Awakening to Reality

Available online at www.elixirpublishers.com (Elixir International Journal)

Civil Engineering

Elixir Civil Engg. 112 (2017) 48882-48885

Elixir ISSN: 2229-712X

Innovation of Airport Runway by International Standards

Ashok .Gullathoti and Ankamma Rao.Thiruvulluri
A.M. Reddy College of Engineering & Technology, Narasaraopet. 522601.

ARTICLE INFO

Article history:
Received: 24 September 2017;
Received in revised form:
21 October 2017;
Accepted: 1 November 2017;

Keywords
Runway,
Icao manual part 1
Runways,
Runway pavements,
Designing of airport.

ABSTRACT

This paper involves the design of the international runway for the proposed Gannavaram International airport site. The data required for the designing part was taken from the competent authority ‘City Industrial Development Corporation’ (CIDCO). The runway has been designed by international standards following the design procedure given by the ‘International Civil Aviation Organization’ (ICAO). Physical characteristics of the runway and its sections have been studied in depth and designed according to the standards. Images have been provided for better understanding. . The methodology and their references have been specified clearly.

I. Introduction

An airport is a location where aircraft such as fixed wing aircraft, helicopters, and blimps take off and land. An airport consists of at least one surface such as a runway for a plane to take off and land, a helipad, or water for take offs and landing, and often includes buildings such as control towers, hangars and terminal buildings.

According to the International CivilAviation Organization (ICAO) a runway is defined “rectangular area on a land aerodrome prepared for the landing and takeoff 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).

The proposed Airport is situated in the geographical centre of Gannavaram, at latitude 16°32'18.9276" N and longitude 80°47' 53.5848"E on the National Highway No. 16 near Panvel at a distance of approx. 21 km from the existing prakasam barraige in Vijayawada. The National Highway 16 provides the main road access to the Airport from the east, whereas the nehru Marg provides road access to the Airport from the west. The Airport is also accessible from the existing Kesarapalli and Gannavaram village moreover Vijayawada metro rail is under development.

The existing airport at vijayawada, is fast reaching saturation and scope for further enhancement of passenger and cargo handling facilities along with aircraft maintenance and city side facilities appear very much limited. Enhancement of aviation facilities in MMR is critical for maintaining Maharashtra's leadership in attracting Foreign direct Investment and cementing Vijayawada's future as an International Financial Centre. The air travel demand forecasts for the vijayawada Muncipality Region reveal that demand will grow from 10 million passengers per annum in the year 2014-17 to 15 million passengers per annum by 2030-31. The vijayawada airport alone will be unable to handle such an increase in demand. It is therefore imperative to build a second Airport for MMR.

Tele:
E-mail address: ashok.raina747@gmail.com

II. Design of the Runway

The design of the runway is done in the following order:

1)Runway orientation
2)Runway length calculations
3)Runway pavement
4)Runway marking
5)Runway lightings

The designing part is as follows:

1)Runway Orientation: The number and orientation of the runways play an important role in the overall arrangement of various components of an airport. The number of runways will depend on the volume of air traffic while its orientation will depend on the direction of wind and sometimes on the extend area available for the airport development.

Wind data: The wind data i.e. the direction, duration and intensity of the wind were obtained from Indian Metrological Department, vijayawada.

Direction	0.0-5.0 (m/s)	5.1-23.5 (m/s)	23.6-38.7 (m/s)	%	%	%	Total %
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	23	8	0	6.28	2.19	0	8.47
E	0	0	0	0	0	0	0
ESE	30	0	0	8.20	0	0	8.20
SE	0	0	0	0	0	0	0
SES	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	38	53	1	10.38	14.48	0.27	25.14
WNW	143	70	0	39.07	19.13	0	58.20
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0

FIG (1). Wind Data.

According to the wind rose diagram FIG (2) the direction of prevailing wind is across WEST-NORTH-WEST direction. For the Orientation of a Runway, WNW direction is very suitable but due to the presence of Matheran hills in SE direction and Belapur residential zone in NW direction.

We oriented the runway in 83° ENE and 263°WSW direction. The cross wind component for the air field is 10.3 m/s

2) Runway Length Calculations: The runway is designed to carry the takeoff and landing of the largest aircraft in the world A380. The categories of the runway and their corresponding length and width have defined by "INTERNATIONAL CIVIL AVIATION ASSOCIATION" (ICAO). A380 falls under the category 4F and the minimum take off run is 2700m and the width of the runway is 60m.

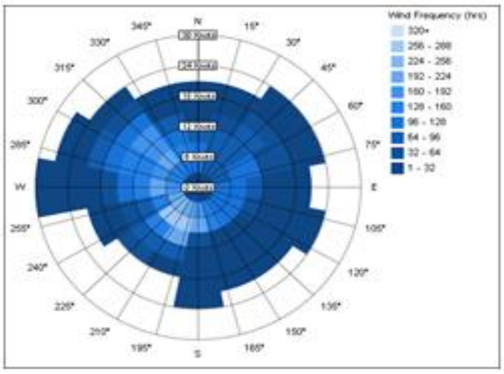

FIG (2). Wind Rose.

The runway length is calculated under two constraints:

1. **Basic runway length**
2. **Actual runway length**

1. Basic runway length: Basic runway length is the length calculated under the following assumed conditions,

a) Airport altitude is at sea level
b) Temperature at the airport is standard
c) No wind is blowing on the runway
d) Runway is levelled in the longitudinal direction
e) Aircraft is loaded to its full capacity
f) Enroute temperature is standard
g) No wind is blowing enroute to the destination

Basic runway length is determined from the take off performance charts and is greater of the either:

When one of the critical engines fails, the pilot has an option to continue the run or abort the take off after attaining a certain speed called as the decision speed, if he aborts the take off then the take off run and the stop distance should be equal. If both the lengths are equal then the total length is called as the balanced field length.

Take off speed (v) = 280km\hr

The decision speed is less than or equal to the take off speed

Decision speed ≤ Take off speed

Hence decision speed, V_f = 280km/hr

Velocity= (280× 1000)/3600 = 78m/s

The acceleration is assumed as, a=1m/s²

Time= v/a= 78/1= 78 s

Now, actual velocity is the difference between final velocity and initial velocity. Hence, V = (V_f -V_i)/2 = (78-0)/2 = 39m/s

Hence, Total Distance (Take Off Run) = 39×78= 3042 m… **(1)**

b) When all the engines are operating: 115% Of Take Off run = (115×2700)/ 100 = 3100 m… **(2)**

Taking maximum value of **(1)** and **(2)**,

Hence, Take Off Run from aircraft's performance = 3100m

Now, the landing length requirement Landing Run = 2050 m; Hence safe

2. Actual Runway length: Actual runway length is the length obtained after applying the corrections of temperature, elevation and slope. The actual runway length should be adequate to meet the operational requirements of the aircrafts for which the runway is designed and should not be less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aircraft. Local conditions that have to be considered are temperature, elevation, slope and humidity and runway surface characteristics. The length is calculated as follows,

a) The basic length selected for the runway should be increased at the rate of 7% per 300m elevation.

Runway elevation at the aerodrome= 3m Runway take off length corrected for elevation

= [Take off run × .07 × ________]

= [3100 × .07 × (3/300)] + 3100

= 3102m

The length of the runway determined should be further increase at the rate of 1% for every 1°C in the aerodrome reference temperature exceeds over standard atmosphere for the aerodrome. If however, the total correction for elevation and temperature exceeds 35% then the required correction should be obtained by means of specific study.

Runway take off length corrected for elevation and temperature

= [Take off run × (ART – Standard Temperature) × .01] + Take off run

ART= Aerodrome reference temperatureT_a + ((T_m – T_a) ÷ 3)

Where, T_m = the monthly mean of the maximum daily temperature for the hottest month of the year. T_a = the monthly mean of the average daily temperature for the hottest month of the year. Standard temperature is obtained by interpolation from the below given standard temperature

Table 1. **Temperature Data.**

Altitude(m)	**Temperature(^{0}C)**
0	15.00
500	10.67
1000	7.18
1500	6.35
2000	3.00
2500	-1.78
3000	-4.90
3500	-7.79
4000	-11.98
4500	-13.28
5000	-17.47
5500	-19.45
6000	-22.77

The temperature data was available from the "Indian Metrological Department" for the period of 1st November 20165to 31St October 2016 and the month of March was found to be the hottest**. Table 2**(temp data)

From **Table 2**, the monthly mean of the average daily temperature for the month of March =T_a = 32.18°C From **Table 2,** the monthly mean of the maximum daily temperature for the month of March = $T_{m =}$ 35.9°C

Therefore, Aerodrome reference temperature = ART = Ta + = 33.25° C Standard temperature at 3m is found out by interpolation from the **Table 1** = 14.98° C

Runway take off length corrected for elevation and temperature = [3102 × (33.25 – 14.98) × .01] + 3102 = 3600m

c) The runway length is increased at the rate of 10% for each of 1% of the runway slope, where the runway length is greater than 900m.

Table 2.

Date	Temperature		Date	Temperature	
	Max °C	Min° C		Max °C	Min °C
1 March 2017	36.6	17.1	17 March 2017	36.6	22.9
2 March 2017	36.2	18.2	18 March 2017	36.6	22.6
3 March 2017	36.1	18.2	19 March 2017	34.9	23.9
4 March 2017	36.3	17.9	20 March 2017	37.1	20.9
5 March 2017	34.4	18.9	21 March 2017	34.3	25.9
6 March 2017	36.8	19.4	22 March 2017	35.5	25.5
7 March 2017	37.2	20.4	23 March 2017	34.8	25.6
8 March 2017	37.6	20.5	24 March 2017	33.9	23.1
9 March 2017	37.5	21.6	25 March 2017	34.7	23
10 March 2017	32.1	21.7	26 March 2017	33.6	22.7
11 March 2017	36.2	21.2	27 March 2017	33.9	22.3
12 March 2017	33.6	23.1	28 March 2017	34	22.3
13 March 2017	34.5	20.9	29 March 2017	33.7	23.8
14 March 2017	34.5	20.3	30 March 2017	36	23.5
15 March 2017	37.2	21.8	31 March 2017	32.2	21.5
16 March 2017	38.5	21.9			

Runway take off length corrected for elevation, temperature and slope = [Take off run × % runway slope × .10] + Take off run

The runway length obtained from correction of elevation and temperature is divided in 4 parts. The runway slope in the first quarter and the last quarter is taken as zero. In the second quarter the slope is taken as 1.25% and in the third quarter it is taken as 0.35%.

For second quarter:

— × 100 = 1.25

Dy

—90ııC × 100 = 1.25

Dy = 11.25

Total elevation at the end of second quarter = 11.25

For third quarter:

— × 100 = 0.35

Dy

—90ııC × 100 = 0.35

Dy= 3.15m

Total elevation at the end of the third quarter = 3.15+11.25 = 14.40m

Hence, the maximum elevation is 14.40 and the minimum elevation is 0.

Therefore the average slope is given by the equation,= (Maximum elevation – Minimum elevation)/3 Slope = (14.4 – 0)/3600 = .4%

Runway take off length corrected for elevation, temperature and slope= [3600 × .4 × .10] + 3600 = 3744m

So the total length of the runway is 3744m

Width of the runway:

The width of the runway = 60m

Runway shoulders: Runway shoulders must be provided to ensure a transition from the full strength pavement to the unpaved strip of the runway. The paved shoulders protect the edge of the runway pavement , contribute to the prevention of soil erosion by jet blast and mitigate foreign object damage to the jet engines.

Width of the runway shoulders = 7.5m on either side of the runway

3)Runway pavements: The pavements in general are classified as flexible and rigid pavements according to their structural action. The black top pavement including gravel and water bound macadam follow the flexible group and the cement concrete pavement is the popular example of rigid pavement. Flexible pavements may consist of a relatively thin wearing surface built over a base course and sub base course, and they rest upon the compacted sub grade. Rigid pavements are made up of Portland cement concrete and may or may not have a base course between the pavement and sub grade.

The runway pavement designed is flexible pavement and the "California Bearing Ratio"(CBR) Method has been used. The CBR value of the soil at the site was 4% but we are providing a rock fill of 5m depth hence the CBR value increased to 20%. The thicknesses of the pavement section and the materials used have been designed in a software called as the "FAARFIELD" which has been designed by "Federal Aviation Administration" (FAA). The air traffic mix required for the software was acquired from "City Industrial Development Corporation" (CIDCO). The results obtained from the software are as follows: Dense bituminous concrete = 100mm Dense bituminous macadam= 125mm

Water bound macadam = 150mm

Granular sub base= 200mm

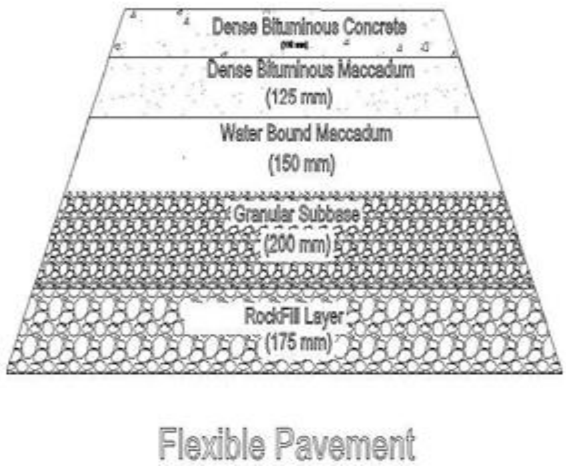

FIG 3.

Runway markings: The markings on the runway help the pilot during the aircraft operations

1. Threshold Markings

Commence 6m from both side of runway ends

2.1m from either side of edge of runway

Number of strips=16
Length of each strip=30m
Width of strip=1.80m
Gap between each strip=1.80m

2. Aiming Point Markings

One rectangular strips on either side of centre line
Distance from threshold=300m
Length of each strip=50m
Width of each strip=10m
Gap between strips=20m

3. Touchdown Zone Markings

Number of strip on both side=4 Length of each strip=25m
Width of strip=3m
Gap between each strip=1.5m
Lateral spacing between strips on either side= 20m

4. Centre Line Markings

Length of each strip=40m
Width of strip=0.5m
Gap between each strip=35m

5. Runway Strip Markings 30m from centre line
Width = 1m

FIG 4.

4) Runway lightings:

1. Runway End Identification Lights (REIL): Unidirectional (facing approach direction) or unidirectional pair of synchronized flashing lights installed at the runway threshold, one on each side.

2. Runway end lights: Pair of four lights on each side of the runway on precision instrument runways, these lights extends along the full width of the runway. These lights show green when viewed by approaching aircraft and red when seen from the runway.

3. Runway edge lights: White elevated lights that run the length of the runway on either side. On precision instrument runways, the edge-lighting becomes yellow in the last 2,000 ft (610 m) of the runway, or last third of the runway, whichever is less.

4. Runway Centreline Lighting System (RCLS):

The lights embedded into the surface of the runway at 50 ft (15 m) intervals along the runway centreline on some precision instrument runways. White except the last 900 m (3,000 ft): alternate white and red for next 600 m (1,969 ft) and red for last 300 m (984 ft).

5.Touchdown Zone Lights (TDZL): The rows of white light bar (with three in each row) at 30 or 60 m (98 or 200 ft) intervals on either side of the centreline for 900 m (3,000 ft).

Fig.5.runway Lights.

References:

S. K. Khanna- M. G. Arora- S. S. Jain; Airport Planning and Design; Seventh Edition; Nem Chand & Bros, Roorkee (U.P)
ICAO-Aerodrome Design Manual; Doc 9157 AN/901; Part 1 Runways
ICAO-Annexure 14; Seventh Edition; July 2017 FAA-Advisory Circular 150/5320-6E