Introduction to Multimodal Urban Transportation System

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Lecture – 33
Non-Motorized Transportation (NMT) Planning: HCM 2010 Methodology for PLOS (Contnd)

Welcome back friends so in this lecture we will continue our previous discussion of developing pedestrian level of service scores and then pedestrian level of service grades for an urban pedestrian facility.

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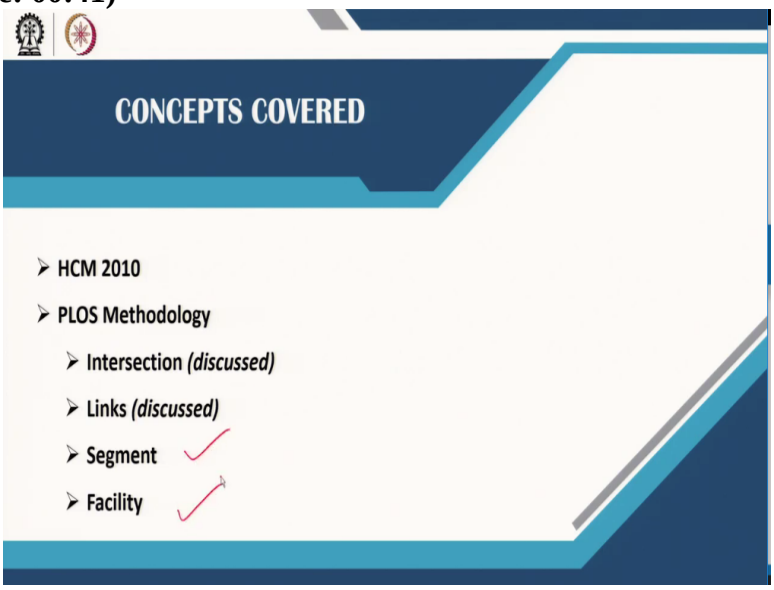

We have already looked at calculating predestine level of service scores for intersection and links. So, in this lecture we will start looking at how do you calculate it for the segment and for a facility.

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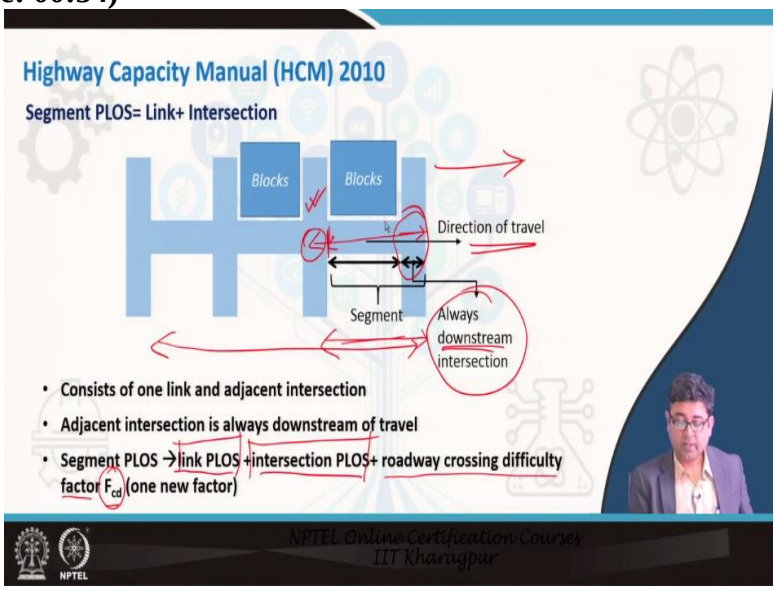

So, as you remember again what is a segment and what is a facility. So, a segment is a combination of the intersection and the link as far as you have a signalized intersection, if you do not have a signalized intersection between the two blocks, then you can continue it till you find a signalized intersection. So that is a segment, and then facility is considered the entire summation of all the segments. So, in order to determine the pedestrian level of service score for a segment, it is nothing but the link pedestrian level of service scores, the intersection pedestrian level of service score and in addition to that, we have another factor called the roadway crossing difficulty factor or F_{cd}. You already know these two, we already told you how to use the formulas involved in calculating these two elements. Now you will calculate a further element which is called the roadway crossing difficulty factor, and then you will be able to determine the pedestrian level of service score for a segment. You know one thing to remember in this case is we are always calculating in the direction of travel, and the intersection that has to be considered is always the downstream intersection and not the upstream one. So always include the pedestrian level of service score of the downstream intersection and add it to the link in the direction of travel.

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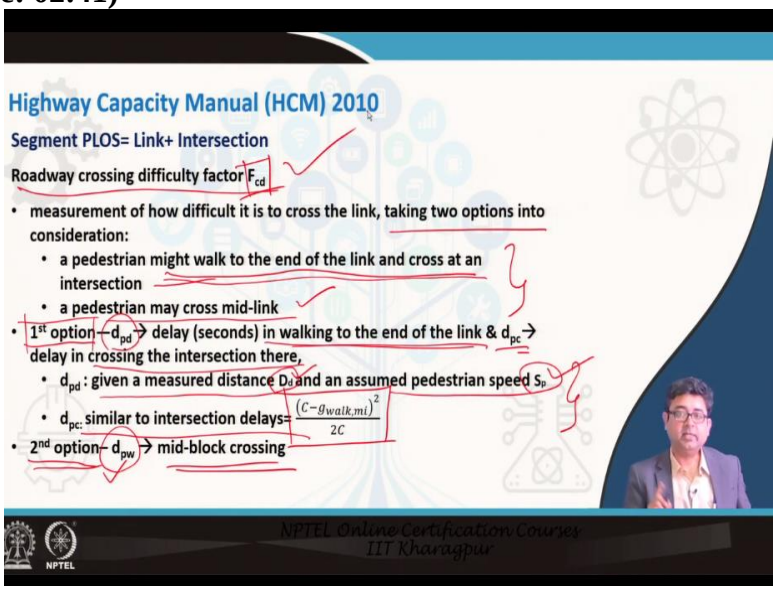

What do you have to measure in the field in order to calculate this fourth factor which is the roadway crossing difficulty factor? It has two options, one is a pedestrian might walk at the end of the link and then crosses at an intersection, that may be one situation. Whereas the other situation may be the pedestrian may cross mid link or midblock. It may arise that you may come across any one of these two situations. So, for each of those two situations we have to understand what this factor is going to be, if the situation is such that the pedestrian is walking till the end of the link and then crossing at the intersection, then you calculate what is called a delay in walking to the end of the link plus the delay in crossing the intersection, and delay in crossing the intersection, you already know is given by this formula. Whereas the delay in walking to the end of the link is a measured distance for that d_{pd} and an assumed pedestrian speed of S_p. Right. So, you assume a stream of pedestrians and are walking at the speed and for that distance along that segment. And what is the delay in walking? Those two elements you have to understand if you are taking if you are considering the first option where the pedestrian walks till the end and then cross at an intersection. However, if you consider the second option where the pedestrian may cross midblock, then you have to calculate the delay of such pedestrians who are trying to cross midblock. So, we will tell you how each of these delays you can calculate in order to determine the F_{cd} factor.

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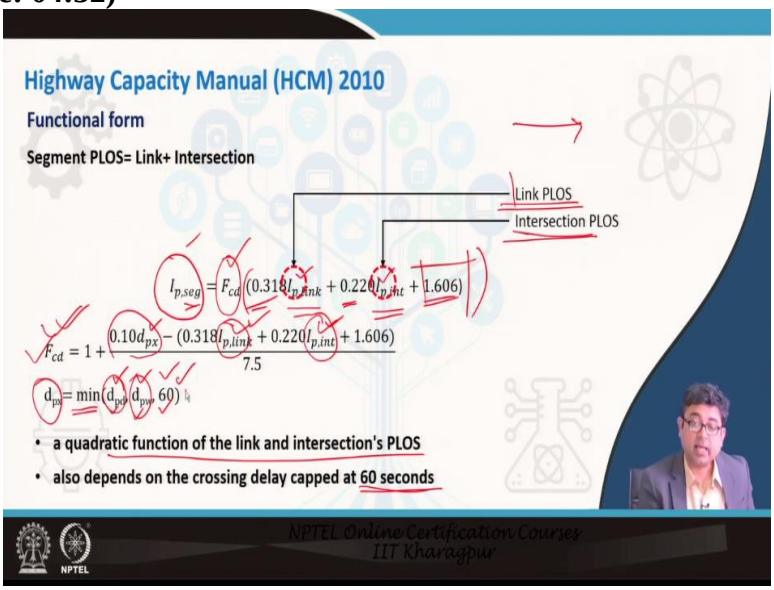

So, in order to know the pedestrian level of service scores for a segment, you have to know the pedestrian level of service score of the link. You have to know the pedestrian level of service score of the downstream intersection in the direction of travel. You have to know both of those multiplied by certain factors and added to a constant, all of this has to be then multiplied by what is called the F_{cd} factor.

$$I_{p,seg} = F_{cd}(0.318I_{p,link} + 0.220I_{p,int} + 1.606)$$

$$F_{cd} = 1 + \frac{0.10d_{px} - (0.318I_{p,link} + 0.220I_{p,int} + 1.606)}{7.5}$$

$$d_{px} = \min(d_{pd}, d_{pw}, 60)$$

The F_{cd} factor is given by this formula again, it is a quadratic function link, what the F_{cd} tells you is that you already know your link score, you already know your intersection score. All you have to calculate is this delay that the passenger encounters and that delay depends upon those two options or the two conditions that we already discussed. The pedestrian may walk the entire segment or walk the entire link and then cross at the intersection. Said case two the pedestrian may cross midblock, so it is the minimum delay if they walk the entire segment if they cross midblock, or 60 seconds. So, whichever is the minimum that will be the delay, so once you determine the delay and plug it in here, you already know what these two are, you will get that

before you plug in that value here. So, it becomes a quadratic equation right and you will get the pedestrian level of score for the segment. So, this is capped at 60 meaning this is the minimum of these three, so even if the delay faced by a pedestrian crossing midblock is greater than 60 seconds or greater than a minute, but we will cap it only at 60.

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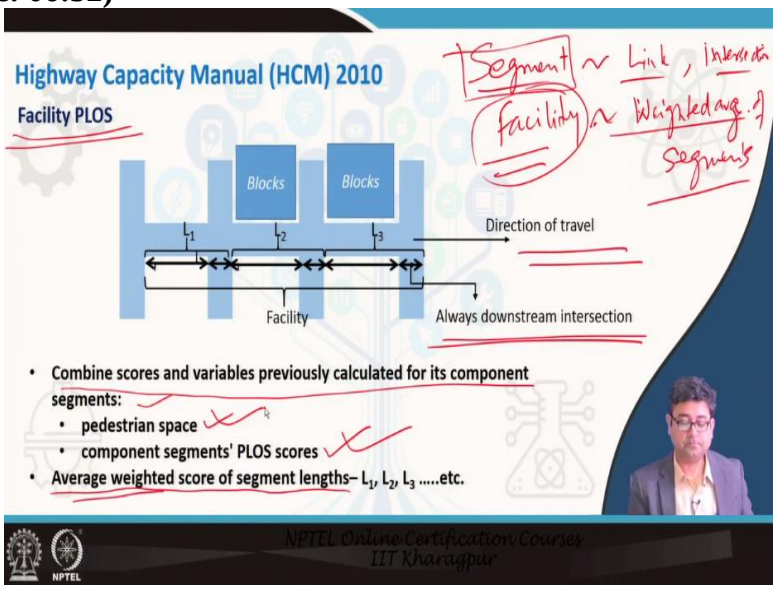

So once you know that, now you have calculated the pedestrian level of service score for an intersection and link and now you have calculated for the segment as well. Once you know all of these, then you have to calculate the pedestrian level or service score for the facility. Now, this combines the scores previously calculated for each of its components for the pedestrian space available and all of these components' pedestrian scores. Again, you have to calculate now the average weighted score of the segments. It is easy to remember, a segment is usually a combination of two elements of link and intersection whereas a facility is a combination of segments. That is how you have to remember, if you just have to remember it off the top of your head. So, we already know all of this. Now if we calculate the weighted average score of all of these segments, you will determine the pedestrian level of service score for the facility. Weighted average is weighted by the lengths. So, how much length is each segment, that is how the pedestrian level of scores of each of those segments are weighted. Again, it is in the direction of travel, always the downstream intersection is taken into account. So, once you know the score and you know the pedestrian space available for the entire facility, then you will be able to determine the pedestrian level of service offered by the facility.

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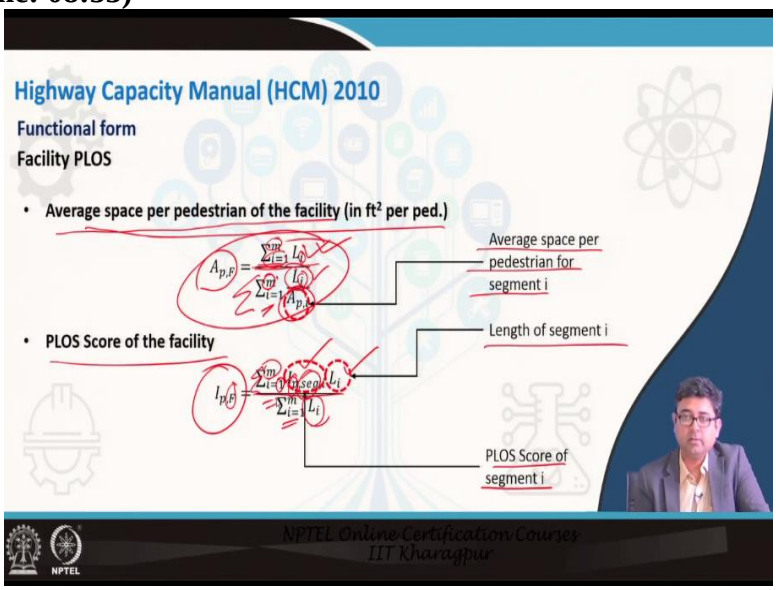

The average space per pedestrian for the entire facility will be given by just the summation of all the lengths of the segments divided by average space per pedestrian for each segment summed over length by segment.

$$A_{p,F} = \frac{\sum_{i=1}^{m} L_i}{\sum_{i=1}^{m} \frac{L_i}{A_{p,i}}} \qquad I_{p,F} = \frac{\sum_{i=1}^{m} I_{p,seg,i}\, L_i}{\sum_{i=1}^{m} L_i}$$

This is length of segment divided by the area of the pedestrian for that segment summed over all the segments, i=1 to m, which is in the denominator and then in the numerator is the length of each of the segments, sum from segment i=1 to m. That will give you the average space per pedestrian of the entire facility, and the PLOS score of that entire facility will now depend upon the weighted average. Remember we told you that it is the weighted average of all the lengths of the segments. PLOS score for the segment i this summed over from segment 1 to segment m divided by just the length of each of the segments 1 to m, okay, that will give you the pedestrian level of service score for the facility (shown as F). So, when you say 'F', it is facility, and when you say 'seg' it is for the segment; 'p' is always pedestrian; 'I' would be the intersection and 'L' would be the link.

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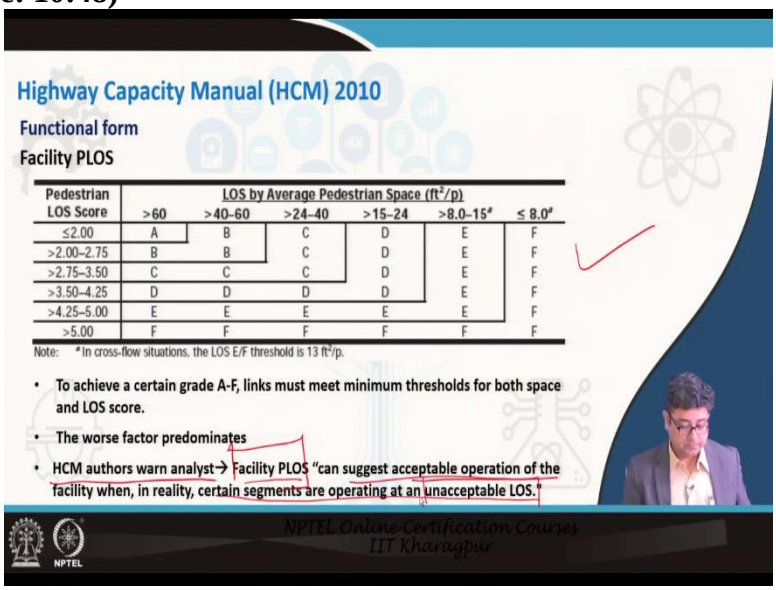

Similarly, this is a same table that we have already shown you for the different links this can be developed for the different facilities as well. Okay. The HCM authors have a small warning saying that the facility PLOS can suggest acceptable operations of the facility when in reality certain segments are operating at an unacceptable level of service. So what happens is that since you are doing a weighted average of all the segments. In order to calculate the pedestrian level of service of the facility as a whole within that facility certain segments may still be operating under unacceptable level of service, but that may be only for a smaller length because it is weighted average of the segment lengths. But even if that small length is operating at unacceptable pedestrian level of service, the entire facility may be having a good pedestrian level of service. So if you are looking at it at a facility scale then you may not get a realistic understanding of the micro pedestrian level of service offered by individual links and intersections in that facility. So if you have took know the micro level then you have to calculate the link or the intersection, pedestrian level of service scores in order to make identified changes or makes very pertinent changes, spatial changes in your network. So the facility scores may not be always representative of the individual level of service along that facility. So you have to be careful when you are conducting or when you are depicting a pedestrian level of service of the entire facility.

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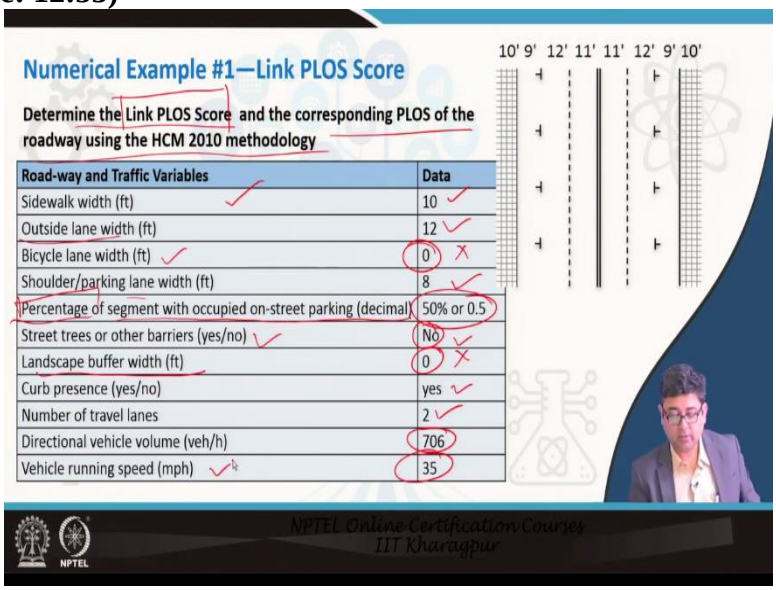

So let us give you a simple example where you will understand what all the inputs that are needed. Inputs meaning what are all the data that you have to actually collect in the field. If there is already data that is available then it just becomes an exercise of plugging in that data into this particular equation and determining the pedestrian level of service. However in Indian conditions you may not have all this data available to you at a point in time. So you may have to undertake an exercise of picking a facility, picking different links within that facility, picking different intersections within that facility and then calculating the pedestrian level of service score for each of those intersections, links. Summing it up to a segment level and then summing it up to a facility level. So if you were to be asked to determine the link Pedestrian level of service score and the corresponding pedestrian level of the roadway using the HCM 2010 methodology how would you do it? So, for example you then have to know what the sidewalk width, here it is given us 10 feet. Flow the outside lane width, to go back to the formula, remember the outside lane width is necessary in order to determine the effective width. So you would know the outside lane width or would know the bicycle lane width. In this case, there is no bicycle lane present, you have to know either the shoulder or the parking lane width right. You have to know the percentage of segment with occupied on street parking. If on street parking is permitted alongside that facility you have to know what percentage of that segment 50% or 0.5 or whatever you have to know the percentage. You have to know if there are barriers which is just a 0, 1 or yes, no kind of input that you require. You have to know that landscape buffer width, since there is no barrier, no tree, so the buffer width will also be 0 in

this case. Curb presence yes or no? Do you have a curb and gutter or a curb in that facility? Again 0 or 1 and a yes or no kind of input. The number of travel lanes: so, this case there are two lanes directional volume you have to know the volume of vehicles. Remember volume of vehicles is important and the vehicular running speed is also important. So vehicle running speed say 35 miles per hour.

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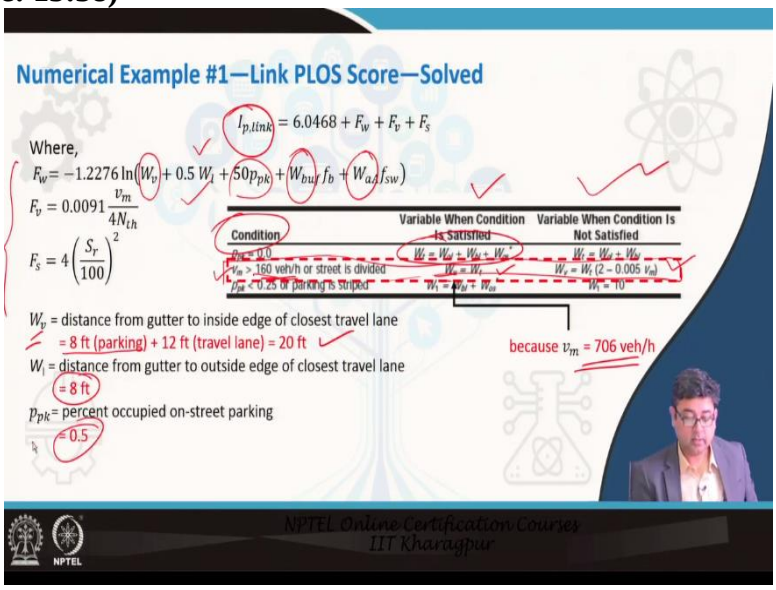

Now given all of this situation, first you have to start understanding what is the link pedestrian level of service right we have told you all these what are the individual formulas for this. So the link pedestrian so far in order to calculate the link production service. Remember you have to know the weighted or the effective width of the outside lane bicycle lane as well as the parking or shoulder width. So that W_l you have to know the effective width of the outside shoulder lane plus the bicycle lane, percentage of parking if there is any buffer width. So since we have for different conditions have to use different formulas to find out the width. So in this condition what we have noticed is that since the volume of vehicles is 706, which is greater than 160 vehicles per hours. So, we will use this formula to calculate the calculate all the W_v. For, W_v again we have to pick which formula either this formula or that formula. So, if the condition is satisfied you do this, if it is not satisfied you just use the other form. So in this case distance from the gutter to the inside of the closest travel, 8 feet of parking plus 12 feet of travel lane. You have 8 feet of parking, 12 feet of traveling that gives you 20 feet distance from the outside is too close travel lane 8 feet of parking is given 50% of it has parking. So you know all of these three.

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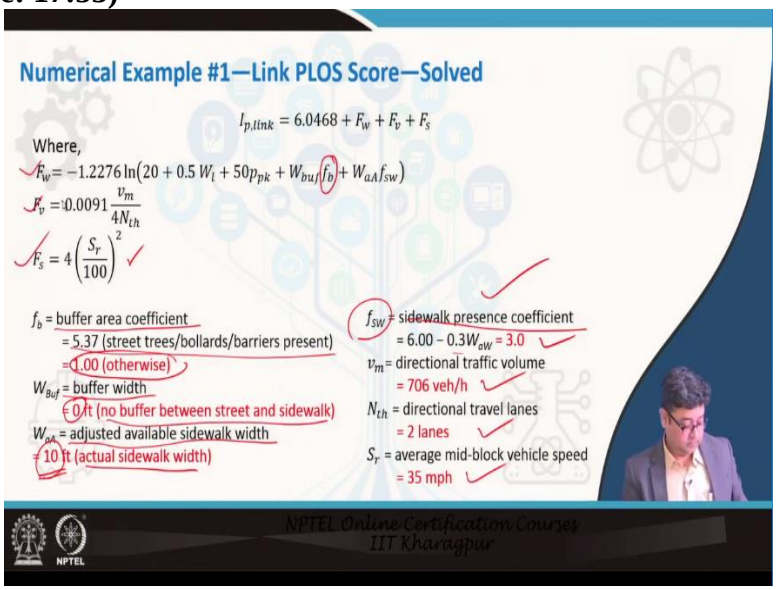

Once you know all of these 3 what is given? How do you determine this? Factor of a buffer area coefficient is 5.37, if it is continuously present at a height of at least 3 feet but in this case it is not present nothing is given to you saying that it is continuously present and the height of it is 3 feet. So we will consider f_b as 1. So we will take it as 0. And the adjusted sidewalk width available is the actual sidewalk width because we have not said that anything is encroached upon on that sidewalk. So we will actually take the entire width. In this case the sidewalk, so if you calculate if we just put 10 here. So you will know the factor of sidewalk presence coefficient which comes out to be 3. We already know this, we already know this, we all know the average speed here, we will know each of these factors.

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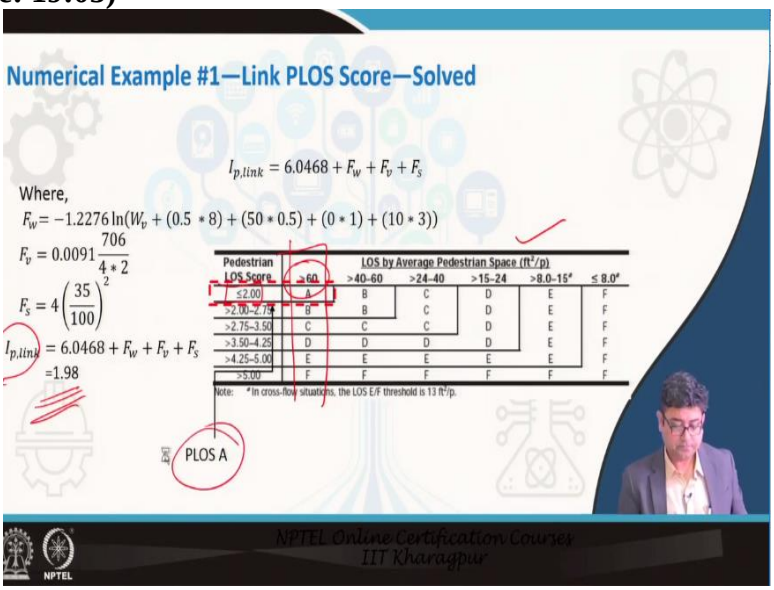

Now, if you just calculate each of this you will see that you get a score of the link score of 1.98. So you have already got the link score of 1.98 you have already calculated average space or in this case you do not even have to calculate the average space because it is already satisfying this criteria of less than less than or equal to 2. If it is less than or equal to 2 you can categorize that as a pedestrian level of service A. We will just go back to see if there is a value given to the average space available because the space is also one of the factors which is necessary in order to find out the pedestrian level of service score. So, in this case we assume that a pedestrian space of something greater than 60 was provided and hence you get a pedestrian level of service of A.

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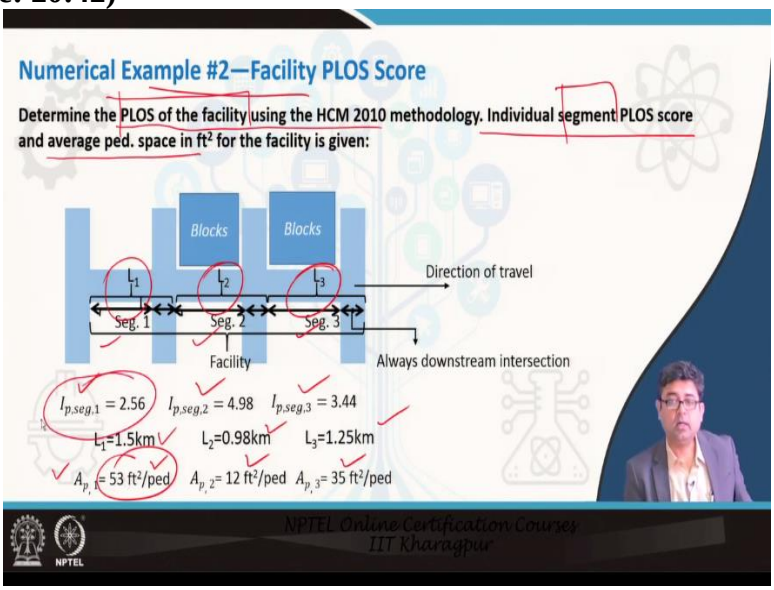

Similarly, now in the second example what we want to find out is if you have multiple such segments or multiple links and intersections. Now if you want to calculate the pedestrian level of service of the entire facility, how do you do that? You have to calculate the pedestrian level of scores for individual segments and you have to have an average pedestrian space in square foot in order to understand that. So if you are given three different segments and if you are told that the segment pedestrian level of scores are this, each of the segments are this kilometres long and the area average area available along each of these segments are this. So this is very simplistic where you are given already the area and you are given each of these segments pedestrian level of score for each of these segments.

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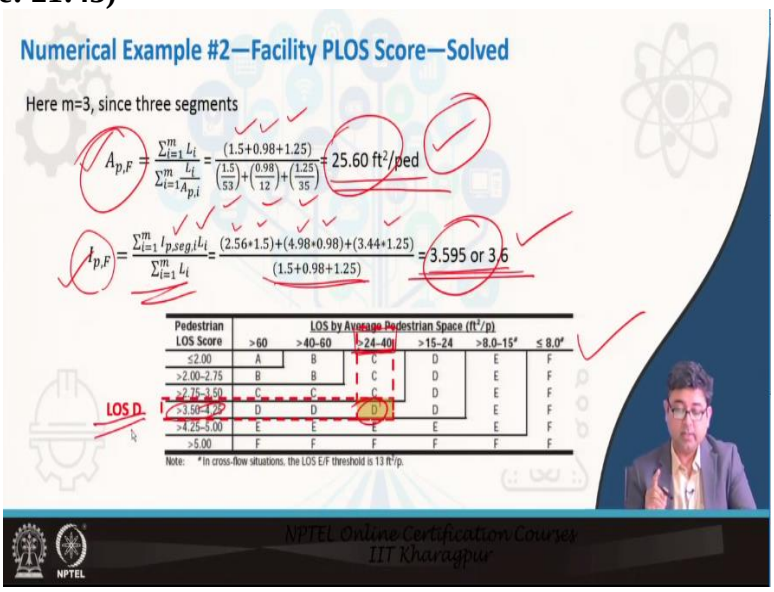

Then all you have to do is, because you just have to calculate the weighted average and we have already given you the formulas. So each summation of each of the lengths and this is the summation of the length divided by the areas. So you know that the average pedestrian space available in the facility is 25.60. In order to calculate the pedestrian level of service score for the entire facility. You have to again just do a weighted average of the individual pedestrian level of service score for the segments by their length and divided up by the individual lengths. So if you know each of the lengths you will know that the pedestrian level of service for the entire facility is 3.59 or 3.6. So by knowing both of these you kind of come to this table. You will see that it is 25 so it will fall in this category and this is 3.6, so it falls in this category so your level of service for the entire facility is D. So this is a very simplistic example where we gave you the individual pedestrian level of service for the individual segments but if you are also told to calculate the pedestrian level of scores for all these segments you should be able to do it. Because you know how to calculate the pedestrian level of service scores for the links as well as how to calculate the pedestrian level of score for the intersections as well as. So intersection plus link will give you the segment and then weighted average of all the segments will give you the pedestrian level service score for the facility.

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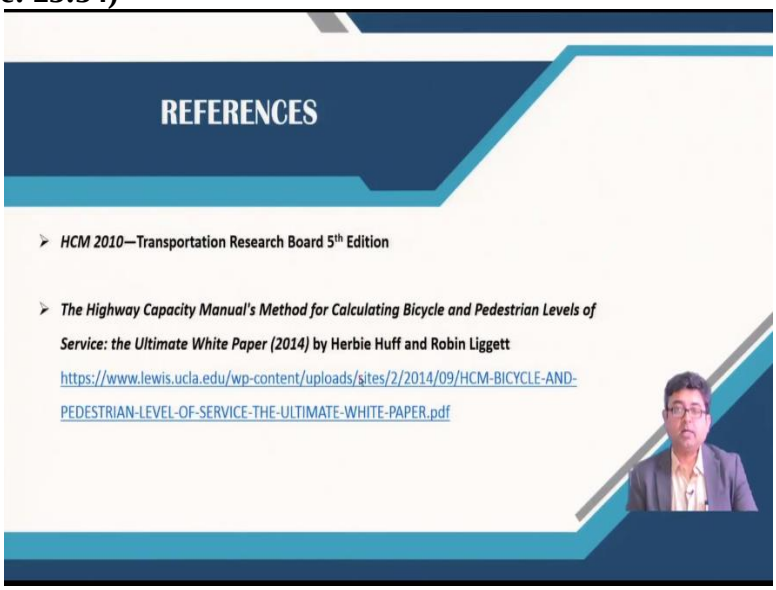

So that hopefully it was an extended session from the last lecture as well where in the last lecture, we only told you about how to calculate the pedestrian level of service for the link and the intersection in this section. In this lecture, we continued from that to tell you about how to calculate the pedestrian level of service for the entire segment and then for the entire facility. So you have to look at both of these lectures in one continuous order to understand the entire picture. We have also given you a simple example of how to calculate each of the level of service hopefully you would be able to now take this methodology and develop pedestrian level of service scores for different facilities in your city as well. These are the references, essentially we have used the HCM 2010 method and all of the calculations are based on this study that was used for developing the predictive model.

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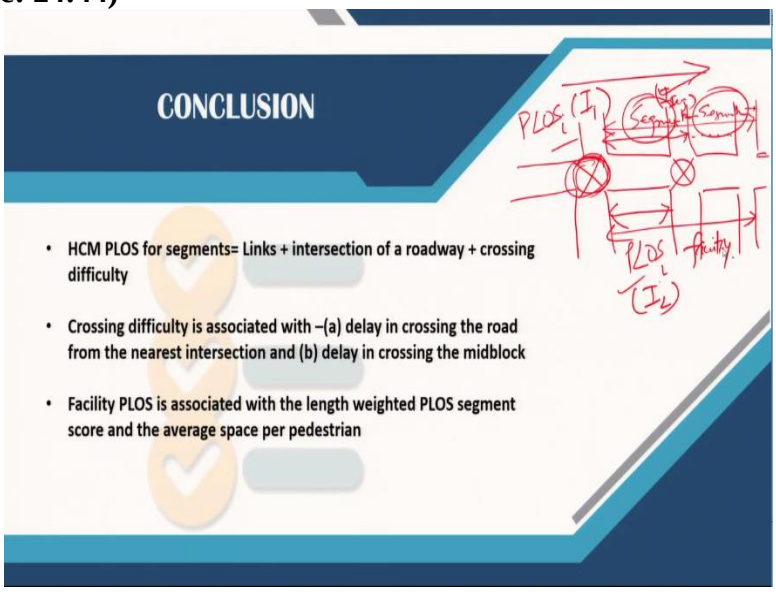

So in conclusion one thing to remember is that there are different units for a facility right for a pedestrian facility you have different units. So you have to consider each of the units separately when you are trying to develop a pedestrian level of service score. So if this is a facility and you are walking along this direction. So, intersection pedestrian level of service would be this. So you are calculating a pedestrian level of service for an intersection which may or may not have a signal because not all signals or not all intersections are signalized. So if you are only looking at this, you are looking at a pedestrian level of service score for an intersection or that is given by I_i. Whereas if you are looking at a link you are looking at only this segment so that is a pedestrian level of service score for only a link L. Now you may be looking at a link plus the downstream intersection, given that this intersection is also signalized. If it is not signalized then you have to carry on to the next signalized intersection. So say that this is the next signalized intersection or that will be the segment right. So that is given by I_{seg} pedestrian level of service score. Then if you are looking at the entire facility, you have to take it and go to the downstream signal. So that will consists of multiple segments—this will be segment one, this will be segment two right. So that segment one and segment two together will constitute the facility. So we have given you an entire understanding of how to develop the pedestrian level of service scores for intersections links segments as well as the facility which will now allow you to take it forward and do it for your own city or town. Thank you.