted apron, launching apron is provided for a length, generally equal to 1.5D, where D is depth of scour. It is provided to protect the impervious floor & the pile from the scour holes progressing towards floors.

17. Ans : 2

Energy dessipators can be provided below the spillway depending upon the relative positions of Tail water curve (TWC) & jump height curve (y_2) as explained below

1) When T.W.C. coincides with y_2 curve at all discharge :

This is most ideal condition for jump formation. The jump will form at the toe of the spillway. The simple horizontal concrete apron of length 5 (y_2 - y_1) is sufficient.



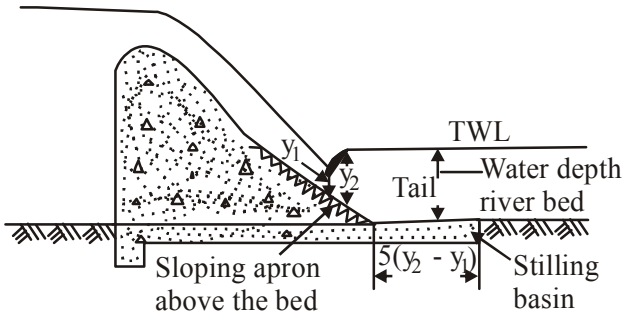
2) When T.W.C. is lying above the y_2 curve at all discarges :

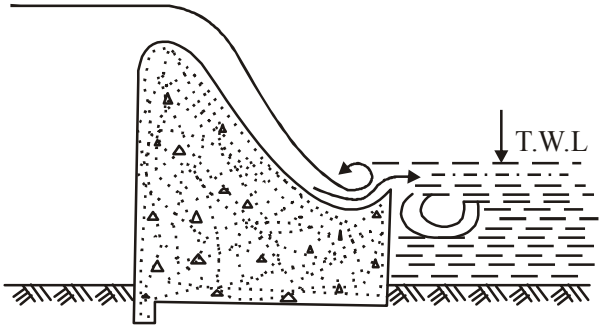
The jump forming at toe will be drowned by tail water.

a) By construction of a sloping apron above river bed level.

b) A provision of a roller bucket type of energy dissipator. It consists of an apron, which is upturned sharply at ends.

Two main rollers are formed which dissipate the energy due to internal turbulence.



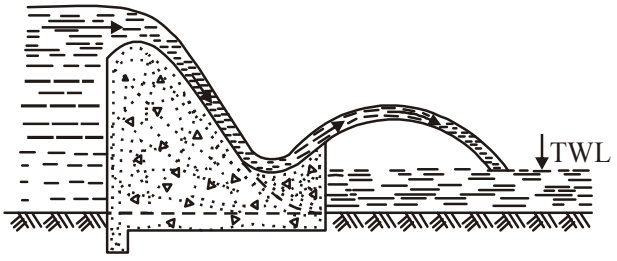


3) When T.W.C. lies below the y_2 curve at all discarges :

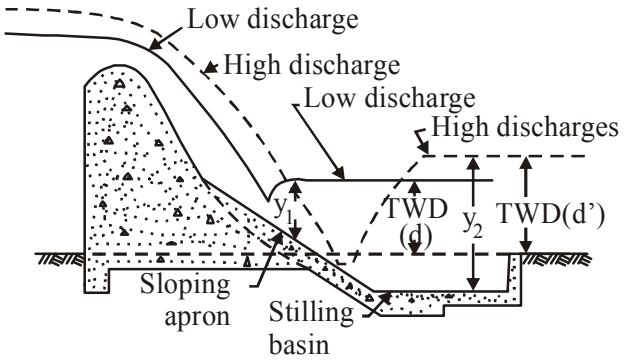
a) Ski jump bucket :

The water may shoot up out of the above bucket & fall harmlessly into the river at some distance d/s of bucket.

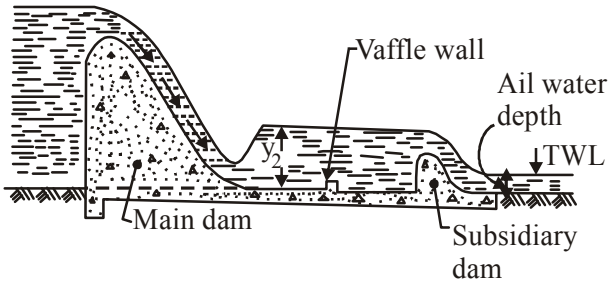
The ski jump type energy dissipator rquires sound and rocky river bed because a part of energy dissipation takes place by impact, although some of energy is dissipated in air by diffusion & aeration.



b) Sloping apron can be provided below the river bed.



c) Construction of a subsidiary dam below the main dam, so as to increase the tail water depth.

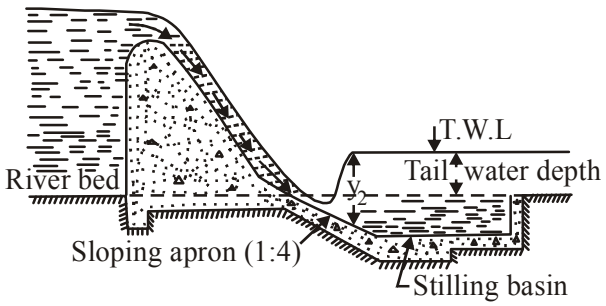


4) When T.W.C. lies above the y_2 curve at low discharges and lies below the y_2 curve at high discharges :

Providing a sloping apron partly above and partly below the river bed.

5) When T.W. depth is insufficient at low discharges and it greater at high discharges :

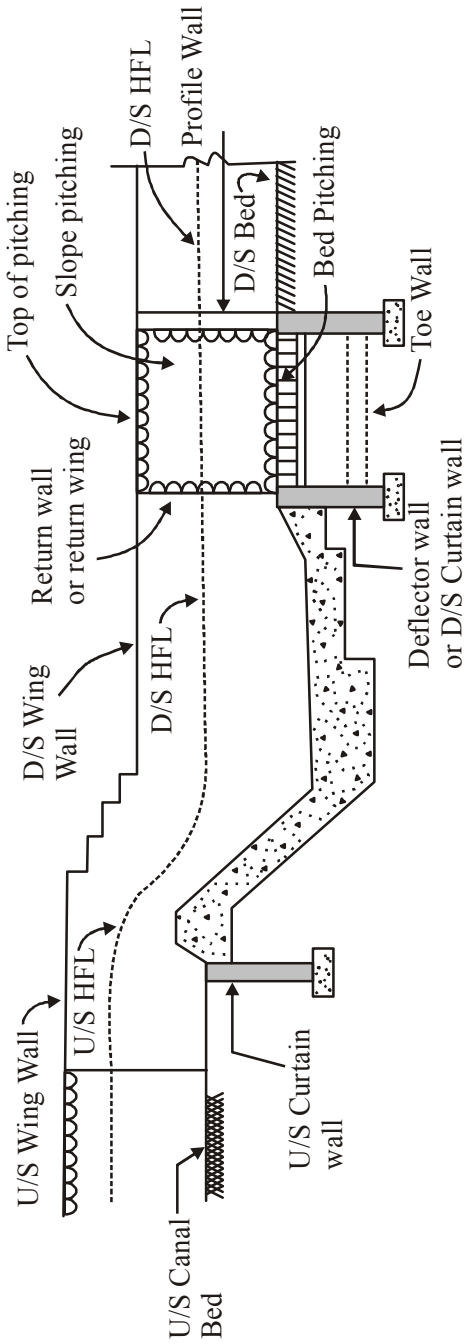
Same arrangement in case (a) will selve the purpose.



GPSC

1. Ans : 1

Glacis Type Fall :



The glacis type of falls utilizes the standing wave phenomenon for dissipation of energy.

The glacis type of falls are mainly of two types

i) Straight glacis type.

ii) Parabolic glacis type (Montague type falls).

2. Ans : 4

Ogee spillway is the most common type of spillway provided on gravity dam. The profile of the spillway is 'S' shaped. Overflowing water is guided smoothly over the crest and profile of the spillway so that the overflowing water does not break contact with the spillway surface.

Discharge over an Ogee spillway is given by :

$$Q = \frac{2}{3} C_d \sqrt{2g}\, L H_e^{\frac{3}{2}}$$

He = Total head upstream of the crest.

L = crest width

Cd = coefficient of discharge

3. Ans : 3

1) Vertical Lift Gates :

Fixed wheel & the slide gates are two type of vertical lift gates mainly used to provide a vertical water barrier in waterworks. Fixed wheel or roller gates are designed to control flow through large waterway openings where economy and ease of operation are important. They may be designed as either upward or downward (skimmer) opening type gates.

2) A fixed wheel or roller gate :

Consists of a fabricated steel slide with cast iron/ forged steel rollers and rubber seals. The gate leaf is a box-like design of welded construction. It varies in width and height as required by the size of the opening in the concrete dam and varies in thickness depending on the water head. Recesses at the sides of the gate opening are provided with guides and with contact faces for side seals.

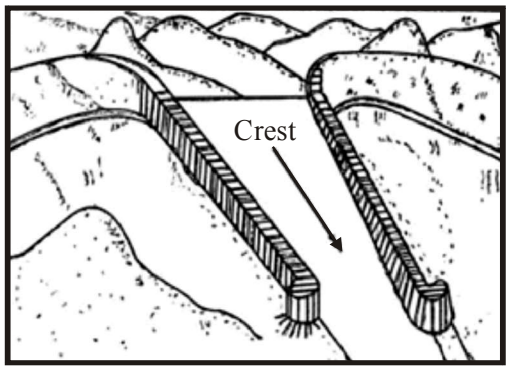
3) Slide gates :

Are the simplest form of flat gates. They basically consist of a flat structurally reinforced gate leaf that slides along side-guides embedded in concrete. The leaf is provided with sliding surfaces, usually metallic which under tight contact at the load bearing surfaces act as seals.

WBPSC

1. Ans : 4

Chute Spillway :



- Spillway discharge flows in an open channel in usually supercritical stage the reservoir to the downstream river.
- Open channel can be located either along the abutment of the dam or through a saddle. Generally provided on earth dam or rockfill dam.
- The chute is in general narrowed for economy and then widened near the end to decrease the discharge velocity.

2. Ans : 1

Length of hydraulic Jump :

- It is defined as the length between the two sections where one section is taken before the hydraulic jump and the second section is taken after the hydraulic jump.
- For a rectangular channel, from an experiment, length of hydraulic jump is found to be 5 to 7 times that of the height of the hydraulic jump.

3. Ans : 4

As for given model, linear scale used is 1: 20 = Model : Prototype

Now

Since height of hydraulic jump in model is 20cm,

Then Height of hydraulic jump in prototype = 20*20 = 400 cm

1 Highway Devolpment & Planning

MPSC

1. Organizations/Institutions involved with Road Development in India are :
(1) NHAI, IRC, BRO (2) NHAI, IRC, BCI
(3) IRC, HRB, BCI (4) NHAI, HRB, BCI
[MPSC : 2013]

2. Pavements of major roads should be designed for at least a life period of .
(1) 5 years (2) 10 years
(3) 20 years (4) 30 years
[MPSC : 2013]

3. Which of the following statements gives the most suitable meaning of highway alignment ?
(1) Fixing the direction of highway
(2) Deciding the radius of horizontal and vertical curves
(3) Determining the gradient of valley and summit curves
(4) Layout of the centre line of the highway on ground
[MPSC : 2013]

4. The road length of National Highway by Third Road Plan Formulae, in a certain district in India having its area as 13,400 sq.m will be
(1) 134 km (3) 268 km
(2) 402 km (4) 1340 km
[MPSC : 2017]

5. The maximum utility system is based on the concept of
(1) Maximum utility per unit cost of road
(2) Maximum utility per unit length of road
(3) Maximum utility per unit population
(4) None of the above
[MPSC : 2017]

6. Match the following :

List - I :
A. Primary survey
B. Map study
C. Realignment of bighway
D. Reconnaissance

List - II :
1. Collect general characteristics of an area
2. Improvement in horizontal and verticala a lignment
3. Collect physical of highway information
4. Alignment avoiding valleys, ponds or lakes

Codes :

	A	B	C	D)
(1)	1	4	2	3
(2)	3	2	4	1
(3)	1	2	4	3
(4)	3	4	2	1

[MPSC : 2017]

7. As per the modified classification of road system by the Third Road Development Plan, 1981 – 2001, the roads in the country under 'Primary System' of road network consist of
(1) Expressways and National Highways
(2) State Highways (SH) and Major District Roads (MDR)
(3) Other District Roads (ODR) and Village Roads (VR)
(4) All of the above
[MPSC : 2017]

8. Match the design speed recommended for various roads by IRC 86 : 1983

List - I :	List - II :
A. Collector roads	**1.** 30 kmph
B. Local roads	**2.** 80 kmph
C. Arterial roads	**3.** 60 kmph
D. Sub-arterial roads	**4.** 50 kmph

Codes :

	A	B	C	D
(1)	2	1	4	3
(2)	3	1	2	4
(3)	4	1	2	3
(4)	2	4	3	1

[MPSC : 2018]

9. Match List-I (Type of plan) with List-II (Details collected during fact finding surveys are shown) and select the correct answer using the codes given below the lists.

List - I	List - II
A. Plan I	**I.** Location of places with their respective quantities of productivity
B. Plan II	**II.** General area plan
C. Plan III	**III.** Distribution of population groups
D. Plan IV	**IV.** Existing road networks with traffic flow and desire line diagram

Answer options :
(1) A-III, B-II, C-I, D-IV
(2) A-II, B-III, C-I, D-IV
(3) A-IV, B-II, C-III, D-I
(4) A-I, B-II, C-III, D-IV

[MPSC : 2020]

GPSC

1. Preliminary project report for a road project must contain
(1) The detailed estimated cost based on detailed design
(2) The several alternatives of the project that have been considered
(3) The soil survey, traffic survey, concept design and approximate cost
(4) The contract documents for inviting tenders

[GPSC : 2017]

2. The objective of Pradhan Mantri Gram Sadak Yojana is to provide all-weather roads to the eligible unconnected Habitations in the rural area with a population of
(1) 250 persons and above in Plain areas and 100 persons and above in Hilly and Desert areas
(2) 500 persons and above in Plain areas and 250 persons and above in Hilly and Desert areas
(3) 1000 persons and above in Plain areas and 500 persons and above in Hilly and Desert areas
(4) 2000 persons and above in Plain areas and 500 persons and above in Hilly and Desert areas

[GPSC : 2019]

3. The length of National Highway (Km) as per Lucknow road plan is given by
(1) Area of the country (Km^2)/75
(2) Area of the country (Km^2)/50
(3) Area of the country (Km^2)/40
(4) Area of the country (Km^2)/25

[GPSC : 2019]

BPSC

1. The National highway Number of Pune-Solapur-Hyderabad Vijayawada is
(1) 6 (2) 9
(3) 10 (4) 11

[BPSC : 2006]

2. Suggested designed speed for arterial roads (urban) as per IRC is
(1) 60 (2) 80
(3) 50 (4) 30

[BPSC : 2006]

WBPSC

1. 3 'E' important in road safely are
(1) Engineering, Enhancement, Education
(2) Engineering, Environment, Economy
(3) Engineering, Enforcement, Education
(4) Engineering, Enforcement, Environment

[WBPSC : 2012]

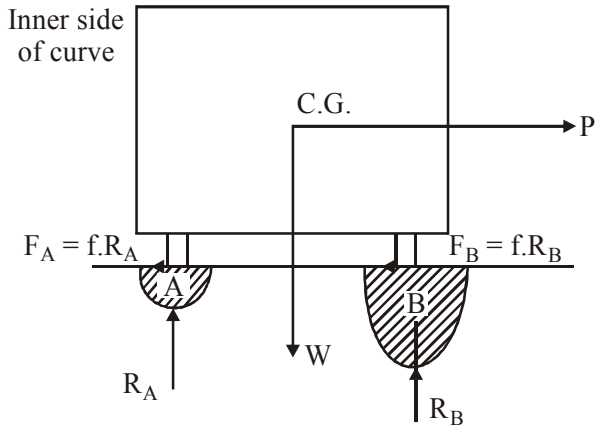


Fig.: Shaded areas show the pressure under the inner and outer wheels A and B

When the centrifugal ratio attains a value equal to the coefficient of lateral friction f there is a danger of lateral skidding.

i.e. $P/W \leq f$

Thus to avoid both overturning and lateral skidding on a horizontal curve, the cetrifugal ratio should always be less than (b/2h) and also lateral friction, f.

Note :

1) If the friction coeff. f is less than b/2h, the vehicle would skid and not overturn.
2) If the value of b/2h is lower than f, the vehicle would overturn on the outerside before skidding.
3) Thus the relative danger of lateral skidding and overturning depends on whether f is lower or higher than b/2h.

14. Ans : 1

Stopping sight Distance (SSD) :

- The minimum distance visible to a driver ahead or the sight distance available on a highway at any spot should be of sufficient length to safely stop a vehicle travelling at design speed, without collision with any other obstruction.
- This stopping sight distance is also called absolute minimum sight distance or non-passing sight distance.
- The sight distance available to driver depends on

a) Features of road ahead.
b) Height of drivers eye.
c) Height of object.

Note :

IRC has suggested the height of eye level of driver as 1.2m and the height of the object as 0.15 m above the road surface.

The stopping distance depends on "

a) Total reaction time of driver.
b) Speed of vehicle.
c) Efficiency of brakes.
d) Frictional resistance.
e) Gradient of road, if any.

The stopping distance of a vehicle is sum of

1) Lag distance :

The distance travelled by the vehicle at uniform speed during the total reaction time t is known as lag distance.

Lag distance = $v \times t$ m

When speed is in kmph, lag distance = 0.278 vt m

IRC has recommended the value of reaction time t as 2.5 sec for the calculation of sight distance.

2) Braking Distance :

The distance travelled by the vehicle after application of the brakes, until the vehicle comes to a dead stop which is known as 'Braking distance'

$$\text{Braking distance} = \frac{V^2}{2gf}$$

V = speed of vehicle m/sec

f = design coeff. of friction.

$$\text{Stopping distance} = vt + \frac{V^2}{2gf}$$

If speed is v kmph, stopping distance

$$= 0.278Vt + \frac{V^2}{254f}$$

The stopping distance may be modified for n% gradient and given as,

$$\text{SD, m} = 0.278\ vt + \frac{V^2}{254(f \pm 0.01n)}$$

Note :

Ascending gradient is taken as + n% and descending gradient is taken as - n%.

The minimum sight distance for various conditions is given below.

1) In one-way traffic lanes = SSD.
2) In two-way traffic roads
   When there are two or more = SSD
   traffic lanes
3) On roads with restricted width or on single lane roads when two way = 2 × SSD
   movement of traffic is permitted.
4) Intermediate sight distance = 2 × SSD

15. Ans : 3

Stopping sight distance (SSD) :

- It is the minimum sight distance available on a highway at any spot having sufficient length to enable the driver to stop a vehicle travelling at design speed, safely without collision with any other obstruction.
- IRC has suggested the height of eye level of driver as 1.2m and height of object as 0.15 m above the road surface for the purpose of measuring the stopping sight distance.

Note :

1) For overtaking sight distance, the height of eye level and height of object is taken as 1.2 m.
2) For headlight sight distance, height of headlight above ground surface is taken as 0.75 m.

16. Ans : 1

Summit Curve :

- Summit curves are vertical curves with convexity upwords.
- The design of summit curves are governed only by considerations of sight distance.
- Circular summit curve is ideal one but parabolic summit curves are generally adopted.
- Two cases are to be considered in deciding the length.

1) When the length of the curve is greater than the SSD. (L > SSD).

$$N = \frac{NS^2}{\left(\sqrt{2H} + \sqrt{2h}\right)^2}$$

S = Stopping sight distance (SSD)
N = Deviation angle, equal to algebric difference in grades.
H = height of eye level of driver
h = height of object

$$L = \frac{NS^2}{4.4} = \text{(for SSD, substituting H = 1.2 m \& h = 0.15 m)}$$

$$L = \frac{NS^2}{9.6} = \text{(for OSD, substituting H = 1.2 m \& h = 1.2 m)}$$

2) When the length of curve is less than SSD (L < SSD)

$$L = 2S - \frac{\left(\sqrt{2H} + \sqrt{2h}\right)^2}{N}$$

$$L = 2S - \frac{4.4}{N} \rightarrow (\text{for SSD})$$

$$L = 2S - \frac{9.6}{N} \rightarrow (\text{for OSD})$$

In problem, SSD = 100 m
n_1 = + 5%
n_2 = - 5%
$N = n_1 - n_2 = 0.05 - (-0.05) = 0.10$
Assuming case 1) i.e. L > SSD

$$L = \frac{NS^2}{4.4} = \frac{0.1 \times 100^2}{4.4} = 227\,\text{m}$$

as 227 > 100 i.e. L > SSD, assumption is correct so no need to go for case two.

Note :

If assumption one does not satisfied, we need to go for case 2.

17. Ans : 1

The stopping sight distance is the sum of lag distance and the braking distance.

SSD = lag distance + braking distance

$$= 0.278Vt + \frac{V^2}{254\left(F \pm 0.01n\right)} = \text{for speed V}$$

$$= Vt + \frac{V^2}{2g\left(F \pm .0.01n\right)} = \text{for speed V}$$

$$= 14 \times 2 + \frac{14^2}{2 \times 9.81 \times 0.28}$$

$= 28 + 35.70$

$= 63.70$ m

Note :

If reaction time is not given in question, it should be taken as 2.5 sec for stopping sight distance and 2 sec for overtaking sight distance.

18. Ans : 2

Please Refer (MPSC) Q. No. 6.

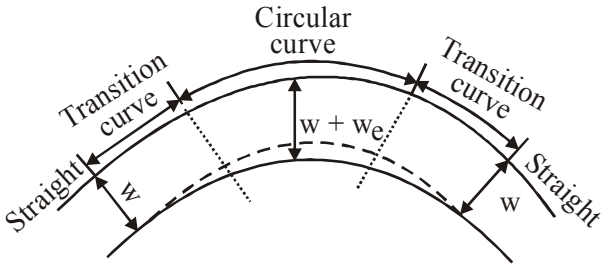
19. Ans : 3

Please Refer (MPSC) Q. No. 2.

20. Ans : 4

Transition curve :

Transition curve is provided to change the horizontal alignment from straight to circular curve gradually and has a radius which decreases from infinity at the straight end to the desired radius of the circular curve.



The minimum length of transition curve should be determinated as the maximum following two criteria rate of change of centrifugal acceleration, rate of change of superelevation.

1) Rate of change of centrifugal acceleration :

The length of transition curve, $L_S = \frac{V^3}{CR}$

may be written as

If the design speed is V kmph,

$$L_S = \frac{V^3}{46.5CR} = \frac{0.0215V^3}{CR}$$

R = radius of the circular curve, m

C = allowable rate of change of centrifugal acceleration

The IRC has recommended the following equation for finding the value of C for the design speed vkmph :

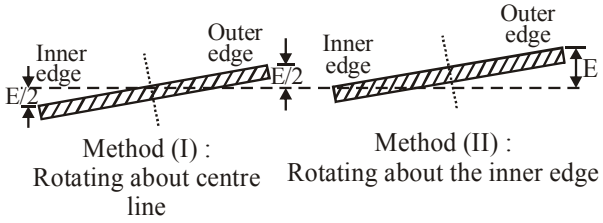
$$C = \frac{80}{75 + V} \text{ m/s}^3 = \{0.5 < C < 0.8\}$$

i.e. the minimum and maximum values of C are limited to 0.5 and 0.8 respectively.

2) Rate of introduction of superelevation :

a) It the pavement is rotated about inner edge,

$L_S = EN = eN\ (W + We)$



b) If the pavement is rotated about centre line,

$$= L_S = \frac{EN}{2} = \frac{eN}{2}(W + We)$$

e = rate of design superelevation

W = width of pavement

We = Extra widening

E = Total raising of pavement w.r.t. inner edge

1 in N = rate of change of super elevation and should be as follows :

a) 150 for plain and rolling terrain.

b) 100 in built up areas.

c) 60 in mountain/steep terrains.

3) According to the IRC standards, the length of transition curve should not be less than following formulas.

a) For plain and rolling terrain

$$L_S = \frac{2.7V^2}{R}$$

b) For mountainous and steep terrains

$$L_S = \frac{V^2}{R}$$

Where,

V = Design speed in kmph

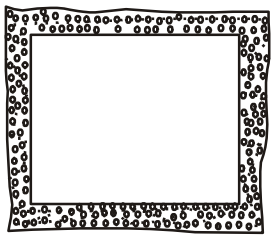
21. Ans : 4

Please Refer (MPSC) Q. No. 1.

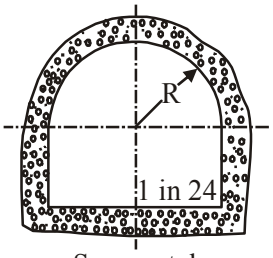
4) Elliptical section :
In softer materials than rock, elliptical section with its major axis vertical gives suitable section.

5) Rectangular section :
They are suitable for pedestrian tunnels, in subways.
They are most suitable for hard rocks.
They are very difficult to place concrete lining.

6) Segmental/D-section :
It is commonly used for subways or for navigational tunnels.



Box type cross-section



Segmental cross-section

4. Ans : 3

Based on their position or allignement tunnels are called as :

1) Saddle and base tunnels :
To minimise the length of tunnel the track is led through valleys as long as natural slope of the valley does not become steeper than rulling gradient of the route. Such tunnels are called saddle and base tunnels.

2) Off-spur tunnels :
Tunnels that are made to short-cut minor local obstacles are known as off-spur tunnels.

3) Spiral tunnels :
In narrow valleys, the additional length for minimum permissible radius is obtained by forming a loop into, the interior, of mountain such tunnels are called spiral tunnels.

4) Slope tunnels :
To ensure safe operation and protection to railway and highway routes in steep mountains 'slope tunnels' are used.
These are also constructed economic point of view.

Note :
Jacked box tunnels are used where surface must not be disturbed like beneath a runway or embankment.

5. Ans : 3

The pattern of drilling used for shafts are as follows :

1) Wedge cut :
Commonly used for rectangular shafts.

2) Step cut :
When shafts are large in cross section or alternate wedge cut.

3) Pyramid cut :
Used for circular shafts.
The pattern selected for drilling holes to be loaded with explosives varies with the type and size of drill used, depth of hole, kind of rock, quantity and rapidity of the explosive, amount of stemming etc.

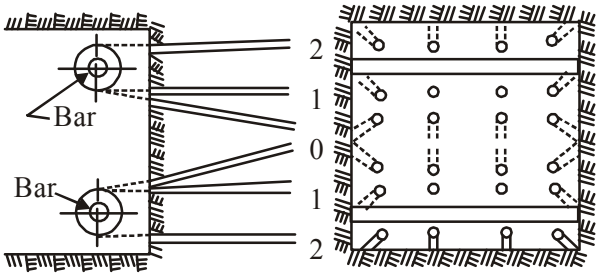
1) Horizontal wedge cut :
The pattern is used when height of tunnel is greater than its width. (Bar mounting)

2) Vertical wedge cut :
This is the best cut when drilling from columns.

3) Bottom cut :
This is commonly used in mining.

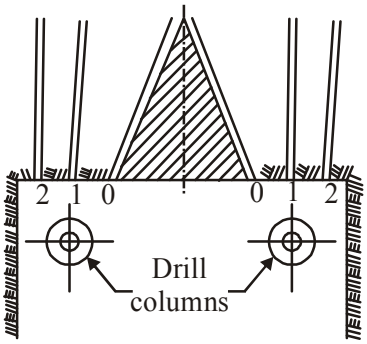
4) Pyramid/Angle cut :
Used for circular or horse shoe shapes of the tunnel. This provide as much freedom of movement for the rock as possible.

5) Buster cut :
Occasionally used when drilling unusually deep holes.

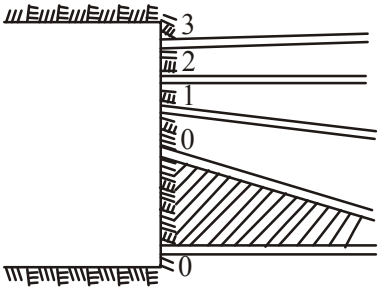


Side elevation Cross-section

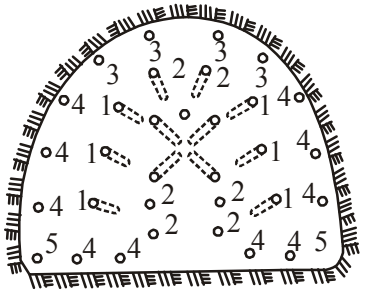
Horizontal wedge cut



Vertical wedge cut

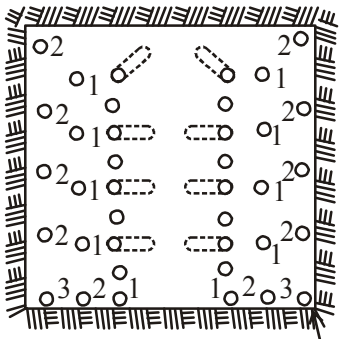


Bottom cut



Cross section

Pyramid Cut/Angle Cut



Cross section Buster cut

6. Ans : 1

1) Circular section :

Theoretically it is the best for resisting external or internal forces.

It provides the greatest cross-sectional area for the least perimeter.

It is best suited for carrying water.

Circular and elliptical shapes area used for water and sewage conduits.

Best suited in non-cohesive soils.

2) Horse-shoe section :

The floor of the tunnel is flat enough to give working space to the contractor, for construction.

Suitable in soft rocks.

Best suited for traffic purposes.

3) Egg shaped section :

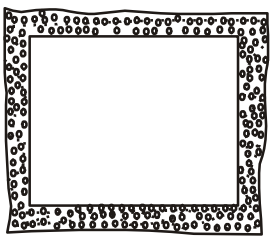
It is used for sewers.

Smaller cross section at the bottom maintains required self-cleansing velocity both in dry and storm weather flow.

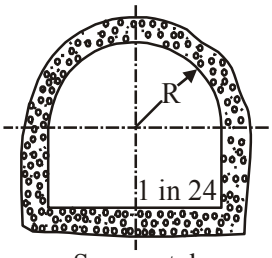
4) Segmental/D-section :

In this section, roof is a segment of circle, sides are vertical and the floor is flat.

It is commonly used for subways or for navigational tunnels.



Box type cross-section



Segmental cross-section

7. Ans : 4

Checking of tunnel cross-section :

Tunnel must be cross-sectioned twice.

Tunnel is cross-sectioned for

a) Locating the the high points for trimming.

b) For calculating yardage, concrete etc.

Following methods are used for cross-sectioning:

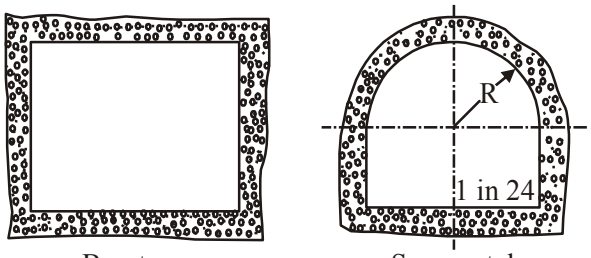
a) Cross-sectioning is usually done by making a light framework of 2.5 cm lumber to a size exactly 1.5 cm less than true cross-section of the tunnel, carrying a cross-board with a hole in it on the axis of the tunnel.

The frame is carried through the tunnel and suspicious points are marked.

b) A more accurate way is to have two such frames made and used approximately 15-30 m apart.
Tunnels must be accurately cross-sectioned at regular intervals, 8 to 15 m.
Pantographs and sunflowers can be made to record directly the cross-section of the tunnel on paper.

8. Ans : 2

1) Segmental/D-section :
In this section, roof is a segment of circle, sides are vertical and the floor is flat.
It is commonly used for subways or for navigational tunnels.



Box type cross-section Segmental cross-section

2) Circular section :
It is best suited for carrying water as no necessity of filling.
Circular and elliptical shapes are used for water and sewage conduits.
best suited for non-cohesive soil.

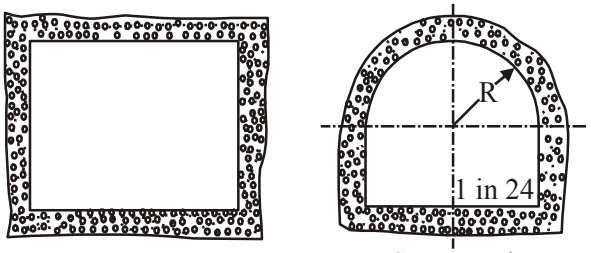
3) Horse-shoe section :
This shape is very commonly used for railway and highway tunnels.

4) Egg-shaped section :
It is used for sewers smaller cross-sectional the bottom maintains required self-cleansing velocity both in dry and storm weather flow.

5) Rectangular section :
It is suitable for pedestrian tunnels, in subways.
Rectangular tunnels are almost never used these days.

9. Ans : 1

D Shape/Segmental section :
In this section, roof is a segment of circle, sides are vertical & floor is flat. As it resembles D shape, it is also known as D-section.
It is commonly used for subways or for navigational tunnels.



Box type cross-section Segmental cross-section

10. Ans : 3

Please Refer (MPSC) Q. No. 3.

11. Ans : 2

Shield method of tunneling :
- A tunnel exavated in soft ground always poses the threat of caving in because the ground is unstable. To prevent cave-in the 'shield method' is used during the tunnel construction.
- Shields permit fast, relatively safe construction to be carried without interfering with structure or traffic above ground.
- This method is commonly used in urban tunnelling because of continueous ground control and no blast vibrations.

Note :
Closed shields are also known as tunnel boring machines.

1) The skin. 2) Cutting edge.
3) Propelling jacks. 4) The hood.
5) The tail. 6) Port holes.

Shield driven tunnels are generally circular in cross-section because of its suitability due to following reasons :
1) Circular shape is most ideally suited to resist semi-fluid pressure of soft ground.
2) It provides greatest cross-section area with a minimum perimeter.
3) Circular shield can rotate without affecting the primary lining, which is being erected within the tail.
4) It offers least resistance to rotation and centre line is not disturbed.

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