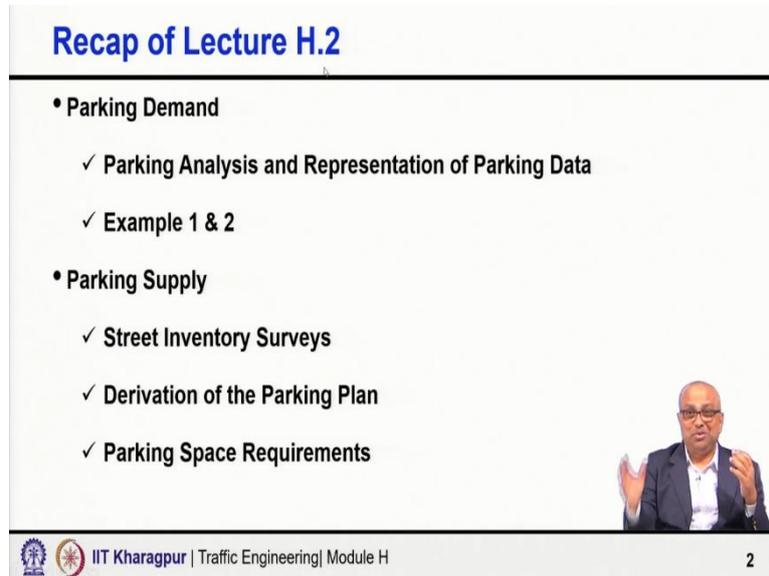


**Traffic Engineering**  
**Professor Bhargab Maitra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kharagpur**  
**Lecture 58**  
**Parking Management Unit – III**

(Refer Slide Time: 0:23)



The slide is titled "Recap of Lecture H.2" in blue text. It contains a bulleted list of topics covered in the lecture. The first main bullet is "Parking Demand", which includes "Parking Analysis and Representation of Parking Data" and "Example 1 & 2". The second main bullet is "Parking Supply", which includes "Street Inventory Surveys", "Derivation of the Parking Plan", and "Parking Space Requirements". In the bottom right corner of the slide, there is a small video inset showing Professor Bhargab Maitra speaking. At the bottom of the slide, there is a footer with the IIT Kharagpur logo, the text "IIT Kharagpur | Traffic Engineering | Module H", and the number "2".

- Parking Demand
  - ✓ Parking Analysis and Representation of Parking Data
  - ✓ Example 1 & 2
- Parking Supply
  - ✓ Street Inventory Surveys
  - ✓ Derivation of the Parking Plan
  - ✓ Parking Space Requirements

Welcome to Module H, lecture 3. In this lecture, we shall continue our discussion about the Parking Management. Previously, we discussed about how to measure the parking demand, what all field works, field service we can do, parking occupancy survey, parking beat survey, and then how to estimate the parking supply doing the street inventory, then how to derive the parking plan, where we cannot allow parking, and then remaining considering the traffic considerations, how and also looking at the parking space requirement, how you decide that how much supply is really reasonable.

So, without compromising safety, without significant impact on the capacity of available for the moving traffic, without compromising the safety, without compromising the security, how much rationally we can accommodate? Now, with that background, we have demand, we know how much is the demand, we know how much we can accommodate.

(Refer Slide Time: 01:33)

The top slide is a title slide with the text "Parking Management" in blue. Below the title is a small video inset of a man in a suit speaking. At the bottom of the slide, there are logos for IIT Kharagpur and the text "IIT Kharagpur | Traffic Engineering | Module H" and the number "3".

The bottom slide is a flowchart titled "Parking Management Strategies & Measures". The flowchart starts with a decision diamond: "Is supply  $\geq$  demand?". If "Yes", it leads to a box "No intervention required". If "No", it leads to a box "Restrict parking based on duration". From "Restrict parking based on duration", it branches into two decision diamonds: "On-street supply  $\geq$  Short duration demand?" and "Off-street supply  $\geq$  long duration demand?". If "On-street supply  $\geq$  Short duration demand?" is "Yes", it leads to "Assign to On-street facility". If "No", it leads to "Adopt suitable policy for parking demand management". If "Off-street supply  $\geq$  long duration demand?" is "Yes", it leads to "Assign to Off-street facility". If "No", it leads to "Develop Off-street parking Facility (OR) Adopt suitable policy for managing the demand". A video inset of the speaker is visible in the bottom right corner of the flowchart.

IIT Kharagpur | Traffic Engineering | Module H 4

Based on that, now going to the parking management, how we do the management. Here, I am representing different possibilities with the help of a simple flowchart and then try to explain you. If the supply, whatever you have worked out for a given study area is greater than equal to demand then there is no problem. Suppose, you have 5000 parking space available and your demand is 4000, no problem, just simply accommodate everything. So, no further intervention is required, only you organize, mark the base, give proper traffic signs, parking signs, people to know and go ahead, no issue.

But in most cases, existing cities, existing urban areas, Indian urban areas, where there is so much of imbalance in every aspect of transport, even in the parking area, you will find your

demand is higher than the supply, that is the case, most cases, then what you will do, then you are in this no loop.

Now, we have two possibilities, either we adopt suitable policy for parking demand management, what I mean go for pricing, I have my supply is so much my demand is higher, so I will go for pricing, I will increase the pricing, so that it acts as a deterrence and help me to bring down, my demand to match my supply, exclusively on par pricing and rigorous enforcement that is what you can do, that is this box.

Alternatively, what we can think which is also practical, very practical. That it is all about on street parking, demand and on street parking supply. We can restrict the on-street parking only for short duration parking demand that means allow on street parking, if the duration of parking is small, short duration parking. From your occupancy data and bit survey data, occupancy gives you the total demand, bit survey gives you the duration distribution, you can easily find out how much is of the total parking demand, is actually one hour, up to one-hour parking duration or 0 to 1 and 1 to 2 maximums up to 2 hours, you can think.

So, suppose you take it, that, I will allow, no more than 2 hour, depending on the land use, where this is located, what is the land use, what kind of requirements it is, so accordingly you decide, what is the duration, but idea is to promote and encourage only short term parking for the on street, why? Quite logical, if you want to stop the vehicle for a while just go to a shop buy a some small things on the way back from your office to home. You would not like to go to an off-street parking facility, park your vehicle walk for 5 minute or 10 minute and then buy some small thing for 15-20 minutes and again you go back.

Second, if I allow short-term parking the same parking space can be used by n number of people. So, with one parking space, I can satisfy the requirement of 5 people 6 people rather than one fellow coming in the morning occupying that parking bay for 6 hours or 8 hours. So, the short-term parking mostly would be by the customer, one thing you will observe who comes to the shopping, shop, first, it is the owner, so nobody will be there, so owner will come and park his vehicle in front of the shop.

Throughout the day, that parking lot is occupied, the customer will not get, let it owner will do a long-term parking, go and park the vehicle upstream, then the same place can be used by the customer who will come and will actually add to the economic activity, let them use that space, they will come and park for one hour 1 and half hour or even less than 1 hour sometimes.

So, restrict on street parking to only short duration parking, then, how much will be my short duration parking demand, I can estimate. Because I know the parking occupancy data is available parking bid survey data is available, so you can calculate on street then what will be the on-street parking supply and what will be your short duration parking demand say 1 hour or 2 hours. The remaining has to go to off street, so now I am splitting on street, off street.

Now, again I have to see, yes, I have probably taken a decision that I will allow on street parking only for short duration parking, but then is my on-street supply is greater than short duration demand. Suppose, your 4000-parking space is there and use your on-street parking demand less than that or within that, if it is so, yes, there is no problem, your problem is over. Just simply you can restrict the parking to short duration parking, not exceeding 1 hour or 2 hours as the case may be and you just need to enforce it nothing else and push everybody wants to park more than 2 hours, go to off street facility.

But here also, if it is low, suppose you have 4000 parking space and your short-term parking demand is also 5000 not 4000, then what we will do? use a gain pricing, restrict it to only 2 hours, over and above the remaining gap you can bridge by pricing, increase it. So, you have 5000 parking demand, short duration demand 5000, and your 4000 spaces, so 1000 you have to reduce, how you will reduce? Go for pricing, restrict it and then go for pricing, so adopt suitable puzzle policy for parking demand management.

Coming to the off-street supply, if you find that off street facilities, again, off street facility how much is the demand? How much is your supply available? If your supply is more than the demand, no problem, just simply assign to off street facility, job is over, demarcate it, give proper signage, information, people know it, enforce it, let people go to off street facility for long term or long duration parking, the matter is over.

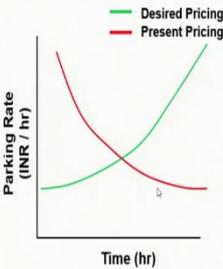
Here also it may not be so, it could be that your demand is higher than the supply, even in the off-street parking demand is higher than the supply, so what you will do? You have two possibilities. Either you develop additional off-street facility, give new off-street facility, you develop and accommodate more parking, if you can do that, fine, if not again pricing, use pricing adapt suitable policy for management of demand try to do the demand management, these are the general possibilities. We can discuss even further, but I would like to stop it here.

(Refer Slide Time: 10:48)

## Parking Management

### Pricing Policy

- Basic objective is to use pricing as an **instrument for demand management**
- On-road parking needs to be prioritized for short term parking with higher parking rates than long-term parking facilities in surface areas



IIT Kharagpur | Traffic Engineering | Module H

5

Now, I would like to say in this overall context of parking management, some of the things are very important, one and the most important thing, I cannot see the most important because everything is equally important, one of the important thing is the pricing policy, one very important thing is the pricing policy.

Now, you will find all over India, wherever you go, you have to pay for the parking, but unfortunately you do not know why you are paying, what purpose the payment is or the pricing is serving? It has become an instrument for revenue generation, nothing to do with parking management. Many cases, I cannot say in all places that will be too much, but in so many cases or many cases you will find, just it has become an instrument for revenue generation.

So, much money is getting generated, but according to me as a traffic engineer, as a transport policy person, I would always consider and like to see that we are using parking policy as an instrument for demand management. I have an imbalance, I have an imbalance between the demand and supply demand is higher, supply is less, so I want to do pricing to bring my demand and match it to the supply, that is what is my objective.

And for that reason, if I have to charge 5 times then what is being charged now, that is fine and that can be justified also considering the impact on congestion, economic loss, environment, degradation of air quality due to congestion, all this can be justified, if you understand it correctly. So, remember that pricing, the basic objective is to do demand management.

On road pricing needs to be prioritized for short term parking, as I said, if there is an imbalance, we would like to give priority to short term parking for on street and you can also make on

street parking rates higher than the off-street parking, just as a as to give some encouragement for people that go to off-street facility you pay less, make the on street parking charges higher and off street lower, that could be a good practice, this will encourage people to go to off street facility.

The other thing what I would like to say here in this graph, you will find the parking rates, parking rate per hour. In many cases even in India, you park longer time, your per hour rate is lower, how it is done? It is done considering the public transport fare model something like that you travel longer your per kilometre travel, you are charged less.

But here it is not that of that is not the objective I do not want people to come and park for longer duration on street, so my actually desired pricing curve should be reverse as shown in the green one, that means the longer you park, you pay higher rate for every additional hour. Second hour rate should be higher than first hour, third hour rate should be even higher than second hour, fourth hour rate should be even higher than third hour, then the pricing impact will be failed, people would will not be encouraged to park longer and that is what is our objective, we do not want people to park longer.

If they park longer, let them go to off street facility, on street I do not want, so even when we do not restrict the duration or even when I am restricting the duration, in both cases, my charges should be following this principle, every subsequent hour the rate should be higher, hourly rate should be higher.

Contrary to that, most cases you will find the curve is very different, is it like am I trying to encourage them park longer I will give you cheaper rate, that is not the objective for the demand management, that is not really the objective for which the I am using pricing. Why pricing? Why somebody has to pay for parking, when there is an imbalance, so pricing is an instrument for demand management.

(Refer Slide Time: 16:03)

## Parking Management

- Elimination of free parking and introduction of effective parking charges reduces parking demands
  - ✓ Fixing of parking base price and making it variable according to peak and non-peak demand may also be done to influence demand
- **Increased parking fees alone may help to bring down on-street parking demand**
  - ✓ In this case, no restriction is imposed directly on duration of parking but parking fee becomes instrumental to bring down the overall on-street parking demand up to the required level



IIT Kharagpur | Traffic Engineering | Module H

6

Pricing can help you to eliminate, you can also do elimination of free parking because of this imbalance and introduction of effective parking charges to reduce parking demand, and as I say that you can always do, you can fix up a base price and then make it variable top up, according to peak and non-peak demand. So, base price is this one, you can decide in so many ways, like the base price is this one and then depending on congestion I will or the demand, I will keep on increasing the price parking charges.

As I said earlier, the without even restricting the on-street parking, I can only do, you know the similar kind of same thing I can achieve what I wanted to achieve is the imbalance between the demand and supply of on street parking, through effective pricing. So, increase pricing, increased purchasing parking fee alone also may help me to bring down the on-street parking demand. So, we can study the behaviour of people how much pricing will make how much deterrence and how much gap then it can you know address, it can fill up, how much gap it can fill up.

So, in this case, there may not be any restriction to directly on the duration of parking but parking fee itself becomes an instrument to bring down the overall on street parking that means you make the rate such that, you make the rate such that the longer the duration of parking every additional hour, the charges are going higher and higher and higher.

Obviously, that kind of pricing itself will push long duration parking to off street facility, so you do not have to do you know restrict it separately, just through effective pricing you can, meaningful pricing and scientific pricing based on the behaviour, you need to understand the behaviour. The effect of 10 or 20 rupees in every city in India is not same, so make 50 rupees

in Mumbai and 50 rupees in Calcutta or in Delhi or in a small town, the impact may not be same, it depends on the income average, income of people and so many other considerations. So, as per the context, you have to study the behaviour and then come out with the effective parking policy, how much pricing will be important.

(Refer Slide Time: 19:10)

## Parking Management

**Enforcement**

- Enforcement is extremely important and **primarily the responsibility of the police**
- Penalty for illegal parking is aimed to be stringent enough to be a deterrent
- The services of **traffic hosts and traffic wardens** can be effectively utilized for orderly on-street parking



IIT Kharagpur | Traffic Engineering | Module H

7

Enforcement, very very important, equally, I said that pricing is the most important thing but then immediately I remembered, enforcement is as important as actual pricing, because whatever you do, if you do not enforce and it has to be done continuously every day with the same, you know with the same level of effort you have to do enforcement, monitoring, otherwise nothing will work, you may take good policy but without enforcement people will still do, make double parking, triple parking, block the driveway, park near the bus stop, near intersection, causing safety issues, there is no point, so enforcement is equally important.

So, enforcement is extremely important and primarily it is the responsibility of the police. Remember, that penalty for illegal parking is aimed to be stringent enough to be a deterrent. If you do not give you know adequate fine, then it has to be failed, it has to act as a deterrence. If my fine is 20 rupees, probably nobody will bother, they will still come there, come and take 20 rupees. They will see like a parking charge they are paying, it should not be like that, it should be high enough, high value which can create sufficient deterrence and so that people do not park illegally in that area. The service of traffic host and traffic wardens could be effectively utilized for orderly on street parking.

(Refer Slide Time: 21:06)

## Parking Management

- Traffic hosts:
  - ✓ Address car-drivers who were looking for a parking space or parked illegally and guide them to an available parking place
  - ✓ Provide drivers with information, if needed
- This can prevent towing of vehicles parked in unauthorized manner



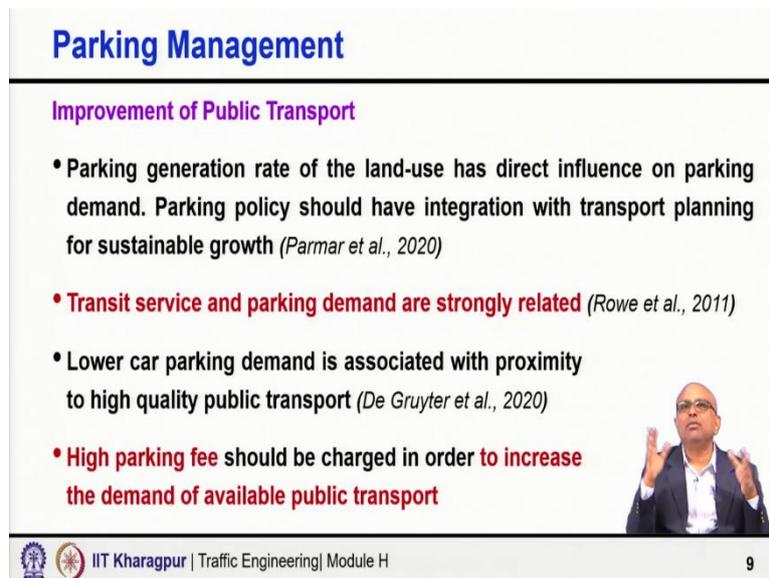
(Source: Times of India)

IIT Kharagpur | Traffic Engineering| Module H 8

Traffic host can address car drivers who are looking for a parking space or parked illegally and guide them to available parking place, they are like, we want to help you, you are looking for a parking, space, maybe you parked illegally and said, here you cannot park please go and there is a parking space where you can park or just please go to the off street facility where you can go and park, so provide necessary information also to driver and this can prevent towing of vehicles parked in an unauthorized manner.

Because ultimately remember, money generation, fund generation is not the objective, should not be the objective according to me. So, we do not want to penalized, we do not want to towing of vehicles, all what we want, we do not want anybody to park illegally in an unsafe manner, causing congestion, causing safety issues, we need to ensure that. So, traffic host on that kind of support can really be helpful.

(Refer Slide Time: 22:22)



**Parking Management**

**Improvement of Public Transport**

- Parking generation rate of the land-use has direct influence on parking demand. Parking policy should have integration with transport planning for sustainable growth (Parmar et al., 2020)
- **Transit service and parking demand are strongly related** (Rowe et al., 2011)
- Lower car parking demand is associated with proximity to high quality public transport (De Gruyter et al., 2020)
- **High parking fee should be charged in order to increase the demand of available public transport**

IIT Kharagpur | Traffic Engineering | Module H

9

Third, again equally important point, as I say every point is important. Improvement of public transport, whenever you are doing some regulation, I am saying, okay, by pricing suppose I need to bring down the overall parking demand, that means if I am not giving the parking provision, maybe using pricing or with rigorous enforcement, that means I am not allowing people, some people to come by car.

Is there any alternative for them to travel? Suppose your public transport capacity is exhausted over crowded, you go to many Indian cities the public transport is really overcrowded, so if there is no capacity left in public transport, and I am also not allowing people to come by car, because I am not giving them parking's place, then how people will travel, so I have to think in a sensible manner, in a sensible way, I have to be sensible enough.

So, improvement of public transport is extremely important when you are trying to do a proper parking management. As you are restricting the entry of vehicle in an indirect way, by pricing or by you know enforcement or so, you have to improve the public transport then only it will be successful, otherwise it will not be socially acceptable just by using deploying police, you cannot you know implement things successfully, not only police deployment is very important, because you have to enforce.

But if you do not understand the requirement, you are asking me do not eat rice, and you are not ensuring that I can eat something alternative, an alternative is available to rice, I will say you are restricting me, you are not allowing me to eat rice, but you are not allowing, where is my alternative food? Then I have to eat, I have to go to travel, I have to travel to go to work, I have business, I have work, I have to travel.

So, it is fine, you give me good public transport, and then you make the restriction that makes sense, but you are not giving public transport options, I cannot get into the bus because it is so crowded and service is so bad that I do not know sometimes, but may be available may not be available and you are forcing me you cannot go by car, it will not be acceptable socially.

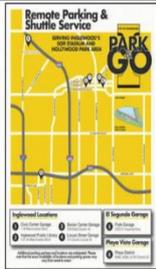
So, improvement of public transport is as important as it is important to do a balance between the demand and supply of parking. And if you find at a given time there is a high imbalance between the supply and demand, but public transport is also over crowded, maybe you do not drastically reduce the parking supply, little bit compromise and go slow, slowly bring down the parking supply, take the time to improve your public transport.

(Refer Slide Time: 25:56)

## Parking Management

### Park and Ride

- In congested areas or old city areas **'Park and ride'** policy may be helpful
- Parking facilities can be located at a distance from the main commercial centre
- A special transit service (may be free of cost) from the parking to the commercial centre may be provided as part of **'Park and Ride'** policy
- In the absence of transit service, the facility may also be provided in the form of **'park and walk'**



IIT Kharagpur | Traffic Engineering | Module H

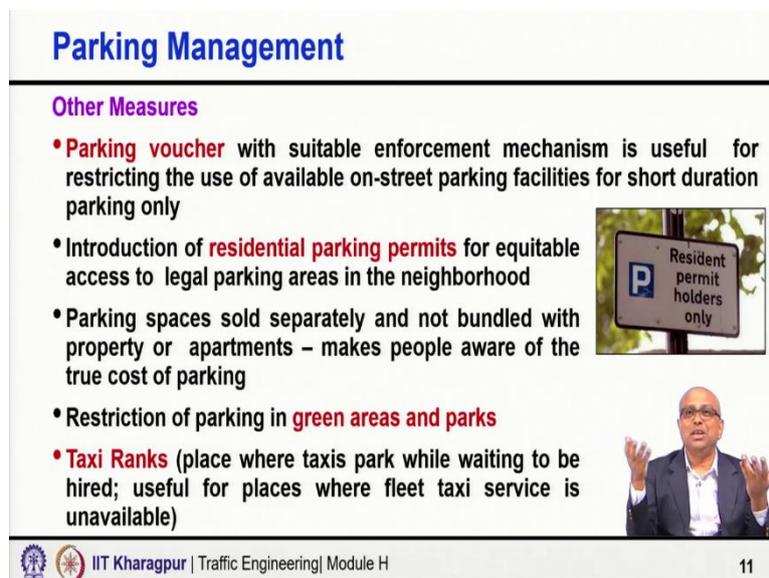
Park and ride this kind of facility needs to be developed. In congested areas or old cities areas CBD areas, you give park and ride. So, what you do? Just outside the CBD area or the city area, up to that point if people are travelling by car, you have no problem, so just outside the civilian or outside the city area as the case may be at a convenient location, you create a parking space of street parking, sometimes you can give that parking even with a very nominal price, just to make it more attractive. You encourage people to come and park the vehicle there and provide good public transport connectivity from that place up to the city centre or to different parts of the city or the CBD.

So, tell people basically you park your vehicle there, up to that you come by vehicle, leave the vehicle there, there is a good place, all other facilities amenities are developed and there is very good public transport connectivity from that place to city centre, just travelling bus, when you

come back to this place end of the day again, you take your vehicle and the longer distance you travel by car I have got no problem.

In some cases, you can also use park and walk, if it is within that close proximity where walking is a feasible option, so give good facilities for walk, park, good parking facilities and then good work facilities or bicycle facilities. But facilities should be provided, you cannot expect people to walk in an unsafe manner, that means no crossing facility, no sidewalk or footpath and you want people to walk, that is not possible give convenient and safe facilities for people to walk or use bicycle and then you can use park and walk facility, so park and ride or park and walk, this could be very important.

(Refer Slide Time: 28:15)



**Parking Management**

**Other Measures**

- **Parking voucher** with suitable enforcement mechanism is useful for restricting the use of available on-street parking facilities for short duration parking only
- Introduction of **residential parking permits** for equitable access to legal parking areas in the neighborhood
- Parking spaces sold separately and not bundled with property or apartments – makes people aware of the true cost of parking
- Restriction of parking in **green areas and parks**
- **Taxi Ranks** (place where taxis park while waiting to be hired; useful for places where fleet taxi service is unavailable)



IIT Kharagpur | Traffic Engineering | Module H 11

There could be other measures, lot of things are there, you have to care, I have put all of them under other measures. One is if you want to restrict say on street parking to 1 hour or 2 hour, how do you know that whether the when the vehicle has been parked and whether the vehicle is actually parking for within 1 or 2 hour or for more than that? you can use simple parking voucher system, it is something like a scratch card, so the time hour and the minute is written, so they can simply get it from multiple shops or in local area, have some distribution system, and people can buy and then they put it inside the windscreen.

They scratch the thing, 10 hour 15 minutes, so 10 and hour, 10 and minute 15 they scratch and they put it inside the windscreen, so the traffic warden or the enforcement the police can come and say oh, no, it is 10-15 the vehicle has parked. So, for 2 hours or 1 hour as the case may be, so you can see the watch, see the clock and decide, now it is fine and if it overshoots, he can

actually take an action, can clamp the wheel, and towing away the vehicle or punishing, making some financial punishment, many things are possible.

Second one, another issue which comes often in old city area. Suppose, if you are working in some of the areas in Bombay, very old city or even Calcutta or some part of Delhi also, old city areas now those buildings, when they were developed that time building rules were something motorization was practically very very insignificant, hardly people used to have vehicles or even later on also when you allowed, whatever parking provisions you kept within the building premises.

Now, the motorization has gone to a different level every house has got a vehicle in many cases, some cases multiple vehicles owned by a household because the locality, the land use has changed so much, they are rich people, they can afford multiple cars. But within the building premises there is no provision for parking, because when it was developed it was developed as per the law as per the regulation at that time, so many of them they park on street, vehicles will be left on street, you have to think about their requirement.

You cannot give all the parking place to them, because then the outside vehicles cannot get any place to park their vehicle. Because throughout the ride from morning midnight the vehicles are parked, by you know all the parking lots are occupied by the residents, that is extreme, that is not acceptable, but if you do not consider the requirement, completely ignore, then you are ignoring the reality, the real requirement.

You have to take them also into confidence, so you may in some cases some dedicated parking place you can allocate for residential parking permits, that mean those are the places you have to allocate to residents for ah residents who are actually staying there, the remaining slots residential parking cannot be done. How many you have to give? How many to resident for residential parking permits you will give? How many for other outside vehicles? That depends on the context but you have to understand this requirement.

Another thing is when new buildings or housing complexes, somebody is buying a flat or so, these are all different measures actually, that parking spaces sold separately, not bundled with the property or apartment, only thing this will make people aware of the true cost of parking when they pays a huge amount of money to get a parking lot, they know what it means to, if I want to take a parking lot, how much actually it cost, then in the, when you are doing the parking supply or overall parking management, you have to be careful that you should not use green areas or parks for parking, since the demand parking is high, I cannot you know encroach

the green areas or the parks which are equally important. So, never encroach those areas for parking.

Some places where the fleet taxi is not so popular, so there the conventionally taxi stands or ranks will be there, you know the one place some 2 or 3 taxis will be there, traditionally that was the system. So, people know there is a taxi rank or stand there and go there and you will get a taxi, so you have to give parking place for them as well. Some cities in some stage, because some of the cities probably now the fleet taxi, that way they do not or the fleet taxi operation is so popular like ola, uber, so you really do not need to put taxi stands or ranks.

So, you can simply, wherever you are you just book a vehicle and your location is shared, so the vehicle will come and pick you up, pick up you from your place. So, you do not need really conventional tax systems or taxi parking or taxi ranks, but where such kind of fleet tax is not popular so popular or not available also till date, small small towns fleet taxis not available or medium size cities also fleet tax is not available, so there when you are allocating the parking space, you cannot give every parking space for the car parking, you have to allocate some parking for the taxis, some parking for the residential parking, as and when it is they are required.

(Refer Slide Time: 34:40)

## Parking Management

- **Vehicle Quota Scheme (Singapore):** Certificates of entitlement is made each month & bids are made for the limited number in each category of vehicles
- **No-Drive Days (Seoul):** Each vehicle will be off the roads for one weekday out of ten according to license plate number
- **Area Licencing (Seoul):** Vehicles are charged a fee to enter the CBD area
- **Congestion Tolls**
- **Relocation of some activities/developments:** Activities/developments generating high parking demand may be relocated outside CBD area



IIT Kharagpur | Traffic Engineering | Module H

12

So, then vehicle quota system, these are some of the things which are followed in different country. Certificates of entitlement is made each month and bids are made for the limited number in each category of vehicle you bid it, I have so many parking space, every month you can bid, whoever pays higher may be given that parking space. No drive days followed in Seoul, each vehicle will be off road for one-week day out of 10, according to the license plate

number 0 to 9. So, every out of 10 days, one day the as for the registration number last visit the vehicle will not be allowed to be on road. So, that kind of parking also you will not give.

Area licensing, again, consequential vehicles are charged a fee to enter into the CBD area because that is congestion pricing, you are doing. Congestion toll, again, you can do it you can decide the tool, earlier also in our previous module, I have mentioned some of these things. Then relocation of some activities or developments because you know within the CBD area, if you know some of the establishments, they attract lot of vehicles, lot of parking,

So, you can actually think if can you relocate some of those establishments outside the CBD area, less congested area, so that people can go taking their vehicle, get easily parking place also and that will overall the CBD environment it will improve, because the parking demand will reduce. So, land use, change in the land use or relocation of activities this also could be there.

(Refer Slide Time: 36:30)

**Parking Management**

**Parking Signs**

- Parking signage as appropriate, should be installed making them clearly visible to road users
- Some examples of parking signs as per IRC: 67-2012

The slide displays four examples of parking signs:

- No Parking:** A red circle with a diagonal slash over a black 'P' on a white background.
- Parking not Allowed on Footpath:** A red circle with a diagonal slash over a black 'P' with a white footpath symbol on a white background.
- Parking Restriction Sign for Traffic Management:** A yellow rectangular sign with a blue circle and red slash at the top. Below it, the text reads: "KEEP CLEAR MONDAY TO FRIDAY". A table shows: AM 8.00 - 9.30, PM 4.30 - 6.30. Below the table, it says: Mon - Sat 8 am - 6.30 pm, 8 am - 6 pm.
- Parking:** A blue square with a white 'P' on a white background.

A speaker in a suit is shown in the bottom right corner of the slide, gesturing with his hands.

IIT Kharagpur | Traffic Engineering | Module H 13

Then, wherever you are doing the parking along with that parking signs are very important, because parking signs as appropriate should be installed, making them clearly visible to road user and there are some examples of parking signs, I have given as per our Indian roads congress guideline, IRC 67-2012, any updated version comes out, you use that version. So, I have showed here, no parking, parking not allowed on foot path, here the parking is allowed, here clearly giving the description boards, what time which day.

(Refer Slide Time: 37:11)

### Parking Management

- Examples of Parking Signs
  -  Car Parking
  -  Two Wheelers Parking
  -  Cycle Parking
  -  Auto Rickshaw Parking
  -  Information for Disabled Parking
  -  Park and Ride
  -  Park and Ride

IIT Kharagpur | Traffic Engineering | Module H 14

And then these are the other parking signs when car parking, two-wheeler parking, cycle parking, auto rickshaw parking's, as is a different vehicle types, you have to accommodate, so these are very important.

(Refer Slide Time: 37:23)

### Parking Management

#### Example Problem

- Presently, **8000 cars are parked** in a CBD and there is charge for parking. A rational estimate indicates that **only 4000 cars can be accommodated** safely in the CBD area. The outcome from the parking beat survey is shown in the table.
- The probability of bringing cars in the CBD may be expressed as:
 

Duration of Parking (hr)	0-1	1-2	2-3	3-4
Percentage of Vehicles	30	30	20	20
- $P(X) = 1 - 0.04X$ ; [where  $P(X)$  is the probability of bringing car when a total of Rs.  $X$  to be paid towards parking charge]
- Will a **parking charge of Rs. 5 per hour** be instrumental in bringing down the parking demand to 4000 cars?

IIT Kharagpur | Traffic Engineering | Module H 15

Let us look at a small example, say presently 8000 cars are parked in a CBD area and there is a charge for parking. A rational estimate indicates only 4000 can be accommodated, safely in the parking area. The outcome of the parking bit survey is shown here 0 to 1 hour, 30 percent parking, 1 to 2, 30 percent vehicle, again 2 to 3, 20 percent and 3 to 4, 20 percent, so total 100 percent.

If it is so, and the probability of bringing car in the CBD may be expressed like this, this is an equation developed by someone. What we want, will a parking charge of rupees 5 per hour be instrumental in bringing down the parking demand to 4000 cars. So, the whole problem is 8000 cars are there, we want to bring the number to 4000 or lower, because that much, that mini parking space I can provide safely, and I know how the parking fee is going to impact the probability of bringing vehicle, how it is going to get impacted by the parking fee and I know the duration of parking, so I want to you to answer that whether 5 rupees per hour will be all, right or not.

(Refer Slide Time: 38:45)

### Parking Management

**Solution**

- Present demand: **8000 vehicles**
- Probability of car parking:  
✓  $P(X) = 1 - 0.04X$ ; ( $X = \text{Parking Fee}$ )
- e.g., for 1 hour,  $P(5) = 1 - 0.04 \times 5 = 0.8$
- Total expected demand of car parking will be **4320 vehicles** (sum of the last row) for imposing a parking fee of Rs. 5 per hour
- Parking fee needs to be increased to bring down the demand further.

Duration of parking (hr)	0-1	1-2	2-3	3-4
Percentage of vehicles	30	30	20	20
Number of vehicles	2400	2400	1600	1600
Parking fee payable (X)	5	10	15	20
Probability of parking (P)	0.8	0.6	0.4	0.2
Expected parking demand	1920	1440	640	320




IIT Kharagpur | Traffic Engineering | Module H

16

So, if you say duration of parking, 30 percent, 30 percent, 20 percent, 20 percent, now total is 8000, so 30 percent of 8000, 20, 4000 here, 20 4000 and 20 percent of 8000, 1600, that is what is the actual base original demand and if it is 5 rupee per hour, then, x is for up to one hour parking 5 rupees, up to 1 to 2 hour, 10 rupee, 2 to 3 hour 15 rupee, 3 to 4 hour 20 rupee.

Then using this equation 1 minus 0.04X you can find out, then what is the probability of a person bringing vehicle who wants to stay here 0 to 1 hour, that is 0.8. Similarly, it is 0.6, 0.4, 0.2, so actual, then the demand will be how much 0.8 into 2400, 1920, 0.6 into 2400, 1400 like this, 640 and 320, so if you add all of them you get 4320. So, what you find? It is not being able to bring down exactly 4000 or below but somewhat little more than that 4320.

So, probably you need to increase the parking fee further, and that will help you to get a demand, effective demand or expected parking demand, less than 4000, so you can check like this. Different pricing, I can give, you can check, which one is going to be more effective, so that way you can evaluate actually.

(Refer Slide Time: 40:35)



Off-Street Parking Facility Development

IIT Kharagpur | Traffic Engineering | Module H 17

This slide features a title 'Off-Street Parking Facility Development' in blue text. Below the title is a small inset image of a man in a suit and glasses, gesturing with his hand. At the bottom left, there are logos for IIT Kharagpur and the course 'Traffic Engineering | Module H'. The slide number '17' is at the bottom right.



Off-Street Parking Facility Development

Off-Street Parking Space Requirements (IRC-SP: 12 - 2015)

- For a city with population of 1 to 5 million, One car parking space for every:
  - ✓ Tenement of 100 sq. m built-up area in residential areas
  - ✓ 3 guest rooms for hotels, lodging establishments
  - ✓ 50 sq. m area of business offices, educational areas
  - ✓ 100 sq. m area of public/ semi-public offices
  - ✓ 50 sq. m plot area of marriage/ community halls
  - ✓ 20 seats in theatres, assembly halls
  - ✓ 10 seats in restaurants
  - ✓ 100 sq. m of industrial areas, etc.

IIT Kharagpur | Traffic Engineering | Module H 18

This slide features a title 'Off-Street Parking Facility Development' in blue text. Below it is a subtitle 'Off-Street Parking Space Requirements (IRC-SP: 12 - 2015)' in green text. The main content is a bulleted list of requirements for a city with a population of 1 to 5 million. Each requirement is preceded by a checkmark. At the bottom right, there is a small inset image of the same man from the previous slide. At the bottom left, there are logos for IIT Kharagpur and the course 'Traffic Engineering | Module H'. The slide number '18' is at the bottom right.

Now, going to the off-street parking facility development. When you want to develop off street parking facility, then how much car parking space is required, that is one very, I should design it for how many parking space. So, IRC-SP: 12 - 2050 and Indian roads, congress guideline, you can use it. Here, I have given it, for example, for a city which, where the population is one to 5 million.

So, there are different ranges like that and different values are given, all I have not mentioned here, I just wanted to give you an example, for residential area, hotels, lodging, establishment, educational areas, public or semi-public, office, community hall, marriage hall, assembly hall, restaurants, industrial areas, what are the norms at which rate we should give provide the

parking space? So, similar kinds of provisions are also there for different population range in the city, so you can use them and you can design accordingly.

(Refer Slide Time: 41:50)

## Off-Street Parking Facility Development

### Types of Off-street Parking Facilities

- Surface car parks
- Underground car parks
- Multi-Storey car parks
- Roof parks
- Mechanical car parks





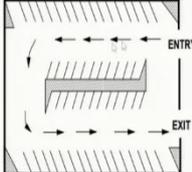



IIT Kharagpur | Traffic Engineering| Module H
19

## Off-Street Parking Facility Development

### Surface Car Parking

- Usually these are **provided at the surface and at some distance** from the activity area to be catered. These are known as **'surface lots'**
- Arrangements are made for the **systematic entry and exit of the vehicles**
- Stalls are designated by vehicle types and proper circulation area is designed for smooth movements of vehicles
  - ✓ Stall size of 2.5m x 5m (IRC)
  - ✓ Stall size of 2.6m x 5.5m (AASHTO)
- Such facilities may be **developed on private or public land and the investment is minimum**






IIT Kharagpur | Traffic Engineering| Module H
20

The types of off-street parking facility could be surface car park, underground car park, multi storey car park, roof park, mechanical car park. So, when it is surface park area, usually they are provided at a surface at the same ground level and at some distance away normally from the city centre and these are not known as surface slots, normally there will be definite entry definite exit, and this kind of arrangements will be there for the vehicles, for you to park your vehicles.

Sometimes the entry exit could be the same point, but definite point of entry, definite point of exit and then what should be the stall size or so that also is given, typical as per IRC, what

should be the size as far as to what should be the size, and such facilities may be developed on private or public land and the investment is also not that much and obviously the capacity is also not that high normally, because near CBD area somebody has got this place, so it may not be really huge place available, so maybe reasonable or a small place is available and you want to operate it for and like an upstream parker surface car park.

(Refer Slide Time: 43:13)

## Off-Street Parking Facility Development

### Underground car parks

- It is also **known as basement parking**, mostly **located in city centers or below play grounds or at similar locations**, where there is not much space available to build other types of parking facility
- May be **provided underneath apartments and also commercial buildings** to provide parking facility to inmates & also for public visiting the commercial building
- **Underground parking involves large quantities of excavation, construction of retaining walls, ventilation and lighting**



IIT Kharagpur | Traffic Engineering | Module H 21

Underground car parks also known as basement parking, mostly located in city centres or below playgrounds or at similar locations where there is not much space available to build other types of parking, if you want to multi storage facility, you need the ground to build that, but here it is below. So, maybe outside if you see, you will find it is a city centre or it is a playground but below it is huge parking place, underground car parks. Such facilities may be provided underneath apartments and also commercial buildings.

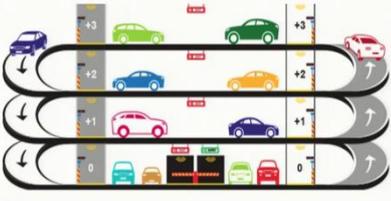
Sometimes they do it, you go to shopping malls, there will be parking below underground car parks, very common. To provide parking facility to inmates and also for public visiting the commercial buildings, underground parking involves large quantities of because you are going below the ground level, so you have to do lot of excavation, to construct retaining wall, ventilation, lighting, drainage, number of things you have to really take care to design but quite common, you find in many places such kind of underground car parks are available.

(Refer Slide Time: 44:38)

## Off-Street Parking Facility Development

### Multi-Storey or Multi Level Car Parking (MLCP)

- Parking **comprising of more than two levels** should be provided in respect of apartments & commercial establishments including **malls, multiplex, etc. for parking of cars**
- **Requires considerable investment** and also availability of land and investment by urban local body and/or private participation



IIT Kharagpur | Traffic Engineering | Module H 22

Multi-storeyed or multi-level car parking, MLCP parking comprises of more than two levels, should be provided in respect of apartments and commercial establishment including malls, multiplexes, etc. for parking of cars, and such kind of facilities, quite normally will have huge capacity, very well developed quite good amount of investment is required to build it, also you need fund to operate it properly and take care of all other requirements. So, it requires considering investment and also availability of land and investment by either local body or sometimes such facilities are also developed by with private participation, PPP model.

(Refer Slide Time: 45:35)

## Off-Street Parking Facility Development

- Desirable standards for designing of MLCPs as per IRC-SP: 12 (2015)
  - ✓ Ramp gradient: 1 in 10 (preferably), 1 in 8 (max)
  - ✓ Parking stall dimensions 2.5 m X 5 m
  - ✓ Clear height between floors: 2.1 m
  - ✓ Radius of curves: 7 m
  - ✓ Width of lanes at ramps and entrances: 3.75 m
  - ✓ Gradient of sloping floors : Not steeper than 1 in 20



**Other Types**



Roof Parking



Mechanical Parking

IIT Kharagpur | Traffic Engineering | Module H 23

And desirable standards for designing the multi-level car parking, there are specifications are given as I have reproduced it from IRC-SP: 12 2015 like the Ramp gradient, how much it

should be? What should be the parking stall dimension? Clear height between floors and all such kind of things, so I do not want to read out all the points but only a reproduced is to show that, if you are really interested to design, you refer to the code and get all the design controls. Within those design controls you have to design the facilities.

(Refer Slide Time: 46:20)



**Parking Design for Differently Abled People**

IIT Kharagpur | Traffic Engineering | Module H 24

This slide features a title in blue text and a small inset image of a man in a suit speaking in the bottom right corner.



**Parking Design for Differently Abled People**

- In order to ensure **universal accessibility**, it is essential to provide appropriate parking facilities for differently abled people
- Following guidelines must be adopted while designing parking for people with disabilities:
  - ✓ **Sign with the international symbol of accessibility** mounted high enough so it can be seen while a vehicle is parked in the space
  - ✓ **Boundary of the access aisle must be marked**
  - ✓ **Two parking spaces may share an access aisle**
  - ✓ For parking facilities of less than 50 cars, **at least one accessible parking** space should be provided

IIT Kharagpur | Traffic Engineering | Module H 25

This slide features a title in blue text, a list of guidelines, and a small inset image of a man in a suit speaking in the bottom right corner.

Then once you are developing parking you have to take care of the requirement of differently abled people. So, in order to ensure universal accessibility, it is essential to provide appropriate parking facilities for differently abled people. Now, following guidelines must be adopted, you have to use proper sign with the international symbol of accessibility, boundary of the access aisle must be marked, because you need the wheelchairs to, should be able to go by

wheelchairs, so that provision should be there. Two parking spaces may share an access aisle for parking facilities of less than 50 cars, at least one accessible parking should be provided.

(Refer Slide Time: 47:09)

### Parking Design for Differently Abled People

- For parking facilities of a maximum number of 400 spaces, accessible parking spaces should at least be provided in the ratio of **1:50**

Width of Accessible Parking

Common Access Aisle

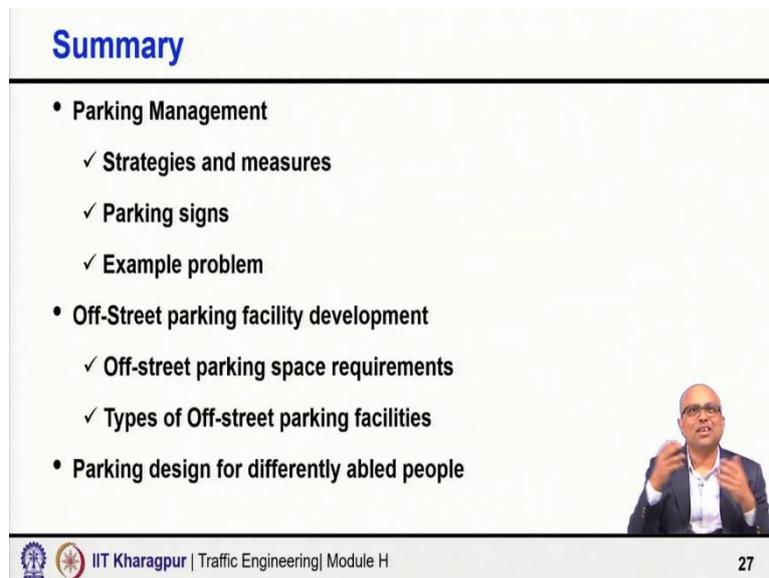
IIT Kharagpur | Traffic Engineering | Module H

26

And for parking facilities of maximum number of 400 spaces. The accessible parking spaces should be at least provided in the ratio of 1 is to 50. So, similar kind of thing, 50 cars, one such facilities and I have showed then, what could be the width of the accessible parking and if you are using a common oil common excess aisle, you can use that, what would be the dimension? these are in meters.

So, that kind of things are also available in details in the IRC guideline, so please take care of those when you are designing the off-street facilities and particular type of off-street facility, what are the requirements? What should be the design controls? Those are all available, please follow those and design the off-street facility.

(Refer Slide Time: 48:04)



## Summary

- **Parking Management**
  - ✓ Strategies and measures
  - ✓ Parking signs
  - ✓ Example problem
- **Off-Street parking facility development**
  - ✓ Off-street parking space requirements
  - ✓ Types of Off-street parking facilities
- **Parking design for differently abled people**

IIT Kharagpur | Traffic Engineering | Module H 27

So, with this, what we discussed in this lecture is about the parking management, what are the strategies and measures that we can do to sort out this imbalance between the demand and supply, requirements of signs and some example problems we took, and also said something about the off-street parking facility development, what are the different space requirement? What are the different types of facility? And finally we reminded ourselves, that we must take care of the different label people their requirements of parking. So, with this, I close this lecture and close this module. Thank you so much.