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Research Paper Engineering

Airport Runway Design

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ABSTRACT

In last one decade air traffic in India has increased by multiple folds. Considering the above fact, Indian government has decided to have at list one airport in every district in India. Airport design & eventually Runway design has become important aspect of growing airport industry. This paper focuses on the assumptions in runway design, basic parameters & Factors affecting runway design.

KEYWORDS

RUNWAY
a **runway** is a «defined rectangular area on a land aer odrome prepared for the landing and take off of aircraft ». Runways may be a man-made surface (often asphalt, concrete, or a mixture of both) or a natural surface (grass, dirt, gravel, ice, or salt) … ICAO

Runway Orientation
Runway is usually oriented of prevailing winds. The direction of wind opposite to the direction of landing & take off which provides greater lift on the wings of the aircraft because of this aircraft rise above the ground much earlier & in shorter runway length. Thus Landing & Takeoff operations of the aircraft performs opposite to the wind directions.

Cross Wind Component
It is not possible to obtain the direction of the wind along the direction of the centre line of runway throughout the year. Some time wind blow making certain angle with the centre line of the runway. The normal component of the wind (90Degree) is called cross wind component and interrupts the safe landing and takeoff of the aircraft.

BASIC RUNWAY LENGTH
- It is the length of runway under the following assumed condition at the airport:
  i. Airport altitude is at sea level
  ii. Temperature at the airport is standard (15 C)
  iii. Runway is levelled in the longitudinal direction.
  iv. No wind is blowing on runway
  v. aircraft is loaded to its full loading capacity
  vi. There is no wind blowing enroute to the destination
  vii. Enroute temperature is standard

ICAO Classification
- The International Civil Aviation Organisation (ICAO) classifies the airport in two ways, In first method the classification is based on the basic runway length of the airport
- It also describes various other geometric standards of the airport
- The classification has been done by using code letter viz. A to E
- A type of airport has the longest runway length and E type of airport has the shortest runway length.

Summary Of Runway Geometric (ICAO)

Airport Types	BASIC RUNWAY LENGTH				Runway pavement width		Maximum Longitudinal grade %
	MAXIMUM		MINIMUM				
	MTR.	FT.	MTR.	FT.	MTR.	FT.	
A			2100	7000	45	150	1.5
B	2099	6999	1500	5000	45	150	1.5
C	1490	4999	900	3000	30	100	1.5
D	899	2999	750	2500	22.5	75	2.0
E	749	2499	600	2000	18	60	2.0

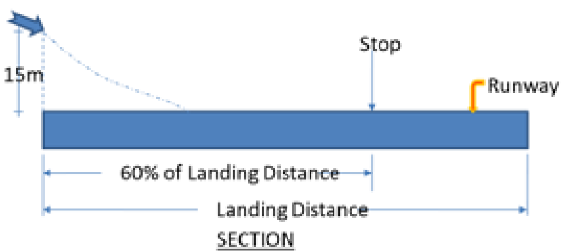
In second method of the airport classification ICAO gives one chart which presents one numeric numbers from 1 to 7. This chart gives the equivalent single wheel load (ESWL) and the tire pressure of the aircraft which will use the airport.

ICAO classification of the airport based on Aircraft Wheel Load Characteristics.

Code	Single isolated wheel load		Tire Pressure	
	Kg	Lbs	Kg/cm2	Lbs/in2 (p.s.i.)
1	45,000	1,00,000	8.5	120
2	34,000	75,000	7.0	110
3	27,000	60,000	7.0	100
4	20,000	45,000	7.0	100
5	13,000	30,000	6.0	85
6	7,000	15,000	5.0	70
7	2,000	5,000	2.5	35

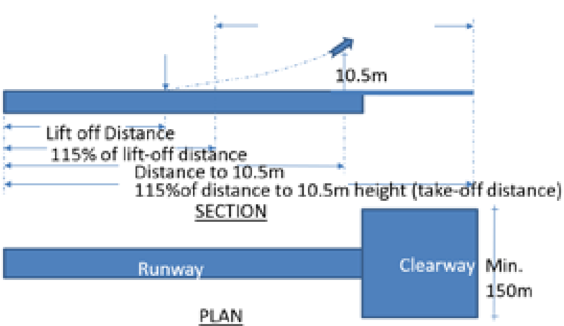
Runway Design
- Basic runway length is determined from the performance characteristics of the aircrafts and airport classification.
- The following cases are usually considered for runway design:
  i. Normal landing case
  ii. Normal take-off case
  iii. Engine failure case

NORMAL LANDING CASE



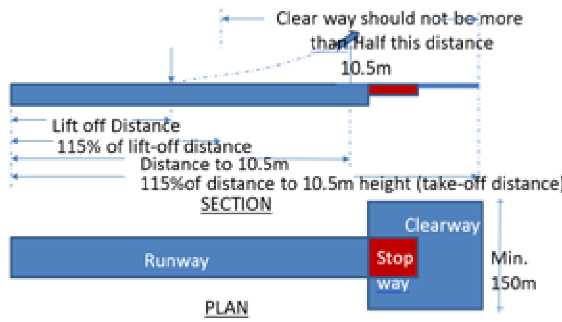
- In this case aircraft should come to a stop within 60% of the landing distance.
- The runway of full strength pavement is provided for the entire landing distance.

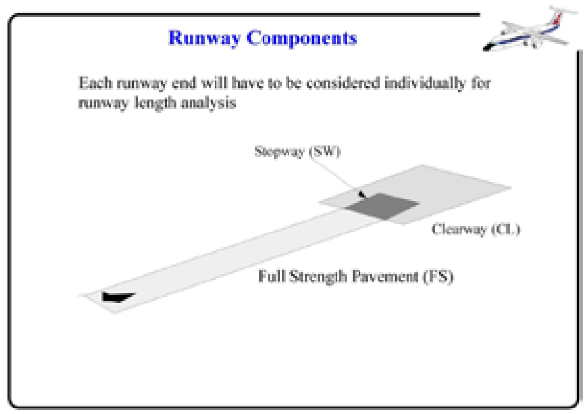
II. NORMAL TAKE-OFF CASE



- Normal take-off case requires a clearway which is an area beyond the runway and is in alignment with the centre of the runway
- The width of the clearway is not less than 150m and is also kept free from obstructions
- The clearway ground area or any object on it should not protrude a plane inclined upward at slop of 1.25% from the runway end.

III. THE ENGINE FAILURE CASE





- The engine failure case may required either a clearway or a stop way or both.
- Stop way is described as an area beyond the runway and centrally located in alignment with the centre line of runway.
- It is used for decelerating the aircraft and bringing it to a stop during an aborted take-off.
- The strength of the stop way pavement should be just sufficient to carry the weight of aircraft without causing any structural damage to the aircraft.
- If the engine has failed at a speed, less than the designated engine failure speed, the pilot decelerates the aircraft and makes use of the stop way.

CORRECTIONS

As discussed, basic runway length is for mean sea level elevation having standard atmospheric conditions. But in actual life airport may be at any elevation with reference to mean sea level. Also there will be change in atmospheric temperature with reference to assumed standard atmospheric condition. Necessary corrections are therefore required to apply for any change in elevation, temperature and gradient for the actual site of construction.

CORRECTIONS FOR ELEVATION

- As the elevation increases, the air density reduces this in turn reduces the lift on the wings of the aircraft and the aircraft requires greater ground speed before it can rise in to the air
- To achieve greater speed, longer length of runway is required.
- ICAO recommends that the basic runway length should be increase at rate of 7% per 300m rise in elevation above mean sea level MSL.

Corrections for elevation= Basic runway length X (elevation of airport / 300) X (7/100)

For Example If Elevation of airport = 450m above MSL & Airport is class B airport

Corrections for elevation= Basic runway length X $\frac{\text{(elevation of airport)}}{(300)}$ X $\frac{(7)}{(100)}$

$$= 1500 \times \frac{(450)}{(300)} \times \frac{(7)}{(100)}$$

CORRECTIONS FOR TEMPRATURE

- As the elevation increases, the atmospheric temperature get reduces.
- Airport reference temperature is defined as the monthly mean of average daily temperature (Ta) for the hottest month of the year plus one third the difference of this temperature(Ta) and the monthly mean of the max. daily temperature (Tm) For same month of the year

Airport Ref. Temperature (Ta)= Ta+(Tm-Ta/3)

- The basic runway length after having been corrected for elevation, should be further increased at the rate of 1% for every 1C rise of airport reference temperature above the standard atmospheric temperature at that elevation.
- The temperature gradient of the standard atmosphere is 0.0065C per meter.

CORRECTIONS FOR TEMPRATURE

Rise In Temp. (RIT) = Airport Ref. Temp. (ART) – Standard Atmospheric Temp (SAT)

$$\text{SAT} = 15\text{C} - \frac{(65)}{(10000)} \times \text{ELEVATION}$$

CHECK FOR THE TOTAL CORRECTION FOR ELEVATION PLUS TEMPERATURE

- ICAO further recommends that, if the total correction for elevation plus temperature exceeds 35% of the basic runway length, these corrections should then be further checked up by conducting specific studies at the site by model tests.

$$\text{Check} = \frac{\text{Total increase in Runway Length – Original Length}}{\text{Original Length}} < 35$$

CORRECTION FOR GRADIENT

- Steeper gradient results in greater consumption of energy and as such longer length of runway is required to attain the desired ground speed.
- ICAO does not recommend any specific correct for the gradient.
- FAA recommends that the runway length after having been corrected for elevation and temperature should be further increased at the rate of 20% for every 1%of effective gradient.
- Effective gradient is defined as the maximum difference in elevation between the highest and lowest point of runway divided by the total length of runway.

So airport runway design is the process which considers the standard assumptions for basic runway length & aircraft performance characteristics. If airport conditions vary from standard conditions which are assumed then corrections for the elevation, temperature & Gradient are required.

REFERENCES

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