Proposed Geometric Design of a Runway for Green Field Bhogapuram International Airport

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***Abstract*: As AAI (Airports Authority of India) has proposed a new green field international airport at Bhogapuram in Visakhapatnam, Andhra Pradesh. As a research I did this study on various surveys of this location where new airport is proposed, such as Climatic conditions, Metrological surveys, Traffic survey, Soil surveys and Geographical aspects also. Depending up on the regional surveys and estimated traffic intensity, the geometrical design of runway with high efficient standards which can fulfil an international airport is designed, the proposed design of runway for the green field international airport is done by using a FAA certified software tool i.e. F806FAA.xls spread sheet. based up on surveys and international standards. By considering a Boeing and its load values using this software the structure of the pavement is designed with required sub bases and geometrical design of the runway pavement is evaluated.**

***Keywords*: FAA (Federal Aviation Authority), AAI (Aviation Authority of India), Wind Rose, Runway, Boeing.**

I. INTRODUCTION

A. General

The growth of economy of any country depends upon the development of transportation. In country like India, having second largest system of railways in the world and fully developed highway transportation, there is growing demand for air transportation. Demands for larger capacity and more facilities at the airports are increasing at a faster rate. The increased number of airlines and their increasing fleet size and flight frequencies has created competitive domestic services with fare reductions, in spite of zooming oil prices. Indian airport besides runway capacities are also lacking very much in accommodating new airline offices and their demands for handling passengers. Present growth rate places Indian airports among the fastest growing in the world, next to China.

The AAI considered the proposed second airport at Visakhapatnam, for which the International Civil Aviation Organisation has completed a feasibility study and submitted a report. Apart from these issues, the development of airports in Visakhapatnam and Vijayawada airport were also under consideration. A design paper like this on Airport Engineering is essential in accomplishing the technical resources required for investment in airways, airport improvements and development of new airports.

An airport is a location with facilities for commercial aviation flights to take off and land. Airports often have facilities to store and maintain aircraft, and a control tower. An airport consists of a landing area, which comprises an aerially accessible open space including at least one operationally active surface such as a runway for a plane to take off or a helipad, and often includes adjacent utility buildings such as control tower, hangars and terminals.

Study Area

Bhogapuram Airport, a Greenfield airport project will be built near Bhogapuram, 40 kilometers north-east of Visakhapatnam, India. The project will come up on 5,311 acres in and around Bhogapuram, including 1,673 acres of government land.

- The airport will be built by the Bhogapuram International Airport Company Limited (BIACL), a Special purpose vehicle (SPV) owned by the government that was set up in May 2015.
- The airport will be built as part of an aerotropolis, which will also have a maintenance, repair and overhaul (MRO) facility along with an aviation academy. The project will be taken up in the Public Private Partnership (PPP) mode with the state holding stake in the form of land holdings.
- The proposal for setting up a green field airport was mooted during the Congress regime in 2013. Alternate sites like Atchuthapuram, S Rayavaram and Bheemili were also considered before settling for Bhogapuram, but the Indian Navy raised objections to these sites.
- The Airports Authority of India (AAI) gave its technical approval of the project site in June 2015..

1. Study on runway:

Runway Rectangular-shaped, paved surfaces on an airport, designed for the landing or takeoff of airplanes. 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). Runway Designations Based on a runway's magnetic heading, using the 360 degree compass system. It may be used in two opposite directions All runways have TWO runway design.

2. Basic runway length

Runway length A runway of at least 6,000 ft (1,800 m) in length is usually adequate for aircraft weights below approximately 200,000 lb (90,000 kg). Larger aircraft including wide bodies will usually require at least 8,000 ft (2,400 m) at sea level and somewhat more at higher Altitude airports. International wide body flights, which carry substantial amounts of fuel and are therefore heavier, may also have landing requirements of 10,000 ft (3,000 m) or more and takeoff requirements of 13,000 ft (4,000 m).

At sea level, 10,000 ft (3,000 m) can be considered an adequate length to land virtually any aircraft. An aircraft will need a longer runway at a higher altitude due to decreased density of air at higher altitudes, which reduces lift and engine power, requiring higher take-off and landing speed Runway length.

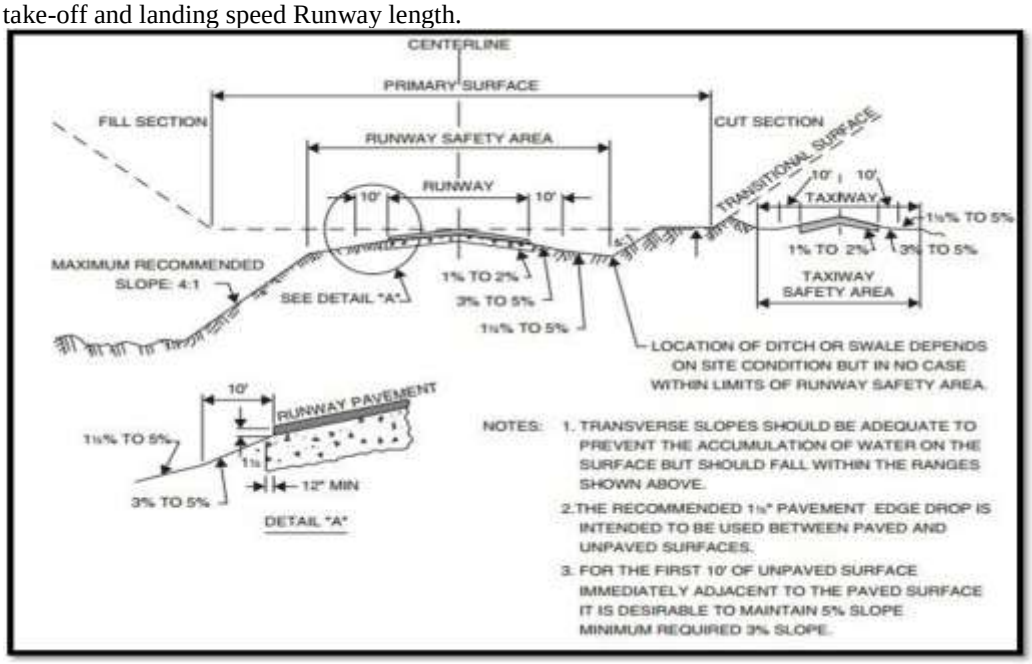

Fig1.1: Layout of runway structure.

3. Single runway

This is the simplest of the runway configurations. Suitable when winds predominantly blow along the runway and the peak hour air traffic demand is less than 50 operations. When winds are light both ends can be used for both arrivals and departures. When winds are strong only one end can be used for operations. The capacity of a single runway depends on air traffic mix and type of control.

Fig 1.2 : Single Runway

4. INTERSECTING RUNWAY

It becomes necessary to use this configuration when winds are blowing in more than one direction. When the winds are light both runways can be used. When the winds are strong only one runway can be used. Capacity depends on the location of the intersection point and the runway-use-strategy. The farther the intersection is from the takeoff end of the runway and the landing threshold, the lower is the capacity. Highest capacity is achieved when the intersection is close to the takeoff end and the landing threshold.

Fig 1.3 : Intersecting Runway

B. Objectives

The main objects or purposes for conducting the detailed surveys are as follows:

- To ascertain the characteristics of soil.
- To collect details which are essential for the design of various components of an Airport.
- To demarcate the ground on plan and to initiate the land acquisition Proceedings.
- To give an idea of the meteorological conditions prevailing at the proposed site.
- To make provision for future extension of the airport.
- To prepare suitable drawings.
- To submit report for getting sanction of the concerned competent authority.
- To propose a certain runway design with complete analysing through software.
- To suggest the use of locally available construction materials and labour.
- To work out the detailed estimate of the project, etc.

C. Hypothesis

The location of airport to be constructed in Visakhapatnam considered in this research is proposed by AAI with international standards. Which should be designed with a runway and all other desirable requirements of a International airport. A design paper like this on airport engineering& runway is useful in accomplishing technical resources and design of airport construction.

D. Research Approach

The main objective of this research is to propose a runway design with high traffic ability at international standards by using FAA developed software and following AAI norms.

This report states the required dimensions of an international runway with proposed pavement design standards.

II. LITERATURE REVIEW

Airport Layout and Design, Trent Baldwin & Jim Clague of PBS&J.

Thickness design calculations for the new large aircraft (NLA) airbus a380, Moshe Livneh, Transportation Research Institute, Technion-Israel Institute of Technology, Haifa 3200,Israel.

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- Wind rose description was proposed previously by with compass stating directions of the flow of wind at satandard limitations and considerations "Origins of the Compass Rose" Thoen, Bill. (2004)
- Wind Rose Data is gathered by following many systemic techniques and . Natural Resources Conservation Service. By Jan Curtis (2007)
- Edwards AFB Rogers Lakebed Airport Diagram developed the airport layout "Order JO 7340.1Z: Contractions" (PDF). Federal Aviation Administration. March 15, 2007.
- FAARFIELD 1.42 runs on Windows™ operating systems. Windows 7 or higher is recommended. Programmer Dr. David R. Brill, FAA Airport Technology R&D Branch, ANG-E262. -2012
- FAARFIELD stands for FAA Rigid and Flexible Iterative Elastic Layered Design. FAARFIELD 1.42 incorporates full 3D finite element responses to aircraft loads (for new rigid pavements and rigid overlays). The 3D finite element models used for rigid pavement designs are computationally intensive and may result in long run times, depending on the computer characteristics. We would appreciate your comments concerning this program and your suggestions on how it could be improved.
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Present study:

This study focuses on the design of the runway by considering the particular conditions of the location By using software analysis to calculate wind rose diagrams and various surveys necessary which determine the stability of soil and wind speed and direction which will help us to design of runway. IACO cross wind design criteria is also gathered. We use F806AA.xls to design the pavement required with this software we can conclude the design of the pavement and structural elements can specified.

III. BACKGROUND KNOWLEDGE

An Airport is a location with facilities for commercial aviation flights to take off and land. Airports often have facilities to store and maintain aircraft, and a control tower. An airport consists of a landing area, which comprises an aerially accessible open space including at least one operationally active surface such as a runway for a plane to take off or a helipad, and often includes adjacent utility buildings such as control tower, hangars and terminals. Larger airports may have fixed base operation services, airport aprons, air traffic control centres, passenger facilities such as restaurants and lounges, and emergency services.

An airport with a helipad for rotor craft but no runway is called a heliport. An airport for use by seaplanes and amphibious aircraft is called a Seaplane base. Such a base typically includes a stretch of open water for take-offs and landings, and seaplane docks for tying-up. An international airport has additional facilities for customs and immigration.

In warfare, airports can become the focus of intense fighting, for example the Battle of Tripoli Airport or the Battle for Donetsk Airport, both taking place in 2014. An airport primarily for military use is called an airbase or air station.

Most of the world's airports are owned by local, regional, or national government bodies.

A. Airport Surveys

The airport project requires intensive study and careful considerations from various points of view. The data and details collected during preliminary surveys are properly analysed and the results of the detailed surveys are accommodated in the recommendation report of the proposed site of an airport. In this chapter, the usual detailed surveys which are carried out to ascertain the feasibility of an airport site are briefly described.

Objects of surveys:

The main objects or purposes for conducting the detailed surveys are as follows:

- To ascertain the characteristics of soil.
- To collect details which are essential for the design of various components of an Airport.
- To demarcate the ground on plan and to initiate the land acquisition Proceedings.
- To give an idea of the meteorological conditions prevailing at the proposed site.
- To make provision for future extension of the airport.
- To prepare suitable drawings.
- To submit report for getting sanction of the concerned competent authority.
- To suggest the measures, if any, to improve the existing site condition
- To suggest the use of locally available construction materials and laborers.
- To work out the detailed estimate of the project, etc.

B. Types of Surveys:

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

- Approach zone survey
- Drainage survey
- Meteorological survey
- Natural resources survey
- Soil survey
- Topographical survey
- Traffic survey.

1. Approach zone survey:

The term approach zone is used to indicate the wide clearance area on either side of the runway along the direction of landing and take-off of an airport. The approach zones permit smooth functioning of an aircraft during landing and take- off operations. The glide path of an aircraft during landing varies from a steep slope to a flat slope. But the rate of climbing during take-off is controlled by its wing landing and engine power. 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. 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. It thus helps in the determination of the locations of the objects protruding above ground level and which may prove to be hazardous during landing and take-off of the aircrafts. The approach zone determines the ownership of such undesirable objects on the ground and suggests the measures to remove the existing such objects and to prevent the construction of such structures by implementation of suitable zoning regulations. If it is not possible to remove such objects, the survey should recommend the best way to make them prominent day and night by some suitable means.

2. Drainage survey:

It is necessary to have complete data about the sources of water and the quantities of water to be handled near the airport site. The water reaching the airport has to be intercepted and diverted in proper way.

The rainfall intensity of the locality and the study of contour maps will help in determining the quantity of storm water to be disposed off. It is also necessary to collect necessary information about every possible outlet in the form of natural streams or river near the airport site. The drainage survey is also as certain that the pavement of airport will not be submerged during floods or heavy rains. 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:

The science of the atmosphere and its phenomenon is known as meteorology. Hence, in the meteorological survey, the study of weather and climate is made and if required, the help of an experienced meteorologist is also taken. The data to be collected in this survey can be numerated as follows:

- Barometric pressure;
- direction, duration and intensity of prevailing wind;
- frost and fog;
- periods of low visibility;
- rainfall intensity and duration;
- snow fall;
- Temperature; etc.

It is to be noted that the above details are to be collected for several years in the past and after proper scrutiny, they should be applied for the planning and design of the various components of an airport.

Some of the applications of the details obtained in this survey can be mentioned as follows

- The accurate rainfall data will be of immense help in the design of pavement and airport drainage.
- The barometric pressure measures the density of the earth's surface and it has direct impact on the length of runway.
- The maximum depth of frost action can be determined for the frost affected areas.
- The orientation of runway basically depends on the conditions of the prevailing winds.

4. Natural resources survey:

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

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

5. Soil survey

The sub grade soil supports the runway and other structures of the airport. Hence, the knowledge of soil is considered to be very important to an airfield engineer.

From the geological point of view, the soil is defined as the relatively thin layer of disintegrated rock lying on or near the surface of the earth, mixed with organic matter which is the product of decaying vegetation and animal material. Thus, the soil is the result of the residual concentration of the alteration products of rock, which in turn, have been changed by the influences of chemical and physical processes as well as living and dead organisms. It is under laid by the subsoil fragments containing little organic matter.

Objects of soil survey: The main objects of soil survey with respectto airport engineering can be mentioned as follows:

- To carry out the design of pavement.
- To decide the best location of various drainage structures.
- To decide whether or not the subsurface drainage for the airport will be necessary.
- To determine the location and extent of areas from which desirable construction materials can be obtained.
- To determine whether or not the sub grade soil requires to be improved so as to increase its bearing capacity.

To establishes top and bottom elevations and lateral limits of all the natural formations to be encountered in cutting and embankment.

6. Topographical survey:

In this survey, the surface features like hills, rivers, levels, etc. of the region are measured and studied. The detailed topographical survey of the area provides sufficient data for the following:

- To describe the nature of property to be acquired.
- To estimate the excavation quantities.
- To estimate the quantities of clearing the site, removing roots and stumps from ground, etc.
- To prepare an accurate contour map having contour interval which will allow the selection of the best alignment for the runway and also for determining the drainage cost accurately.
- To prepare an accurate map showing roads, hills, property lines, streams, buildings and all other important physical features of the airport site.
- To provide information for the best locations of the outfall for the drainage system and for which the survey can be extended beyond the airport boundary.

7. Traffic survey:

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

C. Runway Orientation:

1. Preliminary information required:

It is necessary to collect the following data before deciding the orientation of the runway:

- Maps of the area in the vicinity of the airport showing contours at suitable intervals and
- 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.

2. Headwind & Tailwind:

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

3. Crosswind**:**

A crosswind is any wind that has a perpendicular component to the line or direction of travel. In aviation, a crosswind is the component of wind that is blowing across the runway, making landings and take-offs more difficult than if the wind were blowing straight down the runway. If a crosswind is strong enough it may exceed an aircraft's crosswind limit, and an attempt to land under such conditions could cause structural damage to the aircraft' sunder carriage.

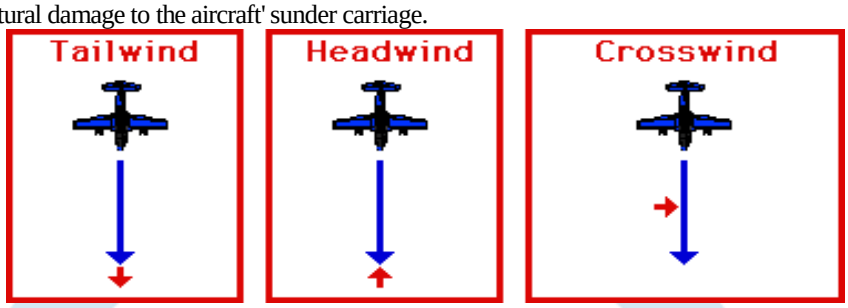

Fig 3.1 : Tail wind, Head wind & Cross wind

D. Wind Rose Diagram:

A wind rose is a graphic tool usedby meteorologist to give a succinct view of how wind speed and direction are typically distributed at a particular location. Historically, wind roses were predecessors of the compass rose (found on maps), as there was no differentiation between a cardinal direction and the wind which blew from such a direction. Using a polar coordinate system of gridding, the frequency of winds over a long time period is plotted by wind direction, with color bands showing wind ranges. The directions of the rose with the longest spoke show the wind direction with the greatest frequency. The following is the example of wind rose diagram. Example**:**

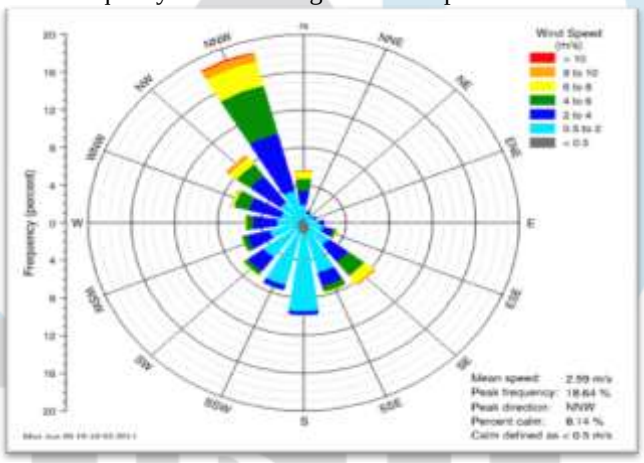

Fig 3.2 Example of Wind Rose Diagram

E. Land Side and Airside Areas:

Airports are divided into landside and airside areas. Land side areas include parking lots, public transport railway stations and access roads. Airside areas include all areas accessible to aircraft, including runways, taxiways and ramps. Access from landside areas to air side area is tightly controlled at most air ports.

Most major airports provide commercial outlets for products and services. Airports may also contain premium and VIP services. The premium and VIP services may includ express check-in and dedicated check-in counters. In addition to people, airports move cargo around the clock. Many large airports are located near railway trunk routes.

F. Minimum Circling Radius

A certain minimum radius in space is required for aircraft to a smooth turn and it depends upon the type aircraft.

The knowledge of minimum circling radius helps in separating two nearby airports by an adequate distance so that aircrafts landing simultaneously on them do not interfere with each other.(fig given below) shows the minimum circle radii are different types of aircraft.

Table 1 Minimum Circle Radii

S. No	Type of aircraft	Minimum circular radius in Km
1	Small general aviation aircraft's under VFR (visual flight rules) conditions	1.60
2	Bigger aircrafts say two piston engine under VFR condition	3.20
3	Piston engine aircrafts under IFR (Instruments flight rules) condition	13
4	Jet engine aircraft under IFR condition	80

G. Minimum Turning Radius

It is necessary to known minimum turning radius of an aircraft to decide the radius of taxi ways and to ascertain its positions in the landing aprons and hangers. (fig given below) shown the method of determining the minimum turning radius.

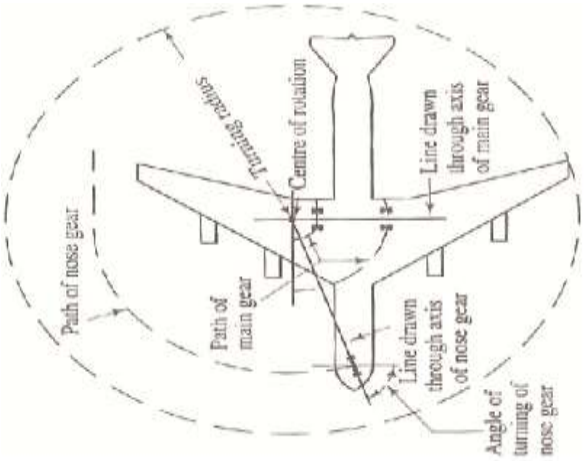

Fig 3.3: Turning radius of plane

a. Fuselage length: The length of aircraft decides the widening of taxiway on curves, size of aprons and hanging.

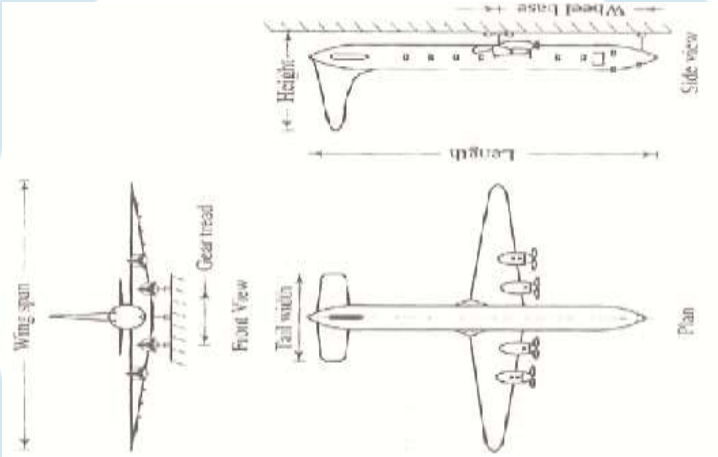

Fig 3.4: Size of the aircraft

b. Gear tread: It is the distance between the main gears and it governs the minimum turning radius of the aircraft.
c. Height: It decides the height of the hanger gate and other miscellaneous installation inside the hanger.
d. Tail width: It helps in deciding the size of the parking and apron.
e. Wheel base: It decides the minimum radius of the taxiway.
f. Wing span: It governs the width of taxiways, clearance distance between two parallel traffic ways, size of aprons and hangers, width of hanger's gate etc.

IV. METHODOLOGY

A. Basic Runway length:

The length of runway based on the following assumed conditions is known as the basic runway length:

- No wind is blowing on the runway.
- The aircraft is loaded to its full loading capacity.
- The airport is situated at sea-level.
- There is no wind blowing on the way to the destination
- The runway is leveled in the longitudinal direction or in other words, it has zero effective gradients.
- The standard temperature is maintained along the way.

The standard temperature of 15^0C exists at the airport.

The manner in which an aircraft actually performs the landing and take-off wilt decide to a large extent the length of a runway. Following three cases will be considered:

- Normal landing.
- Normal takeoff.
- Stopping in emergency.

B. Normal Landing:

As shown in fig. the aircraft should come to a stop within 60 per cent 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. The beginning of the runway portion to be used as landing is known as the threshold. The runway of full strength pavement is provided for the entire landing distance.

C. Normal Takeoff:

The take-off distance (TOD) must be, for a specific weight of aircraft, 1 15 per cent of the actual distance the aircraft uses to reach a height of 10.5 m, as shown in fig. The distanceto reach the height of 10.5 m should be equal to 115 per cent of the lift-off distance(LOD).

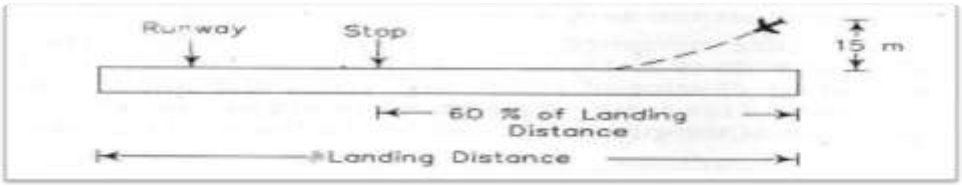

Fig 4.1 : Landing Distance

The normal take off 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. It is expressed in terms of a clearway plane extending from the end of the runway with an upward slope not exceeding 1.25 per cent. It is to be seen that the clearway is free from any obstruction. The clearway should not be more than one-half the difference between 115 per cent of the LOD and TOD.

D. Stopping in Emergency

For the engine failure case, the TOD is the actual distance required to reach a height of 10.5 m with no percentage applied. It also incidentally recognizes the infrequency of occurrence of the engine failure .In case of an engine failure, suffici1ent distance should be available to stop the airplane rather than continue the take off. This distance is known as the accelerate-stop distance, as shown in fig.

Fig 4.2 Normal takeoff Disatance

It is required to providea clearway or a stop way or both in this case. The stopway is defined as a rectangular area at the end of runway and in the direction of take-off. It is a paved area in which an aircraft can be stopped after an interrupted take off due to enginefailure.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. The clearwayshould not be more than one-half the difference between TOD and LOD.

V. APPLICATION METHODOLOGY

Surveys for Site Selection

A. Meteorological Survey

To determines the direction, duration and intensity of wind, rainfall, fog, temperature and barometric pressure etc. The following wind data is collected from the reliable web sources that depend upon the Polar Orbiting Satellite Systems for the weather forecast or report of a region based on the user given input data like the latitude and longitude of the required location or site.

Location: Bhogapuram near Visakhapatnam, south-East of Andhra Pradesh.
Latitude and Longitude: 18.0311, 83.4967 E 18° 1′ 51.96″ N, 83° 29′ 48.12″ E
Indian Standard Time: UTC+05:30
Elevation: 37m (121 feet)

The raw data collected includes the following:

- Wind data: Speed and Direction.
- Sky: Cloudy/Clear/Overcast
- Rain
- Temperature

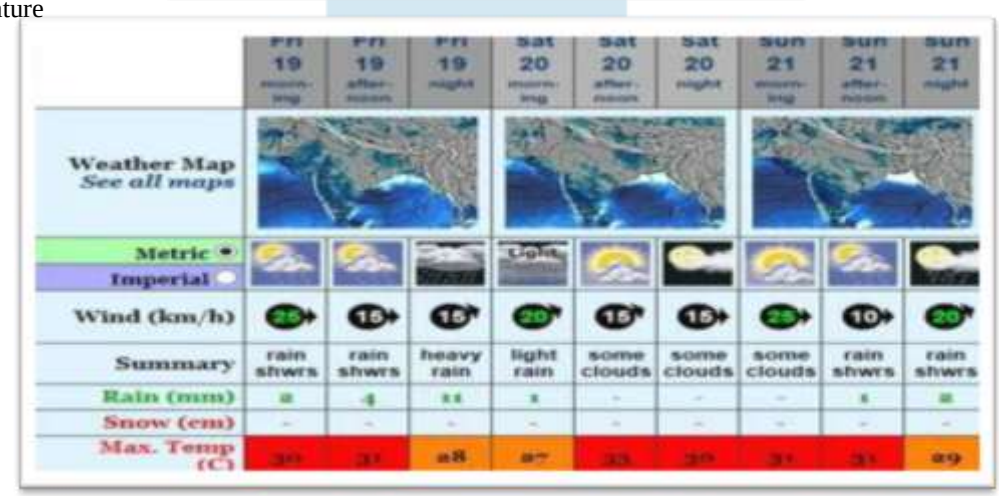

Fig 5.1 Meteorological report of the Bhogapuram region on 19th, 20th and 21st August 2017

	17 8 AM	17 11 AM	17 2 PM	17 5 PM	17 8 PM	17 11 PM	18 2 AM	18 5 AM	18 8 AM	18 11 AM	18 2 PM	18 5 PM	18 8 PM
Metric / Imperial													
Wind (km/h)	20	20	25	25	15	10	15	15	20	25	20	15	10
Summary	clear	clear	some clouds	some clouds	some clouds	rain shwrs	some clouds	some clouds	some clouds	some clouds	some clouds	some clouds	rain shwrs
Rain (mm)	-	-	-	-	-	2	-	-	-	-	-	-	1
Snow (cm)	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp (C)	30	33	35	34	32	30	29	28	30	34	34	32	31
Wind Chill (C)	30	33	35	34	32	30	29	28	30	34	34	32	31

Fig 5.2 A 3hr detailed report on 17th and 18th August 2017

B. Topographical Survey

To prepare contour map showing other natural features such as trees, streams buildings, roads etc.

Fig 5.3: Map showing water bodies, roads and other villages and towns connecting Visakhapatnam

C. Soil Survey

To determines the type of soil. This assists the design of runway, taxiway, terminal buildings and the drainage system. Geologically, Visakhapatnam belongs to the Visakhapatnam Formation which is characterized by erinaceous and argillaceous rock units comprising of splintery green shale, clays and sandstones with ironstone intercalation and conformably overlying either the Precambrian basement or Precambrian boulder beds and green shale. The beds contain marine intercalations. Their litho logical suites and fossil fauna are suggestive of deposition under shallow and brackish conditions, probably close to the shoreline. Brown clayey soil is the most predominant.

Fig 5.4: Soil samples from the proposed region at Bhogapuram

D. Drainage Survey

To determines the quantity of storm water for drainage. This can be done by interpreting rainfall intensity and the contour maps of the area. To determines the possible outlets for draining water in the vicinity of the site. The general slope of the town is towards north-east leading to Bay of Bengal. The rain water during monsoon is conveyed through the network of drains designed. The excess water from these tanks is drained which ultimately leads to the Sea. Storm water drainage network is intercepted and encroached. Dumping of debris and garbage into the open Drains. Due to this inadequate drainage system is prevailing in this town.

E. Runway design

The runway is a major element of the airport. It is clearly defined area of an airport prepared for landing and/or take off of aircraft. Runways and taxiways should be so planned in relations to other major operating elements such as terminal building, cargo areas, aprons air traffic services and parking etc. to provide an airport configuration offering the maximum overall efficiency. Runways are normally identified by the principal elements.

Runway location and orientation are of the utmost importance to aviation safety, comfort and convenience of operation, environment impacts, and the overall efficiency and economics of the airport. In establishing a new runway layout and/or

evaluating existing layouts for improvements where runways are added and/or existing runways are extended, the factor influencing runway location and orientation should be considered.

VI. CALCULATIONS & RESULTS

A. Formulae

- Correction for elevation:

Increased at the rate of 1% per 300 m rise in elevation of airport above the mean sea level

- Correction for Gradient:

Effective Runway gradient = (Difference in elevation along the proposed profile of runway/Basic Runway Length)*100

- Correction for Temperature:

Airport reference temperature = [T1+ {(T2-T1/3)}]

- The radius of central curve **R**= $V^2/125\boldsymbol{f}$
- The length of entrance curve **L** =$\mathbf{V}^3/\ \mathbf{45.5CR}_2$
- SULTS deflection angle of entrance curve $\mathbf{D_1}= \mathbf{180}\boldsymbol{L}_1/\boldsymbol{\pi R}_1$
- The stopping distance **SD =V ^{2} /25.5**

B. Considering a BOEING 727:

The Boeing 727 is the biggest flight under design consideration with a maximum take-off weight of about 160000 pounds. The take-off distance of the Boeing 727 at the maximum take-off weight varies from 8,300ft to 10,000ft (given by manufacturer). The landing distance required for the Boeing 727 is 920m.as the take-off distance is higher than the landing distance take-off distance is only considered for the calculations.

- Basic length = 3050m.

C. Correction due to Elevation:

The elevation of the city Visakhapatnam above mean sea level is 54m. The basic length is to be increased at the rate of 7% per every 300m elevation above mean sea level.

=(7/100)X(54/300)X3050

= 0.07 X 0.18 X 3050

= 38.43m = 39m

Corrected length = 3089m

D. Correction due to Temperature:

The maximum temperature recorded in the city Visakhapatnam is 450C and the standard temperature is 150^0C.

Difference in temperatures 450 – 150 = 300

= (3089X30)/100 = 926.7m = 927m

Total length correction = 966m

Corrected Runway Length = 4016m

We are going to provide a Runway length of 4020m in total.

E. The Angle of Turn of the Exit Taxi way Should in Between 300 to 600.

so we are providing an angle of 350 for the angle of turn of high speed exit taxiway and designing for a design speed of 80kmph.we are providing the standard dimensions for the runway width and taxiway width of an international airport of 45m and 22.5m respectively.

Angle of turn = 350

Design speed = 80kmph

Runway width = 45m

Taxiway width = 22.5m

The radius of entrance curve will be given by International Civil Aviation Organization (ICAO) based on the design speed and for 80kmph it will be 731m.

Radius of entry curve R1 = 731m.

The radius of central curve is given by the following formula.

R = $\boldsymbol{V}^2/\mathbf{125}\boldsymbol{f}$

R_2= 802/125(0.13) = 394m

Radius of central curve R_2 = 394m.

L =$\mathbf{V}^2/\mathbf{45.5CR}_2$

L_1= 803/(45.5)(0.39)(394) = 73.23m

Length of entry curve L_1 = 74m.

F. The Deflection Angle of Entrance Curve is Given by the Following Formula.

D_1= $\mathbf{180}\boldsymbol{L}_1/\boldsymbol{\pi R}_1$

D_1= 180(74)/π (731)

D_1= 5.750 or 50451

Deflection angle of entrance curve D_1 = 5.750 or 50451

The deflection angle of central curve is given by the following formula.

D_2 = 350 - 50451

D_2 = 290151

Deflection angle of central curve D_2 = 290151.

The length of entrance curve is given by the following formula.

L_2= $\boldsymbol{\pi R}_2D_2/\mathbf{180}$

$L_2 = \pi(394)(29.25)/180 = 201.14$m
Length of entry curve L_2 = 201.14m.
Stopping Distance:
The stopping distance SD = $V_2/25.5$
SD = 802/25 .5 = 251m
The stopping distance is 251m.This is to be measured from the edge of the runway pavement along the central line of the exit taxiway.

G. Radius of Entry Curve

The entry curve radius will be given by following formula.
We had designed the entry way to a design speed of 40kmph (V = 40).
The coefficient of friction for any airfield design is to be taken a
Radius R = $\boldsymbol{v_2/125f}$
Where, V = velocity in kmph.
F = coefficient of friction.
Radius R = 402/125(0.13)
R = 1600/16.25 = 98.46m.
Therefore, the radius of curvature of the entry curve obtained is 98.46m at a design speed of 40kmph.

H. Result

- Corrected length = 3089 m.
- Runway length of 4020 m.
- Length of entry curve L_2 = 201.14 m.
- The stopping distance is 251 m.
- The Radius of curvature of the entry curve obtained is 98.46m.

CONCLUSIONS AND FUTURE SCOPE

Conclusion

At present, the Airport Authority of India in collaboration with the Government of Andhra Pradesh is in the process of acquiring land for the proposed International Airport at Bhogapuram in Visakhapatnam. The information regarding the above mentioned airport is presented in a systematic manner as a feasibility report .
This report concentrates on the Geometrical design aspects of runway and its orientation.

- The region specific and real time collection of field data,
- Site selection and related surveys.
- Computerized wind analysis @ Wind Rose diagram
- Computerized system of design @ faarfield.xls software is used and solutions are obtained in detail.
- The runway is designed for the current trend new large aircrafts by considering their future increase in the number of annual departures.
- This is one of the comprehensive efforts to focus the preliminary report preparation of a typical airport's runway design.

By the wind rose diagrams obtained Runway orientation along with the geometrical design of the airfield pavement are designed successfully by using software tools which are strictly in accordance with the ICAO design criteria and FAA guidelines (Advisory Circular).

Future Scope

This Paper is mainly intended to propose a geometric design of runway for the newly approved bhogapuram international airport, It presented a frame work on how to design R u n w a y using software approved by FAA & AAI. Dimensions of the runway is designed up to international standards. Considering all aspects of climatic and regional conditions. This model need to be improved by using more reliable parameters and be calibrated to specific local conditions. Research can be under taken to design other requirements of the Airport such as Taxiways, Approns, control zones, approch area/zone, clearways, hanger and terminals and other to improve the predictiv equalities of the frame work using expertice approach**.**

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