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Aim of the Subject

- This course imparts the student's knowledge of planning, design, construction and maintenance of railway tracks
- The students acquire proficiency in the application of modern techniques such as GIS, GPS and remote sensing in Railway Engineering.

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Objective of the Subject

- To impart knowledge of the various construction techniques of railways
- To attain adequate knowledge about airport planning and design with the prime focus on runway and taxiway geometrics
- To attain adequate knowledge in various tunneling techniques and piling techniques.
- To impart knowledge about conversant with the definition, purpose, location and materials of coastal structures such as piers, breakwaters, wharves, jetties, quays and spring fenders.
- The students acquire knowledge on site reconnaissance for location and planning of harbours

Course Outcomes:

1. Railway engineering is a multi-faceted engineering discipline dealing with the design, construction and operation of all types of railway systems
2. Acquire Knowledge about various types of rail constructions and maintenance
3. Understand the application of technology and scientific principles to the planning, functional design, operation of airport engineering
4. Student should also be able to know the planning and design of harbours, components and environmental concern of port operations

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CE6604 RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

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OBJECTIVES:

To expose the students to Railway planning, design, construction and maintenance and planning and design principles of Airports and Harbours.

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UNIT I RAILWAY PLANNING 10

Significance of Road, Rail, Air and Water transports - Coordination of all modes to achieve sustainability - Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, - Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys, conventional and modern methods- - Soil suitability analysis - Geometric design of railways, gradient, super elevation, widening of gauge on curves- Points and Crossings.

UNIT II RAILWAY CONSTRUCTION AND MAINTENANCE 9

Earthwork – Stabilization of track on poor soil –- Tunneling Methods, drainage and ventilation –- Calculation of Materials required for track laying - Construction and maintenance of tracks –Modern methods of construction & maintenance - Railway stations and yards and passenger amenities- Urban rail – Infrastructure for Metro, Mono and underground railways.

UNIT III AIRPORT PLANNING 8

Air transport characteristics-airport classification-air port planning: objectives, components, layout characteristics, socio-economic characteristics of the Catchment area, criteria for airport site selection and ICAO stipulations, Typical airport layouts, Case studies, Parking and circulation area.

UNIT IV AIRPORT DESIGN 8

Runway Design: Orientation, Wind Rose Diagram - Runway length - Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles – Elements of Taxiway Design – Airport Zones – Passenger Facilities and Services – Runway and Taxiway Markings and lighting.

UNIT V HARBOUR ENGINEERING 10

Definition of Basic Terms: Harbor, Port, Satellite Port, Docks, Waves and Tides – Planning and Design of Harbours: Requirements, Classification, Location and Design Principles – Harbour Layout and Terminal Facilities – Coastal Structures: Piers, Break waters, Wharves, Jetties, Quays, Spring Fenders, Dolphins and Floating Landing Stage – Inland Water Transport – Wave action on Coastal Structures and Coastal Protection Works – Environmental concern of Port Operations – Coastal Regulation Zone, 2011.

TOTAL: 45 PERIODS

OUTCOMES:

- On completing the course, the students will have the ability to Plan and Design various civil Engineering aspects of Railways, Airports and Harbour.

TEXT BOOKS:

1. Saxena Subhash C and Satyapal Arora, "A Course in Railway Engineering", Dhanpat Rai and Sons, Delhi, 2003
2. Satish Chandra and Agarwal M.M, "Railway Engineering", 2nd Edition, Oxford University Press, New Delhi, 2013.
3. Khanna S K, Arora M G and Jain S S, "Airport Planning and Design", Nemchand and Brothers, Roorkee, 2012.
4. Bindra S P, "A Course in Docks and Harbour Engineering", Dhanpat Rai and Sons, New Delhi, 2013

REFERENCES:

1. Rangwala, "Railway Engineering", Charotar Publishing House, 2013.
2. Rangwala, "Airport Engineering", Charotar Publishing House, 2013.
3. Rangwala, "Harbor Engineering", Charotar Publishing House, 2013.
4. Oza.H.P. and Oza.G.H., “A course in Docks & Harbour Engineering”. Charotar Publishing Co., 2013
5. Mundrey J.S. “A course in Railway Track Engineering”. Tata McGraw Hill, 2007.
6. Srinivasan R. Harbour, “Dock and Tunnel Engineering", 26th Edition 2013

Unit No	Sl No	Topics to be covered	Ref	Hours Planned	Cumulative Hours
UNIT-I RAILWAY PLANNING	01	Introduction; Objectives; COs, References; Time Table, Evaluation pattern, Significance of Rail, Air, Road and Water Transportation	TB1&TB2	1	1
	02	Meaning of Sustainability; Different types of modes; Coordination plan to achieve sustainability; Elements of ***PW***	TB1&TB2	1	2
	03	Introduction, Functions of Rails; Requirements; Types of rail sections; Length of Rails; Kinks in Rails; Buckling of Rails	TB1&TB2	1	3
	04	Sleepers-Types; Sleeper Density Ballast-Requirements; Types (list)	TB1&TB2	1	4
	05	Rail Fixtures and Fastenings-Fish Plates (requirements; Section);Spikes (requirements; Types (pictures)); Bolts (Types with pictures); Cast Iron Chair; Keys advantages of Morgan key	TB1&TB2	1	5
	06	Track Stresses-discuss eight points; Creep in Rail (definition; effects of creep; measurement of creep	TB1&TB2	1	6
	07	Coning of Wheels; Route alignment surveys Gradient-types of Gradients Superelevation-Introduction	TB1&TB2	1	7
	08	Superelevation-derivation; Negative SE	TB1&TB2	1	8
	09	Soil suitability analysis	TB1&TB2	1	9
	10	Points and Crossings-Turnouts Crossings	TB1&TB2	1	10

Unit No	Sl No	Topics to be covered	Ref	Hours Planned	Cumulative Hours
UNIT-II RAILWAY CONSTRUCTION AND MAINTENANCE	11	Earth work soil stabilization – Tunneling Methods	TB1&TB2	1	11
	12	Tunnel Ventilation Drainage	TB1&TB2	1	12
	13	Materials required for track laying	TB1&TB2	1	13
	14	Track Maintenance (modern methods): Introduction; Mechanized Maintenance; Need/ requirement for Mechanized Maintenance Methods of mechanical Tamping (off-track tamping)	TB1&TB2	1	14
	15	Track Maintenance (modern methods): Methods of mechanical Tamping (on-track tamping-Light on-track, heavy on-track); Measured Shovel Packing (MSP-merits, demerits)	TB1&TB2	1	15
	16	Track Maintenance (modern methods): Measured Shovel Packing; DTM	TB1&TB2	1	16
	17	Railway Station & Yards: Site Selection Classification of Railway Station Block Station Non-block Stations; Junction Station; Terminal Station	TB1&TB2	1	17
	18	Railway Station & Yards: Types of Yards (passenger bogie yard; Goods Yard; Marshalling yard (Type-Flat/Gravitational/Hump)	TB1&TB2	1	18
	19	Underground railways -monorail	TB1&TB2	1	19

Unit No	Sl No	Topics to be covered	Ref	Hours Planned	Cumulative Hours
UNIT-II' AIRPORT PLANNING	20	Air Transport (*advantages & Limitations*); Airport Classification	TB3	1	20
	21	Airport Planning: General, Airport Master Plan, ICAO Recommendations	TB3	1	21
	22	Airport Planning: Regional Planning, data required before site selection	TB3	1	22
	23	Airport Planning: Airport Site Selection	TB3	1	23
	24	Airport Planning: Estimation of future air traffic needs (brief)	TB3	1	24
	25	Airport Planning: Airport Layout	TB3	1	25
	26	Vehicular Circulation and Parking Area; Apron	TB3	1	26
	27	Basic Parking Configurations: Number of gate positions, Aircraft parking system;	TB3	1	27

Unit No	Sl No	Topics to be covered	Ref	Hours Planned	Cumulative Hours
UNIT-IV AIRPORT DESIGN	28	Runway Design: Runway Orientation, cross wind component and wind coverage, wind rose	TB3	1	28
	29	Runway Design: Type I wind rose diagram, Type II wind rose diagram	TB3	1	29
	30	Airport Runway: basic runway length,	TB3	1	30
	31	correction for elevation, temperature, gradient	TB3	1	31
	32	Problems on runway length	TB3	1	32

	33	Airport configuration, Taxiway Design	TB3	1	33
	34	Runway and taxiway marking and lighting	TB3	1	34
	35	Runway and taxiway marking and lighting	TB3	1	35

Unit No	Sl No	Topics to be covered	Ref	Hours Planned	Cumulative Hours
UNIT-V HARBOUR ENGINEERING	36	Definition of basic terms: Harbour, port, satellite port (net), docks, waves and tides	TB4	1	36
	37	Planning and design of harbours : Harbours, Requirement of a harbor, classification	TB4	1	37
	38	Components of a harbor coastal structures: Definitions	TB4	1	38
	39	Breakwaters: Introduction, broad classification only	TB4	1	39
	40	Jetty, Dock fenders (broad classifications)	TB4	1	40
	41	Piers; Wharves (broad classification)	TB4	1	41
	42	Dolphins; Coastal Protection (Brief)	TB4	1	42
	43	Inland Water Transportation (ITW)	TB4	1	43
	44	Environmental Concern of Port Operation	NET	1	44
	45	Coastal Regulation Zone 2011	TB4	1	45

UNIT I – RAILWAY PLANNING (PART-A)

1. **List the various gauges used in Indian Railways?** (May/ June 2012)

   a) Broad Gauge (B.G.) – 1.67 mtrs.

   b) Meter Gauge (M.G.) – 1.00 mtrs.

   c) Narrow Gauge (N.G.) – 0.762 mtrs.

   d) Light Gauge or Freeder Track Gauge –0.610 mtrs.

2. **Give the various functions of rails?** (May/ June 2011)

1. Rails provide a hard, smooth and unchanging surface for passage of heavy moving loads with a minimum friction between the steel rails and steel wheels.

2. Rails bear the stresses developed due to heavy vertical loads, lateral and barking forces and thermal stresses.

3. The rail material is such that it gives minimum wear to avoid replacement charges and failures of rails due to wear.

3. **Define obligatory point.** (May/ June 2012)

Obligatory points are controlling points which govern the alignment of railway tracks. Some important obligatory points are; (i) Important towns and cities (ii) Shortest width and permanent path of rivers (iii) Hill passess.

4. **What are the disadvantages of "Coning of wheels"?** (Nov/ Dec 2012)

The disadvantages are:

- ✓ Pressure of horizontal components near the inner edge of rails has a tendency to accelerate wearing of rails.
- ✓ It tends to turn rails outwardly and consequently, the gauge is widened.
- ✓ Cause damages to outer edge of rails, if no base plates are provided.

5. **What is meant by cant deficiency?** (Nov /Dec 2012)

The equilibrium cant is provided on the basis of the average speed of different trains on the track. This equilibrium cant or super elevation will fall short of that required for speed higher than average speed. This storage of cant is called cant deficiency.

6. **What are the various types of the Gradients that are adopted in laying a railway track?** (May /June 2013)

(1) Ruling gradients

(2) Momentum gradients

(3) Pusher gradients

(4) Gradients in station yards.

7. **On a B.G track of 4° curve, equilibrium cant is provided for a speed of 60 km/hr. Calculate**

(i) Value of equilibrium cant

(ii) **Maximum speed allowing maximum deficiency** (May /June 2013)

Given data:

Degree of curve = 4°

Nominal Gauge (B.G) = 1750 mm

Speed of train = 60 km/hr

Solution

Radius of curvature R = 1750/D = 1750/4 = 437.5 m

Equilibrium cant $e = \frac{GV^2}{127R}$ = 1750 x 60^2/127x 437.5= 113.39 mm

8. **List the uses of Remote sensing in route alignments.** (Nov / Dec 2013)

Gives a birds' eye view of a large areas. Ground condition can be defined with a combination of satellite images and topographic maps.

9. **Mention the functions of formation** (Nov / Dec 2013)

Formation is the base over which the ballast is spread. Sometimes the natural ground may not meet the requirements for placing ballast. In such cases a raises bank is constructed over the natural ground which is called the embankment. Sometimes, the formation below the natural ground is made which is called cutting.

10. What is creep? How is it prevented? (Nov/ Dec 2014)

Creep is the longitudinal movement of rails in a track.It occurs due to several reasons The effect of creep tends to dig the track. It is prevented by providing sufficient ballast which could hold the rails.

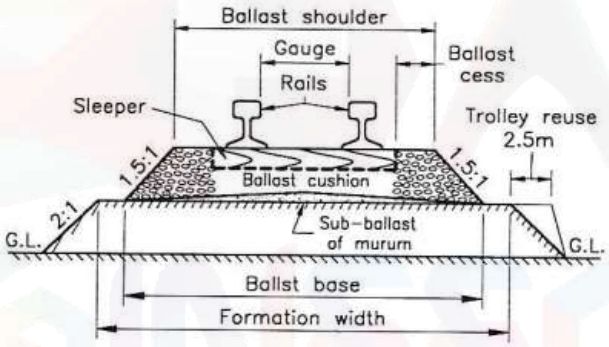
11. What do you mean by sleeper density? (Nov/ Dec 2014)

Sleeper density is defined as the number per rail length. It is specified as

M+ x where M is the length of the rail in metres

X is the number that varies

12. Sketch the cross section of a permanent way (May/ June 2015)



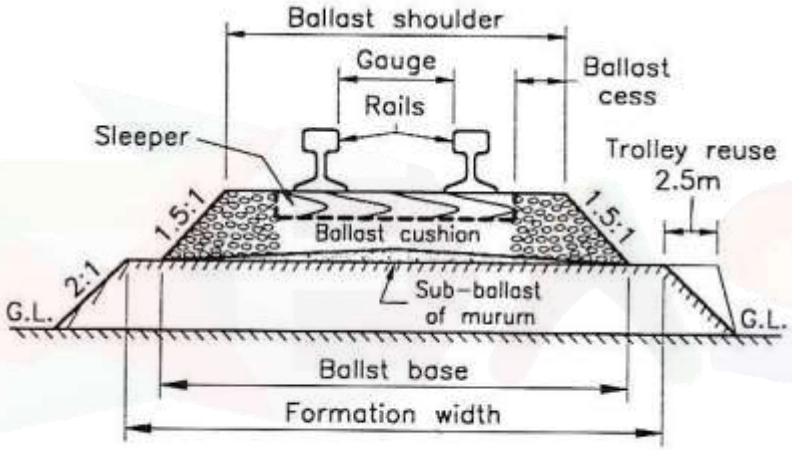
Typical Cross-section of a Permanent Way on Embankment.

PART B

1. Explain the permanent way components with neat sketch. (May / June2013)

The combination of rails, fitted on sleepers & resting on ballast & subgrade is called as railway track or permanent track something temporary tracks.

In permanent way, the rails are joined in series by fish plate & bolts and then they are fixed to sleeper by different types of fastening.



Typical Cross-section of a Permanent Way on Embankment.

Permanent way

Rails:

Rails are unsymmetrical I sections,made up of steel.They are laid along two parallel lines over sleepers.Rails are joined longitudinally by fish plate or by welding.These are placed end to end to provide a continuous & level surface for trains to move.

Types of rails.

1. Double headed rails.
2. Bull headed rails
3. Flat footed rails.

Functions:

1. Act as gider and transmit load to large area of formation through sleepers and ballast..

2. It should be an economic section consistent with strength stiffness and durability

3. The head of rail should have adequate depth to allow for allow for vertical wear.

4. Web should be sufficiently thick to withstand stresses.

Sleepers.

Sleepers are members generally laid transverse to the rails on which the rails are supported and fixed, to transfer the loads from rails to the ballast and subgrade below.

Functions of sleepers:

Sleepers perform the following functions,

1. To hold the rails to correct gauge.

2. To hold the rails in proper level or transverse tilt i.e., level in turnouts, cross-overs,

3. To act an elastic medium between the ballast and rails to absorb the blows and vibrations of moving loads.

4. To distribute the loads from the rails to index area of ballast underlying it or to the girders in case of bridges.

5. They also provide means to rectify track geometry during service life.

Ballast: layer of material which is place below and packed around sleepers for distribution of load from sleepers to the formation.

Functions:

(i) Provides level and hard bed for sleepers

(ii) To hold sleepers while passage of trains

(iii) Forms a load distribution medium between sleepers and formation

(iv) Provides elasticity and resilience to the track for proper riding comfort.

(v) Acts a draining of water.

(vi) Resists lateral, longitudinal and vertical displacements of the track

Types:

(i) Broken stone (ii) Gravel (iii) coal or ash cinders

(ii) (iv) Sand (v) Moorum (vi) Selected earths

2. **If a 8° curve track diverges from main curve of 5° in an opposite direction in the layout of a B G yard. Calculate the super elevation and speed on branch line, if the maximum speed permitted on the main line is 45 kmph. (Nov / Dec 2010) (8 mark)**

Solution:

Radius of main curve,

$$R_m = \frac{1719}{8} = 214.9 \text{ m}$$

Radius of branch curve,

$$R_b = \frac{1719}{5} = 348.8 \text{ m}$$

Super elevation of main line,

$$e_m = 1.315 \frac{V^2}{R}$$

$$e_m = \frac{1.315 \times 45^2}{214.9}$$

$$= 12.39 \text{ cm}$$

Assume cant deficiency as 76 mm = 7.6 cm

Theoretical super elevation on main line = Cant deficiency + change in super elevation (c_h)

$$12.39 = 7.6 + e_{ch}$$

$$e_{ch} = 12.39 - 7.60 = 4.79 \text{ cm}$$

$$e_{ch} = e_b - 7.6$$

$$-4.79 = e_b - 7.6$$

i.e., $e_b = 2.81$ cm

Super elevation of branch = 2.81 cm

Speed of branch line $= \sqrt{\frac{e_b \times R}{1.315}}$

= 27.10 kmph

Speed of branch line = 27.10 kmph

3. **What are the requirements of an ideal rail joint? Explain the various rail joints used in railways with neat sketches. (Nov / Dec 2013)**

Requirements of Ideal Rail Joints:

Two rails are connected by a joint which forms the weakest part of the track.

Different fastenings are used to make this joint as much efficient as possible. The characteristics of a good ideal rail joint are as follows:

- The rail joint should hold the two ends of rails as nearly as possible and should be at same level in a straight line.
- It should have the same strength and stiffness with rails.
- It should provide space for expansion and contraction of rails due to changes in temperature.
- It should be arranged in such a way that any rail while repair.
- It should be durable, cheap in initial cost and maintenance.
- It should provide sufficient elasticity to absorb vibrations and shocks.
- It should provide resistance to the longitudinal forces developed due to acceleration, deceleration.
- The joint fittings should be simple and universal type so that iit can be used for all types of sleepers.

Types of Rail joints:

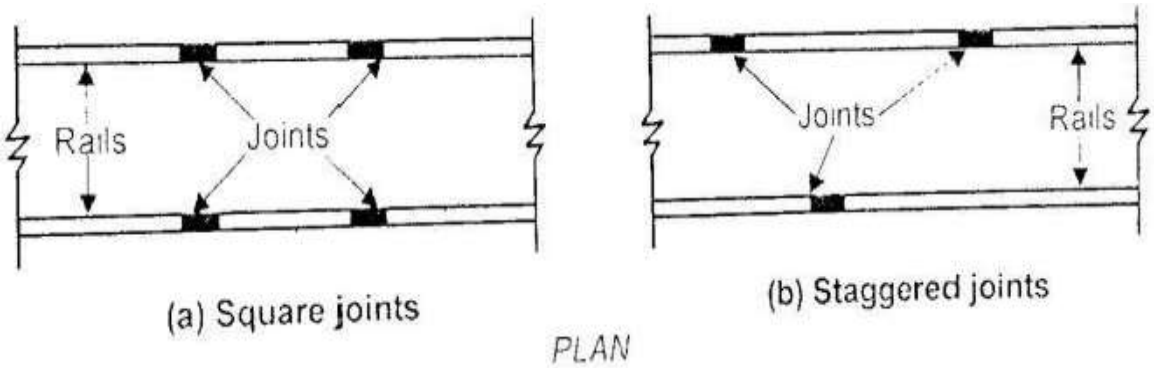
Depending upon the position of joints or sleepers, rails are classified as

(1) According to position of joints:

- Square joints
- Staggered joints

Square joint: When a joint in one rail is exactly opposite to the joint in the parallel rail, it is known as a square joint and it is very common in straight track.

Staggered joint: When a joint in one rail is exactly opposite to the centre of the parallel rail length, it is known as a staggered joint.



(2) According to position of sleepers:

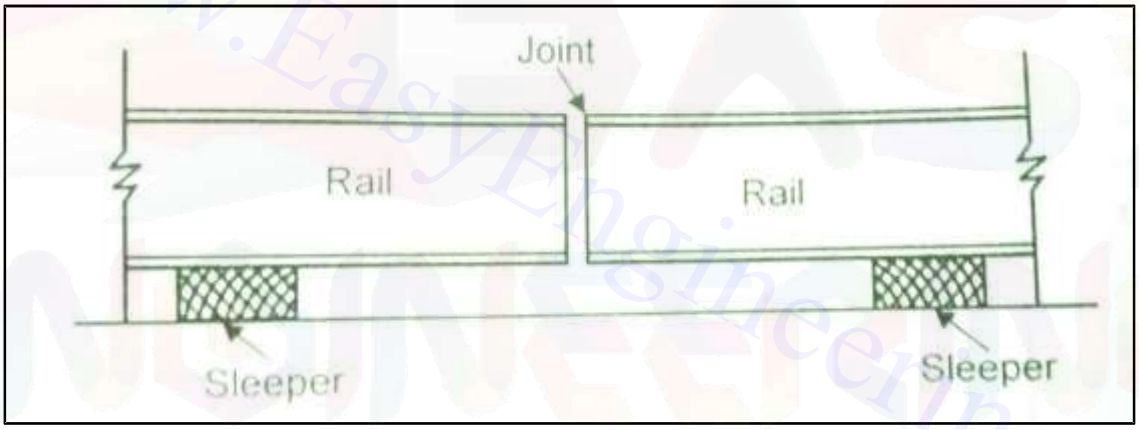
- Suspended joints
- Supported joints
- Bridge joints

Suspended joint:

The rail joint, when placed at the centre of two consecutive sleepers is known as suspended joint.

In this type of joint, load will be equally distributed on sleepers and also when joint is depressed, rail ends are pressed down evenly.

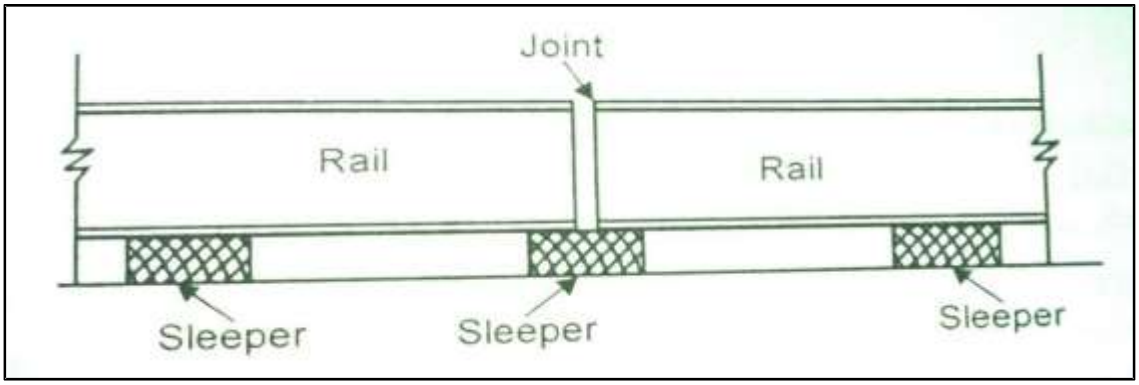
It is most commonly adopted since it provides greater elasticity.



Supported joint:

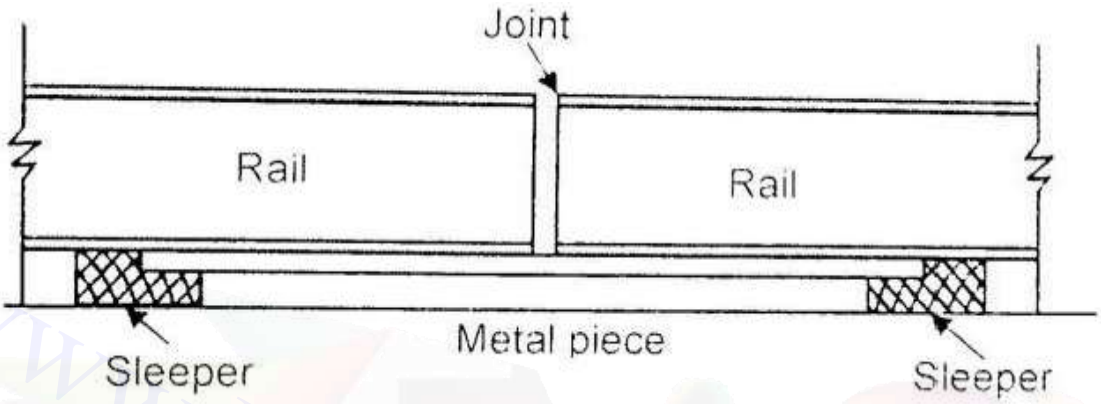
When the sleeper is placed exactly below the rail joint, it is known as supported joint.

These types of joints are not used at present.



Bridge joint:

When a suspended joint is bridged by a metal piece so as to connect the ends of the two rails and thereby preventing bending stress in the rail.



4. Briefly explain the modern methods of surveys for track alignment. (Apr / May 2011) (8 mark)

Introduction:

Railway planning needs precious and cost effective methods of surveying. Modern methods like GIS, GPS etc were incorporated for effective surveying.

Different features :

- Survey of India map
- Village map
- Ward / block map
- Updating of map

Application of modern survey equipments for railway alignment surveying:

i. Global positioning system (GPS)

It measures co-ordinates of any point anywhere on the globe. This survey is possible at any weather conditions and a minimum of 24 no. of satellites at a distance of 10,000 km from earth's surface will be involved in surveying.

ii. Electronic distance meter (EDM)

EDM works on electromagnetic waves travel between the given origin and

destination. Typical EDM can measure a distance upto 5 – 10 km.

iii. Total station (TS)

It works on same procedure of EDM but it also measures the angle along with the distance. It is more accurate than EDM and has a least count of one second. Also reduces human interventions and measurements.

iv. Geographical Information systems (GIS)

It is a system of software and hardware. It is used to prepare highway, railway alignment. Techniques of GIS such as buffering and network analysis are widely applied in highway and railway planning.

v. Remote sensing data products

a. Aerial photos
b. Satellite imageries
c. High resolution satellite imageries

Merits of modern methods:

- Rapid process of surveying
- Optimum resource planning
- Acceleration construction programming
- More accuracy
- Less time consuming
- Updating and correction of old map will be much easier.

Demerits of modern methods:

- Applies only for skilled workers
- Exact boundaries cannot be determined on satellite imageries
- Procurement of equipment/systems such as GPS, EDM, GIS, Stereo potters are cost intensive.

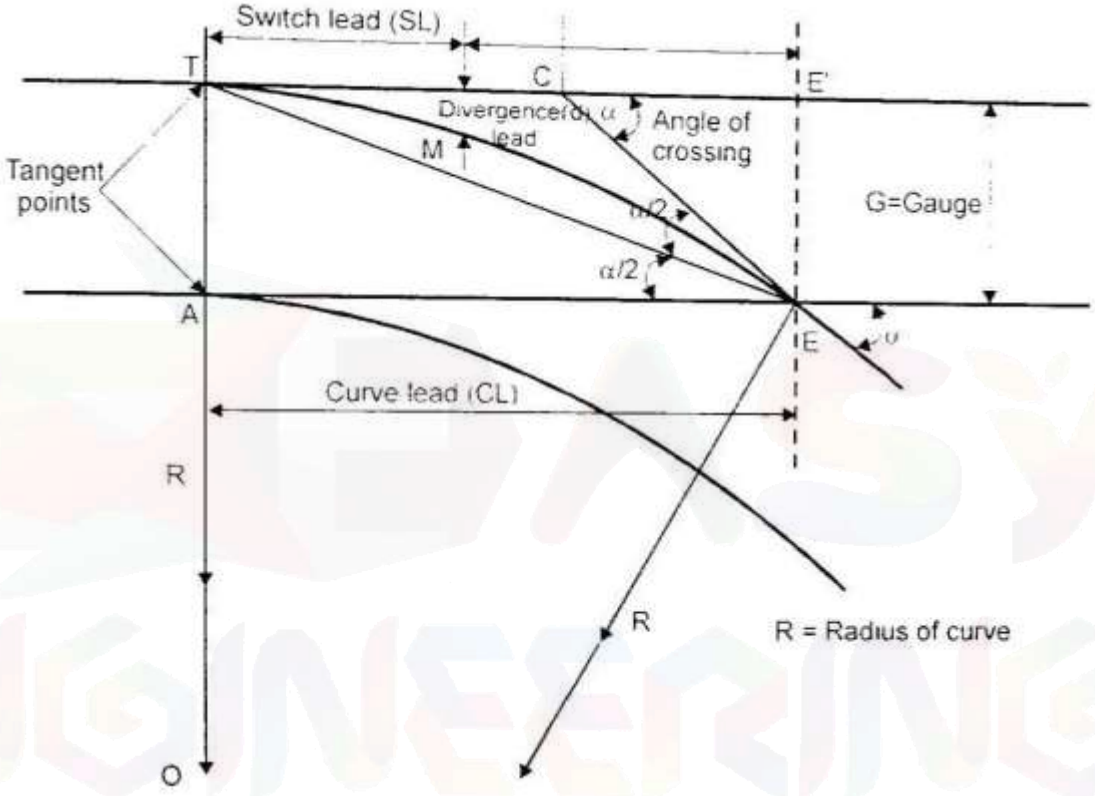
5. Determine all the elements of a turnout, when the following data is given:

Heel divergence = 13.65 cm

Angle of switch = 1 34' 27"

Gauge = 1.676 m

Number of crossing = 8.5 (Nov / Dec 2012)



Solution:

Number of crossing = 8.5

Gauge of track (G) = AT = EE' = 1.676 m

Angle of crossing (α) = = = $\cot^{-1}$ (8.5)

(i) Curve head, CL

CL = 2 GN

= 2 x 1.676 x 8.5

= **28.49 m**

Heel divergence (d) = 13.65 m

= 0.1365 m

(iii) Radius of curve (R)

R = 1.54 + 24N2

= 1.54 + 248.52

= **1735.54 m**

(iv) Switch Lead (SL)

SL = $\sqrt{2}\,x\,1735.54$ - 0.137^2

= **58.91**

(v) Lead Crossing (L)

L = G cot α/2 - $\sqrt{2Rd}$ - d^2

= **1.676 x cot α/2 – 58.91**

6. Illustrate with neat sketches a right hand or a left hand turn out, points and crossings and explain their working principles. (Apr / May 2011)

Turnout:

A turnout is a complete set of points and crossings along with lead rails which enables a rolling stock to be diverted from one track to another.

Important components:

- A pair of points or switches
- A pair of stock rail
- Check rail
- Lead rail
- Stretcher bar
- Crossings or 'V' piece
- Wing rail

Points or Switches:

Types:

Stub switch: No separate tongue rail is provided

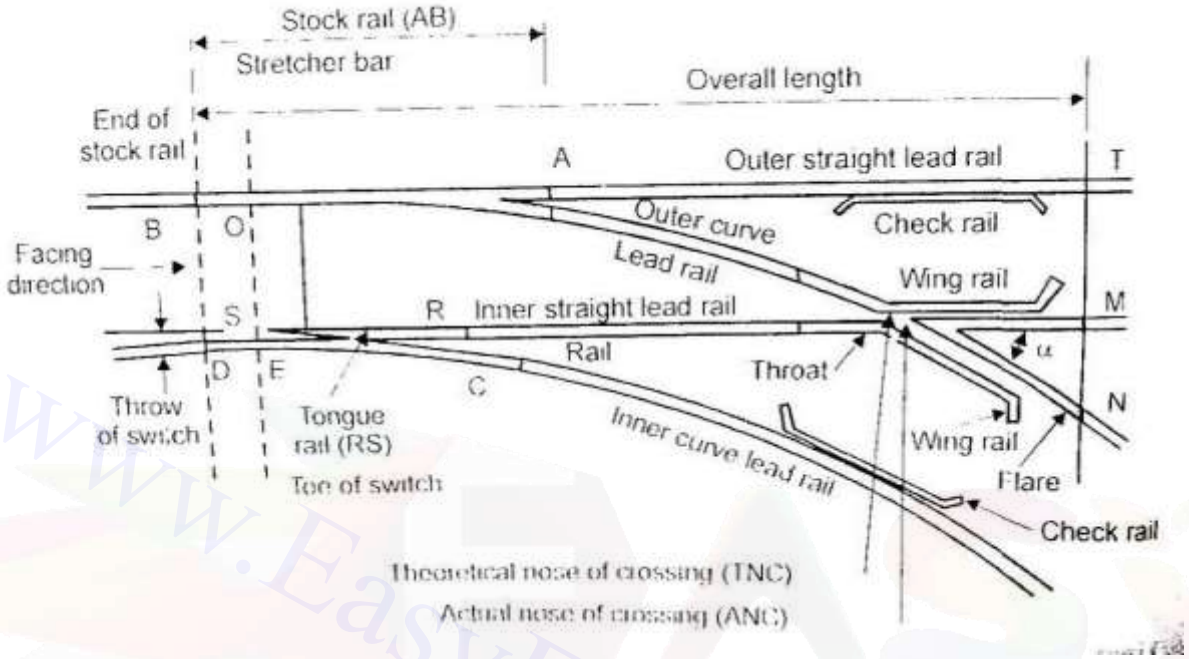
Split switch: Loose heal type

Fixed heal type

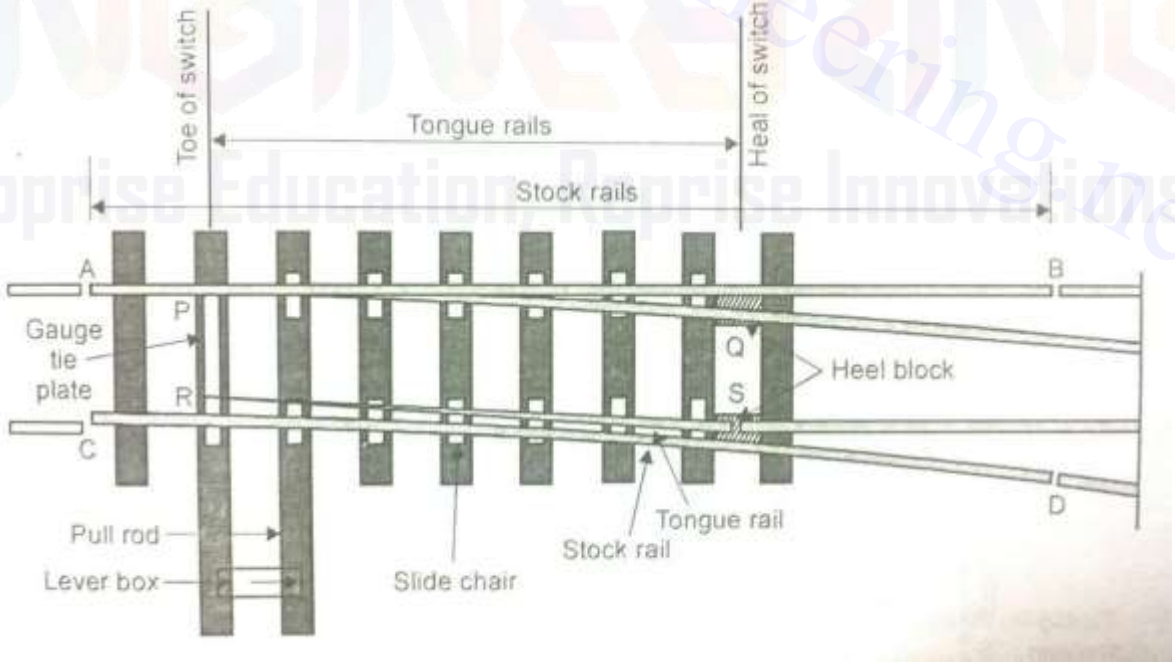
Constituents:

- A pair of stock rails AB and CD
- A pair of tongue rails PQ and RS

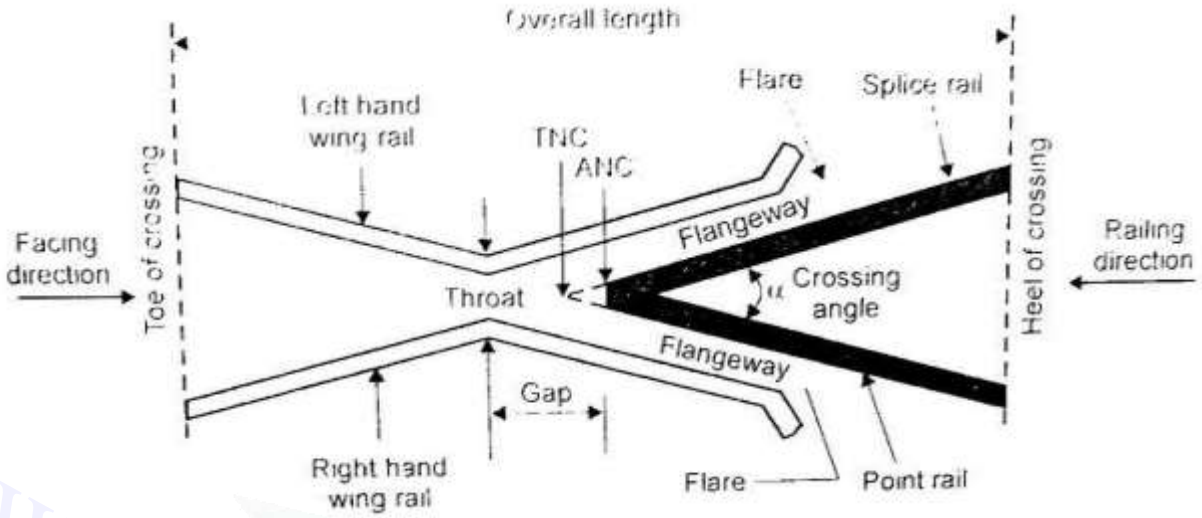
- A pair of heel blocks
- A gauge tie plate to ensure correct gauge



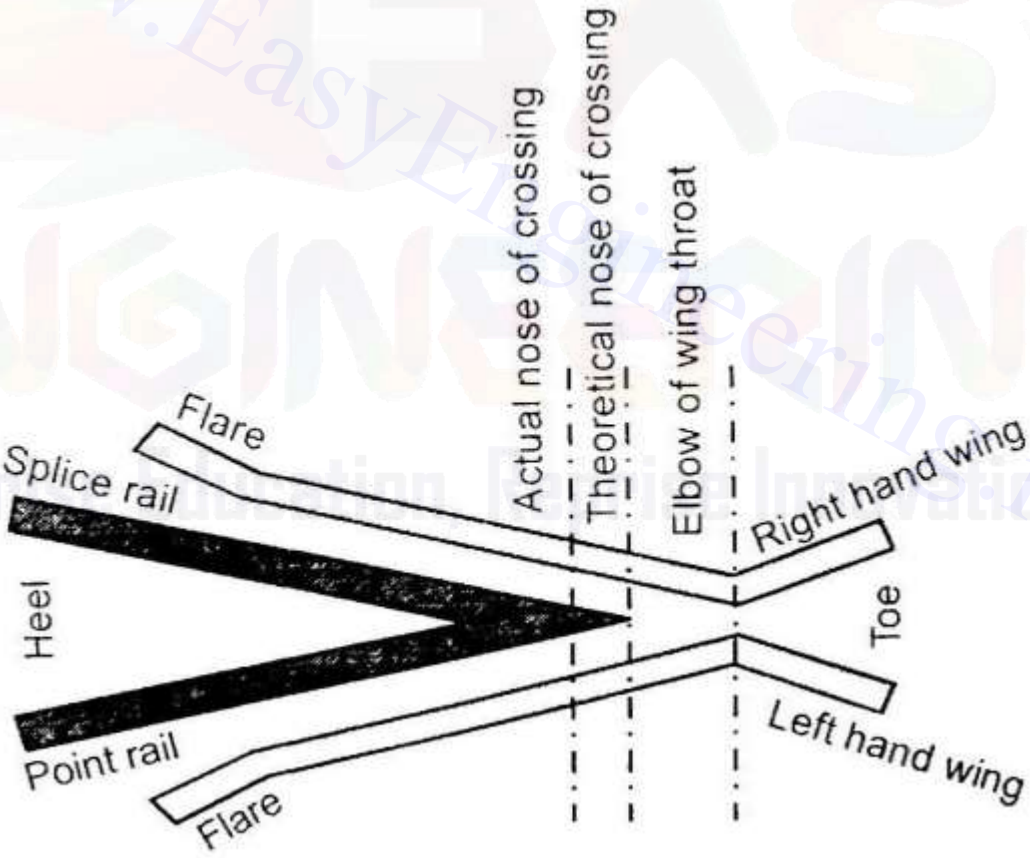
Components of a right hand turnout



Details of a switch



Details of a crossing



Point rail and splice rail

Crossings:

Definition and purpose: A Crossing is a device, inserted at a location where two rails

cross each other. It enables the wheel flanges of rails to pass from one track to another track. Flanged wheels jump over the gap provided from the throat to the nose of the crossing.

Constituents: A crossing consists of

- Two rails called point and splice rail which are machined to form nose. The point rail ends at the nose.
- A left hand and right hand wing rails form a throat and diverging again on either side of nose.
- A pair of check rails to guide and to provide a path for wheel flanges.

Working principle of points and crossings:

a. **Split switch:** It consists of tongue rail and a stock rail with fastenings. A pair of them constitutes a set of points. The points by their operation can divert traffic moving in facing direction from one track to another track.

b. **Crossing device:** A crossing is a device introduced at the intersection of two running rails to permit the wheel flanges, moving along one to pass across the other. The crossing should be rigid enough to withstand against severe vibrations.

c. **Check rail:** A pair of check rails are provided to guide the wheel flanges and to route a path for them by which the sideway movement is prevented.

7. Explain super elevation giving its relationship with gauge, speed and radius of the curve. (Nov / Dec 2014) (8 mark)

Superelevation:

Superelevation or cant is the difference in height between the outer and inner rail on a curve. This is provided in the field by a gradual lifting of the outer rail while maintaining the inner rail in its original level.

Functions:

i. To minimize the wear and tear of the rails and rolling stock

ii. To have better load distribution on both the rails

iii. To modify the effect of lateral forces

iv. To provide a comfortable journey to the passengers

Equilibrium superelevation:

While vehicle on curves experience an outward centrifugal force due to the radial acceleration. The centrifugal force is given as

$$F = m (V^2 / R) = (W / g) (V^2 / R)$$

Where F = centrifugal force (tonnes)

W = weight of the vehicle (tonnes)

V = speed (m/s)

g = acceleration due to gravity (m/sec^2)

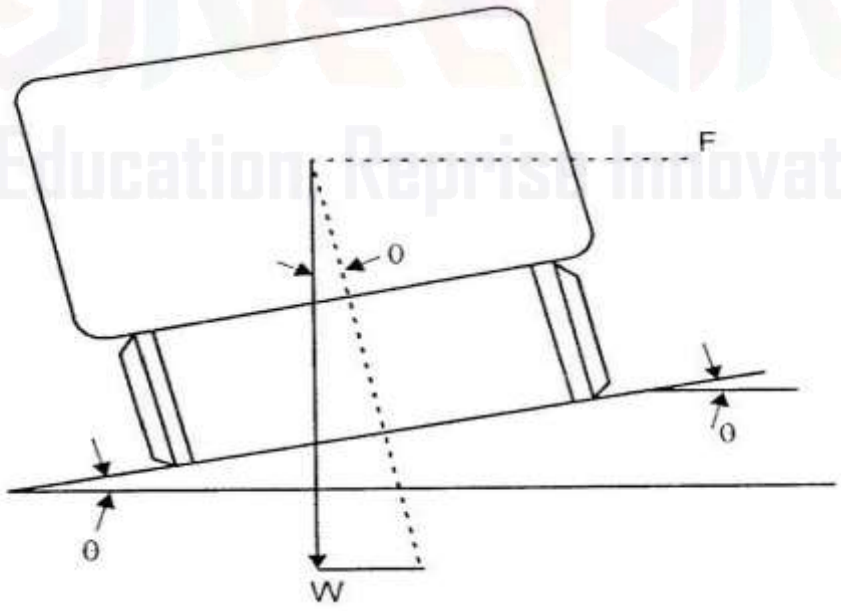
R = radius of the curve (m)

In order to counteract the effect of centrifugal force, the outer rail of the curve is raised with respect to the inner rail by an amount equal to the superelevation.

Let ⍰ be the angle that the inclined plane (line joining the top inner and outer rails) make with the horizontal. Then

$$\text{Tan } \Theta = \frac{\text{Superelevation}}{\text{Gauge}} = \frac{e}{G}$$

Also $$\text{Tan } \Theta = \frac{\text{Centrifugal force}}{\text{Weight}} = \frac{F}{W}$$



Equilibrium Superelevation

Equating the values of Tan ◆

$$\frac{e}{G} = \frac{F}{W}$$

Or $$e = F \times \frac{G}{W} = \frac{W}{W} \times \frac{V^2}{g} \times \frac{G}{R}$$

i.e., $$e = \frac{GV}{gR}$$

where, e = superelevation

G = gauge (min)

= gauge length + width of rail heads

This is equal to

1750 for BG tracks

1058 for MG tracks

8. What do you understand by "cant deficiency'? (Apr / May 2015) (8 mark)

Cant deficiency:

When a train moves around a curve at a speed more than the equilibrium speed, then deficiency in cant occurs. Thus the cant deficiency is the difference between the theoretical cant required for high speed and the actual cant provided.

Cant excess:

When a train moves around a curve at speed less than the equilibrium speed then excess in cant occurs. Thus cant excess is the difference between the actual cant provided and the theoretical cant required.

Cant gradient:

Cantgradient and deficiency gradient express the increase or decrease in the cant or the deficiency of the cant in a given length of transition. For example, a gradient of 1 in 1000 represents that a cant deficiency of cant of 1 mm is attained or lost in every 1000 mm of transition length.

The maximum values of cant deficiency prescribed for Indian railways are given below:

Gauge	Group	Normalcant deficiency (mm)	Remark
BG	A and B	75	For BG group
BG	C, D and E	75	A & B routes: 100 mm cant deficiency permitted only for nominate stock and routes with the approval of CL
MG	-	50	
NG	-	40	

9.What is meant by gradient and enumerate the various types of gradient with all the details.(Nov / Dec 2008)(May / June 2012)

Any departure of the track from the level is known gradient or gradient. Reason for the usage in railway track

1. To provide a uniform rate of rise or fall as far as possible
2. To reach the various stations located at different elevation
3. To reduce the cost of the earthwork.

Types of gradient

1. Ruling gradient
2. Momentum gradient
3. Pusher or helper gradient
4. Gradient at Station Yard

1. Ruling gradient

The ruling gradient on a section may be defined as a gradient which determines the maximum load that the engine can haul on the section.

In determination the ruling of the section may be defined as, it will not only be that the survey of the gradient that will come into play but also the length of the gradient and it's position

In plain terrain = 1 in 150 to 1 in 200

In hilly terrain = 1 in 100 to 1 in 150

2. Momentum gradient

The rising gradient is called as momentum gradient and in such cases a steeper grade than the ruling grade can be adopted.

The gradient on the section which through more severe than the ruling gradient, do not determine the maximum load of the terrain but on account of their favorable position on the track.

For example in valleys, a falling gradient is usually followed by a rising gradient

3. Pusher or helper gradient

If the grade concentrated in a Specific section such as mountainous section. Instead of limiting the terrain load.

It may operationally easy or even economical to run the terrain on the basis of load that can carry in the remaining portion of the track and arrange for an assisting engine is called pusher or helper gradient.

4. Gradient in Station Yard

The gradient at Station Yard has to be sufficiently low due to the following reason

(a) To prevent the movement of Standing vehicle on the track due to the effect of the gravity

(b) To prevent the additional resistance due to the grade on the Standing Vehicle

9.Enumerate the concept of an grade compensation and also explain the basic formulas used in grade compensation.(Nov / Dec 2012)(April / May 2011)(Nov / Dec 2007)

Grade Compensation

In order to avoid the resistance beyond the allowable limit, the gradients are reduced on curves. Then the reduction can be named as Grade compensation

Due to the rigidity of the Wheel base, it is sometimes found on the Curve that the rails are tilled outwards so that the actual gauge in more than the theoretical value

Wheel Base is defines as the distance between the adjoining Axes which are held in a rigid frames.The maximum value of the rigid wheel base in India on B.G Yard and M.G yard are 610cm and 48 cm respectively. To prevent the tendency the gauge of

the track is sometimes widened on Sharpe Curves. The amount of widening of gauges depending upon the radius of the Curve, Gauge and rigid Wheel base on the vehicle.

The various formulas are Available for finding out the Extra Width of the gauge required on Curves. Incase, the Extra width should not Exceed 25mm on 1676mm and 1435mm gauges and 16mm on the M.G. Some rules are mentioned as follows

Rule 1:

$$D = (B+L^2)*125 / R$$

Where

D= Extra width of the gauge in mm

B=Rigid Wheel base in mm

L=Lap of the Curve

R=Radius of the Curve

Now, the value of lap of flange in mm is obtained by the Following equation

$$L = 2\,[(D+H)*h]^{1/2}$$

Where

D= Diameter of the Wheels in mm

H=Depth of the Wheel flange below in mm

Rule 2:

Multiple half of the Wheel base by lap of the flange and when divide this result by the radius of the curvature plus half the gauge

Multiple the gradient by 3000 and the result will be the Extra required in mm. The Wheel base, lab of flange, radius of the curvature and the gauge to be Expressed in meters

Rule 3:

The gauge was widened for a curve of over 3 degrees. But at present the Gauge is not widened up to the curvature of 4.5 degree on the B.G Yard and 5-9 to on M.G in USA the practice is not to widen the gauge at the rate of 3mm for every 2 degrees of curvature up to a maximum of 19m.

UNIT II – RAILWAY AND CONSTRUCTION MAINTENANCE

PART A

1. What are the types of signals based on the various categories(May/June 2015) or What are the characteristic classification of signals? (May/June 2013)

i. Operating characteristics a) Audible signals b) Visual indication signals

ii. Functional characteristics a) Stop signals b) Warner signals c) Disc signals d) Coloured signals

iii. Locational characteristics a) Outer signals (reception) b) Home c) Starter s ignals d) Advanced Starter signals

iv. Special characteristics a) Routing signals b) Repeating signals c) Co-acting signals d) Calling- on signals e) Indicators

2. State the principles of interlocking. (May /June 2011).

(a) When a train is properly set and locked to a particular line, it shall be responsible to unlock or reverse points.

(b) It shall be impossible to admit trains from opposite or converging directions in the same line, at the same time.

(c) When a signal is set for a particular line, it shall be impossible for loose wagons from any yard to obstruct the line.

and cabin. Its prime function is to specify the presence of any train or vehicle on the track. Various types of circuits used in Indian Railways are:

3. What is meant by track circuiting? (May /June 2011)

Track circuiting is an electric circuit formed by combining running rails, signals

(i) D.C track circuit

(ii) A.C track circuit

(iii) Electric track circuit

4. What is cross-over? (May /June 2012).

When two adjacent parallel or diverging tracks, which may be straight or curved, are connected by two sets of turnouts, with or without a straight length between them,

the connecting line is known as cross-over.

.5. List the components of switch (Nov/Dec 2012)

A set of switches or points comprises of the following components:

(i) A pair of stock rails
(ii) A pair of tongue rail or switch rail.
(iii) A pair of heel blocks
(iv) Slide chairs
(v) Stretcher bars
(vi) A gauge tie plate.

6.Define interlocking (May /June 2013).

Interlocking is defined as the mechanical relationships established between various levers operating the signals and the points through mechanical or electrical agencies such that contrary effects are not at all possible in the working of the signal mechanism.

7.Distinguish between gravity yard and hump yard. (Nov/Dec 2013)

Sl no	Gravity yard	Hump yard
1	Wagons move under gravity in the marshalling yard provided with suitable gradient	The wagons are pushed upon the hump by the engine and then allowed to gravitate
2	Shunting operations are carried out slowly assisted by engine power.	Shunting operations are carried out quickly
3	Uneconomical since power is required to move the wagons	Economical since no power is required to move the wagons

8. What are the various sources of moisture in a railway track? (May /June2014)

The various sources of moisture affecting a railway track are: a) Surface water due to rain, dew or snow. b) Hydroscopic water or Held water. c) Seepage water d) Moisture by capillary action in sub grade.

9. What is a buffer stop? (May /June2015)

The dead end of a siding or the end of any track of terminal station is not kept bare but a form of stop or barrier is provided at the end of the track, to prevent the

vehicles, from running off the track. This stop or barrier provided at the end, across the track of a siding or at terminal station is known as “Buffer stop”.

10. Write the difference between ‘loop and siding’. (Nov/Dec 2012)

Loop: Loop lines are the ones provided near the station building to stop slow-moving or passenger trains to stop and give way for express trains to move on the mainline without any difficulty.

Siding: Sidings are provided at the marshalling yard. There are three types of sidings

(i) **Reception sidings –** intended to receive incoming trains.
(ii) **Sording sidings –** for shunting operations
(iii) **Departure sidings –** similar to reception siding and is used for departure

PART B

1. How are stations classified? Explain the features of each station. (May/June 2014)

Stations and yards are the field control units of the railway communication system. They also provide waiting places and repairing places for the locomotives and wagons.

Classification of Railway stations:

Two categories: 1. Operational considerations

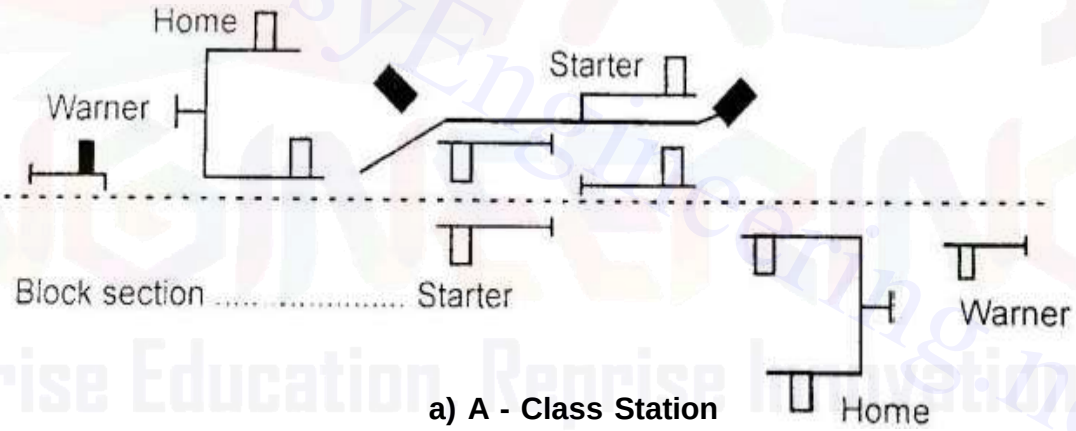
2. Functional considerations

Operational considerations:

As per Indian railways, (i) block stations or (ii) non-block stations

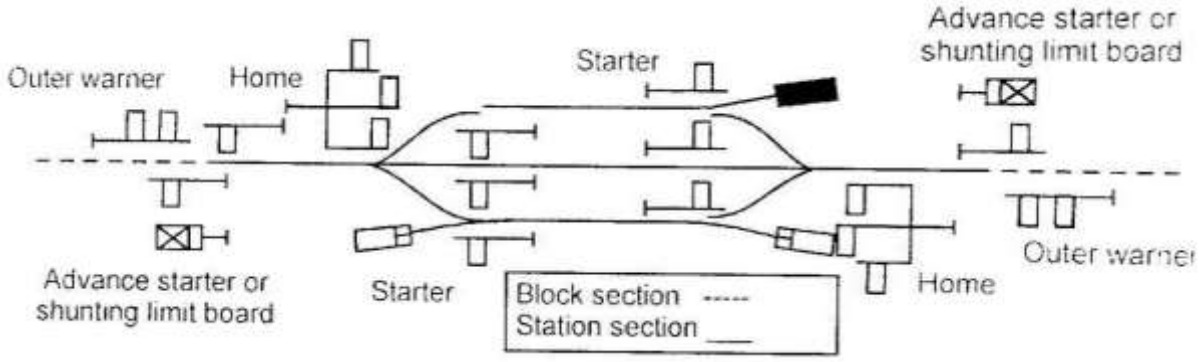
(i) Block station: No traffic is dealt, but trains have to get permission to proceed further. Further classified as A, B, C classes.

A – incoming train is received after clearing at least a distance of 400 m beyond home signal



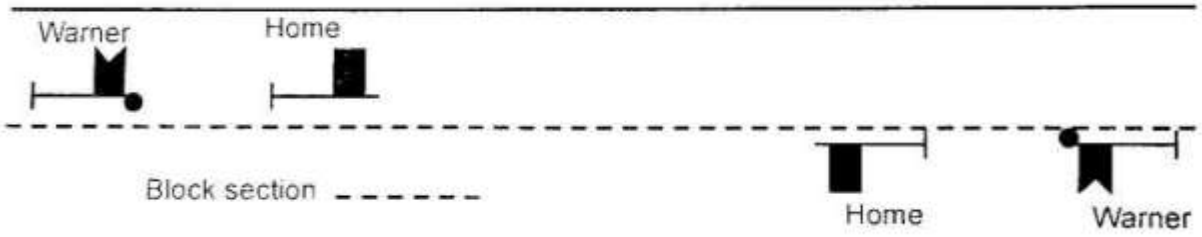
a) A - Class Station

B –permission to the incoming train is given before the receiving line is made clear within the station section



b) B – Class station

C –stations where train do not stop



c) C – Class station

(ii) Non-block station: classified as D-class or flag stations. Only traffic is dealt and no arrangements to control the movement of train. Located between two block stations.

Functional classification:

(i) Halt stations

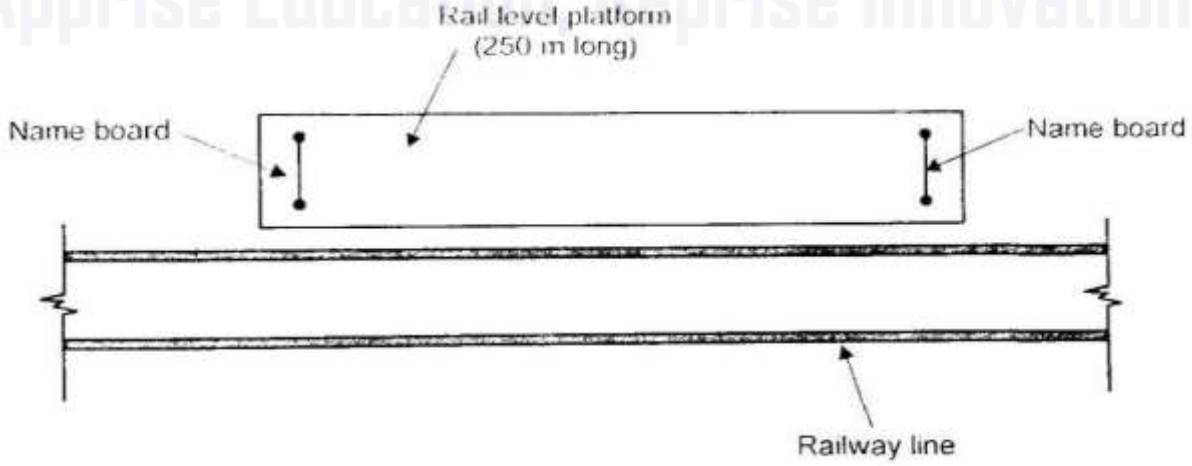
(ii) Flag stations

(iii) Wayside junctions

(iv) Junction stations

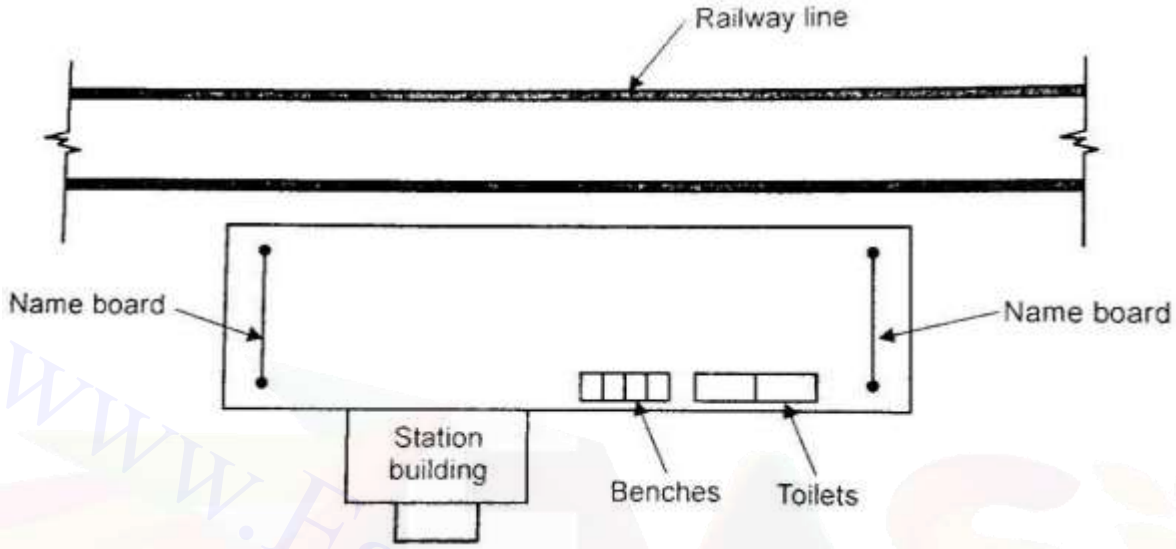
(v) Terminal stations

Halt stations: simplest station where trains can stop on a railway line. Provided with small waiting shed, name boards are provided at both end.



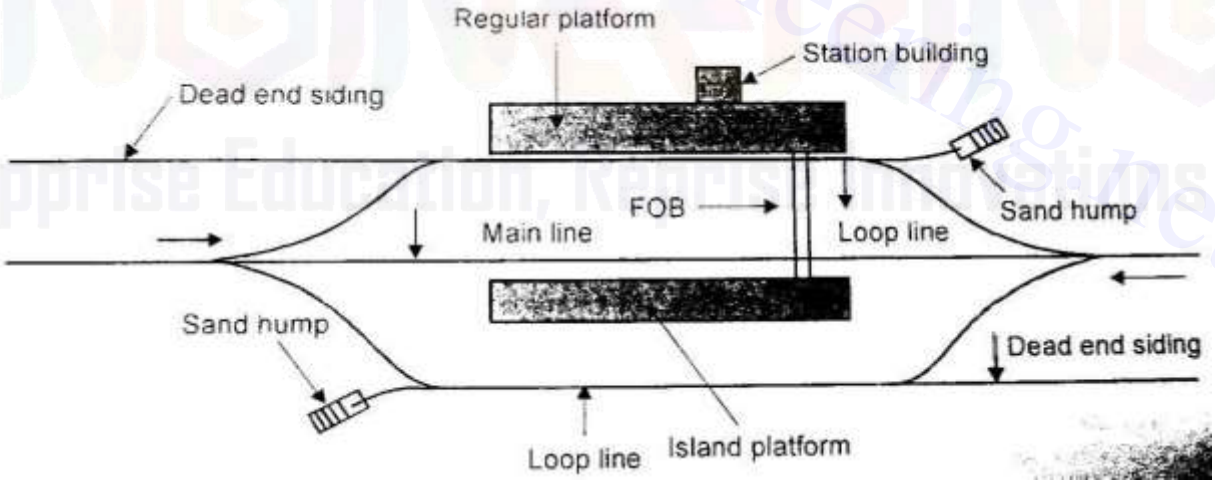
Halt station

Flag stations: provided with station building and staff. Provided with booking office, benches, drinking water facility. Sometimes siding is also provided for stabling of wagons booked for that station.



Flag station

Wayside station: called as crossing station. Provision is made to cross an up and a down train or for over-taking the slow-moving trains by the fast-moving trains.



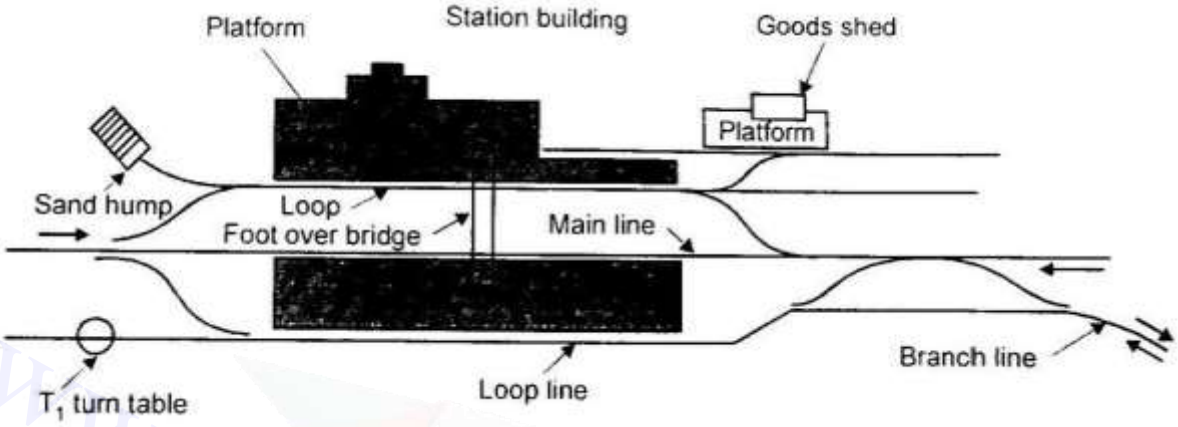
A wayside or crossing station on a single-line section

Junction stations: is a meeting point of three or more line coming from different conditions.

a. Feasibility to interchange of traffic inbetween main and branch lines

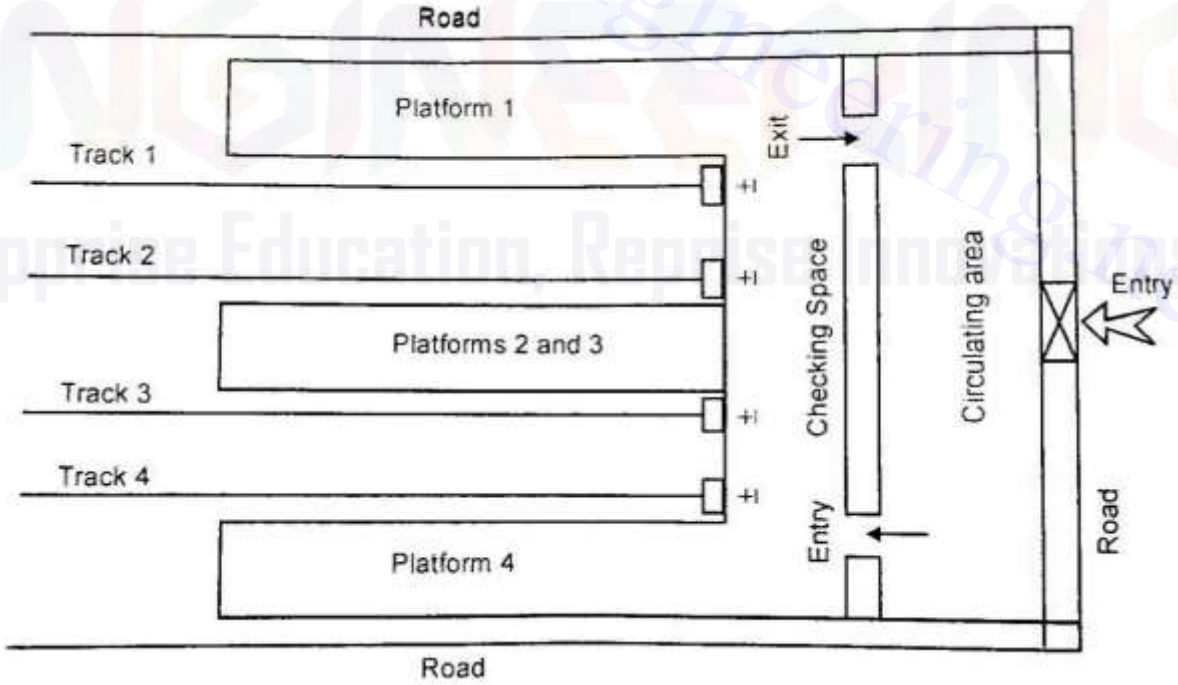
b. Possibility to clean and repair vehicles which terminate at the junctions

Occur between a single branch line and a single or double main lines or between double branch line and main tracks.



Junction station with single main line and single branch line

Terminal station: station at which a railway line or one of its branches ends or terminates without further proceeding. Provided with facilities to reverse the locomotive, examination pits, additional sidings, ticket office, restaurant etc.



Terminal station

2. What is marshalling yard? Explain with a neat sketch, the working of a hump type of marshalling yard. (Apr / May 2011)

Yard:

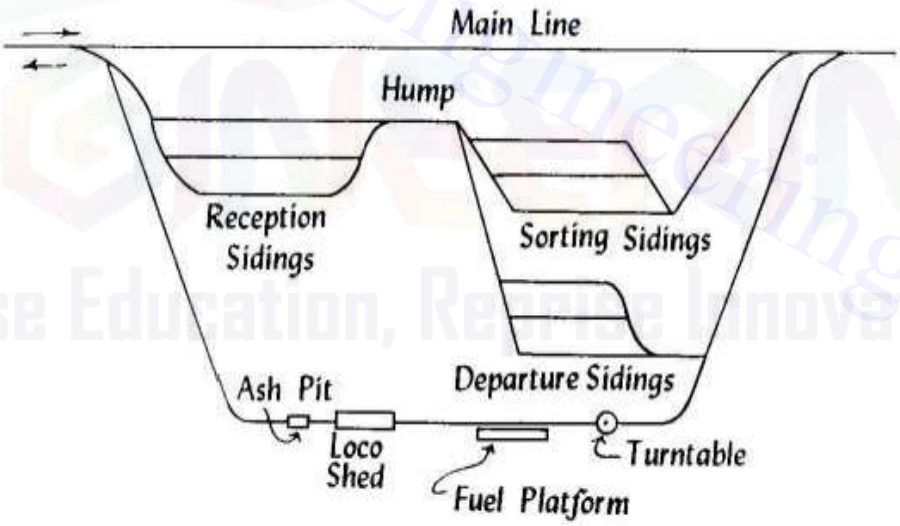
A yard is defined as a system of tracks laid within definite limits for various purposes such as storing of vehicles, making up trains, despatch of vehicles, etc. It attends to unscheduled movement of trains subjected to rules and regulations.

Types:

- Passenger yards
- Goods yards
- Marshalling yards
- Locomotive yards

Marshalling yards:

The main purpose of marshalling yard is to isolate goods wagons received from various centres in order of station at which they are to be sent. It works as distribution centres and also the empty wagons are kept in marshalling yards.



Marshalling yard

Design aspects of marshalling yards:

- Shunting operations should not disturb the regular movement of trains.
- More number of wagons should be despatched rather than storing more wagons.

- It should be feasible for future expansion so as to accommodate more goods traffic.
- To the maximum extend the marshalling yards should be made parallel to the running lines.
- All main stations should have the marshalling yard facility.
- Wagons are to be made to move in one direction only.
- Adequate repair facility for sick wagons.
- Enough lighting arrangements should be made to function at all times.
- The cost of construction and maintenance should be low.

Layouts of marshalling yards:

An ideal layout of marshalling yard consists of three types of sidings:

a) Reception sidings
b) Sorting sidings
c) Departure sidings

a) Reception sidings:

These sidings are used to receive incoming trains. These sidings are laid in the form of parallel grid with equal length. Such arrangement enables the goods trains to stand on these sidings till they are shunted out.

b) Sorting sidings:

These sidings are intended for shunting operations. Each sidings is allotted to specific destination wagons. The sorting sidings are generally laid in the form of fan or balloon. The number of sidings depends on the number of destinations.

c) Departure sidings:

These are similar to reception sidings. If the mainline is not busy their sidings may be omitted. The number of sidings both for reception and departure depend on the intensity of traffic on the main line, time required to marshall and number of goods trains to be marshalled at the same time.

Types of marshalling yards:

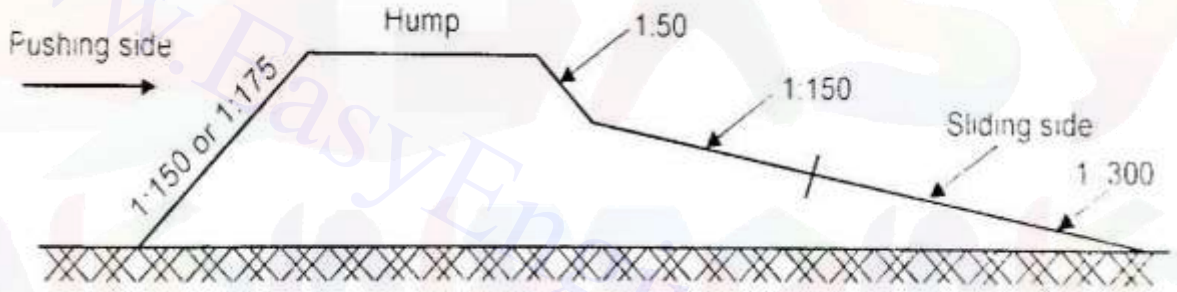
- Flat yards

- Gravitation yards
- Hump yards

Hump yards:

Hump or summits or man-made hills are provided and the wagons are pushed upto this point by the engine. Then the wagons are allowed to gravitate down the slope. The modern trend is to adopt this type of marshalling yards as shunting operations are carried out more quickly than gravity or flat yards.

They are found to be more economical because no power is required to move the wagons. A rising gradient of 1 in 150 or 1 in 175 is provided at the pushing end for a length of about 183 metres. Then the hump is kept level and it is followed by falling gradients of 1 in 150 and 1 in 300 an then level. (Ref Fig)



Hump yard

Functions: The stopping of individual wagons or group of wagons in hump yards is carried out as follows:

(i) Men run along the wagons and apply the wagon brakes at the desired point of stoppage.

(ii) Retarders may be employed to stop the moving wagons. These are blocks or bars which are fixed on either side of the rails. The retarders are operated automatically to press against the sides of wheels of moving wagons to stop it.

(iii) Skids may be placed on the rails to prevent further movement of wagon by friction developed on skid.

The action of hump yards is little uncertain because the rate of movement of wagons depends on the following factors:

- Climatic conditions
- Different types of axle-boxes
- Weight of the wagons

3. Describe the following:

(i) Necessity of track maintenance (6)

(ii) Essentials of good track maintenance (5)

(iii) Advantages of proper track maintenance (5)(May/June 2014)

(i) Necessity of track maintenance:

There are mainly two reasons for maintain track in proper order:

New track:

- The newly laid track will settle down slowly, so special gangs are to be employed to bring the embankment to the proper formation level.
- Generally 4 men are employed per kilometre length of this track for this purpose.

Constant use:

- The railway tracks are being constantly used by trains, therefore it requires some treatment to remain in the working condition.
- It is achieved by maintenance gangs all along the railway track, which keeps the track in good condition.
- For this type of maintenance the track is divided into suitable sections, each having a length of about 6 km for main line and 8 km for branch line section and one gang is attached to this section. The number of men required depends on the volume of traffic, nature of soil and strength of permanent way.

(ii) Essentials of good track maintenance:

The following are the characteristics of a well maintenance track

i. Curvature of gauge subjected to limitations.
ii. Rails at same level with appropriate super elevation at curves.
iii. Alignment free from kinks and other irregularities
iv. Gradients as per standards, prescribed.

v. Track with the property of resilience to regain its original position after deformation.

vi.vi. Track with lateral strength to withstand side thrust and centrifugal and lateral forces and to maintain the alignment intact.

vii.vii. Upkeep and maintenance of radius of curvature, super elevation, points and crossings.

viii. Perfect drainage system.

ix. Precaution against creep.

x. Various components of the railway track such as formation, ballast, sleepers and rails fullfill the essential requirements of maintenance.

(iii) Advantages of Proper track maintenance:

It consists of one gangmate or ganger, one keyman and nine to ten workers for B.G and about four to five workers. Each gang works in a length of about 90 meters a day. The duties of gangmate, keyman and P.W.I are:

i. The ganger is the head of the gang and he is personally responsible for the upkeep of track in his section.

ii. The ganger must keep his section in good running condition at all times.

iii. He is responsible for maintaining the track in his section in correct alignment and level.

iv. The ganger has to arrange for tools and other equipments required by his gang.

v. The points and crossings should be periodically checked and examined by the ganger.

vi. In case of emergency, the ganger should stop or slow down a running train by the use of temporary signals.

vii. In case of accident, the ganger should look after the broken fittings of the rolling stock and track components.

4.(i) List the conventional and modern methods of maintenance of railway track. What are the different types of equipment used?

4.(ii) What are the advantages of welded rails? Describe any one method of welding the rails. (May/June 2012)

(i) Track maintenance:

The maintenance of track irrespective of old or new is to be done periodically. Since the track may be damaged due to weathering effect like rain, sun and sand, track maintenance is necessary.

Conventional methods of track maintenance:

The conventional method of maintaining of tracks by manual labour has been traditionally accepted. The calendar system of maintenance has been followed by Indian railways. As per this system a time table has been charted out which outlines the track maintenance work to be performed by gangs in the course of the year. The following operations are carried out:

- Through packing
- Systematic overhauling
- Packing up slacks

i. Through packing:

Due to the movement of trains over the track frequently the ballast under the sleepers become loose. The ballast under the sleepers should be regularly packed so as to keep the track in good running condition.

ii. Systematic overhauling:

In order to ensure the best possible standard of track conditions, tracks should be overhauled (renewing) periodically.

iii. Picking up Slacks:

Slacks are those points in the track where the running of trains is faulty or substandard. Depending on the season working sessions are decided. In rainy season only slacks are picked up and no through packing is done. In every working session, a certain number of days in each week are allotted for picking up of slacks.

Modern methods are track maintenance:

- Track Machines (TMs)

- Measured shovel packing (MSP)
- Directed Track maintenance (DTM)

i. Track Machines:

Different types of track machines are used in Indian railways are discussed below:

Plassermatic tamping machines have the functions of tamping, levelling and aligning.

Plasser Ballast cleaning machine is used to excavate, clean and put the screen ballast back in the track and remove unwanted material.

Switch relaying machines are used which can remove and install parts or complete assemblies of points and crossings.

Track Relaying Trains are capable of relaying the entire track automatically with very less use of labour.

ii. Measured Shovel packing:

It comprises of taking accurate measurements of track defects such as unevenness and voids in ballast.

iii. Directed Track Maintenance:

It is a method of maintaining track based on the directions that are given for maintenance every day rather than routine maintenance.

Different types of equipments used in maintenance:

TOOLS REQUIRED DURING MAINTENANCE		
S.No	**Name of the tool**	**Use**
1	Beater cum pickaxe	To pack ballast under sleeper
2	Rail guage	To verify the distance between inner faces of rails i.e. gauge
3	Cant board	To verify cant
4	Spanner	To tighten or loose fish-bolts
5	Powrah	To handle the ballast
6	Jim crow	To bend the rails
7	Auger	To drill holes for the spikes
8	Chisel	To cut rails, bolts, etc.
9	Lifting jacks	To lift the track
10	Rail tongs	To lift the rails.
11	Ballast screens	To screen the ballast
12	Sleeper tangs	To lift sleepers

(ii) Advantages of welded rails:

a) It increases the life of rails due to decrease in wear of ends.
b) It results in decrease in maintenance cost to the extent of about 25%.
c) It results in comfort of passengers due to smooth working of the track.
d) The creep is considerably reduced.
e) For track circuited and electrified tracks, the welding of rails shows better results.
f) They are helpful for large bridges as rails of length equal to each span give better performance and reduce the effect of impact.
g) It decreases construction cost due to less number of rail joints.
h) The fast and heavy traffic may be permitted on track with long welded rails.
i) The rail coaches and wagons with reduced weights can be used on the welded track.
j) The pulling effort is reduced due to elimination of the loss of strain energy and impact energy at rail joints, hence it reduces fuel consumption.
k) The use of long welded rails affords more lateral, longitudinal and vertical stability to the track.

Methods of welding:

- **Electric arc welding**
- **Oxy-acetylene welding**
- **Chemical welding**
- **Flash-butt welding**

Oxy-acetylene welding:

In this process, intense heat is produced by means of oxy-acetylene flame. Site welding can be done, since it can be easily carried from one place to another. The cost of welding is high and this can be adopted for cutting of steel.

It is also known as gas pressure welding process and it is used widely due to various techno-economic considerations. In this process, the rail ends are heated by gas mixture. The temperature does not reach the fusion temperature of the rail ends either at the beginning or at the end of the welding process. The welding temperature

renders easy plastic flow where upon the application of pressure causes the welding surface to come into close contact and be joined with smooth upsetting.

It is mainly performed mechanically as a result of which, the weld strength is uniform and its reliability is high. In India, it was successfully used for rail welding on the Konkan Railway for its entire 760 km. The gas pressure welding plants can be either as a portable plant or as a movable plant.

6. Name the various methods of tunneling in hard and soft rocks. Describe one in each case. (R 2013)

Tunneling may be basically divided into two main groups.

(a) Tunneling in hard rocks

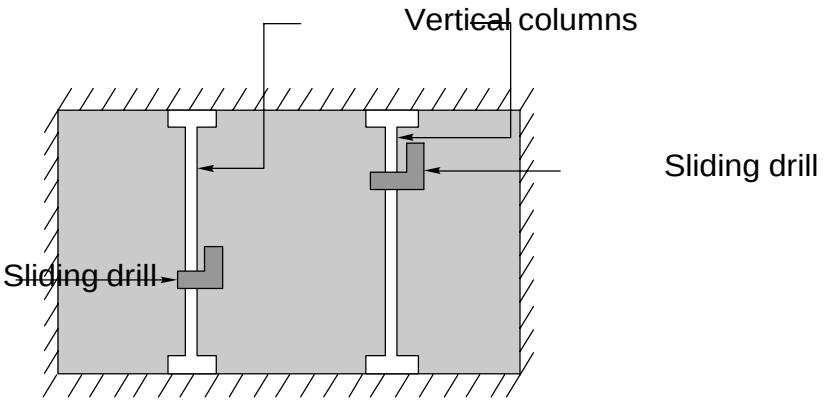
(b) Tunneling in soft rocks

Tunneling in Hard Rocks

- ✓ **Full face method**
- ✓ **Heading and bench method**
- ✓ **Drift method**
- ✓ **Pilot tunnel method**

Full face method

The full face method is normally selected for small tunnels whose dimensions do not exceed 3 m. In this method, the full face or the entire facade of the tunnel is tackled at the same time. Vertical columns are erected at the face of the tunnel and a large number of drills mounted or fixed on these columns at a suitable height as shown in Fig. A series of holes measuring 10 mm to 40 mm in diameter with about 1200 mm centre-to-centre distance are then drilled into the rock, preferably in two rows. These holes are charged with explosives and ignited. Next the muck is removed before repeating the process of drilling holes.



Full face method

Advantages

(a) Since an entire section of the tunnel is tackled at one time, the method is completed expeditiously.

(b) Mucking tracks, which are tracks used for collecting muck, can be laid on the tunnel floor and extended as the work progresses.

(c) With the development of the 'jumbo' or drill carriage, this method can be used for larger tunnels too.

Disadvantages

(a) The method requires heavy mechanical equipment.

(b) It is not very suitable for unstable rocks.

(c) It can normally be adopted for small tunnels only.

Tunneling in Soft Ground or Soft Rock

Tunneling in soft ground or soft rock is a specialized job. It does not involve the use of explosives and the requisite excavation work is done using hard tools such as pickaxes and shovels. In recent times, compressed air has also been used for this purpose. During excavation, the rail requires support at the sidewalls and the roofs depending upon the type of soil. The support could be provided in the form of timber or steel plates or other similar material. The various operations involved in soft rock tunneling are as follows:

(a) Excavation or mining

(b) Removal of excavated material

(c) Scaffolding and shuttering

(d) Lining of tunnel surface

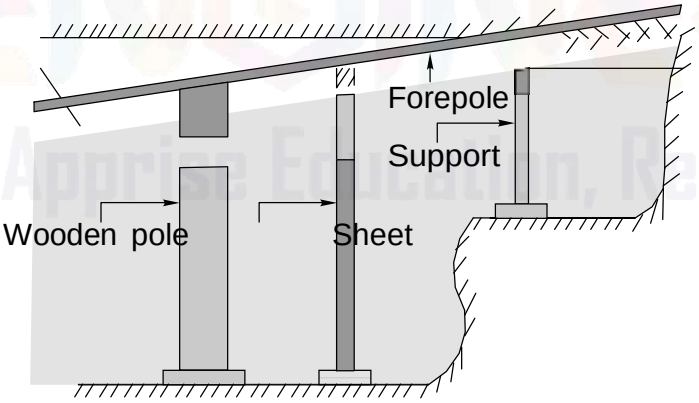
The nature of the ground is the most important factor in deciding the method to be used for tunneling.

The important methods of tunnelling in soft rock are:

- ✓ **Forepoling method**
- ✓ **Linear plate method**
- ✓ **Needle beam method**
- ✓ **American method**
- ✓ **English method**
- ✓ **Austrian method**
- ✓ **Belgian method**

FOREPOLING METHOD

Forepoling is an old method of tunnelling through soft ground. In this method, a frame is prepared in the shape of the letter A, placed near the face of the tunnel, and covered with suitable planks. Poles are then inserted at the top of the frame up to a viable depth. The excavation is carried out below these poles, which are supported by vertical posts. The excavation is carried out on the sides and the excavated portion is suitably supported by timber. The entire section of the tunnel is covered thus. The process is repeated as the work progresses.



Cross-sectional view

Forepoling method

Forepoling is a slow and tedious process and requires skilled manpower and strict supervision. The method has to be meticulously repeated in sequence and there is no short cut for the same.

7. Explain about Track Drainage, and how Surface and Sub surface Water Can be removed From Railway track. Give all in Details. (AUC NOV/DEC 2011)

Definition

Drainage of a track, Station Yards and platforms are the three places Where Drainage arrangements are needed. Track Drainage Comprises of Interception, Collection and disposal of from the track. This is done by adopting proper Surface and Subsurface Drainage System.

Types of track Drainage

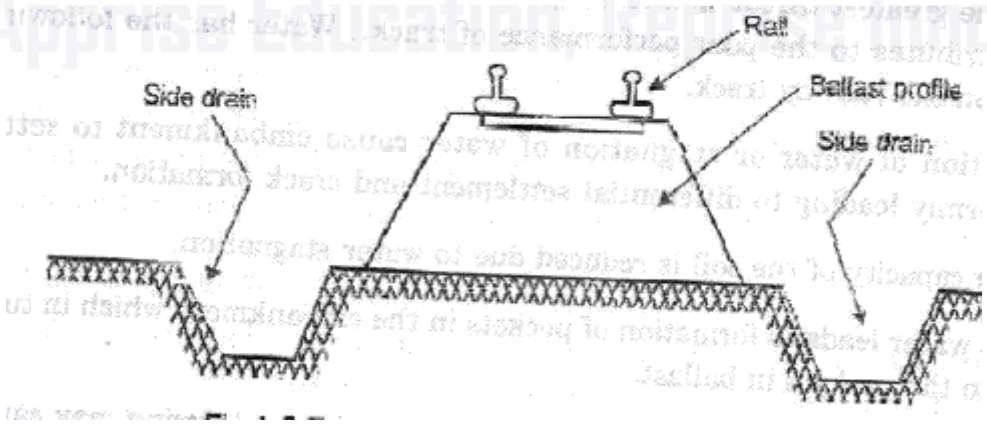
Surface Drainage

Surface Water due to rain or Snow or Flow From Adjacent areas have to be Disposed of Through Surface Drainage. Surface Drainage has to be attended to in three locations. Drainage in mid- Section Between railway Stations.

1.Drainage in mid-section
2.Drainage in Station Yards
3.Drainage at Station Platforms

1.Drainage in mid-section

A typical arrangement of cross Section of a mid-section. Side Drains may be unlined or lined. At a level Crossing all water should flow to the side Drains. In cutting catch water Drains Have Been Provided Wherever Necessary. All Extra Ballast on the Side Should be Recovered Which Encourage Growth of the vegetation.



2.Drainage in Station Yards

Open Surface Drains-Shaped Drains, Longitudinal Drains and Open Drainage are Provided to Free Station Yard From Water.

A typical surface drainage system with open Drains for a Station Yard .Every Station Yard is Provided with a network of Cross and Longitudinal Drains.

In Station Yard the vulnerable points are water columns and carriage watering points with washing Hydrants.

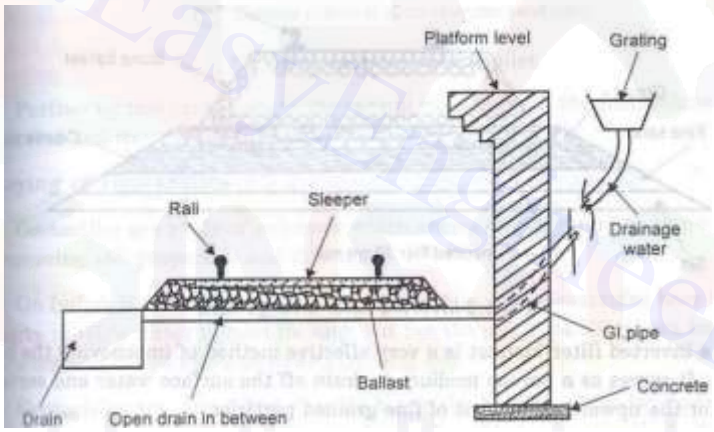
3. Drainage at Station Platforms

For Drainage of Station Platforms the following Points Should be Taken into account 1.Slopes away From the track

2. Discharge on non-Track Side
3. Discharge not towards Ruin-through lines

In general all end of platforms should be sloped away From the Track. all other Discharges Form tea Stalls, Toilets, Water taps. If there is need be covered longitudinal Drains Should Be Provided

In case of island platforms, all Drains Should discharge on the less important side of the track



2.Sub-Surface Drainage

Sub-surface water is due to the capillary water. Other sources are seepage from adjacent areas percolation of rain water. The sub grade and the formation are immediately affected by the Sub-Surface irrigation.

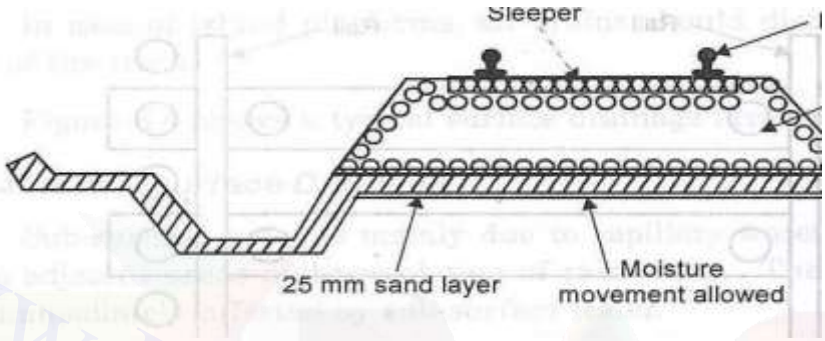
1. **Provision of an inverted fillers**
2. **Sand piling**
3. **Laying of Geotextiles**
4. **Other Methods**

1. Provision of an inverted fillers

An inverted fillers blanked of adequate thickness is provided between the ballast

and the week formation. The Blanket is of non-Cohesive material with enough bearing capacity to sustain the load.

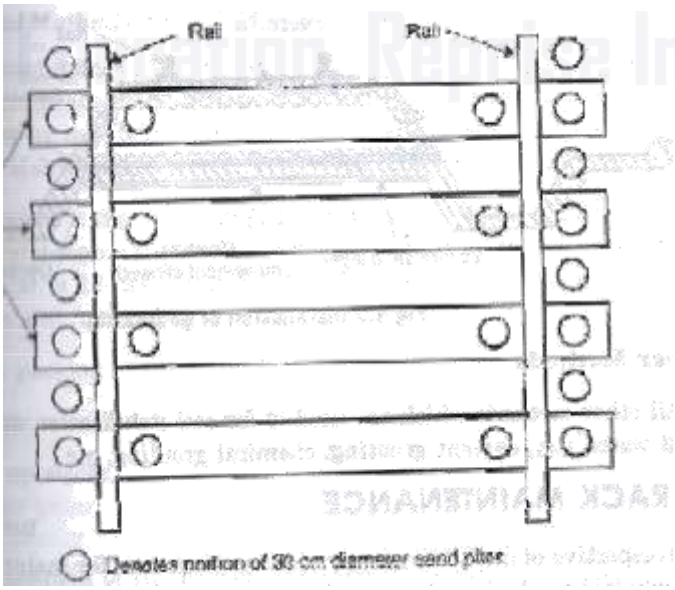
The inverted fillers Blanket is a very effective method of improving the bearing capacity. It serves as a porous medium to drain to drain off the Surface Water and Serves as a barriers for the upward movement of fine Grained particles



2. Sand piling

Sand filling is an effective technique . A series of 30cm diameter vertical holes are drilled inside and outside the rail to a depth of 2-3m. the holes are filling with clean sand and the surface is resurfaced. The area covered by the Sand piles Should be About 20% of the formation area. Sand piles provide a mechanical support and the Drainage of the Sub grade improves.

Further by the arrangement of the Subsoil rises through the sand column And get evaporated.



3. Laying of Geotextiles

Geotextiles are made of polymers which are Extensively as a new Technique in improving the Soil Properties and Drainage.

On Indian railways Geotextiles are Extensively used. Geotextiles are having the unique property to allow water to pass through but not the soil fines. They not only Work as separate and filters But also as reinforcement bed.

Geotextiles are either laid directly below the ballast or sandwich between a 50mm layer of sand on top and a 25mm layer so sand below so that the ballast directly does not rest on Geotextiles .and thereby preventing tear and puncture of textiles .

4. Other Methods

All other methods Which are used to for Soil Stabilization may be used to arrest Sub-Soil water. Cement Grouting , Chemical Grouting.

UNIT III – AIRPORT PLANNING

PART - A

1. **What is wind rose diagram? (May /June2011)**

   The diagram showing direction, duration and intensity of wind over a certain period in a specified region is known as wind rose diagram.

2. **Write the difference between cross wind component and wind coverage (May /June2011)**

   Cross wind component: The normal component of the wind ($V \cos \theta$) with a velocity V and direction making an angle θ with the centre line of runway is called as cross wind component.

   Wind coverage: The percentage of time in a year during which the cross wind component remains within the limits is called the wind coverage.

3. **What is the difference between runway and apron? (May /June2011)**

   Runway: Runway is a long and narrow rectangular strip which is constructed with adequate structural strength for landing and takeoff of aircrafts at an airport.

   Apron: Apron is the area provided on land so as to accommodate aircraft for purposes of loading and unloading passenger, mail or cargo, fuelling parking, maintenance etc.

4. **What is transitional surface in airport design? (May /June2011)**

   Transitional surface lies along the side of the strip and part of the side of the approach surface. It slopes upwards and outwards in the inner horizontal surface.

5. **State the importance of airport drainage (Nov/Dec 2012)**

   (i) Improper surface drainage leads to ponding and making way for hazardous movement of aircrafts on runways, taxiways, aprons etc.

   (ii) Improper sub-surface drainage may weaken the subgrade and thus reduce the load bearing capacity of the soil resulting in distress to pavements.

   (iii) Good drainage arrangements increases the efficiency of all the pavements.

   (iv) Good drainage increases the efficiency of the airport by providing all weather service.

   (v) Good drainage reduces the maintenance cost of an airport.

6. **What is wind rose diagram? (May /June2011)**

The graphical representation of wind data comprising of direction, duration and intensity is called wind rose

7. **What are the factors influencing runway length? (Nov/ Dec 2013)**

(i) Aircraft's landing is normal.

(ii) Aircraft after starting a takeoff completes the takeoff safely.

(iii) Aircraft after starting a takeoff is brought safely to a stop, if there happens to be an engine failure.

8. **State the primary functions of an airport drainage system.(Nov/ Dec 2013)**

The following are the functions:

(i) Removal of surface water from the pavements.

(ii) Lowering of the sub-surface water level in the airport area so as to be within permissible limits.

(iii) Intercepting and diverting the surface and sub-surface water flow originating from lands adjacent to the airport area.

9. **What is an airport master plan? State the steps in its formulation.**

Master plan of an airport is the one wherein the concept of ultimate development of the airport is made by a planner. It is made both for the expansion of an existing airport and a new airport. The following are the steps

(i) Preplanning

(ii) Achieving goals.

10. **What is clear zone? (Nov/ Dec 2014)**

Clear zone is the inner most portion of an approach area which is the most critical area. It is generally recommended to procure adequate land for effective implementation of zoning laws. It is achieved by clearing all the obstructions excluding minor obstructions such as fences, ditches etc.

11. **What are the factors affecting runway design? (May /June2015)**

Following are the factors affecting runway design

(i) Cross wind component

(ii) Wind coverage

(iii) Calm period

PART B

1. Discuss in detail the factors affecting the choice of selection of site for an airport. (Apr / May 2011, May / June 2012)

Introduction

Site selection is a very crucial in airport planning. A few alternate sites identified in the designated region are evaluated against set criteria and the best among them is chosen. Cost of construction, cost of maintenance, efficiency and safety of airports depend upon sites. Therefore, sites for airports are selected with very great consideration. Federal aviation agency (FAA) and international civil aviation organization (ICAO) have stipulated norms for various parameters. The following are some criteria elements.

(i) Regional plan
(ii) Types of airports
(iii) Ground accessibility
(iv) Topography
(v) Soilcharacteristics
(vi) Meteorological factors
    (a) Wind
    (b) Frost and fog
    (c) Temperature
(vii) Noise nuisance
(viii) On-site and off-site infrastructures
(ix) Shape and dimensions of site
(x) Future development

2. Regional plan

(i) ICAO stipulations

A region is a larger area consisting of cities, town and villages. A regional plan aims at balanced development within the region. The regional plan, gives a bird's eye view of all natural and manmade features. The ICAO has stipulated a minimum distance of separation between airports. Scrutiny of the regional plan shows shadow sub –

regions from transport point of view. This helps to narrow down location of proposed airport at macro level.

(ii) Significance of regional plan in airport planning

Under significance landing system, aircraft are brought to ground with the help of radio beam facilities. The operator of an aircraft manipulates control instruments as directed by radio beams. If two airports are close by, operations of electronic instruments and movement of aircraft may interfere. Therefore, a minimum separation as per ICAO standards is required.

(iii) Minimum spacing as per FAA

(a) Smaller airports under visibility Flight Rules(VFR) condition-3Km

(b) Bigger airports under VFR condition -6Km

(c) Airports operating piston engine aircrafts -25Km

(d) Airports operating jet engine aircrafts -160Km

The proposed site should satisfy standards for separation of airports.

3. Types of airports

The site suitability depends upon the type of proposed airports such as commercial- domestic international, or defense. In case of defensepurpose, it has certain special requirements such as providing natural cover from air raids. If the airports are located in combat zones, sites with thick bushes where aircrafts can be parked unnoticed, is preferred.

4. Ground accessibility

Location of a site should be such that it is easily accessible by different modes- rod, rail and water. This is very important because airline passengers are concerned about total time taken for journey between an origin and destination. It takes two and half hours to travel a distance of about 2000 km between Delhi and Chennai by air travel.

5. Topography

(i) Details: topography is details or a description of natural made features. It refers to natural features such as ground contours, water bodies, hillocks, forests, bushed, trees and man-made features such as pattern of land use, intensity and height oh buildings.

(ii) Advantages of elevated sites:

(a) Less obstruction in approach and turning zones.

(b) Natural drainage

(c) Uniform wind intensity

(d) Better visibility

Tall buildings in the proximity of a site and uses, which generate wastes and consequently attract birds, are objectionable. Therefore a site, which is better from topographical point of view, should be preferred.

6. Soil characteristics

Sub grade soil supports runway and other structures o an airports. A site with better soil characteristics is preferable because it reduces cost of grading , drainage, construction and maintenance. Soil containing reasonable composition of pervious materials like gravel or sand with a suitable natural binder is considered desirable. A site with expansive soil like clay is considered unsuitable.

Desirable principal properties of soil as a runway material are stability, strength and minimum change in volume and stability under adverse conditions. Grain size distribution liquid limit and plasticity index are some index properties based on which soil is classified and identified. Cost of development of a site can be advantageously reduced by selecting a site with favorable soil characteristics.

7. Metrological factors

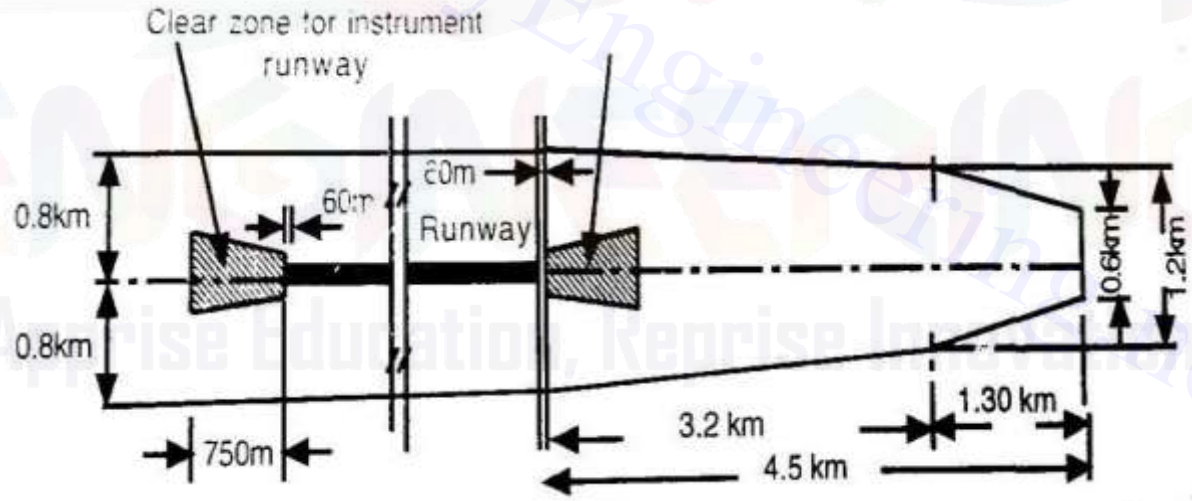
Metrology is the science of atmosphere and its phenomenon. It is concerned with direction, duration and intensity of prevailing wind, forest, fog, and temperature. Air transport is highly susceptible to meteorological factors. Therefore any proposed site should be carefully evaluated against wind, forest, and fog.

(i) Wind: Orientation of runways and efficiency of airports greatly depend up on the direction , duration and intensity/velocity of the prevailing wind . runway is oriented in the prevailing wind direction. Landing and takeoff operations take place in head wind. During both operation air craft's heads into the wind .therefore wind data greatly influence the site selection.in turn the desired orientation of the run way determines the suitability of the site. Wind data on direction, duration and intensity are collected at least or 10 years or available sites and the one which has favorable wind is chosen.

(ii) Forest and fog: Visibility of sites may be greatly affected by forest and fog. Any site selected should therefore be free from fog, forest, and smoke. Fog generally settles in area like a valley where wind blow is less. Smoke exists at sites nearer to industrial areas. Therefore a site located on the leeward direction should be preferred than that on windward direction. Trend of future development of industries should also be studied and sites should be chosen accordingly.

(iii) Temperature: Temperature influences runway length. Increase in temperature results in decrease in air density. Therefore, sites with standard temperature are preferred.

8. Noise nuisance: Type and pattern developments in surrounding area play a very crucial role in selection of sites for airports. Proximity of airports to areas of human habitation, residential areas and institutional areas such as schools, hospitals should be avoided. Intensity of noise nuisance depends upon climb-out paths of aircrafts, types of engines propulsion and gross weights of aircrafts.



Buffer zone for noise nitigation

9. **Scope for future expansion:** Area of a site selected for location of an airport should be more than that stipulated by ICAO. It should be adequate not only to meet present demand but also future requirements like runways, aprons, terminal buildings etc.

2. What is an airport master plan? Briefly describe the steps in it formulation. (Nov / Dec 2014)

1. Introduction

Airport planning refers to preparation of a scheme beforehand for development of airports. Requirements of an airport are to ensure safe and speedy transport of air travel passengers. It has to facilitate reception and departure of aircrafts with least possible delays.

(i) Important objectives of airport planning:

(a) Justify the need for an airport

(b) Formulated a layout plan for the airport and design of runways, taxi ways and airport buildings.

(c) Prepare cost estimation and

(d) Propose institutional arrangements.

(ii) Components of airport planning: Airport planning has following components.

(a) Assessment of traffic potential.

(b) Site selection

(c) Design and drawing of airport components.

(d) Cost estimation

(e) Evaluation of economic viability, engineering feasibility and environment impact.

(f) Financial resources.

(g) Institutional arrangement.

(iii) Good airfield layout characteristics:

(a) Landing. Take off and taxing – independent operations.

(b) Shortest taxiway.

(c) Safe runway length

(d) Safe approaches.

(e) Excellent control tower visibility.

(f) Adequate loading apron space.

(g) Comprehensive terminal building facilities.

(h) Land area for future expansion.

(i) Cost effective construction, maintenance and operation.

2. Socio-economic characteristics of catchment areas

(i) Assessment of traffic potential

Assessment of traffic potential for a proposed airport in terms of passenger and cargos is a crucial element in establishing the need for an airport. The first step in assessment of traffic potential is to delineate catchment area of the proposed airport in the national network of airports. After demarcation of imaginary influence area, socio-economic characteristics of the population are studied.

The following aspects reflect the socio-economic characteristics.

(ii) Population

a. Total population.

b. Rate of growth of population.

c. Estimation of future population.

(iii) Economic characteristics

a. pattern of employment – industries , business , government , private, others.

b. income group –composition of families under high income group and middle income group.

c. average per capita income of persons in income groups of HIG and MIG.

d. pattern of expenditure – proportion of expenditure for different items and more particularly for travel.

(iv) travel- characteristics

a. frequency of air travel.

b. modal choice.

Socio-economic characteristics of the region are compared with that of other comparable regions, where airports are already in existence. From the comparative analysis, annual passenger volume and expected cargo volume are assessed.

3. Site selection for airports

Site selection is a critical element in airport planning. Efficiency, safety and capacity of airports to a greater extent depend on suitability of sites. Therefore, site analysis for alternate sites is under taken and the best among them is chosen.

Parameters for site selection include physical and economic characteristics of sites and on-site and off-site facilities available.

4. Factor influencing size of an airport

(i) Type of airport i.e, domestic or international, or defense. Size of an airport depends upon whether it is an international or domestic one.

(ii) Traffic potential of an airport region.

(iii) Aircraft characteristics such as aircraft capacity, aircraft speed, minimum circling radius, minimum turning radius, noise level, and take off and landing distances

(iv) Site characteristics such as topography and land availability.

5. Design and drawing of airport components

Airport planning involves the preparation of following plans.

(i) Topographical plan.

(ii) Layout plan.

(iii) Design of runway, taxiway, and buildings.

(iv) Vehicular circulation and parking area plan.

(i) Topographical plan: Topographical plan indicates all natural and manmade features on a site , besides boundaries of the site. Boundaries of cleared and graded area, contour lines and access roads are marked on the topographical plans. Width for which features are incorporated depends upon the type and size of the airport.

(ii) Layout plan: It is the process of laying out various elements is arranged. An airport lay-out plan shows the positioning of various components of an airport.

(a) airport landing area- approach zone.

(b) Airport terminal area - runway, taxiway, apron, airport building, vehicular parking

Area and airport road network.

(iii) Design of runway: following are the design elements of a runway.

(a) Runway orientation.

(b) Length of runway- basics and corrected runway lengths.

(c) Runway width

(d) Width and length of safety area.

(e) Transverse gradient.

(f) Longitudinal and effective gradient.

(g)Rate of change of longitudinal gradient.

(h) Site distance.

(i) Design of runway pavement.

Similar designs are carried out for taxiways.

(iv) Vehicular circulation and parking area: air travel passengers and visitors to airports normally use motorized personal transport such as cars and vans to arrive at or to leave airports. Therefore, road circulation and parking patterns are vital aspects in airport planning. Road circulation pattern in an airport should facilities easy and safe ingress and egress. Based on peak hour demand, parking duration and parking accumulation and basic vehicular parking pattern is designed.

6. Cost estimation

(i) Capital cost: Rough estimation is prepared for following constituents.

(a) Cost land acquisition and cost of land development.

(b) Formulation of design and drawing.

(c) Construction of terminal area and landing area.

(d) Cost of air traffic control devices.

(e) Cost of provision of visual aids.

(ii) Maintenance cost: Annual maintenance cost including repair and renovation for all components of airports of airports is realistically assessed and provided for.

7. Economic evaluation

Objective of economic evaluation is to assess worthiness of a project. The evaluation is done by analyzing costs and benefits both tangible and intangible. The project is evaluated against economic viability, engineering feasibility, environmental stability, social acceptability and spatial development. Economic costs and benefits include capital costs, and maintenance cost. Economic benefits are receipts through sale proceeds, and rental values.

8. Institutional arrangement

(i) Organizations: Institutional arrangement is concerned with organization for planning, design, execution, maintenance and mobilization of resources. The

organizational pattern depends on the type of airports and sector in which it is developed viz.; public or private.

(ii) Financial resources: 'Airport Finance' deals with various methods of generating funds for projects. Financial resources for airport projects are generated normally from governmental sector. However, with the introduction of B.O.T concepts, private sectors have also come forward to build new airports in the country. Capitalinvestment in road project is generally recovered from the road users in the form of direct and indirect taxations. The same logic may be applied for airport also.

3. (i) What are the different systems of aircraft parking? Explain the suitability of each system.

(ii) Draw a typical layout of an airport showing all the features on it. (Nov / Dec 2012)

(i) Introduction

The two major components of airport are

(i) Airport Landing Area (ii) Airport Terminal Area

Airport landing is the most critical of all operations. Therefore, airport-landing areas a crucial one. Landing area includes approach zone and clear zone. In these zones, airport zoning regulations are under effective enforcement. The terminal area includes, terminal and operational buildings, vehicle parking area and service hangars.

(a) Apron (d) Terminal building

(b) Hangars (e) Motor Vehicles parking

(c) Circulation pattern

Airport terminal is a focal point of an airport. It is always vibrant with activities.

The elements of an airport terminal area are:

Apron

It is a paved area for parking of aircrafts for embarkation and de-embarkation of passengers, loading and unloading of cargo and serving of aircrafts without interference to surface traffic aircrafts. Aprons in airports are synonymous with platforms in railway stations and quays and Jetties in harbours and ports. It is very close to terminal buildings and hangars. The size of aprons depends upon

(i) Type of airports

(ii) Numbers and type of aircrafts using airports and

(iii) Basic parking configurations of aircrafts.

Apron should be adequate to permit expeditious handling of airport traffic. Apron in subjected to higher stresses than a runway due to slow moving or stationary position of aircrafts. Aprons should be stronger enough to withstand intended traffic.

Airports can be grouped into different patterns adjacent to terminal buildings they are

(a) Frontal system

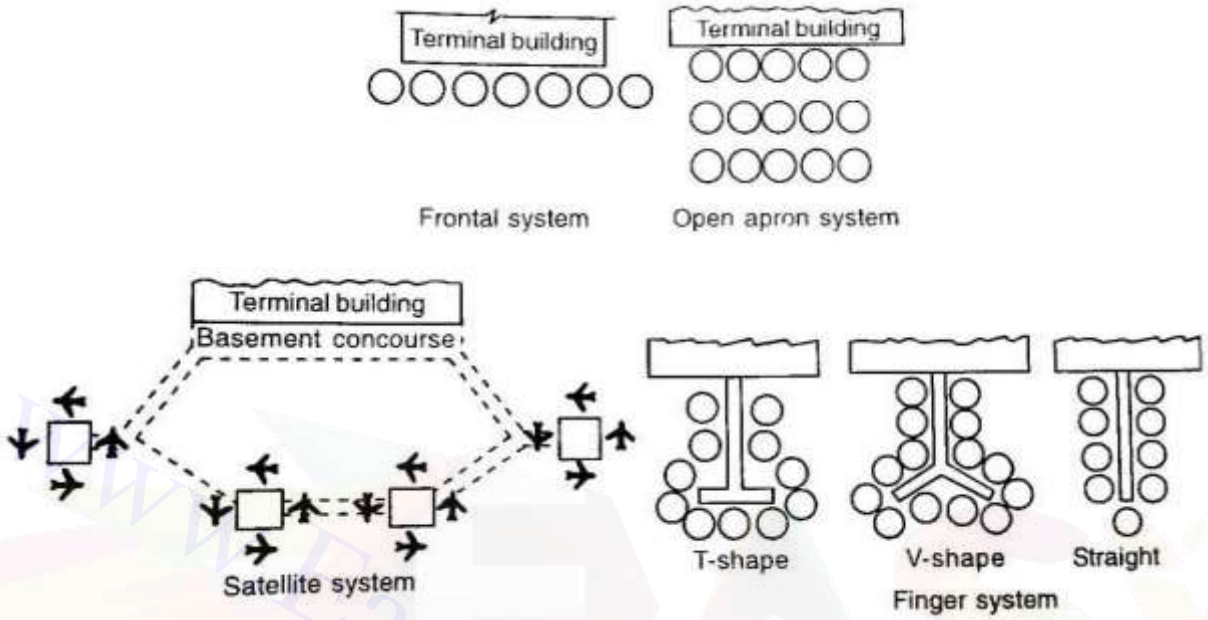
(b) Open Apron System

-→Finger system -→Satellite system

Merits and de-merits of each type of aircrafts parking.

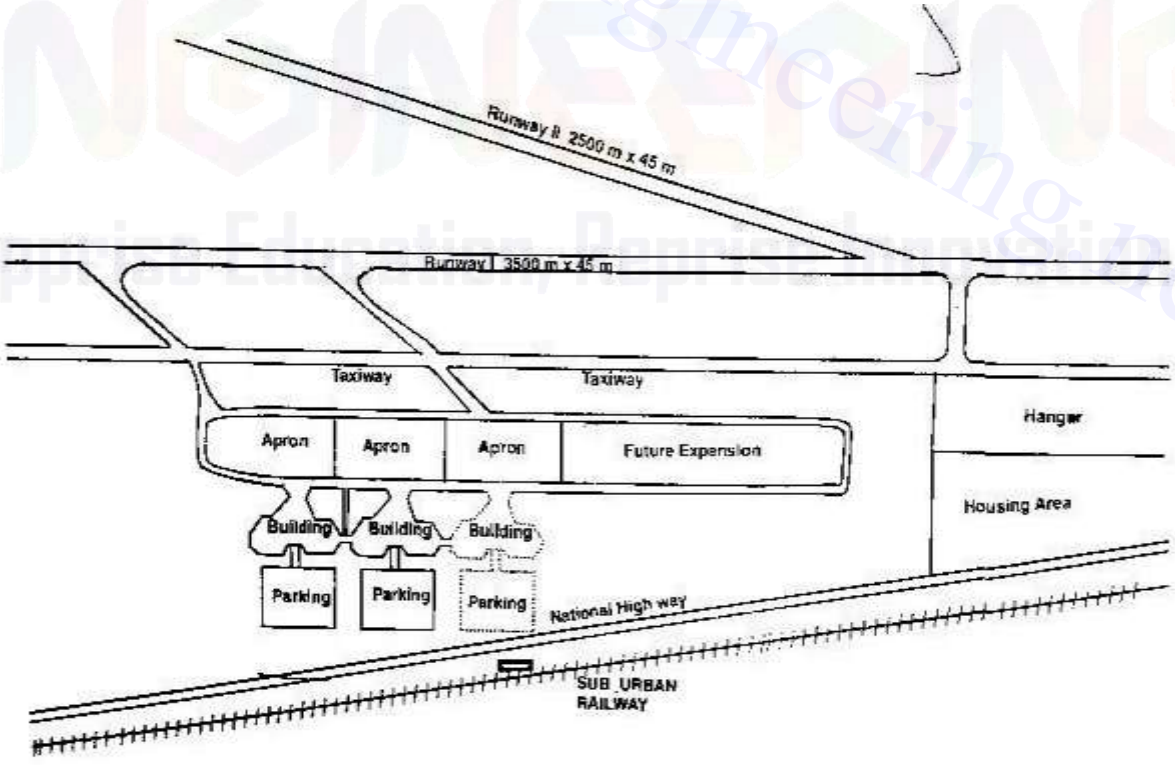
Sl.No	Type of parking	Description	Merits and de-merits
1.	Frontal system	Aircrafts are parked in front of airport buildings	Simple and economic. Suitable only for small airports
2.	Open apron system	Parked cob open apron, in rows	Area is un wiedly, Therefore, passengers may have to walk longer distances and are exposed to weather. It is very economic.
3.	Finger system	Aircrafts are parked about extensions of terminal buildings. The extensions are in shapes of fingers.	Provides protection to passengers Further, expansion is easier. Not Economic
4.	Satellite system	A small building is built on apron to park around. These buildings are satellites of main terminal buildings.	It is advantageous if satellite buildings are linked through under ground channel. However, it involves huge construction cost.

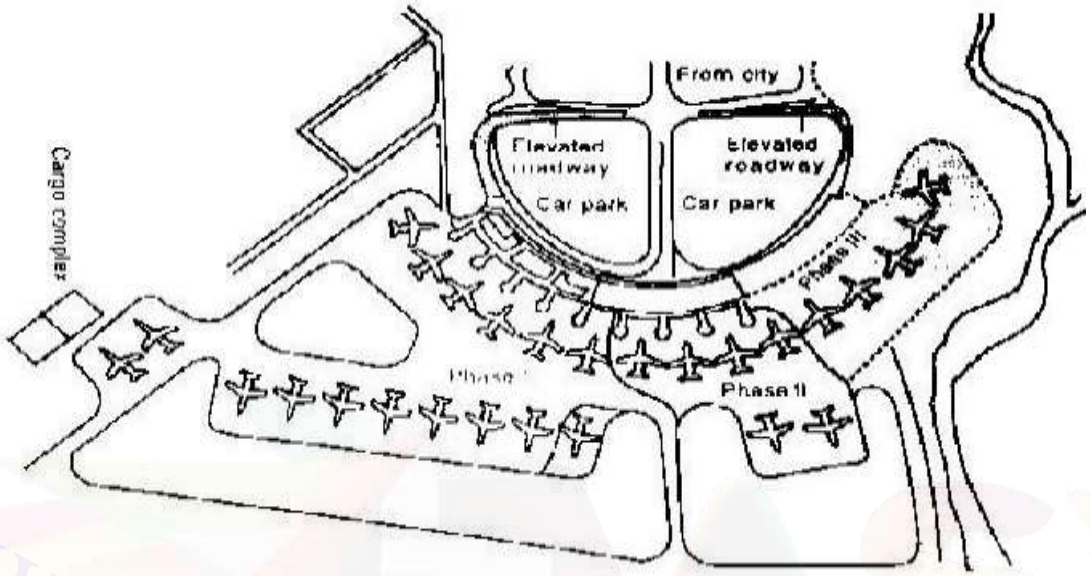
Fig. shows various patterns of aircraft parking system adjacent to terminal buildings. Table below indicates geometric design standards of aprons.



Pattern of parking of aircrafts

(ii) Layout of an International Airport





4. What are the different types of terminals? Explain its concept with neat sketchs (Nov / Dec 2013)

Introduction

The two major components of airport are

(iii) Airport Landing Area (ii) Airport Terminal Area

Terminal building

(i) Primary function of an airport building: Primary function of an airport building is to accommodate terminal and operational activities, control towers, weather bureau, and administrative block and passenger facilities. Location of building area with respect to runway and taxiway should provide adequate space for future expansion of all structures. Terminal buildings should be set back by 150m and 75m for instrumental and non instrumental airports respectively for all class of airports.

(ii) Planning concept of terminal buildings: Terminal buildings in commercial airports may be based on planning concept of centralization or decentralization.

Centralized : all passengers, baggages and cargos are formulated through a central building.

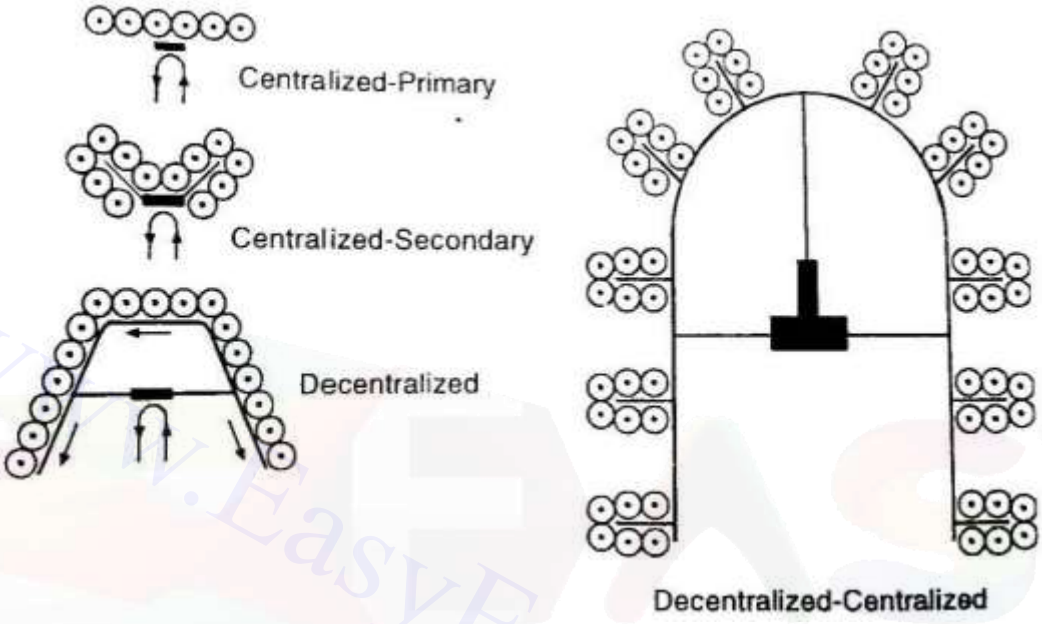
Decentralized: passengers and baggages arrive at a point near departing planes.

(iii) Principles of passenger flow:

(a) Passengers walking distance should not be more than 180m from the surface transportation to their boarding in an aircraft

(b) Maximum distance carrying baggage – 25m

(c) Maximum check-in time 3minutes.



Planning concept of terminal building

Passenger facilities and services:

General facilities provided at airports:

(a) Economic longues to sit comfortably

(b) Electronic lockers

(c) Prayer room

(d) Swimming facilities

(e) Television, children playground

(f) Departure and arrival hall

(g) Smoking rooms

(h) Inter-terminal transport

Services required at airports:

(a) Money changers

(b) Medical services

(c) Lost and found

(d) Shopping malls

(e) Supermarkets

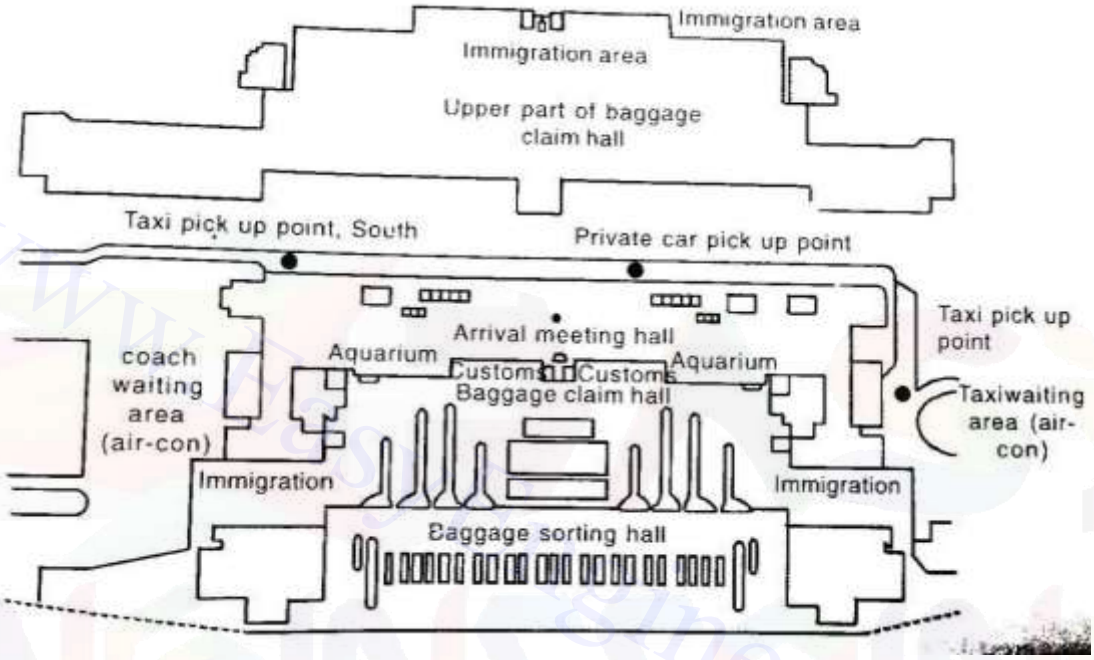
(f) Duty free zone

(g) Flight information enquiries counter

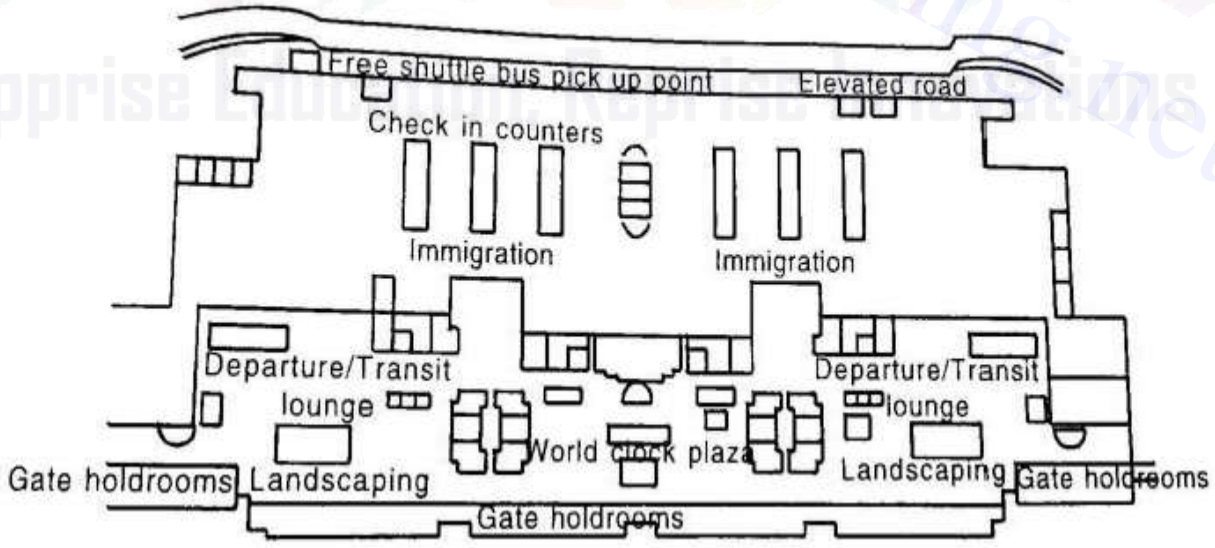
(h) Nursery for feeding and changing of devess for babies

(i) Bus service stand

(j) Hotel reservation counters

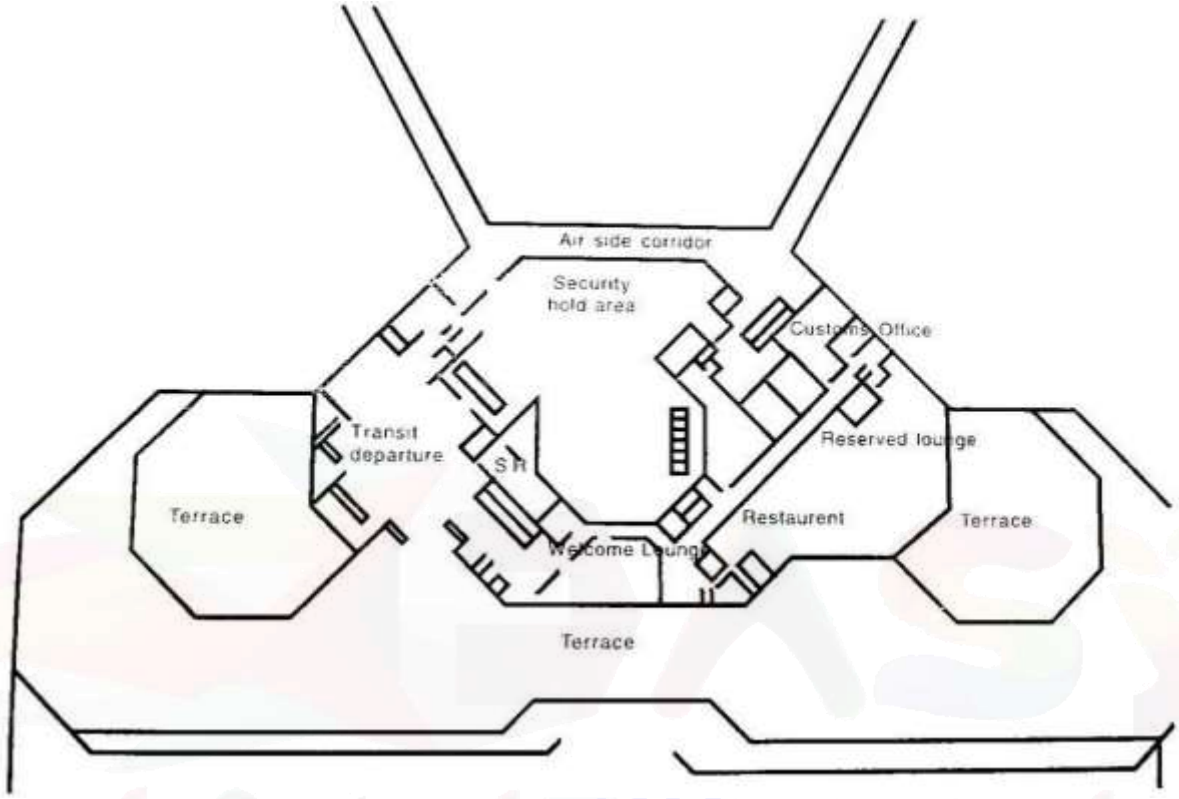


Arrival hall



Departure hall

International airport building and passenger facilities



Domestic Airport building and passenger facilities

5. List the different types of airports. Explain the ICAO classification of airports. (May / June 2012) (8 marks)

Types of Airports:

Airports may be classified differently based on the functions, usage, available facilities, and type of aircrafts intended to be used.

a) Based on functions

i. Conventional - for normal commercial aircraft

ii.ii. Heliports - for use of helicopters

iii. STOL ports - for short landing and take off

iv.iv. Seaplane bases or Aquaports - constructed on sea as a float

b) Based on usage

i. Public - used for public and owned by government

ii.i Private - used for private persons

ii. Military - used for military purposes

iv. Joint use - used for military and civil purposes

c) Based on facilities

i. General airport - provided with more number of runways and taxiways

ii.ii. Special facility airport - provide with navigational aids

d) Based on type of aircraft

i. Basic utility airports, BU - accommodates most single engine and light twin-engine aircraft (< 5670 kg)

ii. General utility airports, GU - accommodates additional medium twin-engine aircrafts

iii. Basic transport airports, BT - for to handle business jets under 27200 kg

iv. General transport airports, GT - for all types of aircrafts

International Civil Aviation Organization (ICAO)

The aims and objectives of ICAO are to develop the principles and techniques of international air navigation.

The main objectives of ICAO are:

ii. To regulate the order orderly growth of international civil aviation throughout the world.

i. To promote safety to flight in internal air navigation.

iii. To encourage the aircraft design and operation for peaceful purposes.

iv. To guide in the general development of all aspects of international civil aviation.

v. To avoid discrimination between contracting nations

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ICAO works in close coordination with other specialist institutions such as World Meteorological Organization (WMO), International Civil Airports Association (ICAA),etc

Airport Classification based on ICAO

Aircraft classification helps in the design of airport. It also provides adequate information to pilots in identifying the size and the services which the airport can provide.

ICAO has classified airports based on the factors like

i. Runway length, width and longitudinal grade

ii. Aircraft wheel load and tire pressure

ICAO classification based on runway length

Airport type	Basic runway length		Runway pavement width (m)	Maximum longitudinal grade (%)
	Maximum (m)	Minimum (m)		
A	-	2520	45	1.25
B	2520	2100	45	1.25
C	2100	1770	45	1.50
D	1770	1500	45	1.50
E	1500	1260	45	1.50
F	1260	1050	45	1.50
G	1050	900	45	1.50

ICAO classification based on Equivalent Single Wheel Load (ESWL) and tire pressure

Code no.	Single equivalent wheel load (kg)	Tire pressure (kg/cm^2)
1	45000	8.5
2	34000	7.0
3	27000	7.0
4	20000	7.0
5	13000	6.0
6	7000	5.0
7	2000	2.5

6. What are the basic patterns of runway configurations? Discuss each pattern. (May/June 2014)

(i) Pattern of runway configuration: Configuration of runway refers to shape or arrangement of runways. Runways may be grouped as inter-dependent or independent units. They may be parallel or intersecting. The pattern of runway in any depends upon volume of traffic in an airport.

(ii) Recommendation for International airport: Two intersecting runways at near threshold is recommended for international airports. Practical annual capacity of this pattern per unit runway is greater. Therefore, this pattern is suitable for international airports in metropolitan cities.

Basic pattern of runways

(i) Basic pattern of runways normally adopted are:

(a) Single runways

(b) Parallel runways

(c) Intersecting runways

(d) Non-intersections runways.

(ii) Minimum Distance between parallel runways:

(a) Non-instrument parallel runways for simultaneous use:

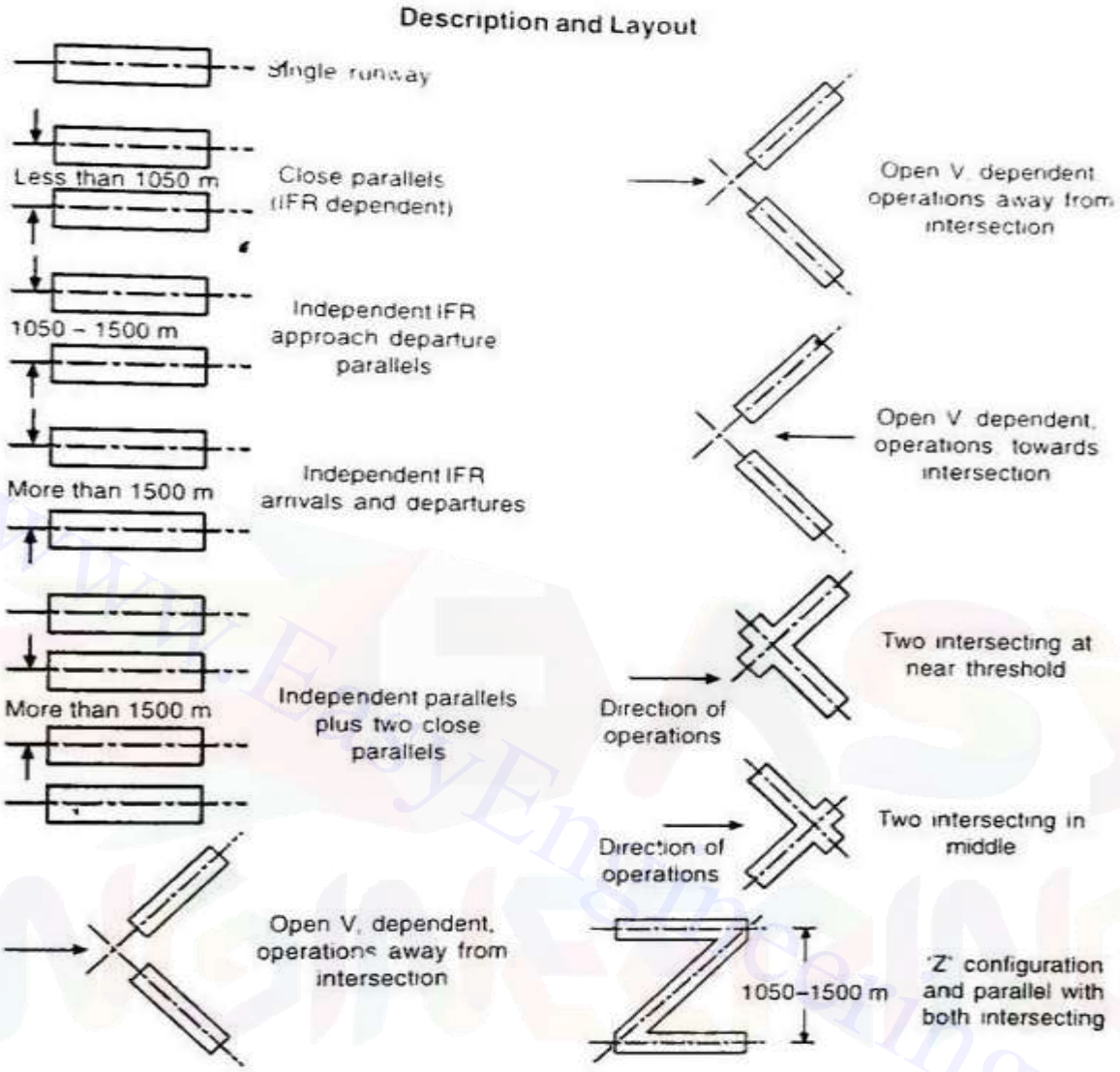
- 210m where the highest code number is 3 or 4;
- 150m where the highest code number is 2; and
- 120m where the highest code number is 1.

(b) Parallel instrument runways for simultaneous use:

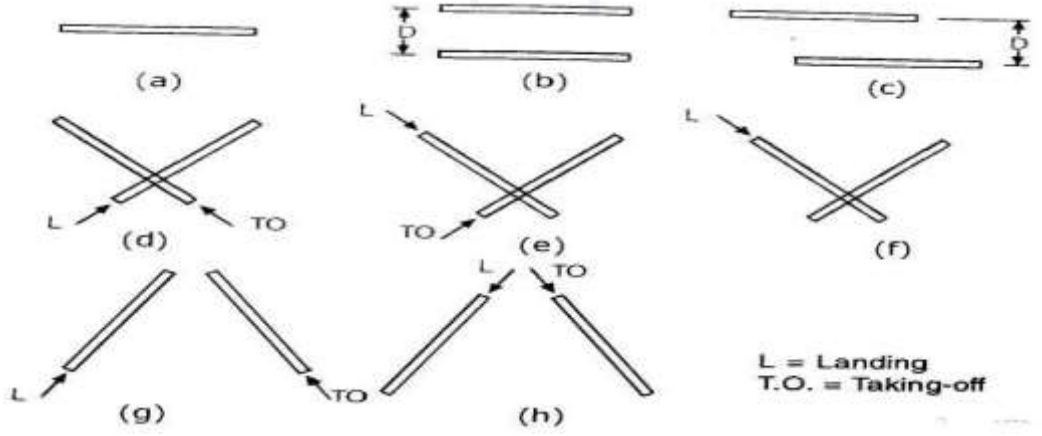
- 1035m for independent parallel approaches;
- 915m for dependent parallel approaches;
- 760m for independent parallel approaches;
- 760m for segregated parallel approaches;

(c) For segregated parallel operations

- May be decreased by 30m for each 150m so that the arrival runway is staggered toward arriving aircrafts, subject to a minimum of 300m; and
- Should be increased by 30m for each 150m so that arrival runway is staggered away from arriving aircrafts.



Runway configuration



Runway basic pattern

UNIT IV - AIRPORT DESIGN

PART A

1. How do you select the site for terminal building? (Apr / May 2011)

- It should be centrally located with respect to the runways.
- It should have convenient and easy access to the highway.
- The site should have easy facility of natural drainage.
- There should be adequate space available for the parking of the vehicles.

2. Define exit taxiway. (May / June 2012)

Exit taxiways are the taxiways which are provided to minimise the runway occupancy time by landing aircrafts.

3. What is a hangar? (May / June 2012)

The large shed erected at the airport for the purpose of housing, servicing, andrepairing of aircrafts is known as hangar.

4. Distinguish between 'holding apron' and 'blast pad'. (Nov / Dec 2012)

Aprons are located on the airside area of an airport which are accommodating aircrafts for one purpose or the other. Holding apron is provide at the end of a runway to allow an aircraft to stop temporarily when the runway is occupied by another aircraft.

Blast fences or blast pads are provided to deflect and dissipate the energy of the jet exhaust. Based on the type of protection needed, accordingly particular type of protection is used.

5. Define 'number of gate position' (Nov / Dec 2012)

Number of gate positions depend on

(i) The peak hourly aircraft movement

(ii) The occupancy time of each aircraft in a gate position.

The number of gate positions can be obtained from the relationship

No. of gate positions = {Capacity of runway / (60 x 2)} x average gate occupancy time

It is measured in units of movements per hour.

6. Define calm period. (May / June 2013)

Percentage of time in a year during which wind intensity is less than minimum intensity is termed as calm period. During calm period, intensity of wind is negligible and do not interfere with landing and take off operations.

7. Why is airport zoning important? (May / June 2013)

To own the entire flight approach areas and the turning areas to prevent undesirable growth of structures.

8. What is clear zone? (Nov / Dec 2014)

Clear zone is the innermost portion of an approach area which is the most critical area. Runway clear zone length varies from 300 to 750 m.

9. List the factors affecting the location of exit taxiway. (Nov / Dec 2011)

Factors affecting the locations of exit taxiway are:

- Air traffic control
- Number of exit taxiways
- Exit speed
- Types of aircrafts
- Weather conditions
- Topographical features
- Attitude of pilots
- Optimum locations of exit taxiway

10. What are the different types of aircraft parking systems? (May / June 2014)

Aircrafts can be grouped adjacent to the terminal building in a variety of ways. They are

- Frontal or Linear system
- Open apron or transporter system
- Finger or Pier system
- Satellite system

11. List the various types of marking on runway. (Nov / Dec 2014)

- Centre line marking
- Threshold marking
- End-strip marking
- Touch down or landing zone marking
- Runway numbering
- Parallel runway marking
- Runway Shoulder marking

12. What are the various airport zones? (Apr / May 2015)

- Approach zone
- Clear zone
- Turning zone

PART B

1. Explain the steps in determination of proper orientation for runway. (Apr/May 2011, May/June 2012, Nov/Dec 2012)

Orientation of runway: Orientation is positioning of runways. Orientation of a runway is usually along prevailing wind direction. This facilitates landing and takes off operations in 'head wind. In other words, landing and takeoff operations take place in directions opposite to the prevailing wind. When landing operations take place against wind direction, the head wind provides a braking effect to aircraft and they come to a stop in a smaller length of runway. Similarly, when aircrafts take off, the head wind provides greater lift on Wings of aircraft and enables it to rise above the ground within a shorter length of runway. Therefore, a runway is oriented in head winds.

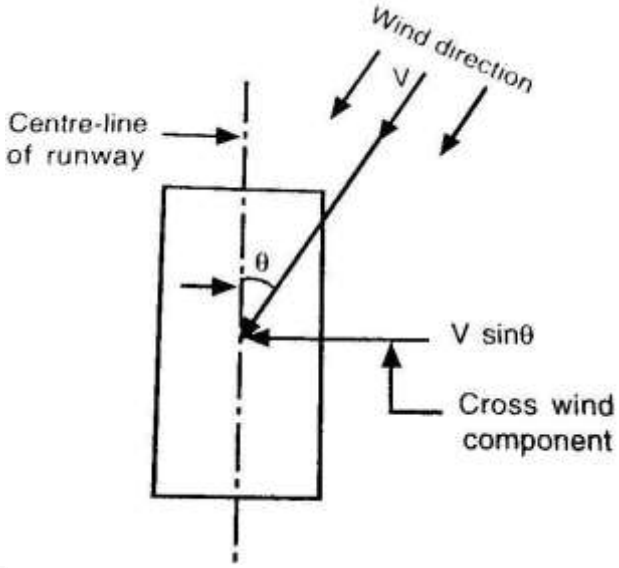
Wind data in terms of direction, duration and intensity for the selected site is collected for 5 to 10 years. These factors impact orientation of runways.

Cross wind component

Centre line of a runway is oriented along prevailing wind direction. However, it is not possible to obtain the direction of wind along the centre line of a runway throughout a year on some days of a year and few hours of a day, wind may blow making certain angle with a centre line of the runway. If an angle between the centre line of the runway and direction of wind is 0, the component along the direction of a runway is V cos &#65533;and the component normal to the runway is V sine &#65533;, where 'V' is the wind velocity. The normal component of the wind is termed as a cross wind component. The cross wind component is very dangerous and may interrupt safe landing and takeoff operations. As per ICAO, following are permissible cross wind components.

Permissible cross wind components

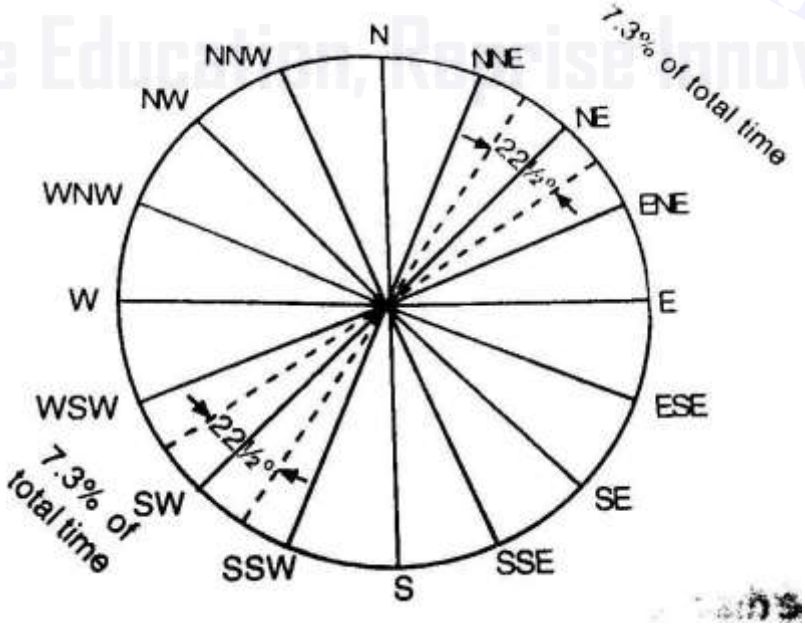
Airport/Aircraft Type	**Cross wind components (velocity)**	**Field length**
Small aircrafts	14-24 km/h	<1200m
Mixed traffic	25-37 km/h	1200 to 1500m
Big aircrafts	> 37 km/h	> 1500 m



Cross wind component

Wind coverage

Coverage is the percentage of time in a year during which, a cross wind component I remains within permissible limit. A runway can be safely operated only when the cross wind component is within permissible limits. For purpose of calculating coverage n assumption is made to the effect that a deviation in direction up to 6122.5^ + 11.25° degrees from directions of landing and takeoff is permissible. For example, if 'NS' s the best orientation, the coverage for orientation is obtained by summing up durations n the, directions of N NNE, NNW, S, SSE, and SSW. Below fig. shows wind directions aid their coverage.



Wind directions and coverage

Calm period

Percentage of time in a year during which wind intensity is less than minimum intensity is termed as calm period. It is assumed that during calm period, intensity of wind is negligible and do not interfere with landing and takeoff operations. Therefore, the calm period is added to the calculated wind coverage.

Wind rose diagram —Type I

(i)Determination of 'Orientation of Runway':

Past wind data for a selected site of an airport is collected for as many years as possible. Data should be collected at least for 5 years and preferably for 10 years. Average data is obtained with sufficient accuracy. Since wind data may vary considerably from site to site, observations should have been taken at or near a site selected as far as possible.

(ii) Direction and Duration:

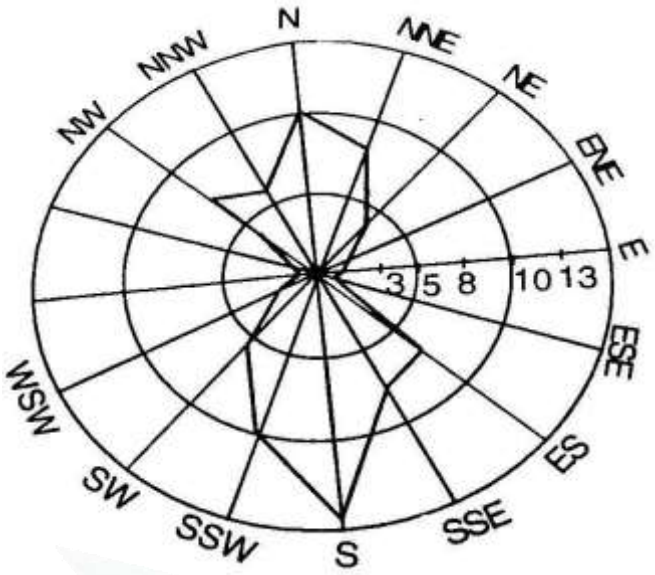
Radial lines indicate wind directions. Average wind data are obtained for 16 directions as indicated in above Fig. Each direction covers an angle of 223". It is assumed that wind may blow from any point within 22.5". Each circle in below fig. represents duration of wind.

(iii) Best orientation of the runway:

Values of durations from wind data are marked In respective directions. All plotted points are joined in straight lines as shown it Fig. The hest orientation of a runway is usually along the direction of the longes line in wind rose diagram.

(iv) Wind coverage:

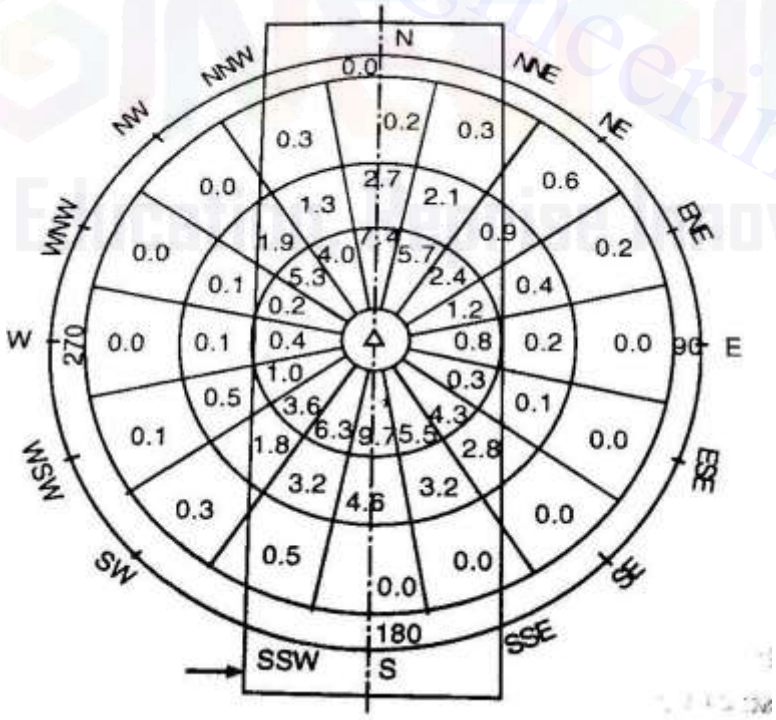
It is assumed that deviation of direction permissible is upto 33.7.5v (12 50 + 11.2.5). Percentage of time during which a runway can be used for landing and take off in this example is obtained by summing percentages of time along NNW. N. NNE. SSE.S and SSW. Fig. depicts the method to draw my wind rose diagram - type I.



Wind rose diagram – Type I

Wind rose diagram — Type II

Wind Rose diagram type II is illustrated in fig. Wind data used for type I is used for type ii also. Each circle represents wind intensity to scale. Radial lines indicate wind directions Value entered in each segment represent percentage of time in a year during which wind having a particular intensity blows from the respective direction.



Wind rose diagram – Type II

Procedure to determine the orientation

(1) Draw three parallel lines on a transparent paper at an equal distance apart. The distance between parallel lines is equal to permissible cross wind component. it is drawn to the-Mame scale with which the wind rose diagram is drawn. Cross wind component in the example is 25 km/ h.

(2) Place a transparent paper over the wind rose diagram in such a way that its centre lies over the central line of the Wind Rose diagram.

(3) With the centre of wind rose, rotate the tracing paper and place it in such a position that the sum of all values of duration of wind, bound by two outer parallel lines has a maximum value. Thus, the direction indicated by the central line is the orientation of the runway. Wind coverage is calculated by adding up all percentages of duration shown in segments. The percentage of duration is assumed to be equally distributed over the entire area of segment. If outer parallel lines of transparent strip cross a segment, proportional value is assessed and added.

Second runways

As per guidelines of the Federal Aviation Agency (FAA), runways handling mixed air traffic should be so planned that the coverage is more than 95%. In other words, the airports should be operational at least for 95% of the time in a year. For busy airports, the wind coverage may be increased up to 100%. However, this may be possible only by planning for second and more runways. Orientation of the second runway is the second longest direction in the wind rose diagram. While calculating additional coverage for the second runway, duration of any direction, already added for the first runway should not be added for second time.

2.What are the various corrections to be applied on to the runway length? Explain the amount of such corrections with a typical example. (Nov/Dec 2012)

The actual runway length to be provided should be adequate enough to meet the operational requirements of aircraft which are intended to use the runway. It should not be longest length required for the local conditions. The conditions to be considered are:

- ✓ Elevation (above mean sea level)
- ✓ Temperature
- ✓ Runway slope (gradient)

Corrections if any to meet the local conditions have to be incorporate in deciding the final length.

(a) Correction for elevation:

Air density decreases with increase in elevation. This in turn reduces lift on wings of aircrafts. Since longer runways are required. ICAO has recommended that basic runway length has to be increased by 7% for every 300 m rise in elevation above MSL.

(b) Correction for temperature:

Air reference temperature is the sum of monthly mean of average daily temperature for the hottest month of a year (T_a) and the monthly mean of maximum daily temperature (T_m) for same month of the year.

$$\text{Reference temperature} = (T_a) + \{ (T_m - T_a) / 3 \}$$

As per ICAO recommendations, the basic runway length has to be increased at a rate of one percent for every one degree rise of an airport reference temperature above standard atmospheric temperature at that elevation.

Standard temperature at the site can be determined by reducing the standard sea level temperature of the 15°C at the rate of 6.5°C per 1000 m rise in elevation.

(c) Correction for gradient:

Steeper gradients consume more energy of the aircraft. Because of this longer length of runway is required to attain the desired ground speed. No specific correction is recommended by ICAO.

But FAA recommends that after correction for elevation and temperature the length of runway should be further increased at the rate of 20% for every 1% of effective gradient.

Effective gradient is the difference in elevation between the highest and the lowest points of runway divided by the total length of runway before correcting for gradient.

(d) Combined correction for elevation and temperature:

Further ICAO recommends that if the total correction exceeds 35%, the required correction should be obtained after conducting a specific study at the site.

4. Briefly explain the Night – time aids provided at Airports. (Apr/May 2015)

Airport lighting:

Markings only help in good weather conditions. During bad weather conditions and during night time it is essential to provide adequate lighting in the airport. Such lightings should convey similar information's to the pilot during good visibility conditions as the markings do in any time.

All the airports need not to be provided with the same type and intensity of airport lighting. They depend on the following factors:

- Airport classification
- Traffic density
- Types of aircrafts using the airport
- Types of landing surfaces provided
- Types of night operations planned

In order to maintain uniformity to the pilots, the colour of lights and general arrangements are to be standardized. The elements which contribute for efficient airport lighting are:

i. Beacons
ii. Boundary lighting
iii. Approach lighting
iv. Threshold lighting
v. Runway lighting
vi. Taxiway lighting
vii. Apron and hangar lighting
viii. Lighting for wind and land direction indicators

Beacons:

Beacon is a high luminous beam of light which is used to demark any geographical location. It is positioned above the surrounding ground and rotated at a specific frequency. Rotating beacon provided at airports is rotated at six revolutions per minute. The beams are projected from the beacon in horizontal direction 180° apart. One beam emits a green light and another a clear light. It is usually mounted over the top of the terminal building or hangar.

Boundary Lights:

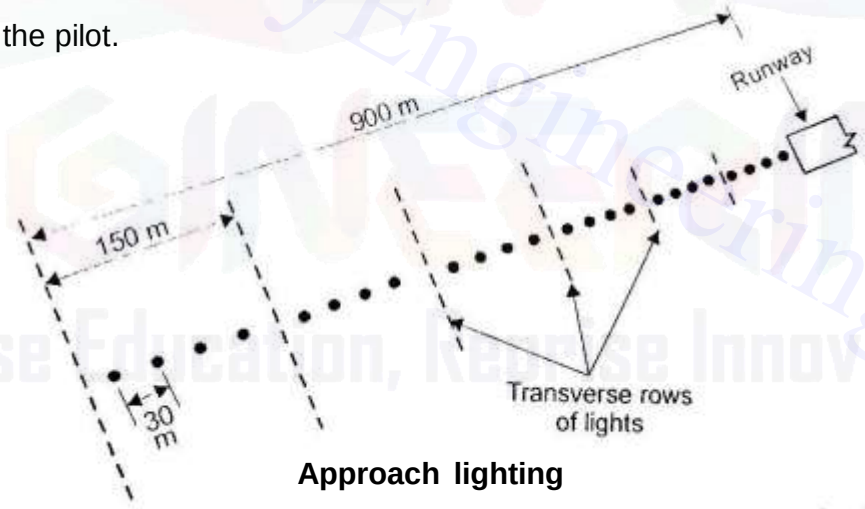
The periphery of the entire landing area is provided with lights at 90 m centre to centre with a height of about 75 m from the ground. In order to indicate the hazardous approach, the boundary lights a provided with the red marker lights.

Approach lighting:

For a pilot while approaching a runway for landing, the approach lights are the only elements of guidance. Actually before the starting point of runway, a sequence of high-intensity lighting arrangements for a length of 900m is provided.

This forms a basic guidance for the pilot to centre the aircraft centrally. These lights then give way to the touchdown zone lights from the threshold of the runway. The approach lights are normally mounted on pedestals keeping the heads of lights at equal elevation.

Calvert system of approach lighting is shown in below figure. It is widely used and standardized by ICAO. The transverse bays each 4.2 m wide and located at 30 m interval along the extended centre line of the runway. This arrangement gives suitable information to the pilot.



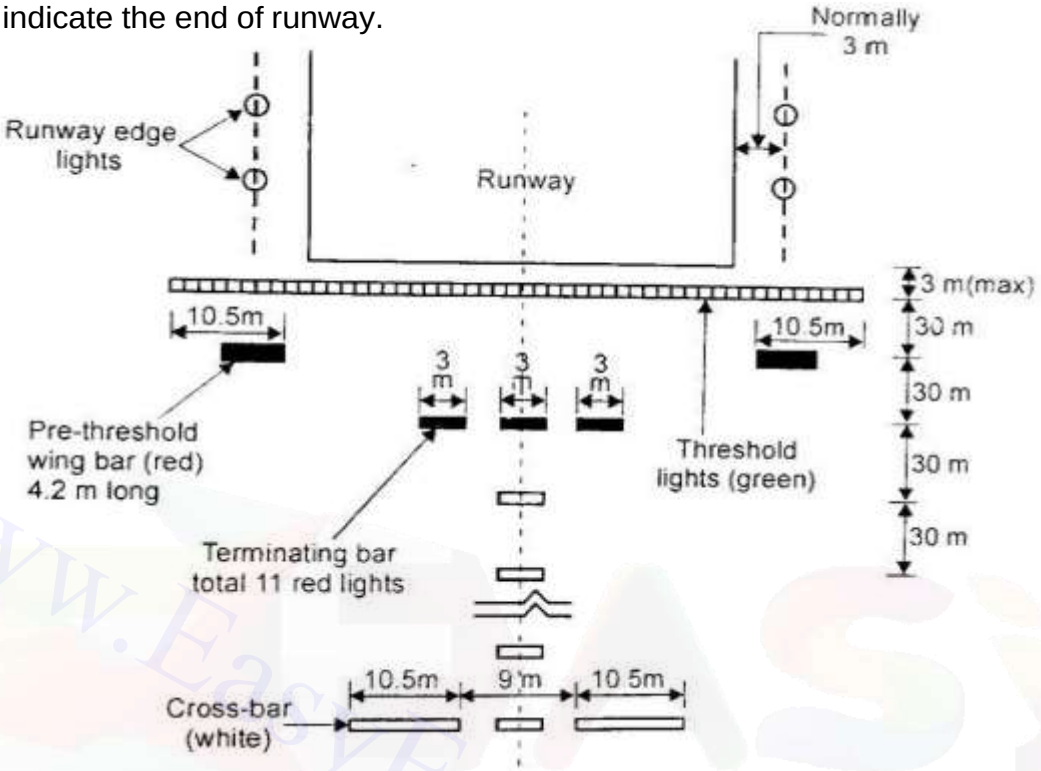
Approach lighting

Threshold lighting:

In order to decide about landing or not the identification of runway threshold in important for a pilot. For this reason, the area near the runway threshold is given special lighting arrangements. The end of approach lighting is denoted by terminal bar of red lights.

The threshold is lighted fully with a continuous line of green light extending the full width of runway. The lights may be semi-flush or elevated type.

The threshold lights in the direction of landing is green and red in the opposite direction to indicate the end of runway.



Threshold lighting

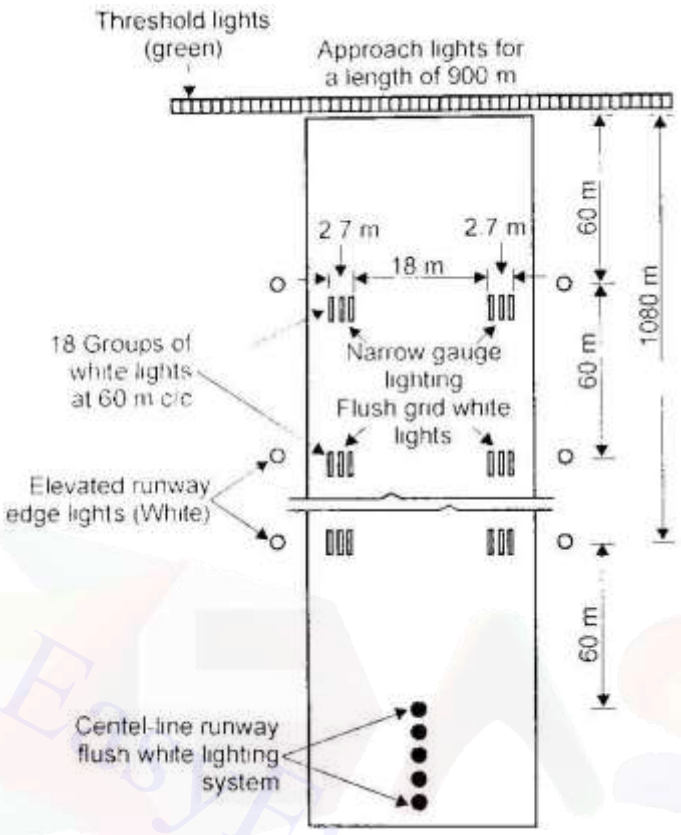
Runway lighting:

After crossing the threshold the pilot has to complete a touch down and then roll the aircraft on the runway. The runway lighting has to be so planned and arranged such that it provides sufficient guidelines to the pilot.

- Alignment
- Lateral displacement
- Roll
- Height of distance

Narrow-gauge pattern is used nowadays. This pattern makes use of the centre-line and touch-down zone lights for operations in very poor visibility.

The narrow gauge pattern forms a channel of light of 18 m width up to 1140 m from the threshold and beyond this distance. All the lights provided on the runway are white in colour and of flush type.



Runway lighting

Taxiway lighting:

Taxiway centre line lights:

(a)Location and application: These lights are provided on exit taxiways, taxiway intersection and apron. Primary purpose of this lighting is to provide continuous guidance from runway centre line to the point on apron where aircrafts commence maneuvering for parking. Centre line lights are provided only for taxiways intended for use during nights in runway visual range conditions of 350 m or greater. These lights are not to be provided on taxiways, where there is low volume of traffic.

(b)Characteristics: These shall be fixed lights on all taxiways except on exist taxiways and runways forming part of a standard taxi-routes. They show green with beam dimensions such that lights are visible only from aircrafts on or in the vicinity of a taxiway.

(c) Spacings for taxiway centre line lights

All straight sections: Normal spacing shall not be more than 30 m. However, for better meteorological conditions, spacing's shall not be more than 60 m.

On short straight sections < 30 m

On a taxiway intended for use in RVR conditions of less than value of 350 m } should not exceed 15m

Spacing on curves:

Light spacings in curves

Curve radius	Light spacing
Up to 400 m	7.5 m
401 m to 899 m	15.0 m
900 m or greater	30.0 m

Source IC AO standards

(ii) Taxiway centre line lights on rapid exit taxiways:

(a) Location: Should commence at a point at least 60 m before beginning of a taxiway centre line curve and continue beyond the end of a curve to a point on the centre line of the taxiway where aircrafts reach normal taxing speed.

(iii) Taxiway centre line lights on other exit taxiways:

Location: The lights should commence at a point where a taxiway centre line marking begins to curve from the runway centre line and followed a curved taxiway centre line marking at least to the point where the marking leaves the runway. Fig. shows taxiway lighting.

(iv) Taxiway centre line lights:

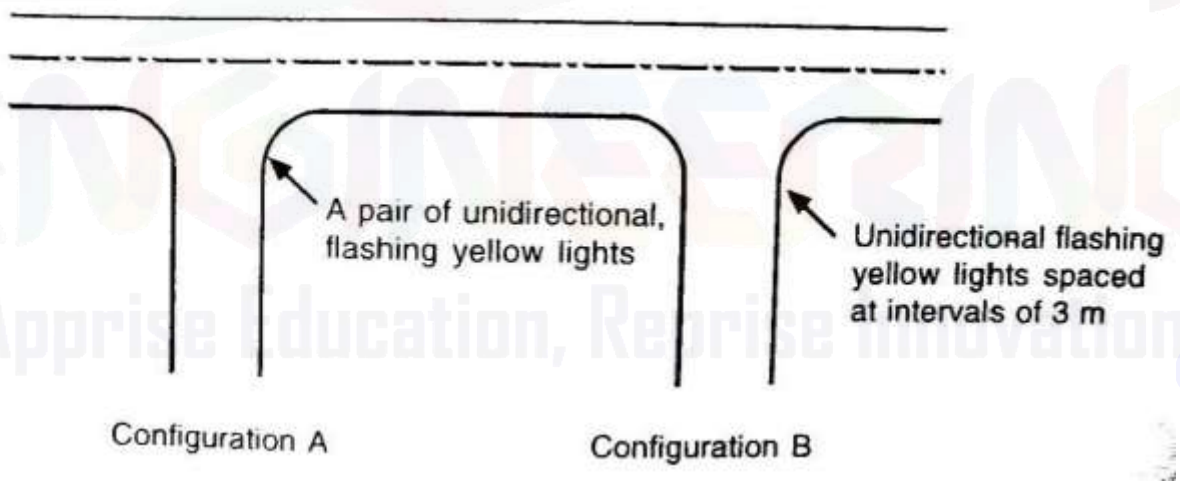
Longitudinal intervals on runways forming part of a standard taxi-route and intended for taxing in runway visual range conditions less than a value of 350 m are not to be more than 15 m. Fig. presents taxiway centre line lights on runways.

(v) Runway guard lights:

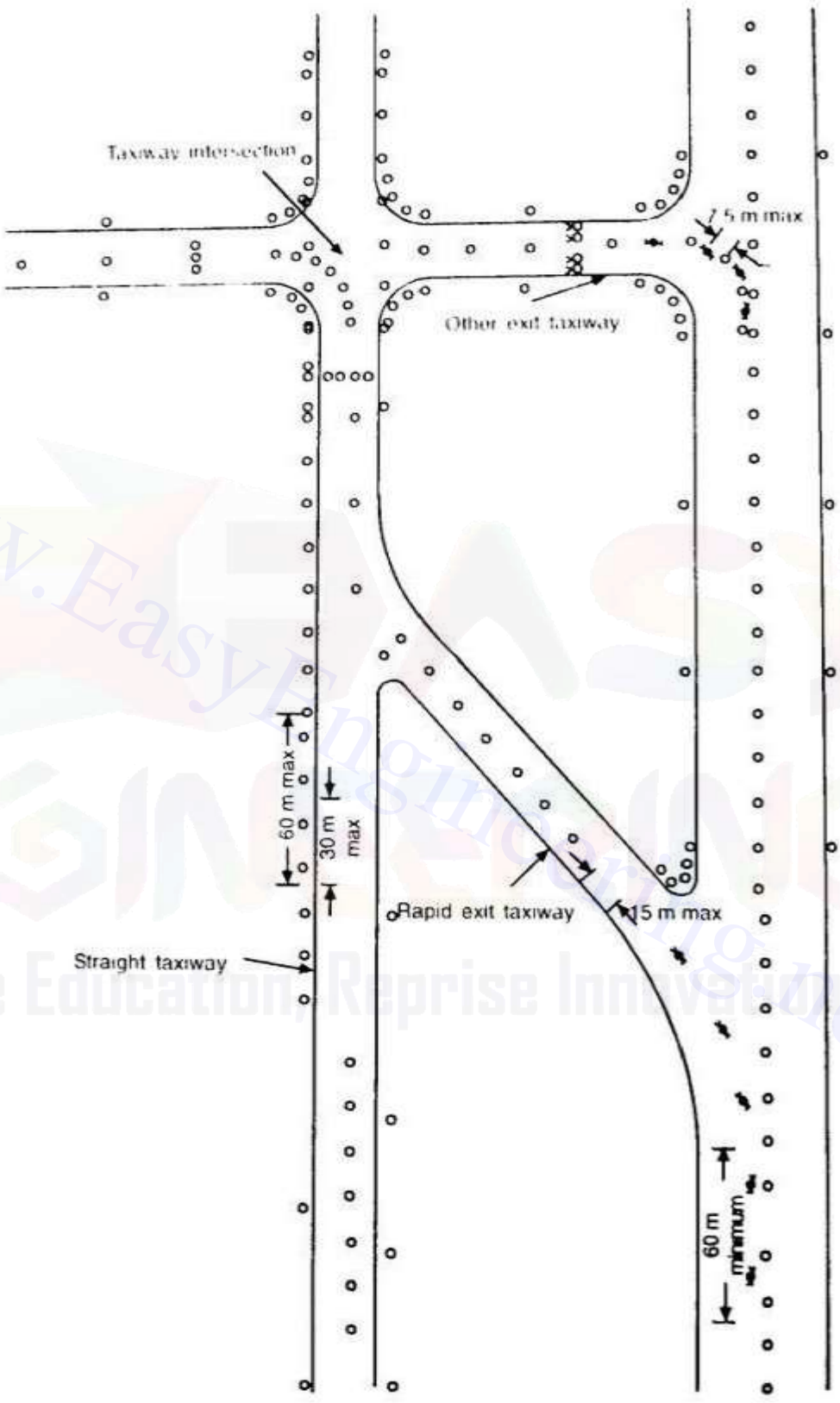
It is provided at each taxiway/runway intersection. Configuration A is associated with runways visual range conditions less than a value of 550 m where a stop bar is installed and runway visual range conditions of values between 550 m and 1200 m where traffic density is high. For configuration 'B', adjacent lights shall be alternately illuminated and alternate lights shall be illuminated in unison. Fig shows runway guard lights

Sign positions at taxiway/runway intersections

Signs are erected to convey mandatory instructions, and information on a specific location or destination on a movement area. Those located near runways/taxiways shall be sufficiently low to maintain clearance for propellers and engine parts.



Runway guard lights



Taxiway lighting

5. Explain with neat sketches, about the Airport markings. (Apr/May 2015)

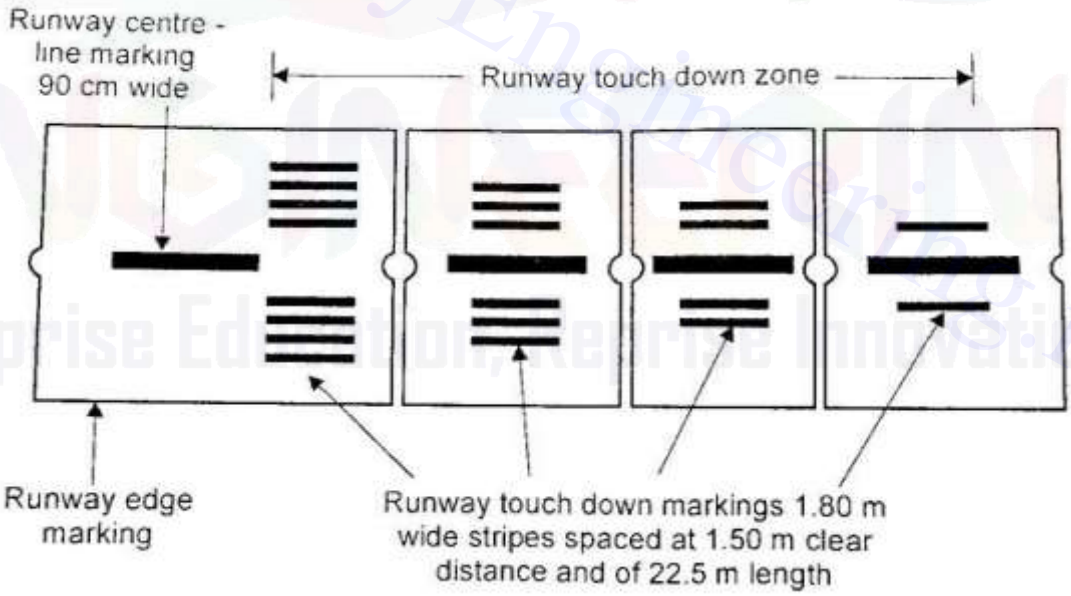
In order to identify and recognize various airport elements by a pilot certain markings are made on the airport area in a simple manner. By these arrangements the pilot should distinctly identify the landing area and the wind direction.

Runway markings: It consists of

- Runway centre-line marking
- Runway threshold marking
- Runway end-strip marking
- Runway touchdown or landing zone marking
- Runway numbering
- Parallel runway marking
- Runway shoulder marking

Runway centre-line marking

The centre-line of a runway is represented by a broken strip running along the full length of a runway. The width of marking is 90 cm.



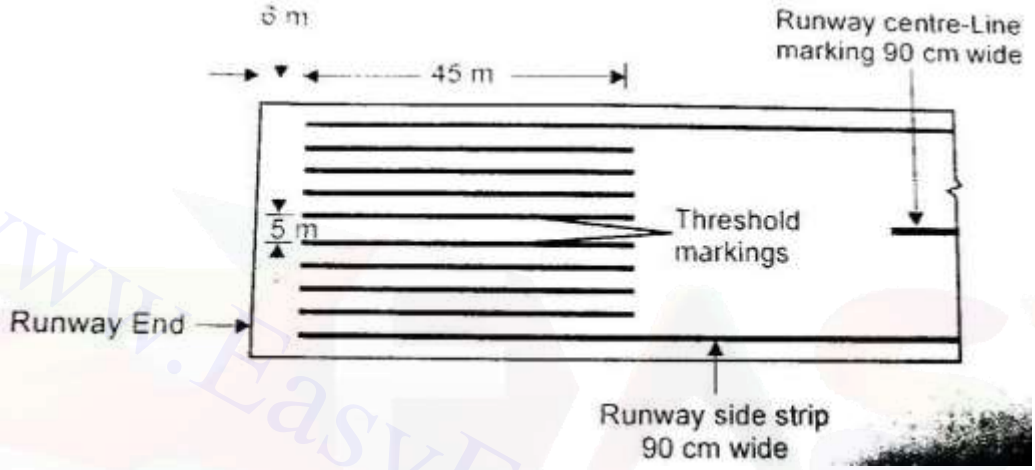
Runway markings

Runway threshold marking

It is indicated by a series of parallel lines commencing from a distance of 6 m from the runway end. The markings are in the form of stripes 3.60 m wide and with a

spacing of 0.90 m. The markings are placed symmetrically on either side of the runway centre-line.

A displaced threshold is one which is moved a certain distance from the end of a runway. In an airport with such a threshold the markings are made. Although such displacement reduces the length of the runway for landing, such arrangement is made to clear obstructions in the flight path.



Runway threshold marking

Runway End-strip marking

Edges of a runway are normally marked. In case of runways with width exceeding 45 m, the strip is made in the form of long continuous lines of 90 cm width marked near the edges.

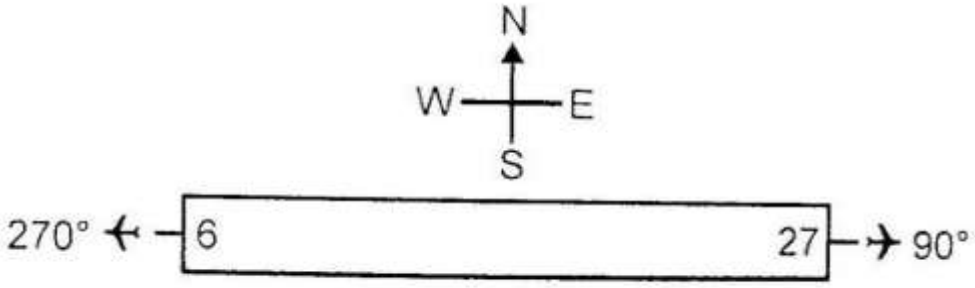
Runway Touch-down or Landing Zone

Runway touch-down markings identify the touch-down zone for landing operations. The coded markings are in white colour which provides distinct information.

Touch-down markings consist of group of one, two and three rectangular strips marked symmetrically about the centre line with their number decreasing gradually in the direction of landing.

Runway numbering

End of each runway is marked with a number indicating the magnetic azimuth. For example east-end of an east-west runway would be marked 27(for 270°) and the west end 9 (for 90°)



Runway numbering

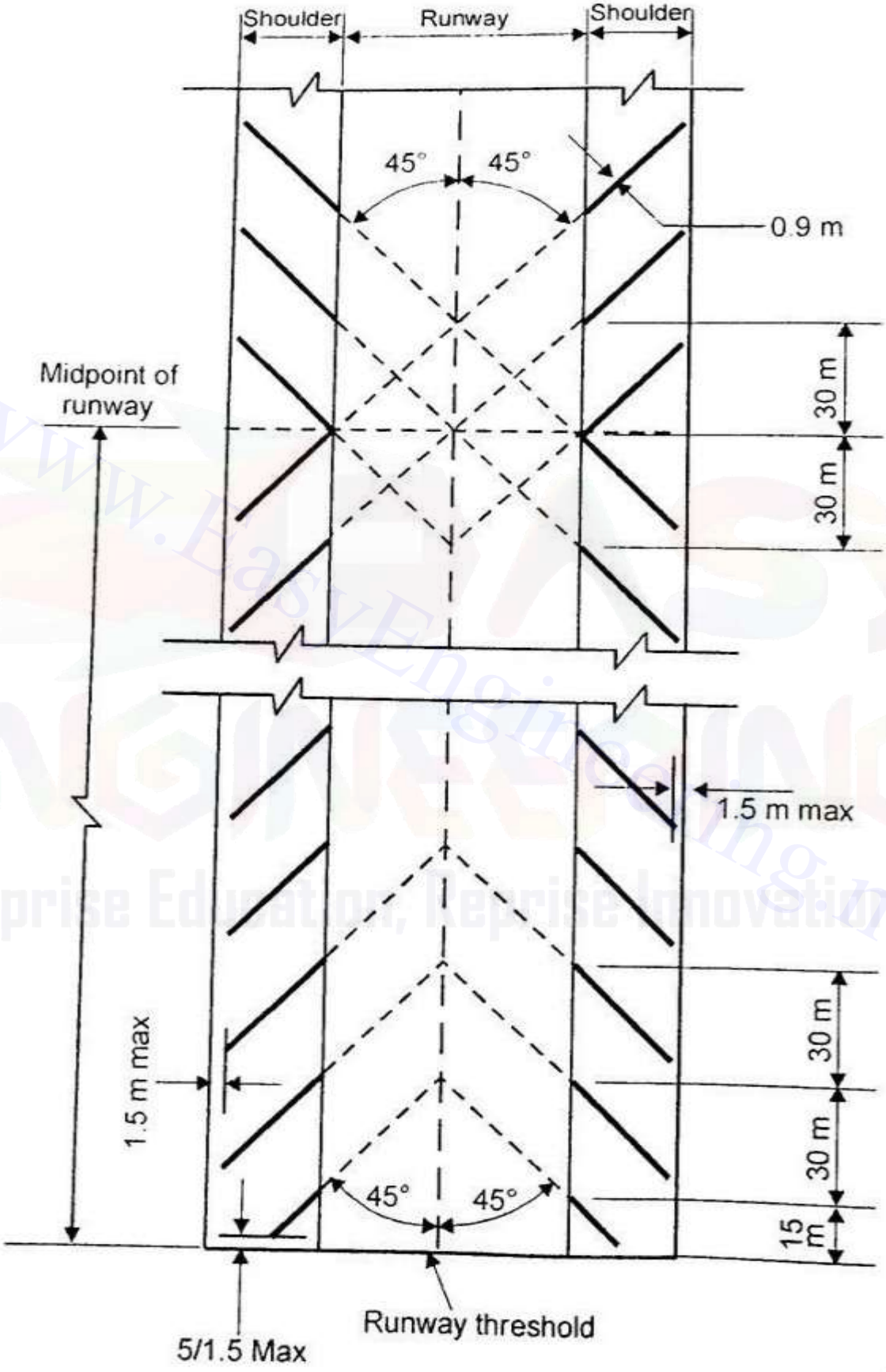
Runway shoulder marking

The shoulders on the edges of a runway and taxiway are paved. Although they appear structurally strong, they are not capable of withstanding the aircraft loads.

Runway shoulder markings are used as a supplement to runway side strips. Shoulder markings are generally needed to guide the pilots to identify the runway from the shoulder.

The colour of runway shoulder marking is yellow and is located between the runway side stripes and the pavement edge.

These markings consist of stripes of 1 m width and spaces 30 m apart. The stripes are marked slanted at an angle of 45° to the centre line and start at the runway mid-point.



Runway shoulder markings

Taxiway markings:

(i) Taxiway centre line marking:

(a)Location: It is marked on paved taxiways with code numbers 3 or 4. If a taxiway is straight, the marking should be located along taxiway centre line. If it is curved, the marking should continue from straight portion of the taxiway at a constant distance from outside edges of the curve. For taxiways with code Nos. 1 or 2, it is marked from centre line of the runway to the point on aprons, where aircraft stands. Purpose of markings is to provide guidance.

(b)Characteristics: Width - 15cm

Length -continuous,expect where it is intersects a taxi-holding position markings. This is shown in Fig

(ii) Taxiway-holding position marking:

(a) Application and Location: A taxi-holding position marking shall be displayed along taxi-holding position.

(b) Character: Taxi-holding positions having two patterns.

- A single taxi-holding position at an intersectional taxiway and precision approach category I, II or III of runway.
- Multi-taxi-holding positions at an intersection, of taxiways.

A single taxi-holding position is marked as indicated in pattern 'A' of Fig.8.42. In case of multiple taxi-holding positions, the one closer to the runway is marked at indicated in pattern A of the Fig. Other taxi-holding positions farther away from the runway are depicted in the pattern 'B' of Fig.

(iii) Taxiway intersection marking:

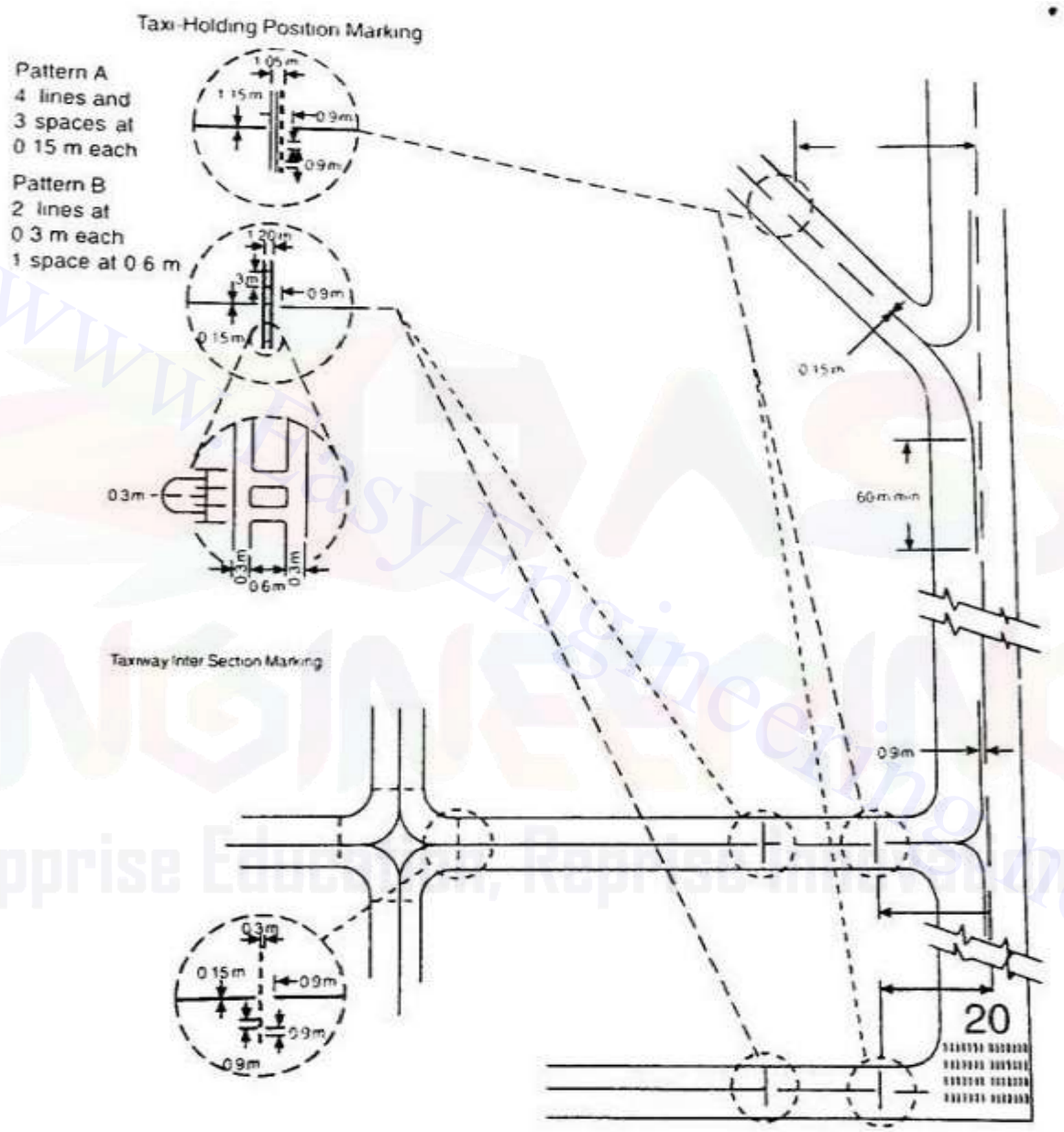
(a) Location and Application: It is marked at intersection of two paved taxiways. Markings located across a taxiway at sufficient distance from the near edge of a an intersecting taxiway. This is to ensure safe clearance between taxing aircrafts. It should coincide with a stop bar or clearance bar.

(b) Characteristics: It shall consist of single broken line.

Taxiway intersection marking:

(a) Location and application: it is marked at intersections of two paved taxiways. Markings are located across a taxiway at sufficient distance from the near edge of a intersecting taxiway.

(b) Characteristics: consists of single broken line. Illustrated in the following figure.



Taxi way marking

UNIT V – HARBOUR ENGINEERING

PART - A

1. Distinguish between quay and pier. (Apr / May 2011)

Quays are artificial structures where vessels can land. Normally quays are parallel to coast and they are made up of monolithic structures.

Piers are built out from a shore into sea where vessels are berthed either at the head or along side. They exit at sea side resorts for use of visitors and for landing and embarkation of passengers.

2. What is the necessity of docks? (Apr / May 2011)

In docks, repairing of vessels, cleaning and painting works at bottom are carried out. The docks and docking arrangements should be such as to expose ship's exterior fully and keep it out of water during progress of repairs or renovation.

3. What do you understand about 'littoral drift'? (Nov / Dec 2012)

As a result of wind effect the sand is carried in a zig zag form along the shore. Such process of movement and deposition is complex. Such sand driffing forming at the proximity of foreshores are called as littoral drift.

4. How will you orient the entrance of a harbour? (Nov / Dec 2012)

A harbour should be easily accessible which is based on the location. The entrance of the harbour should be so designed such that it is easily negotiable during storms. It also depends on factors like density of traffic, number of entrance available at a harbour, navigational requirements and the degree of protection.

5. What is a breakwater? Name its types. (Apr / May 2015)

Breakwater is a structure constructed to reflect and dissipate the force of wind-generated waves. The main function of a breakwater is to break the momentum of water by means of wave breakers.

Types of breakwaters are:

- Mound or heap breakwater

- Mound with superstructure breakwater
- Vertical wall breakwater

6. Differentiate between 'neap tide' and 'spring tide'. (May / Jun 2014)

At new moon or full moon or one or two days after, tides rise higher than the normal height and fall lower than the normal and these tides are known as spring tides.

One or two days after the moon in its quarter, the tides rise and fall less than that at other times and such tides are referred to as Neap tides.

The height of spring tides is generally 1.5 to 2 times as that of neap tides.

7. Distinguish between 'tides' and 'waves'. (Nov / Dec 2014)

The gravitational forces between earth and other celestial bodies like sun and which in turn cause periodical variations in the level of water surface is called as tides.

Waves are produced by joint action of wind and water. It has tremendous damaging power as the harbour barriers. The storm waves take place in the open sea due to the action of wind.

8. Why is dredging so essential in port operations? (Nov / Dec 2014)

Dredging has to be done periodically for the reasons below:

(i) During the construction of structure in a harbour complex, the wastes and other construction rubbish gets deposited in the bed. Thus to maintain design depth the excess material has to be removed.

(ii) The depth of water required has to be decided before finalizing a harbour site.

(iii) Waves and tides have a tendency depositing sand and silt which has to be removed periodically by dredging.

9. What are the types of harbour? (Apr / May 2015)

(i) Based on protection needed:

(a) Natural (b) Semi - Natural (c) Artifical

(ii) Based on the Utility:

(a) Harbour of refuge (b) Commercial (c) Fishery

(d) Military (e) Marina

(iii) Based on Location:

(a) Canal (b) Lake (c) River (d) Sea

10. How to decide the entrance of the harbour?(NOV / DEC 2012)

A harbour should be Easily accessible which is based on the location. The entrance of harbour should be designed Such that it is easily negotiate during the Storms. The entrance is generally placed of the sea such that the effect of rough sea is minimum.

PART B

1. Classify harbours on broad basis and on the basis of utility and explain them. (Apr/May 2011, May/June 2012)

Primary classification

Primarily, harbours can be classified under three categories

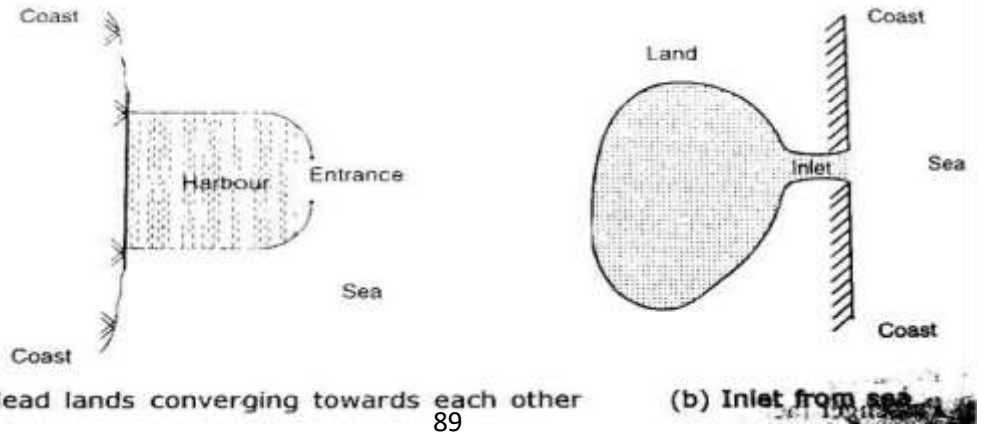
1. Natural or land locked harbours
2. Protected harbours
3. Artificial harbours

(i) Natural or land blocked harbours: Natural harbours are formed entirely by inlets from sea. They may also be constituted by headlands or projecting parts of a coast converging towards each other. They have narrow entrances laeding to a sheltered area of water. They may be of coral reefs, along coast line or a series of islands forming lagoons with gaps in coral reef. Natural harbours do not require protective or formative works. Ex. Sydney,Melbourne,Baltimore,Bombay,kandla.

The estuary of a large river may also form natural type of harbours. These may or may not be near sea. Some are as much as 50 – 70 km, inland. Entrance at the mouth of a river, if narrow, may require protection against heavy seas and shoaling by construction of break waters. Occasionally considerable amount of dredging and training works may be needed to keep main navigation channel navigable in all states of tides. Ex.newyork,London,Liverpool.

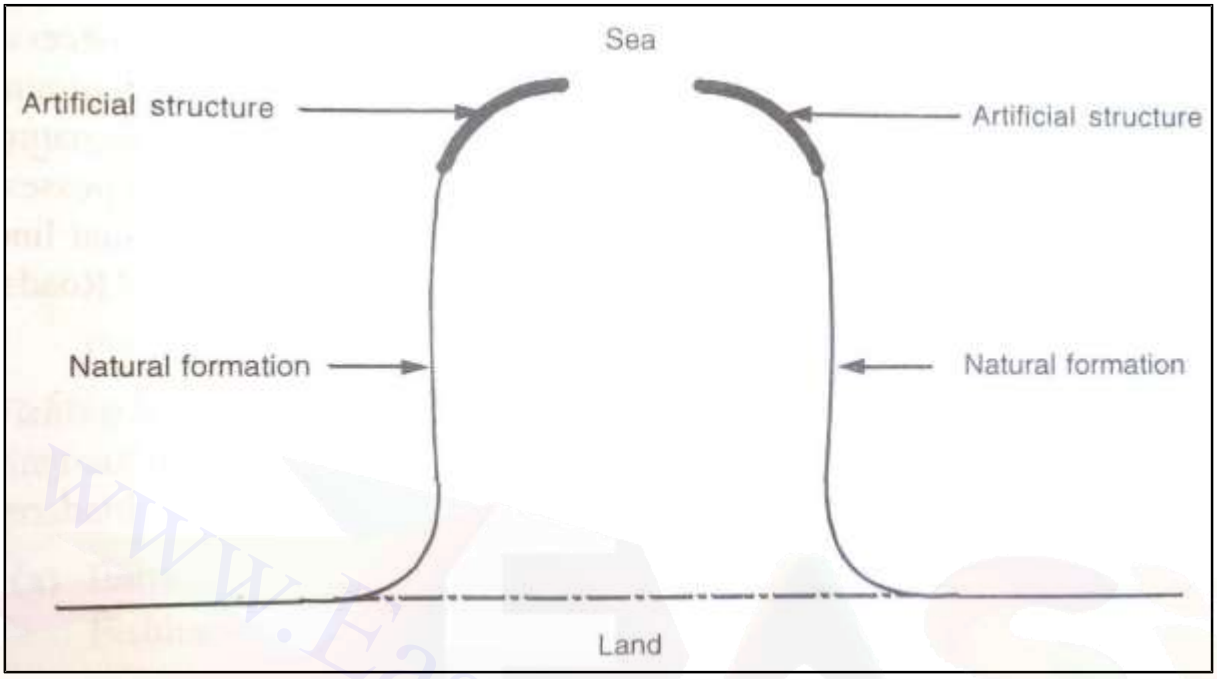
(ii) Protectedharbours: Protected harbours are partly natural and partly artificial. They are formed primarily in bays or such position in coast line. Artificial construction of break waters or entrance moles may supplement existing natural features. They give protection from wave action to vessels, using or entering harbours. Fig shows the concept of protected harbour

Typical example: Cape town, Vishakhapatnam.

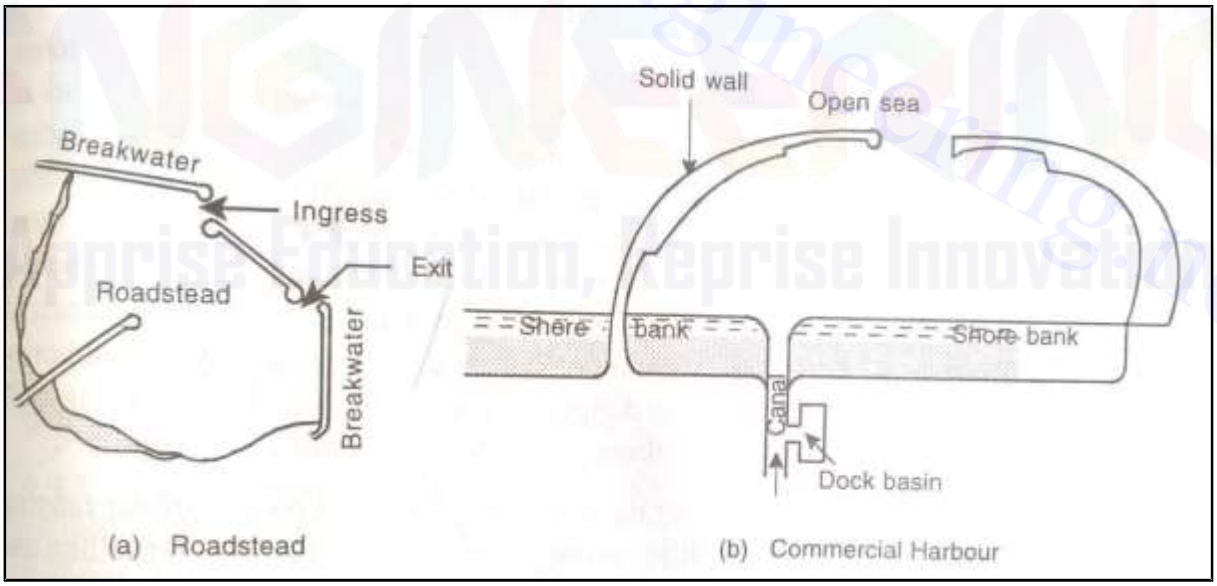


(a) Head lands converging towards each other (b) Inlet from sea

Natural Harbour



Protected Harbour



Artificial Harbour

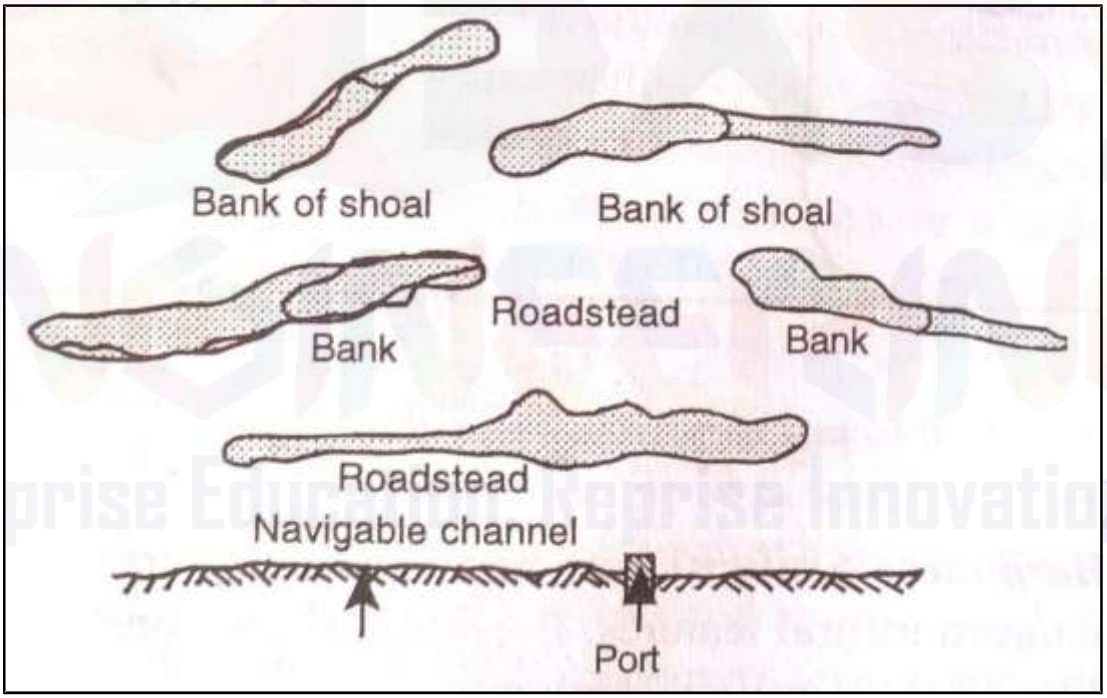
(iii)Artificial harbours: Artificial harbours have to be created where there are little or no pronounced natural features. Breakwaters are constructed on an almost open coast line. Fig shows artificial harbours. Ex. Madras

Sub-divisional classification

The following are subdivisional classification of harbours.

- Roadstead
- Harbours of refuge
- Naval harbours and bases
- Commercial harbours associated with ports and
- Fishing harbours

(i) Roadstead: These are tracts of water. They may or may not be necessarily enclosed.It may be adjacent to a coastline.Roadstead offer may good holding ground for anchors and protected vessels from heavy seas.Roadstead may be either natural or artificial. In case of natural roadstead, a deep channel exists seaward to possess the necessary characteristics. An artificial roadstead may be created on similar lines by a break water either parallel to coast or curvilinear. Fig shows a typicalroadstead



Roadstead

(ii) Harbour of refuge: Their principal duty is to provide a refuge during cyclones or when vessels are under disrepair. However, they are not many such harbours in existence. Those originally constructed for this purpose are associated with other port and harbour facilities. The best location for their construction is at readily accessible stations upon dangerous coast. Even in harbours provided with breakwaters, there is an element of risk in a heavy gale. Under certain conditions at such harbours, vessels in

good trim are advised to leave their moorings and put to sea on approach of a hurricane. At madras, for instance, commanders are recommended by port authority to put out to sea as soon as the “Great Danger” signal is exhibited on port flagstaff. Madras is primarily a commercial harbour, and is not a harbour of refuge.

(iii) Naval harbours and bases: During emergency, every, type of harbour ranging from roadsted with minimum facilities to one possessing facilities for re fuelling and repairs, with dockyard, workshops and warehouses may be used as a naval base. The basic features of design of naval bases are similar to the design of any other type of harbour.

(iv) Commercial harbour: They constitute great termini of highways of sea. Commercial harbours provide accommodation for vessels for loading and unloading operations and transaction of trade.

(a) In addition to fundamental needs of accessibility and accommodation, special requirements are quays and sheds, inner facilities and
mouth of rivers or on banks of rivers some distance land.

(b) They require more shelter than that is required for simple purpose of refuge. It is an indispensable requirements to conditions of modern trade that there should be least possible delay in reception and dispatch of vessels.

(c) Shelter afforded by a breakwater is insufficient for loading and unloading operations. In such cases, simple moles are built out into sea with level quay and covered sheds for reception of vessels. It will be necessary to provide an enclosure practically complete with an inner harbour for commercial purpose.

(v)Fishing harbours: Underlying factor in the design of fishing harbours is fisherman require maximum time for fishing with minimum delay in despatching fishes in view of perishable nature of fishes.

(a) Entrance: While not study wide, must not be made too narrow.

Fishing craft beam: 6-8 meters

Allowance should be made for atleast three or four or even more Vessels entering abreast.

Therefire entrance width: 50 to 100 meters

(b) Size: 4 to 40 hect. However, much depend upon the size and number of vessels

(c) Depth below low water level: Three to five metres

(d) Equipments required:

- Cold storage facilities
- Broad open quays with a large hall/market for storing, selling, packing and dispatching.
- A mass rapid transit service and a railway sidings near quay.
- Cranes, conveyors, transporters and shoots.
- Fish processing centres
- Canning factories.

2. Classify different types of break water. Explain any one in brief. (Apr/May 2011) or Write a detailed note on break waters. (May/June 2014).

Breakwaters

Breakwater is the most important as also the most prominent feature in connection with artificially sheltered harbour. As the name itself implies, its function is to break up and disperse heavy seas. It prevents waves from exerting their destructive influence within enclosed area of the harbour.

(i) Methods of Reducing Wave Motion

Two methods are used in practice for destroying waves or reducing their size.

(a). If a wall of sufficient height and strength is constructed waves will be totally reflected. If it is in shallow water, waves are partially destroyed by wave breaking. Reversal of waves in comparatively short time and their breaking causes great forces to be developed .Therefore, breakwater must be substantially strong.

(b). If waves are made to run up along sloping beach, their energy is absorbed gravitationally.A breakwater in order to destroy waves completely in very deep water, may be impracticable. Practically all breakwaters fall within limits of above two methods of reducing wave action

(ii) Classification of Breakwaters

The Breakwater are of three types.

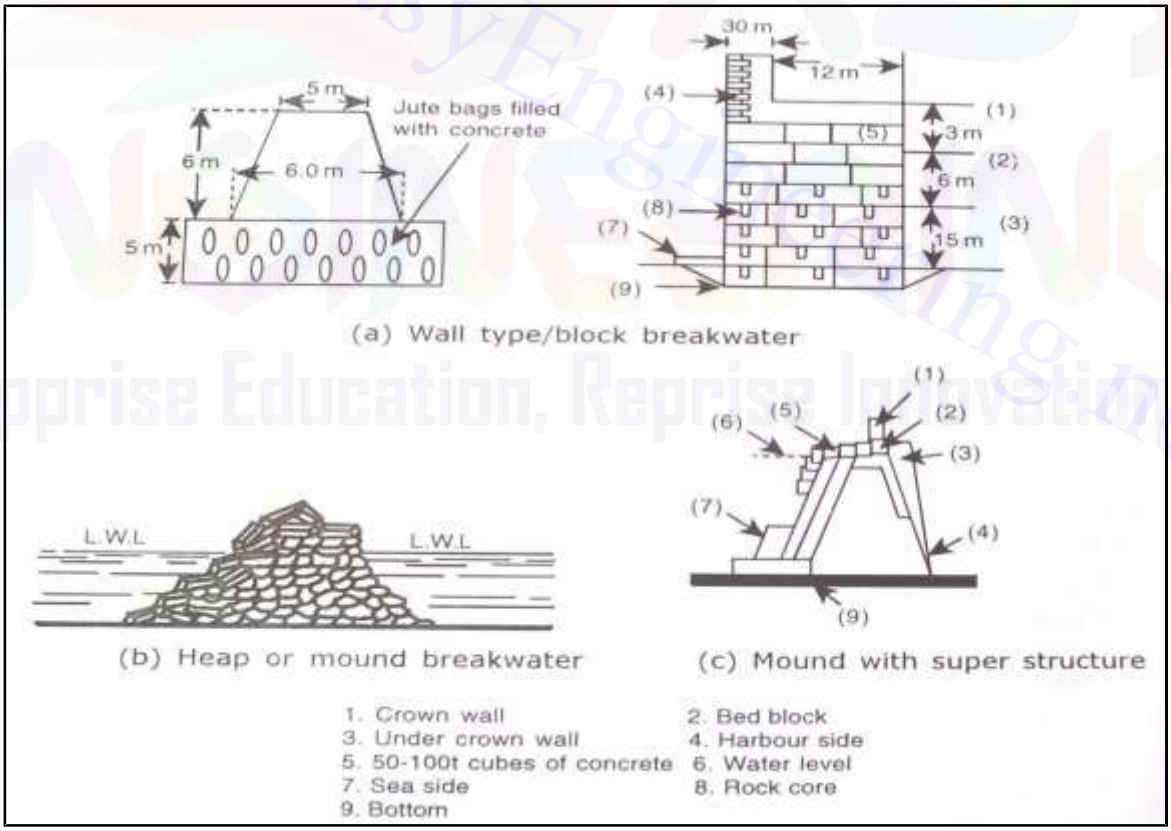
(a). Wall of masonry or concrete blocks or mass concrete,

(b). Mound of rubble stone, and

(c). Subsidiary classes of breakwaters

Wall type mainly involves construction, in a regular and systematic manner of a vertical wall. Mound of rubble stone is a heterogeneous assembly of natural rubble or undressed stones. Stones may be of varying sizes and are supplemented in many cases by artificial blocks. They are deposited in pell-mell, without bonding or bedding.

The subsidiary classes of breakwaters form a c ombination of wall and mound in varying proportions. Sometimes mound may be in larger proportions with a superstructure of regular masonry. In other cases, mound may be to minimum, while wall may be for substantial proportions.



Types of Breakwaters

(iii) Advantages and Disadvantages of Three Types of Breakwaters

(a) Cost of construction

Cost of construction depends upon locality of breakwater and its coastal environment. If a locality is closer to quarries, rubble mound will be chapter. In absence of such essential conditions, wall breakwater will be found preferable. If sea – bottom lies at a great depth , wall breakwater becomes impracticable. On an average it is assessed composite breakwater combining a foundation mound with an upper wall is half the cost of an equivalent upright wall.

(b) Comparative cost of maintenance

Wall type, if properly constructed needs no maintenance of mound breakwaters necessitates a constant replenishment of materials. Thus comparative cost of maintenance of mound type is higher.

(c) Efficiency

Efficiency of a type is of greatest importance than cost of construction and maintenance. A wall with its exposed face vertical, receives wave before any conversion from oscillation to translation take place. The wave is deflected upwards by the wall type and prevents its destructive influence upon foundation.

On rubble mound waves deliver powerful effect and also affect area enclosed by harbour. This action will be more evident as stones or blocks are of greater size. Composite breakwaters are irregular settlements. From the above remarks, no absolute preference could be attached for any specific type of breakwater from efficiency point of view.

3. Distinguish between wet docks and dry docks. Describe the operation of the various dry docks with sketches. (Nov/Dec 2014)

Docks

Definition and classfication

Docks are a completely enclosed place by gates or otherwise. It is therfore not continuously in free or open communication with an outer waterway. Principal functions

of docks are execution if repairs, cleaning and paiting of ship's, bottom. Hence, these docks and docking arrangements should be such be expose ship's exterior fully and keep it out of water durong progress of repair of renovation.

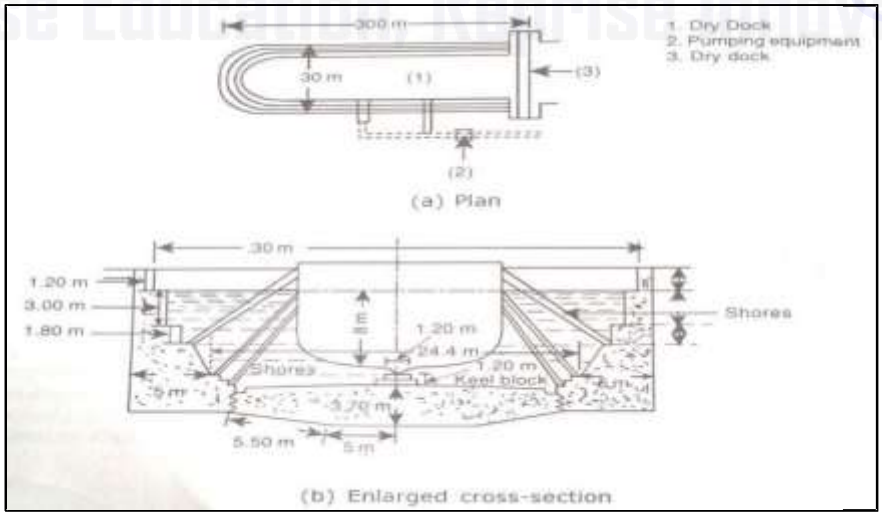
Graving are dry dock

the graving dock is also known as dry dock.it is along excavatir chamber having side walls, a semi circular end wall and a floor. The open end of the chamber is provided with a gate and acts as entrance to lock. Side walls are formed with a series of steps known as alter courses to receive end of the shores which supports vessels in a vertical position while being dry docked. Dock is constructed of concrete or masonry and altar courses and steps are of granite to withstand heavy wear. Suitable culverts are also provided for filling and emtying docks.

Dock floor is finished in concrete and is very heavy. On the floor are fixed keel and blocks on which ship is brought to rest on emptying of block. Floor has a cross fall to tide draining to carry away all wash water. Drains are protucted with proper gratings on top to exclude solids and scrapping carried by the wash while cleaning ship's bottom. Other accessories includes big caoacity pumps, lifting and hoisting machines, and repair equipments. All these are suitably fused on top or inside of side walls.

Methods of dry docking:

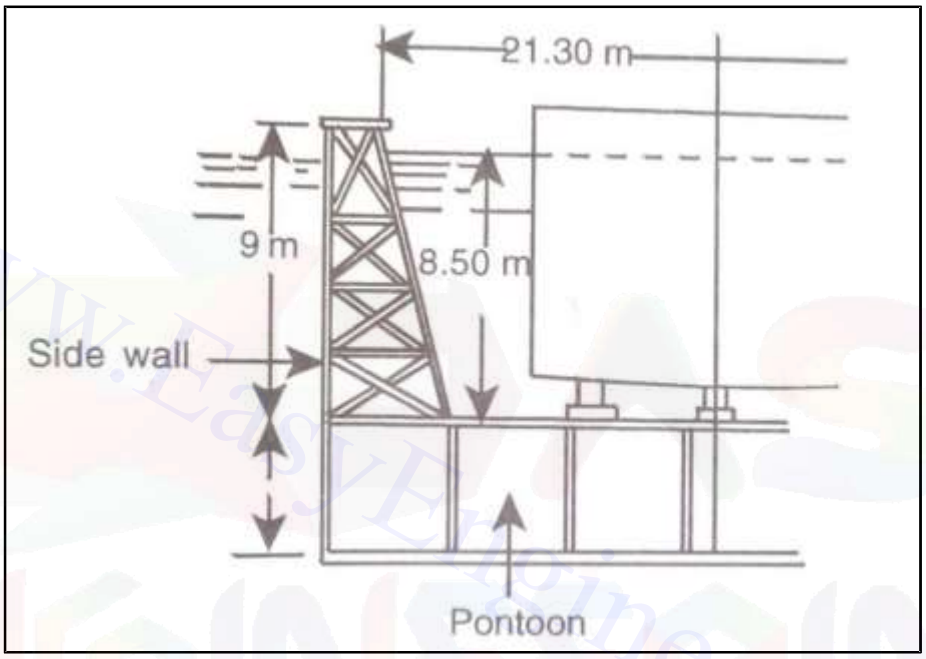
A ship enters the dock on adjusting the water level inside the to that at outside. Then, emntrance gate is closed. Subsequently, powerful pumps and pump out water and ship is lowered on to the keel. Fig. presents a dry dock.



Dry-dock

Floating dry dock

Floating dry dock may be defined as a floating vessel. This can lift a ship out of water by means of its own buoyancy. It is a hollow structure of steel or concrete consisting of two side walls and a floor with end side open. To receive a ship, the structure is sunk to required depth by filling its interior chambers with water. The ship by pumping out water from chamber.

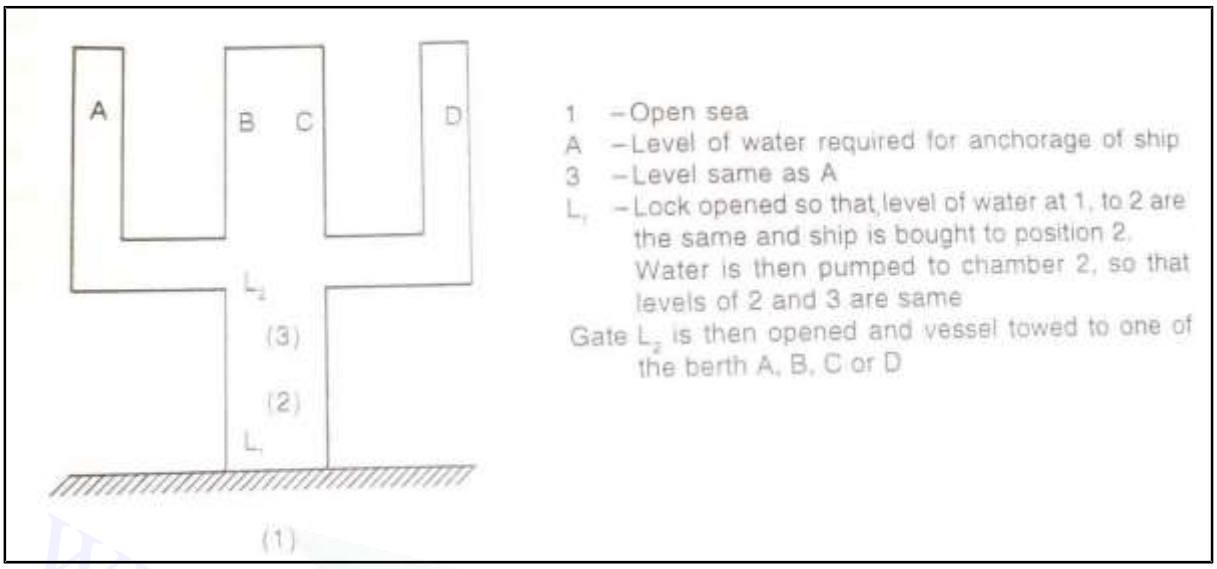


Floating-dock (Rigid type floating dock)

Wet dock

Wet docks are required to ensure minimum required depth of water for vessels.for this purpose, dock system requires entance locks with massive gates. These locks are operated by machinery.

If rise and fall of tidal level is generally considerable raising up to 15m between high and low water , gates have to be provided to impound water between successive periods of high and low water. This impounding of the water to maintain level naturally involves separation of dock from the outer water way, unless levels of outer and inner waters coincide. Such isolation in any commercial port is difficult and is done by locking arrangements.



Wet Dock

The advatages of having a wet dock for berthing are given below

- A uniform level of water is maintained
- Rubbing of ship against quay wall is avoided
- Disturbance in open sea do not have any effect on the working of the dock system

When a vessel is to be brought inside, the lock remains closed and lock L_1 is opened so that levels of water in (1) and (2) are th same and the vessels is brought to th position2. Water is pumped in so that the level in 2 and 3 are the same. Gate L_2 is opened and the vessels is towed to A or B or C or D as required.

Comparison of floating dock and dry dock

Floating dock is a dock structure, which floats. It is generally constructed as a series of pontoons or which can be emptied to provide necessary degree of floatation**.**

Comparison of floating dock and dry dock

Dry dock	Floating dock
More permanent (industructible)	Life limited
Larger and high construction cost immobile	Moveable from one part to another

Floating necessitates a sound natural foundation at a reasonable depth and disposition of site which frequently involves appropriation of a considerable area of land. It also requires a sheltered position withn an adequate depth of water which if not obtainable by nature will have to be arranged by gaining.

4. Define a port and bring out the differences between a port and a harbour. What are the requirements of a good port? (Apr/May 2011, Nov/Dec 2014) (8 marks)

Harbour

Harbour can be defined as a sheltered area of the sea in which sea-based vessels can be launched, built or taken for repair. It also provides shelter in the time of storm and as a platform for loading and unloading of cargo and passengers.

Port

Port is a harbour where terminal facilities such as stores, landing of passengers and cargo, etc are added to it. A port including everything on the landward side such as piers, ships, wharves, sheds, tracks, handling equipment, etc. A port includes a harbour or every port is a harbour but reverse is not applicable.

Requirements of a good port

For an efficient functioning a port should have all these facilities:

i. Hinterland is that part of land to be served by a port. Thus a port should be located near to hinterland to serve the area with economy and efficiency.
ii. Get more tonnage of cargo
iii. Have adequate communication facilities
iv. Should be a place of defence to resist the sea-borne invasion
v. Afford shelter at all seasons
vi. Provide the maximum facilities to all visiting ships including the servicing of ships.
vii. Capable for easy, smooth and economic development
viii. Command valuable and extensive trade
ix. Have advanced culture, trade and industries
x. Should be popular

5. Write short notes on

(i) Wharves

(ii) Jetties

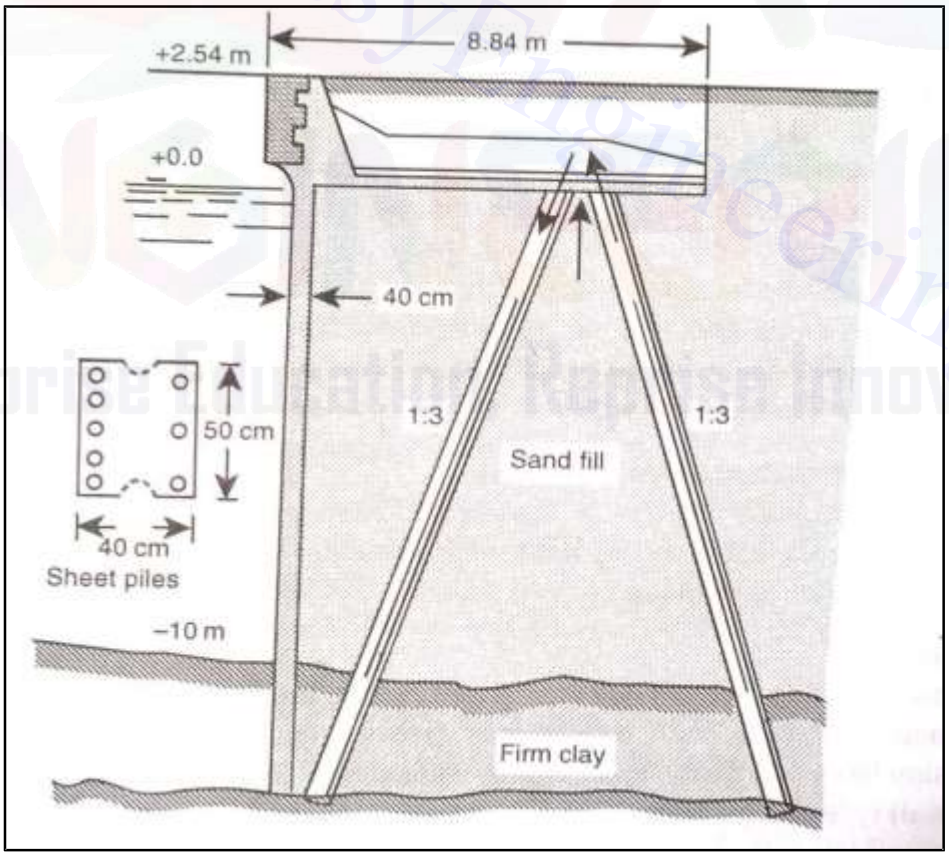
(iii) Quays

(iv) Spring fenders

(v) Dolphins **(Nov/Dec 2012)**

Wharves

Wharves are wide stone walls built along edge or out into sea or river, where ships can be tied up to unload goods. Wharf is a structure for berthing purpose, distinct from quay. It is constructed piles and framing instead of solid masonry or concrete. Both wharves and quays are provided with adjacent space for receiving and loading of cargo.



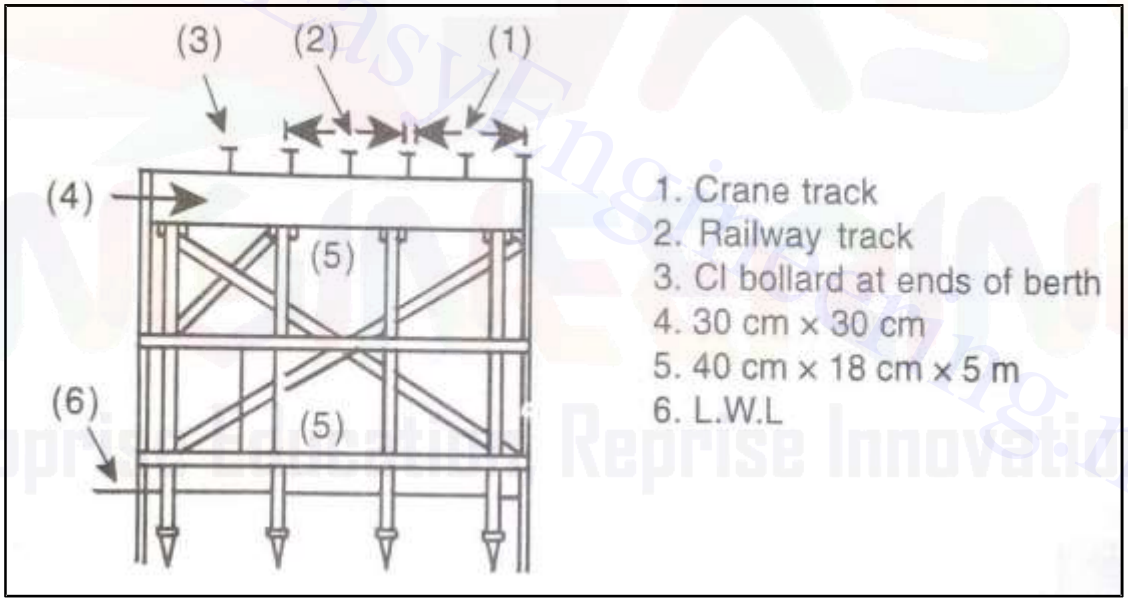
Wharf

Jetties

The term jetties denote projecting structures built out into deep water from shore. These are different from wharves, quays, which are built along banks. Structures in harbours, which perform duties of loading and unloading performs with breakwater, are also termed as jetties.

Types of jetties

- Piled or open
    - ✓ Timber
    - ✓ Steel
    - ✓ R.C.C (can classified two types)
        - ➢ Open
        - ➢ Pilled cylinder
- Solid type



Typical timber jetty

(v)**Material:**

Piles may be of timber, steel or reinforced concrete. Steel jetties are supported on screw materials. The main advantage of timber jetty is rapidity of construction and advantage in cost. Owing to greater resilience of material , timber jetties cost of repairs is nearly same as that of concrete structures. Repairs to timber jetties can be more quickly carried out.

(vi)Transverse beams:

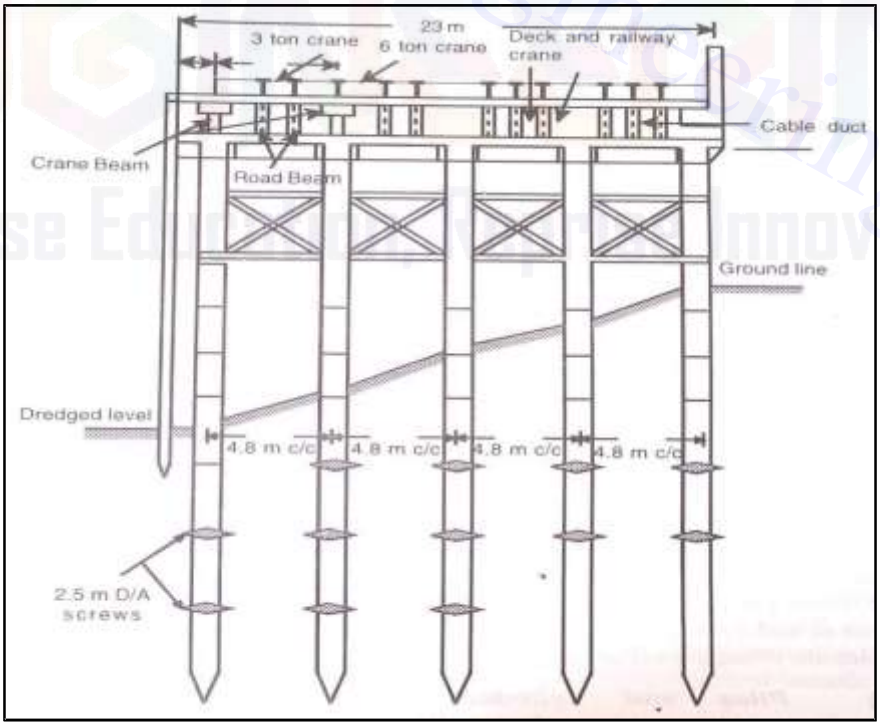
Transverse deck beams are constructed and connected to top piles. Rcc decking is constructed. In open piled type, usually 35cm*35cm or 40cm*40cm piles are used. These piles are braced by Rcc bracings which may be pre-cast or cast in situ. In case of underwater bracings they are invariably pre cast type. After driving , tops of piles are either cutoff or lengthened as the case may be.

(vii) Piles and cylinder jetties:

Piles are encased in concrete cylinders. Weight of the structure is carried by piles and RCC cylinders only act as containers. When cylinders have attained required depth 1.2to 1.3m below bottom, piles are driven through them. Cylinders are filled up with concrete. This filling concrete may be plain or slightly reinforced.

(viii)**Screw cylinders in jetties:**

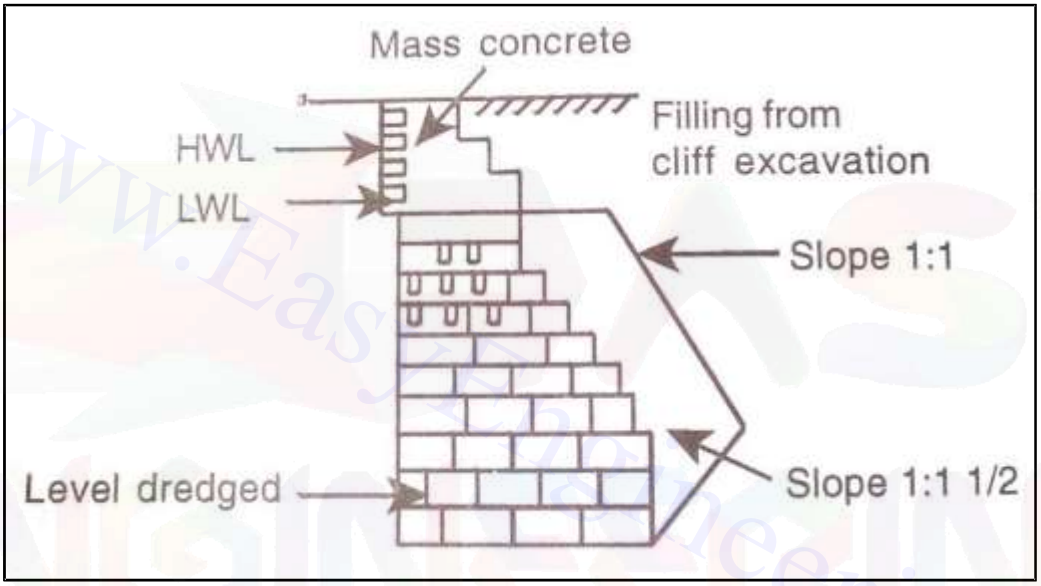
In case of soft ground such as silky strata, screw cylinders are adopted to carry the required load. It is found that immediately after screwing, some subsidence takes place. However, after leaving the beam for several months, ground gets consolidated and settlement becomes negligible. The beams are articulated to allow for non-uniform initial settlement of cylinders .



Screw cylinders in jetty

Quays

Platforms or landing places are necessary for ships to come close enough to the shore, for purposes of embarkation, disembarkation etc., at the same time. These platform locations should give sufficient depth of water for the ship to float. Such platforms are called Wharves. They are built out into or on to the water. Wharves along and parallel to the shore are generally called Quays and their protection walls are called quay walls.



Quay wall

Spring Fenders

(i)**Introduction**

Fenders are objects such as a mass of rope, an old tyre and lump of wood that hangs over the side of a boat to protect it from damage by other boats or when coming to land. At majority of jetties, piers and wharves, berth for larger vessels will usually be well defined. However , provision must be made for vessels of various types and sizes. Therefore, for fending system to be one hundred per cent effective , it should be continuous along entire length of the structures and should extend from deck level to low water level.

In relatively still waters of a dock system or enclosed or sheltered harbours, no great damage to structures normally occurs. However, harbour structures in open sea,

and in open estuaries require special precautions. Therefore, fending of such structures against damage from impact of large vessels is critical.

Many of R.C jetties and wharves are elaborately covered with timber fender work, bolted to structure. In all such cases, such timber work is only useful in preventing concrete from being damaged locally and is not very effective from an impact – absorbing point of view. There are three general ways in which efficient impact fending can be provided.

(a) By separate timber dolphin and intermediate timber work quite independent of structure.

(b) By the same means with some form of resilient buffer interposed between the tops of dolphin and structure. Such buffer may be of coil or rubber or steel springs or hydraulic or pneumatic cylinders and pistons,

(c) In 'fulcurum' fender system, fenders are suspended in such a manner that the force required to push them out of their original stable position is sufficient to bring a vessel to rest by absorbing kinetic energy of the latter.

(ii)Different ways of fending

(a) Simple fending:

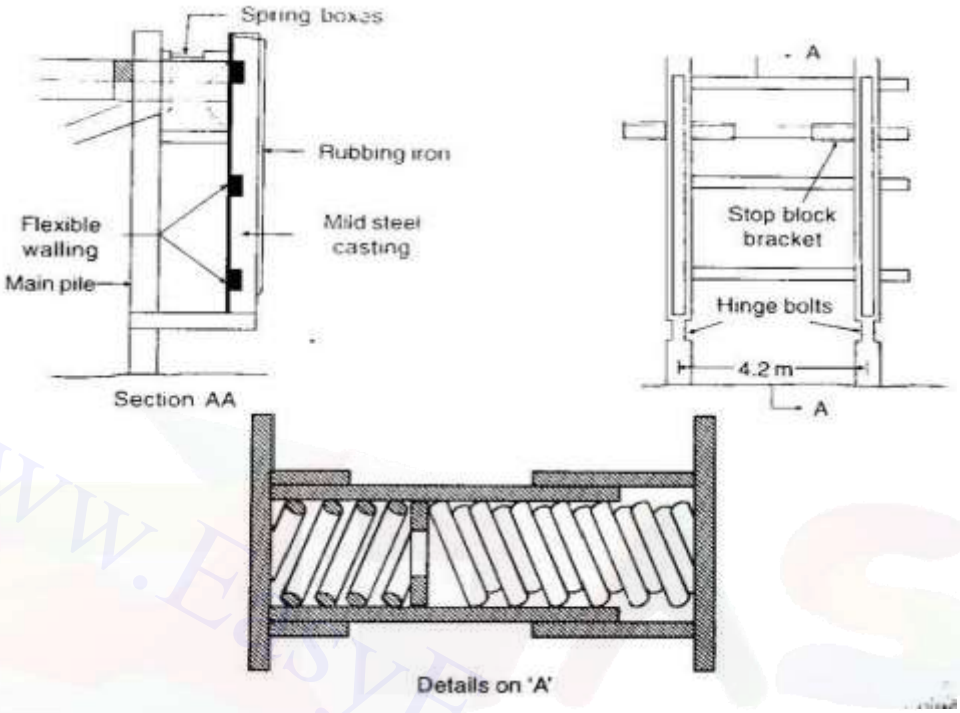
Simple fenders of separate piles are driven in front of structures , with systems of walling and verticals. This ensures safety of barges and lighters .however, in many cases, timber fenders walling and verticals are bolted direct to structures. In such cases berthing of vessels is comparatively easy. It is inefficient for berthing of vessels of 10,000 tons and upwards. Damage are of frequent occurrence.

(b) Spring fenders:

Spring fenders are more appropriate in open or tidal waters. It provides for absorbtion of K.E and for limiting travel of vessels after impact.

The spring fender shown was designed for an approach speed of 46cm/sec or approximately one knot. The fenders were of pyinkado cased in steel and hinged at the bottom to brackets on the main pile of the timber jetty. Three sets of spring were used. Each pair requires a load of 30 tons for full

compression with a stroke of 18 cm, the maximum resistance of each fender being thus 90 tons.



Spring fenders

Dolphins

Dolphins are marine structures which are used in connection with piers and wharves to reduce the length of these structures. They are used for tying up ships and also for transferring cargo from one ship to another when moved along both sides of dolphins. Dolphins are classified as

(i) Breasting dolphins

(ii) Mooring dolphins

Breasting dolphins

This type of dolphins is designed to take the impact of ship while docking and to hold the ship against a broad side wind. They are provided with fenders to absorb the impact of the ship and to protect the dolphin and the ship from damage.

Mooring dolphins: Such a type of dolphins is the additional ones which are provided to hold the ship against a broadside wind blowing in a direction away from the dock. As these dolphins are away from the face of the dock they are not designed for the impact of the ship.

6. Explain about the dredging equipment with neat sketch. (May/June 2013)

Dredging methods

In order to maintain the required level of water in a harbour the external materials deposited in the bed has to be renewed from time to time. This operation of removal of materials from the sea or river bed is called dredging and the mechanical equipment used is called as dredgers.

Types of dredgers

- Bucket or Ladder Dredgers
- Hydraulic or Cutter Dredgers
- Grab Dredger
- Dipper Dredger
- Rock Dredger
- Hopper Dredger

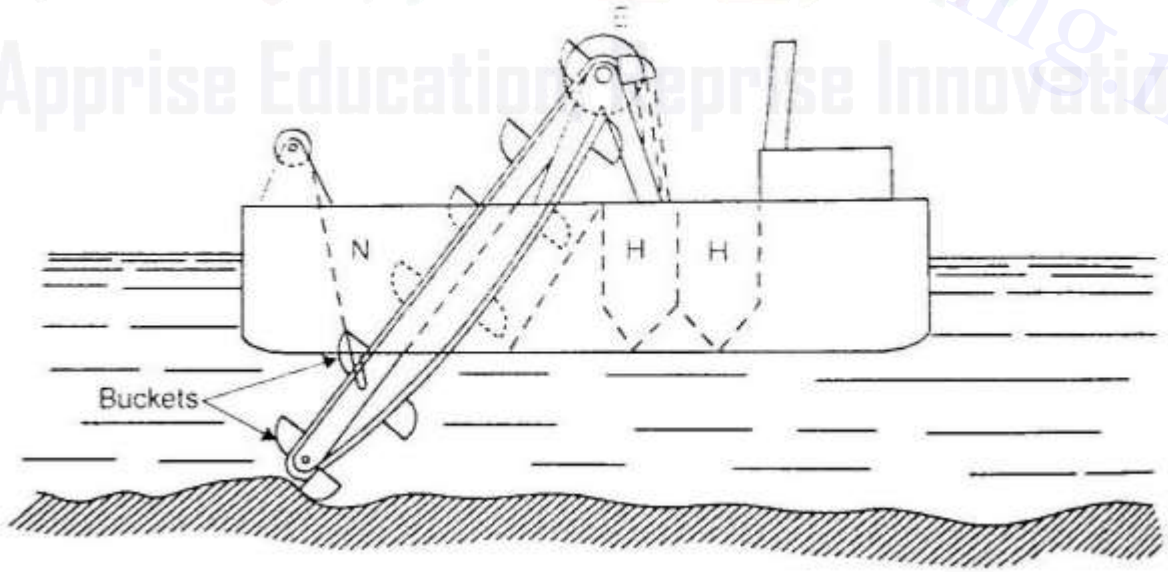
Bucket or Ladder Dredgers

This consists of a chain of buckets fixed to a continuous elevator belting. It comprises of (i) cable arrangement for lowering or raising the ladder

(ii) wheel for manually or mechanically operating the chain of buckets

(iii) containers for receiving the dredged material.

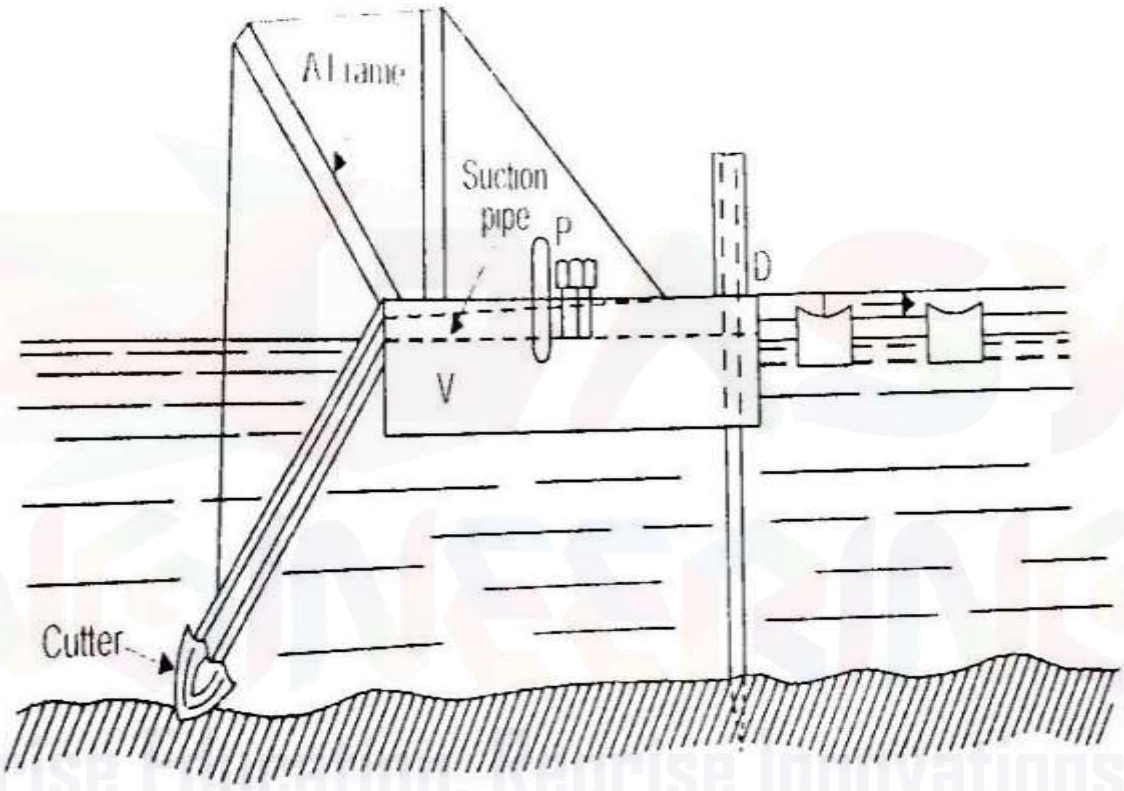
The dredged material is collected in the receivers and disposed off as required.



Bucket or Ladder Dredgers

Hydraulic or Cutter Dredgers

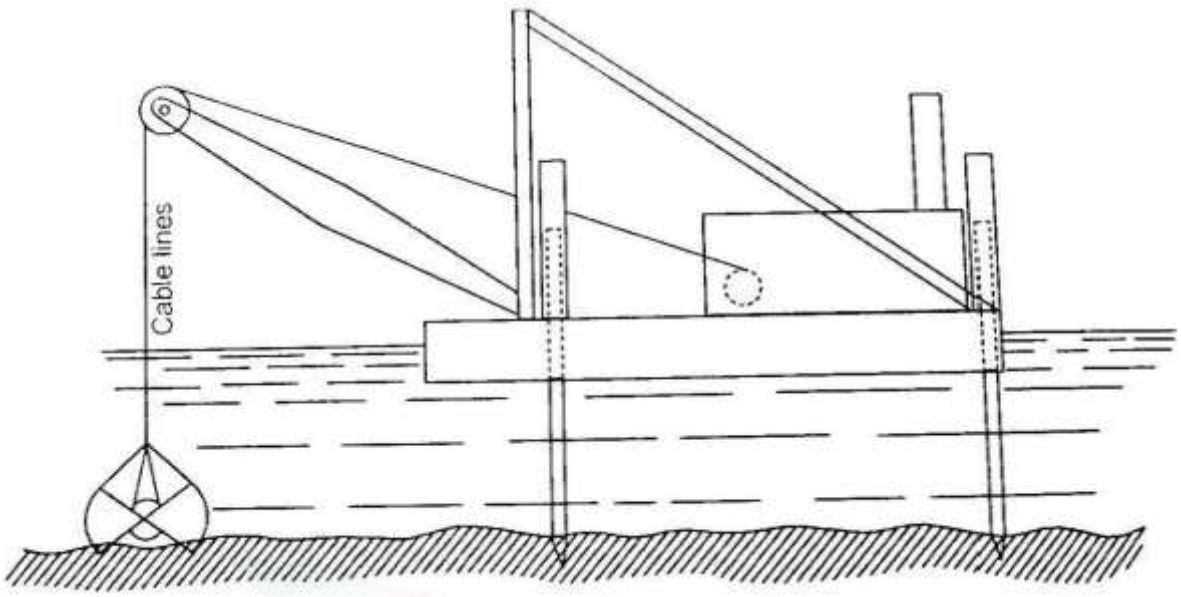
A hydraulic dredger has two fold arrangement, viz, operation of dredging and transporting the dredging material to the disposal site through discharging pipe. In case of loose materials there is no need for dredging but the material is removed by suction. Hard materials like stiff clay or dense sand, a rotating cutter is used at the end of the suction pipe.



Hydraulic or Cutter Dredgers

Grab Dredger

This type of dredger consists of a ‘grab’ which is suspended by a cable. The grab is extended by operating the boom of a crane. Steam diesel or electric power is used for operating the grab cranes. The dredgers may have from one to four grab cranes mounted on the dredger. Special cutting teeth are provided with the grabs for cutting hard rocks. In order to remove cut rockey materials the grab attachment is replaced by poly-grab.



Grab Dredger

7.Discuss the effect of waves on coastal structures. (R 2013)

Effect of waves on coastal structures

The pattern of deposition or erosion depends up on the shape of coastal structures. The general shape of the coastal structures is straight pier, returned pier and double pier. Deposition or erosion may destabilise coastal structures. Therefore, it is important to study the correlation between the form of the coastal structures and the pattern of deposition or erosion.

Most harbours face problems of erosion and deposition due to littoral drift. Structural improvements involve construction and extension of coastal structures such as breakwaters and groins. While designing coastal structures following aspects have to be considered.

(a) Functions of structures

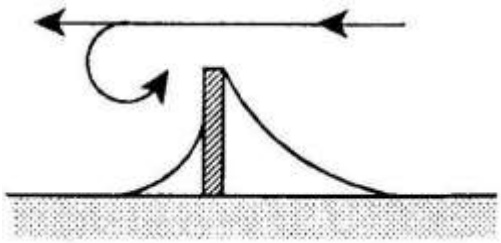
(b) Physical environment

(c) Construction method

(d) Cooperation and maintenance

Straight pier

It is assumed that a dominant current flows parallel to coastline from right to left. The prevailing wind makes an oblique angle so as to give a component in the same

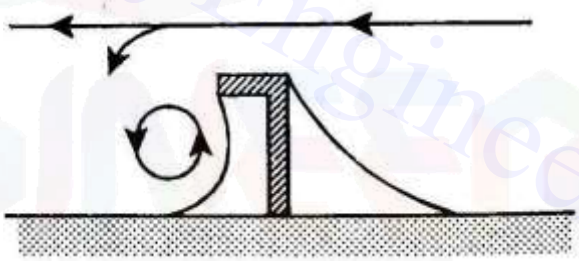


Straight pier

direction. This is brought about by construction of harbour works of typical kinds. Straight pier or breakwater at right angles to coastline induces an accumulation along each of its sides. It is illustrated in the figure which states the shape and orientation of the coastal structures decide its impact on coast.

Returned pier

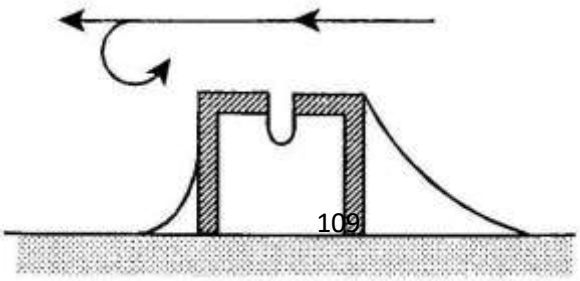
The returned pier serves to increase leeward deposit. This is because of circular motion of the water round the pier-head. The slacker water inside tends to deposit suspended material. The figure denotes present pattern of silting and erosion on coastal structures in the shape of returned pier.



Returned pier

Double pier

Same effect as that of the returned pier is seen with double pier. The accretion is more emphasised because of additional extent of stagnant area. Madras harbour bears evidence to this pattern. The entrance of Madras harbour was slowly but surely silted up and therefore a new entrance was to be provided in a different position. The figure indicates the tendancy of accretion and erosion in double piers.



8.List out the activities prohibited within CRZ. (R 2013)

Ministry of Environment and Forests (Department of Environment, Forests and Wildlife), Govt. of India, issued Coastal Regulation Zone 2011 notification in January 2011.

This notification was issued by the central government with a view to ensure livelihood security to fisher communities and other local communities, to conserve and protect coastal stretches, its unique environment and to promote development through sustainable manner.

Coastal Regulation Zone (CRZ) refers to stretches along coasts, where certain rules are enforced to any development on land or building. Construction activities in these areas are governed by a set of regulations.

Activities prohibited in CRZ

Notifications issued by Ministry of Environment and Forests imposes certain restrictions on industrial, operations and processes in the CRZ are as follows,

(i) Land area from the High Tide Line (HTL) to 500 m on the landward side along the sea front. It refers to the line on the land up to which the highest water line reaches during the spring tide and shall be demarcated uniformly in all parts of the country.

(ii) Setting up of new industries and expansion of existing industries.

(iii) Manufacture or handling oil storage or disposal of hazardous substances.

(iv) Setting up and expansion of fish processing units including warehousing except hatchery and natural fish drying in permitted areas.

(v) Land reclamation, bunding or disturbing the natural course of sea water.

(vi) Setting up and expansion of units or mechanism of disposal of wastes and effluents except where it is permitted under Water act 1974.

(vii) Dumping of solid waste for purpose of land filling or otherwise or ash or any other waste from thermal power stations.

(viii) Reclamation for commercial purposes such as dropping and housing complexes, hotels and entertainment activities.

(ix) Mining of sand, rocks and other substrata materials.

(x) Drawal of groundwater and construction related thereto, within 200 m of HTL.

(xi) Dressing or altering the sand dunes, hills, natural features including landscape change for beautification, recreation and other such purposes.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31207

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Fifth Semester

Civil Engineering

CE 2303/CE 52 — RAILWAYS, AIRPORT AND HARBOUR ENGINEERING

(Common to PTCE 2303 — Railways Airport and Harbour Engineering for B.E. (Part-Time) Fourth Semester — Civil Engineering — Regulation 2009)

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the uses of Remote Sensing in route alignments?

2. Mention the functions of formation.

3. Differentiate between 'gravity yard' and 'hump yard'.

4. What is meant by track circuiting?

5. What are the factors influencing the runway length based on safety requirements?

6. State the primary functions of an airport drainage system.

7. Distinguish between 'runway capacity' and 'gate capacity'.

8. What are the components of a heliport?

9. Write down the equation used for finding the harbour entrance.

10. Differentiate between a 'wharf' and a 'jetty'.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What are the elements of transport? (4)

(ii) Illustrate the advantages of railways. (12)

Or

(b) (i) What are the requirements of an ideal rail joint? (4)

(ii) Explain the various rail joints used in railways with neat sketches. (12)

12. (a) A 5° curve diverges from a main curve of 4° in an opposite direction in the layout of a B.G yard. If the speed on the main curve is restricted to 54.53 kmph. determine the speed restriction on the branch line. Assume permissible can't deficiency as 7.5 cm.

Or

(b) Describe the operations involved in plate laying by the telescopic method.

13. (a) What is an airport master plan? Briefly describe the steps in its formulation.

Or

(b) Bring out the purposes of airport imaginary surfaces.

14. (a) Enlist and explain the factors to be considered for the selection of site of an airport. Discuss the critical issues involved.

Or

(b) (i) What are the different types of terminals? Explain its concepts with neat sketches. (8)

(ii) Describe the principle of operation of ILS with the help of a diagram. (8)

15. (a) Describe briefly the functions of fixed and floating signals with necessary sketches.

Or

(b) Explain the different types of wind-rose diagrams used for finding the harbour entrance.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21207

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Civil Engineering

CE 2303 / CE 52 – RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

(Common to PTCE 2303 Railways, Air ports and Harbour Engineering for B.E. – (Part – Time) Fourth Semester – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the classification gradients.
2. On a Broad gauge track of 4° curve equilibrium cant is provided for a speed of 60 Km/hr calculate value of equilibrium cant.
3. What are the characteristic classification of signals?
4. Define Inter locking.
5. Write the uses of wind rose diagram.
6. Define wind direction Indicator.
7. Define calm period.
8. Why is airport Zoning Important.
9. Define littoral drift.
10. Write the use break water.

PART B — (5 × 16 = 80 marks)

11. (a) Explain the permanent way components with neat sketch. (16)

Or

(b) Explain in detail about rail fastenings and fixtures with suitable fig.

12. (a) Enumerate the Types and classification of signals suitable drawing. (16)

Or

(b) Write short notes on

(i) Turn outs (4)

(ii) Track drainage (4)

(iii) Railway station and Yards. (8)

13. (a) (i) Length of a runway at mean sea level, standard temperature and Zero gradients is 1600 m. The site has an elevation of 320m, with a references temperature 33.6°c. The runway has to be constructed with, an effective gradient of 0.25% determine. The actual length of the runway at the site. (10)

(ii) Write the construction procedure of the wind rose diagram (ii Type). (6)

Or

(b) (i) Following are average wind data for 10 years when wind Intensity is above 6 Km/hr. An airport is to be deigned for a single runway. Determine the best runway orientation and calculate total wind coverage and draw the wind rose diagram.

Wind direction	N	NNE	NC	ENE	E	ESE	SE	SSE	S	SSW
Percentage of time	10.9	8.3	4.2	1.3	0.9	0.3	8.1	7.9	14.6	9.8

Wind direction	SW	WSW	W	WNW	NW	NNW
Percentage of time	5.6	1.8	0.3	0.2	7.5	5.7

(ii) Write short notes on (2 × 4 = 8)

(1) Airport drainage (4)

(2) Factors considered in taxiway design. (4)

14. (a) Draw the layout of airport and explain it's components clearly. (16)

Or

(b) (i) Explain in detail about runway and taxiway marking and lighting with suitable sketches. (10)

(ii) Write short notes on air traffic control network. (6)

15. (a) (i) Briefly explain about navigational aid's with suitable sketch. (10)

(ii) Explain about the dredging equipment with neat sketch. (6)

Or

(b) Write short notes on

(i) Classification of harbours (5)

(ii) Costal structures (8)

(iii) Tidal currents. (3)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 11191

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fifth Semester

Civil Engineering

CE 2303/CE 52 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the disadvantages of coning of wheels.

2. What is meant by 'cant deficiency'?

3. List the components of a switch.

4. Differentiate between 'loop' and siding'.

5. What is a fillet?

6. State the importance of airport drainage.

7. Distinguish between 'holding apron' and 'blast pad'.

8. Define 'number of gate position'.

9. What do you understand about 'littoral drift'?

10. How will you orient the entrance of a harbour?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Elucidate the advantages of railways. (8)

(ii) Determine the length of transition curve on BG track having the design speed on curve is 90 kmph. (8)

Or

(b) (i) Bring out the ideal requirements of a permanent way. (8)

(ii) What would be the equilibrium cant on a MG track of 5° curve for a speed of 60 kmph? What would the maximum permissible speed after allowing the maximum cant deficiency. (8)

12. (a) Determine all the elements of a turnout, when the following data is given :

Heel Divergence	=	13.65 cm
Angle of Switch	=	1° 34' 27"
Gauge	=	1.676 m
Number of Crossing	=	8.5

Or

(b) What are the different systems of controlling the movement of trains? Explain the working principle of the system(s) which has been widely used on Indian Railways.

13. (a) (i) Briefly explain about the airport Master Plan. (8)

(ii) What are the various imaginarily zones in the airport and its near vicinity? Mention their significance. (8)

Or

(b) (i) Explain the methods of orienting the runway of an airport. (8)

(ii) What are the various corrections to be applied on to the runway length? Explain the amount of such corrections with atypical example. (8)

14. (a) (i) What are the different systems of aircraft parking? Explain the suitability of each system. (8)

(ii) Draw a typical layout of an airport showing all the features on it. (8)

Or

(b) (i) How air traffic control is classified? (8)

(ii) Enumerate the various air traffic control methods with neat diagrams. (8)

15. (a) (i) Explain the working principle of dry and wet docks. (8)

(ii) What is 'break water'? Illustrate the construction features of various types of break waters. (8)

Or

(b) Write short notes on the following :

(i) Marine Survey. (4)

(ii) Mooring Accessories. (4)

(iii) Navigational Aids. (4)

(iv) Dredging. (4)

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Reg. No. :

Question Paper Code : 10226

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012

Fifth Semester

Civil Engineering

CE 2303/CE 52/10111 CEE 49 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the various gauges used in Indian Railways.
2. Define 'obligatory point'.
3. What is a cross-over?
4. What is a semaphore signal?
5. Distinguish between "runway" and "apron".
6. What is the transitional surface in airport design?
7. Define exit taxiway.
8. What is a hangar?
9. Define 'mooring buoy'.
10. What is the function of a quay?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss the modern methods for arriving at the optimal alignment of a new railway line. (8)

(ii) What are the functions of ballast? List the different types of ballast material. How will you test the suitability of ballast material? (8)

Or

(b) (i) The average speed on a B.G.4° curve is 70 kph. Compute the equilibrium super elevation and the maximum permissible speed allowing for cant deficiency. (8)

(ii) Define sleeper density. Explain the different types of sleepers used in Indian Railways. (8)

12. (a) (i) List the conventional and modern methods of maintenance of railway track. What are the different types of equipment used? (8)

(ii) Draw the layout of a terminal railway station. Enumerate the facilities to be provided in a terminal railway station. (8)

Or

(b) (i) Draw a neat sketch of a right-hand turnout and describe the various components. Explain the operation of the turnout. (8)

(ii) What are the advantages of welded rails? Describe any one method of welding the rails. (8)

13. (a) (i) List the different types of airports. Explain the ICAO classification of airports. (8)

(ii) An airport is at an elevation of 600 m and the airport reference temperature is 23.4°C. The proposed runway grading works out to an effective gradient of 0.2 per cent. Calculate the runway length required at the site, if the basic runway length is 2200 m. (8)

Or

(b) (i) Discuss the factors to be considered while locating a new airport. (8)

(ii) Explain how the optimum runway orientation is determined using a Wind Rose diagram. (8)

14. (a) (i) What are the components of an international airport? Explain with a sketch of the layout. (8)

(ii) List the different landing aids for aircraft. Explain the operation of the Instrument Landing System. (8)

Or

(b) (i) Describe using sketches the different types of aircraft parking systems adopted in the apron area. (8)

(ii) What is the importance of threshold marking and threshold lighting of a runway? Explain with sketches. (8)

15. (a) (i) Distinguish between dry dock and wet dock. Explain the operation of the docks. (8)

(ii) What are the different types of breakwaters? Draw the cross section of a typical breakwater and indicate the materials used. (8)

Or

(b) (i) How are harbours classified? Explain using examples of Indian harbours. (8)

(ii) What are the different ways of storing cargo in a port? Describe some of the cargo handling equipment. (8)

15

Reg. No. :

Question Paper Code : 11213

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2011.

Fifth Semester

Civil Engineering

CE 2351 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the functions of rail?
2. What are the requirements of ideal fastening?
3. State the principles of interlocking.
4. What is meant by track circuiting?
5. Define wind rose diagram.
6. Explain the term cross wind components and wind coverage.
7. How do you select the site for terminal building?
8. List the types of parking form motor vehicles.
9. Distinguish between quay and pier.
10. What is the necessity of docks?

17

PART B — (5 × 16 = 80 marks)

11. (a) Briefly explain the modern methods of surveys for track alignment. (16)

Or

(b) (i) What is the necessity of geometric design of a railway track? Enumerate the significant features of design of a railway track. (8)

(ii) What are the requirements of an ideal rail joint? Explain any two joints used in Indian Railway lines with neat sketches. (8)

12. (a) Illustrate with a neat sketch, the turnout, points and crossings and explain their working principles. (16)

Or

(b) (i) Explain the centralized traffic control system. (4)

(ii) What is a marshalling yard? Explain with a neat sketch, the working of a hump type of marshalling yard. (12)

13. (a) Discuss in detail the factors affecting the choice of selection of site for an airport. (16)

Or

(b) (i) Explain the steps in the determination of proper orientation for runway. (8)

(ii) Give the various geometric standards for different classes of runways and taxiways. (8)

14. (a) (i) Draw a layout of any one International Airport in India and explain the concept. (10)

(ii) Explain the planning concept of Airport buildings. (6)

Or

(b) Briefly explain the Night- time aids provided at Airports. (16)

15. (a) (i) Classify harbours on broad basis and on the basis of utility and explain them. (10)

(ii) Write descriptive notes on mooring and mooring accessories. (6)

Or

(b) (i) Define a port and bring out the differences between a port and a harbour. What are the requirements of a good port? (8)

(ii) Classify different types of break water. Explain any one in brief. (8)

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Reg. No. : | | | | | | | | | | | |

Question Paper Code : 11213

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2011

Fifth Semester

Civil Engineering

CE 2303 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions

PART A — (10 × 2 — 20 marks)

1.fi What are the functions of rails?

2.fi What are the requirements of ideal fastening?

3.fi State the principles of interlocking.

4.fi What is meant by track circuiting?

5.fi Define wind rose diagram.

6.fi Explain the term cross wind components and wind coverage.

7.fi How do you select the site for terminal building?

8.fi List the types of parking form motor vehicles.

9. Distinguish between quay and pier.

10. What is the necessity of docks?

fi fi

PART B — (5 fi 16 = 80 marks)

11.fi (a) Briefly explain the modern methods of surveys for track alignment. (16)

Or

fi (b) (i) What is the necessity of geometric design of a railway track? Enumerate the significant features of design of a railway track. (8)

fi (ii) What are the requirements of an ideal rail joint? Explain any two joints used in Indian Railway lines with neat sketches. (8)

12.fi (a) Illustrate with a neat sketch, the turnout, points and crossings and explain their working principles. (16)

Or

fi (b) (i) Explain the centralized traffic control system. (4)

fi (ii) What is a marshalling yard? Explain with a neat sketch, the working of a hump type of marshalling yard. (12)

13.fi (a) Discuss in detail the factors affecting the choice of selection of site for an airport. (16)

Or

fi (b) (i) Explain the steps in the determination of proper orientation for runway. (8)

fi (ii) Give the various geometric standards for different classes of runways and taxiways. (8)

14.fi (a) (i) Draw a layout of any one International Airport in India and explain the concept. (10)

fi (ii) Explain the planning concept of Airport buildings. (6)

Or

fi (b) Briefly explain the Night-time aids provided at Airports. (16)

15.fi (a) (i) Classify harbours on broad basis and on the basis of utility and explain them. (10)

fi (ii) Write descriptive notes on mooring and mooring accessories. (6)

Or

fi (b) (i) Define a port and bring out the differences between a port and a harbour. What are the requirements of a good port? (8)

fi (ii) Classify different types of break water. Explain any one in brief. (8)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 71255

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fifth Semester

Civil Engineering

CE 2303/CE 52/10111 CEE 49 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008/2010)

(Common to PTCE 2303/10111 CEE 49 – Railways, Airports and Harbour Engineering for B.E. (Part-Time) Fourth Semester – Civil Engineering – Regulation 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define sleeper density.
2. Sketch the cross-section of the permanent way.
3. List the type of signals based upon functional characteristics.
4. What is a buffer stop?
5. List any two factors which affect the runway design.
6. What is Air Traffic Potential?
7. What is a Hangar?
8. What are the various airport zones?
9. What are the types of harbour?
10. What is a breakwater? Name its types.

PART B — (5 × 16 = 80 marks)

11. (a) What is a sleeper? List the functions, types of sleepers and compare one another. (16)

Or

(b) (i) What do understand by 'cant deficiency'? (8)

(ii) Explain the widening of gauge on curves with the formula. (8)

12. (a) Illustrate with a neat sketch, the turnout, points and crossings and explain their working principles. (16)

Or

(b) How are Railway stations classified? Explain the features of each station. (16)

13. (a) The length of a runway under standard condition is 2100 m. The airport is to be provided at an elevation of 410 m above MSL. The airport reference temperature is 32°C. The construction plan provides the following data.

End to end of runway (m)	Grade (%)
0-300	+1.0%
300-900	–0.5%
900-1500	+0.5%
1500-1800	+1.0%
1800-2100	–0.5%
2100-2700	–0.4%
2700-3000	–0.10%

Determine the length of the runway. Apply the correction for elevation and temperature as per ICAO and the correction for gradient as per FAA. (16)

Or

(b) What is a wind-rose diagram? What is its importance in airport engineering? Differentiate type 1 and type 2 wind-rose diagrams. (16)

14. (a) Briefly explain the Night – time aids provided at Airports. (16)

Or

(b) Explain with neat sketches, about the Airport Markings. (16)

15. (a) Explain about the different types of break waters with the sketches. (16)

Or

(b) What are the types of Navigational Aids? Discuss the fixed navigation structures and floating navigation aids. (16)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91237

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Fifth Semester

Civil Engineering

CE 2303/CE 52 /10111 CEE 49 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008/2010)

(Common to PTCE 2303 /10111 CEE 49 — Railways Airport and Harbour Engineering for B.E. (Part- Time) Fourth Semester – Civil Engineering – Regulation 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL qu. 'ions.

PART A — (10 × 2 = 20 marks)

1. What is creep? How is it prevented?

2. What do you mean by sleeper density?

3. Write Cole's method to determine the number of crossings.

4. State the principles of interlocking.

5. Explain the terms 'cross wind component' and 'wind coverage'.

6. What is clear zone?

7. What is the purpose of a hangar?

8. List the various types of marking on runway.

9. Distinguish between 'tides' and 'waves'.

10. Why is dredging so essential in port operations?

25

14. (a) (i) What are the facilities to be provided in the terminal building of an international airport. (8)

(ii) Describe the importance of runway lighting. Explain threshold lighting with the help of sketches. (8)

Or

(b) (i) List the various types of motor vehicle parking. (6)

(ii) Discuss the importance of air traffic control and list the various aids needed for enroute air traffic control. (10)

15. (a) (i) What are the requirements of a good port? (6)

(ii) Classify harbours on the basis of utility and explain them. (10)

Or

(b) Distinguish between wet docks and dry docks. Describe the operation of the various dry docks with sketches. (16)

27

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 51236

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fifth Semester

Civil Engineering

CE 2303/CE 52 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulation 2008)

(Common to PTCE 2303 – Railways Airport and Harbour Engineering for B.E. (Part-Time) Fourth Semester – Civil Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between LRT and MRTS.
2. What are the functions of formation?
3. What are the sources of moisture in a railway track?
4. List the various types of gradients that are adopted in laying a railway track.
5. Mention the various imaginary surfaces around the airport.
6. What is an Airport Master Plan? State the steps in its formulation.
7. List the factors affecting airport operating capacity?
8. What are the different types of aircraft parking systems?
9. What do you understand about littoral drift?
10. Differentiate between 'neap tide' and 'spring tide'.

PART B — (5 × 16 = 80 marks)

11. (a) Compare the advantages and disadvantages of wooden, concrete and steel sleepers.

Or

(b) (i) What would be the permissible speed on the curve, if on an 8° M.G. track, the average speed of different trains is 50 kmph and allowable cant deficiency is half that of maximum cant deficiency. Give your inference on speed limit board. (10)

(ii) What do you understand by the following terms for the section of the track "Grade compensation on curves" and "Widening of gauge". (6)

12. (a) How stations classified? Explain the features of each station.

Or

(b) Describe the followings:

(i) Necessity of track maintenance (6)

(ii) Essentials of good track maintenance (5)

(iii) Advantages of proper track maintenance. (5)

13. (a) What are the basic patterns of runway configurations? Discuss each pattern.

Or

(b) The length of runway under standard conditions is 1620 m. The airport site has an elevation of 270 m. Its reference temperature is 32.90° C. If the runway is to be constructed with an effective gradient of 0.20%, determine the corrected runway length.

14. (a) Write a detailed note on visual aids in airports.

Or

(b) What are the factors to be considered for the selection of site of an airport? Explain the importance of each factor. Discuss the critical issues involved.

15. (a) Explain the different types of wind-rose diagrams used for finding the harbour entrance.

Or

(b) Write a detailed note on break waters.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21255

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fifth Semester

Civil Engineering

CE 2303/CE 52/10111 CEE 49 – RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulations 2008/2010)

(Common to PTCE 2303/10111 CEE 49 Railways, Air ports and Harbour Engineering for B.E. – (Part–Time) Fourth Semester – Regulations 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the classification of gradients.
2. On a Broad gauge track of 4° curve equilibrium cant is provided for a speed of 60 Km/hr calculate value of equilibrium cant.
3. List the type of signals based upon functional characteristics.
4. What is a buffer stop?
5. What are the factors influencing the runway length based on safety requirements?
6. State the primary functions of an airport drainage system.
7. List the factors affecting airport operating capacity.
8. What are the different types of aircraft parking systems?
9. Distinguish between 'tides' and 'waves'.
10. Why is dredging so essential in port operations?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the permanent way components with a neat sketch.

Or

(b) Explain in detail about rail fastenings and [illegible]

12. (a) Illustrate with a neat sketch, the turnout, points and crossings and explain their working principles.

Or

(b) How are Railway stations classified? Explain the features of each station.

13. (a) What are the basic patterns of runway configurations? Discuss each pattern.

Or

(b) The length of runway under standard conditions is 1620 m. The airport site has an elevation of 270 m. Its reference temperature is 32.90° C. If the runway is to be constructed with an effective gradient of 0.20%, determine the corrected runway length.

14. (a) Enlist and explain the factors to be considered for the selection of site of an airport. Discuss the critical issues involved.

Or

(b) (i) What are the different types of terminals? Explain its concepts with neat sketches. (8)

(ii) Describe the principle of operation of ILS with the help of a diagram. (8)

15. (a) (i) What are the requirements of a good port? (6)

(ii) Classify harbours on the basis of utility and explain them. (10)

Or

(b) Distinguish between wet docks and dry docks. Describe the operation of the various dry docks with sketches.

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 51255

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fifth Semester

Civil Engineering

CE 2303/CE 52/10111 CEE 49 – RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulations 2008/2010)

(Common to PTCE 2303/10111 CEE 49 Railways, Airports and Harbour Engineering for B.E. – (Part-Time) Fourth Semester – Regulations 2009/2010)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

Define sleeper density.

Sketch the cross-section of the permanent way.

List the components of a switch.

Differentiate between 'loop' and 'siding'.

What are the factors influencing the runway length based on safety requirements ?

State the primary functions of an airport drainage system.

Define calm period.

Why is airport Zoning important ?

Write down the equation used for finding the harbour entrance.

Differentiate between a 'wharf' and a 'jetty'.

PART - B (5 × 16 = 80 marks)

11. (a) What is a sleeper ? List the functions, types of sleepers and compare one another.

OR

(b) (i) What do you understand by 'cant deficiency' ?

(ii) Explain the widening of gauge on curves with the formula.

12. (a) Determine all the elements of a turnout, when the following data is given :

Heel Divergence = 13.65cm

Angle of Switch = 1° 34'27"

Gauge = 1.676 m

Number of Crossing = 8.5

OR

(b) What are the different systems of controlling the movement of trains ? Explain the working principle of the system(s) which has been widely used on Indian Railways.

13. (a) (i) Length of a runway at mean sea level, standard temperature and Zero gradients is 1600 m. The site has an elevation of 320 m, with a references temperature 33.6°C. The runway has to be constructed with, an effective gradient of 0.25%. Determine the actual length of the runway at the site. (10)

(ii) Write the construction procedure of the wind rose diagram. (6)

OR

(b) (i) Following are average wind data for 10 years when wind Intensity is above 6 Km/hr. An airport is to be designed for a single runway. Determine the best runway orientation and calculate total wind coverage and draw the wind rose diagram. **(8)**

Wind direction	N	NNE	NC	ENE	E	ESE	SE	SSE	S	SSW
Percentage of time	10.9	8.3	4.2	1.3	0.9	0.3	8. 1	7.9	14.6	9.8
Wind direction	SW	WSW	W	WNW	NW	NNW				
Percentage of time	5.6	1.8	0.3	0.2	7.5	5.7				

(ii) Write short notes on :

(1) Airport drainage **(4)**

(2) Factors considered in taxiway design. **(4)**

(a) Enlist and explain the factors to be considered for the selection of site of an airport. Discuss the critical issues involved.

OR

(b) (i) What are the different types of terminals ? Explain its concepts with neat sketches. **(8)**

(ii) Describe the principle of operation of ILS with the help of a diagram. **(8)**

(a) Describe briefly the functions of fixed and floating signals with necessary sketches.

OR

(b) Explain the different types of wind-rose diagrams used for finding the harbour entrance.

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 80219

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Sixth Semester

Civil Engineering

CE 6604 — RAILWAYS, AIRPORTS AND HARBOUR ENGINEERING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the functions of ballast in a railway track?
2. What do you mean by crossing?
3. What are the methods to improve the poor subgrade soil?
4. What is a marshalling yard?
5. Write a short note on hangar.
6. List the different types of aircraft parking systems.
7. What is the significance of wind rose diagram?
8. State the importance of airport zoning.
9. What are the requirements of a good port?
10. Differentiate between a Pier and a Quay.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Elucidate the advantages of railways over the other modes of transport. (8)

(ii) Draw a neat sketch of the permanent way and explain the functions of different components. (8)

Or

(b) (i) Derive an expression for the relationship between super elevation, gauge and curve in a railway track. (8)

(ii) Discuss the functions and requirements of various elements of railway permanent way. (8)

12. (a) Explain the operations involved in plate laying by the telescopic method. (16)

Or

(b) Explain the methods of maintenance of tracks. (16)

13. (a) (i) Discuss the merits and demerits of air transport. (8)

(ii) Explain the planning concept of airport buildings. (8)

Or

(b) Explain the factors to be considered for the selection of site for an airport. (16)

14. (a) (i) Explain the different runway geometrics as recommended by ICAO. (8)

(ii) The length of runway under standard conditions is 600 m. The airport site has an elevation of 100 m and reference temperature is 28° C. If the runway is to be constructed with an effective gradient of 0.5%, determine the corrected runway length. (8)

Or

(b) (i) What are the basic patterns of runway configurations? Discuss each pattern. (8)

(ii) Explain the elements of airport lighting with neat sketches. (8)

15. (a) (i) Explain the classification of harbours. (8)

(ii) Explain the different components of a port with a neat sketch. (8)

Or

(b) (i) Explain the different types of breakwaters with neat sketches. (8)

(ii) Explain the salient features of Coastal Regulation Zone Notification 2011. (8)
