Traffic Engineering
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Lecture 57
Parking Management - II

Welcome to module 8 lecture 2, we shall continue our discussion on Parking Management.

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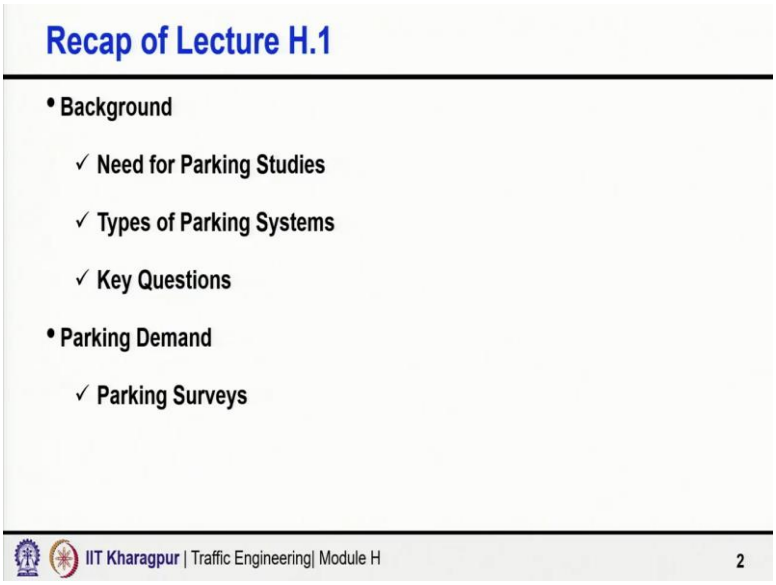

In lecture 1, I mentioned to you about the need for parking studies, why we need to carried out the parking studies, what are the different types of parking systems, the key questions often what the traffic engineers need to answer and the key steps determining or estimating the demand, estimating the supply and then if there is an imbalance between the demand and supply, then what measures what interventions policies actions can be taken to bridge that gap between the demand and the supply. On-street off-street overall parking demand and supply then we started discussion about the parking demand and we talked about various traffic surveys.

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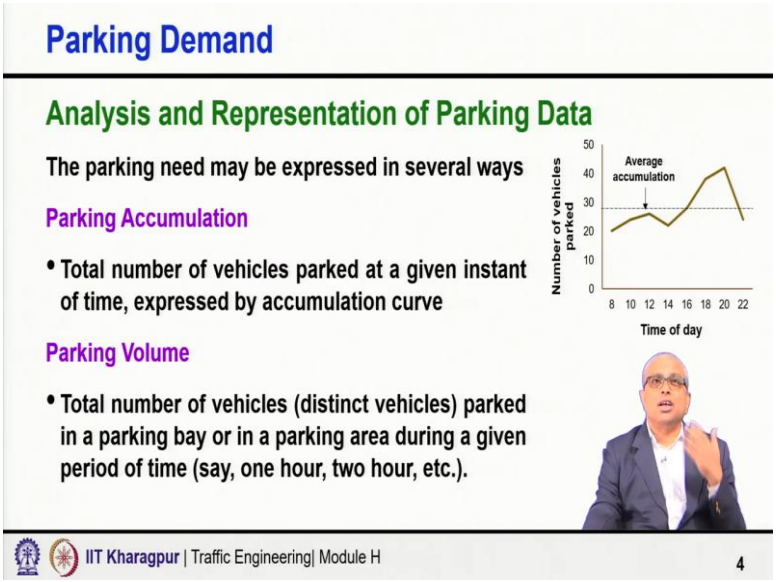

So, in continuation to that, let us discuss now, how we analyze and represent the parking data parking service I said it is particularly the demand one, that how to estimate the demand and then as a part of that initiative to estimate the demand, we do parking occupancy survey, parking beat survey, continuously we can record the entry and exit at off-street car parks or parking facilities, with all this data, what sorts of analysis what meaningful interpretation we can make?

You know that not all the vehicles park in the parking lot for the same duration of time also the overall parking demand also changes over a period of time morning, afternoon every hour probably it is going to change. So, how to analyze parking data to summarize all the findings

related to duration of parking, utilization, the variation of the demand over a period of time and so on.

So, some of the useful methods may include one Parking Accumulation, which says how many vehicles are parked at a given instant of time in a given parking location, you have a parking facility on street or off-street, then how many number of vehicles are parked at a given instant of times, that is normally expressed by accumulation curve.

So, that means say it is 8 o'clock in the morning, I just want to have taken a measurement and I know exactly at 8 o'clock how many vehicles are parked? So, streetwise parking zone wise overall study area wise, I can understand how many vehicles are parked at 8 o'clock, how many vehicles are parked at 9 o'clock, even in same thing is possible in an off-street facility.

So, one way you have the time of the day, typically every hour, and then y-axis how many number of vehicles that are parked, it may be for a given off-street facility, it may be for on-street facility on street parking facility, a single road, multiple roads in a study area overall. You know, parking zone or the larger overall study area, everything is possible.

Next going to parking volume, it is the total number of vehicles very importantly distinct vehicles parked in a parking bay or in a parking area during a given period of time. Say, 1 hour, 2 hour, 3 hour, this comes typically relates to parking beat survey, we are going and observing every parking lot, if we have demarcated we go and check whether what, vehicle is parked or not. If a vehicle is parked, then what is the registration number.

Now, over a period of time 1hour means suppose if I have taking the data every 15 minutes for example only then 4 times I have visited I may find 4 times, 4 different vehicles are parked every time a different vehicle is identified. Then the volume will be 4, if the same vehicle is parked every time I observed the same vehicle then during all the 4 beats or during this entire 1 hour or say 2 hour or 3 hour, if the single vehicle is only observed then the parking volume is 1 that means, we are actually matching the license plate saying whether the same vehicle or not, if it is the same vehicle we do not count it multiple times we count it only once.

So, that is what I said distinct vehicle, total number of distinct vehicles parked in a parking bay. Day wise also we can get parking volume, always it will be either 0 or you know, over a period of time, it could be any number depend on how many what is the duration and whether it is the same vehicle that is parked or different vehicles are parked. Similarly, this can also be

considered for the whole parking area, maybe you have 50 parking places altogether. So, we can say what is the parking volume over a period of time.

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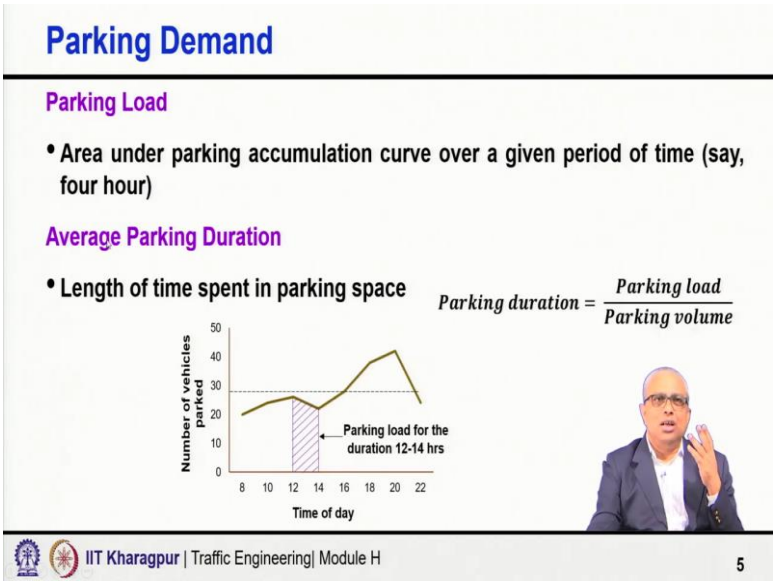

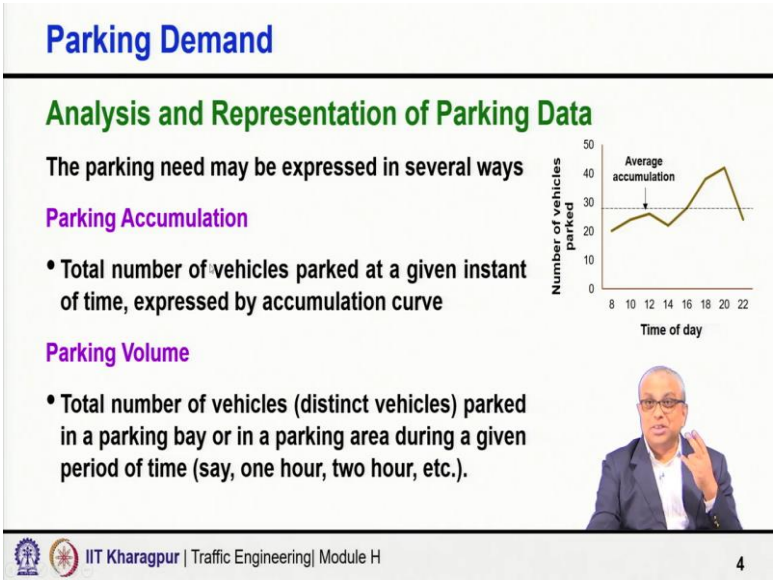

Third, Parking Load, parking load is the area under the parking accumulation curve over a given period of time as I said for a given instant say at 12 o'clock, how many vehicles are parked 13 hour how many vehicles are parked 14 hour how many vehicles are parked. So, if I consider the time duration between 12 to 14 hours, this 2-hour period, then what is the area under this curve, curve means where x axis is the hour or time of the day and y is the number of vehicles parked. That is nothing but parking accumulation not the parking volume it is the parking accumulation.

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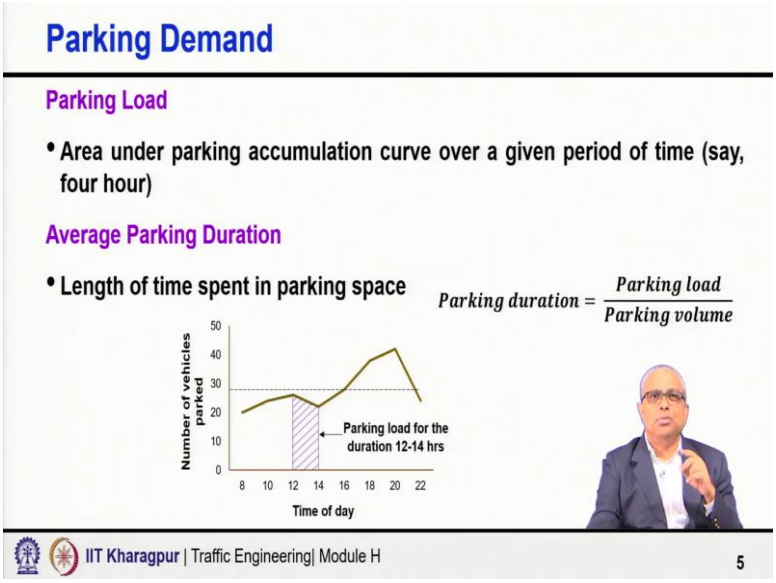

So, what we have this area under this curve that we are saying is the parking load. So, area under parking accumulation curve over a given period of time. In this case, what I have shown it in the figure is the 2 hour. Third, Average Parking Duration you can guess. I am sure you have already guessed how you can get it how you can get it average parking duration this area that says the parking load parking load is nothing but this area divided by parking volume, divided by the parking volume, how many vehicles distinct vehicles are there, we say they are distinct vehicle parking volume. So, length of time spent in parking space. So, total vehicle hour this much and you have this many distinct vehicles which have contributed to this vehicle hour or vehicles minute then what is the parking duration. So, parking load divided by parking volume fine.

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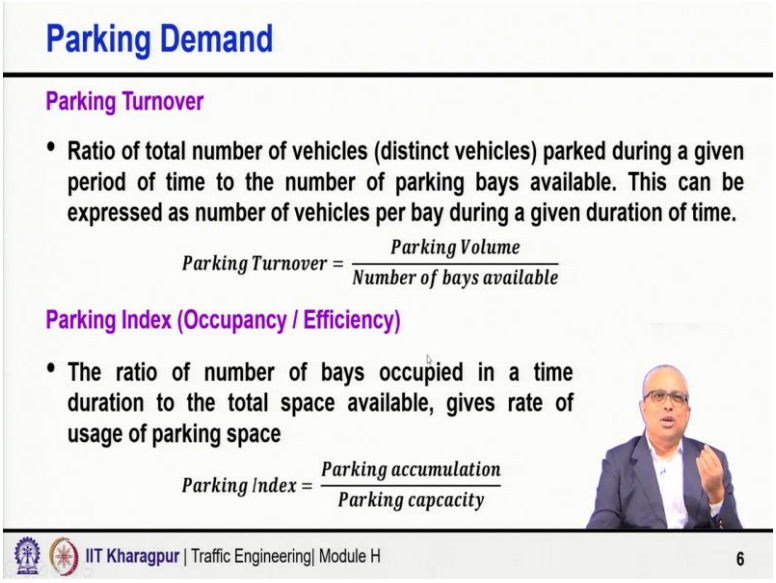

Next Parking Turnover, it is the ratio of the total number of vehicles again distinct vehicles parked during a given period of time which is nothing but we are essentially talking about parking volume distinct vehicles over a period of time to the number of parking bays. So, what is the parking volume how many vehicles have parked divided by how many number of bays are available? That is the turnover.

So, per bay how many vehicle are using how many vehicle is using that parking bay average on an average every bay is used by how many vehicles during this period of time given a given duration of time. You take 2 hours, 3 hours, 4 hour, 5 hours, whatever maybe 8 hours. So, during this period of time, what how many vehicles on an average is parked, distinct vehicle per bay. Now, for a given parking bay also we can carry out the turnover. And then for the overall parking area considering all the bays what is the average parking turnover that also we can carry out. Next going to the parking index, you can call it occupancy or efficiency.

It is the ratio of the number of bays occupied in a time duration at a given time at a given time duration at an instant of time, how many number of bays are occupied to the space available that gives the rate of usage of parking space that means, at a given instant of time, what is your parking capacity that means, how many bays are there and what is your parking accumulation that means, how many vehicles are parked at a given instant of time.

So, how many vehicles are parked means, that many parking bays are actually occupied divided by how many total parking bays is available that gives me the parking index or occupancy or efficiency fine. So, you have got a clear understanding of all these basic terms or terminologies.

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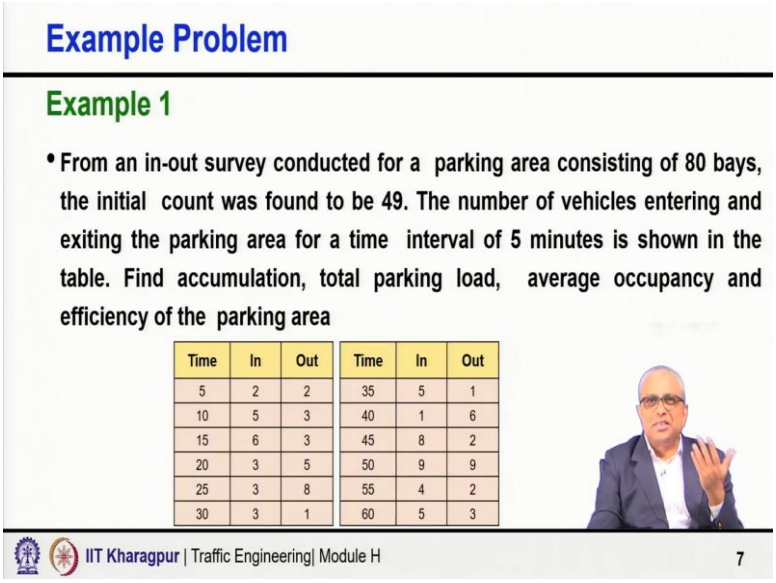

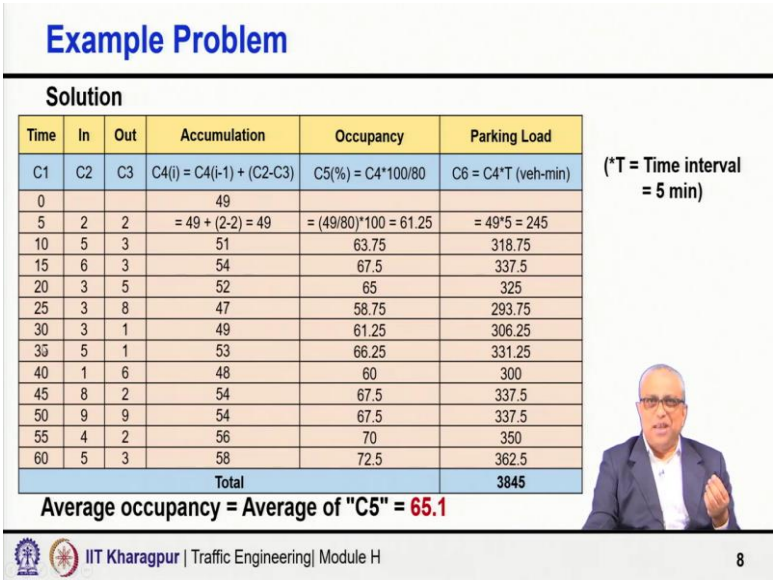

With this, let us take 2 example problems first is form an in-out survey conducted for the parking area consisting of 80 bays. So, you have actually 80 bays available in the parking area parking facility and when you started working, the initial count was found to be 49. It happens I started the work at maybe 9 o'clock already some vehicles are parked in the parking lot.

In early morning also sometimes, we will get vehicles parked which are parked overnight, the number may not be as high as 49. But some 5, 10 vehicles may be parked overnight also. Whatever it is, so, when we started the work, that is our 0, time clock is 0 there were 49 vehicles parked and then the number of vehicles entering and exiting parking area during a time interval of 5 minute all the subsequent intervals is shown in the table.

What do we need to find out we need to find out accumulation total parking load average occupancy and efficiency of the parking area overall, so the time wise we started at time 0 that is 49 vehicles were there. then during this 5 minute 2 vehicles went in 2 vehicles went out, next 5 minutes, 5 to 10 minutes, 5 vehicle went in, 3 vehicle went out, next between 10 to 15 minutes, 6 vehicle went in 3 vehicle went out, that is the interpretation.

So, with this I have created some columns here. So, C1 is the time clock in and out values are given these 3 are inputs, 4, 5 and 6 we are calculating what is 4 we are trying to calculate the accumulation. Accumulation is what at 0 we had 49 vehicle then after 5 minutes exactly after 5 minutes, when the clock is at 5 minute. How many what is the accumulation, accumulation is 49+2 vehicle entered, so plus C2-2 vehicle went out minus 2. So, it is 49. Similarly, next one exactly at 10 minute, what is the accumulation 49+5, 54-3 went out 51. Like that you can calculate each and every cell. So, you can calculate the accumulation at 0, 49, 5 minute 49, 10 minute 51, 15 minute 54 you know.

Next is the occupancy. What is the occupancy? My I have an 80 bays? So, at time 0, 49 are there. Let us calculate it 5 minutes onwards. So, at exactly at 5 minutes, how many are there 49. So, (49/80)*100 because we are expressing it in percentage. So, you have 80 bays that is what is told. So, if a 49/100, 61.25 percent. That is one is the occupancy, 10 minute 51 divided by 80 into 100, like that you can calculate.

Then the parking load we are saying. So, area under the parking accumulation curve over a given period of time. So, what is the parking load? Parking load is here 49 vehicles let us assume into 5 minutes duration is 5 minutes. Similarly, 51 vehicle into 5 minute. So, it is like C4 this one into time interval T that is what is the accumulation.

So, what is the vehicle minute. How many vehicle, what is the minute. You have 49 vehicle into 5 minutes. So, that way you can get the parking load. Now, what is the average occupancy is the average of the C5 column we know that 0 time what is the 5 minute clock what is the 10 minute what is the occupancy? 15 minute what is the occupancy? So, what is the average occupancy average of all these values that is about 65.1? What is the total parking load during this area, during this entire period of 1 hour 60 minutes, 1-hour sum of these. So, you can calculate the parking load occupancy accumulation everything you are getting and average occupancy also.

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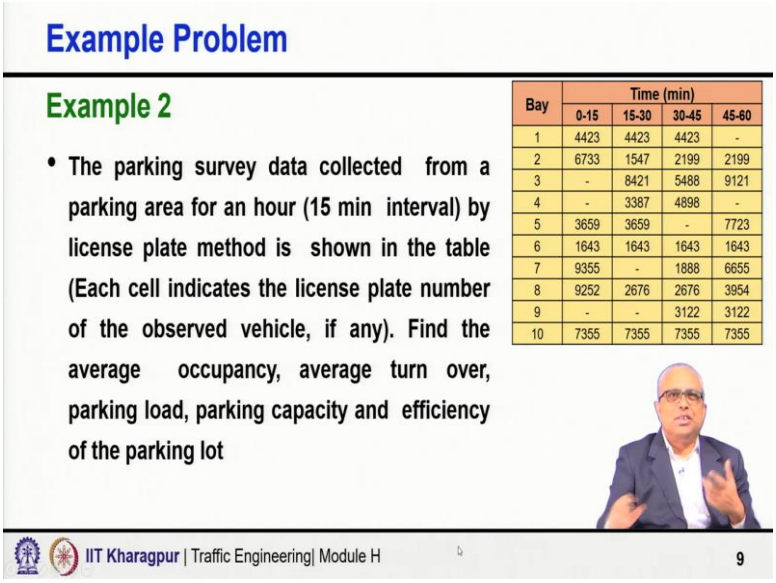

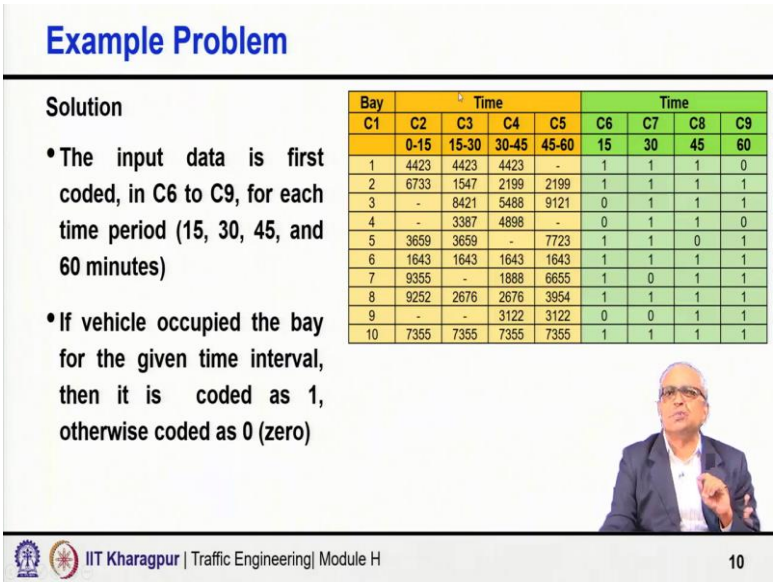

Now, let us take another example, the parking survey data collected from a parking area for an hour that is 15-minute interval by License Plate Method is shown in that table. So, each cell indicates the license plate number of the observed vehicle, if there is a vehicle. Find the average occupancy, average turnover, parking load, parking occupancy and efficiency of the parking lot.

So, what I say let us say bay 1, 0 to 15 minutes when you have taken the beat you found a vehicle was parked the registration number is last 4 digit 4423, then in 15 to 30 minute you make one more beat and you find the same 4423, 30 to 45 minutes again you make a beat, you find a vehicle and it is the same vehicle then 45 to 60 in that fourth bit you do not get the vehicle. So, like that 2 here you get a vehicle next beat you get a different vehicle it is a vehicle

but different vehicle, third again a different vehicle, but third and fourth, you beat you get the same vehicle.

So, like that it is given. So, let us extend it you have C1, C2, C3, C4, C5 these are the columns which are giving as input. Now, I am creating 4 more columns say C6, C7, C8 and C9, what I am saying, I am saying I will put 1 if a vehicle is found in that parking bay, if there is no vehicle Park then it is 0.

So, wherever I noted the registration number in all those cases a vehicle was parked. So, make all those such 1, wherever there are empty nothing is mentioned that means no vehicle was observed. So, make it 0 simple. So, I get every 15, 30, 45 and 60 minute suppose that just at this time I have taken the beat. So, you get these values.

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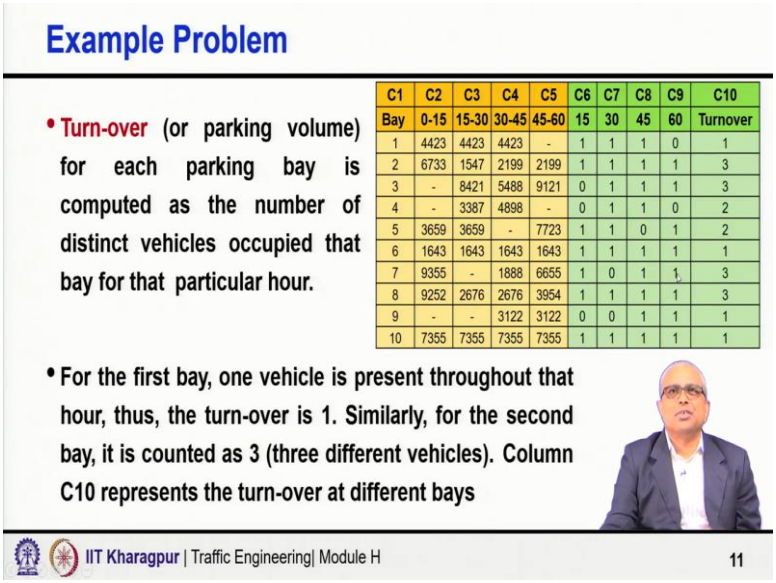
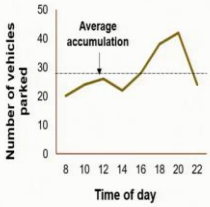


Parking Demand

Analysis and Representation of Parking Data

The parking need may be expressed in several ways



Parking Accumulation

- Total number of vehicles parked at a given instant of time, expressed by accumulation curve

Parking Volume

- Total number of vehicles (distinct vehicles) parked in a parking bay or in a parking area during a given period of time (say, one hour, two hour, etc.).

Parking Demand

Parking Turnover

- Ratio of total number of vehicles (distinct vehicles) parked during a given period of time to the number of parking bays available. This can be expressed as number of vehicles per bay during a given duration of time.

$$Parking\ Turnover = \frac{Parking\ Volume}{Number\ of\ bays\ available}$$

Parking Index (Occupancy / Efficiency)

- The ratio of number of bays occupied in a time duration to the total space available, gives rate of usage of parking space

$$Parking\ Index = \frac{Parking\ accumulation}{Parking\ capcacity}$$

Example Problem

- Parking volume for the parking area (i.e. all 10 bays together) = Sum of the turn over in all the bays (sum of column C10) = 20 vehicles
- Parking accumulation is the total of number of vehicles parked in the parking area (i.e. bays 1 to 10) for a time interval or instant of time
- For example, accumulation for first 15-minute time interval is given by the sum of column C6 = 7

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Bay	0-15	15-30	30-45	45-60	15	30	45	60	Turnover
1	4423	4423	4423	-	1	1	1	0	1
2	6733	1547	2199	2199	1	1	1	1	3
3	-	8421	5488	9121	0	1	1	1	3
4	-	3387	4898	-	0	1	1	0	2
5	3659	3659	-	7723	1	1	0	1	2
6	1643	1643	1643	1643	1	1	1	1	1
7	9355	-	1888	6655	1	0	1	1	3
8	9252	2676	2676	3954	1	1	1	1	3
9	-	-	3122	3122	0	0	1	1	1
10	7355	7355	7355	7355	1	1	1	1	1
Accumulation					7	8	9	8	20

Next, I create 1 more column C10 which I want to say the turnover, turnover or you can call it parking volume since I am calculating it per bay, every bay separately now. So, that means whatever is the parking volume, if only 1 vehicle is utilized, it is 1, if 2 vehicles utilize 2, if 3 vehicle have utilized then it is 3 and it is only per bay.

So, turnover or parking volume both are same. Remember that when I said about parking volume, I said that total number of vehicles parked in a parking bay or in a parking area. So, if we are measuring it in a parking volume parking bay, then it is same as actually parking turnover because parking volume divided by number of it is one bay only have observed in the whole area if we are doing we have number of bays then I have to volume divided by number of beats.

So, here every parking bay, I am then calculating. So, turnover I am getting. So, the first case you can see it is one only the same vehicle was found thrice, once no vehicle so the turnover is 1, second case 3 distinct vehicles, actually used this parking bay over this 1 hour. So, number is 3 in this case again 3 distinct vehicles, so 3 and so on. So, you get the turnover.

Next, we want to get the parking volume for the parking area overall area what will be that, that means all 10 bays together, all 10 bays together during this 1 hour how many distinct vehicles has used this overall parking area how I can get it, simply I can add these turnovers for each bay first bay is used by 1 distinct vehicle, 3 is use 2 is used by 3 distinct vehicles. So, I can add so, I can get 20.

Now, parking accumulation is the total number of vehicles parked in the parking area considering bay 1 to bay 10, that is what is the parking accumulation at a given instant of time how many vehicles are parked. So, how I can get at 15 minutes just take 15 minute suppose how many vehicles are parked add all this column if there is a vehicle parked it is 1 otherwise 0. So, I have 7 vehicle parked. So, my parking accumulation in the parking area entire thing I am getting first 15 minute intervals 7, second 15 minute 8, third 15 minutes 9, fourth 15 minute 8 vehicle, so like that I can calculate.

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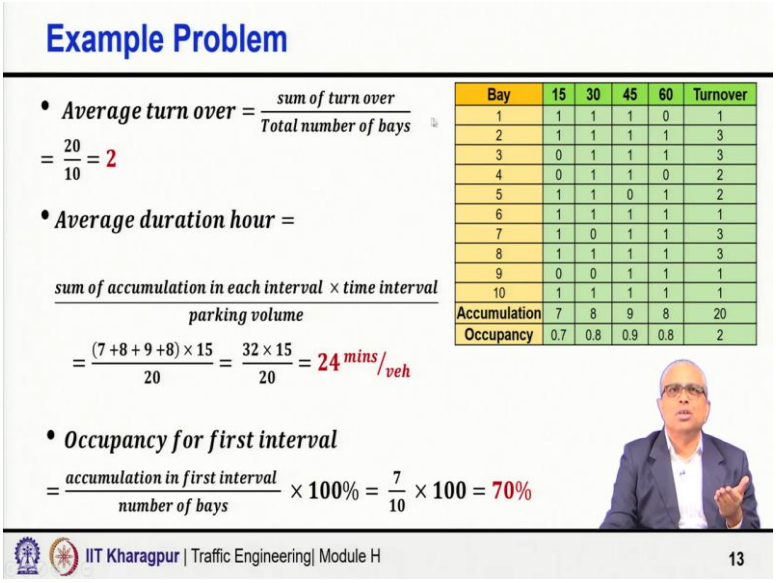

So, what is the average turnover, sum of turnover divided by total number of bays. What is the total turnover 20, 20 distinct vehicle has used it. How many bays I have, I have 10 bays. So, what is the average turnover 20/2. What is the average duration hour? It is you know 7 plus 8 +9+8 and each case the duration is 15 minute.

So, total multiplied by 15 minute that may vehicle minute divided by how many distinct vehicle, 20 distinct vehicle, sum of turnover or accumulation, sum of turnover not accumulation, but some of turnover or it is you can call it as parking volume. So, that that gives you then this 24 minutes per vehicle. So, on an average 24 minutes this distinct 20 vehicles are parked on an average for 20 minutes. Now, what is the occupancy for the first interval, first interval I have 7 vehicles I have 10 parking bays so (7/10)×100=70 percent. Second case occupancy 80 percent 90 percent again 80 percent as you are seeing here.

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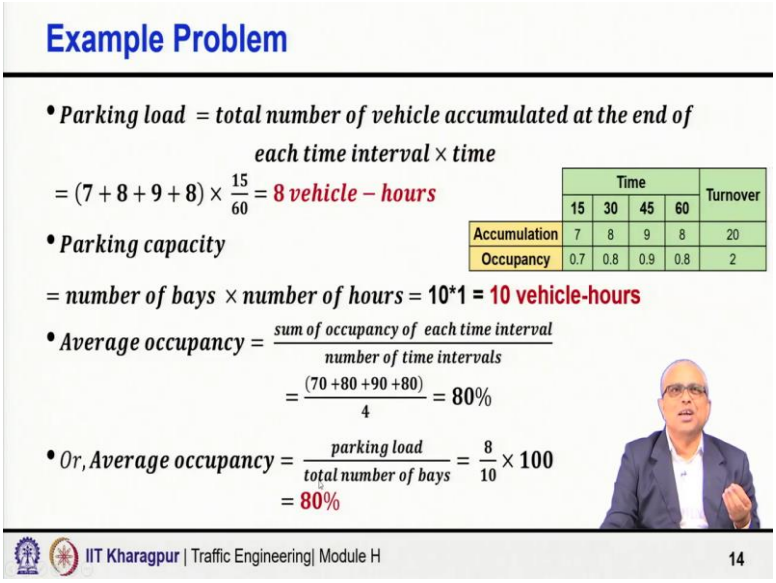

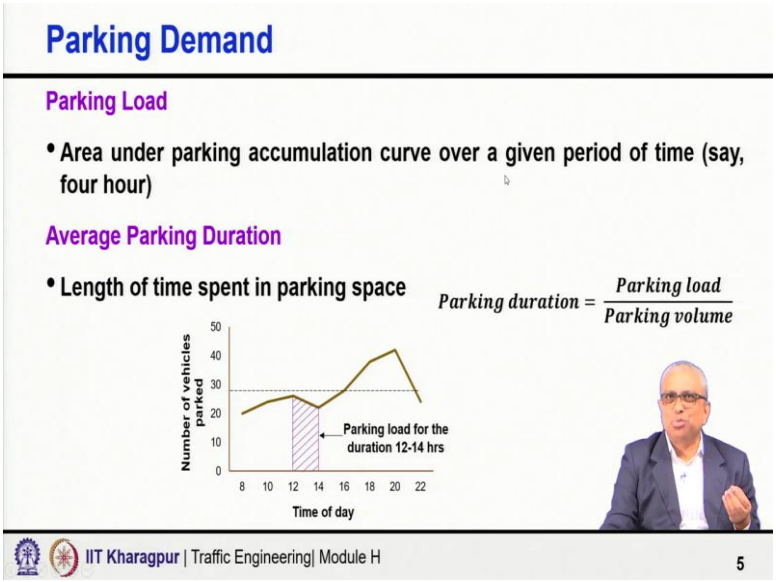

So, what is the parking load then total number of vehicle accumulated at the end of each time multiplied by time, that is what is the parking load. So, go back see again the definition if you have any confusion area under the parking accumulation curve over a given period of time. So, here my given period of time. So, 1 hour 7 into 15 plus 8 into 15 and divided by 60. Because we are expressing it in terms of vehicle hours.

So, what is the parking capacity number of bays into number of hours, I have 10 bays and I have 1 hour so 10 vehicle-hours is my capacity, what is my average occupancy sum of the occupancy this we can get it in 2 ways. You can one way calculate the sum of occupancy is of each time interval. So, 70, 80, 90 plus 80 divided by 4. So, average occupancy is 80 percent. You got here the occupancy separately we have calculated and average occupancy or you can

calculate it based on the parking load, divided by total number of parking bay. What is the average parking load? 8 and what is the total number of bays 10 that way also you can calculate both ways you can calculate.

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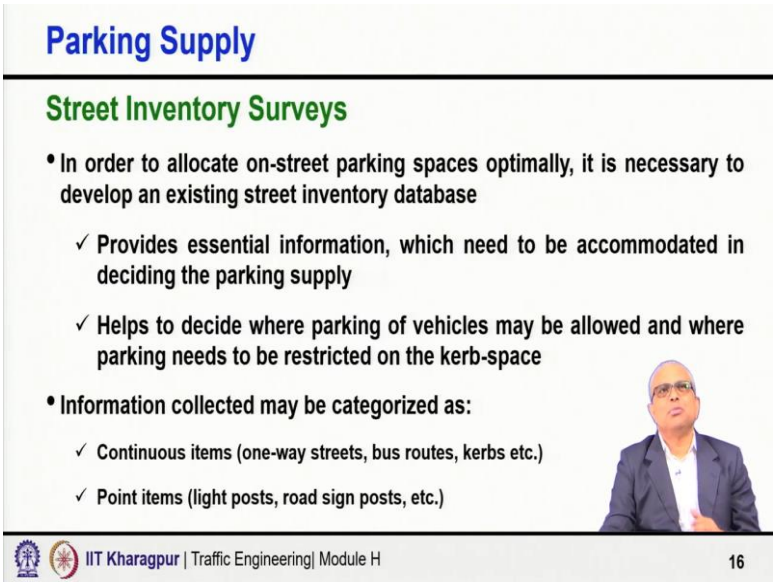

Now going to the next part that is the Parking Supply. So, demand part is done. Now going to the supply for supply, often it is useful to have street inventory survey, if you have a readily available map with every detailed information as it is in the field, then you probably do not need it, but rarely you will have such map, you will have a map showing the road showing the building, grossly showing the feature, but often the map will not be updated.

So, what you have to do you have to actually do a street inventory survey to get an updated map of the area streets particularly an adjoining area as realistic as possible, because that itself

is going to be used for deciding to parking supply. So, in order to allocate on street parking spaces optimally it is necessary to develop an existing street inventory database and which actually provides essential information which need to be accommodated in deciding the parking supply. Where I want to, where I can allow parking. The whole kerb length in the area I cannot occupy with parking.

So, I must know what is there where, so many features, I will come to the next slide. And all these actually help to decide where parking of vehicles may be allowed and where parking needs to be restricted on the kerb space. That is very vital to decide actually the supply how many on street vehicles I can accommodate or how many vehicles can be parked on street. Often this information is collected or the information which are collected may be categorized in 2 groups, continuous item, point items, continuous items means which are actually likely to be continuous and point item is very location specific.

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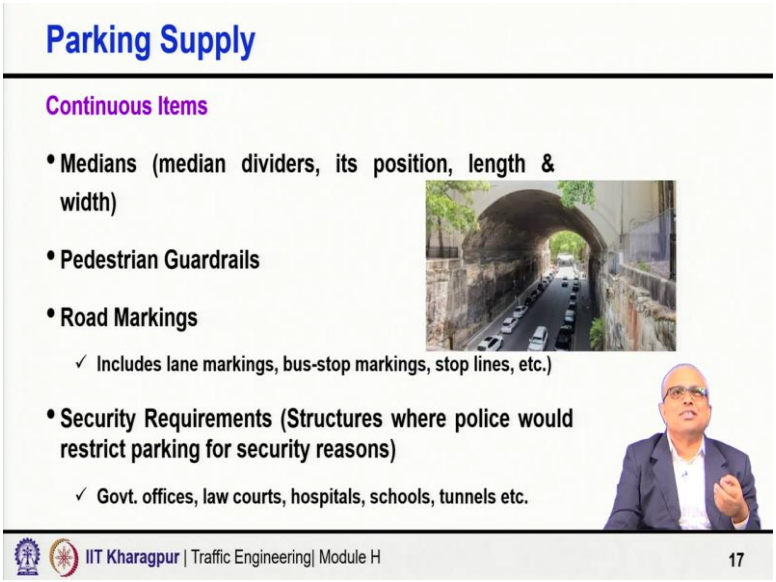

Let us see an example of some of the continuous items or medians somewhere the median maybe there somewhere it may not be there. So, you will say where to where the median is there how much is the need and where the median opening is there and where there is no median it may be an undivided road vehicle can take turn in an unruly situation anywhere and everywhere they want, where the pedestrian guardrails are there, that is the location where you know the pedestrians will not cross here, because the guardrail is present.

So, road markings provide very useful information, because somewhere you know where existing parking is there, where the bus stop is there, where the stop line exactly is located, in

front of pedestrian crossing or in front of a traffic signal or intersection. So, all these precise things you can get for this one, then the security also could be longitudinal. So, continuous also it could be. Security requirements, where you know, many cases, you know that existing regulation is there, there is a police post, you will know that nobody for security is there, nobody will allow parking near the police force.

So, you must know where the police post is located or some sensitive government building the ministry. Secretariat is there, a very sensitive area, you know, that it needs to be under located or marked, so that I do not allow parking there. I do not allocate parking there. So, these are some of the examples you see, you know, it is very difficult to make all such thing exhaustive. So, I am only giving some kind of indication.

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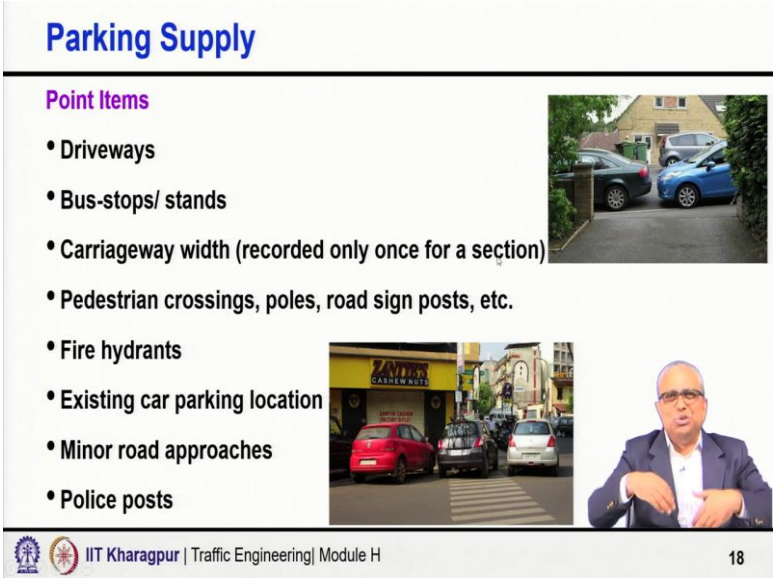

Then number of point items where are the driveways because you cannot block these places where the bus stops are located. What is the available carriageway width, carriageway width point item wise I have said because we are recording it only once. You do not really record it every 2 meter or every 10 meter or 5 meter wherever there is a significant change, you will record it again.

But others ways may be for a given segment or section of a road, you will probably measure it only once, then where the fire hydrants are located. I must know I must have this all this information on my map, then existing carpark locations where the parking is allowed, how the traffic is operating with that. Then minor road approaches where are the police post because police post is there so I will not try to block in front of the road in front of the police post.

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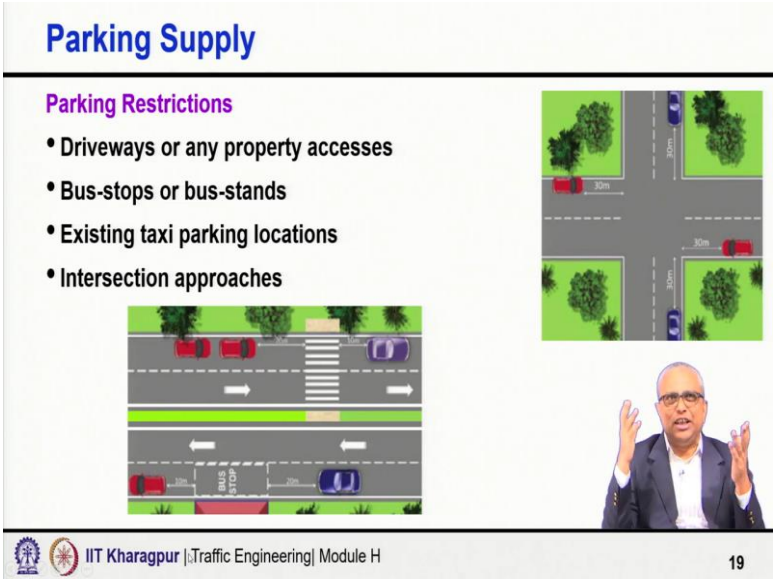

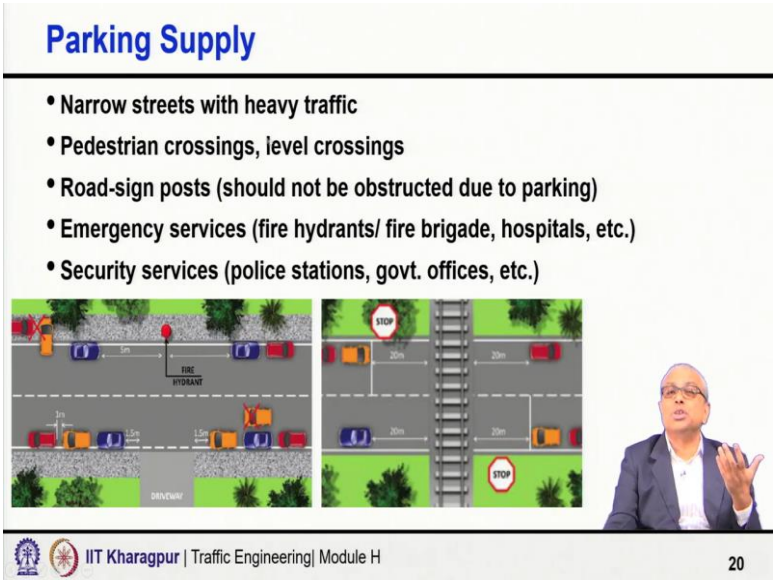

So, these are again indicating then how this get all these features come back, you update your base map, now you have more or less a realistic representation captured in your map base map. So, you know the total kerb length, everything what is available, and where all these things are located where what it is.

So, now what we will do, we have to identify where we cannot allow parking. So, for example, parking restriction driveways or any property access you cannot block and not only that road, but some length also on both sides, so that the turning and when the vehicle is coming out from the driveways or property that should not be any safety issue.

So, you once you know that these are the actual width of the driveway plus some distance always that this some distance I am not going to tell every time say bus stops bus stands we

cannot allow parking also some areas before and after that. Same existing taxi parking location because that is dedicated for taxi.

Intersection approaches you cannot allow parking I have looked at the sketches I have indicated some of the values but I do not want to be too much particular about these values because there are many guidelines where some guidelines may say some value some other guidelines may say some other value.

So, wherever you are working in the country specific context or the local context, whatever is acceptable or what the guideline says accordingly you can follow but these are the locations, I have here the 30 meter from the intersections till that area I cannot park. So, wherever there is an intersection up to 30meter tarp I will mark as red that means I cannot park. Wherever there is an access road I will park red.

Intersection approaches pedestrian crossings I will mark as red and before and after pedestrian crossing there is a bus stop. So, maybe before 20 meter and after 10 meter, why 20 by 10 there is a reason also, a vehicle is, bus is approaching so it is in a motion, so, it will take longer time to actually place the vehicle inside, when it is coming out it starts from 0.

So, relatively shorter length it can come back. So, 20 meter and 10 meter plus the length of the bus stop. So, all these are areas, say narrow streets with heavy traffic, traffic consideration from the point of traffic consideration you reject it. Pedestrian crossing, level crossing sometimes within the city area also the level crossing could be there if not ignore it. Signpost, road signposts particularly, the basic issue is that signposts park should not be obstructed due to parking. So, I cannot allow parking, which will likely to which may obstruct the signpost.

Then emergency services, fire hydrants, fire brigade offices, hospitals, then all places which we should not allow parking due to security reason police station, important government offices like this as a secretariat or the ministries all the ministers are sitting there are high profile people are sitting there and you know for the security reason you will not allow any vehicle to be left unoccupied or unattended around that. So, all these are there. So, again, it is very difficult to make such thing exhaustive, but these are only indicative I am trying to tell you that how you should move.

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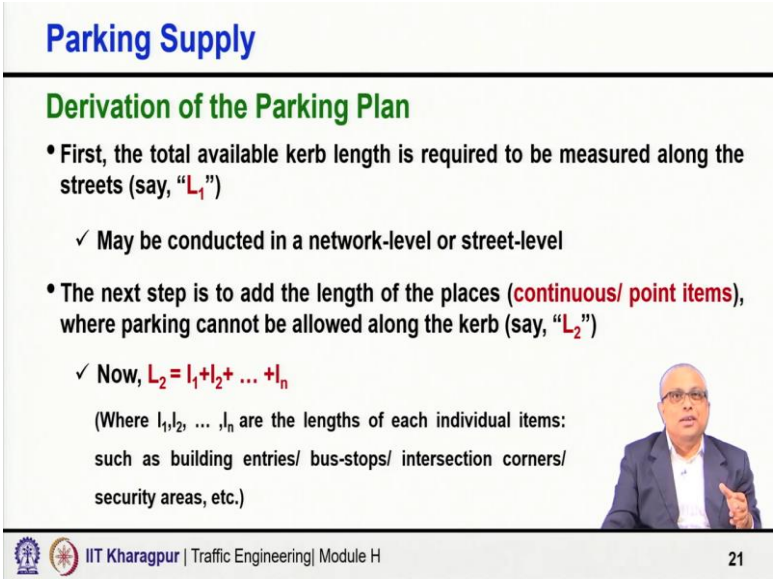

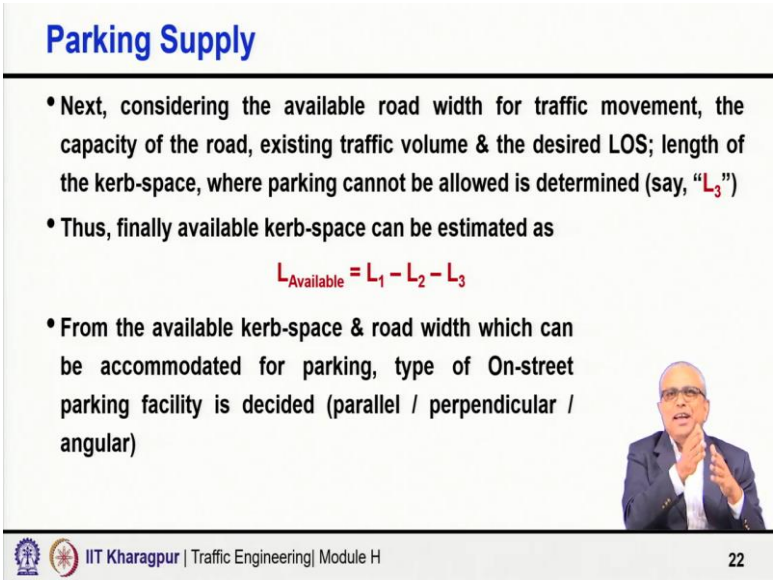

Then the revision of the parking plan first, I know from my bays map total how much kerb length is available then I know where I cannot allow on street parking other than traffic consideration. So, delete those, maybe building entries bus stops intersection corner, security reason, fire hydrant and all such minus, minus, minus, minus. So, all accumulating maybe L2. So, what I have left with, I have left with L1 minus L2 length of the kerb.

Then consider the traffic part. Now these are the kerb length irrespective of the traffic you cannot allow parking, remaining all other places shall we allow parking everywhere? No, you cannot do that. You have to look at the traffic volume. So, how much is the traffic volume? What is your desired level of service? What is the priority of that road? Whether it is a major

arterial whether it is a collector street or you know what is the actually intended and actual use of the road? How much is acceptable?

And if you occupied the place with parking then weather you will have enough it is a 1-way street or a 2-way street. See if it is 2-way street obviously, I would like to keep a minimum of 7 meter irrespective of the traffic volume, if it is 1-way street maybe still around, I will like to keep at least 5 meter if there is not much of commercial vehicles considering the cars, your 1 car is you know, there is a breakdown still the flow should happen all such consideration and bring the traffic consideration.

So, with traffic consideration maybe another L3 length of the kerb is gone, some of the routes you will not allow parking. So, then my available thing is L1 minus L2 minus L3 this is the car space that is available for me for parking, then I have to decide what kind of parking I will allow should I allow parallel parking, shall I allow perpendicular parking or go somewhere in between Angular parking 30-degree, 40-degree, 60-degree all these kinds of things that you have to decide. Why? each has got a different implication if you are allowing parallel parking least you are encroaching the carriageway, but you can less number of vehicles you can accommodate over a given length of road.

If it is perpendicular maximum number of vehicles you can accommodate for a given kerb length, but you are also maximum encroachment you are doing for the existing carriageway. So, the through traffic has to suffer both. So, it has to be all decided judiciously looking at the existing traffic volume existing how much is the width of the carriageway shoulder altogether and what kind of parking arrangement will be acceptable for it will not have serious detrimental effect on the moving traffic stream and also have to look at the demand, sometimes the alternative is not available, what you will do you have to accommodate a little bit maybe you as an when you improve the other public transport and other alternative facilities, then you slowly tune it up reduce the angle and make less parking space available social acceptability of whole what you are trying to do, many things are important.

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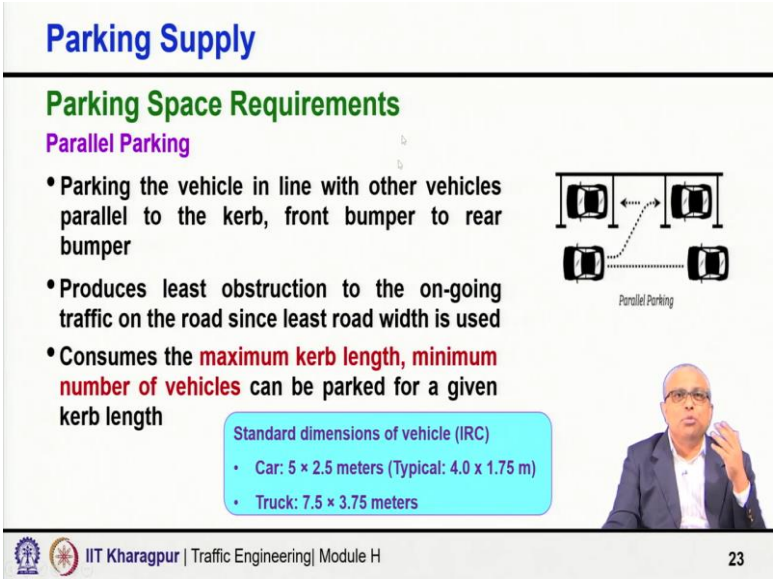

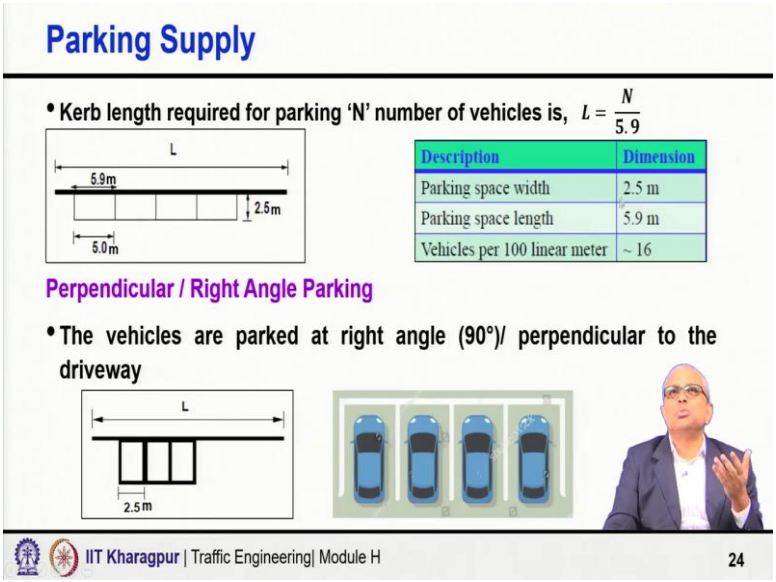

And here I have trying to show the parking space requirement what I told arrangement wise as I am going from parallel parking, I am least encroaching, but here typically Indian Roads Congress guidelines say car dimension is taken as 5 meter by 2.5 meter, it is still with some you know some allowances because if you say typical car length, it may be around for 4.1 meter to 1.7 to 1.8 meter. So, really 2.5 meter is not the width of the car, typically the car width is formatted to 1.75 meter.

So, here my objective is not to give you specification you have to follow the corresponding wherever you will work what is acceptable what is the actual traffic you may follow Indian condition you will follow IRC guideline you may also little bit deviate as per of the context

and take an appropriate thing with justification of course, because everywhere for parallel parking I really do not need 2.5 meter.

You can even parallel parking 2 meter will be sufficient. But if it is perpendicular or angular, yes 2.5 because doors will open sideways door will open in between 2 parked vehicles. So, you have to keep more gap and here also to keep the safety because you open that thing it should not hit with that it should not crash cars crash because the moving traffic stream will be there.

So, all those considerations will be there. So, if it is the size of the vehicle, then suppose it says that what should be the parking bay dimension 2.5 meter by 5.9 meter. You can sometimes go up to a little lesser 5.5 also, you can go, where the predominant small cars are there and this instead of 2.5 you can go up to 2 meter also, I personally think so, we can we can take it up, but if you want to very (39:23) follow a given guideline and that is required follow that.

But local context also it is something because you know we have serious shortage shortfall is severe. So, whatever we can accept without compromising to safety, we should be able to accommodate, but it should not be unrealistic justification is very important. Then if you go to perpendicular then as you say that if you are using parallel parking, then the length L equal to N by 5.9. So, I know how many approximately 100 linear meters you can accommodate maybe 16 vehicle. So, here I have showed if it is perpendicular parking in a given length, you will be able to apply much more.

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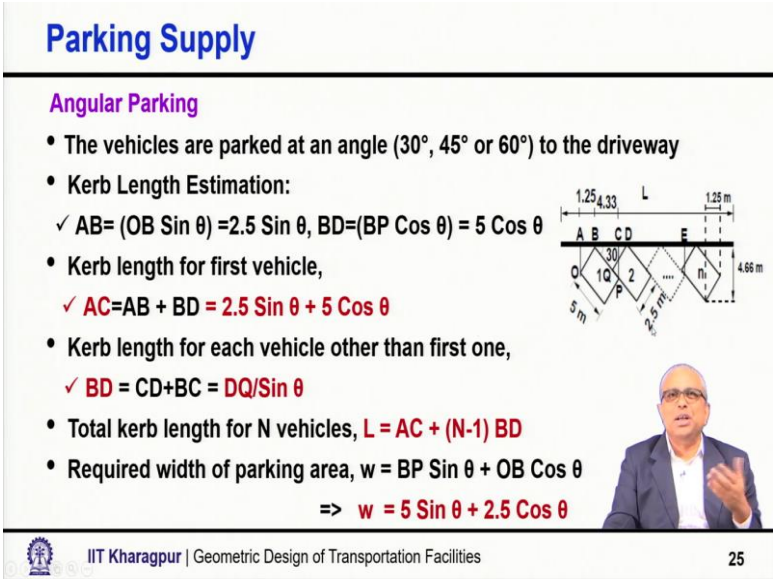

And these are the angular parking what is depending on the angle 30 degrees, 60 degree these are very simple calculation I need not explain it, I have given it in the slide please go through

it you can calculate actually then what is the total Kerb length and what is the width of the parking area that means, how much, what will be the L and what will be the width, this is the one effectively in the last part of the corner of the vehicle body. How much total carriageway and the shoulder altogether how much width from the kerb I am actually occupying.

So, obviously, this will be higher for highest for perpendicular parking and different level of Angular parking and least it will be for the parallel parking, but as I say the number of vehicles which you can accommodate will always be higher as you go from parallel to Angular and did change the angle and eventually go make it 90 degree you can accommodate maximum number of vehicle.

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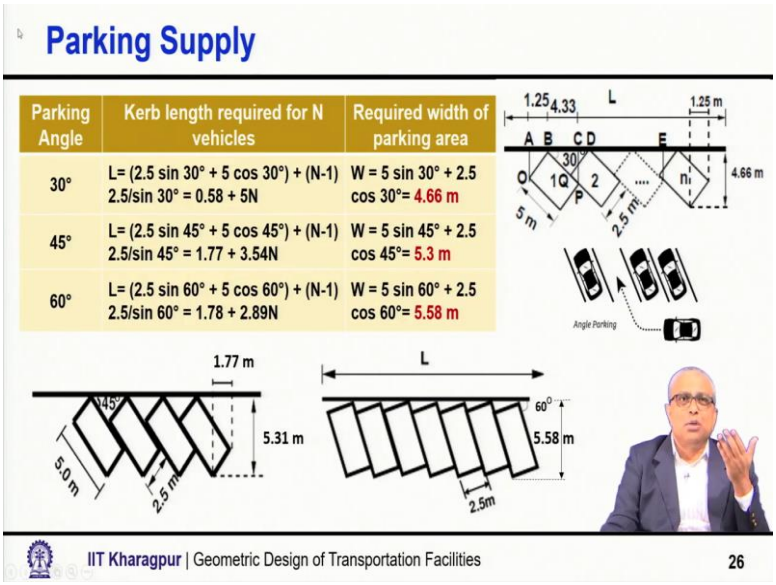

So, these are basically the shown based on this equation simple equation you can understand that what is the kerb length required for N vehicles and what is the required width of the parking area width is this one. So, for example, you use the simple equation and you can get it if it is 30degree parking angle then you would require 4.66 meter here.

Now, as you go to 45degree angle, you will require 5.3 meter you know higher because, we have change the angle, if you go to 60 degree angle you even need higher 5.58 meter. So, you have to think what will be the implications, should I take 2 meter or 2.5 meter, can I take or can I take 4.6 meter, can I take 5.3 meter can I take 5.6 meter then the remaining space how much is the volume, how what will be the impact whether that is acceptable all these considerations here to do and decide then how much parking you can allow.

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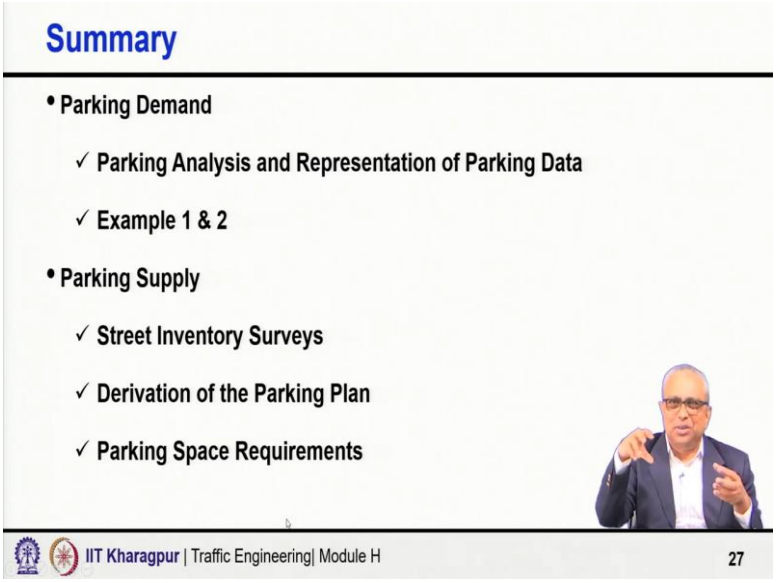

So, altogether what we discussed here about the parking demand part particularly the service part I discussed in an earlier lecture this lecture, I talked about the analysis and representation of the parking data and took 2 example problems to show you how you can do simple calculation but meaningful methods meaningful quantities interpretations and then how to decide the parking supply.

Why we do the street inventory survey what we try to get out of it, prepared basically try to prepare a bays map which is realistic and then how deciding we can decide the parking supply or derive the parking plan and then also mentioned to you finally the parking requirements depending on parallel angular or perpendicular how the space requirements are going to change. So, with this I close this lecture, thank you so much.