Transportation Engineering II
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Lecture - 28
Aircraft Characteristics

Dear students, I welcome you back to the lecture series on course materials of transportation engineering 2. From the previous lecture we have started with the next part of our syllabus within the transportation engineering 2, that is, airport engineering and in the previous lecture we have also seen the introduction of airport engineering that in terms of development of airport engineering and its effect in India and various agencies which have been for controlling of the air navigation and then the classification of airports. In continuation of that in today's lecture we will be looking at different aircraft characteristics. In that sense the lecture has been outlined in the form like aircraft characteristics and the influence of aircraft characteristics. These are the 2 specific aspects which we will be looking at.

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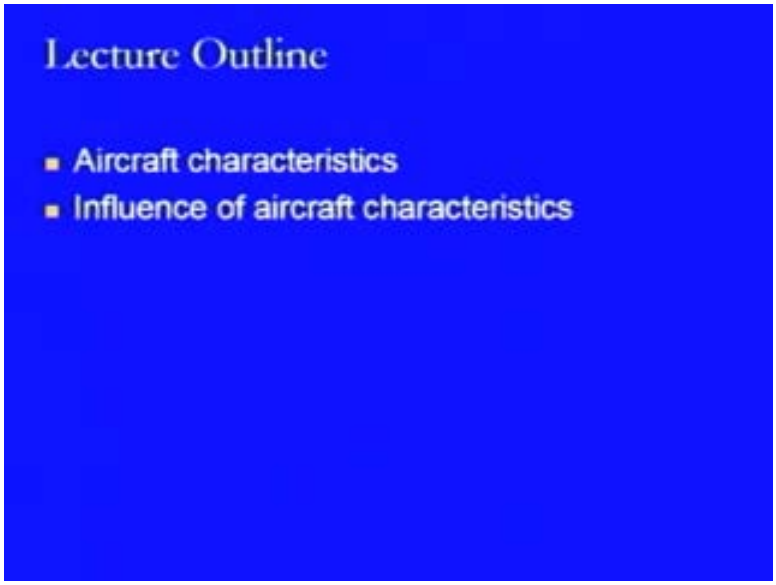

So now we start with the main thing that is the aircraft characteristics and within this aircraft characteristics we will be looking at the various types of characteristics like engine type and propulsion, the size of aircraft, the aircraft weight and the wheel configuration, the minimum turning radius, the minimum circling radius, a speed, capacity, noise, vortices at tail ends, jet blast, fuel spillage.

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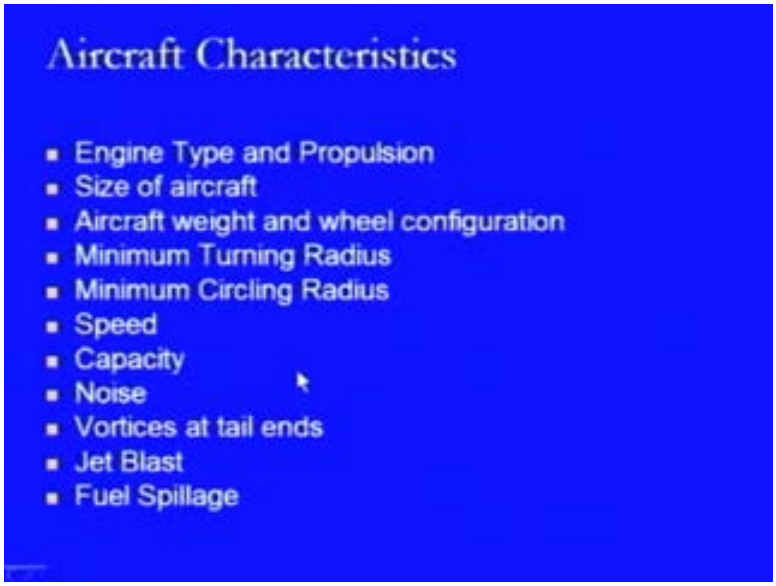

These are the various characteristics which needs to be considered as far as different design aspects of the runways, terminals or taxiways, aprons or the maintenance units are concerned and that is why if we an idea of that what is the characteristic is and how it is going to create an effect then we can design those facilities. So therefore in this the same lecture we are going to discuss at the end about different effects of these aircraft characteristics and those effects are basically related to the design features which ultimately have to be designed in any of the airport. Those design features we will be discussing in different lectures which are supposed to come after this one.

So we will be looking that whatever we are studying today or whatever we are trying to understand today has its implication in the design aspects. So you may be a little careful so as to look at that what characteristic is going to create an effect at what level or for what particular design. So in this case so in the aircraft characteristics we will be starting with the first type of a characteristic that is engine type and propulsion. In this engine type of propulsion we have to look at that what are the various types of engines which are available which can be used so as to provide the movement of the aircraft and then what type of movement of the aircraft can be provided, that is, how fast or how slow that can be provided or at what particular altitude that can be provided or whether it is an atmospheric propulsion system or it is trans atmospheric propulsion system that can be provided.

Now this propulsion maybe through any type of engine we have we have different type of engine which can be used for providing the type of propulsion which we are interested in what we see is that there is a piston engine, there is a jet engine where within the jet engine again there are different type of the jets available, they are termed as turbo jet, they are termed as the turbo propulsion or the ram jet and then there is a rocket engine. So all these things all these type of engines from the name their name itself suggest the tries to define that how they can be used. the piston engine has can be seen or has we have looked at as far as the highways are concerned or as far as the railways are concerned that these are the most conventional type of the engines which have been used where they are dependent on the movement of a piston

and with the movement of the piston the amount of torque and power is being generated and that torque and power is utilized by the vehicle for its movement. So that is more of a conventional types of engines which uses the fuel and then that fuel is utilized so as to convert it into the mechanical or the electrical energy whereas if you come to the jet engine sort of a condition there is let these engines are having a capacity of providing a jet at the back with a height thrust and this height thrust is utilized for moving the vehicle in the forward direction.

So that's the concept with the jet engine types and within these jet engine types then what type of jet is being provided with that jet which is known as turbojet or there is a jet which is termed as turbo propulsion where the not the thrust only is there but there is a sucking of a heavy amount of air and then with the help of the propulsion system and then it is being transformed into the jet from the back, that is the type of the situation where in the case of ram jet we are not using the components of the fuels so as to provide that propulsion system. Rocket engines you have already seen that they are generally trans atmospheric condition that is we are leaving the atmosphere and moving into the space then at that point we require the rocket engines. So it depends on what type of movement we are interested in we can provide type of the engine and as we look at this set of type of engines we move starting from the piston engine to the rocket engine then the amount of power which they are going to generate is higher in these series in this order at the same time the speed which will be provided for the vehicle is also going to be increasing in the same order.

Now when we look at these one then what we found is that these can be used as to avoid the speed as high as 500 kilometers per hour mostly in the case of the piston engine categories and then in the case of jet engine categories it may be somewhere around 800 kilometers per hour. In the case of turbo jet and turbo propulsion systems and the ram jet condition may go to 1280 to 2400 kilometers per hour. That is the speed with which the aircraft can move and in the case of the rocket engine it may go to as high as 4600 kilometers per hour. So that is how the speed may change with the provision of a type of an engine and aircraft and that's the type of the category of the aircrafts which we can look at. These aircrafts may operate at different altitudes it again depends on the type of the engine and the propulsive power available to the engine as well as to the aircraft or the vehicle.

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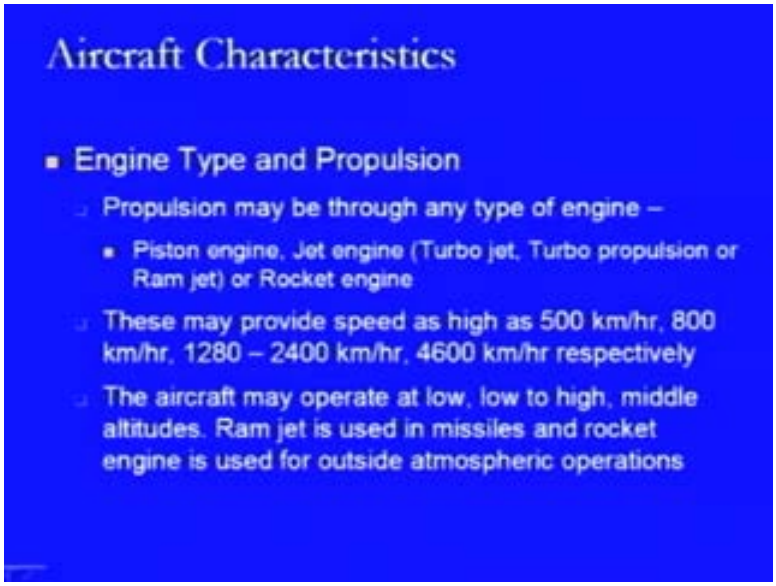

They can be operated at the low altitude or low to high altitude or middle altitudes. Generally when we look at the piston engines then they can be operated at the low altitudes where these turbo jet or turbo propulsions they can vary in somewhere between low to high altitudes, ram jets are around in the middle altitudes. That is the way we are using ram and then this ram jet is also used in missiles and the rocket engines are used for outside atmospheric operations like ram jet as we see that it has a higher speed and then it can be utilized using the middle altitudes where there are less chances of the other type of the operating systems being using with the aircraft which will be either moving at the low or the high altitudes. Most of the time in new technology conditions they are the high altitude conditions then the middle altitude conditions can be used for the operation of the missiles and that is where the ram jets are being used. Then another thing is the size of the aircraft, then this size of the aircraft is one of the important things which is to be looked at. It is to be looked at in the sense that there are three components which are going to create an effect in the most of the cases of vehicles that is its length, its height and its width.

Now here in the case of an aircraft it's not a single main body of the vehicle which we are talking about we have also to look at the wings which are coming out of the main body of the aircraft and that is where the overall wing span also becomes important. As we have seen in the guidelines being provided by ICEO or by FAA that it speaks of not of the size of the main body of the aircraft but it talks about the wing span while classifying the airports. So that is the importance of the wings of the aircraft and that is where the size of the aircraft times as to be defined in terms of the wing span. So we have to look at what are the things which are going to define overall size of the aircraft and this is defined using certain basic parameters like the fuselage length. Fuselage is the area which compasses the fuel which is to be transported along the aircraft which is used along the path at the same time it also encompasses the payload and that is the passengers and the freight that will also be placed within the fuselage length and it's the length which is provided from the nose of the aircraft to the tail of the aircraft. So that is the overall length of the fuselage.

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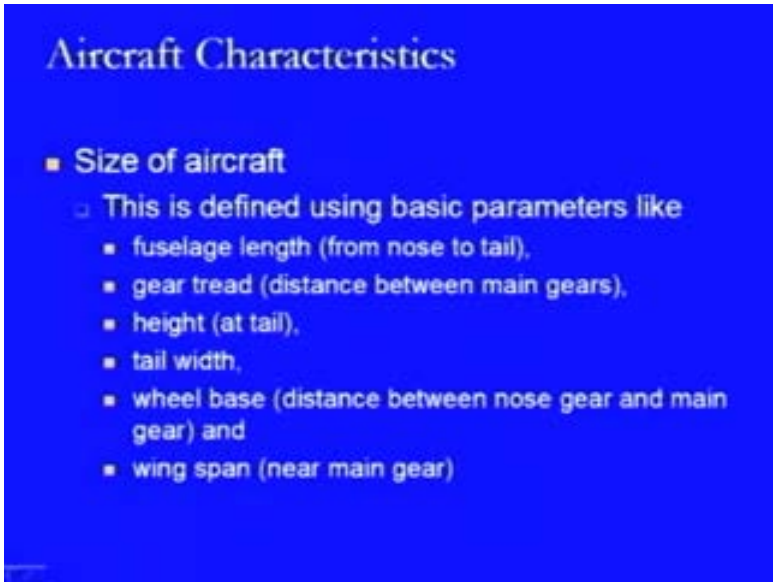

Then another thing is the gear tread. This gear tread is the distance between the main gears being provided. Then height, height is usually taken at the tail because again in the case of the tail we provide a sort of a wing in the vertical direction due to that wing which is provided in the vertical direction the height increases then the height top most level of the fuselage provided at the nose, so therefore the height of the aircraft is taken at the tail. Then the width of the tail is to be examined and is to be computed that what is the overall width of the tail because again in this case apart from the main body at the tail that is the fuselage, whatever is the width of the fuselage at the tail there is again the two small wings which are provided at the back and that is why the overall width of the tail which encompasses the fuselage plus the wings has to be considered.

Then there is a wheel base which is the distance between the nose gear and the main gear because in the case of the aircrafts the wheels are provided at two locations; one is just below the nose where the pilots are sitting that is what we can understand that is what is known as the nose. the pilots are sitting somewhere in the nose and just below that whatever gears are provided they are termed as nose gear whereas the main gears are located at the point where the wings are being connected with the main body that is useless at that particular location at the bottom of the fuselage whatever wheels are provided and way they are been connected that is the location of the main gear. So the distance between this main gear location and the nose gear location defines the overall wheel base.

Then the next important parameter which defines the size of the aircraft is the wing span and this wing span is calculated near the main gears where the two wings provided on the side are getting connected with the fuselage that is the main body and if we go along with these wings to the furthest point from one side to the furthest point on the another side then this is what is the wing span. So this is how the size of an aircraft is defined using fuselage length, treads gears and height tail width wing spans and the wheel base.

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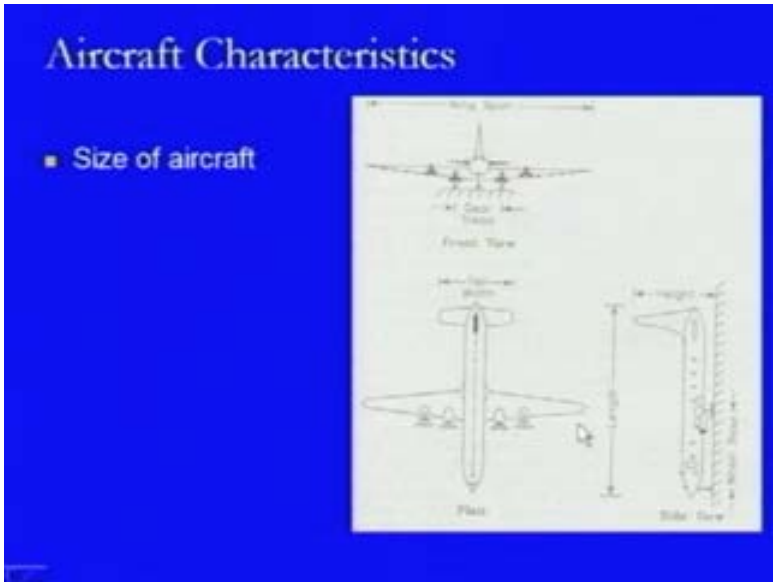

This is one diagram which tries to define the same things as we have discussed just now. Here we have the aircraft in the elevated condition on which we are looking on it from the front side and then we have this look diagram where it is in the plan and then this is from the side. So this is how we are looking at this aircraft and what we see is that we are providing his particular aircraft with a nose gear, that is, this is the nose of the aircraft, this is the nose of the aircraft and this is the location of the glasses of the cockpit where the pilots will be sitting, so this is the location somewhere here where the pilots will be sitting. At this particular location, just below this one, this is the fuselage body, this one, this body is the fuselage. So this is nose and this is the tail and then at this location we are having the wings. So these are the wings which are coming out like this on this side as well as there is a wing which is coming out on this side and that is how the symmetrical design of the vehicle is being achieved.

Now the point is that where these wings are being connected with this fuselage body at that location whatever gears and the wheels are provided they are the main gears and these main gears are provided at the connectivity of this wing with the fuselage and that is where that is how they are provided at this location this is for the nose one and these are for basically the wing gear systems. Here they have been shown below the 4 propulsion systems or the engines being employed on this aircraft here, this is the location of one engine; this is another location of the engine.

Similarly, there are two engines on this wing. The engines are not provided in the case of the aircraft within the main body, they are located on the wings. So whatever number of engines have to be provided they should be located symmetrically and in case there is only a single engine then it has to be placed somewhere here but generally it is not a single engine condition, we have the double engine condition and that case on either of the wing one of the engines will be placed. Similarly, when it is a four engine condition then we have two engines on one wing and two engines on another wing, if it is three then there is one engine to be provided in the nose area condition. So that is how we try to achieve the symmetrical conditions of the engine,

so that the thrust or the torque or the power which is being generated by these engines is distributed evenly through whole of the body of the aircraft.

As we are talking here about the size of the aircraft what we see is that the distance between the one wheel being provided on this side, the connectivity of the wing on the right hand side with the fuselage and the distance between the another wheel which is provided on the connectivity of the wing on the left hand side with the fuselage is termed as gear tread. So that is the gear tread distance because now if the it is taking a turn then this is how it is revolving with respect to this point. Then second thing is that the wings are also provided to the tail so this is a smaller wing on this side and this side therefore we have to look at the width of the tail also. So this is how we take the distance from this to this point as the tail width.

Then the length is from the nose to this end so that is what is the length being shown here. So this is the nose and this is the tail so this is overall length of the fuselage and this is the length of the aircraft. Similarly, the height is taken in terms of a wing which is provided at the back on the tail and this looks like like this in the case of the front diagram so this is at the back we are providing a tail in the vertical direction and this defines the height. So this is the height of the aircraft, so these are the things and along with this one then there is a wheel base as we have discussed. The wheel base is a distance between the main gear which is located here and the nose gear which is located here. So this distance being provided, this is the wheel base that is with respect to this wheel the nose will be moving at a radius of this much, so this will be taking a turn like this or taking a turn like this, so this is why it is termed as wheel base.

Now we come to another important parameter of an aircraft that is aircraft weight and wheel configuration. What is the total amount of weight of an aircraft that is an important aspect at the same time how this load is going to be transferred to the pavement at the bottom is going to be defined by the wheel configuration and number of wheels being provided. So what number of wheels is provided and how they are provided is what is wheel configuration. So in the case of the aircraft weight there are different types of weights which we can discuss. They are defined as the maximum gross takeoff weight, the maximum structural landing weight, the operating empty weight, the pay load and zero fuel weight. So these are the five categories of the weights which can be there and here they have been designated as a, b, c and d so as to define what is the co relational aspect between the these all types of the weights which we will be looking at in a diagrammatic form but what basically this maximum gross take off weight and others are?

In the case of this maximum gross takeoff weight this is the total amount of the weight which can be taken by an aircraft at that time when it is taking off from the landing from the runway strip to the air. So at that point of a time whatever is the weight of an aircraft that weight is termed as takeoff weight and obviously at this point of time whatever is the normal weight of an aircraft that is without any fuel, without any passenger, without any freight, without any queue, without any other materials being provided within this one that is simply the weight of an aircraft with its accessories is one weight plus then it is added to that weight of the fuel which is to be carried.

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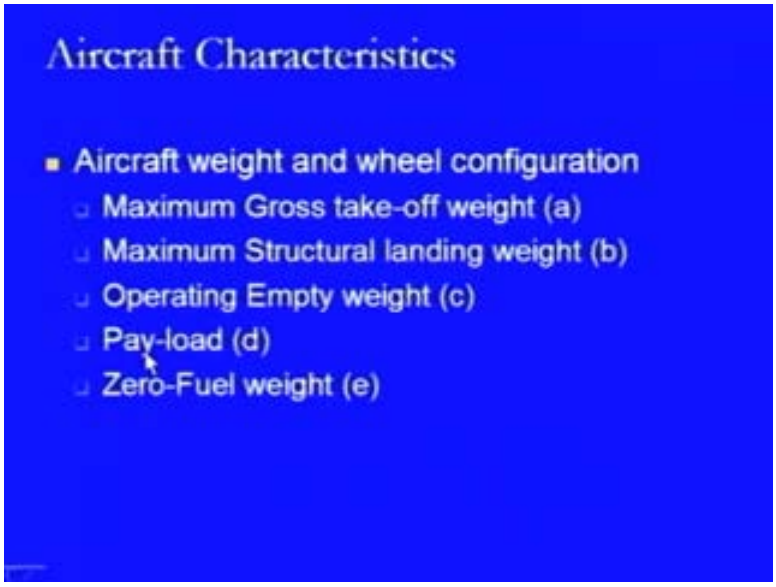

Then to that it is added as the weight of the passengers or the freight. This weight of the passengers or the freight is termed as pay load. Pay load means it is a load which is being paid for and from where the revenues have been generated. So that is the pay load. That it includes the passengers and it includes the freight. Then there is a zero fuel weight, that zero fuel weight is a condition when the aircraft is reaching the destination and the fuel is coming to the 0 level. So at that point of a time whatever is the weightage that is zero fuel condition weight.

Then operating empty weight means then we are operating without taking any other load that is the payload is not there that is what is the empty operating weight and we will look at how the changes and there is another one is like this maximum structural landing weight as we have seen in the case of the takeoff weight. We are it incorporates all the types of the weight which can be there like the weight of the aircraft, weight of the payload, weight of the fuel weight of the accessories being provided for the passengers or for the freight everything is included in this one whereas when we talk about the landing weight as we can understand when we are landing there will be passengers, there will be freight, there will be the weight of the aircraft itself but what is being deducted from the takeoff weight is the weight of the fuel which is being consumed during the journey. So whatever is the fuel which is being consumed during the journey that much amount of weight will get reduced and that will become the maximum structural landing weight. Now the word maximum is coming depending on the size of the aircraft which will be using that airport. So on the basis on that one whatever is the biggest aircraft which will be using the airport we will take the gross takeoff weight and the structural landing weight with respect to that aircraft. So that is an important aspect because some of the supporting system designs are dependent on these type of weights.

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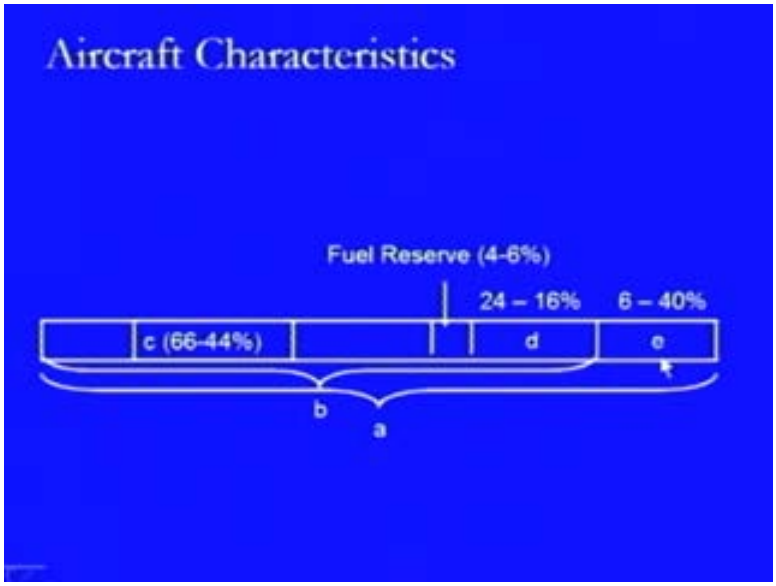

Here in this diagram we are trying to show the relationship of all these components as we have discussed that we have this a, b, c, d and e. If you look at c, d and e; c is operating empty weight, d is payload and e is zero fuel weight. So here this c is here, this is empty operating weight. This empty operating weight varies between 44 percent and 66 percent of the overall weight of an aircraft. So that is we can understand that it comes up to this point. If we take, if we assume this as a 100 percent scale then it will be up to this level. Then we have this d which is the payload, so this payload is it varies between 16 and 24 percent in normal aircraft where it is we are talking about the passengers and we are talking about the freight.

Then we have this zero fuel weight and this zero fuel weight varies between 6 percent and 40 percent depending on the size of the aircraft and distance for which the aircraft is making a flight, so that is what is reliable. Then there is also some reserve of a fuel which varies within a very small value of 4 to 6 percent. So that is what is being shown here in terms of 4 to 6 percent at this level. So these are the different components of the weights which will be there. So this is with respect to the aircraft weight that is what we can understand is the main weight which is coming in within the aircraft overall weight when it is taking off or landing is the weight of the aircraft itself. This is the amount of the weight of the aircraft itself, this is the fuel which is being consumed during the journey and this is reserved condition and these are the passengers etcetera. If they are being removed then it is an empty condition and aircraft is moving with the empty condition.

So here what we are seeing is if we consider whole of this weight then it is total takeoff weight that is takeoff weight being shown by a and if we remove the weight of the fuel which is consumed during the journey then what we are left with is b and this b is nothing but the structural landing weight with which the aircraft will be landing on any airport. So these are the weight and the weight characteristics of the aircraft and now we will look at the wheel configurations. Wheel configurations as I have told is that what we found is that in the case of the wheel configurations it is going to define how the loads are going to be transferred to the bottom supporting system more

are the wheels the less is going to be the stress at certain location and that is where we require a lesser thickness of the material at the bottom or we can have the material which can take lesser amount of loads so that is where the wheel configuration becomes important and there are different types of wheel configurations which are available and it all depends upon the size of an aircraft and the basis of that size of the aircraft we can provide various type of wheel configurations.

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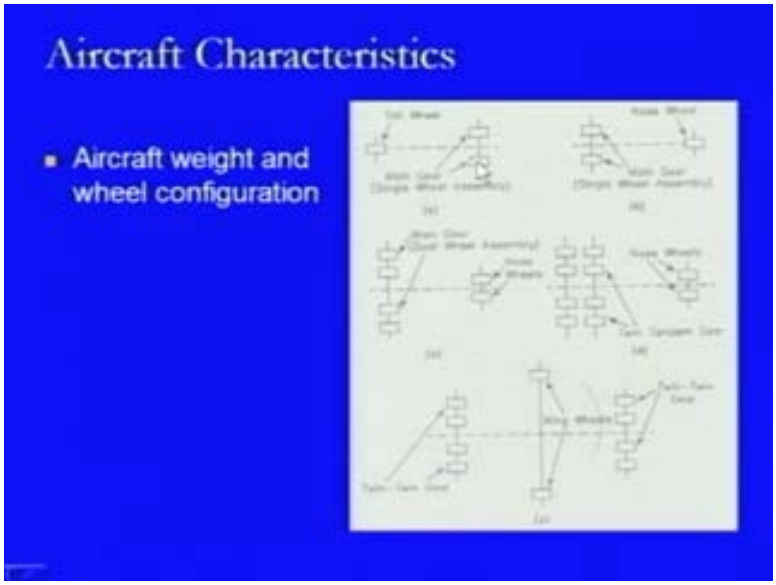

Like here what we can see is this is a single wheel assembly, this is a one wheel on the nose and then there is one wheel and another wheel at the this gear tread that is, that is the main gear which are provided below the wings. Then it can be this is another single wheel assembly in the same case, this is in other direction, then we have the dual wheel assembly where we are providing two wheels at a location. So there are 2 wheels at the nose and 2 wheels at this location and 2 at this location and the center to center of these will be a gear tread of the main gear whereas the distance from this to this point is the wheel base and this is obviously provided in the case of bigger aircraft where we have to transfer more of the loads from one location to the another location.

Within the same one then there is a further modification termed as a twin tandem gear where the axle which is being provided main gear like this is made double and that is what is a twin tandem gear. So we have the two wheels at each of the locations but then we have two sets being provided at the gear location and then there is a twin twin gear system where in this case we are providing the twin twin gears at the back at the wing wheels and then again we are having the gears being provided in the nose area. So in the nose as well as in the tail area we have the wheels as well as at the main gear location also we have the wheels. So these are the different configuration of wheels which can be there.

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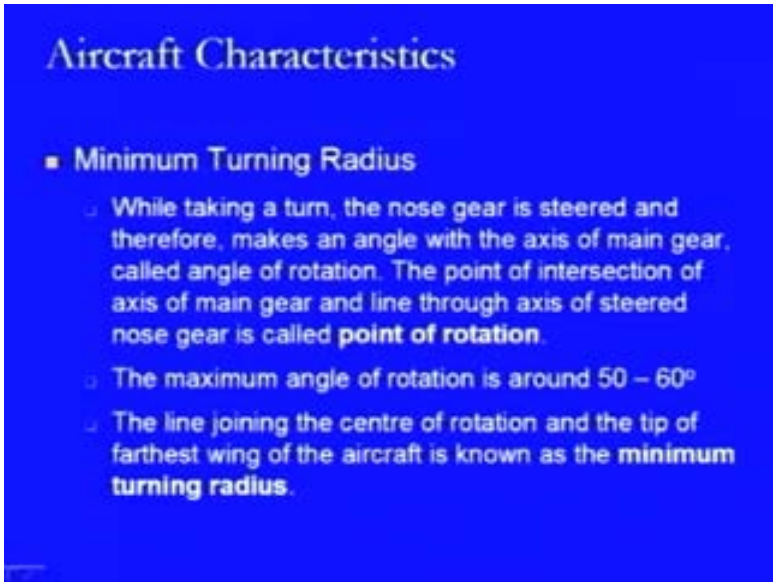

Now we come to another important characteristic that is the minimum turning radius. This minimum turning radius is defined as while taking a turn the nose gear is steered. As we have seen in the case of the road vehicles if we steer the vehicle then the front wheel will be steered and the back wheel is generally the powered wheel from where the power is coming to the vehicle. That is the same condition is here; here the nose gear is steered while taking a turn and therefore it makes an angle with the axis of the main gear because the main gears are provided at the wing location. So it as soon as it is steering then there will be an angle with which it will be coming with respect to the axis of the main gear and this particular angle is known as angle of rotation. The point of intersection of the axis of main gear and the line through axis of the steered nose gear is called the point of rotation, that is, the point above up with respect to which the whole of the aircraft will take a turn. That particular point of rotation is to be identified on the basis of the extension of the axis of the main gear as well as of the steered nose gear and wherever these two extended axis of the gears are intersecting that particular point is termed as the point of rotation.

The maximum angle of rotation varies between 50 degree and 60 degree and the line joining the center of rotation and the tip of the farthest wing of the aircraft is termed as the minimum turning radius. This is the minimum value by which an aircraft can take a turn and any other radius by which the aircraft will be taking a turn which will be more than this one. so what we have to do is once we find out the point of rotation then this point of rotation is connected is joined with the farthest point on the wing on either side and whichever is going to be the maximum then that maximum value is going to be the minimum turning radius. We will try to look at this in the diagrammatic form also. Here this is the plan of an aircraft and this is the nose area, this is the tail and therefore there is a nose gear being provided, then this is the wing, this is another wing.

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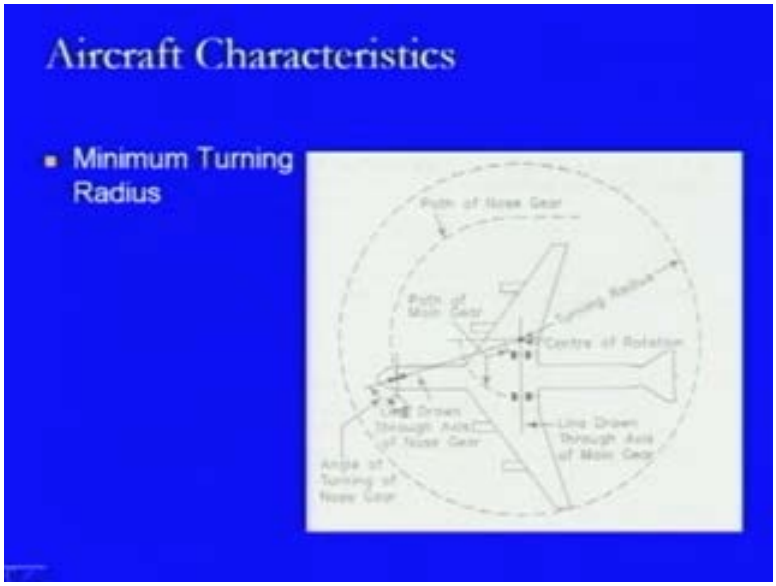

So there at this connectivity there is one wheel base and there is another wheel base provided at this connectivity and that is what is the axis of the main gear. So this is the main gear. Now as this one is being turned there is a steering of the nose gear so what we see is that instead of this location as in this case it becomes a steer to this location and therefore if we take the axis of this one it is going in this direction. So we have this axis and if we extend this axis now in this form and we similarly extend the axis of these two gears then this will be extended in this form like this and this is extended in this form like this. The location where these two axis are crossing each other that is this dotted point, this is the center of rotation means the whole of the aircraft when it is taking and steering in this direction like this will be turning with respect to this point. So that is what is it is not on the main gear itself it is away from the main gear like this.

Now at what radius this aircraft will be taking a turn is another point. So in that case we take that particular points and that is the center of rotation and take the distance of the farthest tip of the wing. So if we take the farthest tip of the wing then this is the farthest tip of the wing from this side so if we connect this, this is one value and if we connect this one with this then this is the another value. The maximum of the two means this one is going to be the turning radius. So it will be taking a turn with respect to this point will move like this and it will move at this particular radius like this. So that is where the turning radius is equivalent to this distance. If I join this dot with last point, that will be the turning radius. So this is the minimum turning radius with which the aircraft will be taking a turn on any airport while it is moving on the ground. So that is the ground turning radius which is to be provided and if the size of the aircraft is big it means it requires a bigger turning radius, if the size of the aircraft is small it requires a smaller turning radius. In the same form we look at another characteristic of an aircraft that is minimum circling radius.

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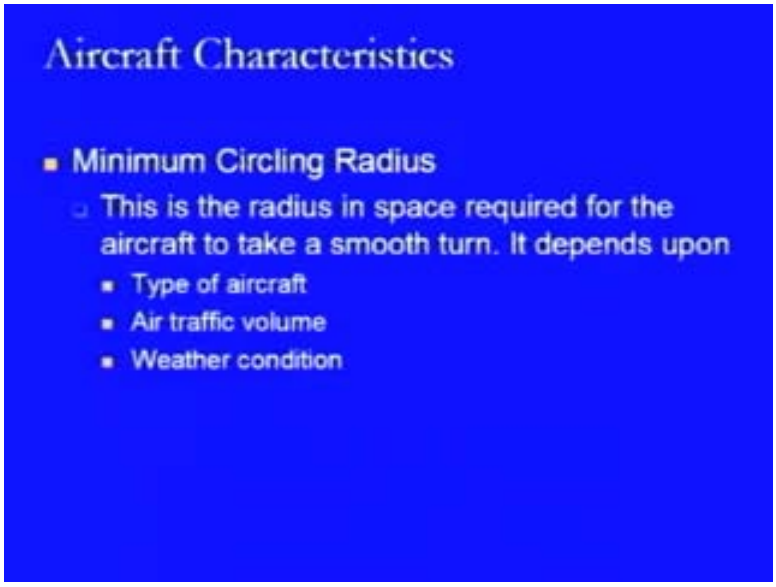

This minimum circling radius is related to the movement of the aircraft within the air and this is the radius in space which is required for an aircraft to take a smooth turn and therefore it is dependent on like what is the type of aircraft, that means what type of power propulsion system is available to the aircraft, what is the size of the aircraft, then what is the air traffic volume and what are the weather conditions that is going to define this minimum circling radius and this minimum circling radius is what happens in this case is that this is the total radius which is provided at the top of the airport in which the aircraft will be circling if it not being allowed to land. So sometimes you must have seen that the aircraft which are moving at the top of the airport that is what is the circling radius and the significance of that we will be looking later.

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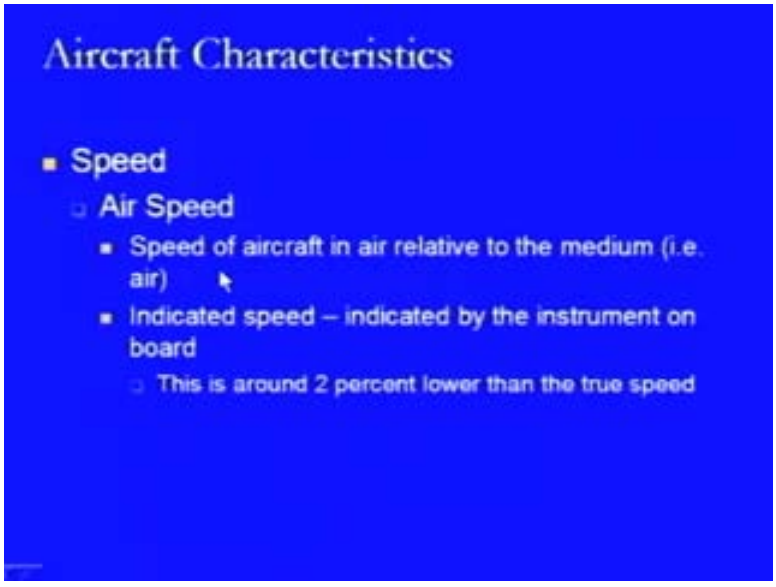

Now in the case of the speed there are different ways the speed of an aircraft can be defined it is like air speed where the air speed is the speed of the aircraft in air relative

to the medium and in most of the cases the medium remains air. So far we are talking about the atmospheric movements and then within this one there is an indicated speed this indicated speed is the speed which is indicated by the instruments on the board.
So whatever instruments are tailing on the board is the indicated speed and generally this is around 2 percent lower than the true speed of the aircraft. The reason is that it is a relative condition and we have to look at the effect of resistance of the air and the effect of that one is to reduce it by something 2 percent.

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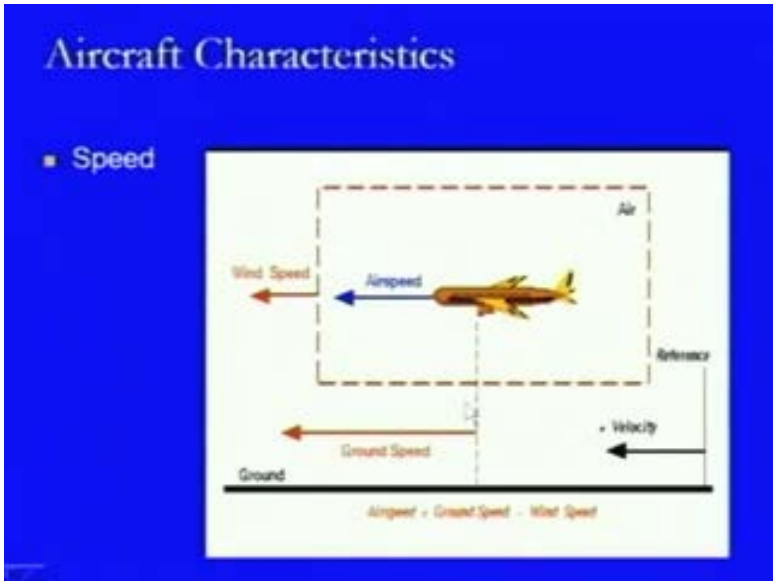

Further like in this diagram what we are looking is that we have the overall speed like there is a wind speed which is working in this direction that aircraft is moving in this direction, so there is certain. This is the medium that is air and the velocity of this aircraft is in this direction. so if we are looking it in terms of relationship between the airspeed that is the speed with which this aircraft is moving in the air by speed which is termed as the ground speed that is the speed which we are looking, which we are getting by looking at this aircraft from the ground and the correlation with the wind speed that is the speed at which the wind is blowing. Then it is termed as airspeed is equals to ground speed minus wind speed. So that is how we can compute the value of the airspeed or that is what is the correlation whatever two values are being given to us we can compute the third one. So in this case the ground speed is the speed of the aircraft relative to the ground and the relationship we have already seen is that airspeed is ground speed plus minus wind velocity and if it is Mach 1 then Mach 1 is termed as equivalent to the speed of the sound. So that is how the speed of the aircrafts are termed.

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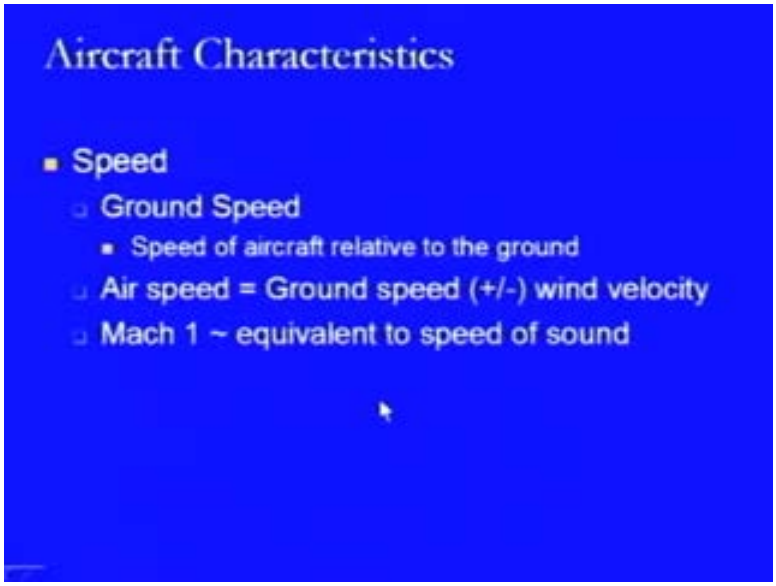

Generally they are being termed in terms of less than Mach value or more than Mach 1 value and on the basis of that we have the subsonic and supersonic aircrafts.

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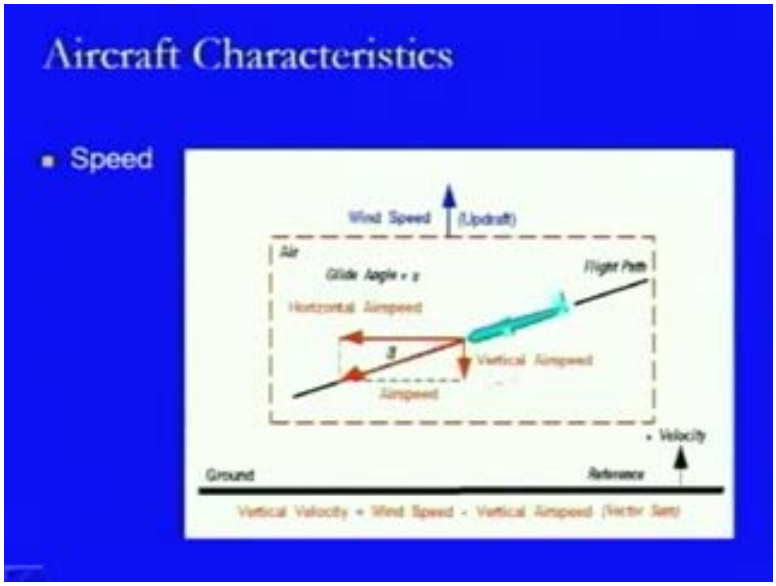

That is another condition where we are looking at the vertical velocity condition.
This vertical velocity condition is nothing but it is the updraft or the lift which will be caused on an aircraft because of heavy wind which is going in the vertical direction.
What is happening is that this aircraft is blending and therefore this is the flight path at which it is coming towards the runway strip and therefore the speed of this aircraft, air speed is working in this direction and if we resolve it into two components then there will be a horizontal airspeed component and a vertical airspeed component and then in this case if the wind is wind speed is if there is an updraft in the upward direction then what happens is that this vertical velocity will be equivalent to the wind speed plus vertical airspeed, that is, the vector sum of this values. That is another way

of defining the speed in this case. Then the next characteristic is the capacity of the aircraft and this capacity of the aircraft is defined in terms of the number of passengers or the total amount of freight which can be transported using that aircraft. Therefore it is going to be governed by certain factors and the factors are obviously the size of the aircraft, then the propulsive power which is available to the aircraft and the speed of the aircraft with which the things can be transported.

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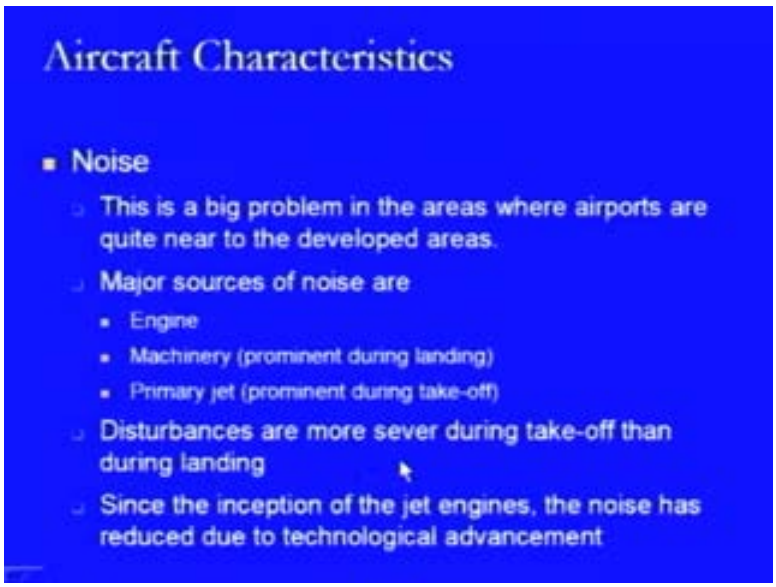

Another characteristic is noise. This is one of the big problems in those areas where the airports are being located very near to the developed areas and the major sources of noises are engine noise, the machinery noise which is more prominent at the time of landing and the primary jet noise which is more prominent at the time of taking off. So these are the different components of the noise, this engine noise will always remain. The disturbances are more severe during the take off than during the landing and that is because of the jet. Since the inception of the jet engines the noise has reduced due to technological advancement. Initially that jet noise was a very heavy noise and that was a factor so to use the jet engines in those areas where the airports are near to the developed areas but now with the technological advancements this noise as been controlled to a lot value.

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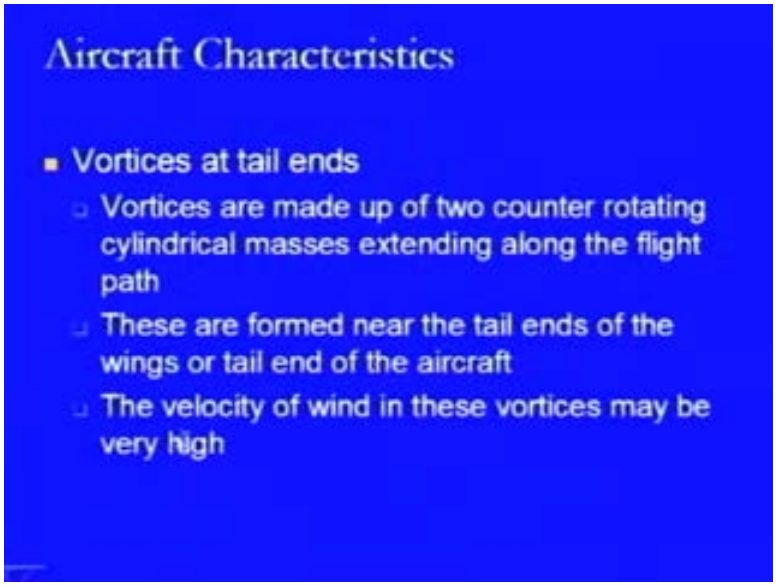

Then another important aspect is the vortices which get formed at the tail and while the aircraft is moving in the air at a very high speed at this vortices have a tendency to break the tail if they are very heavy and if the eddies are being formed at the back and in this case what happens is these are made of two counter rotating cylindrical masses which extend along the flight path. So these cylindrical masses which are counteracting with respect to each other if the value or the measure becomes more then they may become the hazardous condition for the tail end also and these are formed near the tail ends of the wings as well as tail ends of the aircraft where there is a detachment of the movement of the air with respect to the body of aircraft. The velocity of wind in these vortices may be very high, very very high and this is how it looks like.

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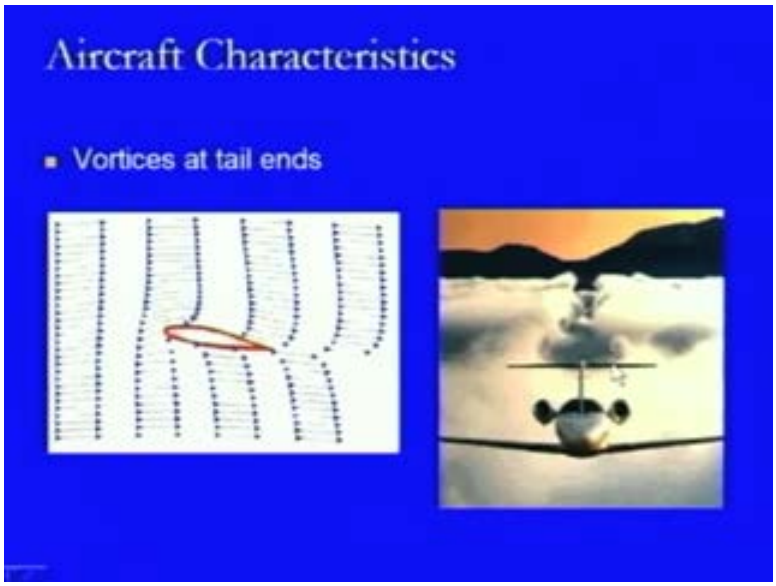

This is the normal tilt condition of the air and the wing of the aircraft is coming in this one then there is a distortion here where there is a higher movement at the upper side and there is a lower movement at the bottom side and then it gets transformed in this particular location and this is what is the point of separation where it goes in this direction and where this goes in this direction. So some separation will get caused at this location because of this type of movement and this type of movement. So this separation is going to create a vertex condition at this level, this direction movement and this is this direction movement and this is how this is the one photograph which has been taken while this aircraft is moving in the air and this is a type of separation which is coming here as talked about at this level where this is going in this direction, this is going in this direction. So that is some separation will be created at this level and these are the vortices being formed at this one and this one and if the speed is so high if something is being left in this one will get turned off.

Then the next aspect in the case of those aircrafts where the jet blast is being used, this is the blast that comes out of the jet engine at the rear of the aircraft and it provides the force which is required for the movement of the aircraft. so that is required for it's movement but at if we consider it in case where the aircraft is standing and the jet blast is coming from the rear, that is so hot and it creates a severe condition for the things on which it will be falling.

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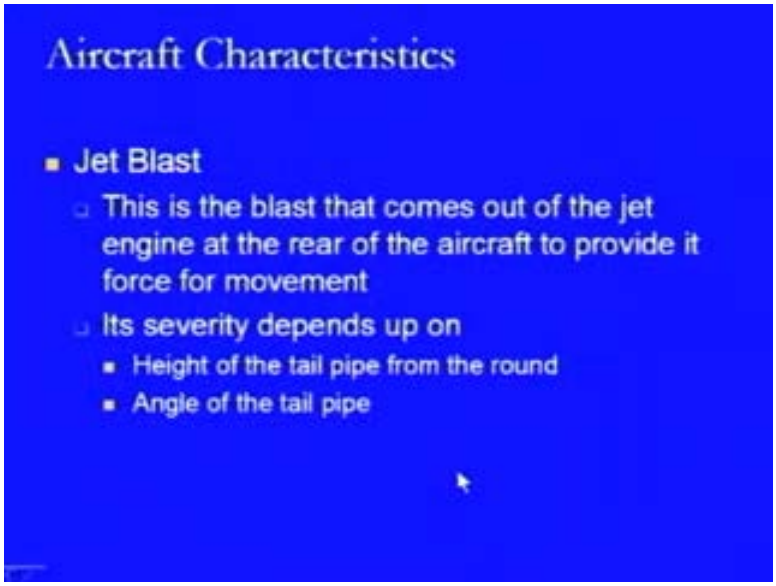

So the severity is going to depend on two things; one is the height of the tail pipe from the round and another is the angle of the tail pipe through which this jet blast will be coming out at the tail end. So if it is in the upward direction then it will go up if it is in the downward direction it will create a pro effect on the pavement on which the aircraft is standing and therefore there is a need to erect the blast fences which can control the damage to the building or damage to the pavement. Then the next one is the fuel spillage, fuel spillage is the fuel which get spilled over the pavement from the engine or from the locations where it has been sprayed into the aircraft and this creates an effect in terms of that it may cost the effect on the speed of the aircraft while it is moving on the runways or the taxi ways or the front areas.

Now we will look at the some of the influencing characteristics of the aircrafts or the effects of these characteristics on the design parameters like in the case of the very first characteristic that is engine type and propulsion, it is going to the size of the aircraft or whatever we have discussed. So far that is aircraft weight and wheel configuration minimum turning radius, minimum circling radius speed capacity, noise, vortices, jet blast and fuel spillage.

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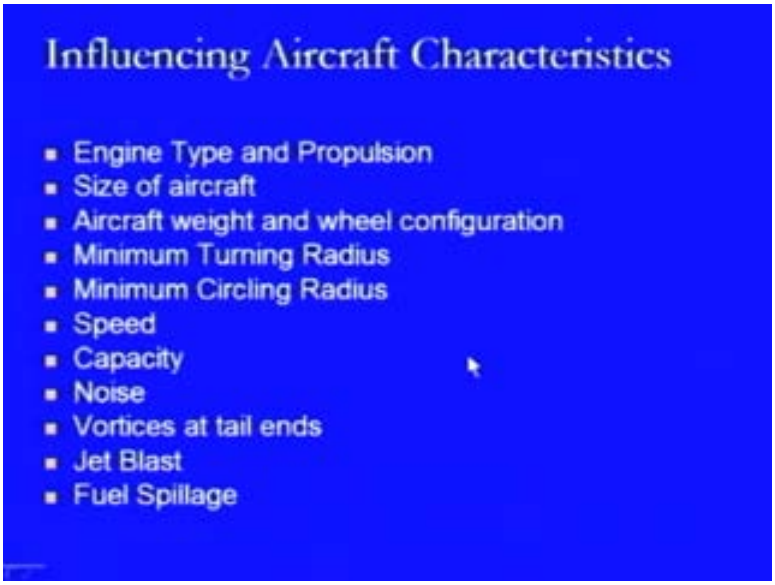

So we will take up one by one. The engine type and propulsion, this decides the size of the aircraft as we have discussed previously, the speed with which the aircraft can move obviously. The length of the runway because the more is the speed or more is the propulsion then the more longer runway strip is required for its movement so as to take off or so as to land and stop.

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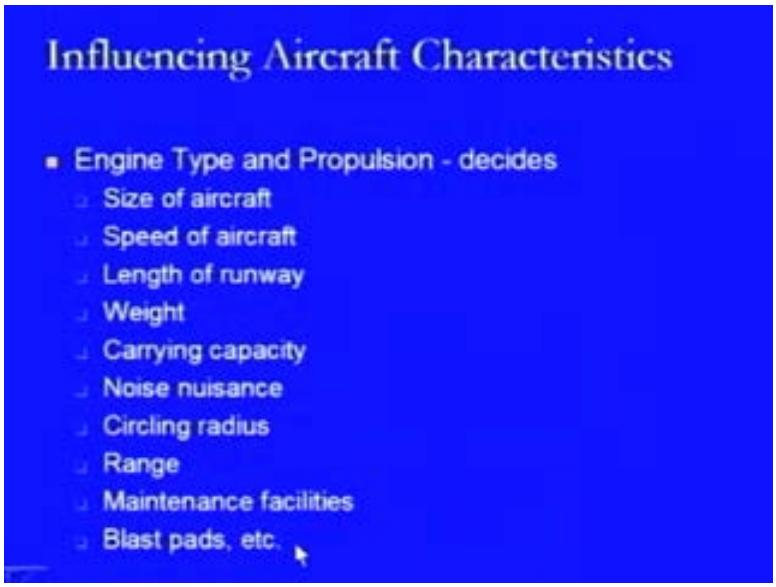

Then it also increases the weight of the aircraft with a bigger propulsion system or a heavier engine is being provided. It is also creating an effect to the carrying capacity of the aircraft because as we have seen it is creating an effect on the size of the aircraft. We are talking here in terms of the load taking capacity, the aircraft which is provided with the bigger engine or a better propulsion system can take higher load.
The noise nuisance depends on the type of the propulsion system, the circling radius if the propulsion system provides a very heavy power than the circling radius will also increase that means we require a bigger area for the movement of the aircraft but at the same time the range that is the distance up to which the aircraft can move without refueling will be also bigger. If the bigger engine type, or a better engine type, or the propulsion system has been used then the maintenance facilities are dependent on the type of the engine, that is, another type of facility which is to be checked on with respect to the type of the aircraft which are coming with different type of engines.
Blast pads etcetera they are required in the cases where the jet propulsion has been used. Then in the case of the size of the aircraft it is creating an effect in terms of the load carrying capacity. The facilities like size of apron or terminal area because whatever is the size of the aircraft say it can carry 10 passengers, 20 passengers, 100 passengers, 500 passengers or 800 passengers on the basis of that what are the facilities which needs to be provided.

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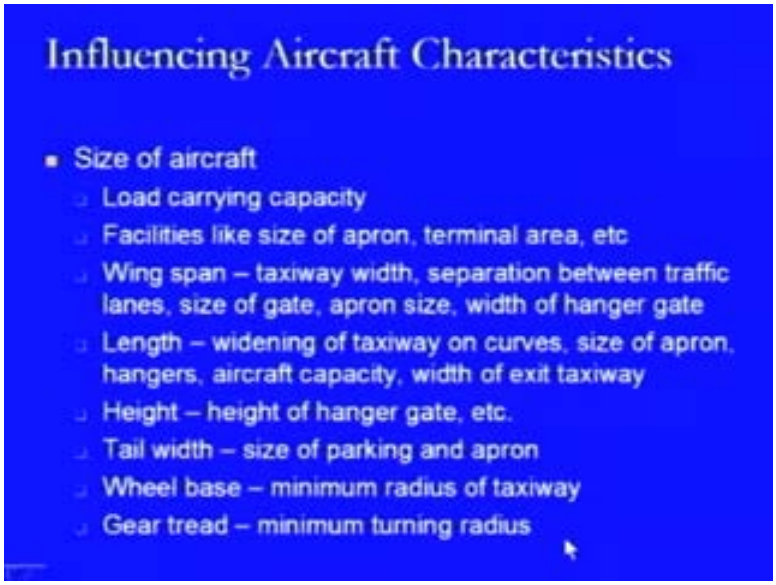

There size also keep on increasing if there is a bigger size of the aircraft, the bigger size of the apron is to be provided the apron means the location where the aircraft is standing and similarly the terminal area size will also increase. Then if the size of the aircraft is increasing the wing span will increase and if the wing span is increasing then it will have its effect on the design on the taxiway width. the separation which is to be provided between traffic lanes, the size of the gates the size of the gates are means the locations from where the passenger will board the aircraft that particular location is known as gate. So what should be the size of that gate it is going to be defined on the basis of the size of the aircraft. Similarly, the size of the apron where the aircraft is standing, the width of the hanger gate, the location where the aircraft

can be parked or can be maintained so that is known as hanger and the size of that hanger is going to be governed by the size of the aircraft.

Similarly, the length that is the widening of the taxiway on curves the size of the apron hangers aircraft capacity this is these are the effects of the length and the width of the exit taxiway because how much width is to be provided by that is taking a turn and that is going to be governed by the length of the aircraft. Then height is going to create an effect in terms of the facilities like hangers. Tail width, tail width is another characteristic out of the size which has its effect on the parking of the aircraft and the size of the apron. Wheel base is creating an effect on the minimum radius of the taxiway which can be provided and the gear tread is having its effect on the minimum turning radius. Then the weight of the aircraft and the wheel configuration it has its effect on the amount of thickness of the runway or taxiway or apron pavement to be provided.

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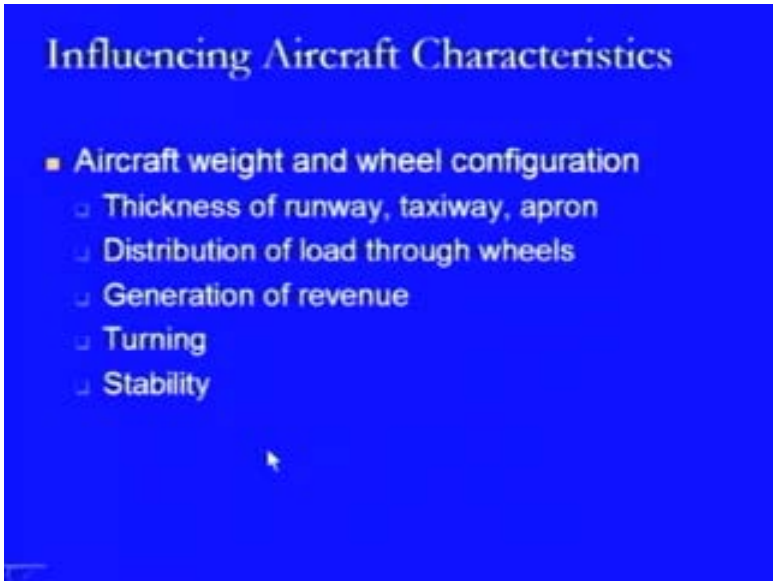

What should be the thickness of that pavement, the distribution of the loads through the wheels that is already we discussed when we discussed about the configuration. Then the generation of revenue because if we can take more of the load then obviously the more revenues will be generated. The turning is also governed by the aircraft weight if it is more of the weight then the turning may be a little difficult at the sharper conditions. Stability is also governed by the aircraft weight. This stability may be in terms of the support system being provided or it may also be in terms of the wheel configuration which needs to be provided depending on the amount of weight which an aircraft is going to carry. so two type of stability concerns can be there.

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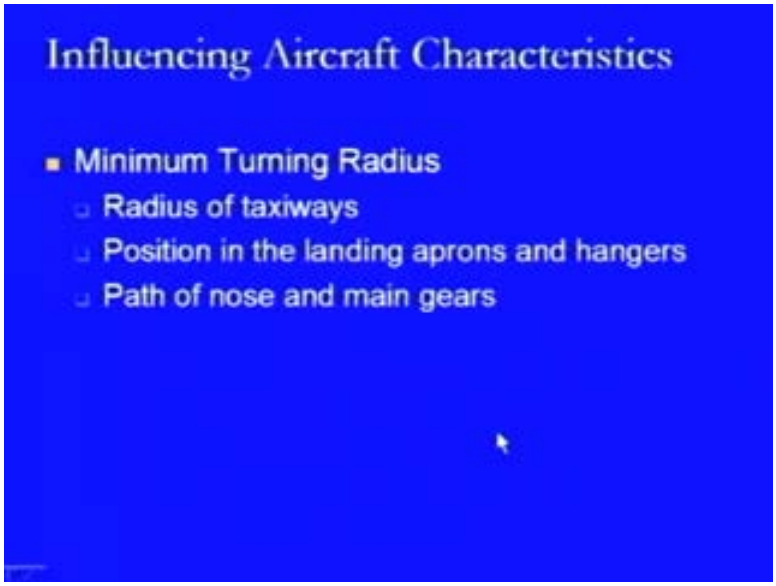

Now the next aircraft characteristic is the minimum turning radius and it has its effect on the radius of the taxiway. Taxiway is the connecting pavement which is provided between the runways and the aprons. The positions in the landing aprons and the hangers is also going to be governed by the turning radius that how they are going to be provided within the aprons or the hangers, the path of the nose and the main gears which will be traced on the pavement while it is taking a turn.

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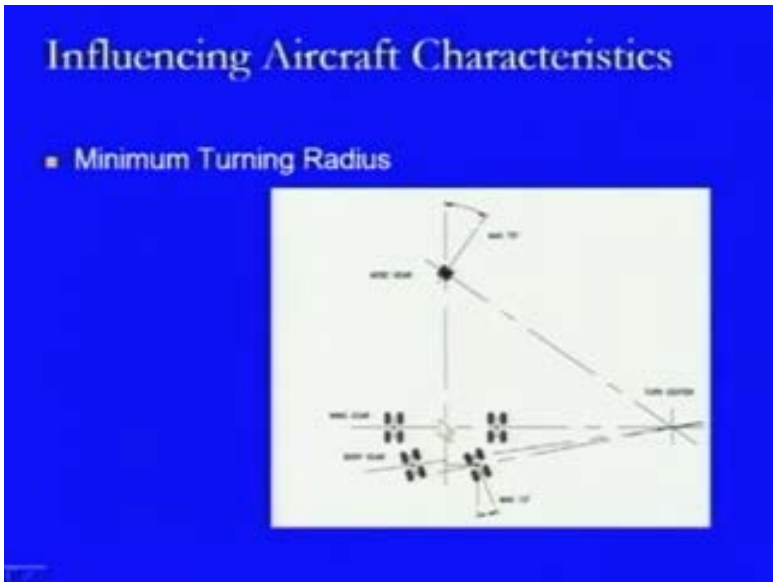

Then there is a minimum turning radius this is how it is being defined in this case that is it is a turn center at this location based on this main gear axis which is coming in this one and this is the steering gear axis which is coming this way. So the point of intersection is here when it is taking a turn then if it is being provided with a dual gear system at the main axis way then they will not be following each other. So that is the thing which we have to look at that how the turning is going to happen. Then the

minimum circling radius because it is related with the movement of the aircraft in the air, so therefore it defines basically the separation of two nearby airports because this circling radius is very very big radius and at times if it is related to a very big aircraft then it may be in kilometers. So that is why it defines that at what particular distance the two airports can be provided with respect to each other.

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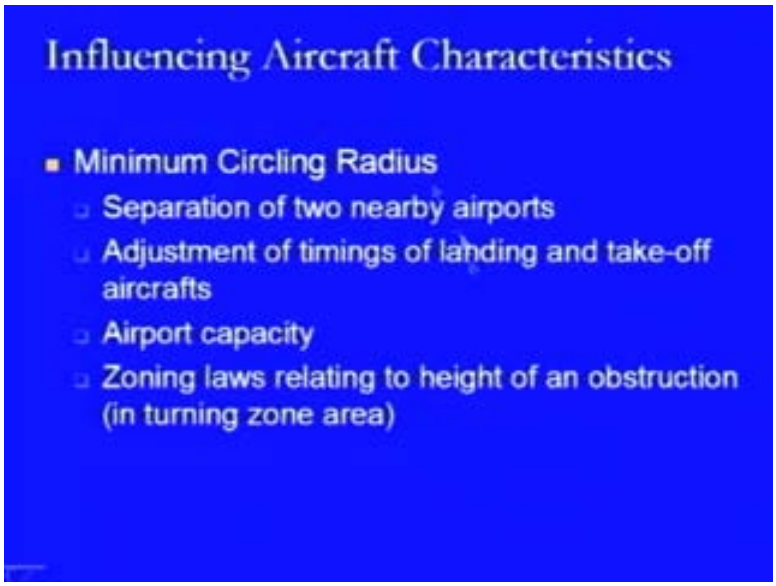

Then adjustment of timings of landings and take off aircrafts will also be dependent on the circling radius as I have told that some of the aircrafts may be having this as in kilometers. So therefore if it is lesser then there can be a frequent landing or take off but if it is bigger then the time difference between a landing or between the take off will also increase and it will have it's effect on the airport capacity which is defined in terms of the number of aircrafts which it can handle in one hour. So, if this timing of landing and takeoff is increasing it means its airport capacity will be reducing because it can handle less number of aircrafts in one hour. Then similarly, it also has its effect in terms of the zoning laws which is related to the height of an obstruction being provided in the adjoining areas of particular airport. So up to what particular height the constructions or the developments can be provided that is also going to be dependent on the circling radius of an aircraft. So within this range the buildings or the other constructions should not go up to a height which can create a problem to the circling radius of the aircraft.

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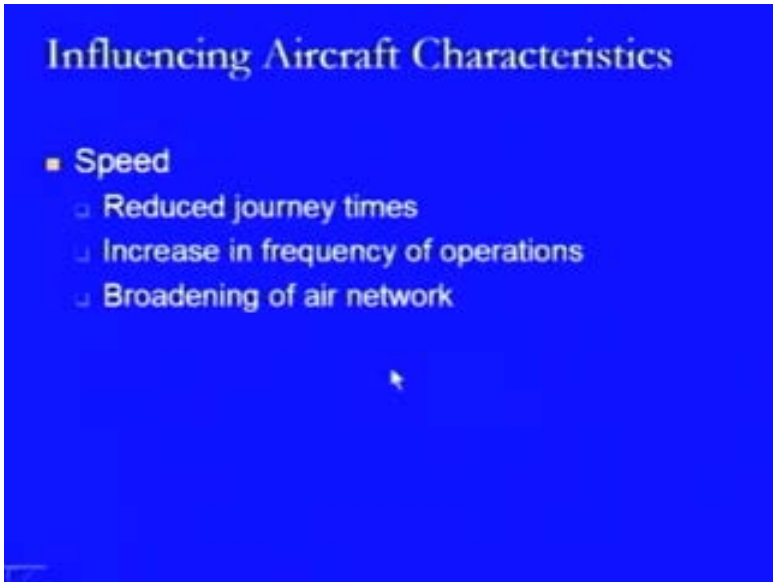

Then speed obviously reduces the journey times and it also helps in increasing the frequencies of operations means there can be more operations within an hour if the speed is more. Therefore it helps in improving in broadening the air network system that are the effects of the speed but the speed is not directly creating an effect in terms of design variables but it has a effect in terms of the cruising speed, with not the cruising speed but the speed with which the aircraft is landing at that particular speed is used for designing of facilities like taxiways or the exit taxiways that is from the location from where the aircraft will be coming from runway to the taxiway.

Then capacity is another characteristic which creates an effect on the processing terminals, that is, what type of facilities needs to be provided. It also creates an effect on the passenger and baggage handling facilities to be provided on the airport. It is dependent on the capacity of the aircraft to handle the passengers; how many passengers or the cargo is coming, cargo processing time is also related with the capacity of that aircraft and the type of the equipments which are needed is also dependent and the equipments which are also needed is also going to be dependent on the capacity. Then the size of the apron which is to be provided is dependent on the capacity of the aircraft because this is directly related to the size of the aircraft.

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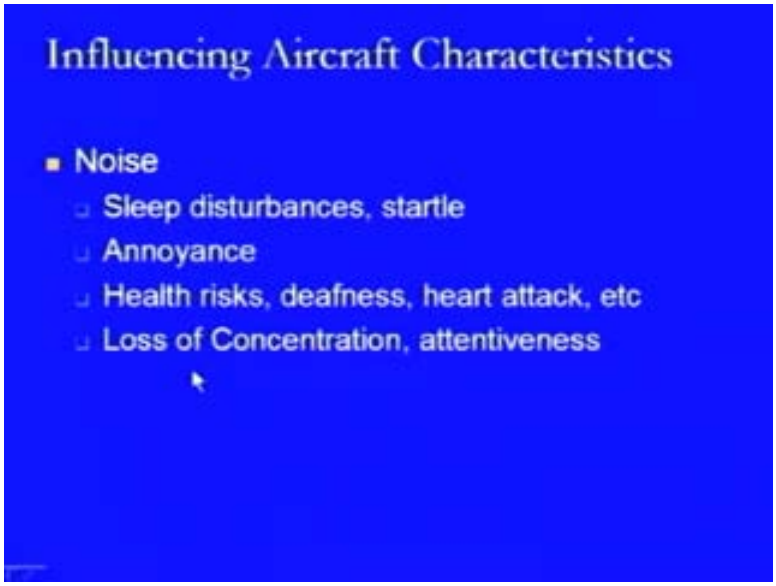

The noise is having its effect in terms of the sleep disturbances or startle annoyances to the people or the health risks or the deafness or the heart attacks etcetera to the people who are living in the adjoining areas of the airport. They can also be the effects in terms of loss of concentration or attentiveness. These are general effects of the noises in any of the locations. Vortices at the tail ends have its effect on the vortices and that is the wind vortices, the stresses at the joints with the fuselage is the location where the problems will be.

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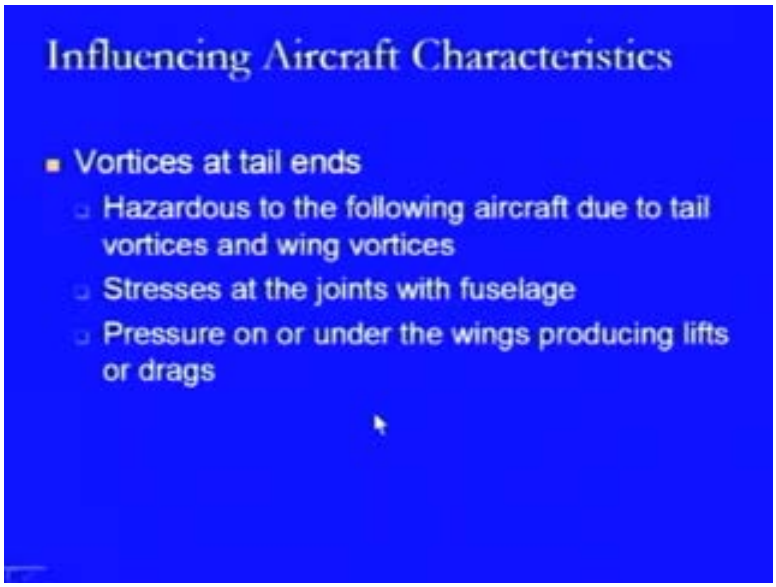

The pressure on or under the wings producing the lifts or the drags that is another problem associated with vortices.

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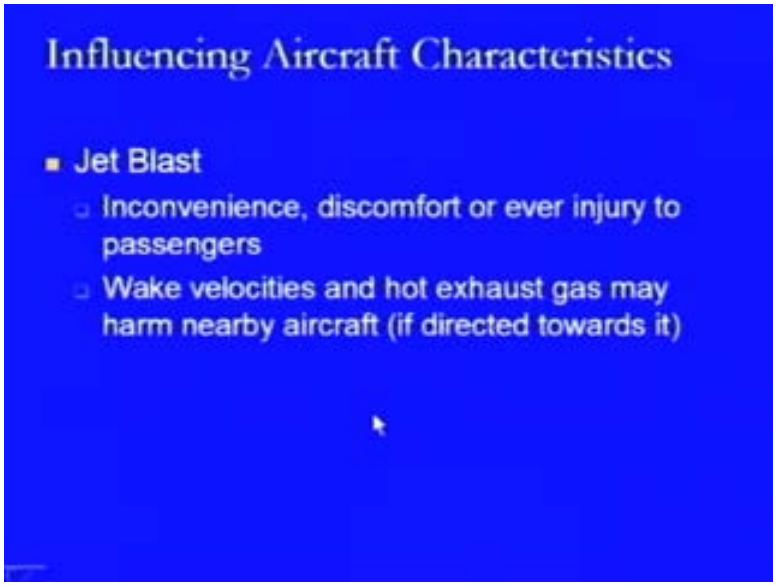

Finally in the case of jet blast this is inconvenience or discomfort or even the injury to the passengers if it is not properly located and the wake velocities and the hot exhaust gas which will be coming out at the back may harm nearby aircraft also if the parking is such.

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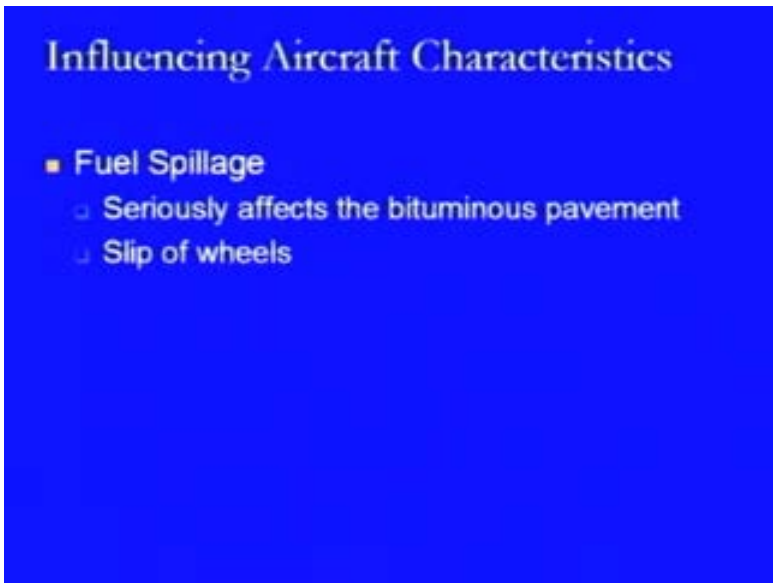

Finally it is a fuel spillage which is seriously affecting the bituminous pavement.
It may cause the slip of the wheels. So these are the some of the influencing airport characteristics aircraft characteristics which can create the effect on the facilities being provided on any of the airport. So in today's lecture what basically we have seen is that the different types of characteristics are there on any of the aircraft.

Though the amount may change with respect to the size or the type of the air but the characteristics will remain the same and finally what we have tried is to see the effect

of those characteristics on the design features or the facilities which needs to be provided on any of the airport with this one we will be stopping at this point and we will be meeting in the next lecture till then good bye and thank you.