RUNWAY DESIGN

- Runway Orientation
  - Crosswind
  - Wind Coverage
  - Calm Period
- Wind Rose Diagram
- Runway Length

Runway Orientation

Orientation of a runway depends on the direction of wind area available for development

- Determination of a runway orientation is a critical task in the planning and design of an airport
- Runways are always oriented in the direction of prevailing wind.
- Reason behind it - to utilize to the maximum the force of wind at the time of take-off and landing of an aircraft
- Lift and drag produced.

The direction of the runway controls the layout of the other airport facilities, such as

- passenger terminals
- taxiways/apron configurations
- circulation roads - parking facilities

Following points need to be considered while orienting the runways and taxiways:

- Avoiding delay in the landing, taxiing and take-off operations and least interference in these operations
- Providing the shortest taxi distance possible from the terminal area to the ends of the runway
- Making provision for maximum taxiways so that the landing aircraft can leave the runway as quickly as possible to the terminal area
- Providing adequate separation in the air traffic pattern.
- Data required
- Map of area and contours
  To examine the flatness of area
  Possible changes in the longitudinal profiles
- Wind data
  Direction
  Duration
  Intensity of wind
  Required for the development of wind rose diagram
  Fog characteristics of the area.

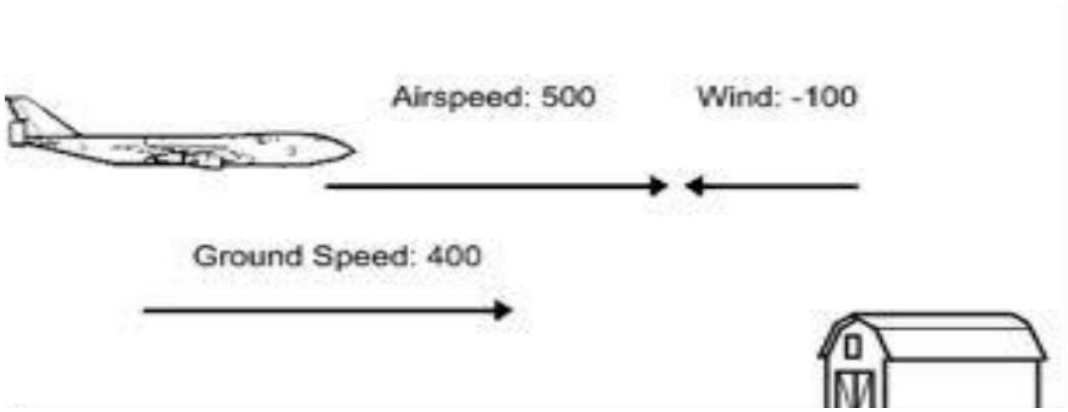
Wind data

- Wind Direction
- To examine whether the wind will attack aircraft from the head or tail side.
- Also the direction of wind is not same throughout the year
- Maximum wind direction needs to be ascertained
- **Wind Intensity:** In terms of velocity in km/hr
- **Wind Duration:** Time period for which the wind of certain intensity blows in a certain direction
- **Wind Direction:** The direction of wind is variable and keeps on changing throughout the year. Its effect on aircraft movement is different and depends up on whether the wind acts as:
- 1. Head wind
- 2. Tail wind
- 3. Cross wind

Wind Direction – Head Wind

- The wind blowing from opposite direction of head or nose of the aircraft (or opposite to the movement of aircraft) while landing or taking-off is termed as Head wind
- It provides braking effect during landing and greater lift on the wings of the aircraft during take off.
- Thus the length of the runway gets reduced. This reduction may be around 10%.

RUNWAY ORIENTATION



Wind Direction/ Tail Wind

- This is defined as the wind blowing in the same direction as of landing or taking-off of the aircraft (or in the direction of movement of aircraft).
- Provides push from the back thus increasing stop distance or lift-off distance.

Wind Direction/ Cross Wind

- Transverse component of wind at 90º angle with the direction of aircraft movement is known as cross wind.
- If the wind contains large component of cross wind then the aircraft may not manoeuvre safely on the runway
- Excessive cross wind component might even veer off the aircraft away.
- The maximum allowable cross wind depends up on

- Size of aircraft
- Wing configuration
- Condition of pavement surface
- For medium and light aircraft CW ≤ 25 kmph.

Wind Components Cross Wind

- The ICAO recommends maximum allowable cross wind component as

Reference Field Length Maximum Crosswind Component

- 1500m or over 37 km/hr
- 200m to 1499m 24 km/hr

Wind Coverage

- ➢ Wind coverage or usability factor of airport is the percentage of time in a year during which the cross-wind component remains within the limit or runway system is not restricted because of excessive cross wind.
- ➢ ICAO and FAA recommend minimum wind coverage of 95%.
- ➢ When a single runway or a set of parallel runways cannot be oriented to provide the required wind coverage, one or more cross wind runways should be provided.

Calm Period

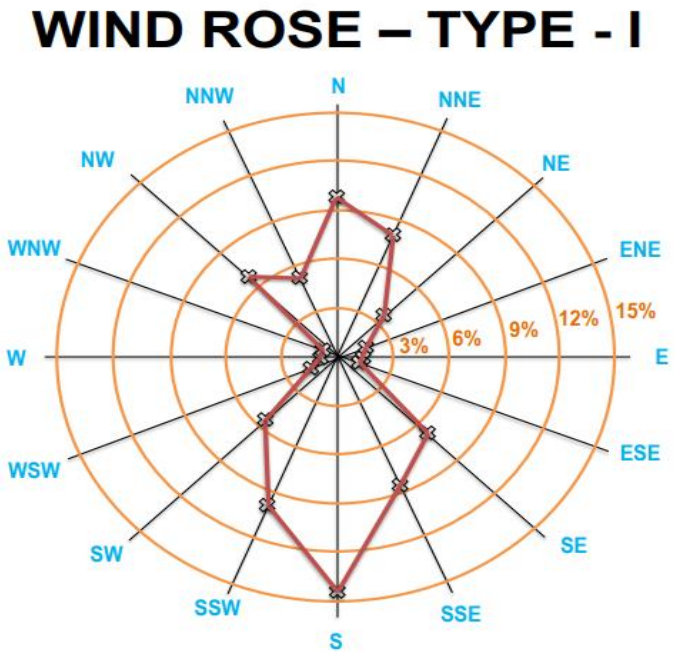
- ✓ This is the period for which the wind intensity remains below 6.4 km/hr
- ✓ This is common to all directions and hence, can be added to wind coverage for that direction
- ✓ Calm Period = 100 – Total wind coverage
- ✓ OR = 100 - ∑Percentage of time wind is blowing in any direction

Wind Rose

- ❖ Application of WIND ROSE diagram for finding the orientation of the runway to achieve wind coverage.
- ❖ The area is divided into 16 parts using an angle of 22.5º
- ❖ Average wind data of 5 to 10 years is used for preparing wind rose diagrams.

Methods

- ❖ Type – I : Showing direction and duration of wind
- ❖ Type – II: Showing direction, duration and intensity of wind.

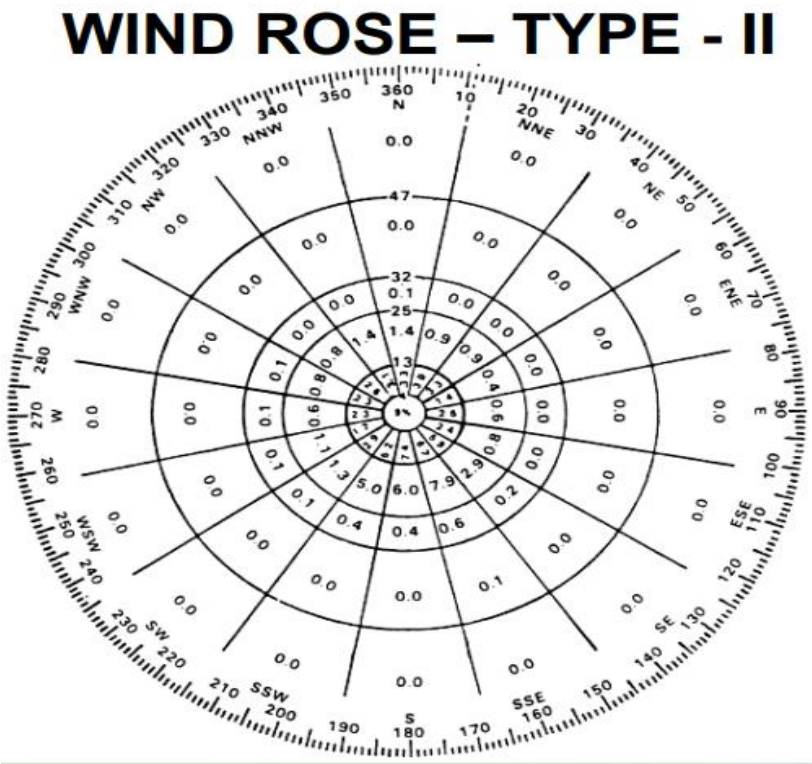


Wind Rose – Type – I

- It is based on direction and duration of wind.
- Minimum eight directions are taken but optimum is 16 directions.
- Data includes total percentage of time in each direction.
- Concentric circles are drawn to scale according to the percentage of time wind is blowing in a direction.
- Total percentage in each direction is marked on the radial line drawn in that direction.
- These points on radial lines are joined together to form a duration map.
- Best direction of runway is indicated along the direction of the longest line on the Wind Rose diagram.

Wind Rose – Type – II

- It is based on direction, duration and intensity of wind.
- Concentric circles are drawn to scale according to the wind velocity.
- The influence of wind is assumed to spread at an angle of 22.5º in a direction.
- Radial lines, from center, are drawn up to mid point of two directions thus dividing the space into 16 directions and 64 parts.
- Categorized duration is marked in the related cell.
- Transparent rectangular template of length greater than the diameter of the diagram and width equal to twice of allowable cross wind component is made.
- Wind rose diagram is fixed in position and the template is placed above it such that center of template coincides with center of diagram. The center line of template should pass through a direction.
- The template is fixed in position and the sum of duration shown in cells superimposed by the template is calculated. This sum is shown as percentage and represents the total wind coverage for that direction.



RUNWAY LENGTH

- Basic Runway Length
- Corrections to basic runway length

BASIC RUNWAY LENGTH

- Length calculated under the following conditions
- No wind is blowing on runway
- Aircraft is loaded with full loading capacity
- Airport is at sea level
- No wind is blowing on the way to destination
- Runway is leveled., i.e zero effective gradient
- Standard temperature of 15ºC at the airport
- Standard temperature exists along the way.

Factors affecting the basic runway length –

- Aircraft Characteristics
- Safety requirements
- Airport Environment
- Aircraft Characteristics
- Power and propulsion system
- Type of an aircraft
- The "critical aircraft" is defined as being the aircraft type which the airport is intended to serve and which requires the greatest runway length.
- To identify the "critical aircraft", flight manual performance data of a variety of aircraft are examined.
- Gross Take-off and landing weights of the aircraft
- Aerodynamic and Mechanical characteristics.