Introduction to Multimodal Urban Transportation System

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Lecture-29
Non-Motorized Transportation (NMT) Planning: Pedestrian Flow Characteristics on Facilities

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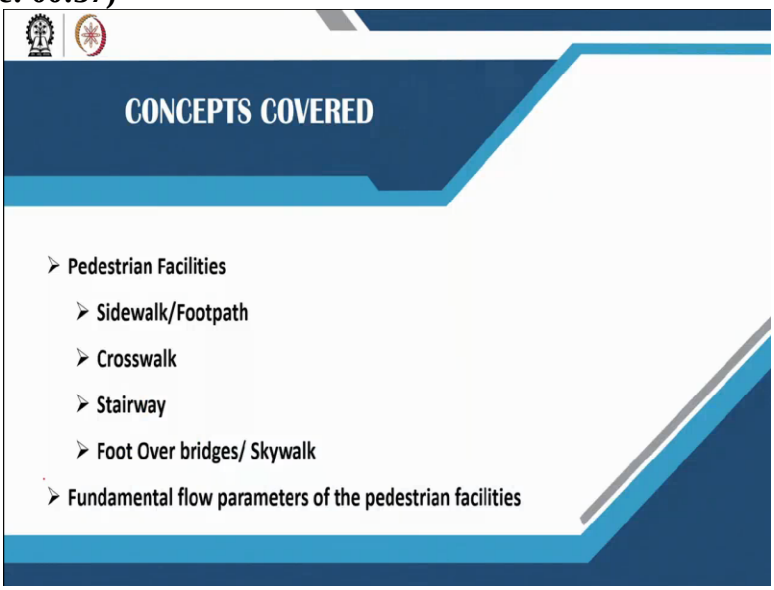

Welcome friends. So, in the last lecture, we looked at the different relationships between the different flow parameters, flow, speed and density and also space. In this lecture, let us look at the different types of pedestrian facilities and what are the important issues in each of these types of pedestrian facilities and how can you develop the flow parameters for each of these different types of pedestrian facilities. We will look at footpaths and sidewalks, crosswalks and also little bit of staircases and skywalk.

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So, when we talk about sidewalks and footpaths, there are different examples all across India. We have some pictures from Jaipur, Delhi, Pune, Gangtok and Hyderabad. So, while in Jaipur, in the old Jaipur area you would see in the shopping places, they have shade, not natural but built shade. So that the pedestrians or the shoppers can be shielded from the harsh weather. Whereas in New Delhi you would see, especially around the busy areas, ITO and such, you much wider sidewalks. Pune is retrofitting some of the shopping areas with newly designed facilities. New design guidelines are being followed and sidewalks are being developed. Gangtok has led the way in showing that even in hilly areas, if the pedestrian facilities are developed in a proper fashion there will be a lot of people willing to use it, especially tourists, who would otherwise want to use motorised modes to go around the city. They have made sure that they have enough pedestrian-only zones where they have restricted the width of the lanes that carry vehicles and have created pedestrian only zones. Also Charminar, which is an old city area in Hyderabad, which is an old city, but the Charminar area is even older, where pedestrian facilities used to be congested. Now they are trying to decongest that area and trying to improve the pedestrian flow there, because what they have noticed is that if there are more people who are walking along these sidewalks, they tend to shop more and in turn help the local economy as opposed to people who are on 2 wheelers or 4 wheelers, they tend to just cross the area and go by very quickly rather than wait there and shop. So, they have kind of found this relationship between local economy and walking. So, they are trying to decongest the area on Charminar and re-pedestrianize those areas.

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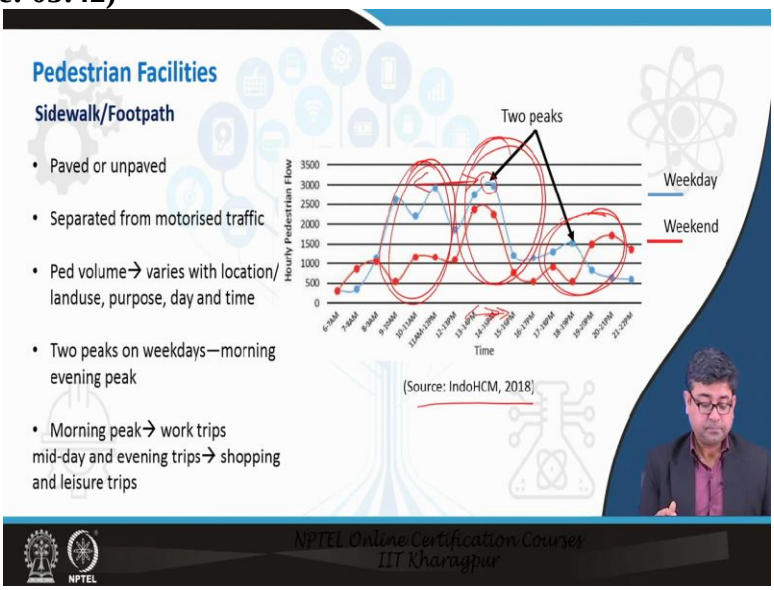

It has also been noticed and published in the IndoHCM that unlike vehicular behavior, which has two prominent peaks—the morning peak and the evening peak, here there is the morning peak and the evening peak, where the evening peak is much lower than the morning peak, and also there is an afternoon-ish peak. So if you see that around 1pm to 2pm there is a high number of pedestrian walking along the different facilities. So that could be because (a) could be the lunch break time for offices so people walk out of the offices to go for lunch; (b) afternoons and weekends; afternoons are usually the time when people go out shopping, so that creates another peak, so, morning peak, usually yes, everybody is walking to go to their work, school, college wherever, evening peak they are returning back. The peak is not as high as the morning peak. So that shows maybe in the evening, a lot of people are tired and then they usually do not want to walk so much. Maybe they are taking a lift from somebody in the office or they are carpooling or they are using a motorised means, so, morning they might have walked, but in the evening they are not walking as much. However, there is another peak in the afternoon. Which is significant peak as close as same as the morning if not even higher than the morning. So, shopping trips or eating trips during the weekdays indicate that peak.

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The other very important pedestrian facility is a crosswalk. Crosswalk is one facility where pedestrians interact with the motorised vehicles. Now these crosswalks could be at signalized intersections. And sometimes crosswalks are also put at mid-block sections which has to be put very carefully, but there are instances where there are marked crosswalks at mid-block sections because the distance between one intersection to the next is too high. So, usually, if anybody wants to cross the road, they would not walk to the nearest intersection, because that is too far a distance. So, they want to cross mid-block. So, at that point rather than not putting in a crosswalk, which encourages jaywalking and illegal behavior, so, it is better to put a marked crosswalk. But it has to be very carefully designed, so that there are no accidents happening. Now, if it is at a signalized intersection, it has to be taken care of that there is a pedestrian green phase that is given so that the people know what time and when to cross. When the red pedestrian sign is illuminated, that means the pedestrians should be not crossing that signalized intersection. So the pedestrians also know that you do not have to suddenly jump across this crosswalk. Because now you have a pedestrian signal which will indicate when you should cross so this is something that is very, very helpful.

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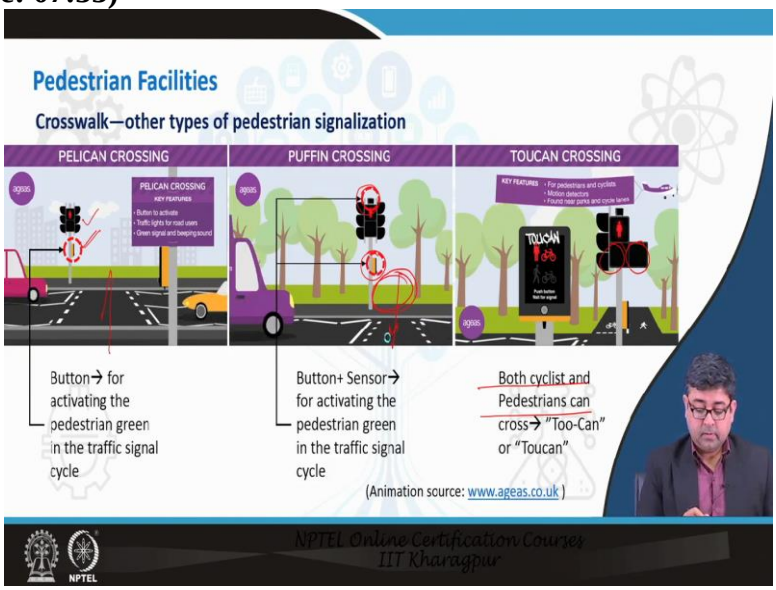

These are different examples of different types of crossings that are available. The most simple one is the button actuated. So there are buttons on poles, which the pedestrians can come and press and when it turns green for them. Now the pedestrians can cross and it must have turned red for the cars as well. Now when this is red, the cars are moving. Puffin are the more sophisticated ones, which have the button as well as a sensor on top of it. As soon as it detects anybody, any pedestrian waiting to cross, there is no need for anybody to press the button. It automatically turns the signal from red to green for the pedestrians and from green to red for the cars and the pedestrian can cross. Similarly, Toucan crossing is both for pedestrians and bicyclists. So now in this case, the behavior is more complex now because the behavior of the cyclists and the pedestrians are different. However, they are both non-motorised modes of transport. So they are kind of combined and the signal that is given has both the signal head of a pedestrian as well as a bicycle. So there is a combined mode. So there are all different types of pedestrian crossing, that can be incorporated at your context specific location, if it is a residential street, you may not want to have sensors, it may be with just having a pelican crossing, but whereas if it is a very crowded junction, then it is better to have a sensor which is always working to give crossing time to the pedestrians to cross.

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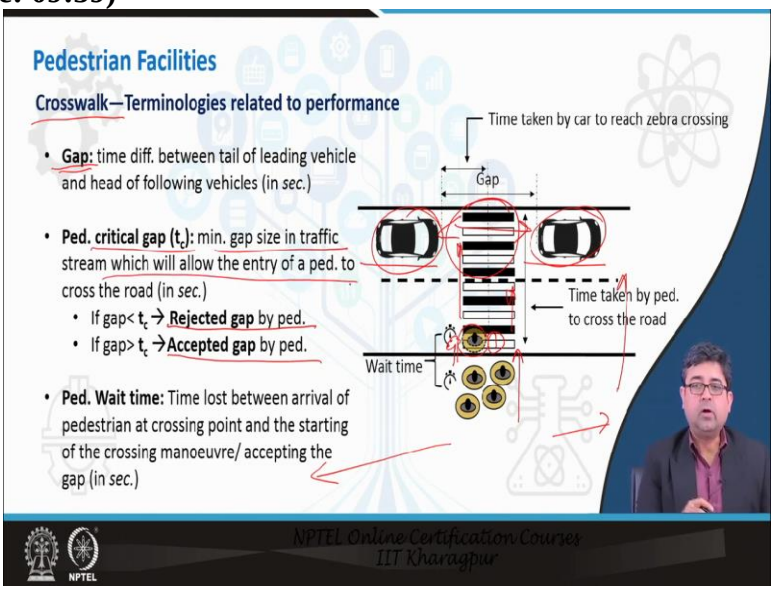

Now some of the important terminologies to understand for the crossing situation is that usually what people are looking for is the gap between the vehicles. So, this is especially, again I should clarify, this is a crosswalk at unsignalized intersections. So, there is no signal, but we have put a crosswalk here also. This is very important in case of intersections where the signalized intersections are too far away from each other. So, people will not walk all the way to the next junction in order to cross but they would want to cross where they are. How do you design that pedestrian signal here? What is it that you look for something at an unsignalized intersection? People look for is the gap between two vehicles, if a person perceives that there is enough gap between two cars that allows him to cross the road, he or she would take that gap.

However, if they perceive that this gap is not sufficient, then they would not take the gap which in turn means that they would still be waiting at this point. So, there is a gap which a person accepts and there is a gap that a person rejects. So usually, what happens is, there are multiple rejected gaps, that means the space between the vehicles is too less for this person to cross. So they wait, and they wait, and they wait and they reject multiple gaps and then there is a gap, which they see or they perceive that is sufficient for them to cross and then they accept that gap. So, it is very essential to find out which are the gaps that are being rejected by pedestrians, and which are the gaps that are being accepted by pedestrians in order to find out what is called a critical gap. Critical gap is a minimum gap size in traffic stream which will allow the entry of a pedestrian to cross the road. So, now because the behavior is different for different people, so for elderly people, they might need a larger gap, so they will be rejecting many gaps before

accepting something. Whereas, for younger people, they might need a very short gap and they will not reject many and they will just accept the first possible gap that is available. So that is the way in which pedestrian crossings are designed at unsignalized intersections. So, pedestrian wait time in turn is the time lost between the arrivals of the pedestrian to the crossing point and the starting of the crossing maneuver or acceptance. So, pedestrian wait time is how long is the pedestrian waiting before he or she accepts the gap.

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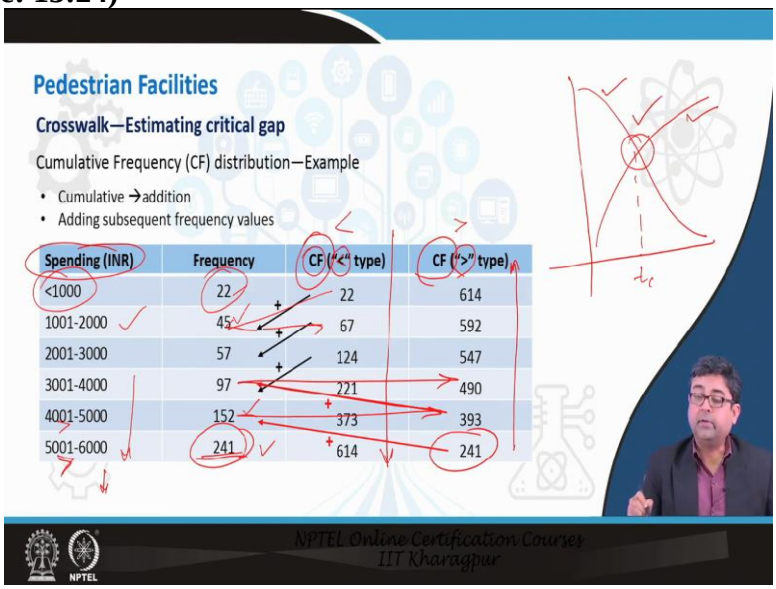

An easy way to make you understand is that say there is a hypothetical data. So, you have spending data, maybe monthly maybe daily spending data and you have how many people spend that much. So, you found out that there are less than 1000 rupees spent every day by 22 people whereas 1000 to 2000 is spent by 45 and so on and so forth. To develop these critical gaps you need to understand the cumulative frequency or the number of people who are less than a certain type, and the cumulative frequency of a people of the people who are greater than a certain time. If you develop a curve of people something greater than a certain type and a cumulative curve of people less than a certain time, both of them would intersect at a point and that point usually, we call it as critical gap. So, in order to understand critical gap, you just have to develop cumulative frequency and the way to develop cumulative frequency is very easy. If you want to know, all the people who have spent less than 1000 you already know 22. Now, if you know if you want all the people who spent less than 2000. Then all you do is you add 22 to 45 you will know 66. Similarly, you add 60 and 65 you know, now, on the other hand if you want to know all the people who have spent more than 5000. So, you know that between 5000-

6000 we have 241. So, more than 5000 should be all of these people. Now, what is more than 4000? They would be all the people between 4000-5000 plus all the people between 5000-6000 so, 241 + 152 would give you 393. Similarly, 393 + 97 would give you 490. So, that is the cumulative frequency curve for the greater type and this is the cumulative frequency type to the smaller type. So, intersection point is what we are trying to develop.

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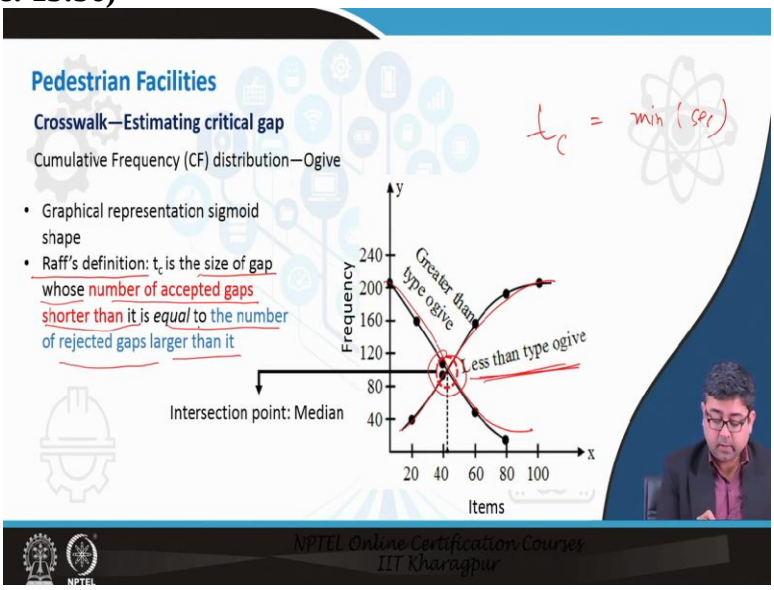

So, this is the less than type; this is the greater than type. Definition of the critical gap is given by Raff, who says that critical gap is the size of the gap whose number of accepted gaps shorter than is equal to the number of rejected gaps larger than it. So, critical gap is usually given in minutes or seconds or whatever it is. So, it is the size of the gap whose number of accepted gaps shorter than it is equal to the number of rejected gaps larger than it; that is the point we are trying to figure out.

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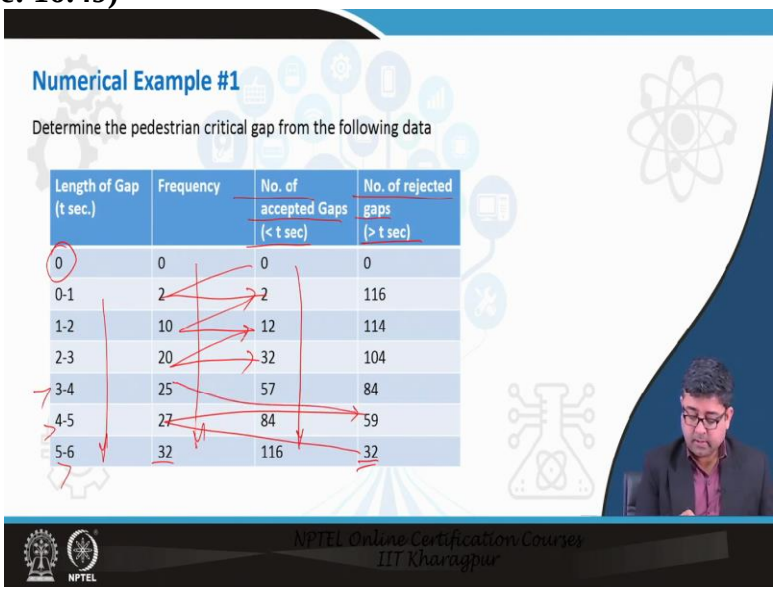

So, if you have a data like this, the gap length is given in ranges the number of people who have accepted this length of a gap is this, then you can develop the number of people accepted gaps less than t seconds. So the less than t seconds will be nothing but 0 + 2 = 2 + 10 = 12 + 20 = 32 it is the cumulative graph for that. And similarly, the cumulative graph or number of rejected gaps greater than t second would be anything greater than 5 seconds, greater than 5 seconds is all the 32; anything greater than 4 seconds would be 32 + 27. Then anything greater than 3 seconds would be 59 + 84 and so on.

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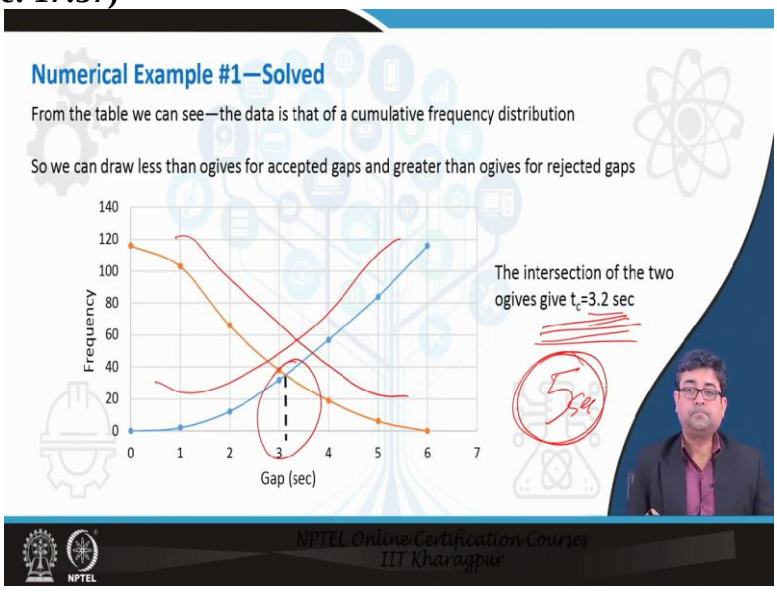

So, when you plot these two, you will find out that the critical gap is 3.2 seconds. So, it shows that 3.2 seconds is that time, which actually should be given when you are designing a crosswalk at unsignalized intersection. So, there should be at least 3.2 seconds between 2 cars and that is when you can cross a facility. So, you have to do all the calculations of how your vehicles are flowing. What is the headway between the 2 vehicles and then at an opportune location along that street, you provide this crosswalk which tells you that at this location usually 95% of the time there is a critical gap there is at least a gap of 3.2 seconds, maybe the gap between two vehicles at that location for 95% of the time is say 5 seconds. So you are confident that because only 3.2 seconds is needed for a person to cross that road. So, this this location is a good location to provide a crosswalk.

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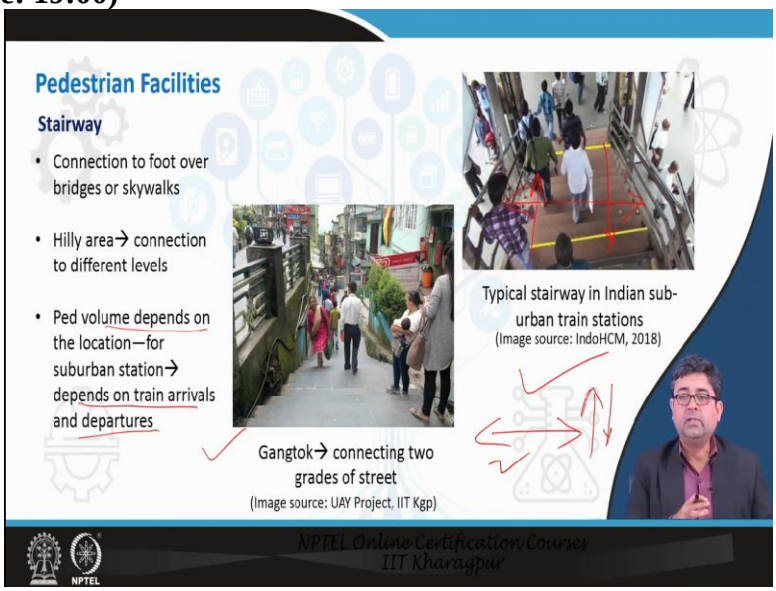

Stairways can be placed indoors as well as outdoors. Many stairways can be placed along the railway stations; there are many stairways where there are level differences, or it is a hilly terrain and so on and so forth. So the pedestrian volume depends on the location, for suburban station this depends on the train arrivals and departures. So how much width of your staircase should you provide? This again depends on the flow of people, bidirectional flow of people along those facilities. We all showed you already the relationship between flow and speed, flow and density. So based on those relationships, in this case, if people are going up, the speed will be less than the people who are going down and collectively this speed on any kind of stairway will be less than usually the speed on a flat road. On flat road people are faster whereas if you are going up then slower. In previous lectures, we had told you the basic relationship between

the flow parameters with the help of which we can design these facilities in a much better way. So, many times you would see that, these staircases are too steep. If they are too steep, then it is very difficult to climb up, meaning their speed goes down, and people stop using that facility. So, many times when there are foot-over-bridges, that is a very important parameter to make sure that the steps are not very steep, then people do not use the foot over bridge and they start crossing on the road at-grade itself. So, that is a very important parameter to understand.

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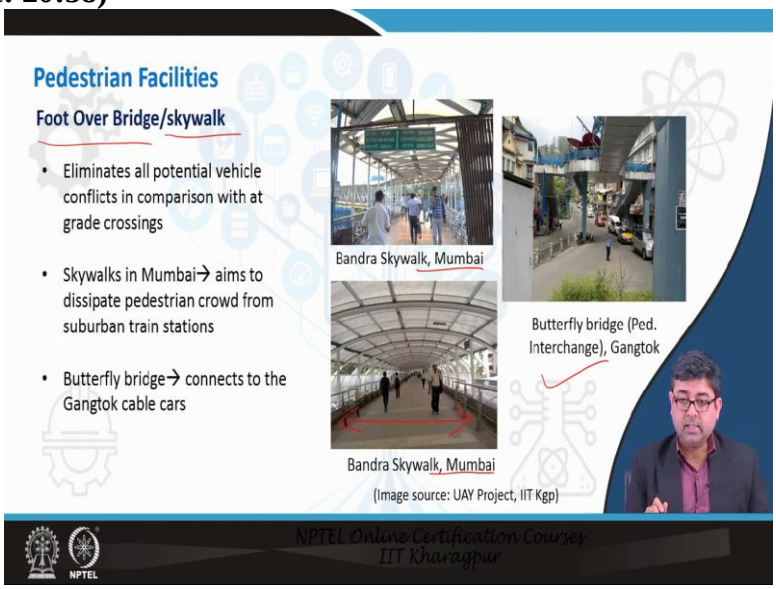

There are some select places in the country that have have foot-over-bridges but then also something called skywalks. The skywalks are usually longer foot over bridges. Foot over bridges are usually from one part of the intersection to the other part of the intersection, whereas skywalks are something that connect you or that segregate pedestrian traffic from the vehicular traffic for a longer stretch of the road. So you will usually see in Mumbai, many of the suburban railway stations are connected with skywalks, because there is a huge volume of people that come out of these suburban railway stations and to avoid them getting on the streets, the network of skywalks that take people away from the suburban railway stations to appropriate locations. And where they can then take a bus or a taxi or whatever they want to. Similarly, there is a butterfly interchange in Gangtok as well which helps pedestrians to weave through the different gradient or different slopes of roads. So, again here also, how much width of these skywalk should you provide depends upon your understanding of the flow parameters the speed and the density and the space required. So, you will see the in this case where there are very few people walking you would think that maybe there we have already provided very

large width and this is not being utilized. However, the picture would be different when a suburban train arrives so, at that point, the rush may be so high that this will be utilized to the maximum. So, again depends upon for what capacity you are trying to build your infrastructure is it just peak hour capacity you are trying build (usually people build it for peak hour capacity) so that the system does not fail the largest volume of pedestrian coming, whereas other times usually the situation is much better. The flow may be lower, but the comfort and speed is better.

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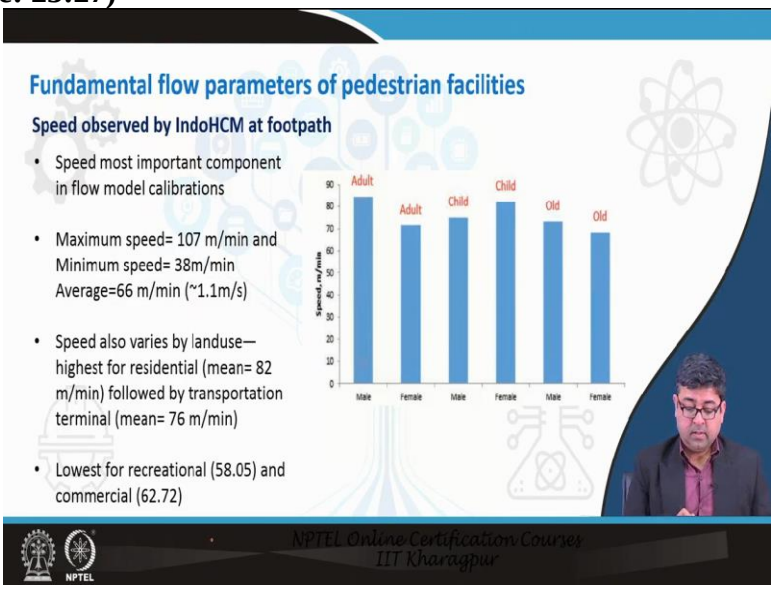

Observing the Indo HCM, for footpaths, maximum speed, minimum speed, they are all given to you. It is a very good idea to at least get a copy of the Indo HCM, which has, for the first time in Indian conditions developed these relationships.

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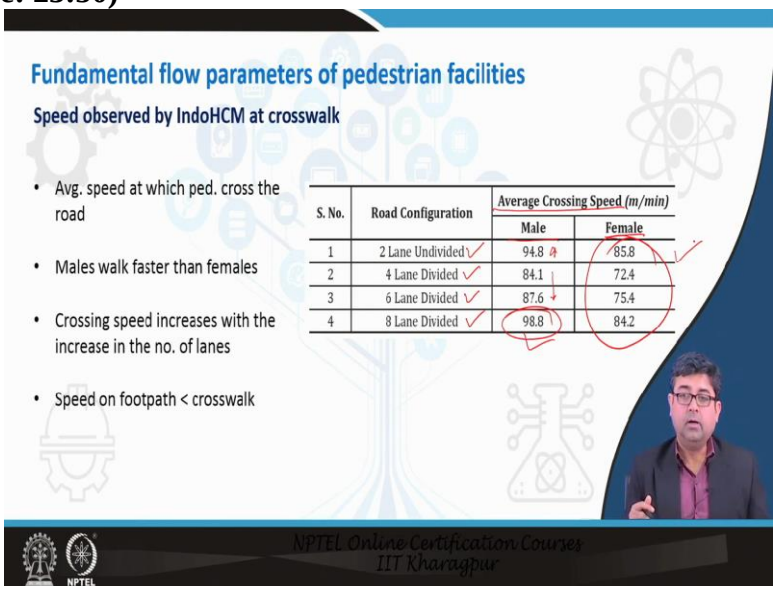

It also shows you average crossing speeds by male and female for different types of road configurations. So if it is a 2 lane un-divided road, the speeds are pretty high for males, whereas they go down for females. When there is 4 lane, 6 lane, 8 lane divided they are high because they usually they have a median, and cross into 2 different regimes rather than 1 regime. So they cross—quickly stop, and then they cross quickly again. So that is why the speeds are kind of higher and female speeds are usually less than the male speeds. So then you always have to make sure that when you are looking for the critical gap, you, design it for female speeds as well. So the female critical gap is how much versus the male critical gap, you have to make sure that you are designing it for both of them and not only for a male who is crossing.

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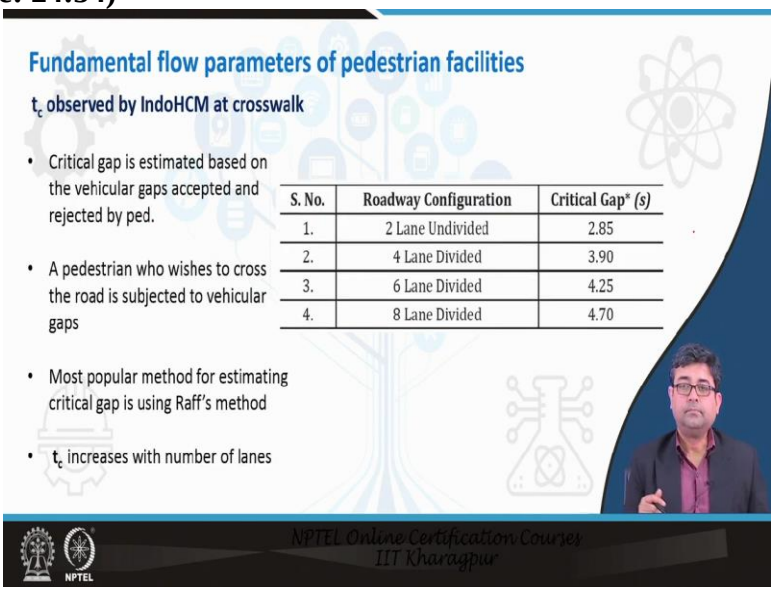

Similarly, so here are the critical gaps for each of those lane configurations. For a 2 lane road, people quickly cross as they are very confident, even if they just have 2.85 seconds between 2 vehicles. Our vehicle A is here and vehicle B is here, and it is only 2.85 seconds is enough for a person to cross, whereas when it is 4 lane divided, he or she is a little bit more careful, and we need the larger gaps. Whereas if 8 lane was the largest gap size.

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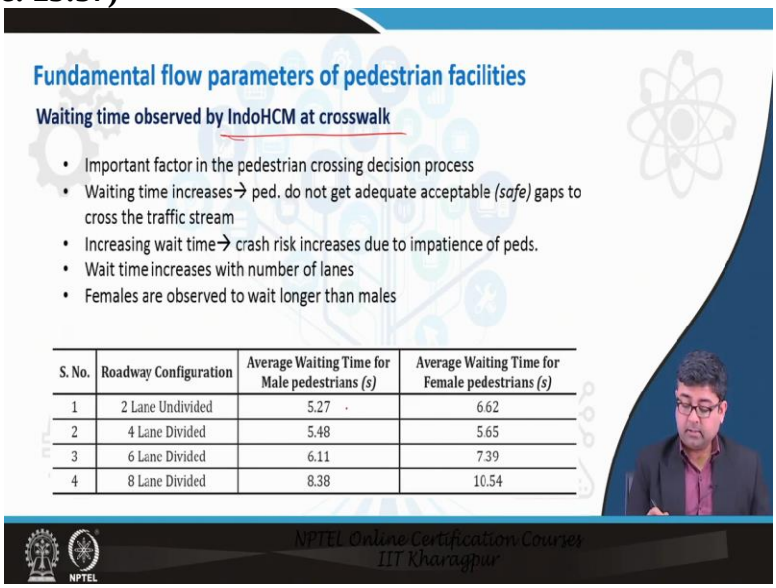

Waiting time for crosswalks can be just seen as in relationship to the critical gaps. For waiting times on 2 lanes is much lower since the critical gap is the lowest they also wait for the lowest amount of time. Whereas as the critical gap also kept on increasing as we saw in the previous

slide, so, does the average waiting time also keeps on increasing and the difference between the male and the female are, shown.

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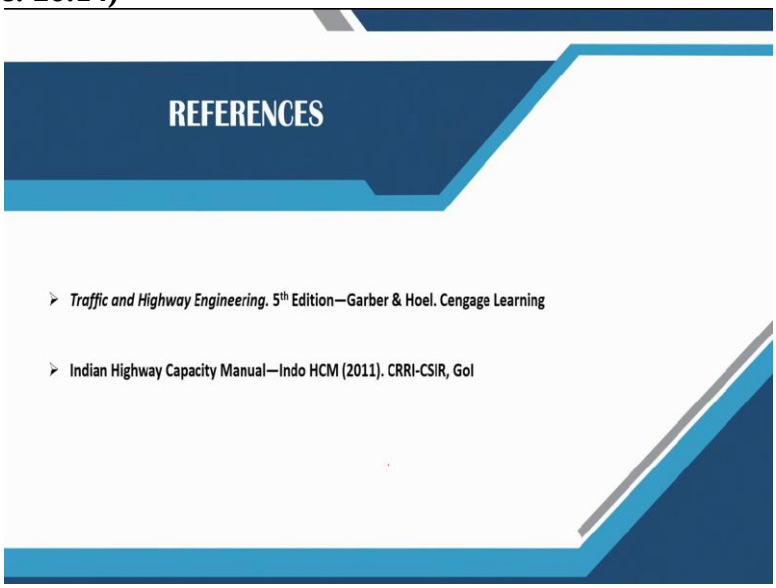

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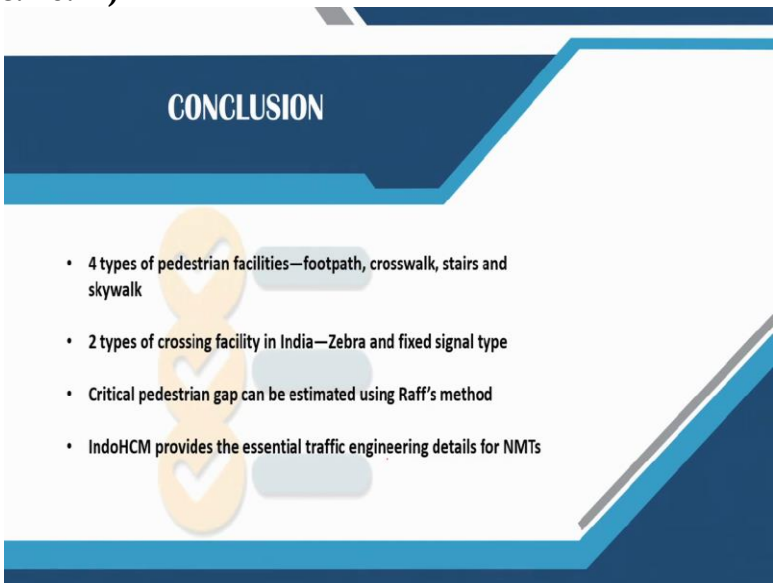

So, that brings us to the end of this lecture. Again the references are provided here, what we showed you in this lecture is the different types of pedestrian facilities and how the flow parameters have to be kept in mind while you are designing for different types of flow, and for different types of pedestrian facilities. Especially when it comes to crossing facilities in India, we showed you how you can have only a pedestrian crossing signal. You can have a pedestrian crossing signal along with a bicycle crossing signal as well.

And when you have a crossing facility without any signal what is that you should keep in mind while designing such a crosswalk is the critical gap that is that pedestrians accept. So, how do we calculate critical gap we showed you an example of that and the various standards that has been observed in the Indian situation and are depicted in the Indo HCM was also shown to you during this lecture series. Thank you.