BUDDHA SERIES

(Unit Wise Solved Question & Answers)

Course – B.Tech (Civil)

College – Buddha Institute of Technology

(AKTU CODE-525)

Department: Civil Engineering

Subject: Railways, Airport & Waterways (KCE 070)

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Unit - 4

Que 1. What are the various characteristics of aircraft to be studied for airport? How orientation of airport is decided?

Answer

A. **Aircraft Characteristics**: Following are the characteristics of a conventional type aircraft:

1. **Aircraft Capacity:** The capacity of aircraft will determine the number of passengers, baggage, cargo and fuel that can be accommodated in the aircraft. The terminal facilities are planned to receive the aircraft of the highest capacity likely to land.
2. **Aircraft Speed**: The aircraft speed is referred in many ways. The difference between the following two terms is worth noting:

1. **Air speed:** This term is used to mean the speed of the aircraft. relative to the medium in which it is travelling.
11. **Ground speed:** It is referred to as the cruising speed is the speed of the aircraft relative to the ground.

3. **Aircraft Weight and Wheel Arrangement**: It is necessary to understand the components c-f aircraft which make up its weight during take offs and landings because weight is one of the major factor which will govern the length and thickness of a runway. The wheel arrangements or configurations also play a similar role.
4. **Fuel Spilling:** The spilling of fuel and lubricants is usually found in the loading aprons and hangars. The pavement of bituminous material is seriously affected by the fuel spilling.
5. **Jet Blast**: The turbo jet and turbo prop aircrafts eject hot exhaust gases at relatively high velocities. The velocity of jet blast may be as high as 300 km ph and it may even cause inconvenience to the passengers boarding the aircraft.
6. **Minimum Circling Radius**: A certain minimum radius in space is required for the aircraft to take smooth turn. It is1' known as the minimum circling radius and it depends upon the type of aircraft, air traffic volume and weather conditions.
7. **Minimum Turning Radius** : It is necessary to know the minimum turning radius of an aircraft to decide the radius of taxiways and to ascertain its position in the landing aprons and hangars.
8. **Noise:** The most serious problem facing aviation is the noise and efforts are made to bring it to the minimum possible level
9. **Range** : The distance that an aircraft can fly without refueling is known as the range.
10. **Size of Aircraft** : The principal dimensions of an aircraft. They are as follows:

1. **Fuselage Length:** The length of aircraft decides the widening of taxiway on curves, size of aprons and hangers.
2. **Gear Tread** : It is the distance between the main gears and it governs the minimum turning radius of the aircraft.
3. **Height:** The height of an aircraft decides the height of the hanger gate and other miscellaneous installations inside the hangar.
4. **Tail Width:** The tail width of an aircraft wingspan of an aircraft helps in deciding the size of the parking and apron.
5. **Wheel Base** : The wheel base of an aircraft decides the minimum radius

of the taxiway.

6. **Wing Span: It** governs the width of taxiway, clearance distance between two parallel traffic ways, size of aprons and hanger, width of hangar gate, etc.

11. **Takeoff and Landing Distance** : The takeoff and landing distances for an aircraft will help in determining the minimum runway length required for a particular type of aircraft.

12. **Type of Propulsion** : The method of propulsion adopted for a particular aircraft will decide the size, speed, weight carrying capacity, noise nuisance, circling radius, etc.

13. **Tyre Pressure and Contact Area:** The tyre pressure and the wheel load will give an indication of the width, type and strength of pavement required for the different types of aircraft.

Que 2. Explain the necessity of airports classification. Give different systems of classification of airports. [AKTU 2016-17, 10 Marks]

Answer

A **Necessity of Airports Classification** : There are several ways of distinguishing between airport types depending upon the circumstances that gave rise to their existence. This combination embraces many causes, ranging from the historical, the functional and the geographical. These causes are interactive, complicating any grouping procedure. Hence airport classification is necessary *in* order to impose some mean of categorizing the infrastructure so as to allow generalization.

B. **Classification of Airports** : Following are the classification of airports :

1. **Based on Functions** :

i. **Heliports** : Meant for helicopters.

ii. **STOL Ports** : Meant for short take off and landing.

iii. **Conventional** : Meant for normal commercial aircraft.

1v. **Sea Plane Bases (Aqua Ports or Seadromes):** Those which float on the sea.

2. **Based on Usage of Ownership** :

i. **Public** : Owned by the government.

ii. **Private** : Owned by individuals.

iii. **Military:** Used for military purposes only.

iv. **Joint Use:** Used by both civil and military aviation.

3. **Based on Facilities Available:**

i. Number and type of runway.

ii. Navigational aids.

4. **Based on types of Aircraft Designed to Serve** :

i. **Basic Utility (BU) Airport** : Accommodates most single engine and light twin-engine aircrafts.

ii. **General Utility (GU) Airport:** Additionally accommodates medium twin-engine aircraft under 5670 kg.

iii. **Basic Transport (BT) Airport** : Can handle business jets under 27,200 kg.

iv. **General Transport (GT) Airport:** Can accommodate almost anything

that flies.

Que 3. Explain briefly the various factors considered in the selection of site for airport. [AKTU 2018-19, 10 Marks]

Answer

Following are the factors which considered in the selection of site for airport:

1. **Atmospheric and Meteorological Conditions** :
   i. The presence of og, haze, and smoke reduces the visibility and the poor visibility lowers the traffic capacity of an aircraft.
   ii. The detailed analysis available weather records of all the potential sites will be helpful in recommending that site which has the characteristics commensurate with the aviation needs.
   iii. The wind data should also be studied and to have minimum blowing of smoke from the city, the site should be located on the windward direction.
2. **Availability of Land for Expan ion** : The field of aviation is expanding day by day. It is therefore necessary to acquire land in advance or to be able to acquire sufficient real estate in the future for expanding the airport.
3. **Availabilities of Utilities:** An airport, especially a large one, has to be provided with the utilities like water electric power, telephone, ewer, etc.
4. **Development of the Surrounding Area:** The study of the type of development of the surrounding area is very important because the airport activities, particularly from the standpoint of noise, are often quite objectionable to the neighbours of the airport.
5. **Economy of Construction** :
   i. It is clear that if alternative sites are available and equally well-suited, the site which is more economical to construct should be **given** preference.
   ii. The availability of local construction materials may also have a significant impact on the cost of the project.
6. **Ground Accessibility** : The location of the airport should be such that it results in the shortest ground access time.
7. **Presence of other Airports** :
   i. The airport should be located at a sufficient distance apart.
   ii. This is necessary to prevent the aircrafts which are maneuvering for a landing at one airport from interfering with the movements of the aircrafts at other airports.
   iii. If this precaution is not taken, there will be severe air traffic congestion due to limited airspace and it will result in the reduction of airport capacity.
8. **Regional Plan:** The airport site should be selected in such a way that it fits appropriately in the regional plan. Such an airport will !Jrm an integral part of the national airport network.
9. **Soil Characteristics** : The airport site with the favourable soil characteristics is desirable because it reduces the cost of grading and drainage to a considerable extent. The area should as far as possible be self drained.
10. **Surrounding Obstructions** :
    1. The airport site should be clear of the obstructions likely to

interfere with the landing and takeoff operations of the aircrafts.

ii. The obstructions may either be natural like trees, sloping ground, etc., or man-made like buildings grid towers, etc.

iii. The removal of the obstructions surrounding the airport site is absolutely necessary to grant safety to the aircraft activities relating to losing or gaining altitude gradually.

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11. Topography : The topographical features like ground contours, trees stream, etc., should be studied while selecting the site for an airport. A raised groWld like a hill top is usually considered to be an ideal site for an airport.

12. Use of Airport : The airport site is decided also by the use of airport, *i.e.*, civil or military. In case of an emergency like war, the civilian airports are taken over by the military. It is therefore necessary to see that the airport site grants natural protection from possible air attacks during war.

Que 4. For the planning of an airport; mention in brief various surveys required to be conducted for collecting various details.

Answer

The airport surveys can be grouped in the following seven categories:

1. Approach Zone Survey:

i. The term approach zone is used to indicate the wide clearance area on either side of runway along the direction of landing and takeoff of an airport.

ii. The approach zone survey forms a part of the topographical survey extended beyond the proposed area of the airport in the direction of the approach zone.

iii. The main aim of this survey is to establish the elevations of the tops of the objects within the airport zone in general and within the approach zone in particular.

iv. It thus helps in the determination of the locations of the objects protruding above ground level and which may prove to be hazardous during the landing and takeoff of the aircrafts.

2. Drainage Survey :

i. It is necessary to have complete data about the sources of water and the quantities of water to be handled near the airport site.

ii. The water reaching the airport has to be intercepted and diverted in a proper way.

iii. The drainage survey also ascertains that the pavement of airport will not be submerged during floods or heavy rains.

iv. The details and information obtained during this survey prove to be very much useful in the design of the airport drainage facilities.

3. Meteorological Survey : In the meteorological survey, the study of weather and climate is made and ifrequired, the help of an experienced meteorologist is also taken.

4. Natural Resources Survey :

i. This survey is aimed to collect complete information about the locally available construction materials, their varieties and quantities, the possible methods of transport to bring them to the site and the econ0my of their use.

ii. The availability of a natural stream as a source of water supply is also included under this survey.

iii. The information and details gathered in this survey prove useful in the construction and maintenance aspects of the airport.

5. Soil Survey :

i. The subgrade soil supports the runway and other structures of the airport.

ii. Hence, the knowledge of soil is considered to be very important to an airfield engineer.

6. Topographical Survey: In this survey, the surface features like hills, rivers, levels, etc., of the region are measured and studied.

7. Traffic Survey:

i. In this urvey, the investigations are carried out to predict the probable amount of traffic including the expected future traffic.

ii. For the purpose of convenience, the details to be gathered during the traffic survey are grouped in the following two categories:

a. For a new airport.
b. For improvement of an existing rurport.

Que 5. Discuss the factors to be considered in runway orientation.

Answer

Following are the factors to be considered in runway orientation:

A. Preliminary Information Required: It is necessary to collect the following data before deciding the orientation of the runway:

1. Maps of the area in the vicinity of the airport showing contours at suitable intervals.
2. Records of direction, force and duration of the wind in the vicinity and fog characteristics of the area for as long a period as possible.

B. Head Wind:

1. The runway is usually oriented in the direction of the prevailing winds.
2. The head wind indicates the wind from the opposite direction of the head or nose of the aircraft while it is landing or taking off.
3. The orientation of runway along the head wind grants the following two advantages:

i. During landing, it provides a breaking effect and the aircraft comes to a stop in a short length of the runway.

ii. During takeoff, it provides greater lift on the wings of the aircraft.

4. If the landing and takeoff were in the direction of wind, reduction in length of runway may be about 10 %.

C. Cross Wind Component:

1. It is not possible to get the direction of opposite wind parallel to the centre line of the runway length every day or throughout the year.
2. For some period of the year at least, the wind may blow making some angle 9 with the direction of the centre line of the runway length as shown in **Fig.** 4.5.1.

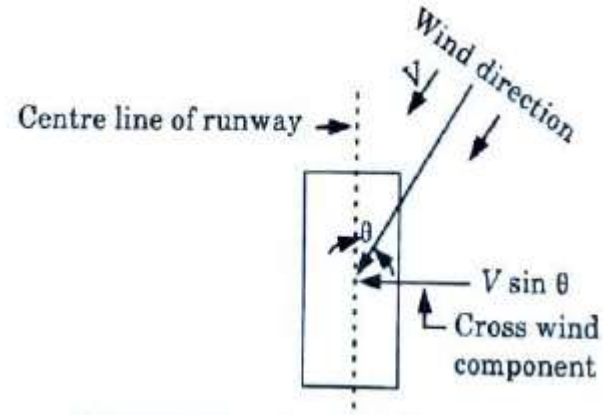


Fig. 4.5.1. Cross wind component.

3. If *V* km/hr is the velocity of the inclined opposing wind, its component *V* sin 8, which is normal to the centre line of the runway length, is called the cross wind component.
4. If this component is in excess, it will interrupt the safe landing and takeoff operations.
5. The orientation of the runway should therefore be such that this component is kept to a minimum.
6. For light and medium weight aircrafts, the cross wind component should not exceed 25 km/hr.

D. Wind Coverage :

1. The percentage of time in a year during which the cross wind component remains within the limit of 25 km/hr is called the wind coverage of the runway.
2. The orientation of the runway should be such that the minimum wind coverage of about 95 % is obtained.
3. For busy airports it is possible to obtain wind coverage up to 98 % **or** even 100 %.

E. Wind Rose :

1. For the airport, the average wind data of 5 to 10 years period are collected and represented graphically in the form of a chart known as wind rose.
2. The diagram is given the na;me wind rose because of its irregular shape resembling a rose.
3. The study of wind rose helps in determining the most suitable orientation of the runway.
4. It is also a useful diagram for estimating the runway capacity.
5. It is as&umed that the duration of wind for any one direction covers an angle of 22.5° as shown in Fig. 4.5.2.

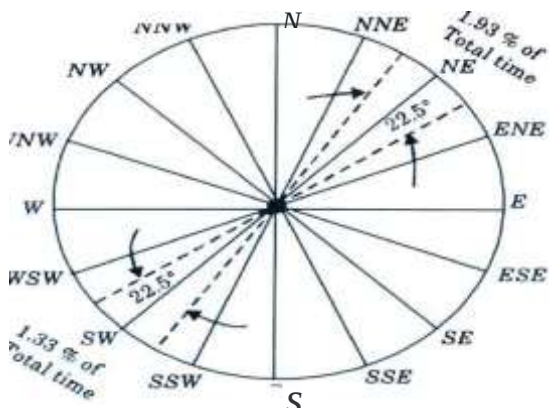


Fig. 4.5.2. Angle showing wind coverage.

The plotting of the wind rose diagrams can be done in the following two ways:

i. Type I: Showing direction and duration of wind.

ii. Type II:Showing direction, duration and intensity of wind.

i. Type I-Wind Rose:

a. Fig. 4.5.3 shows the wind rose diagram of this type.

b. The radial lines indicate the wind direction and each circle represent the duration of wind to a certain *scale.*

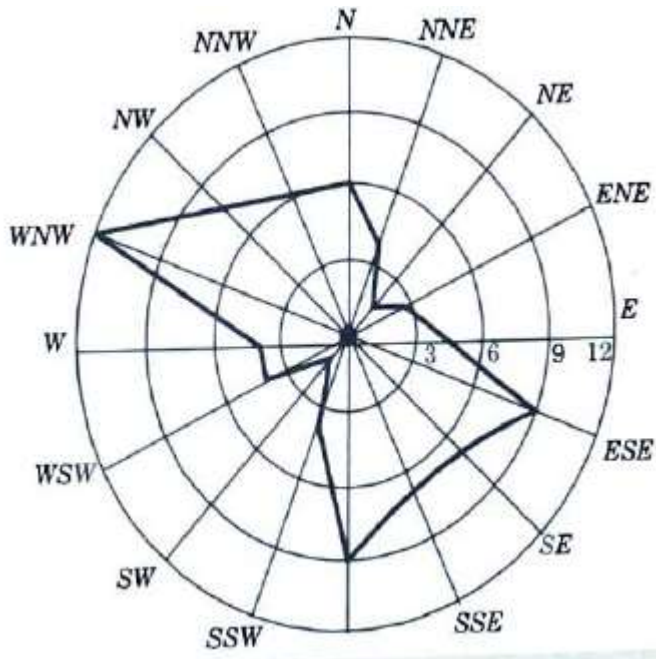


Fig. 4.5.8. Wind rose diagram showing direction and duration of **wind.**

c. The best direction ofrunway is indicated along the direction of the longest line on the wind rose diagram.

d. In Fig. 4.5.3, *WNW-ESE* is the best orientation for the runway.

e. This type of wind rose does not consider the effect of the cross wind component.

ii. Type II•Wind Rose :

a. This diagram shows the direction, duration and intensity of the winds.

b. In Fig. 4.5.3, each circle represents the wind intensity to some scale.

Que 6. What is wind rose diagram ? Explain the procedure of determining the runway orientation.

Answer

A. Wind Rose Diagram : Diagram used for the graphical representation of the average wind data of 5 to 10 years period for an airport is called wind rose diagram.

B. Procedure: The procedure of determining the runway orientation is as follows:

1. Draw concentric circles with radii corresponding to 6, 25, 50 and 80 km/hr to some scale. Thus each circle represents the wind velocity to some scale.
2. Starting with centre of the concentric circles, the 16 radial directions are shown on the outer circle. The mid-points of 16 arcs on the outermost

concentric circle are marked and they are given the cardinal direction of compass *likeN,NNE,NE, ENE, E,* etc.

3. The recorded duration of winds and expressed as percentage are shown for each cardinal direction in the sector pertaining to that direction. It may be noted that the cardinal direction is central to its sector.
4. Taking the wind data for *N* direction, the duration of 6-25, 25-50 and 50-80 km/hr wind velocities are shown on 3 pertinent parts of the *N* direction sector as 4.6, 1.4 and 0.1 percent. Similarly, for the *NNE* direction, the durations in the sector of *NNE* direction are shown as 3.4, 0.75 and 0.00 percent.
5. The durations of wind velocities are thus shown in all the sectors to complete the wind rose diagram.
6. A transparent rectangular template or paper strip is taken. Its length shou1d be slightly greater than the diameter of the wind rose diagram and its width should be greater than twice the allowable cross wind component *i.e.,* (2 x 25) = 50 km/hr.
7. The scale for cross wind component should be the same as that of the concentric circles of the wind rose diagram. Along the centre of the length of this template, a line is marked corresponding to the direction of runway.
8. The two parallel hoes, one on either side of the centre line is drawn at a distance equal to the allowable cross wind component *i.e.,* 25 km/hr from the centre line. In other words, the two parallel lines are 50 km/hr away from each other.
9. The wind rose diagram is fixed in position on a drawing board. A hole is drilled in the centre of the template and it is placed on the wind rose diagram such that its centre lies over the centre of wind rose diagram.
10. In this position, the template is fixed by a pin passing through its centre so that the template can rotate this pin as axis.
11. The template is rotated and is placed along a particular direction. In this position of the template, the duration of 6-25, 25•50 and 50-80 km/hr winds are read for the cardinal direction lying between the two extreme parallel lines marked on the template.
12. The sum of all these durations is expressed as the percentage and it gives the total *wind* coverage for that direction.
13. The template is then rotated and is placed in the next direction. The total wind coverage is calculated and the process is repeated for all the directions.
14. The direction which gives the maximum wind coverage is the suitable direction for the orientation of the runway.

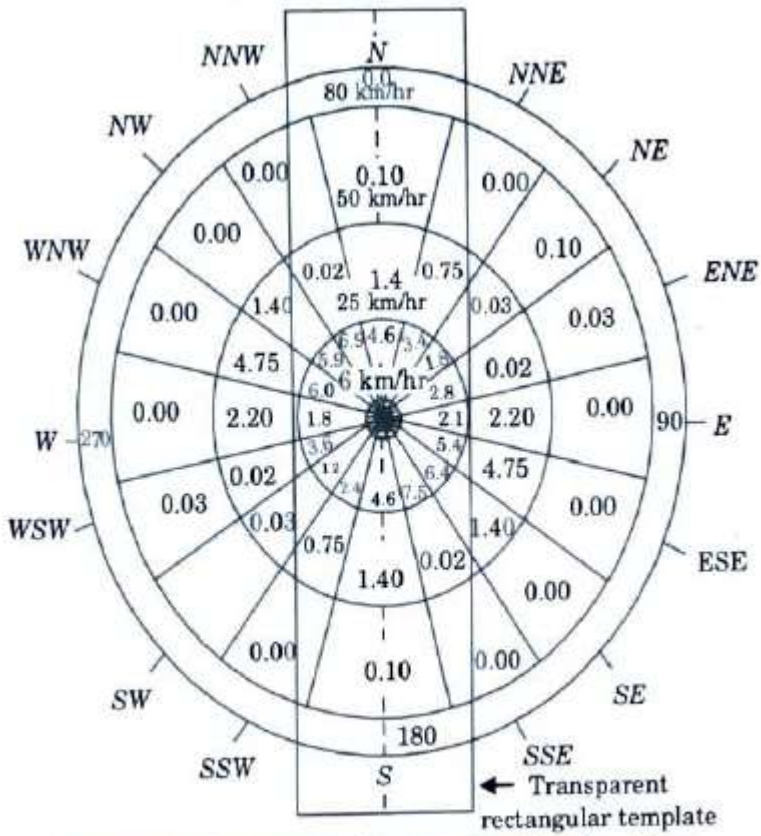


Fig. 4.6.1. Wind rose diagram showing direction, duration and intensity of wind.

Que 7. What is meant by the basic runway length? Discuss the three cases to be considered.

Answer

A. Basic Runway Length: The length ofrunway based on the following assumptions is known as the basic runway length.

1. No wind is blowing on the runway.
2. The aircraft is loaded on its full loading capacity.
3. The airport is situated at sea level.
4. There is no wind blowing on the way to the destination.
5. The runway is leveled in the longitudinal direction or in other words, it has zero effective gradient.
6. The standard temperature is maintained along the way.
7. The standard temperature of 15 °C exists at the airport.

B. Following are the Three Cases to be Considered :

1. Normal Landing:

i. The aircraft should come to a stop within 60 percent of the landing distance assuming that the pilot makes an approach at the proper speed and crosses the threshold of the runway at a height of 15 m.

ii. The beginning of the runway portion to be used as landing is known as the threshold.

iii. The runway of full strength pavement is provided for the entire landing distance.

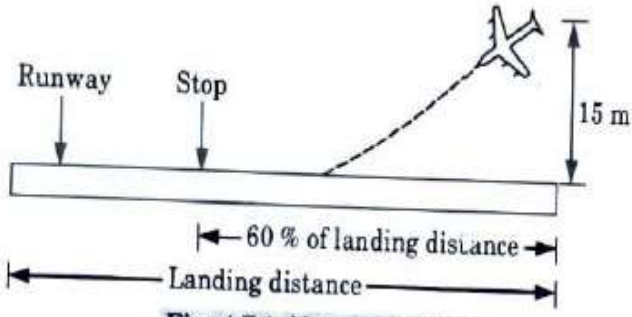


Fig. 4.7.1. Normal landing.

2. Normal Takeoff:

i. The takeoff distance (TOD) must be, for a specific weight of aircraft, 15 percent of the actual distance the aircraft uses to reach a height of 10.5 m.

ii. The distance to reach the height of 10.5 m should be equal to 115 percent of the lift-off distance (LOD).

iii. The normal takeoff requires a clearway which is defined as an area beyond the runway not less than 150 m wide, centrally located about the extended centre line of the runway and under the control of the airport authorities.

iv. It is expressed in terms of a clearway plane extending from the end of the runway with an upward slope not exceeding 1.25 percent.

v. It is to be seen that the clearway is free from any ob truction. The clearway should not be more than one half the distance between 115 percent of the LOO and TOD. Clearway should not be more than half this distance

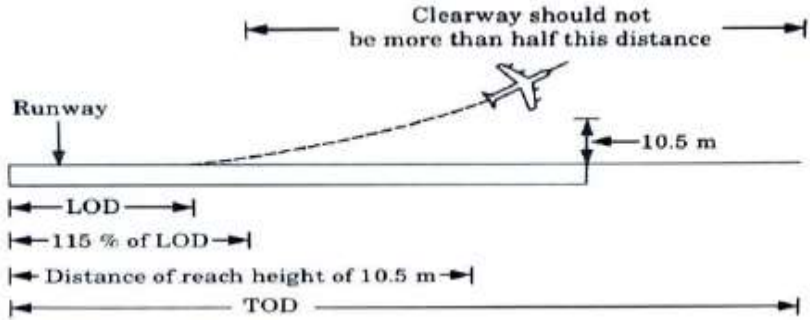


Fig. 4.7.2. Normal take off.

3. Stopping in Emergency:

i. For the engine failure case, the TOD is the actual distance required to reach a height of 10.5 m with no percentage applied.

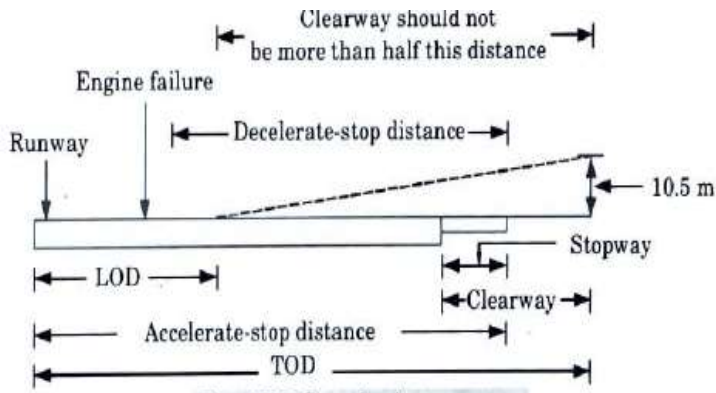


Fig. 4.7.3. Stopping in emergency.

ii. It also incidentally recognizes the infrequency of occurrence of the engine failure.
iii. In case of an engine failure, sufficient distance should be available to stop the airplane rather than continue the takeoff. This distance is known as the accelerate stop distance. It is required to provide a clearway or a stopway or both in this case.
iv. The stopway is defined as a rectangular area at the end of runway and in the direction of takeoff.
v. It is a paved area in which an aircraft can be stopped after an interrupted takeoff due to engine failure.
vi. Its width is at least equal to the width of runway and the thickness of pavement less than that of the runway, but yet sufficient to take the load of aircraft without failure.
vii. The clearway should not be more than one half the difference between TO D and LOD.

Que 8. Describe the corrections to be applied to the calculated basic runway length to get its actual length.

Answer

Corrections to Basic Runway Length: To get actual length of the runway, the following three corrections are to be applied to the calculated basic runway length.

1. Correction for Elevation:

i. As per the recommendation of ICAO, the basic runway length should be increased at the rate of 7 percent per 300 m rise in elevation of airport above the mean sea level.

ii. This correction is required because the air density reduces as the elevation increases which in turn reduces the lift on the wings of the aircraft.

iii. Thus, the aircraft wiJI require more ground speed to rise to the air and for achieving more speed longer length of runway will be required.

2. Correction for Gradient:

i. As the gradient becomes steep, more consumption of energy takes place and longer length of the runway will be required to attain the desired ground speed.

ii. The ICAO does not give any specific recommendation for the increase in length due to the effective gradient.

iii. The maximum difference in elevation between the highest and the lowest points of runway divided by the total length of runway is known as the effective gradient.

iv. According to FAA (Federal Aviation Administration) of USA, the runway length after being corrected for elevation and temperature should further be increased at the rate of 20% for every 1% of the effective gradient.

3. Correction for Temperature :

i. The rise in airport reference temperature has the same effect as that of the increase in its elevation above mean sea level.

ii. After the basic length is corrected for the elevation of airport, it is further increased at the rat.e of 1% for every 1 °Crise in airport reference temperature above the standard atmospheric temperature at that elevation.

iii. The airport reference temperature (ART)is worked out by the following expression:

Airport reference temperature (ART)= $T_1 + \frac{T_2 - 1}{3}$

where, T_1 = Monthly mean of the average daily temperature for the hottest month of the year.
T_2 = Monthly mean of the maximum daily temperature for the same month.

Que 9. At an airport site at sea level with standard atmospheric conditions, the runway lengths required for takeoff and landing are 2000 m and 2400 m respectively. The proposed airport is situated at an altitude of 150 m. If the airport reference temperature is 25°C and if the effective runway gradient is 0.35 %, calculate the length of runway to be provided. [AKTU 2017-18, Marks 10]

Answer

Given: Runway length for takeoff= 2000 m, Runway length for landing= 2400 m, Altitude= 150 m, Airport Reference temperature (ART) = 26 °C, Gradient = 0.35 %
To Find: Length of runway provide.

A. Corrections to Runway Take off Length:

1. Correction for elevation *(Ce)*:
The basic length is to be increased at the rate of 7 % per 300 m elevation above mean sea level.

$$C_e = \frac{7}{100} \times 2000 \times \frac{150}{300} = 70 \text{ m}$$

Corrected length = 2000 + 70 = 2070 m

2. Correction for temperature (C_t)
   i. Standard atmospheric temperature at mean sea level= 15 °C.
   ii. Taking the temperature gradient as equal to 6.5 °C per 1000 m rise in elevation, the standard temperature at the airport site will be.

Standard temperature= $(15° - \frac{6.5}{1000} \times 150) = 14.03$ °C

$$C_t = 2070 \times \left(\frac{25 - 14.03}{1}\right) \times \frac{1}{100} = 227.08 \text{ m}$$

   iii. Corrected length for temperature and elevation= 2070 + 227.08
= 2297.08 m

Check: Total increase in length= $\frac{2297.08 - 2000}{2000} \times 100$
= 14.85 % < 35 %

3. Correction for gradient (C_g):

$$C_g = 2297.08 \times \frac{0.35}{1} \times \frac{20}{100} = 160.80 \text{ m}$$

Correct length for temperature, elevation and gradient
= 2297.08 + 160.80 = 2457.88 = 2458 m.

B. Correction to Runway Landing Length:

1. Correction for elevation (Ce):

$$C_e = -\frac{7}{100} \times 2400 \times -\frac{150}{300} = 84 \text{ m}$$

2. Corrected length for elevation = 2400 + 84 = 2484 m

C. Adopting higher of the two values (2458 m, 2484 m)

Actual length of runway = 2484 m

Que 10. An airport is proposed at an elevation of 600 m above Mean Sea Level where the mean of maximum and mean of average daily temperatures of the hottest 3 month are 45.6 °C and 28.2 °C respectively. The maximum elevation difference along the proposed profile of the runway is 6.3 m. If the basic length of the runway is 1550 m, determine the actual length of runway to be provided. [AKTU 2017-18, Marks 10]

Answer

Given: Elevation= 600 m, Maximum temperature= 45.6 °C, Mean temperature = 28.2 °C, Difference in elevation = 6.3 m
Length of runway = 1550 m
To **Find:** Actual length of runway.

1. Correction for Elevation:

i. The basic length is to be increased at the rate of 7 % per 300 m elevation above mean sea-level.

$$\text{Correction for elevation} = \frac{7}{100} \times \frac{600}{300} \times 1550 = 217 \text{ m}$$

ii. Length of runway after correction for elevation
= 1550 + 217 = 1767 m.

2. Correction for Temperature:

i. Airport reference temperature= $T_1 \frac{T_2 - T_1}{3}$

$$\text{Airport reference temperature} = 28.2 + \frac{45.6 - 28.2}{3} = 34 \text{ °C}$$

ii. Standard atmospheric temperature at mean sea-level = 15 °C rn.

iii. Rise in temperature = (34 - 15) = 19 °C

iv. Applying correction at the rate of 1% for every 1 °C,

v. $$\text{Correction for temperature} = \left(-\frac{1}{100} \times 1767\right) \times 19 = 335.73, \text{ say } 336 \text{ m}$$

Corrected length= (1767 + 336) = 2103 m

3. Total correction for elevation and temperature
= (217 + 336) = 553 m

4. Percentage increase = $\frac{553}{1550} \times 100 = 35.68\ \%$

5. According to ICAO, this should not be more than 35 %.

So, corrected length= $2103 \times \frac{35}{35.68} = 2063$ m

6. Correction for Gradient:

i. Effective gradient = $\frac{6.3}{155} \times 100 = 0.4\ \%$

ii. Applying correction for the effective gradient at the rate of 20 % for each 1 % effective gradient,

iii. Correction for gradient = $\left(\frac{20}{100} \times 2063\right) \times \frac{0.4}{1} = 165$ m

7. **Actual** length of runway = (2063 + 165) = 2228 m

Que 11. An airport is planned at an elevation of 380 m above MSL. The monthly mean of maximum and average daily temperatures for the hottest month at the site are 40 °C and 28 °C respectively. The effective gradient is 0.18 percent. Determine the length of runway required at the proposed site if the basic runway length is 1900 m. [AKTU 2018-19, Marks 10]

Answer

Given: Elevation above **MSL** = 380 m, T = 28 °C, T_2 = 40 °C, Effective gradient = 0.18 %, Basic runway length = 1900 m.

To Find: The length of runway required at the proposed site.

1. Correction for elevation, $C = \frac{7}{100} \times 1900 \times \frac{380}{300} = 168.47$ m

Corrected length of elevation= 1900 + 168.47 = 2068.47 m

2. Correction for temperature, C_1:

i. Airport reference temperature = $\frac{2 + T - T_1}{3}$

$= 28 + \frac{40 - 28}{3} = 32^0$C

ii. Standard temperature = $15 - x\frac{380}{1000} = 12.53$ °C

$C_1 = \frac{1}{100} \times 2068.47 \left(\frac{32 - 12.53}{1}\right) = 402.73$ m

iii Corrected length for temperature and elevation = 2068.47 + 402.73

= 2471.20m

3. Correction for gradient,

$C_g = 2471.20 \times \frac{0.18}{1} \times \frac{20}{100} = 88.96$ m

Corrected length for temperature, elevation and gradient

= 2471.20 + 88.96 = 2560.16 m = 2561 m

4. So actual length of runway = 2561 m

Que 12. The RLs of highest and lowest points along the length of a runway of above said airport are 98:5 and 96.5, apply correction for effective gradient and find the final corrected length of runway. [AKTU 2016-17, Marks 10]

Answer

Given: RL of highest point along length of a runway= 98.5 m,

RL of lowest point along length of a runway = 96.5 m
To Find: Correction for effective gradient and final corrected length of runway.
Assume Data: Length ofrunway = 1000 m

1. Effective gradient= $\frac{98.5 - 96.5}{1000} = 2 \times 10^{-3} = 0.2\ \%$
2. Applying correction for the effective gradient at the rate of 20 % for each 1 % effective gradient.
3. Correction for gradient,
$$C_g = \frac{20}{100} \times 1000 \times \frac{0.2}{1} = 40\ \text{m}$$
4. Final length of runway = 1000 + 40 = 1040 m

Que 13. The runway length required for landing at sea level in standard atmospheric condition is 3000 m. Runway length required for takeoff at a level site at sea level in standard atmospheric conditions is 2500 m. Aerodrome reference temperature is 25 °C and that of the standard atmosphere at aerodrome elevation of 150 mis 14.025 °C. If the effective runway gradient is 0.5 %, determine the runway length to be provided.

Answer

Given: Runway length for landing = 3000 m, Runway length for takeoff = 2500 m, Aerodrome reference temperature = 25 °0, Elevation= 150 m, Standard atmospheric temperature= 14.025 °C, Effective runway gradient= 0.5%
To Find: Runway length to be provided.

1. **Correction to Runway Takeoff Length**:
   i. Runway takeoff length corrected for elevation
$$= [2500 \times \frac{7}{100} \times \frac{150}{300}] + 2500 = 2587.50\ \text{m}$$
   ii. Runway takeoff length corrected for elevation and temperature
   = **[2587.50 x (25-14.025) x 0.01] + 2587.50 = 2871.48 m**
   iii. Runway takeoff length corrected for elevation, temperature and slope
   = **(2871.48 x 0.05 x 0.2] + 2871.50 = 2900.22 =: 2901** ffi
2. **Correction to Runway Landing Length** :
   Runway landing length corrected for elevation
$$= [3000 \times \frac{7}{100} \times \frac{150}{300}] + 3000 = 3105\ \text{m}$$
3. **Actual** length of runway would be the higher of the two lengths (2901 m, 3105 m), so we are taking runway length as 3105 m.

Que 14. Briefly discuss the various geometric standards for the taxiway with special reference to the recommendation of the ICAO.

Answer

Following eight elements of the geometric standards for taxiway:

1. **Length of Taxiway** :
   i. The length of a taxiway depends upon the distance between the apron and entry end or exit end of the runway.
   ii. The limiting length of the taxiway is not recommended by any

organization. But to save fuel consumption, it should be as short as practicable.

2. Longitudinal Gradient:

i. If th longitudinal gradient is steep, there will be more consumption of fuel.

ii. The maximum longitudinal gradients recommended by the ICAO are as follows:

For A and C types of airport -1.5 % For D and E types of airport - 2 %

3. Rate of Change of Longitudinal Gradient :

i. The available sight distance on the pavement is affected by the rate of change of longitudinal gradient.

ii. The maximum rates of change of slope for *30* m length of vertical curve are recommended by the ICAO as follows :

a. For A and B types of airport - 0.1 %

b. For C types of airport - 0.2 %

c. For D and E type - 8.4 %.

4. Sight Distance:

i. The speed of the aircraft on the taxiway is lower than its speed on the runway. Hence, the smaller values of sight distance will be sufficient on the taxiway.

ii. With respect to the sight distance, the recommendations of the ICAO are as follows:

a. For A and B types of airports, the surface of the taxiway should be seen for a distance of 195 m from a point 2.10 m above the taxiway.

b. For C, **D** and E types of airports, the comparable dimensions are 300m and 3 m.

5. Transverse Gradient:

i. For quick disposal of the surface water, it is necessary to provide the transverse gradient for the taxiway.

ii. The ICAO recommends the following maximum transverse gradients :

a. For A, B and C types of airport - 1.5 %

b. For D and E types of airport - 2%

iii. The minimum transverse gradient is not specified. But it will be desirable to provide at least 0.50 percent of the transverse gradient.

The FAA however suggests that it should be 5 percent for the first 3 m width and 2 percent thereafter for all types of the airport.

6. Turning Radius :

i. A horizontal curve is to be provided whenever there is a change in the direction of the taxiway.

ii. It is necessary to design the curve in such a way that the aircraft can negotiate it without significantly reducing the speed.

iii. For this purpose, the circular curve oflarge radius is most suitable and its radius can be obtained by,

$$R = \frac{}{125f}$$

R = Radius of curve in m.
V = Speed of aircraft in kmph.
f = Coefficient of friction between the tyre and pavement surface (usually assumed as 0.13).

7. **Width of Safety Area** :
   i. The safety area of the taxiway is made up of partially paved shoulders on either side plus the area which is graded and drained.
   ii. It may extend upto a point where it intersects a parallel runway, taxiway or apron.
   iii. Before the advent of jet aircraft, the shoulders were giveneither of the following two treatments :
      a. Natural ground protected with low growing vegetation.
      b. Stabilized granular material coating where the soil or climatic conditions do not permit easy maintenance of plantation.

8. Width of Taxiway : The taxiway widths recommended by the ICAO are as follows :

i. For A and B types of airport - 22.5 m
ii. For C type of airport - 15.0 m
iii. For D type of airport - 9.9 m
iv. For E type of airport - 7.5 m.

Que 15. What are the aims of airport drainage ? Why is it Necessary

Answer

Aims of Airport Drainage : Following are the aims for providing airport drainage :

1. It grants longevity to the pavements.
2. It increases the efficiency of the airports.
3. **It** is essential for proper and safe functioning of the aircraft.
4. It reduces the maintenance cost of an airport.
5. It shortens the periods during which the airport might have to be kept out of use due to inundation, etc.

Reason:

1. If the sub-surface drainage system is improper, it may moisten and weaken the subgrade and thus, reduce its load bearing capacity, resulting in the failure of pavements of runways, taxiways, etc.
2. If the surface drainage system is improper, it may result in the ponding on the pavements of runways, taxiway and aprons which might prove hazardous to the takeoff and landing operations of the aircraft.
3. The closing down of the airport results in great loss in addition to the inconvenience of the passengers.

Que 16.Discuss airport drainage with a neat sketch.

Answer

Airport Drainage:

1. Airport drainage is very important for safe movement of the aircrafts.
2. When the runway surface is affected by water to any degree of wetness *(i.e.,* from dampto a flooded state), the friction levels provided by individual runways drop significantly from the dry value.

3. Degradation of available friction can have serious implications on safety, regularity and efficiency of operations.
4. Wet runways could be significant hazard and potential threat to flight operations.
5. Airport drainage characteristics should, therefore, be carefully studied and planned.
6. Standing or excessive water on the pavement or below the pavement reduces the structural ability of the airport pavement, and may result in early failure/deterioration.
7. Natural drainage at site is rarely sufficient to satisfy the needs of airports and artificial drainage system must therefore, be installed.

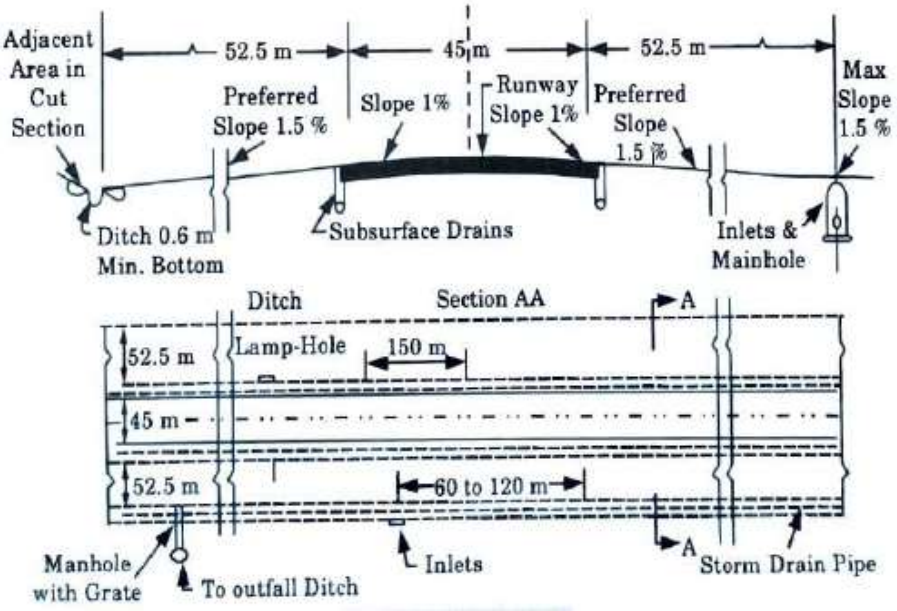


Fig. 4.16.1. Plan.

8. Adequate drainage system is required for :
   i. Removal of surface water.
   ii. Diversion of surface and ground water from adjacent areas.
   iii. Removal of sub-surface flow of water from the airport.
9. The drainage system should have sufficient capacity to handle present and future drainage problems.
10. The drainage demand is determined by local precipitation rates.
11. Proper grading of the site with adequate longitudinal and cross slopes, helps in quick drainage of storm water.
12. The topographic map of the area helps in identifying the directional of natural surface flow of water, from the airport area.

Que 17. What is meant by the zoning laws ?

Answer

A. **Zoning Laws** : The forming of suitable zoning laws is an essential part of an airport master plan and they are to be implemented as soon as the final selection of the airport site is made.

B. **Types** : FoUowing are the types of zoning :

1. **Height Zoning** :

i. The height or hazard zoning is mainly aimed to protect the approaches to the airport from the obstructions.

ii. It regulates the heights of structures on land surrounding the airport.

iii. The standards of height are formed by keeping in mind the size of the airport and the type of aircrafts using it.

2. Land Use Zoning : The land use zoning governs the type of development. The uses can be classified as either closely or remotely related to the aviation.

C. Factors: Following are the factors consider in zoning law:

1. Legal Interests :

i. It should be seen that the zoning laws do not interfere with the legal rights of the land owners to airspace above their land.

ii. A zoning regulation should protect the interests of both the airport authority and those of the owners of the land surrounding the airport.

2. Nature of Ordinance :

1. The zoning laws should not be oppressive, unreasonable or arbitrary.

u. In general, they should be framed to promote welfare of the public, their com.fort, morals, safety and health.

3. Zoning Map :

1. It is necessary to prepare the zoning map showing property lines, land use pattern, permissible height of structures, limits of applicability of zoning laws, etc.

u. Such a map helps the airport management in making decisions concerning the requests for land-use by various interests.

Que 18 Explain with neat sketches, various markings on a runway. [AKTU 2016-17, Marks 10]

Answer

Types of Runway Marking : Following are the markings made on the runways :

1. Runway Centre Line Marking : The centre line of the runway is represented by a broken strip running along the entire length of the runway as shown in Fig. 4.18.1. Its width is 90 cm.

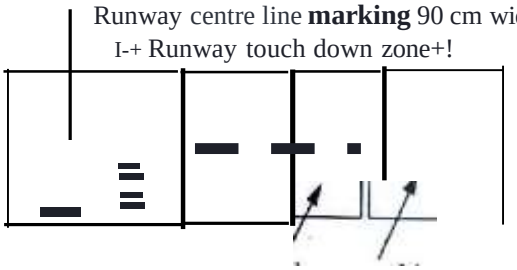


Fig. 4.18.1. Runway markings.

2. Runway Edge Stripes : The runway edges are normally marked. But when the width of runway exceeds 45 m, the side stripes in the form of long continuous line 90 cm wide may be marked near the edges as shown in Fig. 4.18.1 and Fig. 4.18.4.

3. Runway Numbering :

i. The end of each runway is marked with a number which indicates the magnetic azimuth *i.e.*, the angle measured in a clockwise

direction of landing. Thus, the east end of an east-west runway would be marked 27 (for 270°) and the west end 9 (for 90°) as shown in **Fig.** 4.18.2.

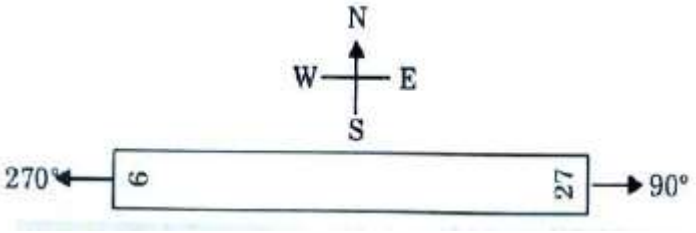


Fig. 4.18.2. Runway numbering ofa single runway.

ii. If there are more than three parallel runways, one pair is marked with the magnetic azimuth to the nearest 10° and the other pair is marked with the magnetic azimuth to the next nearest 10°.

iii. For instance, if there are four runways, one pair would be marked as 9-27 and the other pair would be marked as 8-26 or 10-28.

iv. Fig. 4.18.3 shows the runway numbering of a system of three intersecting runways.

4. **Touch Down or Landing Zone:** The runway touch down or landing zone is indicated by series of stripes arranged symmetrically about the centre line with their number decreasing gradually in the direction of landing as shown in **Fig.** 4.18.1.

5. **Threshold Marking** :

i. The runway threshold is indicated by series of parallel lines starting from a distance of 6 m from the runway end as shown in Fig. 4.18.4

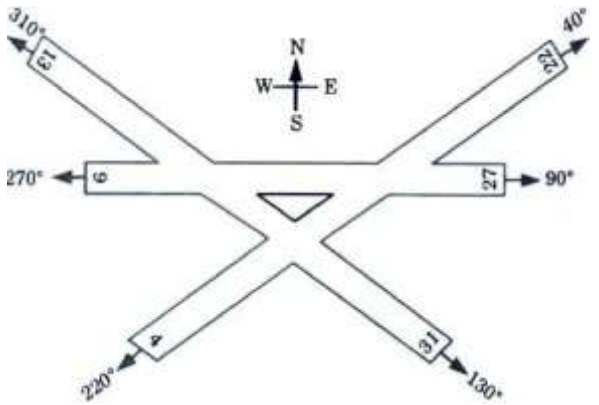


Fig. 4.18.3. Runway numberin of a system of three intersecting runways.

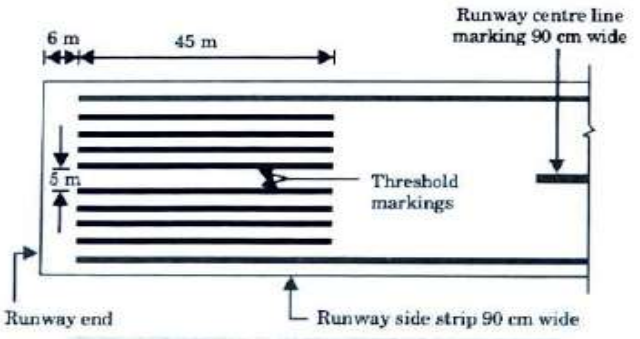


Fig. 4.18.4. Runway threshold marking.

ii. The threshold markings are in the form of stripes 3.60 m wide spaced

0.90 m clear and placed symmetrically on either side of the runway centre line.

iii. At some airports, it is desirable to displace the runway threshold on a permanent basis.

iv. A displaced threshold is one which has been moved a certain distance from the end of the runway.

v. It is usually adapted to clear obstructions in the flight path.

vi. The displacement however reduces the length of the runway for lan<lings, but take offs can use the entire length of the runway.

vii. The FAA requires that the displaced threshold should be marked as shown in Fig. 4.18.5.

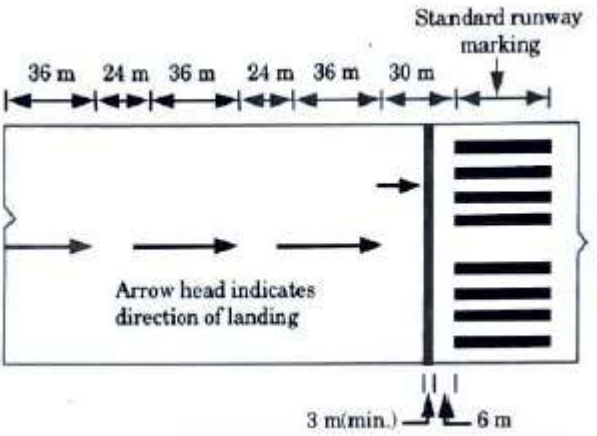


Fig. 4,18.5, Displaced threshold **marking.**

6. **Two or More Parallel Runways**: When there is more than one runway in the same direction, the following letters are added to the azimuth numbers:

Two parallel runways - L, R

Three parallel runways - L, C, R

Four parallel rll;Ilways - L, R, L,

R

Five parallel run ways - L, C, R, L, R.,

Que 19. Write short note on:

A ShouJder Marking.

B. Taxiway Marking.

Answer

A. Shoulder Marking :

1. The shoulders on the edges of a runway and a taxiway are paved, but they are not capable of withstanding the aircraft loads.
2. A paved blast pad about 45 m to 60 min length is provided adjacent to the runway end to prevent erosion of soil. The blast pad is marked with chevron pattern or V-shaped lines.
3. Fig. 4.19.1 shows a typical sketch of the shoulder marking. The paint used is yellow.
4. The runway shoulders are marked with diagonal stripes each having a width of 90 cm.
5. The taxiway and holding apron shoulders are marked with stripes at right angles to the direction of travel of the aircraft.

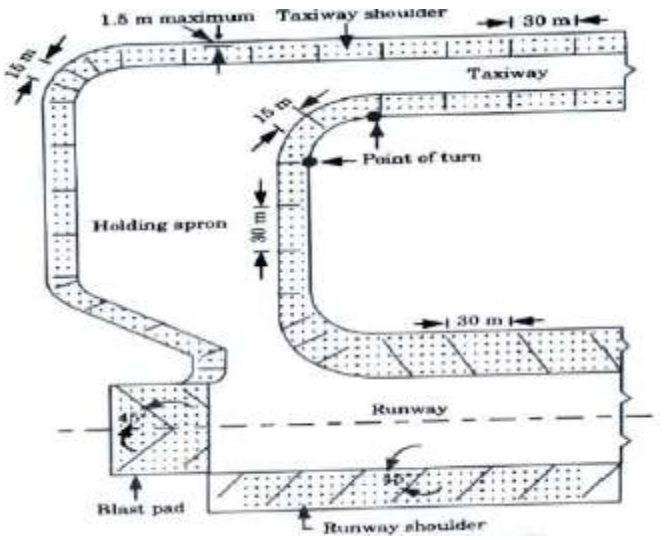


Fig. 4.19.1. Shoulder marking.

B. Taxiway Marking : The essential features of the taxiway marking system as illustrated in Fig. 4.19.2 are as follow:

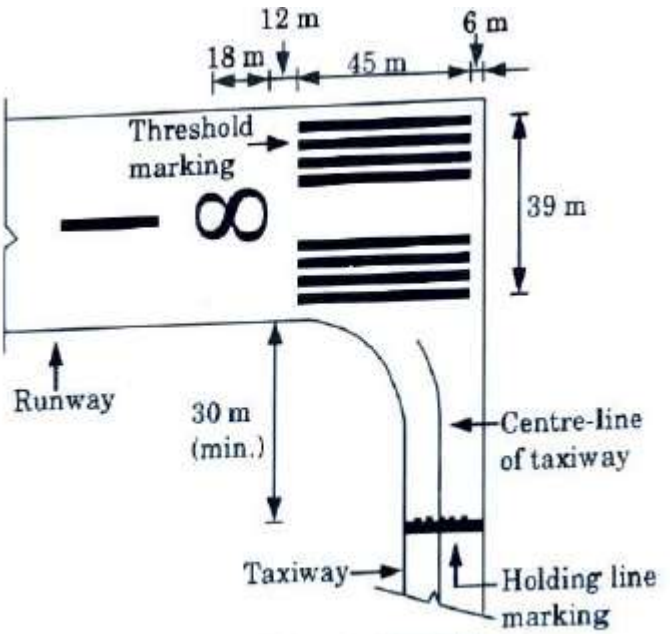


Fig. 4.19.2. Taxiway marking.

1. A single continuous 15 cm yellow stripe is used to mark the centre-line of the taxiway.
2. At intersections of the taxiways with the runway ends, the centre-line of the taxiway is terminated at the edge of the runway as shown in Fig. 4.19.2.
3. At all other intersections of the taxiways with the runways, the centre- line of the taxiway is extended to the centre-line of the runway.
4. At the taxiway intersection, the centre-line markings of the taxiway continue through the intersection area.
5. In cases where the edge of the full strength pavement of a taxiway

is not readily apparent, the edge is marked with two continuous 15 cm wide yellow stripes 15 cm apart.

6. A holding line marking is painted at all the intersections of the paved taxiways with the runways.

Que 20. Write a critical note on wind direction indicator.

Answer

Wind Direction Indicator:

1. The direction from which the wind blows is indicated at the airport by a wind cone. It is placed within a segmented circle together with the landing direction indicator as shown in Fig. 4.20.1.

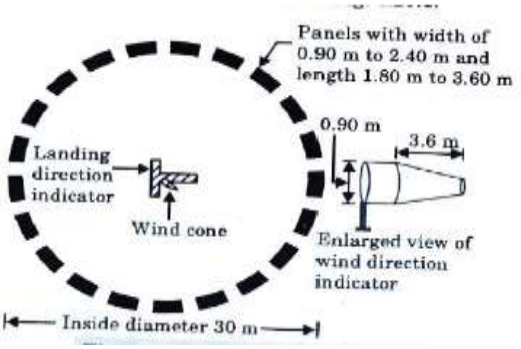


Fig. 4.20.1. Wind direction indicator.

2. Following points should be noted :

i. According to the !CAO, the wind direction indicator should be placed on each airport at a conspicuous place away from the buildings so that it is not affected by the eddies.

ii. The panels forming the segmented circle markers are gable-roof shaped with a pitch of at least 1 to 1.

iii. The panels are usually painted white so as to obtain a distinctive colour contrast between the marker and its surroundings and also to grant them protection against the weather.

iv. The length of the wind direction indicator should not be less than 3.60 m and its diameter at the larger end should not be less than 90 cm.

v. The wind direction indicator is to be painted in such a way that it is visible from a height of 30 m. For getting better colour contrast, it is usually painted with bands of two different colours like white and black, red and white, orange and white, etc.

Que 21. Enumerate the various air traffic control aids. Explain in detail instrument landing system.

Answer

A. **Air Traffic Control Aids** : For the purpose of convenience, the air traffic control aids will be grouped in the following two categories :

1. **En-route Aids or Airway Aids**: During the flight from one airport to another, the following en route aids or airway aids are available to the pilot of the aircraft:

i. Air route surveillance radar.
ii. Air to ground communication.
iii. Airway beacon.
iv. Direction finder.
v. Distance measuring equipment.

vi. Low/medium frequency radio range.
vii. Marker beacon.
viii. Tactical air navigation.
ix. Very high frequency omni-directional range.

2. **Landing Aids or Terminal Aids:** During the process oflanding, the following aids are available to the pilot of the aircraft:

i. Airport service detection equipment.

ii. Airport surveillance radar.

iii. Approach lights.

iv. Instrument landing system.

v. Precision approach radar.

B. Instrument Landing System:

1. Most of the major airports of today are equipped with the Instrument Landing System {ILS) or popularly known as the blind landing system. It enables a pilot to be guided with safety on the optimum approach path for a safe landing.

2. In poor weather conditions such as fog, the ILS may be the only way in which a pilot has any hope of landing safely at all.

3. If this facility does not exist at a particular airport, the aircraft in case of poor visibility will be diverted to the adjoining airport where either proper visibility exists or the airport is provided with the ILS facility.

4. The ILS consists of the following two transmitted signals which combine to form an invisible path along which the aircraft can approach :

i. **Glide Slope Antenna** :

a. It sends out a radio beam signal in the vertical plane at an angle of 2° to 3° from the horizontal. This gives the ideal descent slope for the approach.

b. It is situated at a distance of 225 m to 375 m down the runway from the threshold and to one side of the runway centre line at a distance varying from 120 m to 195 m.

c. The glide slope beam is positioned to allow a clearance of about 15 m from the threshold of the runway so that the point of interception is not on the very edge.

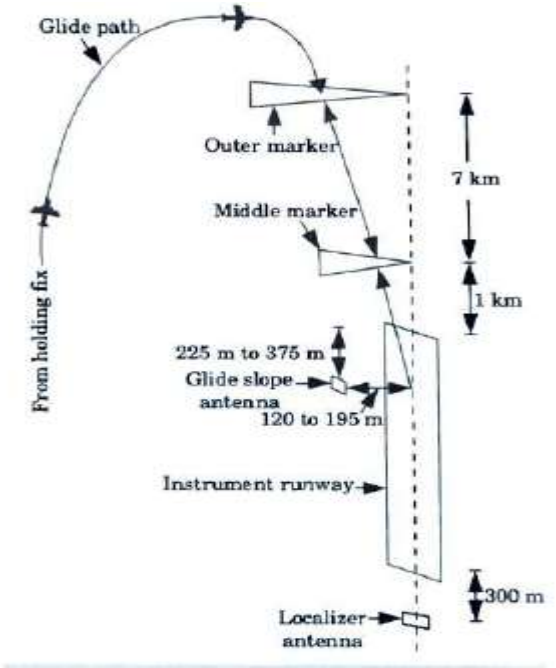


Fig. 4.21.1. Instrument landing system.

ii. **Localizer Antenna** :

a. It sends out a radio beam signal in the vertical plane and indicates to the pilots whether they are left or right of the correct alignment for approach to the runway.

b. It is located on the extension of the runway centre line at a distance of about 300 m from the far end of the runway.

c. The localizer transmitter building is situated at a distance of about 90 m to one side of the runway at the same distance from the end of the runway as the antenna.

5. Fig. 4.26.1 shows the layout of the ILS. In order to further help the pilots on their ILS approach, the following two low-power fan markers are usually installed so that the pilot may know how far along the approach to the runway they have progressed :

i. **Middle Marker:** It is situated at a distance of about 1 km ahead of the runway threshold and it gives an amber light on the instrument panel in the cockpit of the aircraft.

ii. **Outer Marker:** It is situated at a distance of about 7 km ahead of the runway threshold and it gives a purple light on the instrument panel in the cockpit of the aircraft.

Que 22. Explain with a neat sketch to show how 'lighting' is done on a runway. [AKTU 2016-17, Marks 10]

OR

Briefly discuss the various elements of the airport lighting.

Answer

Lights on an Airport: Following are the nine main elements of the airport lighting:

1. Airport Beacon :

i. A beacon is a strong beam of light which is used to indicate any

geographical location. It is situated slightly above the horizontal and rotated to produce the flushing light to an observer.

ii. The term code beacon is used to indicate the light provided sufficiently high to clear all the obstructions.

iii. It consi ts of two 500 watts bulbs with green colour screen.

iv. It continuously flashes a Morse code signal designating the airport.

2. Approach Lighting :

i. The approach light i normally mounted on pedestals of varying height t_o accommodate any irregularities in the ground ensuring that the hghts themselves are always level.

ii. They are specially designed to give way if accidentally hit.

3. Apron and Hangar Lighting :

i. The apron and hangar areas are flood lit for the convenience in servicing and loading.

ii. The flood-lightingsystem constitutes a projector designed to be arranged to illuminate a surface.

iii. These lights are mounted in such a way that they do not cause glare in the eyes of the pilots, passengers and service personnel.

iv. It is recommended that the flood lights should be placed at a height of not less than 12 m above the pavement.

4. Boundary Lighting :

i. The entire boundary of the airfield is provided with lights at a centre to centre distance of about 90 m with height of about 75 cm from the ground.

ii. If a fence is provided along the boundary, these lights should be placed inside the fence at a distance of about 3 m.

iii. For indicating the hazardous approach, the boundary lights are provided with the red marker lights.

5. Lighting of Landing Direction Indicator : The landing direction indicator is illuminated with suitable lighting arrangement so that the airport can be used at night also.

6. Lighting of Wind Direction Indicator :

i. The wind direction indicator is illuminated by four 200 watts angle reflectors placed 1.8 m above the top of the cone for providing a continuous lighting at any position of the cone.

ii. Such an arrangement grants the use of the wind direction indicator at night and during bad weather conditions.

7. Runway Lighting:

i. After crossing the threshold, the pilot must complete a touchdown and roll out on the runway.

ii. The planning of the runway lighting is carried out in such a way that the pilot gets enough information on alignment, lateral displacement, roll and distance.

iii. The lights are also so arranged that they form a visual pattern which the pilots can easily interpret.

iv. Fig. 4.22.1 shows the narrow gauge pattern for the runway lighting.

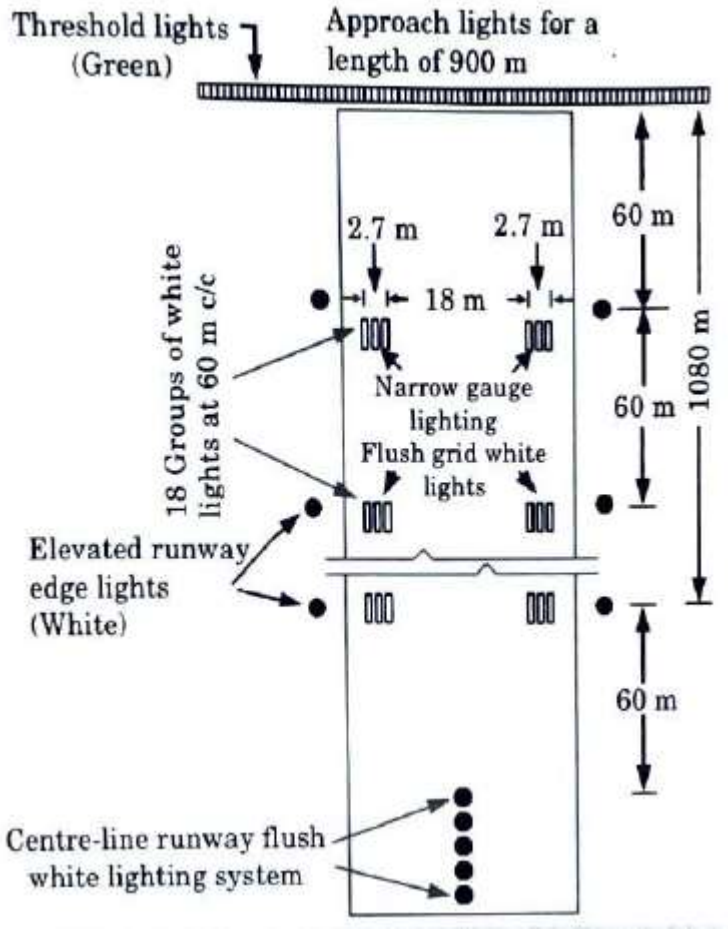


Fig. 4.22.1. Narrow gauge pattern for runway iighting.

v. The narrow gauge pattern forms a channel oflight of 18 m width upto 1140 m from the threshold and beyond this distance, the closely spaced lights are placed along the centre-line of the runway extending upto the other end of the runway.

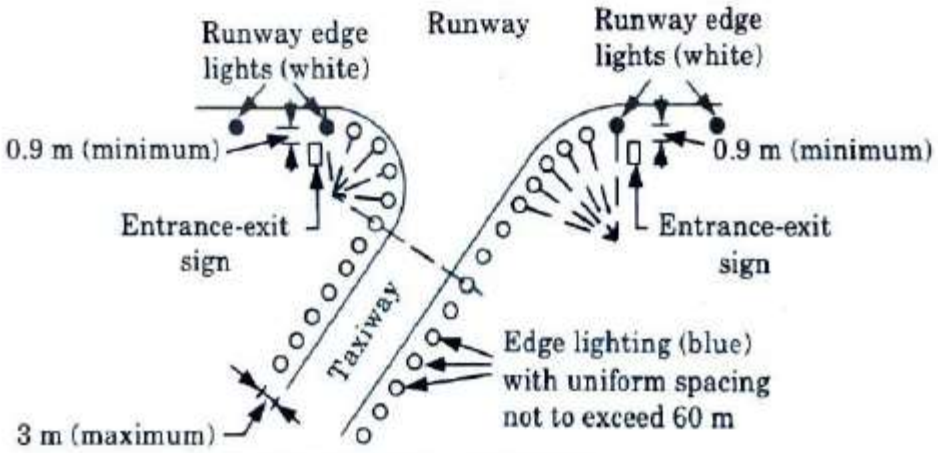


Fig. 4.22.2. Typical taxiway lighting layout.

vi. All the lights provided on the runway are white in colour and of nu h type *i.e.*, they do not protrude more than 1 cm above the urface of the pavement. The runway edge lights are elevated type and they ar

white in colour except for the last 600 m of an instrument runway facing the pilot which are of yellow colour to indicate a caution zone.

2. **Taxiway Lighting** : The taxiway system for a large airport may be very complex and it becomes therefore necessary to provide adequate Lighting aids for taxiing at night and in daytime when the visibility is very poor.

3. **Threshold Lighting** :

L At large airports, the threshold is identified by a complete line of green extending across the entire width of the runway.

11. They must be of semi-flash type *i.e.*, protruding not more than 12 cm above the surface.

lll. At small airports, the threshold is identified by four lights on each side of the threshold.

1v. The threshold light in the direction of landing is green and in the opposite direction, they are red to indicate the end of the runway.

Que 23.Explain the types of parking system of aircrafts and state the advantages and disadvantages of Nose-In / Nose-out parking. [AKTU 2017-18, Marks 10]

Answer

Types of Parking System : FolJowing are the types of parking system:

A. Nose-in Parking:

1. In this arrangement, the aircraft is parked at right angles to the terminal building with its nose as close to the building as permissible.
2. The aircraft manoeuvres into the parking position under its own power and *in* order to leave the gate, the aircraft has to be towed out a sufficient distance to allow it to proceed under its own power.

Advantages: Following are the advantages of nose-in parking:

1. It causes lower noise levels as there is no powered turning movement near the terminal building.
2. It facilitates passenger loading as the nose is near the terminal building.
3. It requires the smallest gate area for a given aircraft.
4. It sends no jet blast towards the terminal building.

Disadvantages : Following are the disadvantages of this type of parking:

1. It requires large power while manoeuvring the loaded aircraft out of the gate position.
2. The nose is too near the terminal building for effectively using the rear doors for the passenger loading.

B. Angled Nose-in Parking:

1. This configuration is similar to the nose-in parking except thatthe aircraft is not parked perpendicular to the terminal building.

2. Thi arrangement allows the aircraft to manoeuvre in and out of the gate under it own power.

3. It however requires a larger gate area than the nose-in configuration and causes a higher noise level.

C. Nose-Out Parking: In this arrangement, the aircraft i parked at right angles to the terminal building with it tail as clo e to the building a perroi sible.

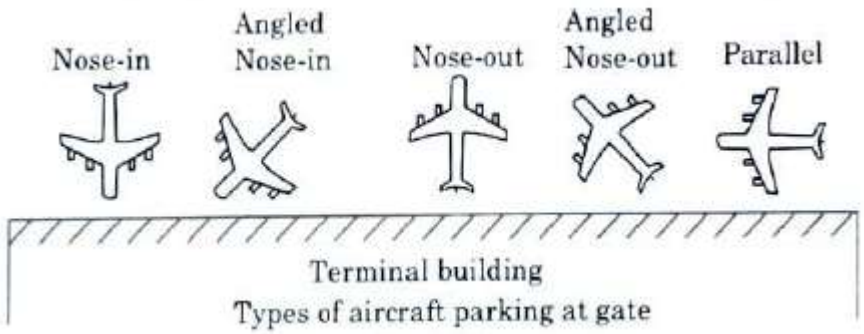
Advantage: Following are the advantages of this type of parking:

1. It permits the effective use of the rear door.

2. It requires le power while manoeuvring the loaded aircraft out of the gate position.

Disadvantages : Following are the disadvantage of thi type of parking:

1. Require Jar e area.
2. Break way ngine blast and noi e are directed of terminal.



Types of aircraft parking at gate

Fig. 4.23.1.

D. Angled Nose-out Parking:

1. This configuration i imilar to the nose-out parking except that the aircraft is not parked at right angles to the terminal building.
2. Thi arrangement allows the aircraft to manoeuvre in and out of gate positions without towing.
3. The only drawback of trus arrangement is that the hot jet blast and noi e are pointed towards the terminal building when the aircraft tart it taxiing manoeuvre.

E. Parallel Parking :

1. This configuration is the ea iest to achieve from the standpoint of the aircraft manoeuvring.
2. The main advantage of trus arrangement is that both front and rear doors can be used for the loac!ing and unloading of the passengers.

Disadvantages : Following are the disadvantage of Lhi types of parking:

1. It require a larger gate position area especially along the terminal building frontage.
2. It requires relatively long loading bridges.
3. The hot blast and noise are directed towards the adjacent gate position.

Que 4.24. Write short note on
A. Heliport Lighting.
B. Heliport Making.

Answer

A Heliport Lighting :

1. Various modes of lighting are used as aids for night operations, these are for:

i. Identification of helicopters.
ii. Wind direction.

iii. Landing area.

iv. Obstruction.

2. Landing and take-off area should be lighted by a food light to provide an illumination level of 15 cm candle over the entire landing area. The design should be such that it does not cause glare to the pilot while landing or taking off from the heliport.

3. The periphery of landing and take-off area should be lighted by amber lights of medium intensity spaced 7.5 m centre to centre.

4. Aprons may be lighted by flood lights so as to provide an illumination level of not less than 30 cm candle over the entire working area.

B. Heliport Making:

1. ICAO recommends that the areas oflanding and take-off should be fully identifif:d with capital letter **H.**
2. This should be done in a manner that a clear vision is possible from all approach directions above the horizon.
3. The following specification are in use for marlring the letter H :

1. Height ofletter : 3 - 4.5 metre (10 - 15 feet).

ii. Width ofletter: 2- 3.5 metre (6 -12 feet).

iii. Width oflines : 45 centimeter (1.5 feet).

4. The recommended colour for painting is white and in some cases yellow i also used. This also followed by black out line. It is recommended to mark the aprons of facilitating the manoeuvring of the helicopters and other equipments.

Que 25. What do you mean by hangar ? Explain its types.

Answer

A. Hangar:

1. The main function of a hangar is to provide an enclosure for housing and repairing of the aircraft. They are constructed of steel framework covered with the galvanized iron sheets.
2. The service hangars are provided with the machine shops and stores for spare parts of the aircraft which require repairs.
3. The size of a hangar depends on the size of aircraft and its turning radius.
4. The number of service and storage hangars depends on the peak hour intensity of the air traffic at the airport and the demand of hangars on rental basis by the different airline agencies.
5. It is neceic;sary to provide adequate lighting inside the hangar.

B. **Types of Hangars:** Following are the two types of storage and service hangars:

1. Nose Hangars:

i. The e are provided for large size aircraft. They enclose only the forward portion of the aircraft and leave the major portion of the fuselage and tail surfaces exposed.

ii. Such a design provides comfortable working conditions for servicing and engine overhaul of the aircraft. It also proves to be very economical.

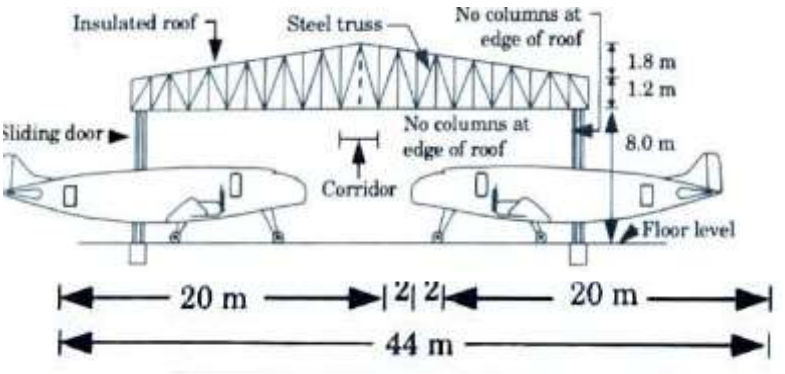


Fig. 4.25.1. Nose hangar.

2. T-hangars:

i. These are provided with small size aircraft. The storage space is designed m such a way that the pilot can maneuver the aircraft in and out of the hangar without any assistance.

ii. The area should be large enough to accommodate different tyPes of aircraft with a minimum clearance of 30 cm.

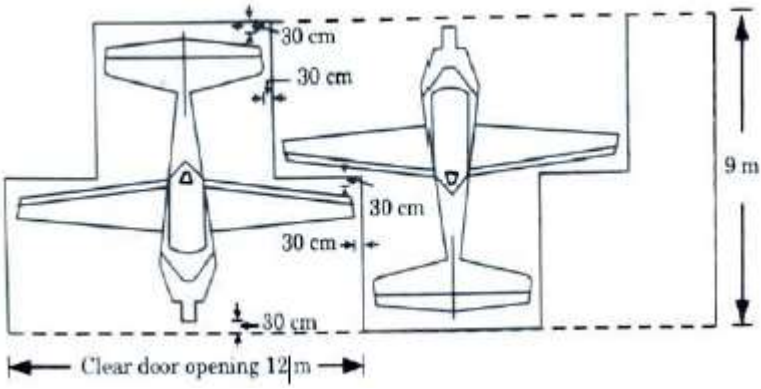


Fig. 4.25.2. T-hangars.

iii. Fig. 4.25.3 shows the layout plan of ground T-hangars showing minimum distance between oppo ite row for one way traffic and two way traffic.

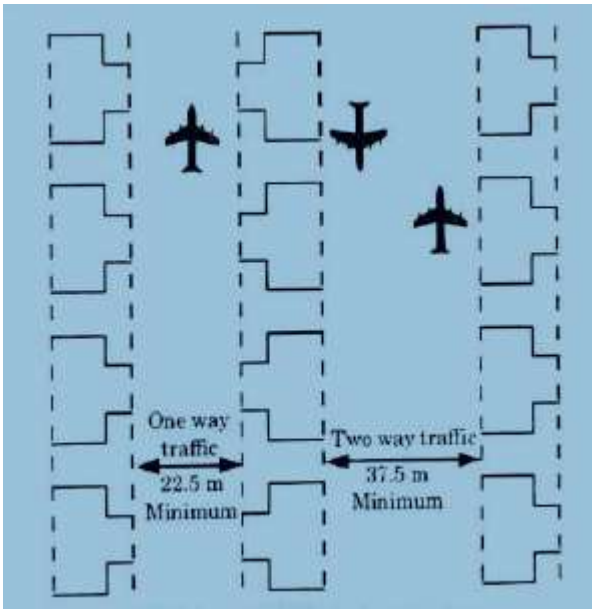


Fig. 4.25.3. Plan of grouped T-hanger

Que 26. What are the various services equipments used at airport?

Answer

Following are the variousservice equipments used at airporl:

A. Non-powered equipment :

1. **Dollies** : Dollies are used for the tran portation of loose baggage's, over-sized baggage's, mail bags, loose cargocarton boxes, etc. between the aircraft and the terminaJor orting facility.
2. **Chocks** : Chocks are used to prevent an aircraft from moving while parked at the gate or in a hangar. Chocks are placed in the front and back of the wheels oflanding gear. They are made out of hard wood or hard rubber.

Aircraft Tripod Jack: They are used to support a parked aircraft to prevent their tail from drooping or even falling to the ground. When the passengers in the front get off an aircraft, the aircraft becomes tail heavy and the tail will droop.

B. Powered Equipment:

1. **Refuelers** : Aircraft refuelers can be either a self-contained fuel truck, or a hydrant truck or cart. Fuel trucks are self-contained, typically containing up to 10,000 gallons of fuel and have their own pumps, filters, hoses, and other equipment.
2. **Tugs and Tractors** : The tugs and tractors at an airport have several purposes and represent the essential part of ground support services. They are used to move all equipment that cannot move itself.
3. **Ground Power Units:** Aground power unit (GPU) is a vehicle capable of supplying power to aircraft parked on the ground.
4. **Buses** : Buses at airports are used to move people from the terminal to either an aircraft or another terminal.
5. **Container Loader** : Container loaders, also known as cargo loaders or *"K* loaders", are used for the loading and unloading of containers and pallets into and out of aircraft.
6. **Transporters:** Transporters are cargo platforms constructed so that, beside loading and unloading containers, they can also transport the cargo.
7. **Air Start Unit (ASU)** : An Air Start Unit is a device used to start the aircraft's engines when the aircraft's APU is not operational. There are three primary types of these devices that exist currently: a stored air cart, a gas turbine based unit, and a diesel engine driven screw compressor unit.
8. **Potable Water Trucks:** Potable water trucks are special vehicles that provide reliability and consist.ency in the delivery of quality water to an aircraft.
9. **Lavatory Service Vehicles:** Lavatory service vehicles empty and refill lavatories onboard aircraft. Waste is stored in tanks on the aircraft until these vehicles can empty them and remove the waste.
10. **Catering Vehicle** : Cat.ering includes the unloading of Wlused food and drink from the aircraft, and the loading of fresh food and drinks for passengers and crew.
11. **Belt Loaders** : Belt loaders are vehicles with conveyor belts for unloading and loading of baggage and cargo onto aircraft.

12. **Passenger Boarding Steps/ Stairs** : Passenger boarding stairs, sometimes referred to as air-stairs, boarding ramps,stair car or aircraft steps, provide a mobile means to traverse between the aircraft doors and the ground.
13. **Pushback Tugs and Tractors** : Pushback tugs are mostly used to push an aircraft away from the gate when it is ready to leave.

14. **Aircraft Rescue and Firefighting:** Aircraft rescue and firefighting (ARFF) is a special category of firefighting that involves the response, hazard mitigation, evacuation and possible rescue of passengers and crew of an aircraft involved in (typically) an airport ground emergency.