Introduction to Multimodal Urban Transportation System
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Lecture – 58
Urban Transport and Sustainability:
Predicting Vehicle-Pedestrian and Vehicle-Bicycle Conflicts

Welcome back friends. Now that we have introduced you to safety performance functions and accident modification factors, let us look at the different ways to predict vehicle-pedestrian and vehicle-bicycle conflicts.

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Vehicle to vehicle conflicts is dealt with in different types of fashions and have been a major research area for a long period of time now, whereas when it comes to vehicle to pedestrian and vehicle to bicycle crashes, the research is not that robust yet, especially because very few of these crashes are reported in the first cases and since they are mostly concentrated around low speed roads in urban areas, it is difficult to usually predict them.

So, let us look at how we can do that using your SPFs and accident modification factors and what are some of the common interventions that are used to improve pedestrian safety in your area.

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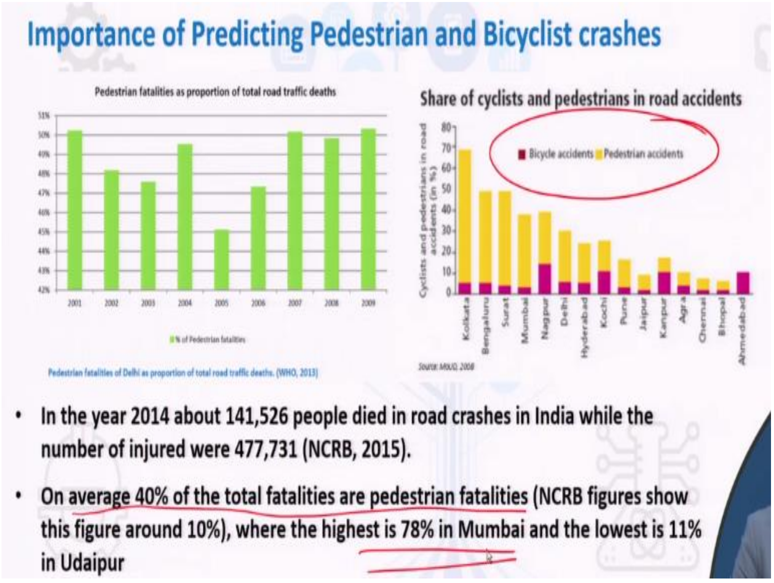

If you look at some of the statistics that are coming out and not only in India, but everywhere around the world, what you would notice is that the vulnerable road users, i.e.,the pedestrians and the bicyclists, they constitute a large portion of the people who are getting killed in these accidents because they are not shielded to the environment, they are exposed to the environment.

So, any kind of accident that they are involved in, it is usually that person either incurs serious injuries or gets killed in those accidents. So, you would see that on average 40% of the total fatalities are pedestrian fatalities and in some statistics in a particular year, this was the highest that was seen in Mumbai.

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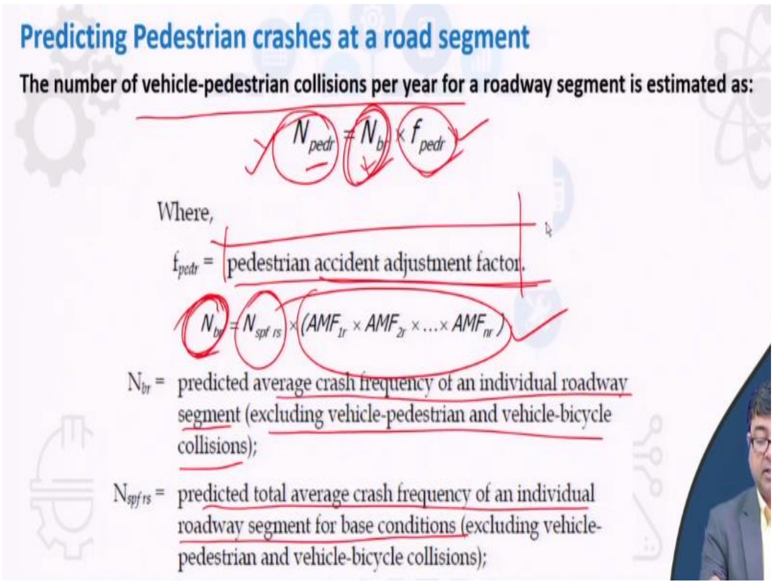

So, how can we use these safety performance functions or SPFs in the case of predicting vehicle-pedestrian collisions per year. So, we already know how the safety performance functions look like and how accident modification factors must be multiplied with them to predict the number of crashes. So, similarly here if you want to predict the number of pedestrian-related crashes, you must know the predicted average crash frequency for an individual roadway segment.

You must know that and then you must multiply it with some sort of a pedestrian adjustment factor, pedestrian accident adjustment factor. So, if you multiply that, so this is already what we have shown you in the previous lecture, N_{br} or the predicted average crashes, which is nothing but it is the safety performance function for a particular type of facility for base conditions multiplied by different types of accident modification factors.

So, this does not consider vehicle-pedestrian or vehicle-bicycle collision. So, this is average. This is normally developed for vehicle-to-vehicle crashes using the different modification factors. But once you know that and if you use that and multiply it with what is called a pedestrian accident adjustment factor, then you can predict the number of pedestrians to vehicle crashes.

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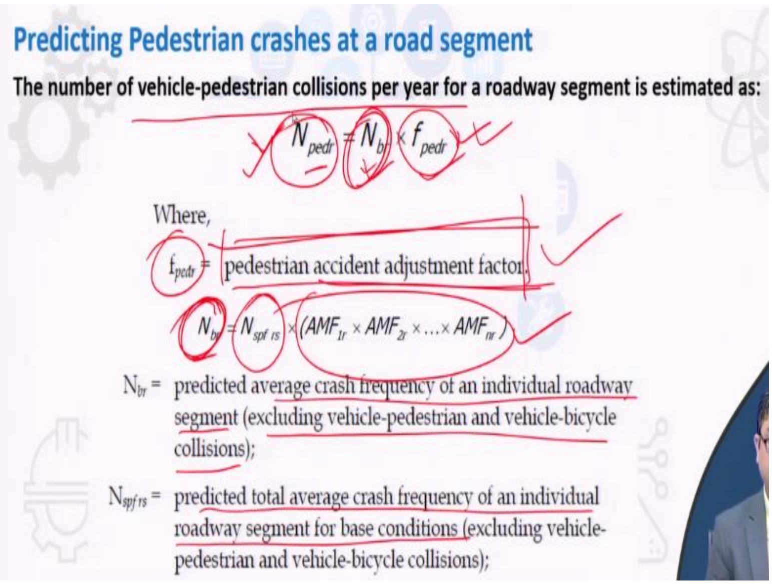

So, to know what are the pedestrian accident adjustment factors? What is usually seen as the most important criteria is the different road types and the speed limit, the posted speed limit. It is not the speed at which the vehicles are moving, it is the posted speed limit. So, it is likely to depend upon also climate and different walking environments, but so far what we have been able to see through research is that if there are different types of roadways for example this is a two-lane undivided road, the 2U meaning, two-lane undivided road, 3T meaning it is a three-lane road with a center turning lane or something like that, whereas this is a four-lane undivided, this is a four-lane divided, similarly a five lane with a center turn lane. So, the pedestrian frequency is the pedestrian crashes, crash frequencies vary by these different types of roads and by different types of speed that is posted there. So, a factor if the posted speed limit is 30 miles per hour or low, the value of f (pedestrian) that is what we have seen in the previous slide, which is the pedestrian accident adjustment factor (f_{pedr}), is 0.036, whereas if the posted speed limit is greater than 30 miles per hour, it is 0.005. So, what that tells you is the adjustment factor is much lower if the speed is higher.

So, if the adjustment factor is much lower and the speed is higher meaning, maybe when the posted speed limits are higher than 30 miles per hour, it is usually that the number of pedestrians walking along that type of road is much lower, so the probability of a pedestrian-vehicular crash is low, maybe that is what it is indicating towards, whereas as soon as you have a street where the posted speed limit is 30 miles per hour lower.

That means they are kind of more pedestrian friendly kind of streets, there you must have a greater adjustment factor. So similarly, you can see it for different types of roadways. So, in case of trying to predict the number of pedestrian and vehicular crashes, pedestrian vehicular crashes, the important thing to know is the type of road and the posted speed limit. These two factors will allow you to understand the pedestrian accident adjustment factor,which, you then multiply with your normal number of accidents that are predicted to happen on that road using the SPF for the base conditions. Then if you multiply those two, you will be able to predict the number of vehicle-pedestrian crashes.

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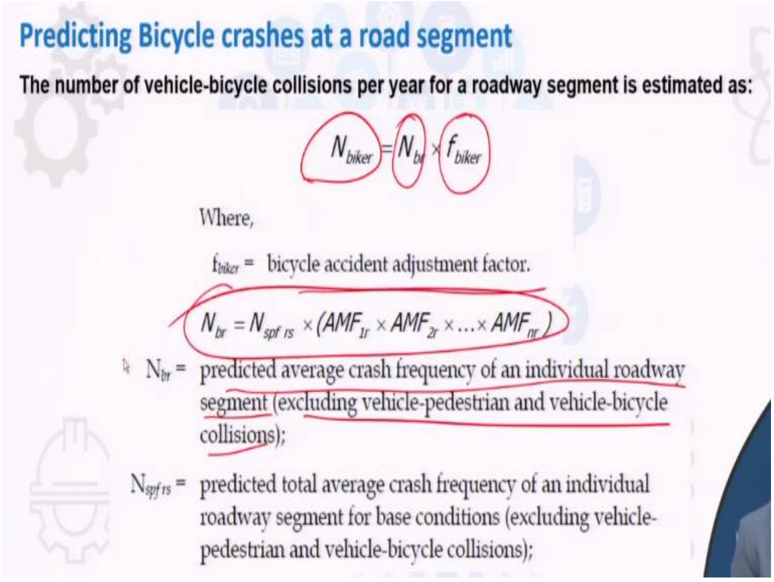

Similarly, to understand or predict the number of vehicle-bicycle crashes, you must multiply the bicycle adjustment factor (f_{biker}) with the predicted average crash frequency on any individual roadway segment excluding all these crashes. Again, it is like the equation that we have seen for pedestrians as well.

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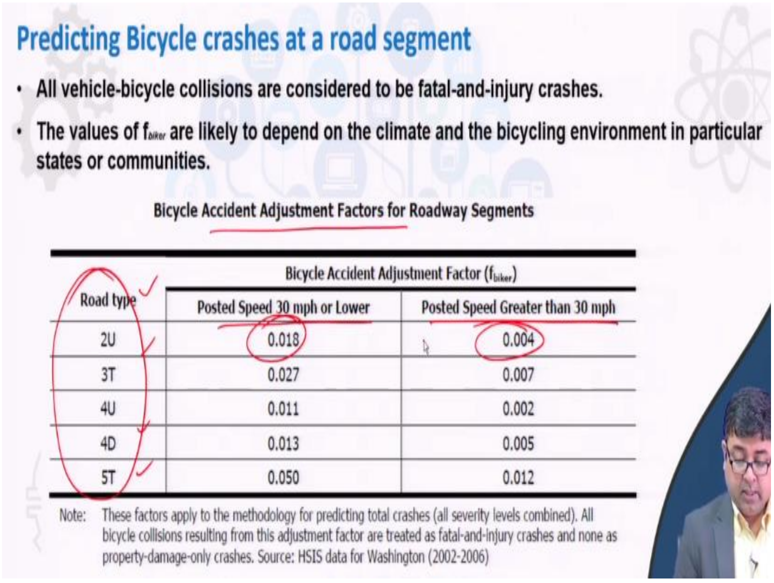

However, in this case as well for bicycle adjustment factors are also dependent on posted speed limit signs and the different types of roadways. However, the values are a little bit different in case of pedestrians versus in case of bicyclists. So that is how you can usually predict the number of vehicle-pedestrian crashes and vehicle-bicycle crashes.

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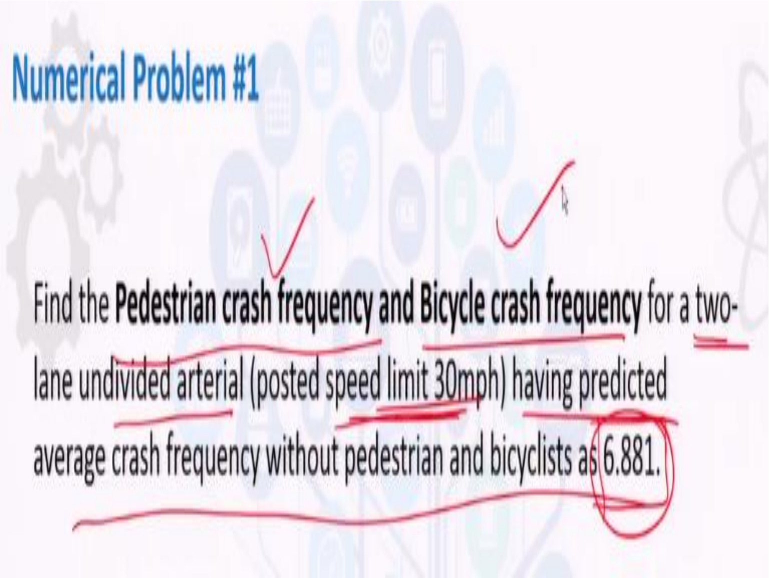

So, if you have a simple example where if you were to asked to estimate the pedestrian crash frequency and the bicycle crash frequency for a particular type of facility, which is a two-lane undivided arterial with a posted speed limit of 30 miles per hour having predicted average crash frequency without bicyclists as without pedestrian bicyclist as this much. So, if that is the predicted number of accidents without bicycles and pedestrians and posted speed limit is this, what would be the expected pedestrian crash frequency and bicycle crash frequency?

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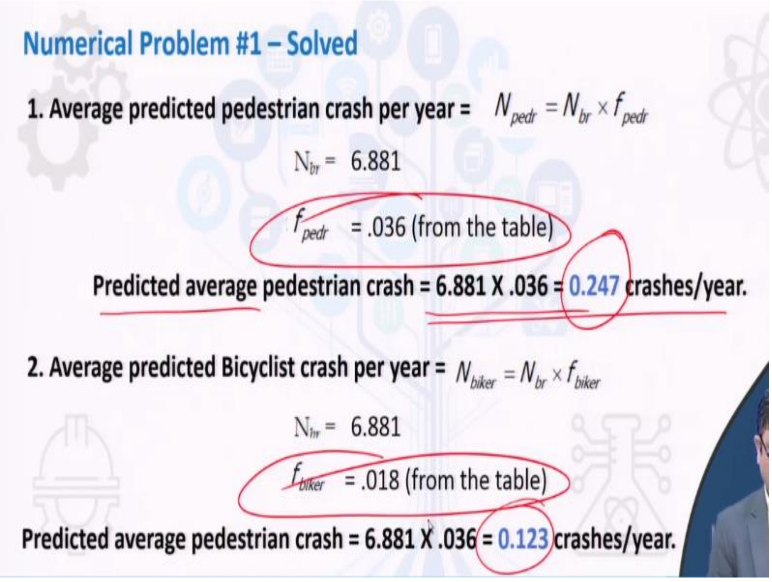

So, you can see that from the table you can use this factor of 0.036. If you go back to the table, you will see that are posted speed limit of 30 miles per hour and lower and for two-lane undivided the factor is 0.036, that is the factor that we have used here 0.036, and so you would see that or you would expect that the average pedestrian crash frequency is only 0.247

crashes per year, so that type of facility you will see very low number of vehicle-pedestrian crashes.

And in case of bicycle also the value is 0.018 and you will see even fewer bicycle vehicle crashes in that facility under a speed limit of 30 miles per hour.

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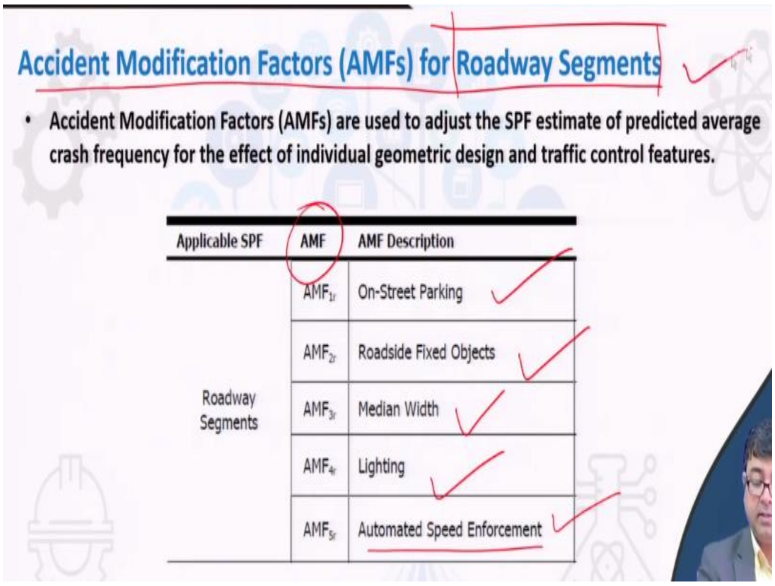

Now, you can also develop different types of accident modification factors for different types of road segments. For example, these have been developed for if the road segment has on-street parking or not, if there are roadside fixed objects on that segment or not, depending upon the median width that is available in that segment, depending upon what type of lighting is available on that segment, and if there is automated speed enforcement or not on those segments.

So, you remember accident modification factors have to be used because SPFs are developed for certain types of conditions, whereas if you want to implement it for different type of condition, then you must multiply those SPFs with these accident modification factors. So, different standard AMFs have been developed based on these 5 different types of roadway segments.

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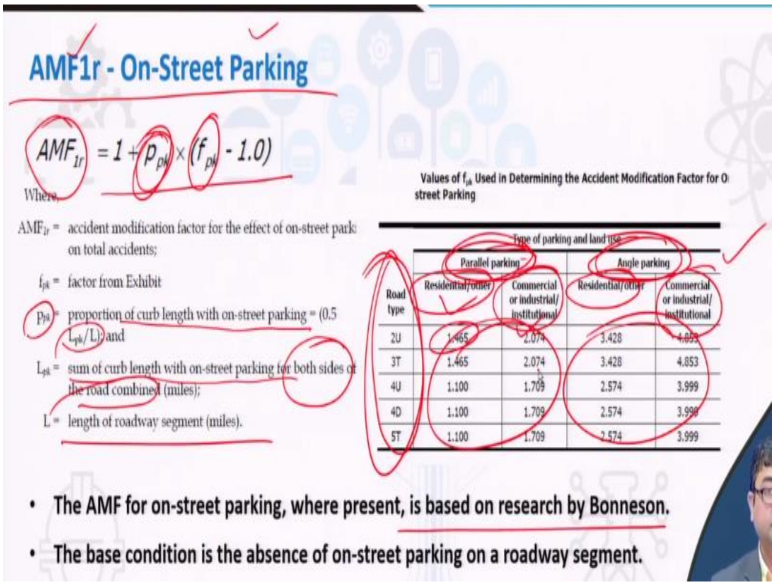

So, if you look at each one of them one by one, the accident modification factor for on-street parking says that it depends upon whether there is parallel parking or angled parking on your roadway segment and it also depends upon what type of land-use your parking is at. So, residential land use versus commercial or industrial or institutional land use, the rates will be different and obviously they will be different for different roadway types.

So, these are accident modification factors and usually they are given by this equation of this model which tells you that P_{pk} which is the proportion of the curb with on-street parking, proportion of curb length where on-street parking is available, your segment length may be longer, but within that segment length only a certain proportion of it is available for legal parallel parking, parallel or angled parking to it available.

And then you must know that proportion and if you know the total length that the proportion can be given by just summing up the curb length with on-street parking for both sides of the roads combined usually, you combine both sides of the road, right, up and down segment and you know the length of the segment anyways. So, if you use that you will get the proportion.

And then you use the factor from this table right here to determine what is the accident modification factor that must be used along with your SPF when on-street parking is there. Again, this is based on research by Bonneson. So, all these are evolving research that is happening, all these factors are being modified or calibrated for different types of facilities, but so far everybody, all the research fraternity, does agree upon that.

The accident modification factor for on-street parking depends upon roadway type, the type of parking as well as the land use that the parking is available at, this at least is constant, these factors are something that are being developed for different areas.

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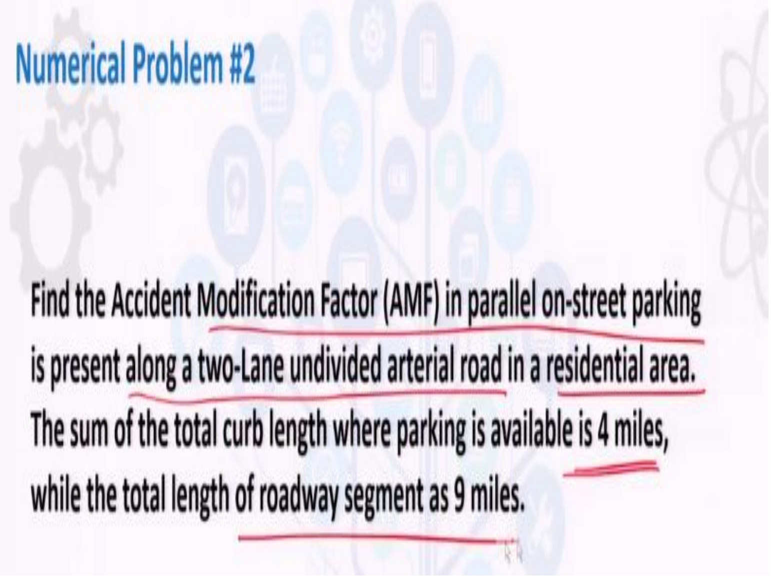

So; if you were to ask to find the accident modification factor if parallel on-street parking present along two-lane undivided arterial road in a residential area and you know that the total curb length where parallel parking is available is 4 miles whereas your roadway segment is 9 miles.

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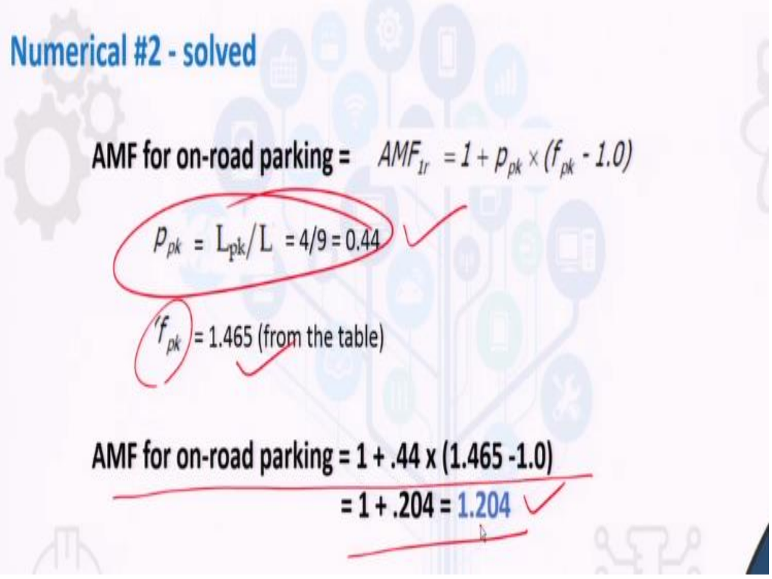

Then all you must do is calculate the proportion, it is 0.44, you look up the f_{pk} value since it is parallel on-street parking and in a residential area for a two-lane undivided arterial. If you go back to this table, parallel residential two-lane undivided so it is 1.465. So, you just use the 1.465 here and put it in that formula you have the accident modification factor as 1.204.

Now if you want to bring in SPF from some other location or if you want to use an SPF for your particular area and find out the difference to the predicted safety that will happen if on-street parking becomes available, then you can now multiply the SPF with 1.204 in order to understand what the change in the safety of your urban street will be.

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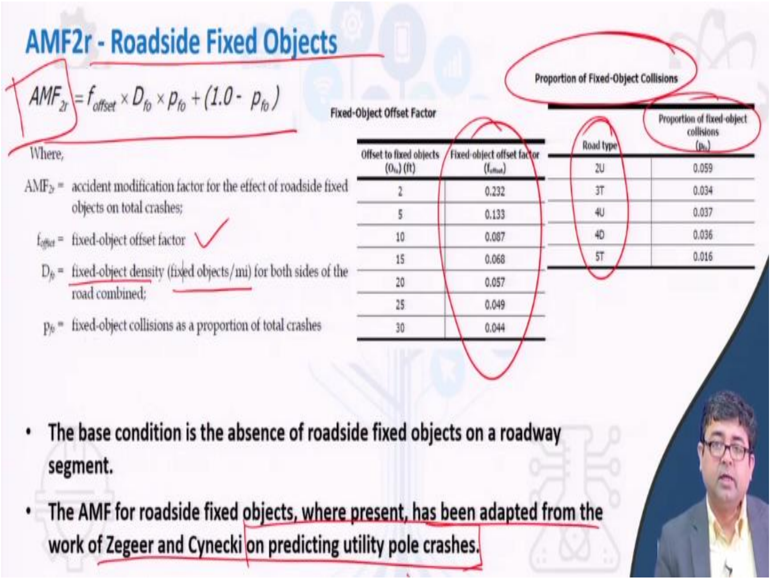

Similarly, we will show you these AMFs for the different types of road segments. The next one is roadside fixed objects. In this case, the proportion of fixed object collisions is something that must be understood. So, how many accidents have happened due to a vehicle crashing into a fixed object on different types of roads that is one factor that is something which impacts the crash rates and the fixed object offset factor, by how much is the fixed object offset by from the side of the roads. So, again it can be given by this formula, simple formula enough. The offset factors are given here, the fixed object density which is the number of fixed objects per mile on both roads combined is something that you can find out, you can measure on your street how many fixed objects, fixed objects meaning light poles, trees, you know trash cans, signposts sometimes, so all those things are fixed objects.

You can find out the density of the fixed objects there, using that you can determine the accident modification factor for roadside fixed objects. Again, this has been adapted from a research which was used on predicting utility pole crashes. If there are too many utility poles, light poles, telephone poles, so what is the prediction? How can you predict the number of crashes if there are so many utility poles?

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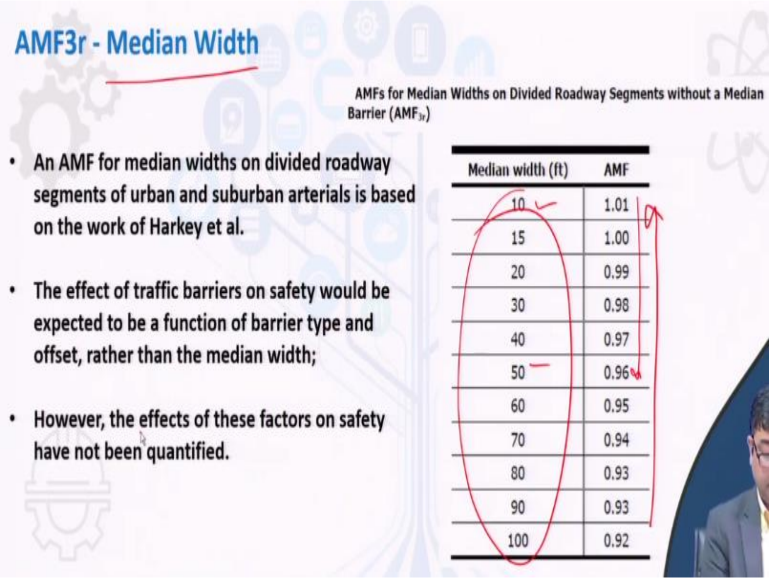

Similarly, by median width, it has been seen that median width influences the average crash frequency, the effect although is not very high if you look at it, but still median width does play a role. So, if you want to change your median width from 10 to 50, then you would expect that there would be some sort of reduction in your accidents.

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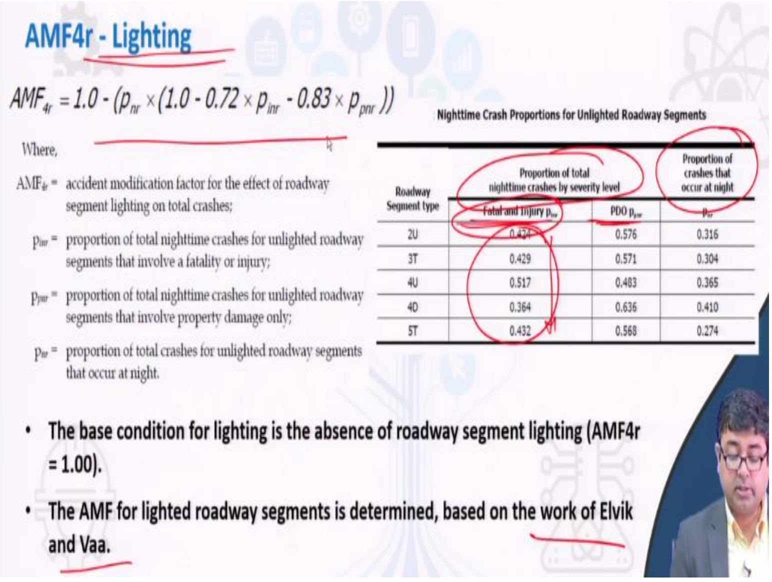

Similarly, for lighting, if your roadway segment has proper lighting or improper lighting that plays a role in determining the number of crashes that happen on your street. Again, what has been seen by research of Elvik and Vaa is that the proportion of total nighttime crashes by severity level depends upon your lighting that is available. So, this case the factors are developed for fatal and injury and property damage only. And, you have to know the proportion of crashes that occur at night, all the crashes versus how many are happening only at night you have to know that proportion and you have to use these factors based on how many fatal and injury crashes were there versus how many only property damage crashes where there. You put that into the equation you will be able to develop the AMF for the case of lighting in your urban street.

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This is something which is a recent phenomenon where people have noticed that automated speed enforcement. This is where you are now getting speeding tickets or speeding challans automatically even if there are no police on the road, but there are cameras that are detecting your speed and sending out automatic challans. So, the second you know that there is automatic speed enforcement you usually tend to drive carefully. And when you tend to drive carefully, the frequency of crashes also tends to reduce. It has been noticed that AMF or automatic speed enforcement is currently taken as 0.95.

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Then if you look at lastly, if you try to look at the different types of interventions that have been made for improving pedestrian safety, you will usually group them under 5 broad categories. One is to reduce the pedestrian exposure to vehicular traffic you will see what that means. The other is to reduce the speeds of the vehicles themselves. Finally, you must improve the visibility of the pedestrians. Either by the pedestrians wearing vests or wearing colored clothing which is easily visible to the vehicles or through roadway design where pedestrians are more visible to the vehicles or people driving the vehicles, improving the vehicular design for pedestrian protection. So, even if the pedestrian gets hit by the vehicle because of the design of the vehicle, the extent of the injury to the pedestrians can be lowered and by providing care to the injured pedestrian, so unfortunately if the accident or if the crash happens, if you provide immediate care to the injured person, then the extent of the injury can be reduced. So, these are the 5 broad categories of interventions that are usually made for improving pedestrian safety.

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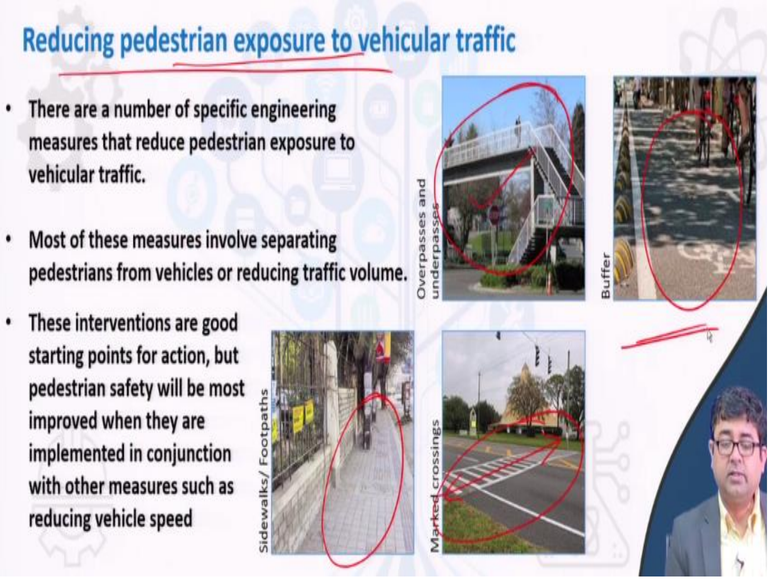

How to reduce pedestrian exposure usually meaning that at specific points along your streets you must have facilities designed in such a way that they are either separating the pedestrians from the vehicular traffic, either grade separated, or they may be separated horizontally at-grade from the vehicular traffic or they may provide safe crossings at-grade for the pedestrians. But somehow their exposure to vehicular traffic or the intermingling of pedestrians and vehicular traffic must be reduced. You can have well designed footpaths that the motorcyclists know that you cannot drive upon and you can have good signalized or even midblock crossings where you if you did not have that and somebody was trying to jaywalk, then the exposure would be much higher.

Whereas now by developing this crosswalk or painting this crosswalk at least the vehicles expect that there might be people who are trying to cross the road. These are effective in certain locations, not effective in others, the foot over bridges and you may have shared use paths with bicyclists that reduces their exposure to the vehicles. So, these are different means of improving pedestrian safety.

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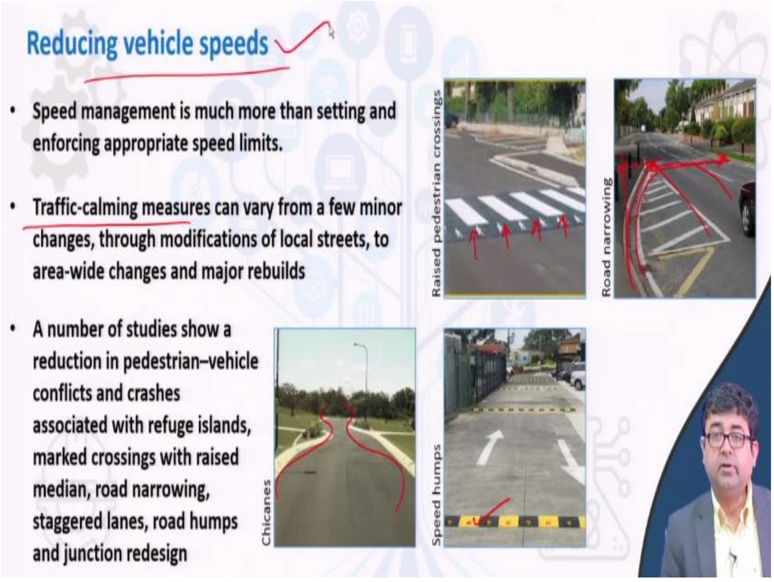

Speed, vehicular speed has been noted as one of the major factors contributing towards pedestrian injuries or pedestrian fatalities. So, how do you reduce pedestrian or vehicular speed by design measures, you may have speed tables, rather than speed humps. Nowadays, you would see that there are speed tables that are in place that are more effective in reducing speed at intersections.

You may have curb extensions that are now reducing the width of the crosswalk that people must cross the road. Now, instead if the curb were straight, now they would have to cross that additional distance. So, usually curb extensions are provided to reduce the distance and by providing this curb extension, the driver who is driving on the on the lane feels that the road is narrowing and this feeling of road narrowing usually reduces their speed. You will see deliberately that some of the low-speed roads have lot of horizontal curves in them. So, these are different ways, then obviously you have speed humps that allow in traffic calming, traffic calming usually is something which is associated with reduction of vehicular speeds.

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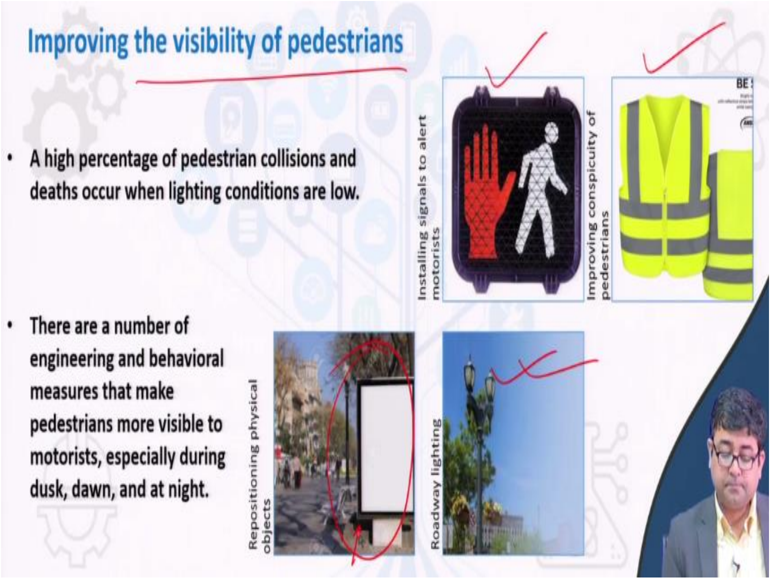

Improving visibility of pedestrians: Not only do you have to have good roadway lighting, maybe you must have pedestrian signals as well that allows vehicles to understand that this intersection has heavy pedestrian volume and hence, they must be on the lookout for pedestrians while they are crossing that intersection. At nights, it is usually recommended that even if the pedestrians do not wear vests that are usually worn by construction workers, but you must wear clothing that is at least bright in color. So that when you are trying to walk, bright and retroreflective, some reflectivity if it has, then if you are walking in darker areas as well through the headlights of the vehicles, they will be able to detect you and also such physical objects that are present very close to intersections where people would not be able to or the vehicles would not be able to see the pedestrians walking here are also some times removed from walkways or sidewalks and so on and so forth.

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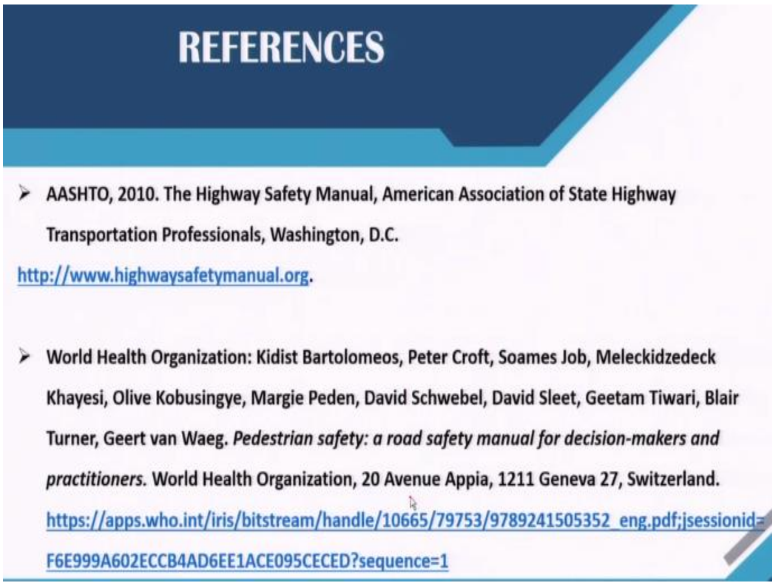

So, that brings us to the end of this lecture and the end of the pedestrian safety, the nonmotorized safety or just pure crashes section of this of this lecture. I hope that we have been able to give you at least an overview of what pedestrian safety or nonmotorized safety is all about and in more general how do you measure crashes; how do you measure crash frequency.

Because this is a vast area, we in this course wanted to just give you an overview of this thing because when you are talking about multimodal transportation, safety is one aspect that you cannot ignore. Again, these are some references that you can look for and study further into.

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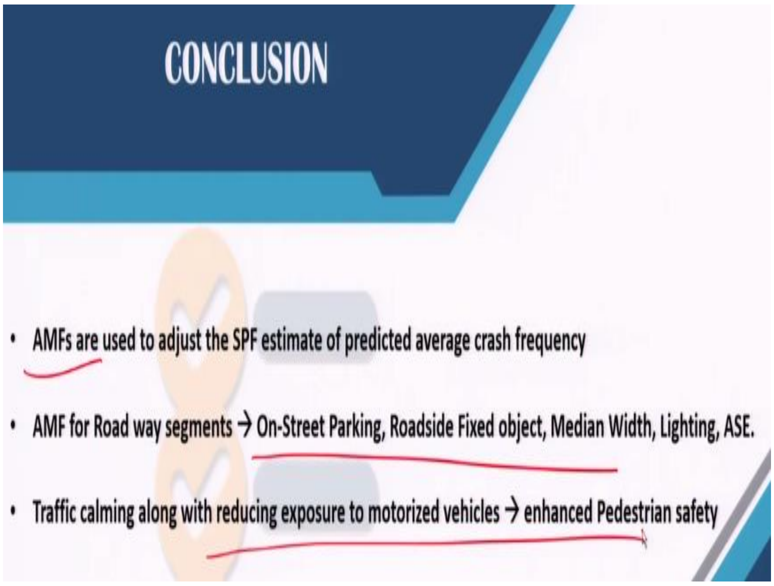

In conclusion, we have identified different accident modification factors for different types of roadway segments. So, the next time you are trying to find the impact of any improvement that you do for your roadways, you can use these accident modification factors or develop your own if that is what you need and keep in mind what are the different types of measures that you can implement to improve pedestrian safety in your area. Thank you.