Traffic Engineering
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Lecture 55
Emerging Traffic Management Measures

Welcome to Module G, lecture 5. In this lecture, we shall discuss about the Emerging Traffic Management methods, mostly the active traffic management or the traffic management based on the real time data inputs.

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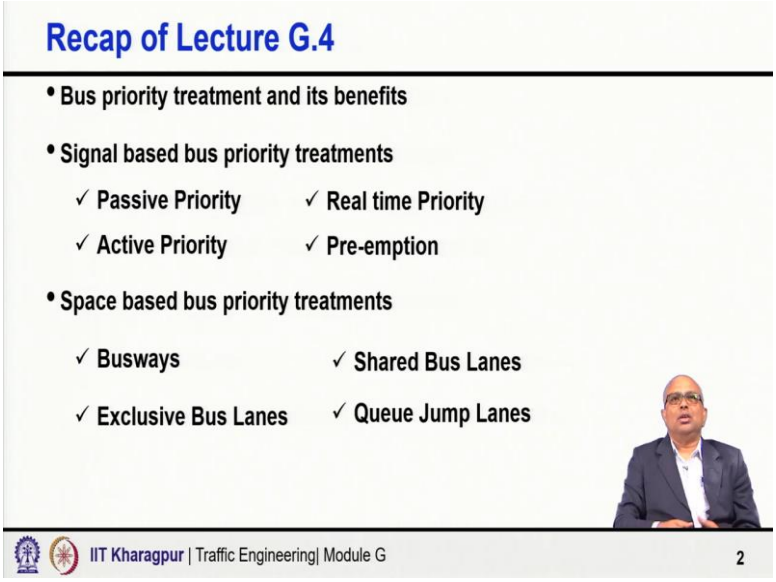

In lecture 2, 3 and 4, we discussed about access management in lecture 2, lecture 3 about the demand management as a part of traffic management and then lecture 4 bus priority treatments. So, this lecture 5 is on the components which are we have I have grouped them together under emerging traffic management measures.

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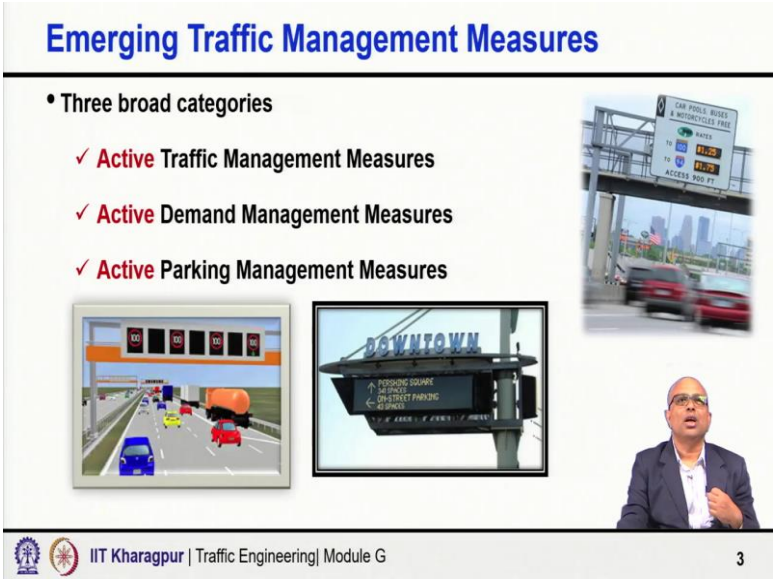

Now, this emerging traffic management measures I have categorized into 3 groups here active traffic management methods, active demand management methods and active parking management measures. The word active indicates that it is on a real time basis based on the real inputs. So, otherwise you are familiar with traffic management measures, the demand management measures and the parking management measures.

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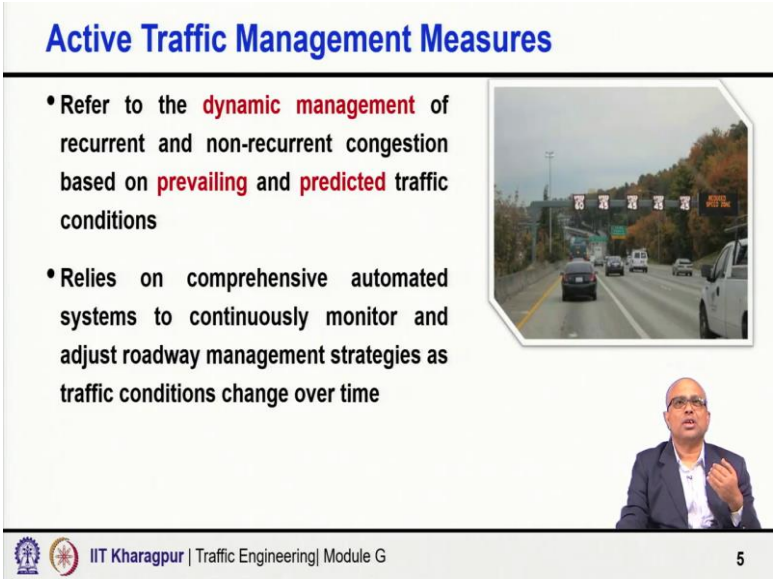

Let us discuss a little bit in details about this active traffic management measures, demand management measures and active parking management measures. First about active traffic management measures, active traffic management measures referred to the dynamic management of you are talking about dynamic management that means, based on the context things will change, dynamic management of recurrent and non-recurrent congestion both you will know the recurrent congestion means, every day during the peak hour the demand is high therefore, congestion is high that is the recurrent congestion, non recurrent there is a sudden breakdown of vehicle or maybe a lane is blocked because of it crashed.

So, the capacity is reduced temporarily and therefore, the congestion occurs. So, dynamic active traffic management measures referred to dynamic management of both recurrent and non-recurrent congestion based on prevailing and predicted traffic condition, we are getting the data, we know the what is the prevailing congestion.

So, as part of the prevailing congestion the management measures are in practice also sometimes it is revealing data and also based on the trend past data, some prediction algorithm may work and also it could be based on certain actions may be taken because of the prediction or considering the predicted steps that okay in another 15, 20 minutes the traffic will increase further or this sort of situation is expected as per the pattern as per the data analytics.

So, this kind of management measures is already in practice already initiated. Such kind of measures rely on comprehensive automated systems to continuously monitor and adjust roadway management methods or strategies as traffic conditions change over time. So, the measures are not fixed as I say this is dynamic. Why it is dynamic? Because we are

continuously monitoring it. At the backend a comprehensive automated system is working with continuously monitoring and feeding the Data and therefore, as per the context as per the data, we are doing necessary adjustment in the traffic management. So, it is changes over time as the situation demands.

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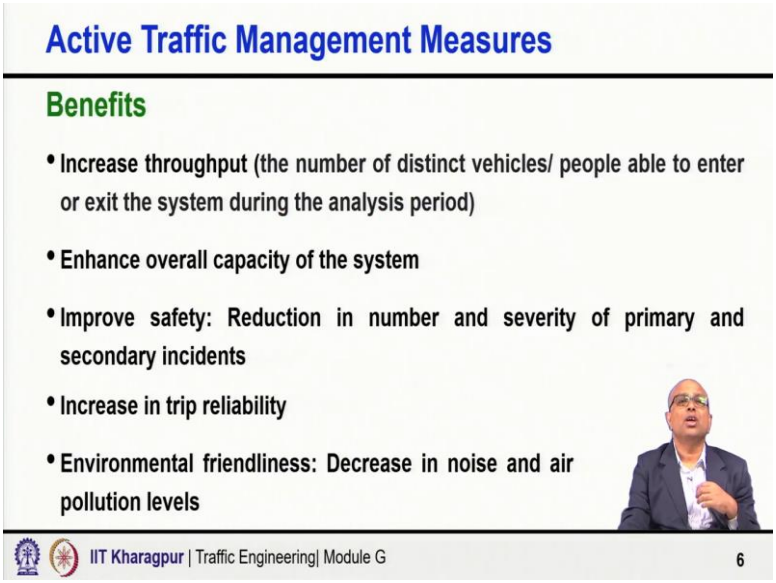

There are enormous benefits when we do active traffic management. For example, it may help us to increase the throughput, overall capacity also may be enhanced, safety will be enhanced, trip reliability may increase and the noise and pollution level may decrease, helping us to make the system more environment friendly.

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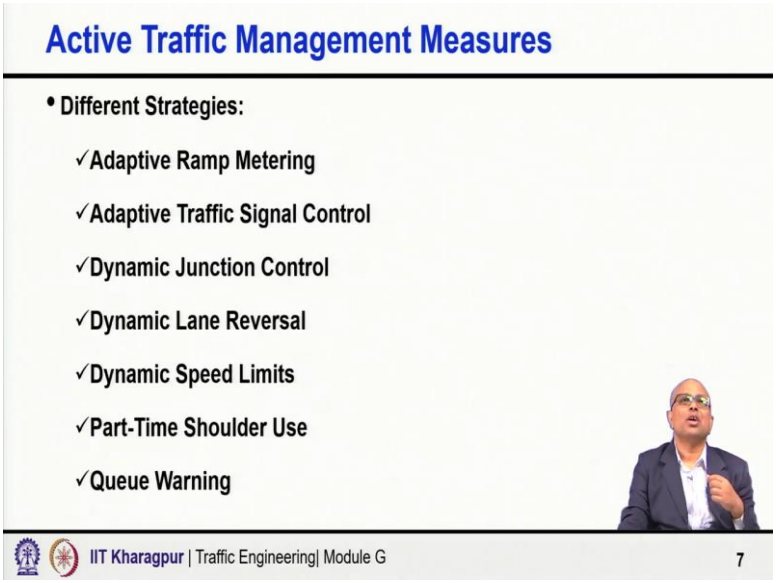

There are different strategies, adaptive Ramp metering, adaptive traffic signal control, dynamic junction control, dynamic lane reversal, dynamic speed limits, part time shoulder use, queue warning, etc. So, let us discuss very briefly about each of these strategies.

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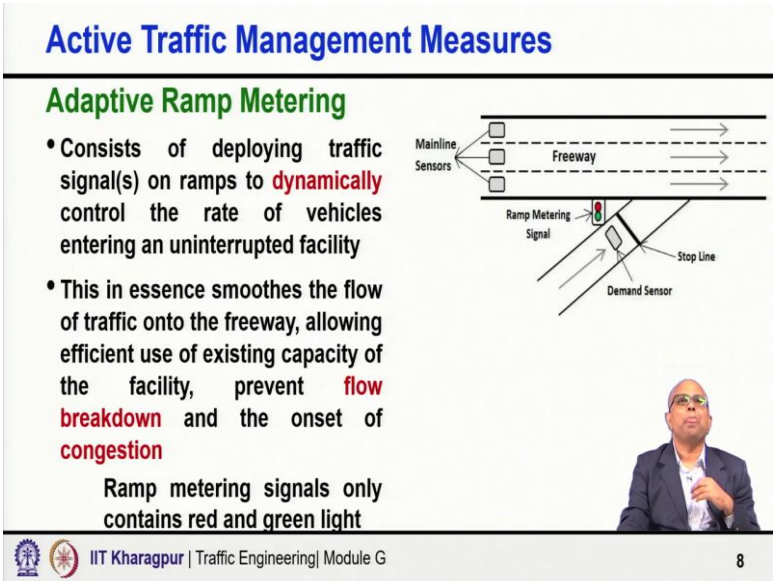

First, adaptive ramp metering, ramp metering you know we do ramp metering during the peak hour, the main freeway which is carrying a lot of traffic, we control the entry of vehicles to freeway as per the congestion here it is adaptive. So, that is what is the ramp metering we control the inflow of vehicles to the freeway, but here the system is adaptive ramp metering that will consists of deploying traffic signals on ramp as you are seeing here to dynamically control the rate of vehicles entering an uninterrupted flow facility, which is a freeway.

So, this is this in a sense help us to make the traffic flow smooth on the freeway and prevent flow breakdown and the onset of congestion. So, why we are doing it because you know sometimes the freeway maybe the demand itself could be quite high and existing flow is high. And then if you allow beyond certain limit entry, then the flow break down may occur, traffic state may change to congested state or forced flow situation bottleneck may be created.

So, we want to control and we know how much tolerance is available in the existing flow on the freeway and accordingly, we are doing the ramp metering. So, ramp metering is not done at a constant rate over time the rate will vary and rate will vary depending on what is the available cushion how much I can actually fit without going without a flow breakdown possibility without a without a flow breakdown or without going to a condition which is not

acceptable. Ramp metering signals only contains red and green light here. So, in green enter red you do not enter.

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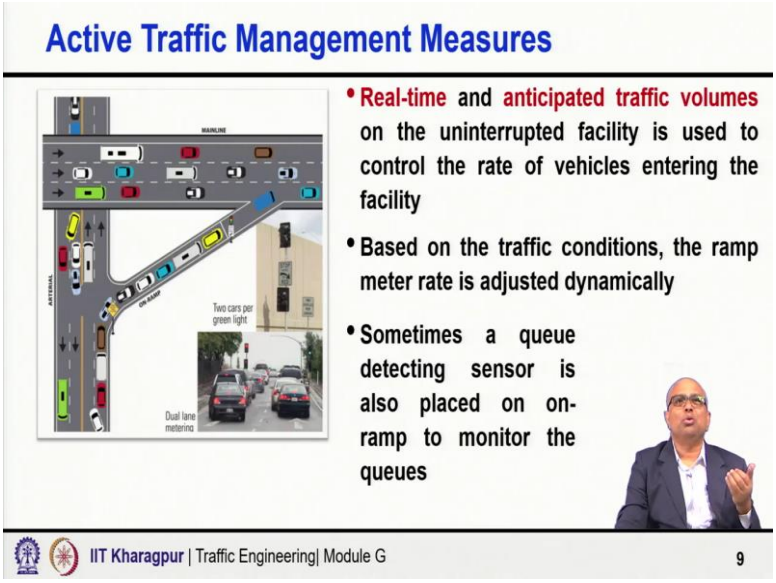

Obviously, what we do the real time and anticipated traffic volume on the uninterrupted facilities used to control the rate of vehicle entering the facility. You can see here this is the actual freeway and this is the ramp which is feeding to this system. So, we are doing ramp metering here at certain rate only we are allowing and that rate is changing as per the condition of the traffic state of the on this freeway.

Based on the traffic condition, the ramp meter rate is adjusted dynamically not just simply time clockwise but as part of the state we are deciding then for a quarter they will allow the vehicle to get into the freeway system from this particular time. And sometimes a queue detecting sensor is also placed on the ramp to monitor the queue. So, you know that how long this queue is growing. So, sometimes we need to monitor that because queue is growing means the lane will be blocked. So, the it will have other impacts. So, it may be required to monitor the queue. So, that sensor is also placed.

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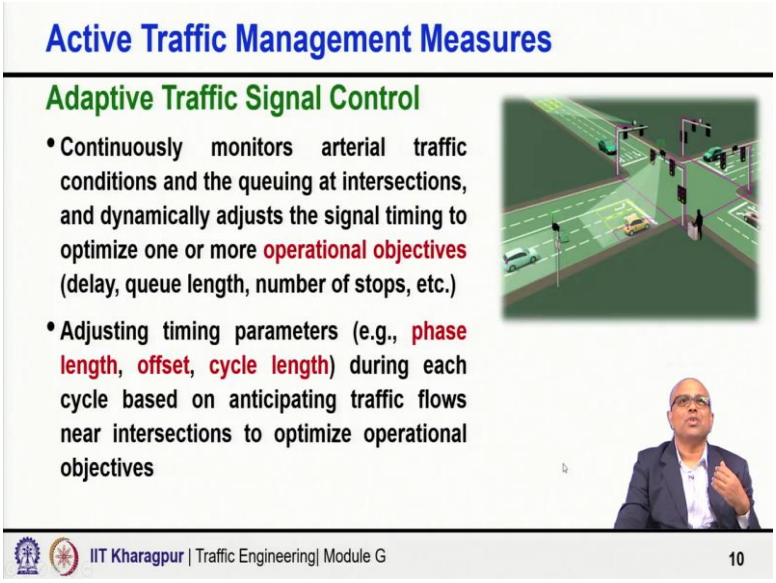

Next going to next system adaptive traffic signal control this you know because already we have talked about partially actuated, fully actuated controller. So, adaptive traffic signal control continuously monitors arterial traffic particularly and the arterial traffic condition and the queuing at intersections and therefore, as per the requirements dynamically adjust the signal timings to optimize one or more operational objectives.

These operational objectives may vary from one context to another, it may be optimizing the delay optimizing the queue length, optimizing the number of stops et cetera whatever may be the operational objectives as per the context, but the whole idea is that continuous monitoring of arterial traffic condition and giving and then dynamically adjust the signal timing as per the operational objectives.

Now, adjusting time parameters say timing parameters. So, for example, what would be the phase length, what would be the offset, what would be the cycle length. All these during each cycle is based on anticipating traffic flows near intersection to optimize operational objective so, we do it based on the actual traffic and also the anticipated traffic.

Anticipated traffic here is the when continuously we have a system we are getting the data at the backend many prediction algorithms may work conventional and also AI based algorithm also may occur make work actually to tell us some kind of forecast to give us some forecast and based on that also we can do it. So, not only the current state, current state as well as the anticipated condition

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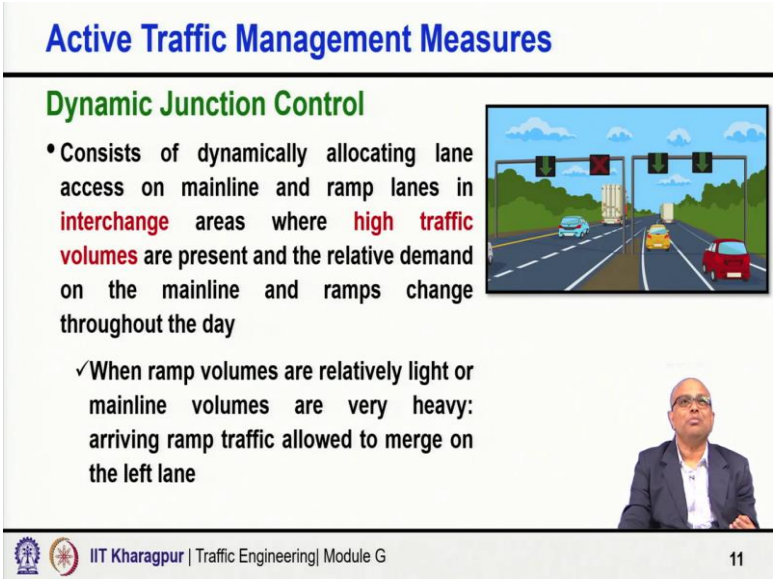

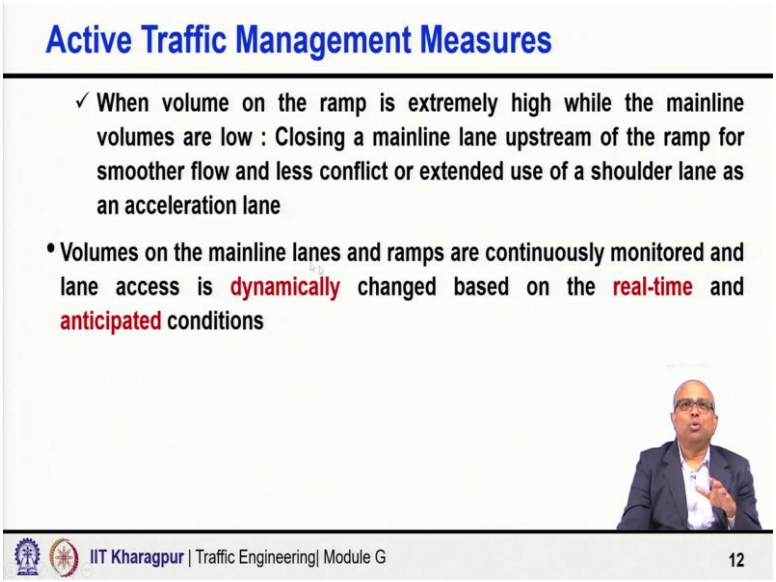

Next dynamic junction control this is something like as you will know that one is the main road and another is maybe a ramp it is not exactly ramp if it is ramp then we are talking about ramp metering dynamic rank by ramp metering I said that adaptive ramp metering. So, here it is consisting of dynamically allocating lane access on mainline and ramp line. So, one you can consider as the mainline and another you can consider as the ramp line.

So, it is mainline is going than ramp line is also going and meeting and quite often you will find some situation where 2 plus 2 actually making it 3 that means 2 lanes, 2 approaches to lane merging and merging to 3 lanes. Now, what happens if both lanes are getting heavily loaded traffic, then you know the bottleneck will occur flow break down will occur.

So, what do you do dynamically we do the junction control that means dynamically allocating lane access on mainline and ramp line in interchanges areas where high traffic volume are present and the relative demand on the mainline and ramps change throughout the day during different times of the day.

Sometimes the ramp volume may be high sometimes the mainline volume which is coming from the upstream may be high and there we do dynamic junction control for example when the ramp volumes are relatively light, ramp volume is light or mainline volumes are heavy, so ramp volume is light mainline volume is heavy. Then what do we do? We arriving ramps traffic allowed to merge on the left lane.

So, you can see here one lane you are making a red cross you are not allowing vehicles to use this lane. So, that means arriving traffic allowed to march on the left lane. So, you are allowing the traffic to go and march on the left lane. Because here both lanes the traffic is heavy, when volumes on the ramp is extremely high, while the mainline volumes are slow, that means it reverse. Now here the traffic is very heavy, but here it is not so heavy in that case what we do closing a main line upstream of the ramp for a smoother flow and less conflict or extended use of a shoulder lane as an acceleration.

So, what we can do, we can then stop this as you are seeing cross here now, we can make cross here so that these 2 lanes can go and march smoothly and traffic will flow only on one lane that is possibility or we can allow shoulder lane as an acceleration lane, shoulder lane also can be used. Volume on the mainline lanes and ramps are continuously monitored and lane access is dynamically change based on the real time and anticipated condition.

So, it is not that throughout they are same arrangement we are monitoring and the fluctuations may happen sometimes ramp volume may be high sometimes other volume may be high. So, as per the context as per the condition the allocation is happening. So, that is the called dynamic junction control.

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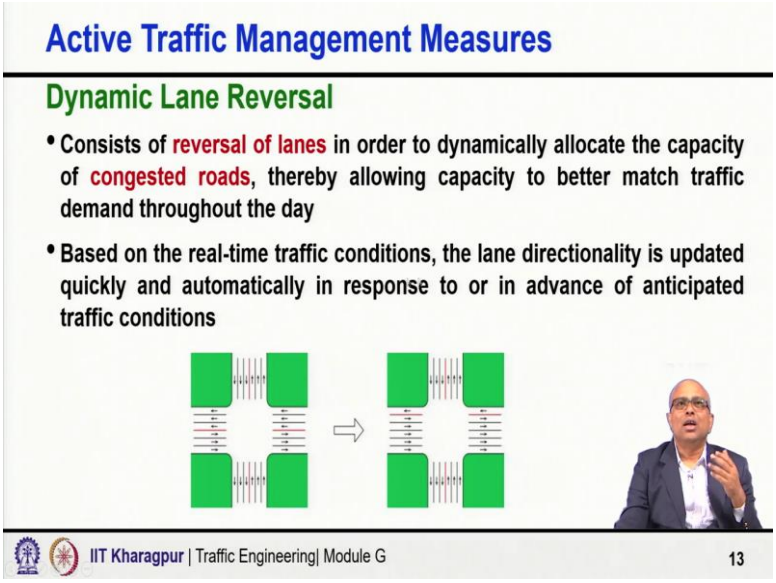

Dynamic lane reversal what is happening you can see here normally 3 lanes on this direction 3 lane on other direction, but you find suddenly the volume in one direction maybe east bounded direction is more. So, you allow now here you can see a well out 5 lanes in this direction and only one lane in the other direction this kind of things may help where the directional distribution is highly imbalanced, directional flows are highly imbalanced, morning peak maybe majority of the vehicles are going towards CBD and very few vehicle is actually travelling in the opposite direction.

So, in that case, wherever the demand is high, you allow more lanes to be used in that direction, but not so easy, there are other things we have to take care of normal road with the permanent divider and that kind of arrangement, you cannot simply change. So, it has to be done with some other arrangements, but what we are able to do, we are able to actually change the given the capacity allocation we are doing as per the demand.

But so conceptually that is fantastic. And that is what is called dynamic lane reversal and then after some time maybe you need 4, 5 lanes in this westbound direction, in the afternoon, it will change give that also. So, that time the lane allocation will change. So, dynamically and reversal will help you to achieve that. So, it consists of reversal of lane in order to dynamically allocate the capacity of congested roads, thereby allocating capacity to better match traffic demand throughout the day.

So, capacity allocation directional capacity allocation is happening as per the current demand during the day the demands are changing. So, directional capacity allocation is also changing

as per the directional demand based on real time traffic condition, the lane directionality is updated quickly and automatically in response to or in advance of anticipated traffic condition.

I am saying it always all these active measures it may be based on the current condition as I am getting the feed from the sensors also it could be based on the current as well as anticipated condition, anticipated condition most cases because you are getting data every day like this you have huge amount of data that is available. So, at the back end all sorts of algorithms are working and that may give you nice prediction as well. So, present condition as well as anticipated traffic conditions based on that also you do. We do not wait the traffic state to be that bad. Even before that we do the interventions.

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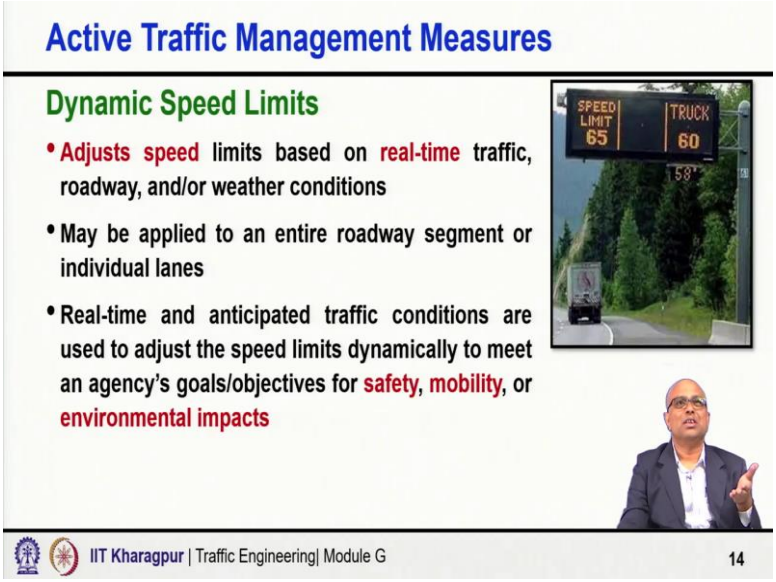

Next dynamic speed limit, this is very useful, as you know that speed is the major factor contributing to road fatality a lot of you know the speed really matters. So, these days more and more emphasis are given on speed management as a measure effective speed management as a measure or as an instrument for reducing the fatality, during crashes. So, it is important to adjust speed limits actual speed limit depends on overall traffic condition, roadway condition weather condition and 24 hours in a day or every day within a week or within a month, the same speed is not really the same speed.

So, there cannot be only one speed. So, maybe what is safe speed at 10 o'clock in the morning at 1 o'clock or 2 o'clock the safe speed may be very different at 5 o'clock in the morning the safe speed may be again very different, because the traffic conditions the road environment,

the road route site, the control condition, everything is changing. So, dynamic speed limit adjusts speed limits based on real time traffic, roadways and weather condition.

And therefore, you can apply this kind of dynamic speed limit when entire roadway segment or even individual lanes both ways. Real time and anticipated traffic conditions as usual always I am saying real time and anticipated traffic conditions are used to adjust the speed limit dynamically to meet an agency's goal's objective for example, the objective could be safety, mobility or even environmental impact whatever the speed controls everything speed influence mobility, speed influence road fatalities.

So, safety also speed influence also the emission or the environmental impact. So, whatever may be your goal single or multiple accordingly, you just see what is the present condition or what is the anticipated condition and then what speed limit you can want to give now, we want vehicles to follow just display that using the dynamic speed limit arrangement.

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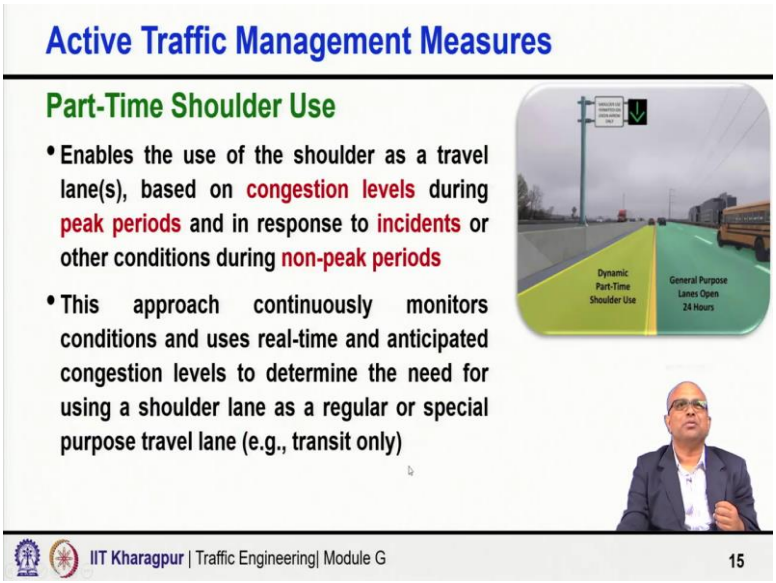

Then part time shoulder use, part time shoulder use enables the use of the shoulder as a travel lane. Normally you know this is the general-purpose lanes which is actually traffic lane for 24 hours and this is the shoulder. So, shoulder normally should not be used as a traffic lane it is only for if there is a vehicle breakdown or a crash happens in that vehicle can be shifted immediately to the shoulder or if there is a breakdown of vehicle then that breakdown vehicle that stalled vehicle could be there.

So, it is not to be used as a regular traffic lane. That is not really the intention of shoulder occasionally use but you can use sometimes the shoulder as a traffic lane, you are doing that.

So, part time shoulder use not always when the situation demands due to some reason or other, I am telling. So, it enables the use of shoulder as a travel lane you are using shoulder as a travel lane, based on congestion levels during peak periods. Maybe other time you do not allow but as you have seen 2 plus 2 meeting into 3 lanes, first case of active traffic management example I said so, there you are not allowing one lane sometimes on the ramp.

Sometimes the even the mainline also one lane you are not allowing depending on which traffic is dominating at what time and if both are dominating, you may even sometimes allow the during that time only you allow the shoulder to be used as a regular traffic lane. So, based on the congestion level during peak period or in response to incidents or other conditions during non-peak period maybe non-peak period otherwise everything is fine, but there is a crash or there is the vehicle breakdown.

So, one regular lane which is to be used for movement of traffic is actually blocked and therefore the situation is not really nice, because you have capacity shortage. So, you may allow the shoulder to be used as a traffic lane. Now, this approach continuously monitors congestion and uses real time and anticipated as a result real time unanticipated congestion levels to determine the need for using a shoulder lane as a regular or special purpose lane, sometimes it could be special purpose lane also, for example, you do not allow all vehicle but he will allow only transit to use that because you do not want to probably give a little bit more priority to transit has compared to the other single occupant vehicles. So, you actually allow the use it like a special purpose travel lane. So, other is vehicles are not allowed but buses can use it.

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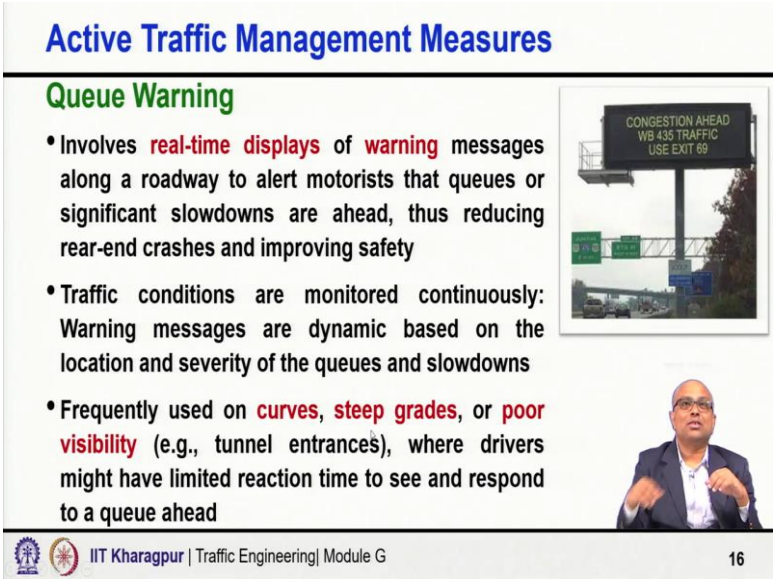

Next queue warning this is also another active traffic management measures it involves real time display of warning messages as you are seeing here obviously you can understand it very clearly. So, it involves real time displays of warning messages along a roadway to alert motorists that queues are significant shutdowns, slowdowns that queues are significant slowdown are ahead and thus reducing rear end crashes and improving safety.

You know that vehicles they have to slow down because in front in the in the downstream there is a congestion there to see you alert the danger well in advance other is they will travel at a very high speed not expecting that suddenly they have to slow down so the possibility of rear end crash will be high.

So, in this case, you actually bring down the probability of the rear end crash and therefore improve safety by displaying this information. So, driver is warned informed so obviously we are helping to improve the safety. Traffic conditions in these cases, such cases are monitored continuously, warning messages are dynamic based on the location and severity of the queues and slowdowns.

These kinds of things are really useful and frequently used on curves, steep grades and country locations with poor visibility for example, the tunnel, tunnel entrances for drivers might have limited reaction time to see and respond to a queue, I mean, if there is a turn. So, driver cannot see completely. So, only when it turns it can see there is a long queue. So, it may be difficult for the driver to immediately respond to that and slow down. So, you inform the driver in

advance or there is a steep grade or locations of other places where the visibility is poor or sight distance is restricted.

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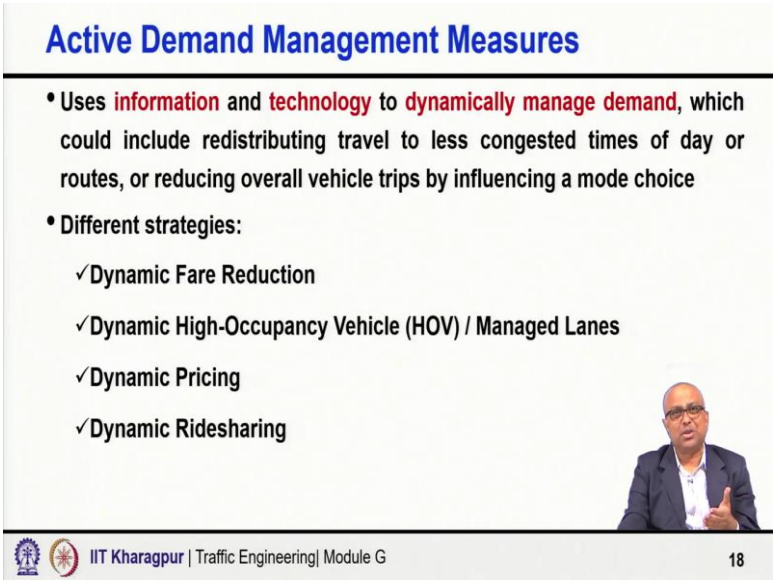

Now going to the next part, so, up to this it was active traffic management with that now we go to active demand management. In such cases or such measures use information and technology to dynamically manage demand. Demand Management is not new, but what is being done. We are dynamically managing the demand.

So, it is active demand management, which could include redistributing travel to less congested time of the day, week to non-peak or routes which are not so congested or reducing overall vehicle trips by influencing a mode maybe shifting from single occupant vehicle to shared mode of transit. So, there could be different strategies to achieve active demand management,

dynamic fare reduction, dynamic HOV or managed lanes, dynamic pricing, dynamic ridesharing.

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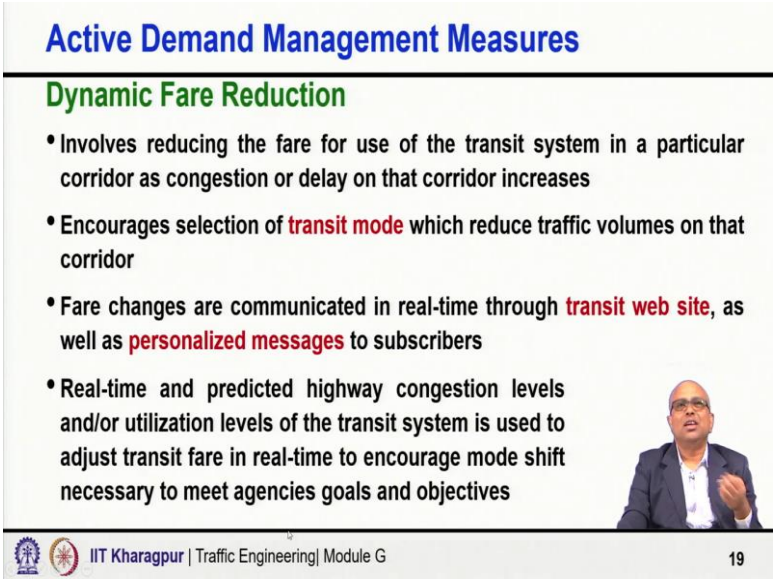

Let us discuss one by one dynamic fare reduction involves reducing a fare for use of a transit system in a particular corridor as congestion on delay on that corridor increases. So, as the road is more congested, becoming more and more congested, you are bringing down the fare of transit you are encouraging more and more people to go.

So, when the road is not congested, you also do not reduce the fare of transit. When the road is becoming more and more congested as it is becoming more and more congested. You actually reduce the price to make the transit more attractive and to bring more people to transit rather than allowing them or encouraging them to use single occupant vehicles or cars.

And such measure will encourage selection of transit mode, which will reduce traffic volume on that road. Now, fare changes are communicated in real time through transit web site, as well as personalized messages to subscribers. So, it should not be a surprise. So, you will know that it is going to increase now, the traffic is increasing. So, it is going to increase now, they have to be informed you know, anything any fare or fare particularly cannot be changed suddenly without information to users.

So, users should know they know the procedure, how it changes, when it is going to change and all such kind of things. Real time when predicted highway congestion levels and or utilization levels of the transit system is used to adjust transit fare in real time to encourage mode shift necessary to meet agency's goals and objectives. These goals and objectives could

be that reduction of congestion, demand management, through demand management, higher usage or higher patronage or how at higher ridership, for the transit and so on.

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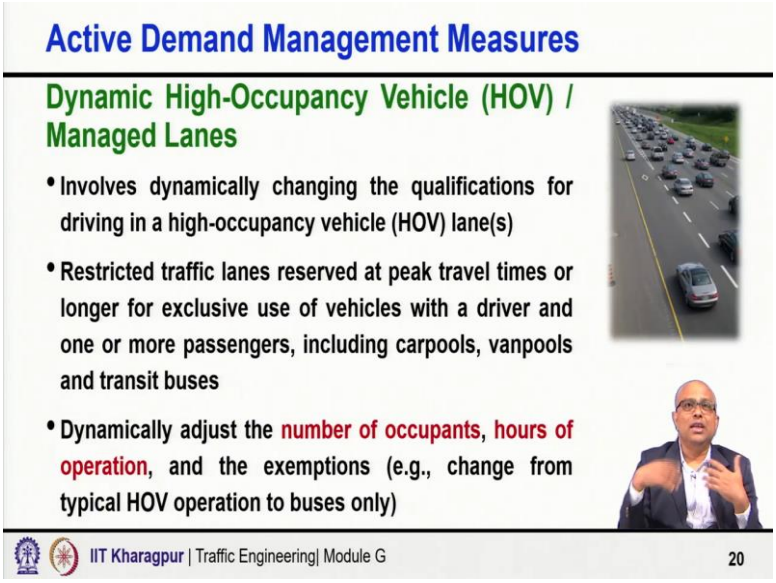

Then dynamic high occupancy vehicle lane and managed lane you know already what is a HOV lane, what is managed lane, what is new here is the dynamic word. So, it is dynamic HOV and managed lane, it involves dynamically changing the qualifications for a driving lane to high occupancy vehicle lane sometimes it is normal lane and sometimes you convert it to a HOV lane and also decide whether you want to allow only bus or also other vehicle types.

So, the full usage will be dynamic in nature will change over time as per the context not following the clock but following the situation as per the situation. So, restricted traffic lanes reserved at peak travel times or longer for exclusive use of vehicle with a driver and maybe one or more passengers including carpools, vanpools and transit buses and such kind of systems can help you to dynamically adjust the number of occupants, hours of operation and also the exemptions that will sometimes maybe you may operate it like HOV lane, sometimes you may operate it exclusively for buses only, only transit, not even other vehicles. So, everything as per the traffic state as per the requirement and doing it dynamically. So, it is active demand management measures.

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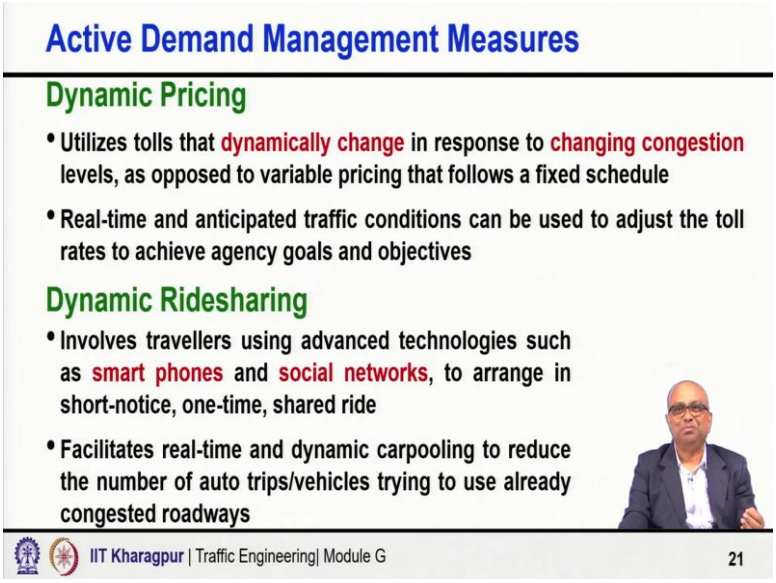

Dynamic Pricing utilizes tools that dynamically change everything is we are making dynamic, dynamically change in response to changing condition level. My primary worry is not to collect money not to gain money, my worry is to keep the congestion level within permissible limits. So, whenever it is required, and whatever extended is required, I will charge.

So, tolls that dynamically change in response to changing congestion levels as opposed to variable pricing that follows the fixed schedule. variable pricing also, we are changing toll rate over time, but there is a fixed value clock is fixed, you will know that up to 9 o'clock it is like that between 9 and 11 it is going to be like that.

And again, beyond 11 it is going to be like that. it is time clockwise fixed. That is the variable pricing, the variable pricing also it is not that single toll value different time different toll values, but here it is dynamically changing that means it is not as per the time clock, but it is as per the congestion state. So, wherever the congestion state will demand I will go and that is based on the current traffic and as well as based on the prediction. Real time and anticipated traffic condition can be used to adjust the toll rates to achieve agency's goal and objective.

Next, ridesharing, dynamic ridesharing. This involves travelers using advanced technologies such as smartphone or social network to arrange in short notice one-time shared ride. That means you do not do that every day. But given the condition or situation, if just use your smartphone, use your social network, and you can change the ride from a normal single occupant vehicle ride to a shared ride. And how you reach two people using smartphone, using social network there may be some specific websites which you can simply post.

And this is one-time shared ride. Not that every day we are doing it. And such kind of arrangements facilitate real time and dynamic carpooling. Carpooling also dynamic. Not that always I am doing carpooling. So, real time with dynamic carpooling to reduce the number of auto trips or vehicles trying to use already congested roadways.

So, it should be other things as well, because you will know that if you are actually do pooling or ride sharing, then there is a benefit for you also that say you are doing it and benefit for you, because that also is a dynamic system which has been set based on the present traffic state.

So, today some of the traffic is too bad. And you know that, there are certain dynamic system because of that, it is going to cost you more significantly high. And if you do a sharing, ride sharing, you can probably get some benefit. So, you get tempted to do the ride sharing and just use your smartphone or social network that okay, let us do it today. One time shared, right, everybody. So, that is what it is.

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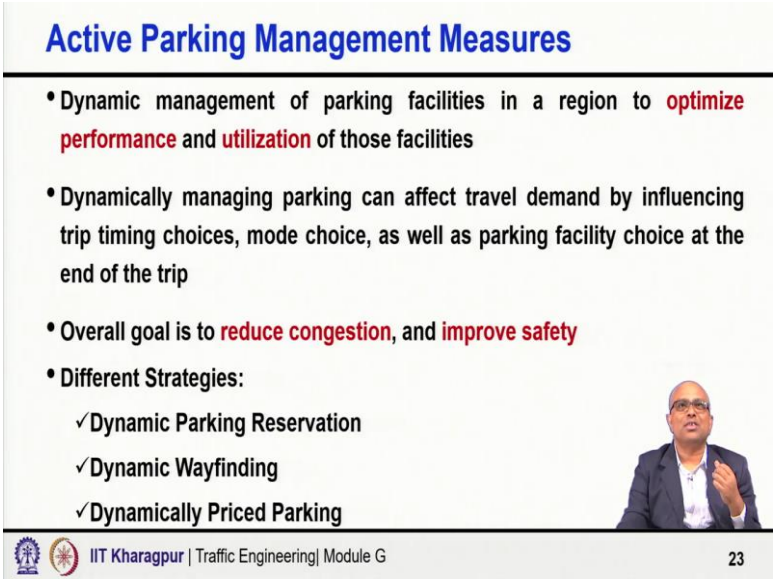

Going to active parking management measures. Dynamic management of parking facilities in a region may be done to optimize performances and utilization of those facilities. Dynamically managing parking can affect travel demand by influencing the trip timing choices, mode choices even as well as parking facility choice at the end of the trip. When they are going on street off street, which area you are going to within the CBD area or little away from that. Now, overall goal here is to reduce congestion and improve safety. So, there are different strategies dynamic parking reservation, dynamic wayfinding, dynamic priced parking.

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So, let us discuss briefly about each of these methods. Dynamic parking reservation provides an opportunity to travelers to utilize technology to reserve a parking space at a destination facility on demand to ensure availability. That means before I reach there, I am booking my

parking lot using technology. So actually when I am booking trying to book that time the information is available, how many slots are free, how many slots have been booked or already utilized and so on.

So, I get benefited out of that information. And I also am allowed the opportunity to book my parking in advance. So, parking availability is continuously monitored and system users can reserve the parking space ahead of arriving at the parking location. Before I reach ahead of arriving at the parking location, I can book my parking. That is the dynamic parking reservation.

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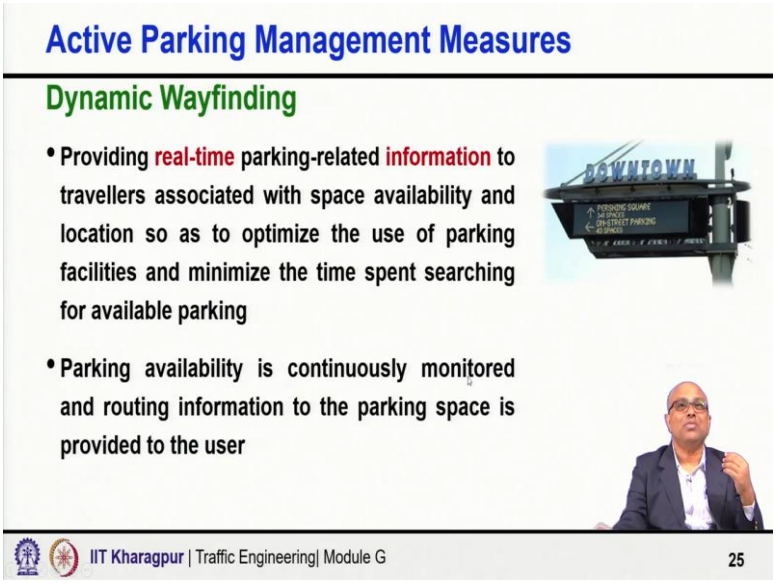

Second, dynamic wayfinding there are multiple places in a CBD area some underground Park some surface park something a little bit away also. So, how I get how I know that where parking is available and that the current time and the present time where the parking is available where I should go. So, dynamic wayfinding helps real actually provide real time parking related information to travelers associated with the space availability, where which parking area what space is available, how many number and so as to optimize the use of parking facilities.

So, I am saying where places are available. So, I want to make optimal use of the facilities, I want people to come and utilize the other facility. And also, I want to help the users, car users. That is because I want to minimize the time spent for by them in searching the in the process of searching the available parking. So, I am displaying, I know that how many parking lots are available at which locations I am displaying. So, I am one way helping to make better use of my existing parking lots.

The other way I am helping users, car users say we are in need of the parking place and giving them right information, helping them to know where they can go and get a parking lot. And I am optimized, helping them to optimize their travel as well. They did not really go around in the search of parking space. So, this is one example shown in the figure how you can display information.

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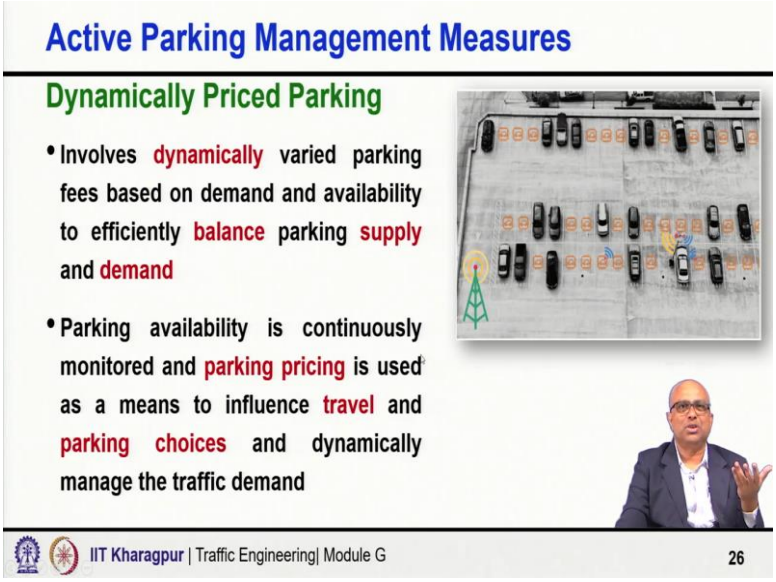

Dynamically price parking involves dynamically varied parking fees based on the demand and availability to efficiently balanced parking supply and demand. It is all through balance in the context of parking the supply and demand balance. how to do it. So, parking charges is our pricing is really an instrument for demand management. We will repeat this statement again in the next module probably.

So, here as the demand and supply imbalance is there based on that you are deciding how much price should be there. It is basically decided by the demand and supply in the market. So, available parking availability is continuously monitored and parking pricing is used as a means to influence travel and parking choices and dynamically manage the traffic demand.

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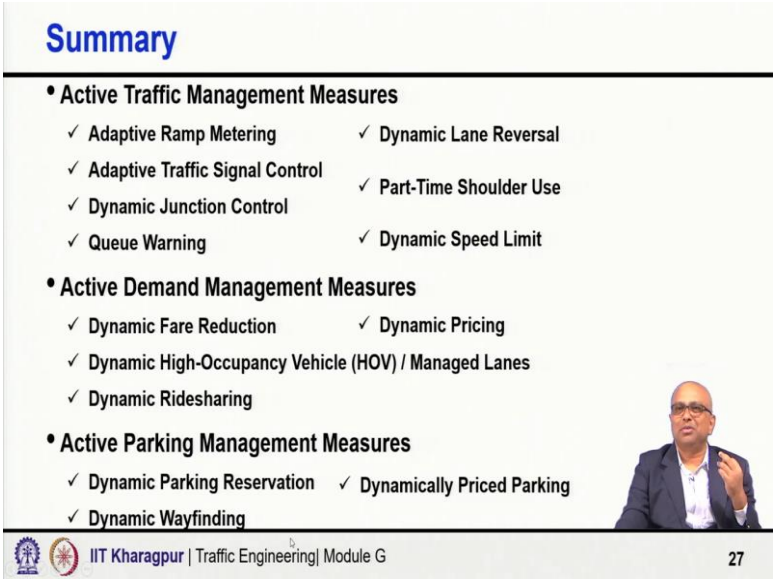

So, overall what we discussed in this lecture, we talked about the active traffic management measures, various strategies and measures, various ways we can implement active traffic management measures, we also discussed about active demand management measures and then active parking management measures. So, all these cases, the word active is very important because it is based on the real time data as we are getting the feed from the sensors and also based on huge such data available from the past.

And the algorithms which are working at the backend, AI based and even the conventional algorithms and they are giving excellent forecast or prediction. So, based on the current state and the forecast on the predictions based on that we are doing all sorts of traffic management, active traffic management, active demand management, active parking management to make better use of the existing facilities. With this, I close this lecture and close this module. Thank you so much.