AIRPORTENGINEERING

Airport Engineering encompasses the planning, design, and construction of terminals,runways,andnavigationaidstoprovideforpassengerandfreight service.

AIRPORTSITESELECTION: Thefollowingarethefactorswhichshould be considered in site selection of an airport:

- Atmosphericandmeteorologicalconditions
- Availabilityoflandforexpansion
- Availabilityofutilities
- Developmentofsurroundingarea
- Groundaccessibility
- Presenceofotherairports
- Regionalplan
- Soilcharacteristics
- Surroundingobstructions
- Useofairport

AIRCRAFTCHARACTERISTICS:

1. **Aircraftcapacity**

The capacity of aircraft will determine the number of passengers, baggage ,cargoand fuel that can be accommodated in the aircraft.

2. **Aircarftspeed**

Theaircraftspeedisreferredinmanyways

- Air speed
- Ground speed

3. **Aircraftweightandwheel arrangement**

It is necessary to understand the components of aircraft which makes up its weight during takeoffs and landing .

4. Fuelspilling:

- The spilling of fuel and lubricants is usually found in the loading aprons and hangars.
- Duetofuelspillingthepavementisseriouslyaffected.

5. Jetblast

- Theturbojetandturbopropaircraftejecthotexhaustgasesatrelativelyhigh velocities
- Thevelocityofjetblastmaybeashighas300kmphanditmaycauseinconvenience to the passengers boarding the aircraft

6. Minimumcirclingradius

- Acertainminimumradiusinspaceisrequiredfortheaircrafttotakea smooth turn.
- Thisdependuponthetypeofaircraft,airvolumeandweather conditions

7. Minimumturningradius

Itisnecessarytoknowtheminimumturningradiusofanaircrafttodecidethe radius of an taxiway and to ascertain its position in the landing aprons and hangars

8. sizeofaircraft

- Thesizeofaircraftinvolvesthefollowingimportantdimensions

1. Wingspan(widthoftaxiway,separationclearancebetweenparallel runways)
2. Length(wideningoftaxiways)
3. Height(heightofhangar)

4. Distancebetweengears
5. Wheelbase(minimumturningradius)

9. propulsion

An aircraft propulsion systemgenerally consists of an aircraft engine and some means to generate thrust, such as a propeller or a propulsive nozzle.

10. Noise

- Noise generated by aircraft create problems in making decisions on layoutand capacity .
- The effect of noise on surrounding communities is essential to the optimallayout of the runways.

RUNWAY:

- Rectangular area on an aerodrome used for landing and take off is known as runway. Runway orientation is important in airport planning.
- Thenumberandorientationoftherunwaysplaysanimportantroleinthe overall arrangement of various components of an airport.
- The**numberofrunways**willdependonthe**volumeofairtraffic**whileits **orientation**willdependonthe **directionofthewind.**

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

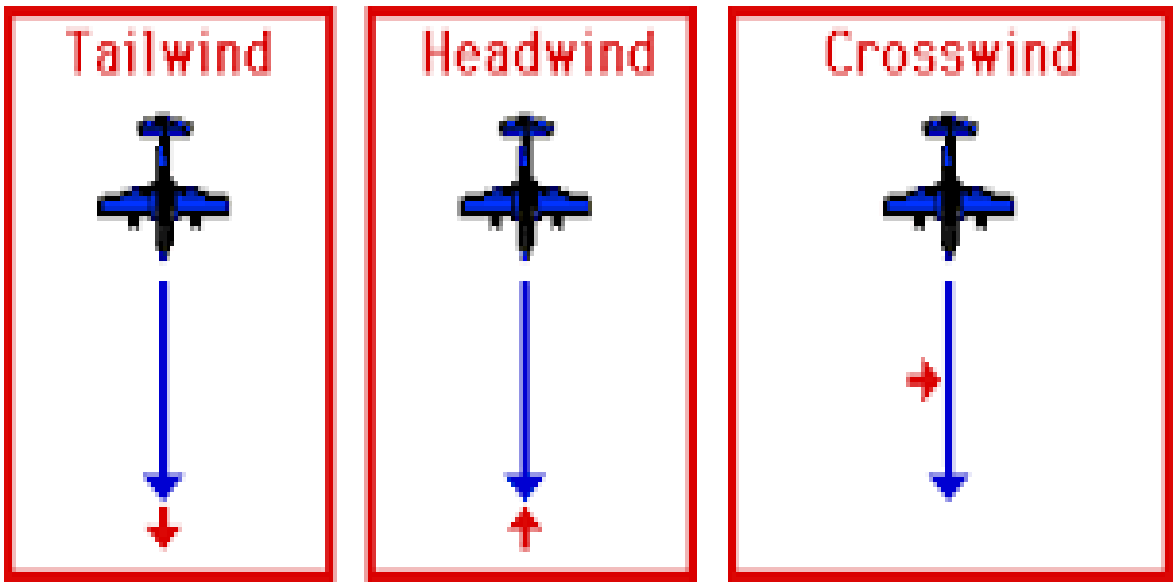
1) Maporareaandcontours–forexaminingtheflatnessofthe areaandpossible changes in longitudinal profile
2) Winddata–direction,durationandintensityof wind

Wind direction is variable and keeps on changing throughout the year. Wind data can be obtained for 5 to 10 years from the Meteorological department.

Typesof Wind:

- **Head Wind**: Wind blowing from opposite direction of head or nose of aircraft. It provides braking effect during landing and greater lift on wings during take-off.
- **Tail Wind:** Wind which is blown in same direction as on aircraft. It increases stopping distance and lift-off distance. This wind isdangerous.

- **Cross Wind:** This wind makes an angle with the direction of aircraft movement (VsinO). If this component is more then aircraft may not manoeuver safely.Generally it should not be more than 25kmph.



WindCoverage: Itisthepercentage(%)oftime inayearduringwhichthe **crosswindcomponentremainswithinthelimit**.

- ICAOandFAArecommendsminimumwindcoverageof95%

Calm Period: It is the period in which the **wind intensity remains below 6.4kmph**

Calmperiod=100–windcoverage

WIND ROSE DIAGRAM: It is a diagram in which the information about wind represents graphically and wind information includes the direction , duration and intensity of wind.

Uses:

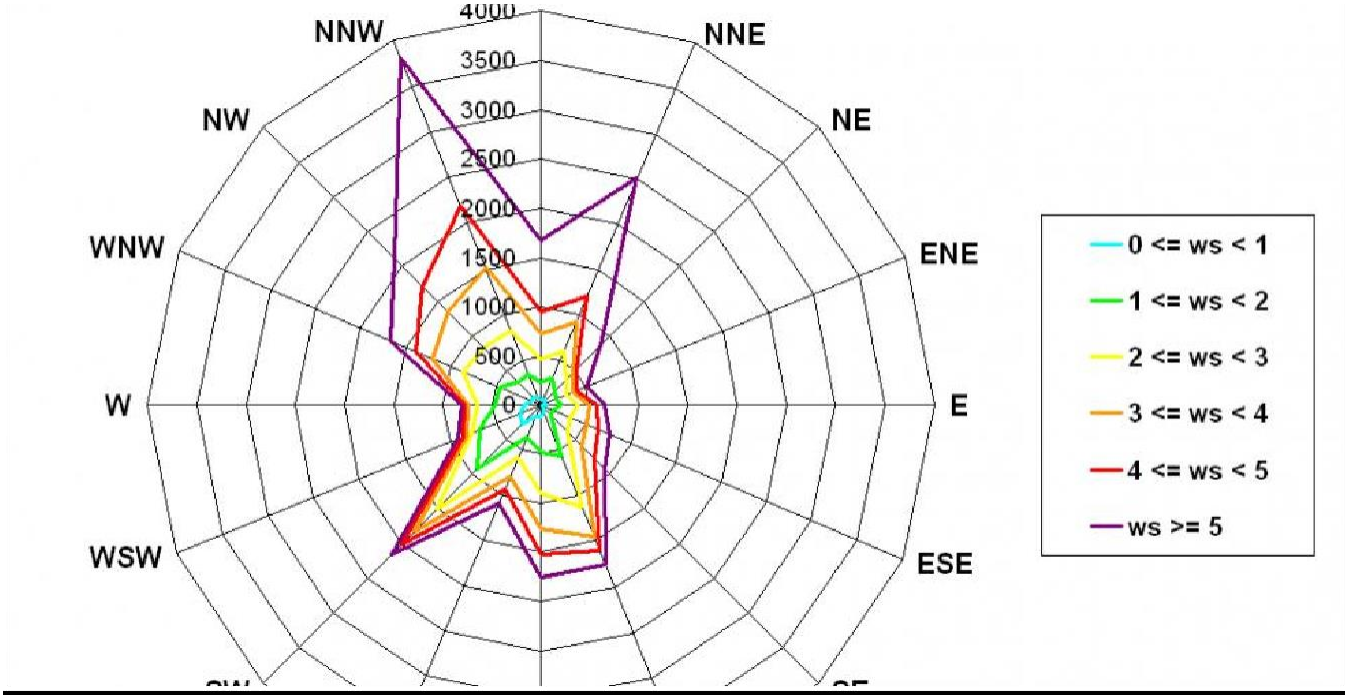
- Windrosediagramisusedtoanalysethewind data.
- Toobtainthemostsuitablerunwaydirection.

TypeI: Thisshowsdirectionanddurationofthewind.

- Concentriccirclesindicatepercentagedurationof wind
- Radiallinesindicatedirectionofwind

TypeII: Thisshowsdirection,durationandintensityofthewind.

- Radiallinesindicatedirectionofwind
- Concentriccirclesindicateintensityof wind



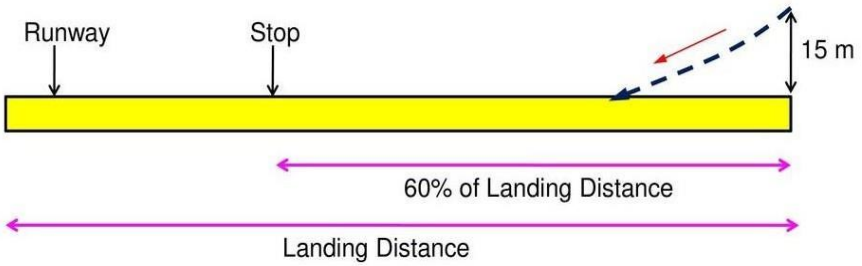
RUNWAY LENGTH: Runway length is computed from the performance characteristics of the aircrafts and by considering some standard conditions.

BASIC RUNWAY LENGTH: The length of runway based on the following assumed conditions is known as the basic runway length. The assumed conditions are:

- Nowindisblowingontherunway.
- Theaircraftisloadedtoitsfullloading capacity.
- Theairportissituatedatsealevel.
- Therunwayhaszeroeffective gradient.
- Thestandardtemperatureismaintainedalongtheway.
- Thestandardtemperatureof15°Cexistsattheairport.

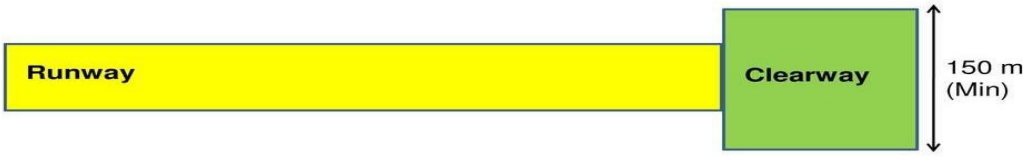
The manner in which an aircraft actually performs the landing and takeoff will decide to a large extent the length of a runway. Following three cases should be considered for basic runway length.

1. **Normallanding**



2. **Normaltake off**

❖ **PLAN: Normal Take off**



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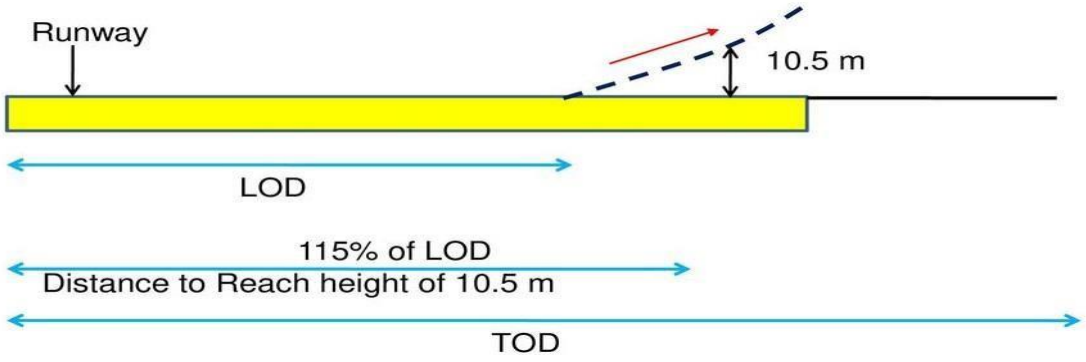
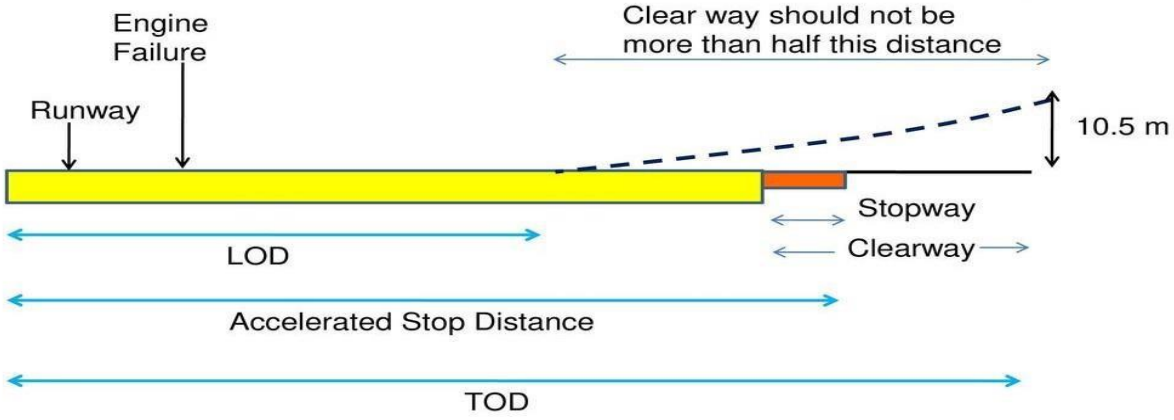


3. **<u>Stoppinginemergency</u>**

❖ PLAN: Stopping in emergency

❖ LONGITUDINAL SECTION: Stopping in Emergency



CORRECTIONSTOBASICRUNWAYLENGTH:

Basic runway length are given by ICAO for atmospheric conditions(at sea level elevation , standard temperature of 15°C and with 0% effective gradient) . Thus corresponding corrections has to be made based on the requirement. The corrections in airport design are made with respect to **elevation, temperature and gradient.**

Correction for elevation: As per ICAO , the basic runway length should be increased at the rate of **7% per 300 m rise** in elevation of airport above the mean sea level.

This correction is required because the air density reduces as the elevation increaseswhichinturn reduces thelifton thewingsoftheaircraft.Thustheaircraft will require more ground speed to rise to the air and for achieving more speed the longer length of runway will be required.

Correction for temperature : The rise in airport reference temperature has the same effect as that of the increase in its elevation above mean sea level. After the basic length is corrected for elevation ,it is further increased at the **rate of 1 % for every 1° C rise in airport reference temperature above the standard atmospheric temperature at that elevation.**

Airportreferencetemperature:Ta+(T m-Ta)/3

T a = monthly mean of the average daily temperature for the hottest month of the year.

Tm= monthlymeanofthemaximumdailytemperatureforthesamemonth.

The standard temperature at the airport site can be determined by reducing the standard mean sea level temperature of 15 °C at the rate of 6.5 ° C per thousand metre rise in elevation.

Thetemperaturegradientis-0.0065°Cpermetreheightfrom msl.

Correctionforgradient:

The maximumdifference in elevation between the highest and the lowest points of runway dividedby the total length of runway is known as effective gradient.

- The ICAO does not give any specific recommendation for the increase in length due to the effective gradient.
- According to FAA (Federal aviation administration) ,the runwaylengthafter being corrected for elevation andtemperatureshould further be **increasedat the rate of 20% for every 1% of the effective gradient.**

AIRPORTCLASSIFICATION:

The ICAO classifies the airport in two ways. In the first method, classification is based on the **runway length of the airport, pavement width and longitudinal grade**. The classification has been done by using code letters A to E , in which the A type has the longest runway length and E type has shortest length..

Airport types	Basicrunwaylength				Runway pavement width		Maximum longitudinal grade %
	Maximum		Minimum				
	m	ft	m	ft	m	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
E	749	2499	600	2000	18	60	2

Inthesecondmethod,classificationisbasedonequivalentsinglewheelload (ESWL) and tire pressure of the aircraft which will use the airport.

Code	Singleisolatedwheelload		Tire pressure	
	Kg	lbs	Kg/ cm2	Lbs /in2
1	45000	100000	8.5	120
2	34000	75000	7	110
3	27000	60000	7	100
4	20000	45000	7	100
5	13000	30000	6	85
6	7000	15000	5	70
7	2000	5000	2.5	35

RUNWAYGEOMETRICDESIGN:

1. **Runway Length:**The basic runway length will depend on the category in which the airport falls as perICAO classification.

2. **longitudinal and effective gradient:**The longitudinal gradient of runway increases the required runway length and also affects the aircraft performance inanumber of ways. The recommendations givenbyICAO for

themaximumlongitudinalgradientandmaximumeffectivegradientare shown in table

Typeof airport	Maximumlongitudinal gradient %	Maximumeffective gradient %
A,B,C	1.50	1.00
D,E	2.00	2.00

03. Rate of change of longitudinal gradient: The sudden or abrupt change of the longitudinal gradient is undesirable because it may restrict the height distance and may cause premature lift — off of the aircraft during the take off operation. For jet and supersonic aircrafts having high lift — off speeds, the premature lift — off may also affect the performance of aircraft and can also develop the structural defects in the aircraft.

The changes in gradients should be made smooth by the vertical curves and as per ICAO, the rate of change of gradient is limited to a maximum per 30m length of the vertical curve as follows:

For A and B types 0.10 percent

For C type 0.20 percent

ForDand Etypes 0.40 percent

04. Safetyarea: Therunwaysafetyarea is an area whichis cleared,drainedand graded. The shoulders are generally unpaved as they are to be used only in case of an emergency.

05. Sight distance: There is generally no sight distance restriction as the longitudinal gradientsfortherunwayare quitegentle.But there are chances forthe collision of aircraft at the points where two runways or a runway and taxiway intersect each other.

06. Transverse gradient: The ICAO recommends the maximum limit of transversegradient as1.5percent forA,Band Ctypes ofairports and2percent for D and E types of airports.

07. Width: The runway width varies from 45 m to 18m depending upon the typeof airport.

Taxiway:

Ataxiwayisapathforaircraftatanairportconnecting runwayswithaprons hangars terminals and other facilities.

Factorscontrollingtaxiwaylayout:

- Taxiways should be so arranged that the aircrafts which have landed and are taxing towards the apron, do not interfere with the aircrafts taxing for take off.
- At busy airports taxiways should be located at various points along therunwayso that thelandingaircraft leavesthe runwayandkeeps it clear for use by other aircrafts. Such taxiways are called exit taxiways.
- The route for taxiway should be so selected that it provides the shortest distance from the apron to the runway
- Theintersectionoftaxiwayandrunwayshouldbeavoided.

Apron:

- It's the Portion of an airport usually paved in front of Terminal building, for Parking, Loading & Unloadingof Aircraft.
- Holding bays are also known as holding aprons, They are provided at busy airports near the runways.
- TheyholdPlanesBeforeits Takeofftowaittilltherunwayis cleared.

- Thesizeofapronsdependsupon:

1. Typesof airports
2. Numberandtypesofaircraftsusingairport
3. Basicparkingconfigurationofaircrafts

HANGAR:

- Hangarreferstolargeshedswhererepair,renovation,servicingsandfuelling of aircrafts are undertaken.
- Generallytheyareofsteelframesstructures
- Sizeandnumberofhangarsinairportdependsupon demand.

TERMINALAREA:

- Itistheportionoftheairportotherthanthelandingarea
- Theairportterminalareaiscomprisedof

1. Passengerandcargoterminalbuilding
2. Aircraftparking,loading,unloadingarea
3. Passengerservicefacilities
4. Automobileparking

VISUALAIDS:

- visualaidinconnectionwithairportrunwaymeansthelandingaidsormarkings made on the runway.
- Therequirementsofthesemarkingsareasfollows:

1. Toenchancethedaytimevisibilityduringpoorweatherconditionorat night
2. To provide sufficient lighting on the runway edges, centre line of runway , runway threshold etc

Theseareavailableindifferentformsofmarkingsintheairportandairfield

1. Indicatorsandsignalingdevices
2. Airportmarkings
3. Airportlighting

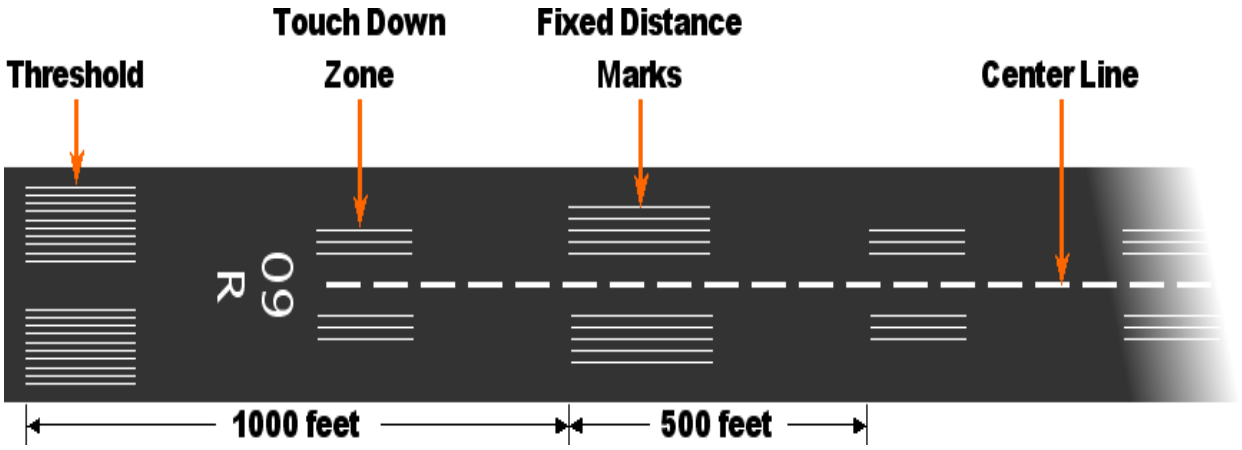
Markings are provided on any of the component of airport in different forms such as Strips, Patches ,Solid lines ,Hollow lines , Cart lines etc.

RUNWAYMARKING:

Theseareprovidedwithdifferentpurposeslike

- Runwaycenterlinemarking
- Runwayedgestripe
- Runwaynumbering
- Touchdownorlandingzonemarking
- Thresholdmarking
    - Definesspecificheightbywhichaircraftshouldcrossit
- Twoormoreparallelrunways

- **RunwayCenterlinemarking**
    - It is represented by a broken strip running along the entire length ofrunway
    - Length of strip should be equal to length of gap or 30m whichever is higher
    - Lengthofstripplusgapshallnotbelessthan50mandmorethan75m



RunwayTouchdownmarkings

- Itisprovidedinthetouchdownzoneandconsistsofpairofrectangular markings placed symmetrically about the runway center line
- Theseare1.80mwidestripesspacedat1.50mcleardistanceandareof 22.5minlength.

RunwayEdgeStripe

- Runwayedgestripconsistsof2stripesonalongeachedgeofrunway
- Ifwidthofrunwayisgreaterthan60m,thestripeshouldbelocated30m away from the runway centerline

RunwayThresholdMarkings

- Runway threshold markings consists of a pattern of longitudinal stripes ofuniform dimensions placed symmetrically about the centerline of a runway
- Theyextendlaterallywithin3moftheedgeoftherunway
- Theyare 1.80m/3.60mwidewith aspacing of1.80/0.90mbetween themand are 45m long.

Runwaynumbering

Theendofrunwayismarkedwithanumberthatindicatesmagneticazimuth

Anglemeasuredinclockwisedirectionfromnorth

- Magneticazimuthismarkedtonearest10degree

- **Twoormoreparallelrunways**
  - Iftherearemorethanonerunwayinsamedirectionfollowing numbers are added to the azimuth numbers
    - 2parallelrunways–L,R
    - 3parallelrunways–L,C,R
    - 4parallelrunways–L,LC,RC,R

RUNWAYLIGHTENING:

- Theselightsareusedtoassistpilotintoidentifythe runway
- **GREENTHRESHOLDLIGHTS:**Linetherunwayedge
- **REDLIGHTS**:Mark theendofrunway
- **BLUELIGHTS**:Runalongsidetaxiways
- Whilerunwayshave**YELLOWorWHITE**lightsmarkingtheiredges