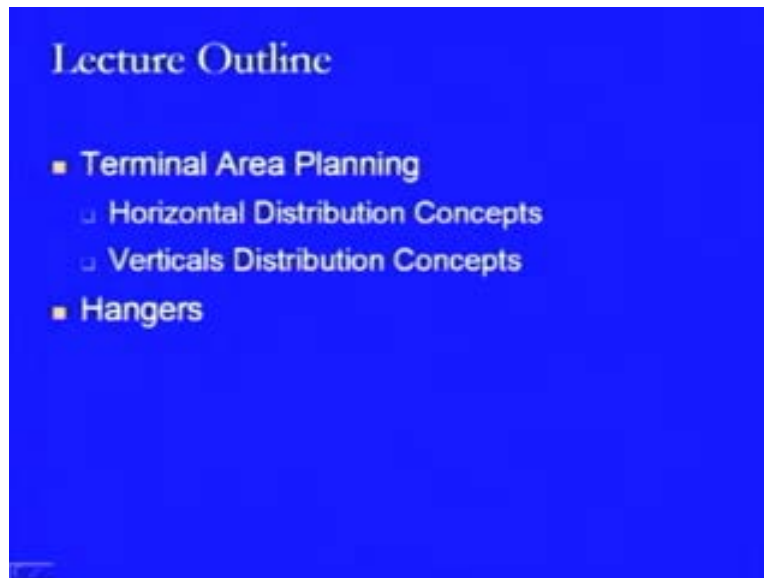


Transportation Engineering – II
Dr. Rajat Rastogi
Department of Civil Engineering
Indian Institute of Technology – Roorkee

Lecture – 38
Terminal Planning & Hangers

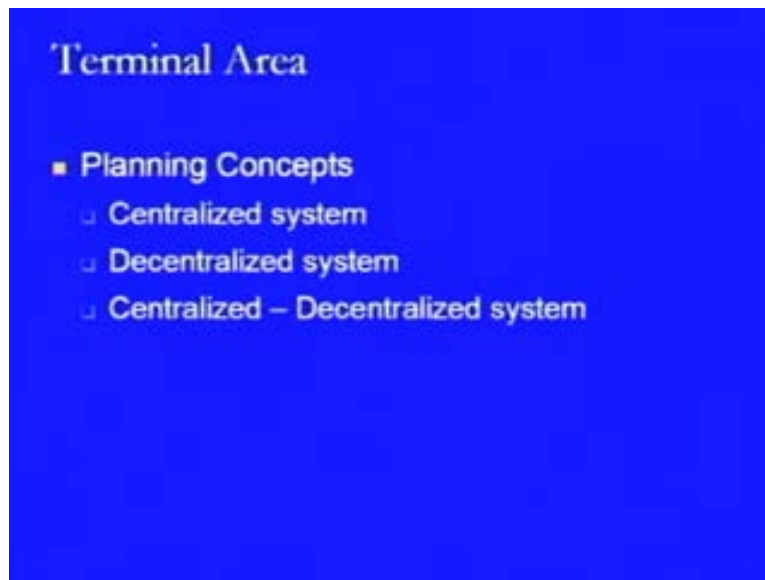
Dear students, welcome you back to the lecture series on course material of Transportation Engineering – II. In today's lecture, we will be discussing about terminal planning and hangers, another specific component which is provided on airports for the storage of aircrafts. In the previous lecture, we were discussing about the terminal area and the terminal building and the various layouts which can be provided for any terminal building with respect to the orientation of runways strips. We have also looked about the various space requirements which are needed on any of the terminal area and in today's lecture, we will try to look at how we are going to plan the various terminals and what are the various concepts which are generally taken up, so that the efficient planning of any terminal area or terminal building can be done.

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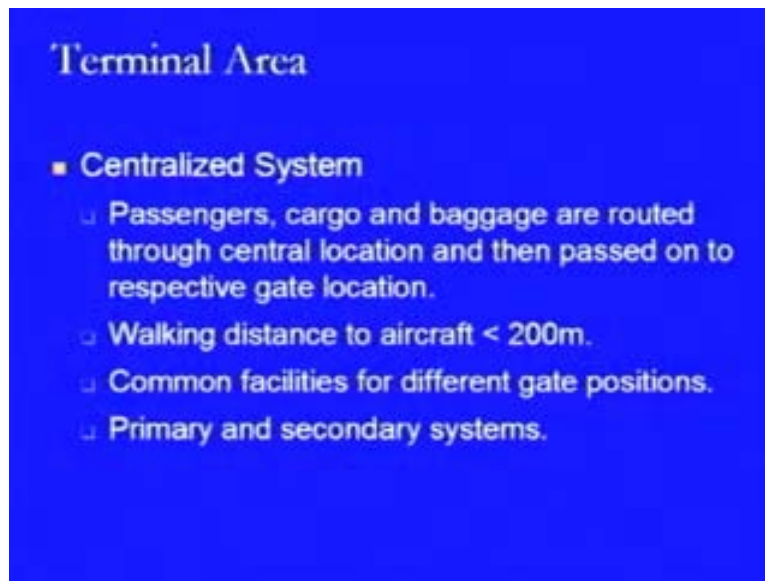
So, the lecture has been outlined using various headings like terminal area planning. Within terminal area planning, we will be looking at concepts like horizontal distribution concepts and the vertical distribution concepts and then, we will be looking at hangers and we will be discussing them.

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So, we start with terminal area and its planning. In the case of terminal area, we have the planning concepts like centralized system, decentralized system and the centralized - decentralized system. These are the three categories in which the overall planning concepts can be categorized. So, we will try to look at the centralized system, decentralized system and centralized - decentralized system concepts and then we will be moving towards the horizontal and vertical system planning.

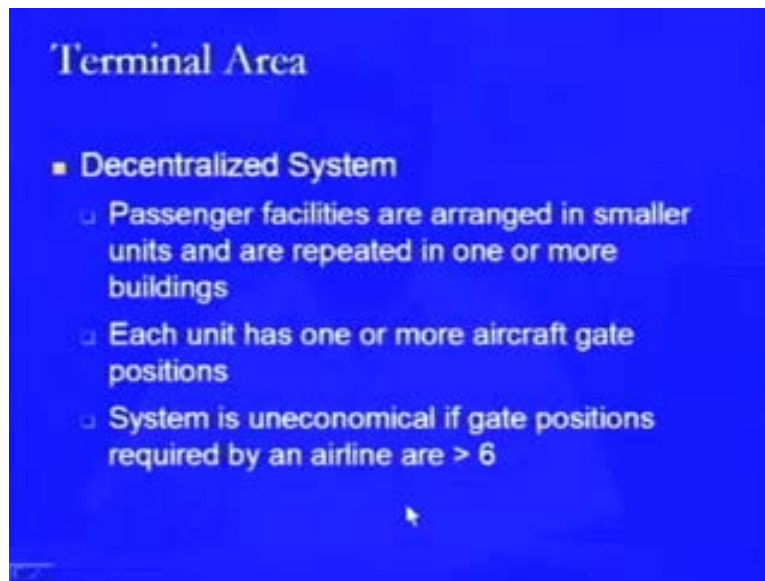
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So, in this case of centralized system, we have to look at the passenger, cargo and baggage routing through the central location and then, they are passed on to the respective gate location. What happens is that here in all the systems which have been listed just previously, we will be looking at the various types of the facilities and then in what sequence the facilities have been provided, at what location they have been provided. So, the facilities are going to be related to passengers or cargo or baggage or the various facilities which are used by the passengers while they are moving on and then, the location of the gate and the facilities being provided very near to the gate location.

So, in this case of centralized system, we have some facilities being provided at the central location and then, the passengers are moving towards the gate location. So, in this case, the walking distance to the aircraft is usually less than 200 meters and the common facilities are provided for different gate positions. So, whatever number of gate positions has been located in a certain area, for those there will be common facilities being provided which will be utilized by the passengers who are going to take their flights on all those gate positions separately. Then, there are primary and secondary systems within the centralized system.

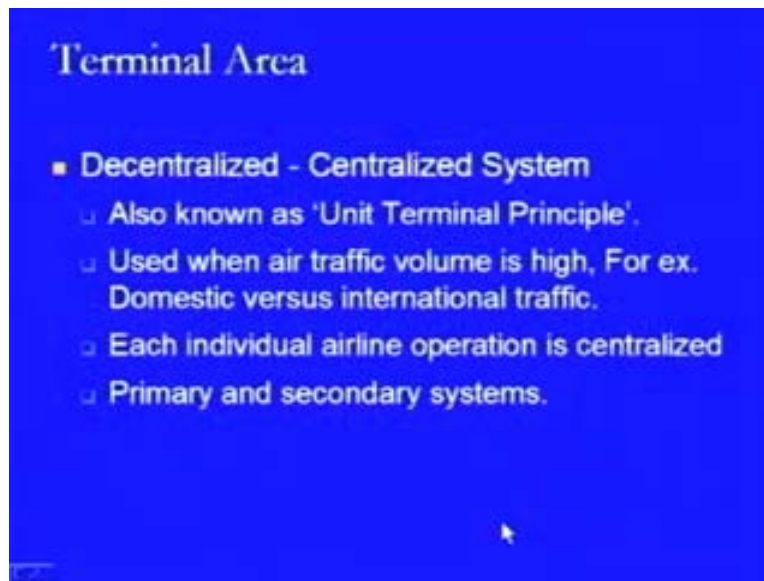
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That is the another thing which can be provided, whereas in the case of decentralized system, which is another type of a concept, the passenger facilities are arranged in smaller units and are repeated in one or more buildings. So, that is the difference from the centralized system. There all those passenger facilities were at the central place, but here we may find that the same facilities are being repeated in more than one building and each unit has one or more aircraft gate positions. So, that is why the passenger facilities need to be provided separately at separate locations.

The system is uneconomical if the gate positions required by any airline become more than 6. That is a restriction or that is a sort of demerit of this decentralized system. The gate position means that at the same time if more than 6 aircrafts are being used by any of the airline, then this system will not work.

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In the case of decentralized and centralized system it is also known as unit terminal principle. Here it is used where traffic, air traffic volume is quite high and it is one of the cases that we have the two types of traffics like domestic traffic and international traffic. So, in that type of a system, we can have a decentralized and the centralized system. So, we have the segregation of the two traffics by using this type of the system and each individual airline operation is centralized.

So, they have been provided a location at which those airlines can operate their planes and it is mostly being done in the case of big hub conditions, where the airlines are designated from one particular gate location to another particular gate location, incorporating a number of gate locations in between and then, the facilities required to those particular gate locations or to that airline are centralized at that point. Again, there can be primary and secondary systems within the decentralized - centralized system. We will be looking at the things one by one, when we go further into the concepts.

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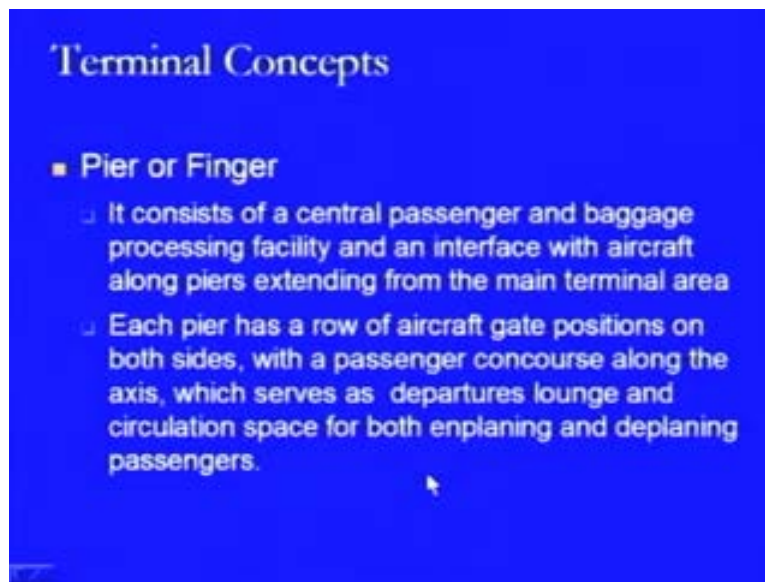
Now, with this type of systems being there that is centralized, decentralized and a combination system, now we will be looking at, with those approaches in mind, the terminal concepts and these terminal concepts as we have defined can be of two types - the horizontal distribution concept and vertical distribution concepts. So, we are starting here with the horizontal distribution concepts. In the case of horizontal distribution concepts, we have pier or finger concept. This pier or finger concept is centralized terminal concept. Then, we have a linear, frontal or gate arrival concepts, which is semi centralized concepts.

We have satellite system, which is centralized concept. We have transporter, open apron or mobile conveyance system, which is again a centralized concept and we have certain combinations. So, will be looking at all these type of horizontal distribution concepts. The word horizontal distribution is being used here, because the movements will be taking place from the terminal building towards the flight area horizontally and that is what we have seen. When, in the previous lecture we were looking at the various components which are provided in any of the terminal area or with respect to the terminal building, in that case we have looked at the facilities being provided from the access side to the air side or the passenger side and likewise. So, all those facilities were located

horizontally one after the other and that is how the size was increasing in the horizontal direction. So, within that direction, we can have different type of orientations or different type of figures. On the basis of that figures, the names are coming. So, they are coming in terms of pier or finger or linear or frontal or satellite or transporter or likewise.

We start with the first type of a concept in this one and that is a pier or a finger concept. It is like finger of our hand. When we look at our hand, then we find that from the palm number of fingers are coming out and that is what is this concept. It says that there is a terminal building and then, there a number of lines which are coming out and then, they are the fingers of that terminal area, terminal building.

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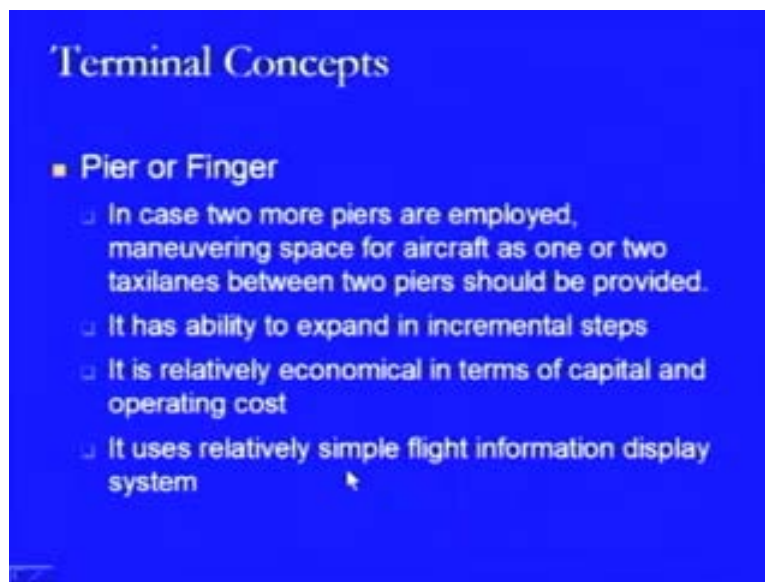


So, in that sense, it consists of central passenger and baggage processing facility, which is provided within the terminal area from which all these fingers or piers will be coming out and then, there is an interface with aircraft along piers extending from the main terminal area and each pier has a row of aircraft gate positions. Because, the size of the pier or the size of that finger will be quite large and on the basis of the size, we can have a number of gate position on which the aircrafts can stand and these can be provided on both the

sides of the pier or that finger as well as at the end of that pier. So, depending on the overall size, we can have big amount of aircrafts handling capacity at that airport.

Further, it serves as departure lounge and circulation space for both enplaning and deplaning passengers, means we can use them in such a way that we can have the circulation space for both type of passengers who are going to board the aircrafts or who are just coming out of the aircrafts.

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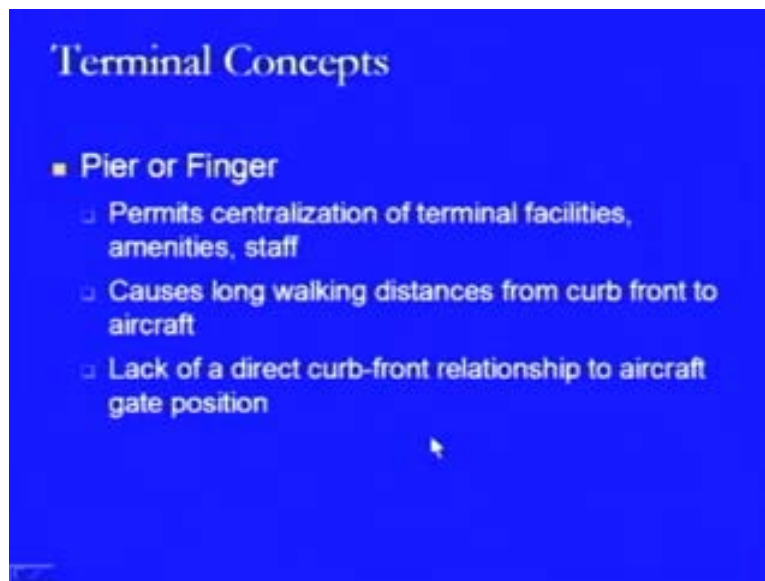


In this case, another thing is that if there are two or more piers employed, then the maneuvering space for aircraft as one or two taxilanes between two piers should be provided. That is another thing that as we have seen in the case when we discussed about the taxiways, then one type of the specific system is taxilane and this taxilane is provided between the taxis stands being located along the terminal building. So, in case there are two piers side by side, then between those two piers, the taxilanes needs to be provided.

This system has the ability to expand in incremental steps, means it can keep on moving outwards and other thing is that these fingers can be further moved in any of the

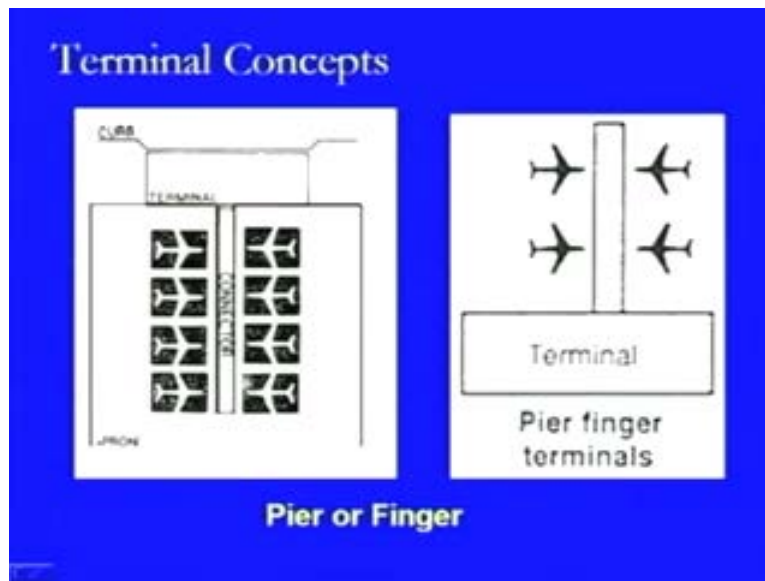
direction, like as we have seen in the previous case of, again in the international airport in the previous lecture, where there was a L shape. So, L shape can be another extension. Instead of I it becomes L, thus expanding the aircraft handling capacity. It is relatively economical in terms of capital and operating cost and it uses relatively simple flight information display system, which is very easily understandable by the passengers.

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Further, it permits the centralization of terminal facilities, amenities and staff and that is how we economize on the space needs to be provided for all these facilities, if otherwise to be located separately at different locations. It causes long walking distances from curb front to the aircraft and it all depends upon the size or the length of the piers or the fingers being provided from the terminal building. So, that is probably one of the disadvantage of this type of a system, but then what we have seen is it is more economical, so that probably gets offset by the economy and there is a lack of direct curb front relationship to aircraft gate position. So, that is another demerit of the system that, as we have seen in the case of some of the type of the layouts, we cannot provide the direct connectivity from the curb front to the gate position, because it is circuited through that terminal building.

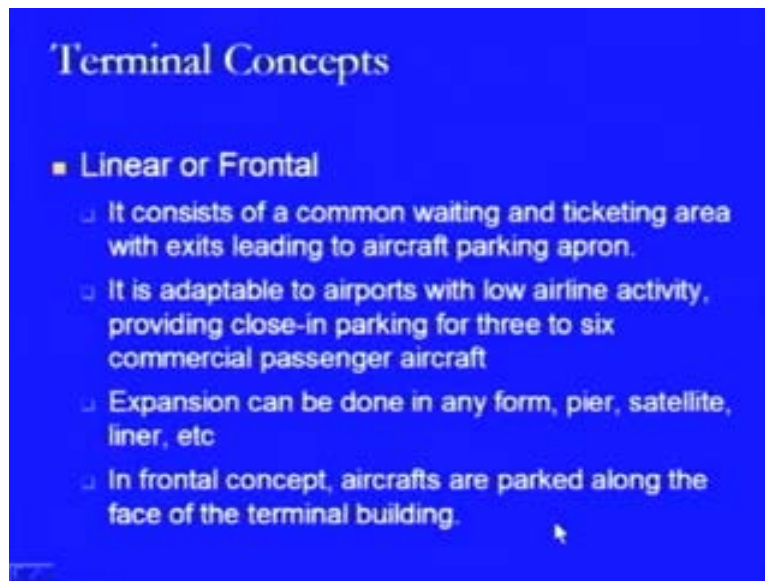
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Here, we are looking at the pier or finger terminals. What we can look at here is that this is the main terminal building in which the centralized facilities will be provided and then, there is a pier which is coming out. This is the single pier system. So, there is a single pier which is coming like this, so we can understand it like a corridor which is coming from this terminal building. So, passengers will be coming in this corridor like this and then, along this corridor, the very number of aircraft stands have been provided like this and these are provided on both the sides of this pier or finger.

So, number of aircrafts can be placed like this at same point. This is one type of system and just a bigger form of the same diagram has been shown here where this is single pier and terminal building and we have the systems of the aircrafts parking with nose in parking being provided in this location. This is also nose in parking, parallel to each other.

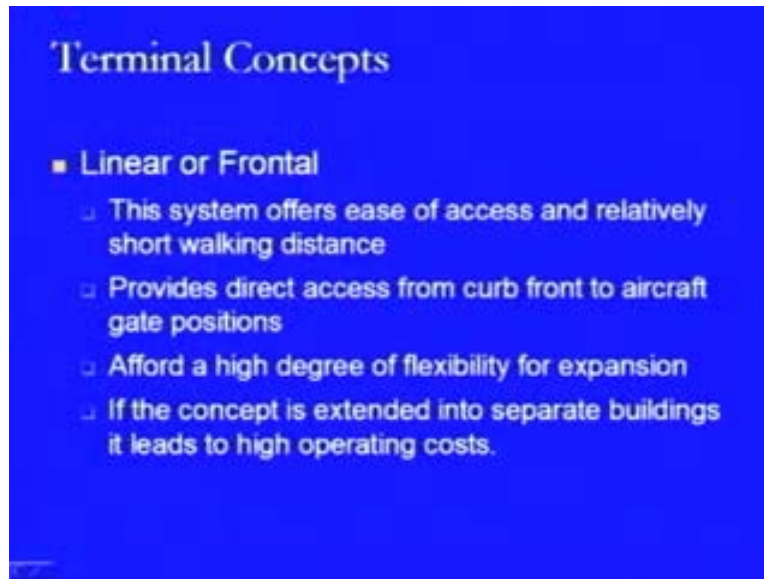
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Now, we look at another type of a concept in horizontal system, which is linear or frontal concept. In this case, it consists of common waiting and ticketing area with exits leading to the aircraft parking aprons. That is the type of the system. So, what happens is that a big common area is being provided, where every facility is being located like ticketing facilities, baggage facilities, etc., and at the same time, at the front of this terminal area towards the parking apron, the waiting facilities are also being provided and the exit directly leads towards the aircraft parking apron. So, you are directly on the aircraft parking apron out of this area.

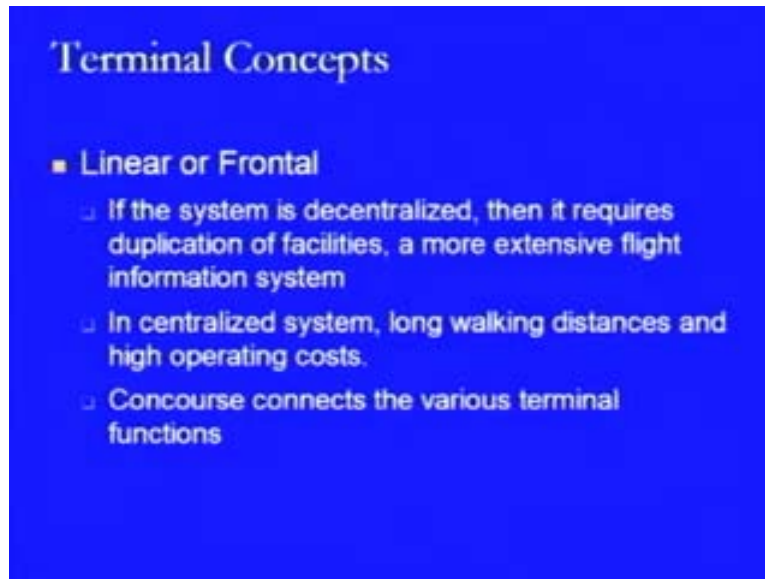
It is adaptable to airports with low airline activity. It provides close-in parking for 3 to 6 commercial passenger aircrafts at the same time. That is the system being provided and this is extended to the other types of systems slowly. Expansion can be done in any form. That is the advantage of this system, where we can go for pier system, we can go for satellite system depending on the space available to us or a liner system or any other type of system. In the case of this frontal concept, the aircrafts are parked along the face of the terminal building. So, as we have been seeing in the previous case of the pier system, the aircrafts were parked with their nose towards the pier, here it will be towards the terminal building.

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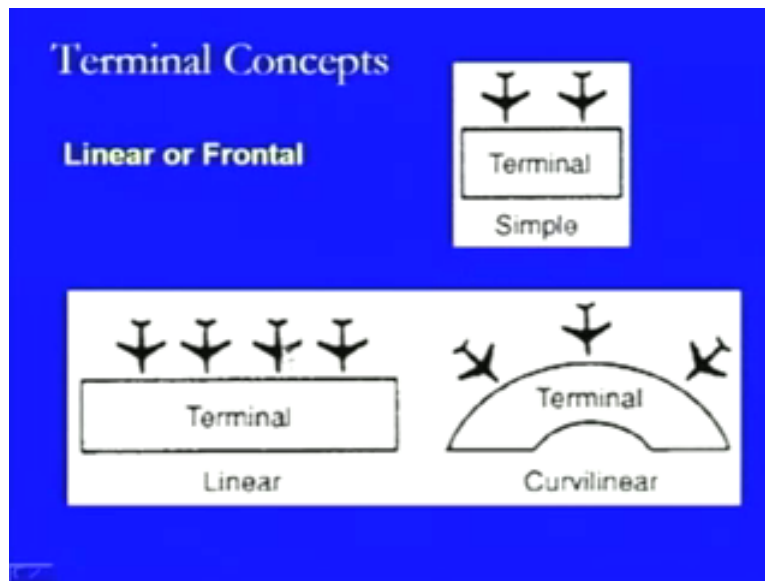
This system offers ease of access and relatively shorter walking distances. That is one another advantage of providing this type of a system and at the same time, it also provides direct access from curb front to aircraft gate positions. So, that was a demerit in the pier system, here it is being possible. This system can also afford a high degree of flexibility as far as expansion is concerned. That is what we have seen that it can be transformed in any other type of system. If the concept is extended into separate building, it leads to high operating cost. So, that is another thing, but then it becomes, obviously the disadvantage of this system.

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If the system is decentralized, then it requires duplication of facilities, a more extensive flight information system. So, that means it is increasing the overall cost of the overall facility being provided. So, that is another disadvantage, because if the space is not available within the same terminal building and the future expansion is required, then obviously we have to go to the other terminal building, construction of that and the provision of the various facilities at that location. In centralized system, long walking distances and high operating costs will be there. Concourse connects the various terminal functions in that case, if number of buildings has been provided.

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Here, we look at one of a simple sort of a diagram. First of all, this is simple rectangular terminal building being provided and this is the terminal apron on which the aircrafts are standing with their nose towards the terminal building. This is the extended form of the same, where more aircrafts are standing along the terminal building and this is another linear pattern. At times a curvilinear patten is provided, where the terminal is provided in curvilinear form and accordingly the aircrafts are provided, again in the same form with their nose towards the terminal building. So, that is another type of system, another type of configuration, which can be there, as far as the linear or frontal concept is concerned.

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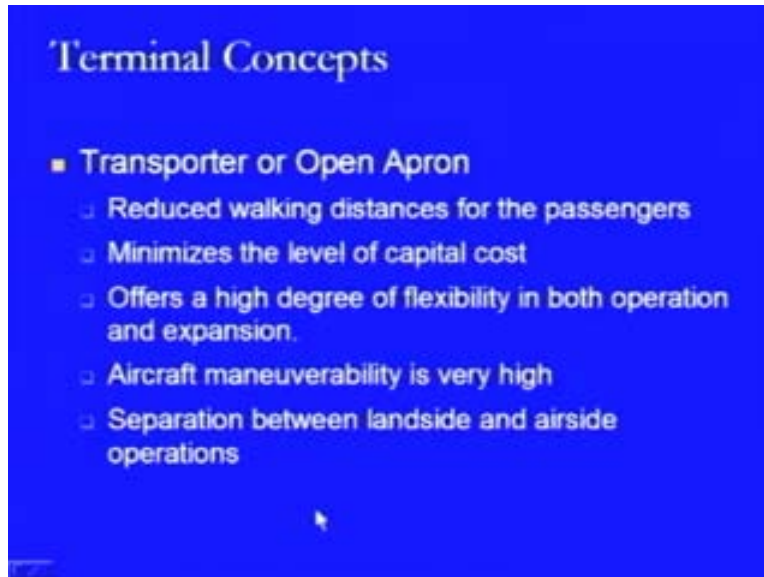


Now, we talk about another concept that is transporter or open apron concept. In this case, the aircraft and aircraft servicing operations are remotely located from the terminal. That is one of the specific things of this system. Here, what happens is that you are coming out of the terminal building and then, there is a big apron which is there in front of you and the aircraft is standing at some distance away from the terminal building. Therefore, you are transported from the terminal building to the location of the aircraft and that is the way this system works. So, that is why it says that it is remotely located operation from the terminal as far as the aircraft to aircraft servicing is concerned.

The connection to the terminal is provided by certain vehicular transport systems, may be like in the form of specific buses or sometimes, if the distances are not big, the airport is a smaller one, then people may be walking to the aircraft or maybe coming back from the aircraft, so both the things can be there. It provides the flexibility of providing additional aircraft parking positions, to accommodate increase in the schedules or aircraft sizes and the capability to maneuver an aircraft in and out of parking position under its own power. So, these are certain advantages of this system. What we find is that we have a flexibility of operating additional aircraft parking positions, because a long big apron is available to us and we can improve upon and we can increase the schedules. We can also

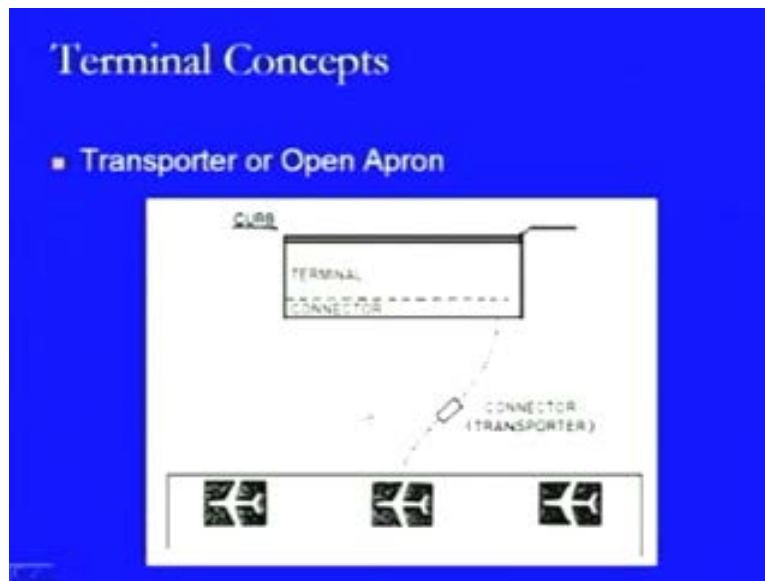
accommodate different sizes of the aircrafts and there is a possibility that the aircrafts will be moving in or out of the parking stand location with their own power, instead of providing the towing vehicle. This is one of the possibilities in this case.

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Then, in that sense, if the people have been transported from the terminal building to the location of the aircraft, then there is a reduced walking distance for the passengers and it minimizes the level of the capital cost which needs to be provided, for providing the different facilities, stands, etc., or the concourses needs to be provided as a connectivity from the terminal building to the aircrafts, all these things will not be required in this case. It offers a high degree of flexibility in both operation and expansion of the facilities depending on the future growth. Aircraft maneuverability is quite high in this case, because of a large open area available to any of the aircraft and it is possible to separate the landside and the airside operations very easily in this case.

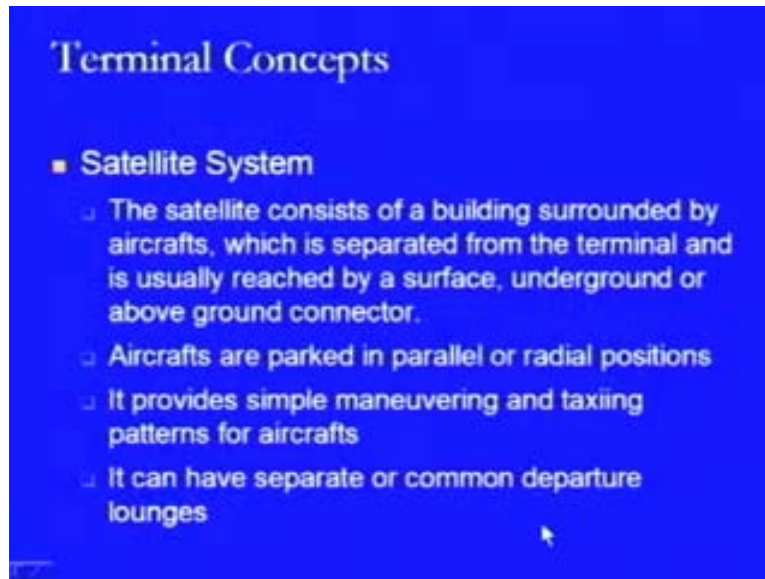
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We look at this diagram, where this transporter or open apron system is being defined. Here, this is the curb area and from this curb, the access is being provided to this terminal building and within this terminal building, in the front of this side where the big apron is being provided in this form, the connector services are located. The connector services will be in terms of, again the departure lounges of the waiting areas, where the passengers will be waiting for their specific flight and from those particular points, the people will be or the passengers will be transported like this way, may be using vehicles and they will be reaching their specific flight, which is standing at this location.

So, they will be coming by the vehicle to this location, they will come out of the vehicle and using the steers they will be moving in this aircraft. That is how this particular system works.

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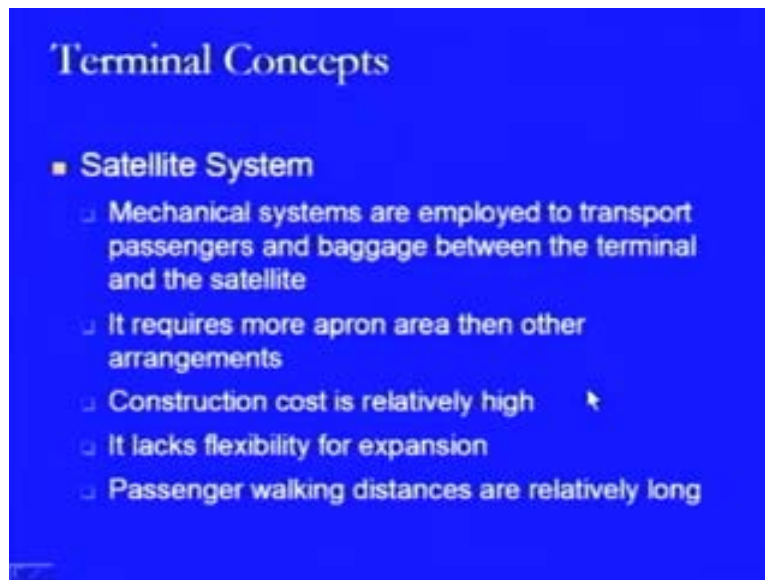
Then, the next system is the satellite system. In the case of satellite system, here the things consist of a building which is surrounded by aircrafts and which is separated from the terminal and is usually reached by a surface underground or above ground connector. So, it is a sort of the further type of modification of transporter system, where in the case of transporter system the terminal building is there and from there we are moving to the aircraft by a vehicle and everything is visible, like you can see from the terminal building your aircrafts, where it is standing. At the same time, from the aircraft you can look at terminal building very easily.

But here, in the case of satellite system, the distances further increases and therefore, there is a requirement of providing connectivity in terms of a surface transport system or an underground transport system or above ground transport system between the terminal building and the location where the aircrafts have been parked. This may be a building which is being constructed at some distance away from the main terminal building and then, the aircrafts will be parked along the side of that building.

So, that is the type of a satellite system and these aircrafts can be parked in different type of positions, which may be parallel to the building or may be radially, like with their nose

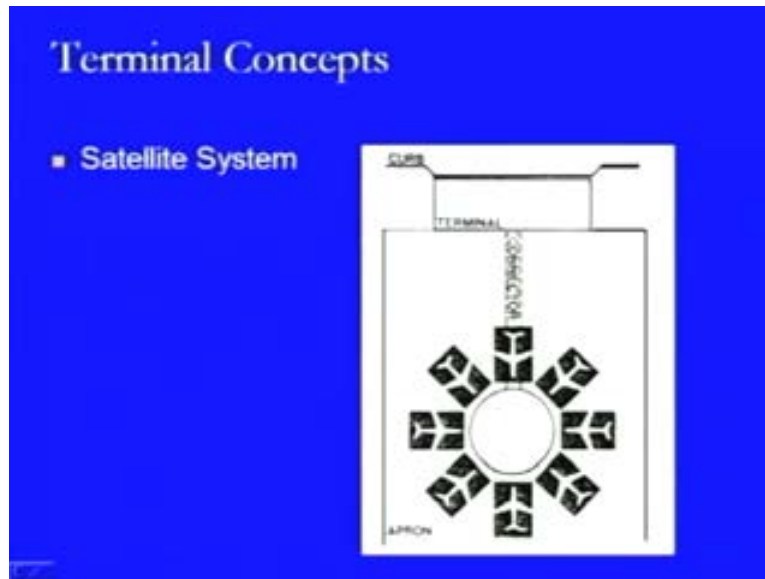
in or nose out conditions towards the building. It provides simple maneuvering and taxiing patterns for aircrafts. That is another advantage of this system. It can have separate or common departure lounges. So, that depends on the overall traffic volume, which needs to be handled for enplaning and deplaning passengers in this system.

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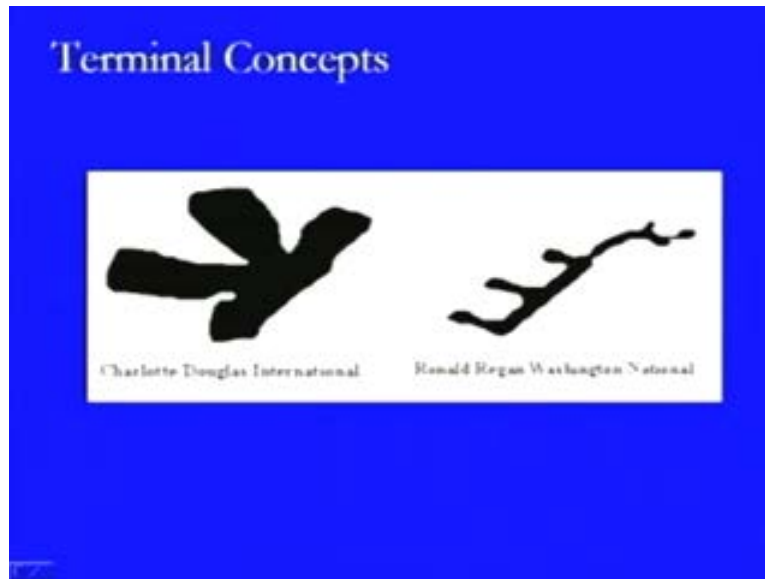
The mechanical systems are employed to transport passengers and baggage between the terminals and the satellite being provided for those terminals. So, that is an added requirement in this case and it increases the cost and therefore, offsets the economy in some form. It requires more apron area than any other arrangements as we have seen and the construction cost is relatively high in this case, because the facilities needs to be provided at different locations. At the same time, we require to provide the connectivity's of higher order. It lacks flexibility for expansion and the passengers walking distances are relatively longer in this case.

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Here, we are looking at the satellite system, where this is a terminal building. Again, the curve locations have been defined here and there is a **one** building which is being constructed at some distance away from this terminal building and then, along the periphery of this terminal building in a radial position what we can see is the various aircrafts which have been parked and the connectivity between this centralized terminal area and the main terminal area is being provided by some connector in this form, which may be underground, which may be surface or which may be above ground connector and there is a big apron area being provided for this type of a facility.

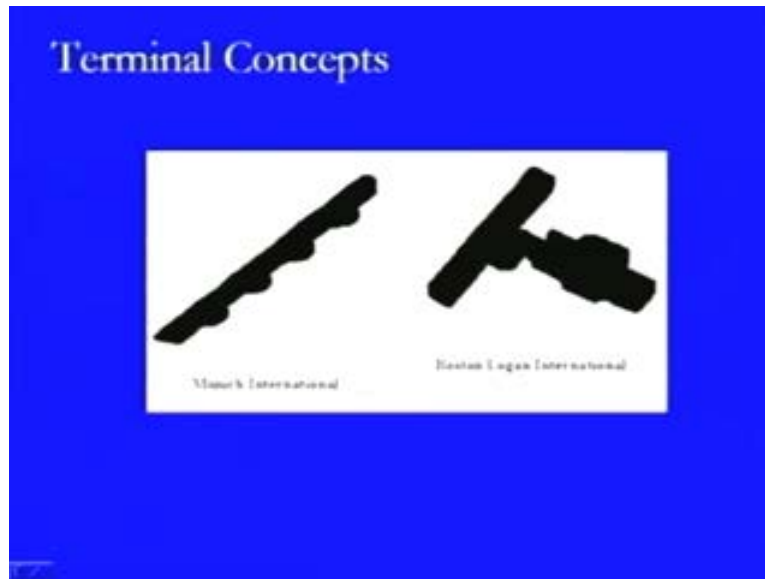
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Now, here we are looking at the various types of the terminal concepts which we have already discussed and what I am interested in here to show you is the different international or national airports within the world, for which some information could be collected and this is Charlotte Douglas International Airport, where we can see this is a pier type of orientation being provided. This is terminal building and we have two piers which are coming in V form from the terminal building.

This another one is Ronald Reagan Washington National Airport, where we have the terminal building, we have the piers which are coming out and we see that there is a difference in the size of the piers, as we are going away and at the same time there is an extension being provided in a curvilinear form with some aircraft stands being located at this location.

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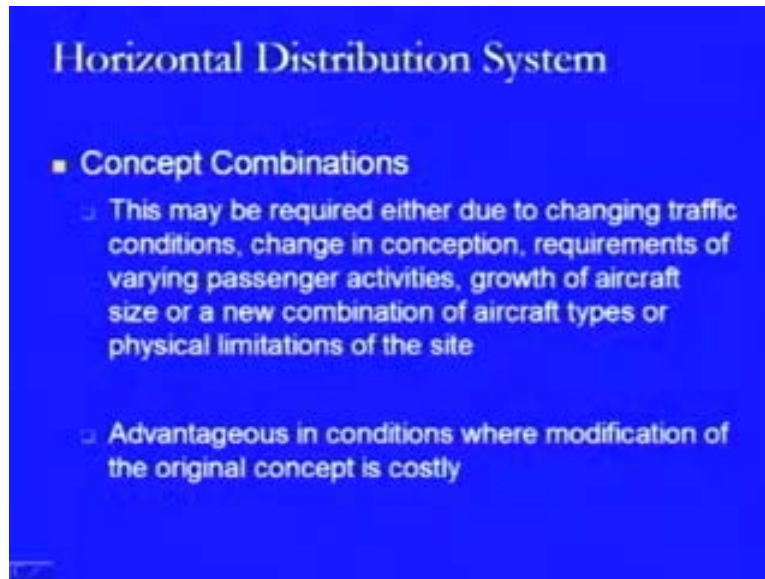
Here, this is the frontal system as we have discussed and it is provided with the curvilinear configuration towards the airplane, air flight side and this is what is being shown in this form. This is for Munich international airport and here the aircrafts will be standing like this like the arrow, if you assume this as an aircraft. This is Boston Logan International Airport, where we have the terminal building, we have the pier and the pier size has been changed and with respect to this change in the pier size, we can accommodate more number of aircrafts with respect to the normal pier which can be provided. At the same time, we can also accommodate the bigger size of the aircrafts in certain locations.

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This is for Pittsburgh International Airport. Here, we have the terminal building at this location and then, there is a combination of, this is terminal area and we have the piers which are coming out of this one and then, there is a connectivity being provided from this to this central area, which has the piers coming this way and the L shape piers coming in this form. So, these piers can also be in future, can be developed as a L shape in this direction or in this direction. That is the future expansion possible for this type of orientation.

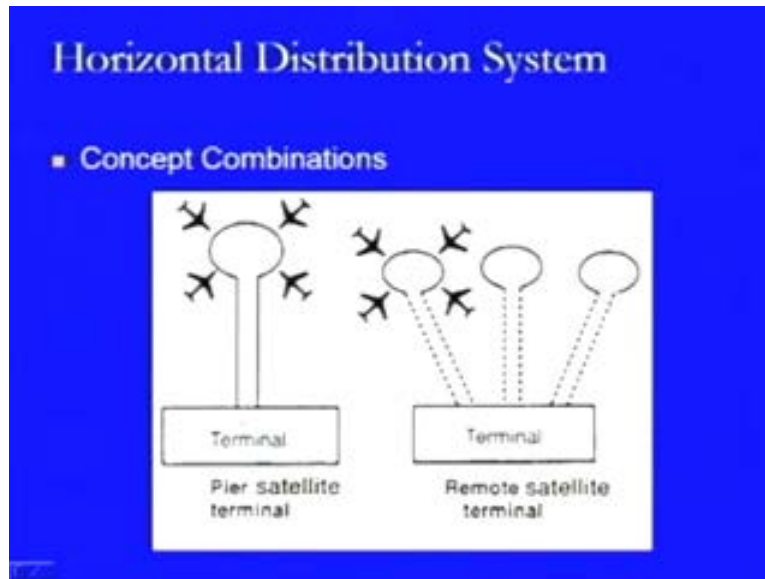
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Now, we look at the concept combinations within the horizontal distribution system. In the case of concept combinations, sometimes it is required due to certain reasons like, due to the changing traffic conditions or the change in conception or the requirements of varying passenger activities or the growth of aircraft size or a new combination of aircraft types or physical limitations of the site and these maybe the different reasons, due to which we have to go for combinations of different horizontal distribution system concepts which we have seen so far.

It all depends, like one thing which always remains there is the overall traffic and its growth at that airport and based on that activity which is increasing and that growth which is coming up, we require to provide more facilities and if the space is such that the same facility in the same form cannot be extended, then we have to go for the combinations and these are advantageous in conditions, where the modifications of the original concept becomes costly. So, that is the combination being provided in those particular conditions.

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This is one of the diagrams, which tries to show that concept combination. Here we have the terminal building, we have the pier and then, this pier is further being designed in the form of a big centralized area along which the number of aircrafts can be provided. So, if we look at this type of a condition, this is a pier with a satellite terminal condition. Here in this case, we have the various satellites being provided. All these are the remote satellites, because the connectivities are, may be of any type of connectivity. Here, if you can assume it as underground facility being provided, because being shown in the form of a dotted line and obviously, this is at a large distance away from the terminal building and this is another sort of a combination.

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Now, we look at this photograph which is of O'Hare International Airport. Here, in this airport, we can look at various types of orientations of the concepts being used in combination with each other. We can see this is a main body of this airport, which provides connectivity on the ground exit side and here, this is Y shape pier being located. Then, this is linear terminal, this is terminal I and this is terminal II. Then, there is a terminal III, which was constructed and here we see another combination, where there is a I sort of a pier, there is a L shape pier and there is Y shape pier being provided on the same terminal phase and then, there is another terminal which has come up that is terminal number V, which is remotely located as a satellite terminal. So, this is another combination, where the connectivity is being provided through this one to this system.

So, this is one sort of combination of the different concepts, which has been used at this international airport and probably it has been, the reason has been that as and when it has been required and then it is being observed that the same system cannot be further enhanced in capacity, so the satellite system was utilized because the space was available in that area.

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This is another airport which is being shown here. This is Detroit metropolitan airport, where we have, we can see this white lines which have been shown here. They are the runway strips, etc., being located like this and then, there is a main connectivity which is coming in this form to this airport and we have different terminals and here this is McNamara terminal being provided, where we have the pier systems which are coming. Here, this is another pier system condition which is coming at this mid terminal and it is found that it is at a certain distance being provided or the connectivity is being provided between this main terminal and this one. So, this is a sort of a satellite condition being created at this location. So, that is the satellite pier concept being provided in this case.

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This is how it looks like, this is the Smith terminal, where we have combination. As we have seen previously that this is the pier which is coming out and then, it is being extended in its area, so that the central facilities will be located at this one and then on this periphery, we have the aircrafts along with this periphery of the pier. Then, this is another pier which is coming out in this side, whereas this is connected with another type of pier system at this location.

Here we have the connectivities with the one central area and from that one the pier is coming out in this form. So, different sort of designs have been used at different airports. So, this is for Detroit metropolitan airport, the various terminals for that one and here it is another terminal which we have just seen. This is McNamara terminal, where the gate positions have been located along the periphery of this one as we can see, the aircraft being located here and then there is another terminal which is Berry's terminal, which has some piers coming like this.

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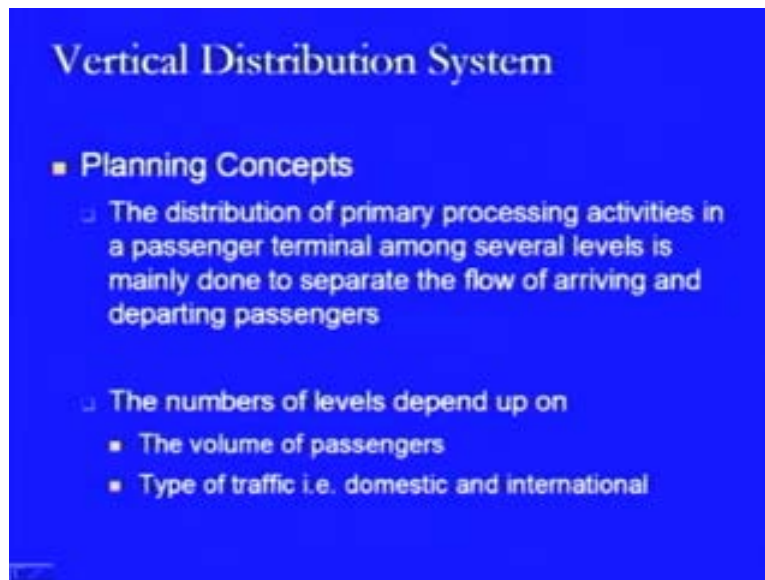


This is another diagram, another layout of the Tampa International Airport, where we can see is that this is the access side or ground access side of this, where the hotel is being provided and then, this is the land side building short term parking located at this one and long term parking is being provided in this area. This is how the system has been provided for access in this way and then, what we find is from this particular system, the various satellites have been created and **we see is** this is an all access system for this facility. These are all routes coming to this area and going out of this area and then, there is internal connectivities being located here.

Here, what we can see is that there are different airside like this is airside A, this is removed baggage sort facility being located in this side. Then, this is airside C and then, there is another airside which is being closed. This is Y shaped pier. This is symbol for baggage and this is again for linear type of condition being provided. So, this is the connectivity which is going up to this distance from this location; similarly for this one. This is also linear frontal condition, where we have some sort of a curvilinear design being provided. Here again, this is another type of building design being just used. This is airside E and what we see is that they have been utilized for different specific airlines like this side is being used for Air Canada, Delta, Tide, and some other one, untitled one,

whereas this one is being used for American, American airways, British airways, Yemen, US airways, US airway express and West to z. So, these are the airlines which will be operating from these gate locations, which have been located along this periphery. Similarly, is the condition for others also.

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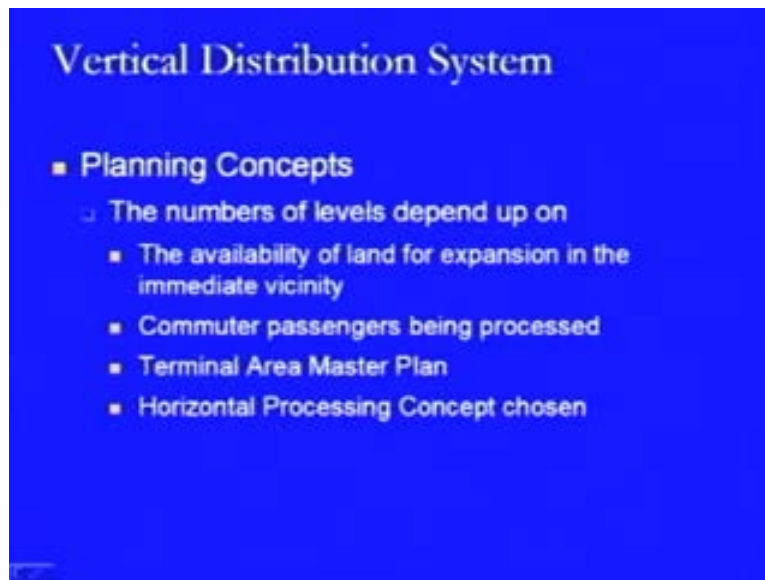


Now, we come to the vertical distribution system and in this case, the planning concept is that the distribution of primary processing activities in a passenger terminal among several levels is mainly done to separate the flow of arriving and departing passengers. This is one of the concepts being used as to vertically segregate the passengers. What so far we have seen in the case of horizontal distribution system is that we were moving in the horizontal direction outwards. Here, we are moving in the vertical direction and then, we have different floor levels at the same location and those floor levels are utilized for specific activities like one of the reason for providing different floor levels is to segregate the arriving and departing passengers. So, that is one concept being used for vertical distribution.

In that sense, this number of levels is going to depend on one obvious thing that is the volume of the passengers who are going to come at that airport with specific type of an

activity that is may be enplaning or deplaning passengers and is there any segregation of the type of the traffic in terms of the domestic traffic or the international traffic. If that is happening, then also we can segregate this type of traffic by taking different levels, so that at one particular level, only one type of passengers will remain.

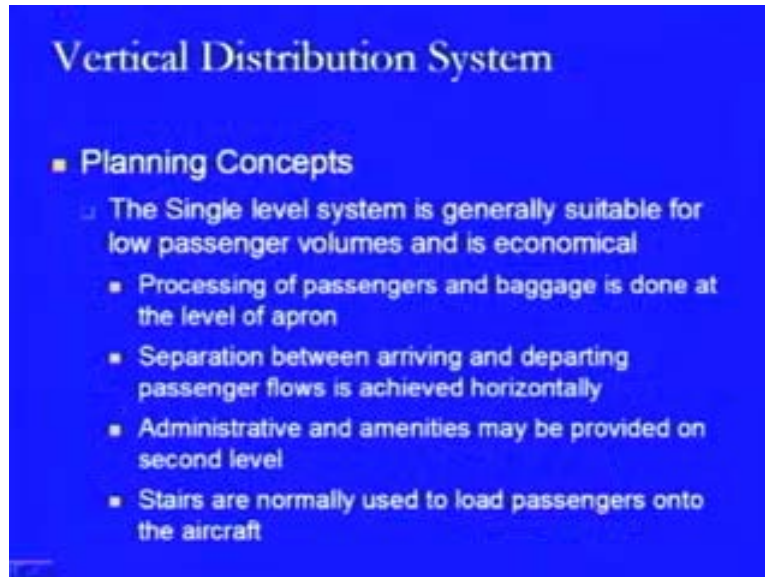
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In this case, further the number of levels may also depend on the availability of land for expansion in the immediate vicinity, because this is what we have seen in the case of horizontal distribution system, where we have been moving in outward direction horizontally. But, if the land is not there, if the land is very costly, then in that case we have to move in vertical direction and that is where the number of levels comes into picture. Then, another thing is the type of commuter passengers which needs to be processed. Then, there is reason like the terminal area master plan, which defines the segregation in terms of the provision of a number of levels in that form and then, the horizontal processing concept chosen in a case that what type of concept is there which further gets simulated in the vertical distribution system.

Here, we have a single level concept or a two level concept or a multilevel concept. Then, we have a look at that how they are getting differentiated from each other and what is the suitability of that type of concept.

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Vertical Distribution System

- **Planning Concepts**
 - The Single level system is generally suitable for low passenger volumes and is economical
 - Processing of passengers and baggage is done at the level of apron
 - Separation between arriving and departing passenger flows is achieved horizontally
 - Administrative and amenities may be provided on second level
 - Stairs are normally used to load passengers onto the aircraft

In the case of single level system, it is generally suitable for low passenger volumes and it will be economical in the conditions where the processing of passengers and baggage is done at the level of apron. Both the things, passengers as well as the baggage they have been processed at the same level with which the apron is being provided and then, there is a separation between arriving and departing passenger flows which is achieved by segregating them horizontally only.

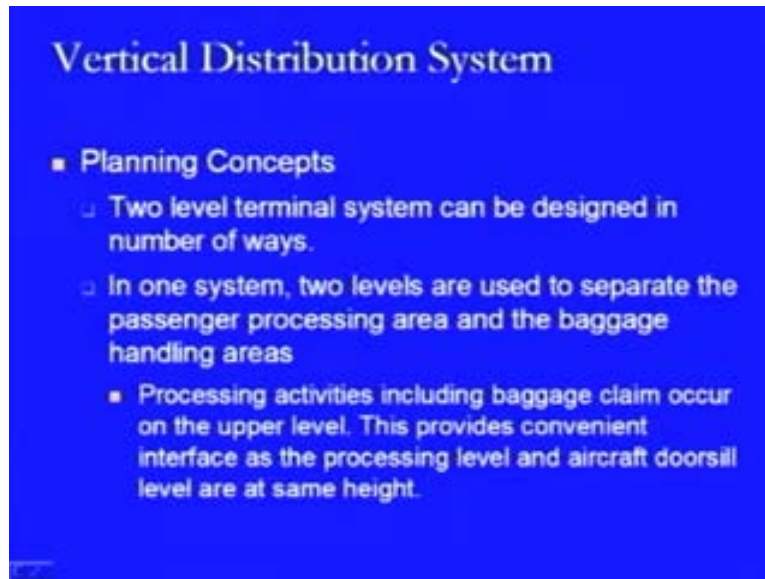
Administrative and amenities are provided at the second level and the stairs are normally used to load passengers onto the aircraft, because they are going all along on the aprons, so they will be boarding the aircraft using the stairs.

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This is one of the types of the diagram of a single level system, where this is the curve space. The access from the groundside is provided like this. Then, the people are waiting here for the deplaning or the enplaning persons. This is the terminal building. So, this is the exit of this side, ground side. This is the exit towards the flight side and various operations take place within this building between this area. Then, this is a departure lounge, where the people or passengers are waiting for their aircraft and when the aircraft comes, these persons will come out of the gate, move on this apron and the stairs will be provided, so as to come to these different gate positions of this aircraft. So, that is how it works and this is what is the single level system.

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Vertical Distribution System

- Planning Concepts
 - Two level terminal system can be designed in number of ways.
 - In one system, two levels are used to separate the passenger processing area and the baggage handling areas
 - Processing activities including baggage claim occur on the upper level. This provides convenient interface as the processing level and aircraft doorsill level are at same height.

Then, we have a two level system, where this is designed in number of ways. In one system, the two levels are used to separate the passengers processing area and the baggage handling areas. Here, the passenger processing activities includes baggage claim which occur on the upper level and this provides convenient interface as the processing level and the aircraft doorsill levels are at the same height, because we have to look at the efficiency and reduction in the delay. So, therefore looking at the level of the aircraft doorsills, the baggage handling conditions have been provided at the upper levels, so that they are at the same level and there is no time which is being used for the vertical movement of those baggages.

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Vertical Distribution System

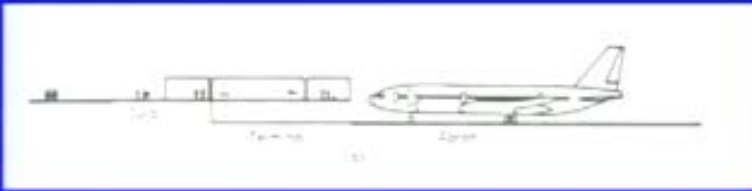
- Planning Concepts
 - Airline operations and baggage handling activities occur at the lower level
 - Vehicular access occur at the upper level to facilitate the interface with the processing system

Then, in this case, the airline operations and baggage handling activities occur at the lower level. So, whatever operations of airlines are there, you are coming from the curve side, move inside that is the curve line level where the airlines will be operating, they will be taking the baggage and then, you will be moving to the other levels. Vehicular access occurs at the upper level to facilitate the interface with the processing system.

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Vertical Distribution System

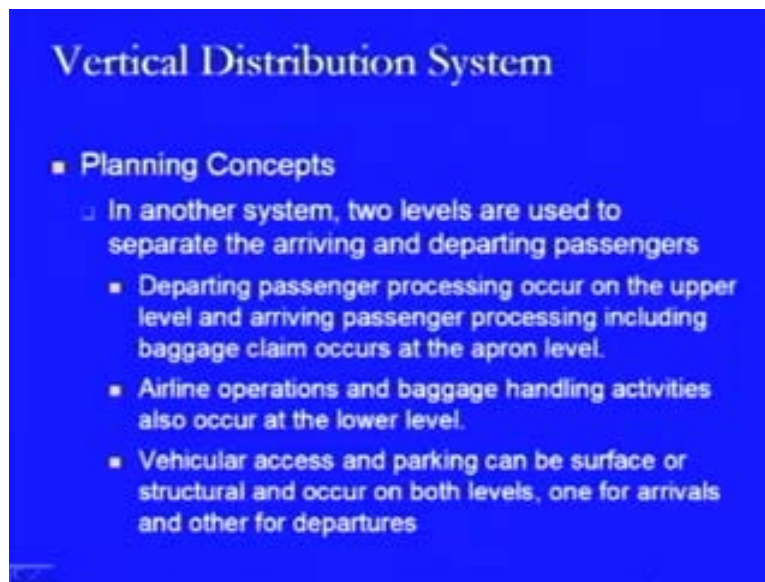
- Planning Concepts
 - Two level terminal system



The diagram illustrates a two-level terminal system. It shows a terminal building with a curved side and an aircraft parked at a gate. The terminal building is labeled 'Terminal' and the aircraft is labeled 'Aircraft'. The diagram shows the terminal building and the aircraft on a horizontal line, with the terminal building on the left and the aircraft on the right. The terminal building has a curved side and a straight side. The aircraft is shown in profile, facing left. The diagram is a simple line drawing on a white background.

Here we are looking at the two level terminal system, where we find the curve level is being located here which is at the level of this upper level of the terminal building. Then, we have the lower level of the terminal building. So, here the passengers who are coming and going out in this form and then, the passengers will be going to the apron and will be boarding this plane as far as the baggages are concerned this we can see the level of this and the doorsills are the same, therefore the material will be transported directly to this location and will come to the passenger baggage claiming location, which will be provided somewhere here very near to the exit and that is how the efficiency can be maintained. So, the passengers in this case will be coming directly to the system, whereas when they are going on to the plane, they will be going in this form.

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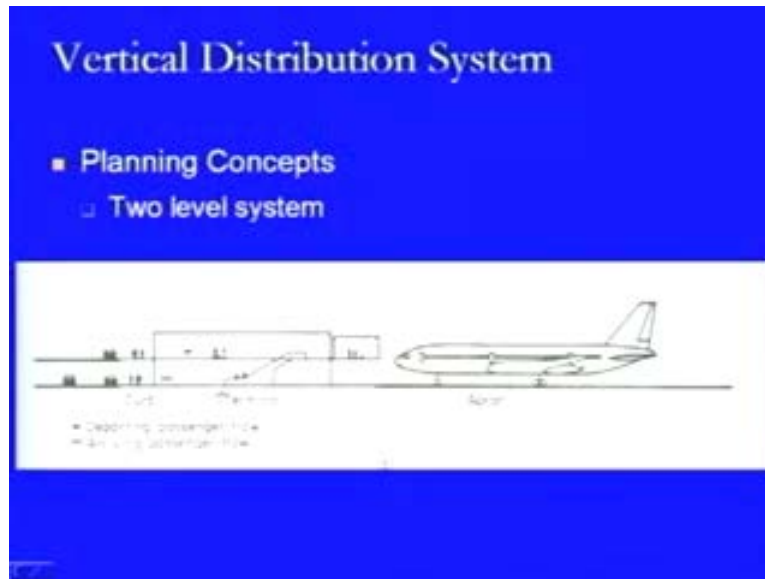
Vertical Distribution System

- **Planning Concepts**
 - In another system, two levels are used to separate the arriving and departing passengers
 - Departing passenger processing occur on the upper level and arriving passenger processing including baggage claim occurs at the apron level.
 - Airline operations and baggage handling activities also occur at the lower level.
 - Vehicular access and parking can be surface or structural and occur on both levels, one for arrivals and other for departures

Then, there is another system which consists of again the two levels and here the departing passenger processing occurs on the upper level and arriving passenger processing including baggage claim occurs at the apron level. So, this is how it is differentiated with respect to previous one and the airline operations and baggage handling activities also occur at the lower level, whereas this is the same as in the previous case. Vehicular access and parking can be surface type of a parking or it may be

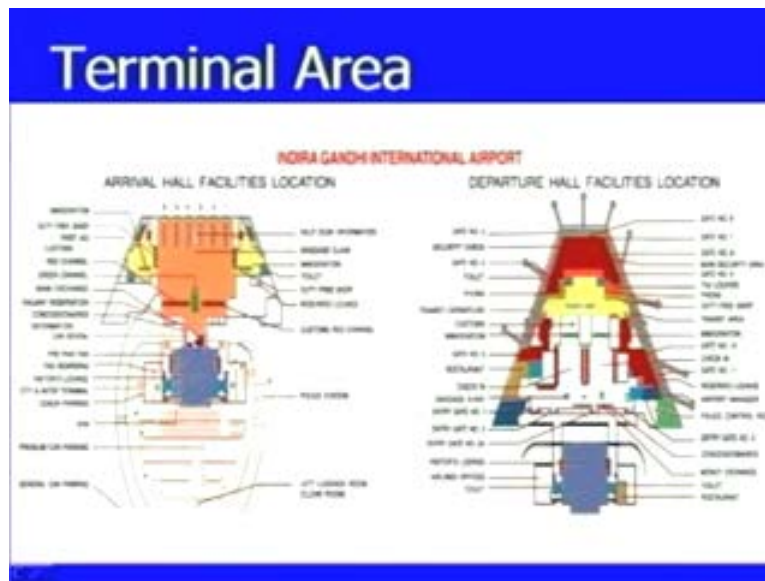
structural or it may occur at both the levels, one for arrivals and other for departures. So, that is again we are segregating the access system also in this case.

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Here, this is another type of a concept being shown that we have the vehicular access being provided at both the levels. So, the persons who are coming out of this plane, they will come to this location and will go in this form, where these are the persons or passengers who are coming to enplaning the plane, they will be coming through this one. They come to this location in the departure lounge and then the concourse will be provided which connect the departure lounge to the gate way in this form at this level, so that these passengers will directly go into the plane. Whereas, the other way is when this plane has come and there are deplaning passengers, then they will come out through the concourse to this level and from there they will be coming by the stairs or the movable stairs to the lower level and will come out of the airport system. So, that is the way it is being provided.

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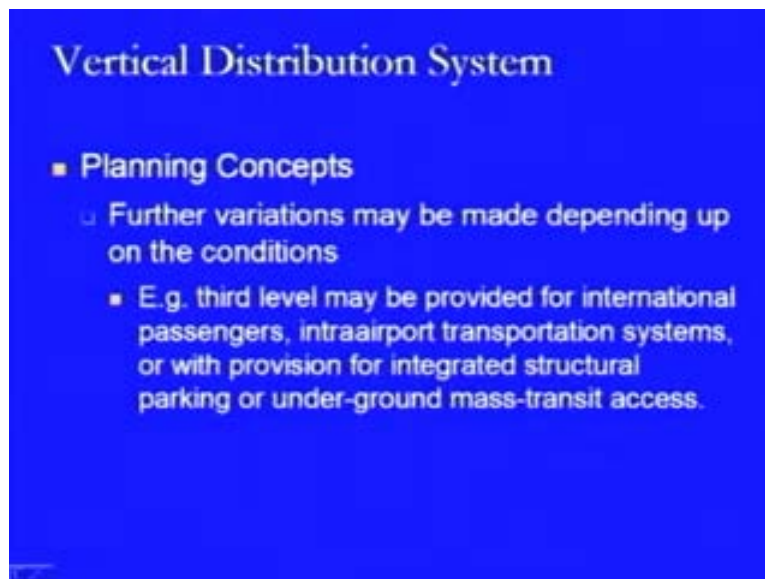


This is a diagram of the Indira Gandhi International Airport at Delhi and here we find that we have the facilities being provided at two levels - one is the arrival hall facility and another one is the departure hall facility. The shape of these are also different and we find that in the case of arrival hall facility, we are providing the facilities like immigration, duty free shops, for state customs, green channels so as to move out without declaring anything, banks, exchange, reservation counters, information and then, the car rental facilities or prepaid taxi facilities or taxi booking, they are being located here along with the visitors lounge and then, these are the car parking area being located in this area and there is another general car parking area which is provided at the outer side of this one and there are also the facilities which are being located at different locations and these 1 to 6 locations are the possibilities of different aircrafts which can take their position and through these checks, immigration checks they will be coming through these different channels to the bigger area, so that they can get out of the system.

This is the departure hall facilities location, where we have the piers which are being located in this form, in this diagram as shown and then, there are certain areas where it is a frontal system. So, we have number of gate locations being provided along this side and aircrafts will be parked in this form and these are the different airline offices being

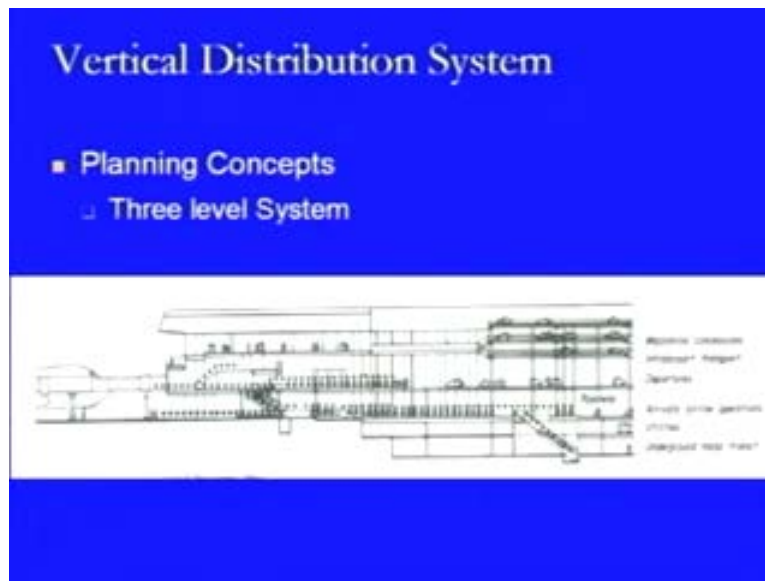
located here, the visitor lounges are also being located here. Then, these are the entry gates to this particular area and then there are check-in areas. This is the security check-in area. In this location, we have the 18 places being provided at different positions; this is one, this is another and likewise and if it is an immigration condition, people are going out, then they need to be checked before they go towards the outer sides. So, that is the immigration checks being provided here as green being shown. So, security check, immigration checks, there are all here in this case and then after immigration is being done, there is custom check being provided at this location after the immigration check and **this one**, this is how it is being designed.

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Further, there are certain variations which can be made depending on the conditions like, for example there can be a third level which will be provided for international passengers or intra airport transportation systems or with provision for integrated structural parking or underground mass transit access.

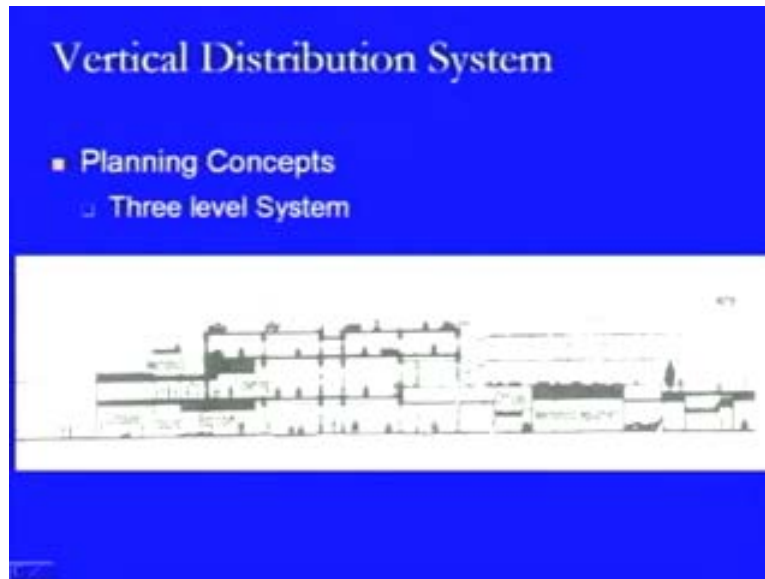
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In this case, we can look at this diagram, where we have this one level, two level and three level conditions and this is the access system have been provided. We have the underground mass transit system being located here. So, people have to go, using movable stair, to this underground facility. There are utilities being located again at the underground level here. Then, there are arrival airline operations at this location at the ground level. Then, there are the departures being provided at the first level. So, we have the vehicles being located here, so that the passengers who are coming out of the system can take the vehicles and move away. Then, there is an intra-transport transfers are also there. So, those types of facilities are being located at some other levels like as been shown here.

Here, what we can see is that there are passengers who are coming out of this system in this form. They are moving in this way towards these facilities or they can be moving in this form and the connectivity is being shown here with respect to this aircraft. This is the concourse which is providing connectivity to the gate of this aircraft. This is how this three level system works as being shown in this case.

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Further, there is another three level system which is shown in this diagram, where it tries to show the mechanical equipment, the motel, the offices and then, the different levels being provided. There are ticketing, there is a baggage claim which is, this is inbound condition and then, there is a connectivity for on bound condition. So, likewise, different design concepts can be there, which can be used.

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Here, we are going to look at this terminal. This is terminal II at Sahara International Airport of Mumbai, where what we can see is that there a multiple levels being provided in this case and the aircrafts are being located and this is a curvilinear frontal area condition, where the aircrafts are located radially like this and these are the concourses being provided. We can see the concourses coming like this one and the persons who are coming out of this aircraft, they will be coming out or going in the aircraft using these concourses and then, they will be moving at different levels as far as their enplaning or deplaning conditions are concerned and these are, this is the radial path way, the radial road which is being provided, which is the ground side access for this airport.

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This is Palm Spring International Airport terminal. The design, which we look at this one, is like a person playing a guitar and here we can see the different type of facilities being located. They are located, all the gate positions have been located, along this one like this. These are the way the gate positions have been provided and here the centralized system is there, the decentralized system is there and for different gate locations, we have the specific type of airline which is using that gate position, like for gate number 1 and 3, it is United express and Delta connection, whereas for 19A and 19B gate, it is American west express. Various types of facilities have been marked here and this is a sort of remote

condition, where the connectivity is being provided, a long walkway is there we have to reach it, this point.

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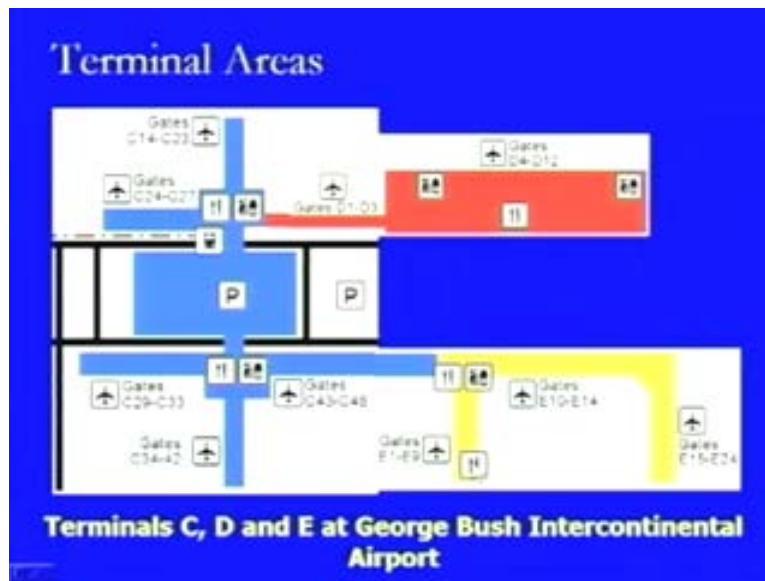
We look at another one. This is George Bush International Airport, big one. We find that there is a highway which is coming in between and here we have this terminal A, terminal B. In between these terminals we are providing the parking area also and then, there is a highway and again we have terminal C, terminal D and terminal E being provided and in between terminal D and E, again there is another highway which is moving. Now, what we see is that, because of this highway and the distance being provided between the terminals B and C, there is a rail train connectivity being provided at this position, underground connectivity. So, that is the size of this airport and it is again in the horizontal concept movement being provided in this way.

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This is terminal A. In this case, this is how the piers have been provided in different directions and we see that there are different gate locations like gate 17 to 24 allocated here, gate 25 to 30 allocated here and so on. This is for B. In this case, we have parking condition, we have the eating area, we have other areas and then, the train connectivity from this one. Now, we have the gate locations like B84 to B91 in this area. So, this is pier with extended round center condition. So, this is another type of configuration which we have already seen in other airports too.

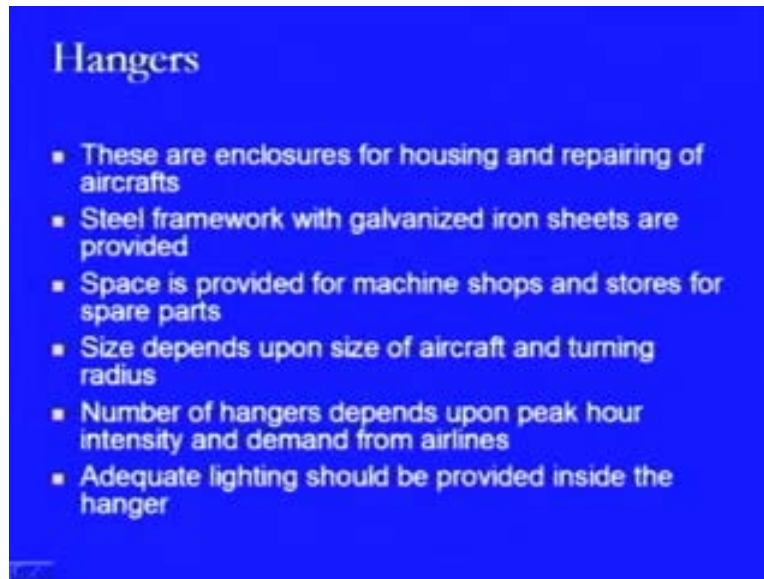
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This is for the C orientation. Again we find that there are certain facilities being located at this location as well as this location. So, this is the multiplicity of these facilities, because of the distances due to which the passengers who are going to board these gate locations cannot move away. So, it is a centralized-decentralized system, which can be there. Then, this is another connectivity which is coming between C and D and here we have gate locations from D4 to D12. Some facilities are again provided in this terminal area and then, we have this E gate locations and terminal area. Again, we find that some facilities are being repeated in this area too. On the whole, what we see is that there is a big number of gate locations or something more than 100 being provided, so means at one particular time 100 aircrafts can use it.

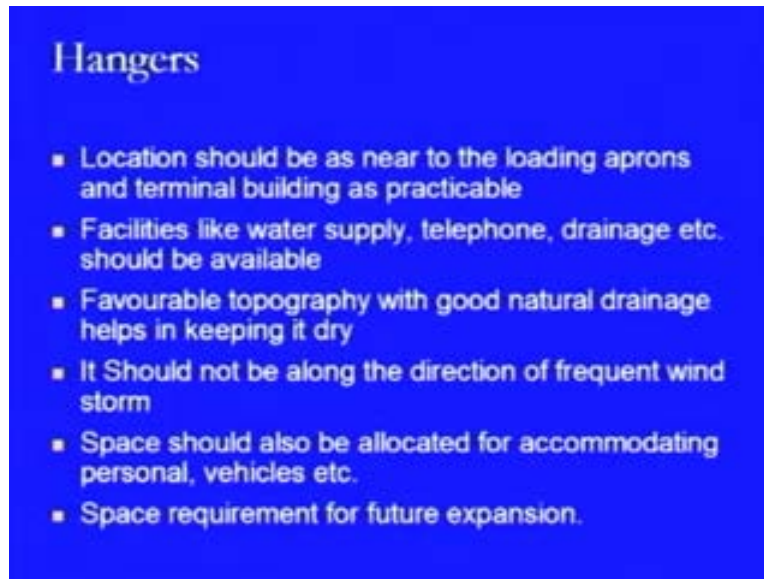
Now, we come to the last thing as far as the facilities or components are concerned and that is hangers.

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Hangers are the enclosures for housing and repairing of aircrafts and steel framework with galvanized iron sheets are generally provided, so as to provide these enclosures. The space is provided for the machine shops and the stores for spare parts which are required for the maintenance of different types of aircrafts within that hanger. The size of that hanger depends upon the size of the aircraft and the turning radii of that aircraft. The number of hangers depends upon peak hour intensity and the demand from different airlines, which are operating from that airport. Adequate lighting system needs to be provided inside the hanger, so that the maintenance can be performed even in bad light conditions.

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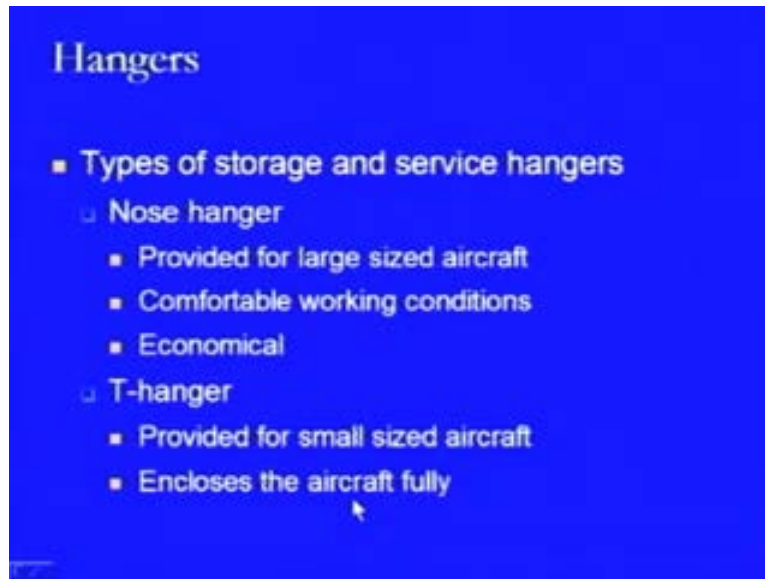


The location should be as near to the loading apron and terminal building as practicable and this is what we have seen when we started with the different layouts of the terminal areas and buildings, where we found that the hangers are allocated next to the terminal area or terminal building. The facilities like water supply, telephone, drainage, etc., need to be made available, which are utilities. The favorable topography with good natural drainage helps in keeping it dry. That is another requirement of any hanger, because otherwise there may be a problem in movement of aircrafts.

It should not be along the direction of frequent wind storm, otherwise there will be danger of overturning of the aircrafts which are being stored in the hangers or being brought to the hangers for maintenance reason. The space should also be allocated for accommodating personal or vehicles etc., and further, there is a requirement of a space for future expansion. So, these are the requirements of different hangers which need to be provided at any location.

Then, there are different types of hangers.

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They are storage and service hangers like nose hangers, where they are provided for large sized aircrafts. Comfortable working conditions are there and they are economical, because only the nose of the aircraft moves into the hanger and rest of the aircraft remains outside. Further, there is a T shape hanger, where it is provided for a small sized aircraft and the enclosure is provided in such a way that the whole of the aircraft can come in.

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This is one type of a hanger being provided, enclosure. It is a nose type of hanger, where only the nose can go inside and the rest of the aircraft remain out and this is another big type of a hanger where the whole of the aircraft can move in as being shown in this case that is the T hanger. So, that is what about the types of the hangers to be provided and that is about the various components which need to be provided as far as **operation of** systems of operations to be provided on any of the airport.

So, with this one, we are trying to complete **.....** the various components and the systems located at any of airport system. In the coming lectures, we will be looking at the visual aids. Till then, good bye and thanks to you.