Fire Protection, Services and Maintenance Management of Building
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Lecture – 16
Design of Lift systems

So, we continue from what we are talking about.

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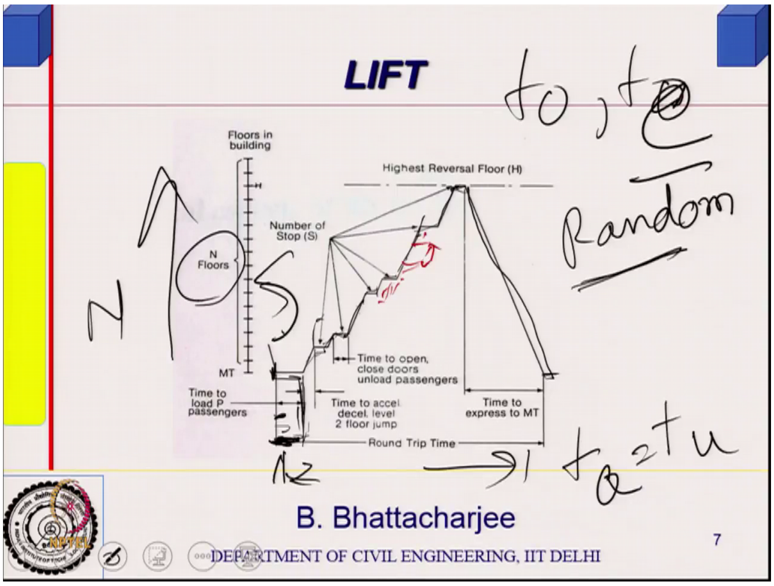

So, we said the loading time is t Q right and, this is also equals to unloading time you know and this so, this is loading time unloading time right, now I am not really bothered, if I take it reverse direction then I will take unloading time also. So, you know t Q is the time for loading, maybe for 1 passenger I can find out multiplied by Q and I can find out for others you will see that.

Then once it is get loaded this is the loading time actually total passengers up to capacity got loaded, then it starts accelerating right lifts up. Then might be accelerating comes to a constant speed and decelerate and then it stops maybe stops at next floor, but then do not stop at many floor because in random. It can stop at some other floor, then some other floor and something like this. And then while coming back you know it unload the passengers, it comes by come straight come straights and opens up.

So, cicely is something starts from here to this is the total cycle and we call it round trip time, round trip time this is a round trip time. So, round trip time it starts from first loading all the passenger, then it every between every stops what it does it accelerates goes to a constant speed.

Then decelerate stops I will have a door opening time, then people will get out some people, then door closing time and then goes up to the next level and next level etcetera. So, there is two types available one is the loading time one is door opening time and door closing time. So, door opening time and door closing time, let me call this t o and t c to and t C t C is the closing time opening time right.

So, how many times now this S this stops number of stops I call them, as S number of stops are S, S is the number of stops number of stops are S, this is somewhat probabilistic. This will depend upon for a given lift this will depend upon the people that have boarded for example, all of us boarded let us say.

And some of you want to get down at third floor then some of you want to get down at fifth floor. And next time we need making a trip some people want to get down at second floor, some down at maybe fifth or maybe sixth or whatever it is. So, this is not same every time, it does not stop at every time right, at general situation, in this stop means S is somewhat probabilistic, it would depend upon the people who have come in, maybe some out of out of 16 capacity 16 people who can board right, all you know 50 percent 8 of them go to fifth floor one time.

Sometime some of them go to two so, it is a number of stop is actually probabilistic, number of stop is probabilistic right. So, S is the number of stops I call it S number of stops, now how many time the door will open and close S stops S time it will close and it will close at the bottom once, and also you know like there will be s plus 1 time because the ground floor lobby, stops are above the ground floor lobby. So, S number of stops at the ground floor lobby, it I am starting from loading time I am starting from loading time; that means, it is open now and loading.

So, now S first it is close at the ground floor and stops at S number of stops including the top floor S, there may be somebody at the top floor, or may not be. So, I am including that so, S number of stops including the total floor sum up plus one time at the ground floor it would have closed. So, S number of stops it would have closed and it would have open coming back again into the ground floor. So, there will be total number of s plus 1 number of times door opened and closed, because at the ground floor it will open and close definitely depending upon, where I am starting from my cycle, but S number of time also it will open and close.

So, open and close S number of times it will accelerate same number of times, because it will have to accelerate the ground floor and S stops. And decelerate also same number of time right, same number of time it will decelerate right, what will all we are assuming is that acceleration and deceleration is same while going up, or coming down the times are same. So, s plus 1 number of time it will accelerate it will decelerate and then in between it will run at constant speed.

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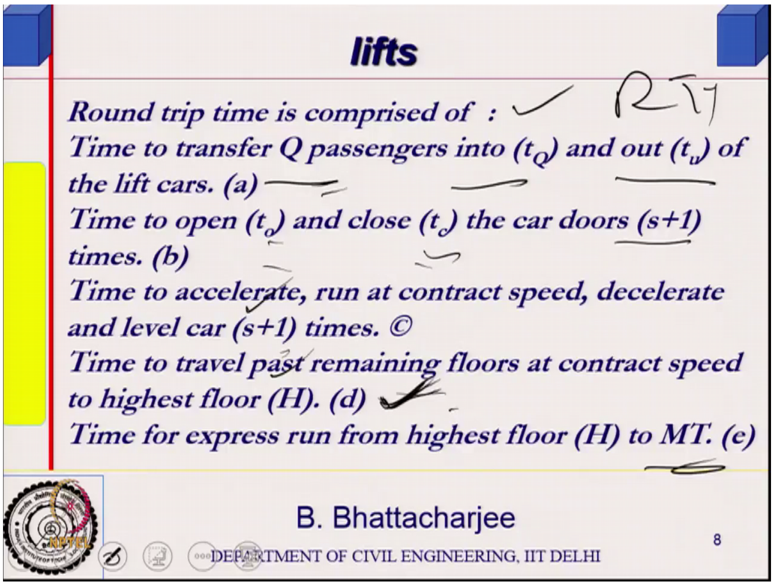

So, all this time let me define now round trip time RTT comprises of, time of transfer of Q passenger into and out of the lift cars, I call it a time to open and close the door s plus 1 1 plus was one time that I call it b. Time to accelerate run at contract speed which is the constant speed actually and decelerate and level the curve s plus 1 time. So, there is an acceleration and deceleration that will be also s plus 1 time I am calling it c.

And trying to travel the remaining distance, at contract speed you know lift speeds are actually specified you will find that it is ok, lift may not you know in the board in there within the lift they may not write the speed, but manufacturer provide the speed at which it will travel, when it is travelling at constant speed. So, that we call as contract speed could be 1.5 meter per seconds etcetera. So, the remaining distance other than acceleration distance deceleration it will actually travel at.

Student: (Refer Time: 6:27)

Constant speed right. And that let me call it as d. Now, this all the time lift may not go to the top floor, it may come down at some level so, let us say this is also probabilistic, only when it we find one person belonging to the top floor, then only it will go to the.

Student: Top floor.

Top floor, otherwise it will go it will empty every people and then simply come down. So, this H is called highest floor of reversal, H is called highest floor of reversal height of you know highest floor of reversal.

And highest floor of reversal, highest floor of reversal is also probabilistic, because it is depends upon chance factor yeah I have to find that out at least one person in the top floor so, that it goes to the highest. So, two things are actually round trip time consists of all this a b c d time and e time right e, is then express run downward so, a b c d time this is the round trip time will be sum total of all these times, sum total of all these times and basically two things are probabilistic here, one is the s and another is H, s is probabilistic in it.

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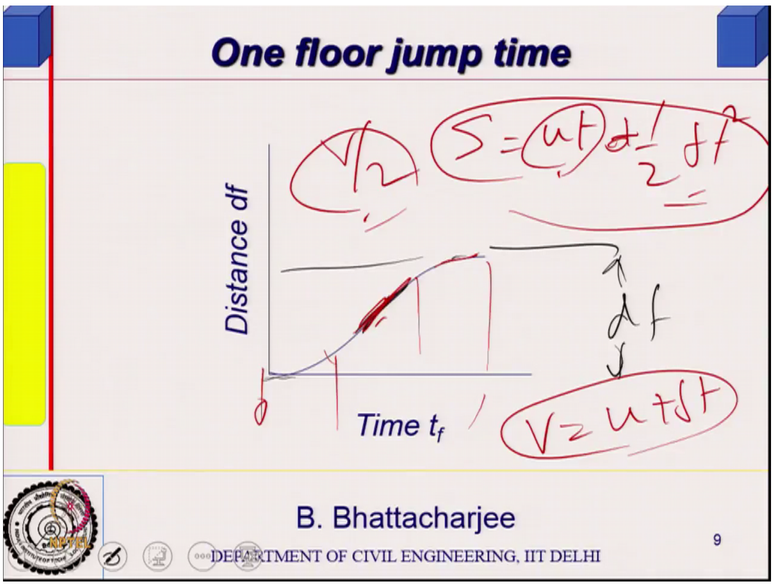

Just to look at the speed typical we define something called one floor jump time, one floor jump time right so, basically one floor jump time is supposing it is only the floor height distance d f is the one floor height, d f is one floor height you know this is the distance one floor height, let us say the height of a floor distance of a floor. Then it starts accelerates then comes to a constant speed, then comes to a constant speed right, it comes to a constant speed here and then again decelerates.

So, this will be the typical time required some acceleration time some deceleration time right and, constant speed time so, this we know this speed is we know and it starts from 0 velocity to this velocity I mean there is constant speed and reduces on an average it will be V by 2 speed, we can take as V by 2 V by 2 in that is what is done S equals to u t plus half f t square, you know the distance is equals to u t plus half f t square. So, if you know the rate of acceleration, or you can you know this comes, basically you take V 2 V by 2, they are very speed during this time is V by 2.

So, you can use this kind of formulae or simply V by 2 is the speed average speed here, some information should be available to its time of acceleration, some information or distance required for acceleration, that should be available to you starting u would be 0, in some cases this would be there, but finally, you know the velocity final velocity will be 0.

So, because you know V equals to u plus f t so, one can use these formulas to find out, but it is basically the knowledge is I mean basically the idea is this, that it accelerate goes to constant speed.

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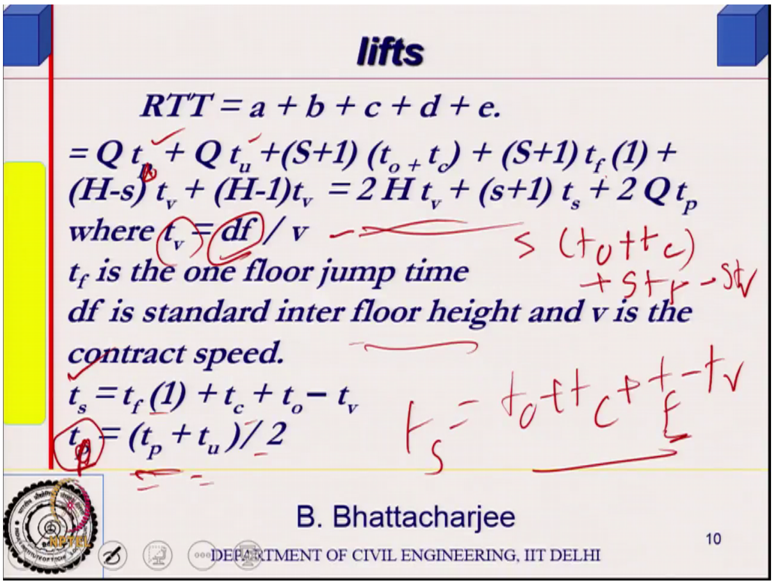

So, let us see how we calculate out round trip time a b c d, a b c d so, a is the time for boarding t passengers t p.

Let us say the passenger boarding time for 1 so, Q into t p Q passenger boarding, this is for disembarking t u. So, Q t u s plus 1 t 0 plus t c door opening time and door closing time, we said it will open and close s plus 1 time 1 at the ground floor lobby plus S stops S probable stops, then S plus 1.

This is becoming this is slightly let us say S plus 1 time, it will accelerate right it will accelerate So, if I combine one floor jump time, one floor jump time, then you know something like this let us say something like this in this diagram, if this is one floor one floor jump time here, one floor jump plus some additional floors where it will run it.

Constant speed so, how many time how many floors says I shall I take floor one floor jump s plus 1 would be there, because one is also ground floor it will accelerate and.

Student: (Refer Time: 11:22).

Decelerate and if the floor heights are all same, then I can take one floor jump time including the ground floor including the ground floor. So, that is what we have done, that is what we have done, that is what we have done, you know that is what we have done so, one floor jump time I am taking one floor jump time, plus H minus s, s is number of stops H is a while going up H is the probable floor of reversal right f minus s, H minus s, if I you know that would be that distance it would travel at constant speed. That distance it will travel at constant speed and H minus 1 that would travel at constant speed while coming down.

So, while counts coming down right this is everything is in so, time to travel through one floor in constant speed this t v; t v is the time, to travel through time to travel through one floor, one floor at contract speed and t f is the time to travel through one floor, travel through one floor with acceleration and deceleration, who what we are calling as one floor jump time.

One floor jump time is a time, which is one floor jump time is time, where I am you know is that time during which actually it will accelerate, come to a constant speed and decelerate and stop at the next floor, while that is that time I am calling as t f; t v is the time it does not stop in that floor passes through the floor.

So, that is a constant speed from the floor bottom to the floor top right. So, if H minus H is a height of reversal H minus s is the number of floors, in which it will travel through constant speed while going up and that is what I am adding here. So, t v is the time required at constants between floors right. So, H minus s is the number of floors while going up it will not stop. So, that multiplied by t v and you know s plus 1 number of floor where it will stop.

Now, I have taken the ground floor into account here, both going up and down because I have taken acceleration deceleration in the ground floor. Acceleration is value it is going up down, I mean sorry while going up deceleration is when it is going down.

So, while going down I must consider H minus 1 into t v, because it will come straight through from H to the ground floor, but the acceleration of the ground floor I have already taken into account, sorry deceleration of the ground floor not. Acceleration and acceleration of the top floor I have already taken into account in this one s plus 1, I have already you know taken care of this one t f in this t f part s plus 1 t f.

Because what I said is t f is the one floor jump time. So, it accelerates, constant speed, decelerates, H is the height of reversal S time this will do t f, because S stops are there, plus 1 I have added because the ground floor acceleration and while coming down there is a retardation.

So, ground for acceleration and retardation is taken care of here, in because I have taken t f right and therefore, it should be H minus 1 t v and H minus s t v, because while coming down it will come down straights it will come down straight. So, my round trip time will be summation of all this. Now, these once are just known from manufacturers data it has to be known, or typically this is known how much time does it require for a person to enter. Because this is Q number of person t p is one person entering the time required for one person entering the lift.

And time require of one person to unload from the lift, or get out from the lift. And this is door opening and door closing again manufacturers will provide them, the only thing I got to know is to S and obviously, t f I will have to calculate out from the contract speed. And acceleration time also will be given manufacturer might supply depending upon height, because if the height is known constant speed is known, then I can find out v is equals to u plus f t either time of acceleration must be known, or I must know you know I must know.

Because V is a constant speed given usually 1 usually you know this start this is 0 from 0 at a type it starts, or I can assume V by 2 is the average velocity, but again if I want to find out the distance floor height, then S you know the time require I need the time I require the time I require the I require the time. So, time of acceleration must be known to me, or distance of acceleration must be also known to me normally the manufacturer will provide at what we does it accelerate, or you know time of acceleration is how much, that should be available to us right.

So, then I can find out t f I can find out t v obviously, contract speed so, it is under the floor height, I can simply find out floor height if I know so, this is how it is. So, t f is the floor jump time etcetera. Now, I can define t s see where I have S involved this is S this is s is involved and s is involved here, so, s multiplied by all the all the term related to s I can actually find out how do I find out, see this will have S into t 0 plus t c.

Student: (Refer Time: 17:40)

Plus S into t f.

Student: (Refer Time: 17:46).

Minus.

Student: S into t v.

t v right S into t v. So, coefficient of S is nothing, but t o plus t c plus t f minus t v let me call it as t s right and t f is there somewhere t f into S here t f t f was also there. So, this is t 0 t f I have already so, you can see that t c t f t minus t v. So, this is I am defining as t s, this is t s is the time you know which is in time in it is a coefficient of S in this equation coefficient of S into this equation coefficient of S into in this, t v is the height floor of the height divided by contract velocity, t v is the height of the floor divided by contract velocity right.

Now, S standard floor height v is the contract speed 1 1 1 assumes that these two are same, or take a average of the two S you know t loading or t or whatever it is some I think I should have used a different notation t p plus t u divided by 2, or you know or t p call this as t p maybe call this as t unloading the loading, or something like that I used t something I use some terminology idea.

Whatever it is this is this could be either same, or I can take average of the 2 average of the 2. So, the point remains is to determine S n H S n H right S n H.

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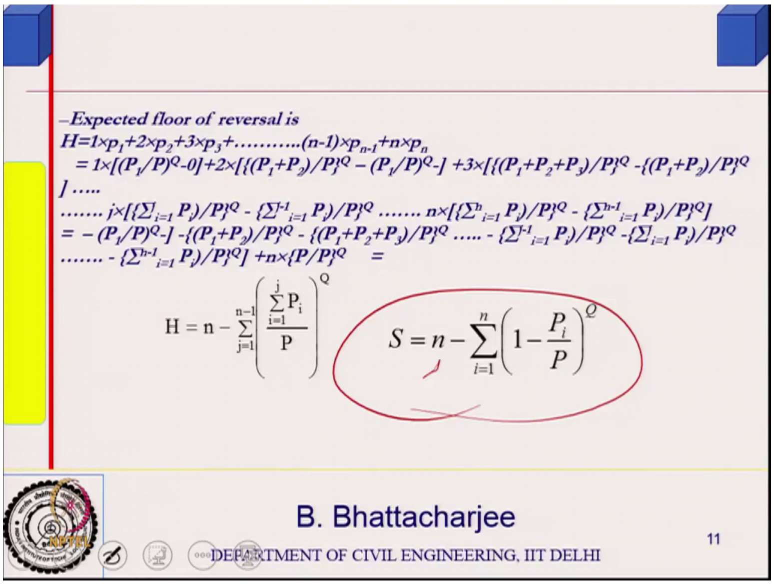

Now, S I can determine heuristically, S I can determine heuristically I can determine S heuristically, how do I determine heuristically.

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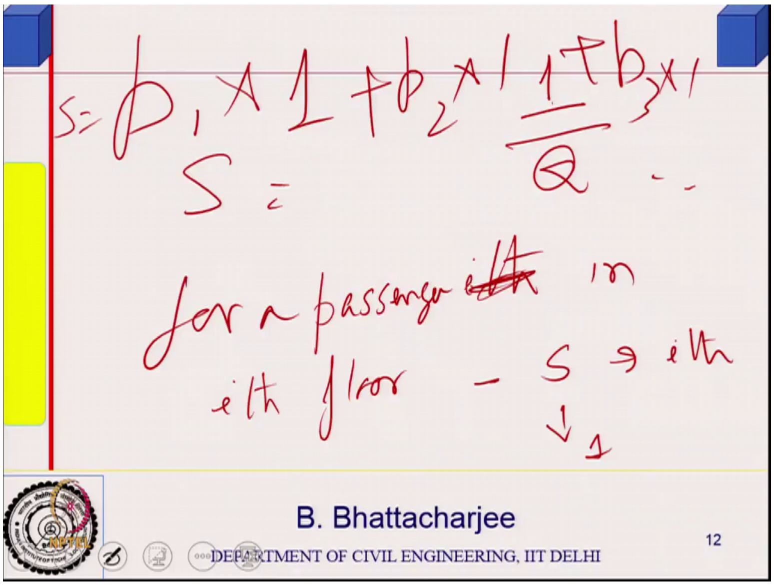

Let us determine S I can determine in some manner. Now, S depends on what S depends on.

Student: (Refer Time: 19:47).

Probable number of stops right; now, if I find a person in ith floor let us say, you know then ith floor will be a stopped. So, for a passenger in ith floor, S is ith floor or 1 S is equals to 1 S is equals to 1, because S is number of floors. So, if I have first thing is I want to find out the probability of finally, because I am looking at expected value, you know the mean value and a probable number of stops probable I am using the terminology.

So, supposing I have got a person out of Q person in some floor, then probability of finding one person is 1 by Q 1 by Q, we know probability of probability of finding a person in a floor is 1 by Q. Now, it will not be a see basically I am trying to find out probability of finding a person in one floor, second floor, third floor etcetera. And if I multips you know if I sum up all of them, then I will get the probable number. So, let me just tell you it can be written like this probability of finding a person in first floor multiplied by multiplied by 1.

S will be equal to probability of multiplying finding it out in first floor, plus p 2 into 1 plus p 3 into 1 etcetera, probability of finding in the floor; if I find one person then I will have multiplied by 1 so, that will be assume become one probability of finding in the second floor multiplied by 1. Now, this probability of finding a person in a floor would be given by population in that floor divided by the total population in the building to be served by the lift, probability of finding probability of you know so, population so it will be related to the population.

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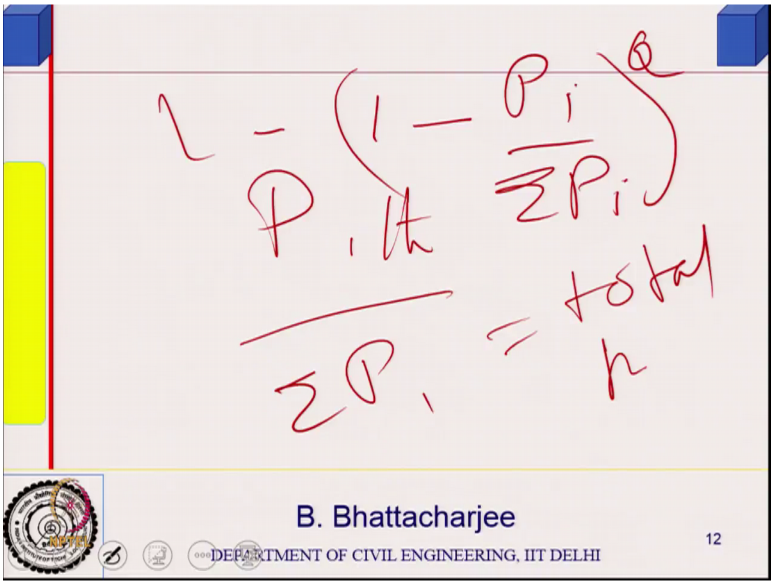

So, if I know the population in ith floor divided by sigma P i a which is the total population to be serve, this is the probability of finding one person in ith floor.

Because all of them will be boarding all are going to the office, all the sum of pi peoples are going to the office. So, if P 1 if I know the population in first floor, divided by total population that is the probability of finding a person in first floor. Now, I am trying to now finding out joint probability of finding problem all people, all people at least 1 person from all the Q people boarded in ith floor. At least one person is it is at least 1 person, which means that rest of the Q minus 1 may not be you know belonging to ith floor. So, how do I find it out I first find out probability of not finding a person in.

That particular floor. So, 1 minus P i divided by sigma P i, that is the probability of not finding a person in that floor. This to the power Q is probability of not finding any person in that floor, that 1 minus that will give me the probability of finding at least.

One person, you see I am looking at probability finding at least one person I might have more. Now, then I should find out probability of not finding any person in that floor, 1 minus that probability is the probability of finding one person, one or more person in that floor do you get the logic, I think its convincing the logic is convincing. So, probability of at least finding one person in the floor is 1 minus probability of not finding any person in the floor.

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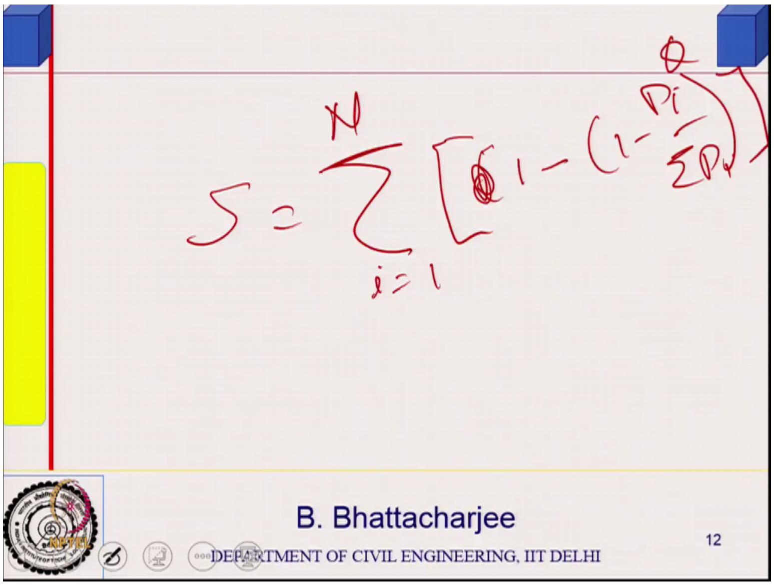

And this is how this is the logic heuristic logic we built up, so, S will be basically you know sum total of all this. Because I said this probability multiplied by 1 plus you know for first floor ground floor etcetera. So, I will have this will be sum total I going from one to.

Student: N

N number of floors and this would be.

Student: N or n minus 1 floor.

No N floors are the N floor above the ground floor.

Student: (Refer Time: 25:01).

N floor above the ground floor right; N floor above the ground floor so, 1 minus 1 minus 1 minus P i divided by sigma P i to the power Q that will be S that will be S right, that will be S so, I think the slides now we can look into the slides, we can look into the slides now look into the slides. So, if I have N floors that should be summed up for all the floors; that should be summed up for all the floors.

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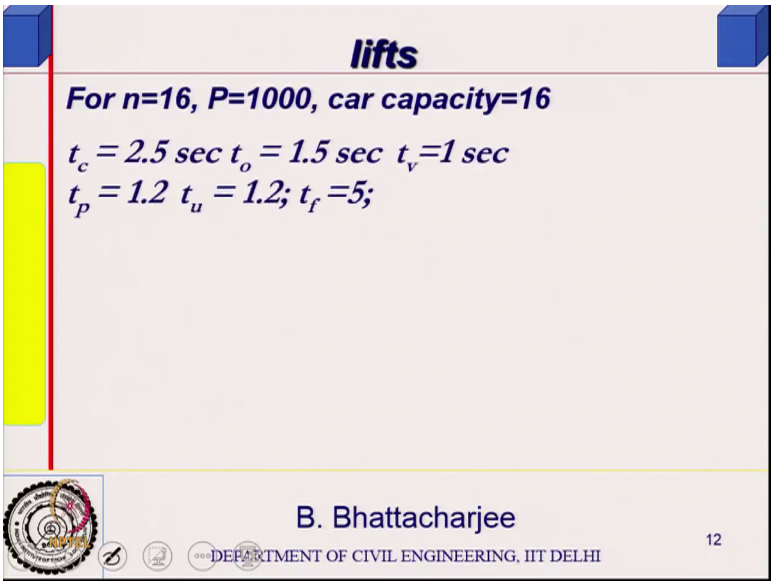

That is I said I said that I should sum up for all the floors, I should sum this up for all the floors. And if you sum up you get in this. So, this is what is S, I think we stop here.