Airport Runway Length

Airport runway length is the total runway length available at the airport required for the safe landing and take-off of the airport. It depends on several factors, and based on those factors, it will be calculated with the help of basic runway length. The design of a runway depends on various factors like wind direction, gradient, the maximum intensity of crosswind, etc.

Runway Design Orientation

The runway design depends upon several factors, some are listed below.

- The runway is usually oriented in the direction of prevailing winds.
- The headwind i.e. the direction of wind opposite to the direction of landing and take-off provides greater lift on the aircraft's wings when it is taking off.
- Crosswind component = V sinθ where θ = Angle of wind direction to the runway centerline
- The normal component of the wind is called the wind component.
- The maximum permissible crosswind component depends upon the aircraft size and the wing configuration.

What is the Basic Runway Length?

It is the length of the runway given at the standard environmental condition. The actual runway length will be determined after applying the corrections over the basic runway length. Basic runway length will be determined under the following assumed conditions at the aircraft.

1. The airport's altitude is at sea level.
2. The temperature at the airport is standard (15°C)
3. The runway is leveled in the longitudinal direction.
4. No wind is blowing on the runway.
5. The aircraft is loaded to its full loading capacity.
6. There is no wind blowing en route to the destination.
7. En route temperature is standard.

Corrections for Elevation, Temperature, and Gradient

The elevation, temperature, and gradient will be corrected over the basic runway length to determine the actual airport runway length. The total runway length at a particular airport depends on its elevation from MSL, surrounding atmospheric temperature, and the gradient of the runway.

Correction for Elevation

Basic runway length is increased at the rate of 7% per 300 m rises in elevation above the mean sea level.

Correction for Temperature

Correction due to temperature is applied after applying the elevation correction on basic runway length. the difference between standard temperature and airport reference temperature is considered as the percentage temperature correction

Airport reference temperature (ART)= $T_a + (T_m - T_a)/3$

Where T_a = monthly mean of average daily temperature

T_m = monthly mean of the max daily temperature for the same month of the year.

Total correction for elevation and temperature. ⇒ 35% of basic runway length.

Correction for Gradient

[Only as per FAA]

After corrected runway length for elevation & temperature, runway length should be increased by 20% for every 1% of the effective gradient.

In the case of landing, only elevation correction is necessary.

- Steeper gradient results in greater energy consumption, and as such longer runway length is required to attain the desired ground speed.
- After being corrected for elevation and temperature, the runway length should be further increased at the rate of 20% for every 1% increase in the effective gradient.
- The effective gradient is defined as the maximum difference in elevation between the highest and lowest points of the runway divided by the total length of the runway.

Runway Geometric Design

Runway geometric design is the design parameter of the runway. It includes the radius of the curves, taxiway design, roadway width, etc. It is designed based on the ICAO guidelines.

- Runway Width: ICAO recommends the percent varying from 45 m to 18 m for a different type of airport.
- Safety Area: Consists of the runway, a paved area plus the shoulder on either side of the runway, and the cleared, graded and drained area.
  For non – instrumental runways, the width of the safety area should be at least 150 m for A, B, and C and 78 m for D and E types, and for the instrumental runway, it should be a minimum of 300 m
- The length of the safety area is equal to the length of the runway plus 120 m

- Transverse gradient: Essential for quick drainage of surface water.
  For A, B, and C types of Airports ⇑ 1.5%
  For D and E type of Airports ⇑ 2%
  Transverse gradient ⇔ 0.5%
- Longitudinal gradient
  Max. limit
  A, B, C type of Airports = 1.5%
  D and E type of Airports = 2.0%
  For effective gradient: Max limit
  A, B and C type of airports = 1.0%
  D and E type of airports = 2.0%
- Rate of Change of Gradient: As per ICAO recommendation, the rate of change of longitudinal gradient per 30 m length of vertical curve for A and B type of airports is limited to a maximum of 0.1%, 0.2% for C type and 0.4% for D and E type of airport. Vertical curves are generally not necessary if the change in slope is not more than 0.4%
- Sight Distance: For A, B, and C types of airports, any two points 3 m above the surface of the runway should be mutually visible from a distance equal to half the runway length. For D and E type of runway within a distance of at least one-half the length of the runway.

Important Points Related to Wind-Rose Diagrams

The wind rose diagram represents the wind direction and velocities near an airport. It is an important parameter of the designing of the airport runway length. Here a few important points about the wind rose diagrams are listed below.

(i) Length of runway requirements will be more if landing and take-off operations are performed along the wind direction.

(ii) Wind parameters (direction and intensity) are graphically represented by the wind rose diagrams.

(iii) Wind parameters should be collected for a period of 3 years.

(iv) Normal wind component is called a cross-wind component, and it may interrupt the safe landing and take-off of the aircraft. For the smaller size of aircraft, max. The permissible limit is 15 km/hr and for bigger →25 km/hr (due to more weight, it's higher) of a cross-wind component.

The percentage of time during which, in a year, the crosswind component remains within the permissible limit is called wind coverage.

What is Airport?

An airport is where airplanes and other aerodromes take off and land. It also includes various facilities for passengers. There are two organizations that classify an airport.

(i) ICAO: International Civil Aviation Organization.

(ii) FAA: Federal Aviation Agency.

ICAO classified airports into two categories-

(i) Based on basic runway length

A → Longest runway

B → Shortest runway

Some Important Elements of an Airport

A stop way is used in case of engine failure conditions.

The length of the runway is decided based on the following:

1. Normal landing case
2. Normal take-off care
3. Engine failure case

The circling radius depends on

1. Type of aircraft
2. Weathering conditions and volume of aircraft.

Aircraft movements will be more in case visual flight rules than instrumental flight rules (applicable in bad weathering conditions.)

The size of the hanger building is decided based on the size of the aircraft (length, width, height).