B.ARCHITECTURE

BUILDING SERVICES-II (AR6511)

CONVEYING SYSTEMS

Lecture 6

Elevators and Classification of Elevators:

Elevators: - Now what is an elevator? **Elevator is a vertical distribution system. It is a vertical transport equipment that moves people or goods between floors or in between any other structures.** Elevators are generally **powered by electric motors** that either drive through traction cables or counter weight measures like hoist or pump will be used.

Classification of Elevators: - Based on the way they are moving they are classified as tractional **elevators, gear or gearless elevators anything** and all those things.

Tractional elevators: - Tractional elevators if you take, you have an **elevator car and a counter weigh**t will be attached to the opposite end. **The ropes will pass through the driving mechanism** which will raise or lower the car with control pressure. They run on load bearing rails that will be placed inside the elevator hoist way. They are traction elevators are mostly used in mid-rise and high-rise buildings with 5 or more floors. This is a traction elevator if you see at the base you have springs for the car to come to rest and this is the car, elevator and you have a counter weight here, the ropes of which go through this motor mechanism. Now these are the guide lines through which we have the ball bearings where the elevator shafts, elevator cars will be moving up and down. There is a machine room on top of this and here you will have all the motor that runs the elevator and the other equipment's will be placed in this machine room. Based on the hoist mechanism, what we saw earlier is a very simple hoist mechanism. There are advanced versions where you can see we have gear and gearless types. The hoist mechanism how we differ here is the electrical power is only more, but the function is to convert the electrical power into mechanical power. That is what is happening in an elevator. When this is

happening the way the mechanical power is generated or used to move the cars is what we call it as geared and gearless types.

Geared: - in geared machine the motor will run in a gear train and that will rotate the sheave. You will have a gear and there the motor will rotate the gear train and the sheave will rotate and the ropes will move on that.

Gearless: - if it is a gearless type, the motor turns the sheave directly. There is no gear at all, the motor will be directly connected to the sheave and it will turn the sheave and the cars will move. A brake is mounted between the motor and the drive sheave to hold the elevator stationary at the floor, because of this gear only we are able to keep the cars at each floor. In a gearless mechanism you will have an additional brake provided between the motor and the sheave and this is usually externally drum type and it is activated by a spray force.

Another hoist mechanism is there, that is **called hydraulic elevators**: - This is by means of forced pressure the elevator car will be taken up and down. So if you see here this is the image. You have a piston underneath and there is a tank and a pump. So this tank will have the liquid or any fluid. That will be pumped through this valve and that liquid will; make the piston to move. Once you open the valve the liquid will drain out and the pump will come down. This is the mechanism of a hydraulic elevator. So as the pressure forces the piston to rise, lifting the elevator and the car enclosure mounted on it. So the car is lowered by opening the valve that is what we saw. Now when the valve is closed the car is stopped. Whenever you want to stop the valve is the main operation to move the car. Since the weight of the elevators is borne by the piston there is no structural framework at all. So only the piston has to be installed. We don't need any concrete structures to hold the elevator cars for its movement. This is commonly found in low-rise buildings where you have 2 to 5 floors. Beyond that it is very difficult, it is not cost efficient to use a hydraulic elevator.

When you consider **the main design consideration** you have to think about the **number of floors you are going to service, the height of the building, the number of people to be transported, the desired passenger waiting times and frequency of use.**

There is another classification **machine room less elevators**. So in a traction or hydraulic elevator you need a machine room, where you have an electric motor or controller cabinet to move the cars. But as I told you it is located above the hoist wheel. In the recent development if you see, it is the machine room less elevator, where you don't have a machine room

at all. What happens is, it is based on gearless technology. So the motor room is mounted on to the car. So the motor room, the configuration of the sheave, motor control system everything is housed in one machine room and it is built in the car on top of the car itself. This is made possible by the application of the permanent magnet system, where the motor size is reduced. So when the motor size is reduced, we use less energy and also the size has gone down 4 times the original machine room size or motor size. This is the machine room less shortly called as r MRL elevators are very cheaper to install and architectural flexibility is low because it does not have machine room, which usually sticks out in the elevation of a building and it has an increased lettable space. Lettable space is leasable space. So when you take the speed and number of rows there is a limitation in this. It can only go up to 30 floors and speed can be up to 2.5meter per second which means if there is going to be a higher development or skyscraper kind of a structure you cannot go for an MRL elevator.

Design Criteria:

The design criteria, **the cost of the elevator depends on these factors. The passenger handling capacity, waiting interval, speed, location, finishes, intelligent group control safety and reliability.**

When you see elevators there are also risks like we have to ensure that persons are not stuck in elevators. For that also you have to make decision. Even if it is stuck the elevator must have the capability to stand wherever it is stuck, it should not free fall down to the floor. So the engineer is responsible for designing, they have to follow the statutory codes and standards. The parameters what we saw for designing the elevators we will look at it one by one.

Now the **characteristics of the premises or the building**. So you should look at **the type and use of the building, the floor plate size which will give you the height, the number of people who will be using the elevators and the height of the building, size of population and its distribution, how it is distributed.** If it is going to be a multi – residential building, the **composition of the people will be different, fire safety and regulations, housekeeping of the premises.**

Then you have the **circulation efficiency** that is the **number of cars that you require and the capacity of the cars.** We cannot have only one car of 20 people capacity for a building where you have in a floor more than

500 people. So the **number of cars and their capacity has** to be checked into. **Location and configuration of elevators in entrance lobby**, how is it accessible to the entire people who are using the floor. **The travel length, number of stops and maximum acceptable waiting time, s**o the elevator just go and stop at each and every floor, so it depends if it is going to be a high rise structure, you cannot expect the elevator to stop at every floor, because the person who is travelling from the ground floor to even more than 10 floors. He need not wait for each and every floor from 1 to 10 and then go to his 11^{th} floor, so the number of stops have to be considered, the travel length, the height of the structure. **Arrangement with the combination of elevators and escalators and emergency stairs.** So whenever there is going to be a mixed use of vertical transportation, not only elevators, you obviously will definitely have a stair case and there might be possible you have an escalator. So the combination, how you are going to place these things is in the entrance lobby also will determine the circulation efficiency.

Then the **characteristics of the equipment**: - The **type of transportation system, rated load and car dimensions**, the entire system we are talking about the equipment fully **the speed of the lift, the motor what is used to drive the car elevator, the enclosure that it is going to have and the hoist way the door finishes how it is going to be**. These things are the characteristics of the equipment. So these things will determine the cost of the elevator. Then the **mode of group supervisory control and safety features**, what has to be followed, if there is going to be more than one elevator how you are going to group it. Then **emergency power supplies and fire protection systems**, because in case of a fire no elevators should be used. All the elevators will automatically come to the ground floor and then there will be one fire elevator that will be provided so all those things have to be considered. **Requirements of the local regulation on vertical transportation system t**hat also has to be considered. So apart from these characteristics, there are some basic things that we have to calculate before going for the type of elevator.

We have to **do traffic planning**. Traffic planning is the vertical traffic planning. So elevator planning in building projects is dependent on the traffic analysis study. Traffic analysis is nothing but the population study, **how many people are in the building, how many people will be using, at what time they will be using, so what will be the peak hour**? So the pattern of flow of the people is traffic analysis. So when you do a traffic analysis it will help you to have the correct number and type of

transportation devices in size and speed and the proper control system to optimize and synchronize the flow. An optimum lay out can be given for this transportation devises an easy access to the building and there will be a smooth flow of people and goods.

Now the efficiency of an elevator system is defined in terms of **quantity of service** that is your **handling capacity**, how many people you can move within a certain time and **the quality of the service.** How much time the people are going to wait. So these two parameters will determine the efficiency of an elevator system.

So when coming **to handling capacity**, **the total number of passengers that the system can transport within a certain time** is what we call the handling capacity. It is usually 5 minutes we take as a minimum time and during this time, peak traffic time how much passengers it can carry with an average car loading. The average car loading we never take 100% loading of the car, we take 80% of the rated capacity. So to achieve this we have a calculation and a formula to do that. The handling capacity is usually a Percentage. So the formula is like this H is the height, capacity is = 0.8 that is 80% ×300 that is the time×RC by I×P. so HC is the handling capacity and RC is the rated capacity of the elevator. How many people it is going to carry? Is it 20 people or 5 people and I is your interval and P is your peak hour/ passenger waiting time.

Interval or waiting interval is the average time that will be expressed in seconds, between successive lift car arrivals, lift car is going and the other car is coming. So the difference of time between the 2 cars coming to a floor is the interval or waiting interval we call. So this will represent the longest time between the elevator dispatch and that will be taken into account.

Then you have a **round trip time**. It is like for a single car trip. You take a single car and how much time it takes to go up and come down, once so that is called round trip time. This round trip time only we use to calculate the passenger waiting time. So if the car is going to take 15 seconds to reach 5 floors and come back people have to wait 15 seconds to get into the lift. So that is what we call it as round trip time.

Then you have **average waiting time.** Average waiting period is the average passenger how much time they wait from the passenger mode he presses the call button till he enters the lift is called the average waiting time.

Then you have **the speed of elevators**. So elevators speed is determine by the travel **distance and the standard of service.** As I told you if it is going to be a high rise structure which has 30 floors, 40 floors, the speed also will be more and slot where the cars stop, it will not stop in every floor, so that is the travel distance we are talking about. So the speed should be selected so that the shortest round time can be obtained which is 25 to 30 second time interval and the least number of elevators will be needed to handle the peak load. Like for example 5 elevators for a peak load. It should use the least 3 or 4.

Then you have something called **destination control system** which is very important in an elevator. We saw there are so many risks involved in using an elevator system. Now this will be helpful in going back. Now traditional elevator control system works with very limited information we don't actually go into the registration of it, the calls are not synchronized, they are going to be multiple lifts, the calling buttons will not be synchronized, all those things will not be there in a traditional elevator.

Now destination control system will have additional information like **desired destination floors and the number of waiting passengers.** So desired destination floors will be which floor more people are using like that it will take information and the number of waiting passengers in that particular floor. So based on this calculation the elevator car system itself will determine the speed and the call stops.

Now when you have a destination control system, you have **2 benefits- increased efficiency for building owners, increased comfort and reduced journey times for passengers.** Both the owners and the passengers are benefitted if they have a destination control system.

Destination Control System:

Let's look at **how a destination control system works**. So you have 3 basic steps in that.

Step 1: - You select your destination floor at the destination operating panel. You have a destination operating panel instead of a call button. The number of floors will be displayed on the call button itself. Whatever floor you want to go you must select your destination floor. Now that display will

tell you which elevator has been assigned to you? If there is going to be a group of elevators like 4 or 6, so that panel will tell you which elevator will be going to that particular floor and where it is located.

Step2:- the next step will be, now we know which elevator is going to where and where it is. Now we go and wait for the elevator there and all the elevators will be clearly marked. So you can identify where the elevators either by the number or some identification with alphabets or some identification will be done. You go and wait in front of the elevator.

Step 3:- the 3rd step will be once you get into the car, **the next stop indicator** will display the destination stops the car is going to make. It is not like, if you are going to 6th floor from 1st floor, it is not going to take you directly to 6th floor, it will assign based on the passengers waiting. It might stop on the 2nd floor and 3rd floor also. So even before you go to the 2nd floor as soon as you get in it will tell you which the floors it is going to stop are. So the position indicator will tell you when you have arrived at your destination floor. So it is a completely automatic system, where the system will take care of the automatic dividing of the people and the moving of the people efficiently. This information on the number of travelers, the destination floors and people with the same wishes will be grouped together. So maybe it will be a group of elevators and there are few people who are going to 6th floor, few people who are going to the 3rd floor. So it will group the people like that so the number of stop the elevators has to make will be less. So this leads to sharper transit times and fewer intermediate stops to visually emphasis using this. This is a group of elevators. These 4 are elevators and these 4 are elevators. So in a traditional system what happens is there will be a collective control system. So what happens is when you click on a call button, so all the call buttons will be grouped together and whatever lift is nearest is going to come down. The people will be very crowded in front of the lift which is going to arrive as there will be an indication that this lift is going to come. Moreover the people who have to travel to upper floors will have to wait for each and every floor for the lift to stop. But in a DCS, destination control system the passengers will select. So if you see the colour that is what is represented here, the people are going to one particular floor they are grouped. That is what is explained here. These people are going in this lift and these people are going in this lift. They are grouped based on the floor they have to go. So before entering the lobby area they are guided to the dedicated car. A limited number of other passengers also will be there within specific range of floors are assigned of the same car. And the boarding is calm and orderly and the travelling time to destination is minimized. But if you see in a

traditional system, all the people are going to whatever floor they like. People will be waiting for this elevator here, sometimes this elevator will come so people will rush from this elevator to here. So there will be chaos and there will be no order. So the destination system is a very efficient system when it come s to an elevator system to be organized.

Escalators:

Now coming **onto escalators: -** So what are escalators? We have seen moving steps in a shopping mall and airport. **They are load carrying units designed to transport people and things between 2 landings. This is basically a staircase, a moving staircase.** There are 2 landings for a staircase, bottom landing and the top landing. So it will transport people from one landing to another. It is not like an elevator where it will move through the entire building but for an escalator you can only move from one floor to the other. This is also driven by an electric motor and it has a driving system and the steps move and the hand rails will also be at synchronized speeds. If you see here, these steps will be moving and the hand rails will also be moving in correspondence to your steps. Her you have an electric motor and a chain system linked to it. You have a drive chain, a drive shaft is here, the motor will be driving the drive shaft and it will be moving the chains and the steps are connected to the chains it moves the steps. It is supported by a truss which contains all the mechanical components that I showed you drive unit, brake, chains everything I showed you this is a support system, a truss kind of system will be there. Now these escalators will have a speed of only 0.5 meter per second. It is fast enough to move people at the same time it will not have a rapid displacement. When you go beyond a certain speed you yourself will feel not comfortable with the travel. So these kind of escalators you can see in commercial buildings and public transport facilities as I told you like airports, metros and railway stations. In these public places we have to carry heavy luggage so there instead of steps they will provide inclined walkways will be there, moving walkways will be there so that you can take up your heavy loads like suitcases. In airports there is another system, were you have a horizontal way, the same thing will be in a horizontal, and the airports will be so huge were you will find walking itself tiring. So to make walking easier they put travellators we call it. So it will just transport you horizontally.

Classification of Escalators:

When you come to classification of elevators, we have a major classification like **parallel, multiple parallel; cross-over or criss cross and walk around.**

This is a parallel arrangement elevator, where you move from this landing to this landing, so this is what we call it as parallel. We can see that the elevators are parallel, so there is no walk around. You just come up here and just go on to the next level.

When you come to criss- cross arrangement it is not like that, so when you start from here you come to this landing, again to go to the next landing you walk around the place and from here you go to the next landing. This is a major problem when you come to criss cross elevation and you see the plan, things are not parallel to each other. So this is in a different level and this is in a different level. You have to walk around the building from one place to the other.

The other classification is **multi parallel and walk around**. So in multi parallel if you see, both the things will be side by side, one way you will be going up and one way you will be coming down. If you have Major traffic flow you see all the three elevators will be going up the direction were you have major traffic flow and the other one will going in the other direction. So this is the multiple parallel, parallels you are going in the same direction. This is your other thing were you get up here and then you walk around and go here. This is something similar to a parallel. But the only difference is you will have many escalators going in same direction.

Now this escalator has to have **many safety features**.

(I)Especially like **hand rails and steps, they have to travel in the same speed** so there is a balance for the people who are getting onto or getting off. This synchronized speed will help. When the steps are large and steady, it should be designed such that it should prevent slipping.

(ii)And in **the step design and step leveling the comb plates** at each landing should prevent tripping. Even the steps that go to the landing and then come down there should not be any level difference. It should not be to such an extent that people can trip and fall. So this is accomplished with 2 or 3 horizontal steps at either end of the escalator. So before this turns

up you have 2 or 3 steps at the end so that goes in a horizontal manner and then it is in flush with the landing

(iii) Then **the Balustrade design to prevent catching of passenger's clothing or packages**. So the hand rail the Balustrade handrail it should be designed in such a way , the people who are getting off their dress or whatever they are carrying should not catch ,because that is also moving. So these things should not catch on to that.

(iv) **Closed clearances provide safety near the comb plates and step threads**, so the clearances that you provide should be very close. It should not have gaps so that anybody's leg or things will go and get stuck.

(v) **Adequate illumination provided by the building at all landings and comb plates down all stairways.** This is very important. It is not a normal staircase, it is a moving one. So adequate lighting should be there at landings, comb plates, (A Comb plate is the place where your escalator and landing meet.) and all the stairways also.

(vi) **Automatic service brake will bring the stop stairway**. So whenever there is an escalator there you can find an automatic service brake will be there also. So in case of emergencies you can also use that to stop it. So this will stop the stairway on the occasion when the drive chains or step chain is broken or stretched automatic brake will happen. When any foreign object is jammed into the handrail inlet or between the skirt guards or between the steps it will stop. Or if there is a power failure, or when the emergency stop button is operated and if a fire safety system operates. Even if case of fire this escalator won't work it will stop, it will be used as a normal staircase, tread sags, rises or breaks, if happens, there will be an automatic stop and driver motor malfunction occurs also you will have an automatic stop. This automatic service break comes into the picture.

(vii) Then you have the final thing**, over speed or under speed**: - The escalator is working but suddenly there has been an over sped or under speed. There is an automatic governor which will shut down the escalator and it will prevent the reversal. Even if it shuts down it should not come back. So it shuts down the elevator and stops in the position itself. So this will operate the mechanic service brake. So even if escalator stops the advantage is people can still keep moving like a staircase.