

Course Name – Pavement Construction Technology
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Week – 09
Lecture – 33

A very warm welcome to all of you; I am Rajan Choudhary, Professor in the Department of Civil Engineering at the Indian Institute of Technology, Guwahati, and instructor for the NPTEL MOOC course, Pavement Construction and Technology, funded by the Ministry of Education, Government of India. Today's lecture will be a part of module 9, where we will discuss some of the roadside safety-related features, focusing especially on road signs, traffic barriers, and road delineators. So, at the very beginning, I would like to acknowledge the use of text, information, graphs, and images sourced from various textbooks, codal standards, journal articles, reports, newsletters, and public domain searches. As we are all aware, the rapid increase in road traffic has raised many safety concerns, specifically because the growing traffic has also contributed to higher fatalities and crash-related losses. So, the roadside safety features, specifically in terms of road signs, traffic barriers, and road delineators, can be called that. They play a vital role in enhancing road safety, and we will discuss some of the key features of the road signs, traffic barriers, and road delineators in this particular talk.

So, road signs—what are road signs? Road signs are devices placed along, besides, or above highways, roadways, pathways, or any other routes, and their purpose is to guide, warn, and regulate. So, it is there to guide the users, to warn the users regarding some features, and to regulate the traffic as well. So, this helps to guide, warn, and regulate the flow of road traffic, including all categories of motor vehicles, bicycles, pedestrians, and other modes of transportation. Road signs provide drivers with adequate and advance information.

This is important for any feature that is to be encountered by a road user; you will receive advance information with the help of the road signs. About upcoming road conditions, specifically necessary warnings and guidance, which may include some warnings, information, and guidance as well. So, this and this will all be delivered in advance to that particular feature that is to be encountered. So, road signs play an important role in the regulation of traffic and are considered the building blocks for ensuring road safety. So, they play a very vital role in the road safety of a particular road network.

So, we have this MORTH book on road safety and signages; it says traffic signs ensure safety in road safety, signages, and signs. And as you can see, it is said that safety is not just a slogan; it is a way of life. Now, considering this, what is the need for it? One important purpose of road science is to enhance the safety and efficiency of the movement

of road traffic on these infrastructure facilities by ensuring the orderly movement of all road users. So, the movement has to be in order; it should be in a proper manner that follows certain information, certain regulatory information, or what we can call mandatory information across both urban and non-urban roads. Certain information is important for urban roads and is also important for non-urban roads; it informs users of regulations and provides warnings as well as guidance needed, and the warnings and guidance will help them to have a safe, uniform, and efficient operation.

So, these are some of the key requirements for it and whenever a sign is installed, we there is something expected out of it. So, road signs are expected to meet some basic requirements if a road sign is installed at a particular location nearby. Therefore, there is something that is expected to be delivered by it, and what we need, it fulfills a need. So, whether it is a warning, it is information, or there is certain control. So, what it wants to communicate, in order to fulfill a particular need and command attention, should draw the attention of the road user.

So, he should be able to get an idea of it. Convey a clear and simple meaning; it should be easy to understand for any road user. Command respect in the way these are installed and designed; it should be good enough to earn respect from road users. See, I cannot place a sign within 50 meters; I am placing two road signs that provide some direction, mandatory direction related to the speed of movement. So, that is not good; that is not a correct practice.

So, that if these practices are not done in a good manner, they do not get a good respect from the users also. Give adequate time to respond; this is also where you are placing it. Then, once the user is able to identify and understand it, you should have some time to make changes specifically in terms of its speed of travel, so as to interact with that particular feature. To achieve these factors, all of which are important, the first requirement is the design of the road signage and their placement, as well as operation and maintenance. Maintenance is also a big concern because it needs to be properly maintained during its service life.

Uniformity, as I mentioned, is to be uniform; the features have to be uniformly presented through them. Must be carefully considered, and for this particular one, we have a good number of specifications available from the Indian Roads Congress and the Ministry of Road Transport and Highways. We have IRC: 67, which is the code of practice for road signs. We have the MORTH 2015; this is the traffic signs ensuring safety, book on road safety, signages, and signs. We have IRC 119, which is guidelines for traffic safety barriers.

We have IRC 79:2019, which is a recommended practice for road delineators. We have our MORTH specifications for road and bridge work. Now, these road signs are basically categorized into three main categories. What are the three main heads? One is mandatory

and regulatory. The word itself indicates that they provide some mandatory and regulatory information.

Cautionary and warning signs give you some warning. So, they give you some information related to certain cautions that are to be taken and informative and guide signs. So, these are the three main categories under which the different road signs are generally classified. So, now this can be on the basis of it the first one can be the one mandatory regulator the one which gives you order say this is the first one stop you need to stop there. So, giving something a mandatory regulatory sign is there; signs that warn you specifically say this is the one slippery road.

So, it is warning you regarding certain features. So, this is the science that warns you, the science that gives you information. So, this one is giving some information that there is a hospital. So, these are what we can understand from their key terms themselves regarding what they are going to represent. Now, how they are represented specifically in mandatory and regulatory science is circular, with some exceptions of stopping and giving a science that is there.

Cautionary and warning signs are triangular and serve to warn, while informative and guide signs are rectangular. So, they again inform certain facilities which will be there. Now, first coming to the mandatory and regulatory signs, they indicate the start of a restriction. So, when any sign is encountered in terms of regulatory or mandatory signs, it means there is some restriction or prohibition, and it must be placed according to the direction in which traffic may be moving, so you need to place it considering which particular direction you want to give this regulation. So, these signs serve to communicate special prohibitions related to vehicle maneuvers, vehicle types, parking, speeds, or load limits.

So, vehicle maneuvers: here you can see no U-turn is allowed, here you can see no parking is allowed, and here you can see this gives you the information that the speed should be 50. So, examples include overtaking prohibited; the first one says overtaking is prohibited, U-turn is prohibited, cycles are prohibited; this can be another one. Parking is prohibited; this is the prohibited parking area. The speed limit is there, and the maximum load limit states that 5 tons is the maximum load limit for vehicles to use that particular facility. So, mandatory and regulatory signs need to be complied with; this is important, and we need to follow them.

We need to follow what they are communicating, and any violation of the rules and regulations conveyed by these signs is a legal offense. So, you will be penalized if you are not obeying these particular signs. Now, mandatory signs, as I mentioned earlier, are mainly circular in shape, with some exceptions, like in the case of a stop sign, which is octagonal in shape, and in the case of a triangular yield sign. These are the two usual

exceptions. Then these mandatory signs can also be further classified into prohibitory regulations.

So, prohibitory means they are prohibiting certain actions or a certain sort of movement. So having a red color with a border and a red oblique bar. So, you can see this is a red circular border with a red oblique bar that is there. So, a left turn is not permitted here. Now this is one type of regulatory sign that comes under the mandatory or regulatory signs that fall under the prohibitory category.

And then operation control one, see this is giving you an operational control or vehicular control, which means that you have to move at a speed of 50. Then compulsory control or other signs, this is again an example of a circular sign with a blue background and a white border; it says you have to make a compulsory left turn in that particular case. So further in this particular case, we can say that the prohibitory signs under these mandatory ones are the red color, a red circular ring, and diagonal bars with black symbols; here, a black symbol is there for a U-turn, or there may be certain arrows or letters on a white background. So, this is what a red border is; there is a black arrow, and a red diagonal is also present. So, this is there on a white background.

So, this is what is available for prohibitory or regulatory size. Now, the red ring indicates prohibitory regulation this is important and the diagonal red bar prohibits the action. So, the diagonal says this action is not to be taken up. So, you cannot take a U turn here in this case or moment indicated by the black symbol that is cannot be taken. So, here you can see the placement of this particular prohibitory symbol.

Now, along with that, the mandatory compulsory control sign may be there, giving positive instructions and a circular shape with a white symbol on a blue background with a white border, so this is again a compulsory control sign, where you can see the compulsory left turn is indicated. So, they indicate what drivers must do compulsorily again. Directional control signs are to be compulsory in regulating certain movements wherever the restriction applies. So, there has to be a compulsory left turn. So, these are regulatory and mandatory signs; their placement is also important.

So, they need to be placed on both sides of the road or on each side of the appropriate carriageway of a dual carriageway. So, on both sides of the roads or on each side of the appropriate carriageway in the case of dual carriageways. However, signs may be installed on only one side; they can be on one side only if specific cases are present, that is, when restrictions apply to a single side of the road only. Because of some obstruction, if there are certain restrictions on one side only, they can be placed on one side or at junctions where traffic turns from a one-way road into the relevant road. So, there may be certain ones where one-way traffic is merging with some intersections; they can be placed on one

side itself, in which case the sign should be angled towards the driver so that those moving in that lane that needs to be followed should be able to see it.

Minimum clear visibility distances are essential so that they can take action at the proper time. So, for this particular one, at which places are you placing it, and the visibility should be good enough. So, clear visibility distances are required for regulatory purposes, and this is IRC 67, which provides detailed information about the placement of these different road signs. So, regulatory and mandatory signs are typically measured from the center of the most challenging driving lanes. So, the one where you find that this is the most challenging for a driver is a lane where, to visualize this particular situation, a simple extraction of information can be used to say that it indicates advanced direction signs; if they are mounted on the shoulder, what should be the minimum clear visibility to that particular sign? So, depending upon what ranges of the design speed are present, if the design speed typically falls in the range of 81 to 100, it should have a visibility of at least 160 meters.

So, this is how important it is that the visibility should be good in terms of being easily understood by the driver so he can take the appropriate action. To ensure clarity, usually no more than two signs should be placed together on one post at the same location, because then it makes it challenging for the driver. While speed limit signs are always displayed alone, they are not displayed along with other signs; they are preferred to be displayed alone for maximum visibility. Then the cautionary and warning signs are there; as we mentioned earlier, they are there to alert the users specifically to the presence of potential hazards or hazardous conditions near the roadway, encouraging drivers to take appropriate action for increased safety. The maximum is in terms of whether they will be informed about what is ahead, if they have to take a turn, or if they need to reduce their speed.

So, these all information if the signs are properly visible in time, so they can take the appropriate action. These signs are typically triangular in nature; cautionary and warning signs feature a red border, which includes a black symbol on a white background. This is a standard color for a caution sign and a warning sign. These signs indicate a need for special caution by a road user and may require a reduction in speed in many cases. Some examples of these signs are: a hairpin bend, which is a right hairpin bend; a narrow bridge, which is an example of a narrow bridge; and a gap in the medium.

Similarly, there can be a sign indicating a school ahead. So, these are there to warn you that there is some median opening or a right hairpin band, so you need to reduce your speed. Some narrow bridges you are approaching; towards a narrow bridge again, you will try to reduce your speed to get accommodated into it. The cautionary warning signs are in the shape of an equilateral triangle with the apex always pointing upwards.

This is again an important requirement. The location and mounting of cautionary signs are as mentioned. Warning signs should not be mounted on the same post as stop, give way,

or terminal speed limit signs, as mentioned earlier, nor on traffic signal posts. They should not be posted on traffic signal posts either. When placed with other types of signs, triangular warning signs must be mounted at the top; specifically, we prefer them to be mounted on the top in that case. Typical details of the size and sighting of cautionary signs, as per IRC 67, are given; if the design speed is between 81 to 120, then the clear visibility distance should be at least specified.

90 meters; now this is within the case of regulatory, it was higher in case of we can see in case of cautionary and warning. It is 90, and the distance of the sign from the hazard should be placed well ahead of it. So, visibility is one part, and how far in advance it is placed relative to that particular hazard is what we want the user to understand in terms of these signs. So, whatever hazard is present for which we are warning through this particular sign should be that the sign is placed at least around 180 to 245 meters ahead for a speed of 81 to 120. Then comes the guide and informative science again; they give some information and guide you about certain facilities.

They are typically rectangular in shape, having symbols on a blue background. This is a typical one to indicate locations such as fuel stations, eating places, and parking areas, while other informational signs can display destination names, distances, and directional arrows. So, in which direction you need to go for a particular place, what should be the distance to a particular place, can also be shown through informative signs that can be further classified into certain headings: direction and place identification signs, which provide you with direction and place information. Facility information, including details about nearby restaurants, fuel stations, parking signs, and certain locations that may have flood-related concerns, is also provided through these informative or guide signs. So, when it comes to direction and place identification science, it states that it should provide drivers with advance information about their approach to a junction.

So, this can be shown through an informative science that you are approaching a junction. It should also indicate the type of junction and what type of junction it is. It should inform them of the destinations that can be reached from each exit. So, there may be multiple exits. So, they may be properly informed that if you follow this exit, what your expected destination will be.

It should identify the route and indicate its status within the network; this particular network of roads, as you can see in the example, goes towards Lucknow, Jaipur, Delhi, and further ahead in this particular one towards Azad Nagar. So, this information is displayed. Now, the facility information sign, as I mentioned, may indicate that there are facilities such as some restaurants and fuel stations. So, this information is shown through the facility information sign. They inform road users about the locations and availability of nearby services.

These rectangular signs have a blue background with a black symbol displayed inside a white square. So, you have a black symbol that is displayed within a white square, and these are the designs; the standards for width and height are all as per IRC 67 guidelines. So, parking information sign. Now the other one that comes under the informative and guide signs is parking information signs. It may be set up parallel to the axis of the road and should indicate the places where parking of vehicles is authorized.

And further, as I mentioned, we get more details about it as per the code requirements, like for parking information signs, one is taken. The sign shall be a square of 600 mm by 600 mm for parking, and the parking sign with vehicular type shall be between 600 mm and 800 mm. If you are providing this parking for a particular vehicular category, in this particular case it is showing for bicycles, then this size should be 600 by 800 mm. It shall bear the letter P in white color again as specified.

The background color shall be blue with a white border. So, this is an important requirement in terms of the designs of the informative and guide signs. So, you have the black background with the white border. Flood gauge signs, as I mentioned, are installed at causeways, submersible bridges, or culverts to indicate the height of the flood above the road level to users. So, this is specifically important to understand because there may be some flooding during a rainfall event.

So, this gives information specifically to the road users. Now, the angle at which it is placed is also important for the orientation of road signs. So, the signs, unless otherwise stated, shall normally be placed at right angles to the line of travel of the approaching traffic. So, this is a general rule that we always try to place at right angles to the direction of travel or the direction of the approaching traffic. So, signs related to parking are, however, fixed at an angle of approximately 15 degrees to the carriageway to provide better visibility because one needs to park towards it. So, generally to have enhanced visibility, it is usually fixed at an angle of around 15 degrees to provide better visibility on horizontal curves; specifically, on horizontal curves, here you can see the signs are not fixed normal to the carriageway.

Because this is in accordance with the line of sight of the drivers and the angle of placement is determined with regard to the course of approaching traffic. So, it should be with respect to the orientation with the approaching traffic or the line of sight of the driver. So, sign on gradients similarly when you are approaching a vertical curve; it says signs on gradients may be desirable to tilt a sign forward or backward. So, depending on whether you are approaching a valley curve or a summit curve. So, a sign should be moved forward or backward from the vertical to finally make it a desired one normal to the line of sight and improve the viewing anchors.

So, this is also important for proper visibility and timely visibility of a sign. Now, the other features involved in the installations are specifically posts and mountings for different signs. The details are that we have different IS specifications; for example, IS 1239, IS 4923, and IS 3589, which provide specifications for different materials used in these road signs. So, the traffic signs shall be mounted on support posts, and these support posts may be of mild steel, typically mild steel or galvanized iron pipes, which should conform to these particular IS specifications that I mentioned here. So, IS1239 or circular hollow sections conforming to IS1161, rectangular hollow sections conforming to 4923, or square hollow sections conforming to 3589.

So, if they are using these different sections, they should be as per their respective ISS specifications requirements. Sign posts, their foundations, and sign mounting shall be constructed to hold them firmly in a proper and permanent position against normal storm winds, as they may tilt during a storm. So, they should be fixed firmly enough to bear the forces that may arise from wind storms, or they should be strong enough to prevent vandalism, as this is often a concern because their removal creates many issues, particularly regarding the safety of road users. Normally, signs with an area of 0.9 square meters, if a signboard has an area of 0.9 square meters, shall be mounted on a single post that is big enough; for a greater area, two or more supports shall be provided. If it is a bigger one, then we need to provide two or more supports. Now again, how they are fixed up, so signposts or supports must be firmly fixed to the ground with a properly designed foundation. A foundation needs to be properly designed or attached to steel posts; they are attached to steel posts by welding and to reinforced concrete or GI posts using bolts and washers.

And there also you can see this is how it is fixed up. Again, in addition to this, it says that bolt tails are hammered after tightening to prevent their removal, in order to avoid vandalism; therefore, these bolt tails are finally hammered in this particular case. Overhead signs are designed to resist; this is important when these overhead signs are in place. They should be good enough; their foundation should be strong enough to resist wind loads of around 150 kg per square meter, which is normal to the signboard, and 30 kg per square meter transverse to the sign face. So, again, the foundation has to be designed in this particular manner. So, the other important category regarding road safety features is the traffic safety barriers.

So, what are traffic safety barriers? We also call them crash barriers. So, the traffic safety barriers, or crash barriers, are installed specifically on high-speed highways to prevent vehicles that lose control from running off the road. So, this serves an important purpose in any situation where the vehicle goes off the road. This particular crash barrier will help to bring it back specifically, control it, and reduce the possible impact. So, it says they are practically important at hazardous locations, and specifically, there may be sharp curves

and narrow bridge approaches when one enters from a wide pavement section to a narrow bridge.

High embankments may be present where there are chances that, in some disadvantaged situations, they can go off the side slopes and areas with roadside obstacles such as posts, trees, etc. So, when properly designed and positioned, traffic safety barriers can redirect vehicles. So, this is very important that they should be able to see this; this is one example of a WBM type steel crash barrier. So, it can redirect vehicles nearly parallel to the direction of travel. So, if it is moving in this direction, it helps to redirect the vehicle in the direction of travel nearly parallel to the direction of the barrier.

So, this is one way to reduce crash severity. Now, depending on the type of these crash barriers, they will definitely try to reduce crash severity and minimize occupant injury and property damage. So, this is an important feature of these crash barriers, which we will call traffic safety barriers. Due to highly cost-effective safety, the safety enhancement is very high with these crash barriers. So, they are provided by these devices that are extensively used on modern high-speed highways because the movements are at relatively higher speeds.

Now, they can be further classified into two main categories. One that is used on the road edges and the second that is used on the medians. So, we will call them road edge barriers and median barriers. You can see here an example of a road edge barrier that is present. So, now let us first look at what a road edge barrier is. So, the road edge barrier, also known as the roadside barrier because it is on the side of a carriageway, is a longitudinal safety system designed to shield vehicles from hazards along the roadway edge.

So, any hazards that may be present on this particular side, such as fixed objects, steep slopes, high embankments, valleys, or sharp curves, should be noted. So, they help shield the vehicles from any hazards that may be present. Installed along the outer boundaries of the travel lane, these barriers typically consist of metal steel barriers or concrete beams. They are mounted about 30 to 60 centimeters above the ground, and they are robust posts made of wood, concrete, or steel; you can see these posts. So, they are mounted on these particular posts which may be made of wood, concrete, or steel.

So, they should be as per IRC 119 guidelines specifically. So, this is: The posts are usually driven about one-tenth of a centimeter into the ground because the impact has to be borne by this particular one and can be set into the backfilled holes. This helps to enable them to absorb the impact energy when a vehicle at high speed comes and strikes this particular crash barrier. So, the energy needs to be absorbed and redirected in the direction of this crash barrier. How much it penetrates the particular soil helps us absorb the impact energy by moving within the soil. Now this is an example; here we can see this is an example of a concrete medium barrier that is there.

So, medium barriers are longitudinal safety systems installed in the center of the divided carriageways when we want to separate the traffic in the two directions. To separate traffic moving in opposite directions, as I mentioned, this has to be as per IRC 119. The primary function of this particular one, the important function it serves, is to prevent vehicles from crossing the median and entering the opposite lane in case a vehicle goes out of control. So, this should not happen if these median crash barriers are there; they will protect any vehicle that has gone out of control from crossing the median and coming into the opposite traffic lane because this will lead to some head-on collisions. So, it is very serious to avoid these severe risks of head-on collisions; these median crash barriers are provided.

In addition, they provide protection to motorists while moving along this particular one by absorbing and redirecting impact forces when they are struck, and the impact energy is absorbed by these crash barriers, allowing them to redirect it. And also shield fixed objects, and if there are certain objects in the medium, there may be some posts, and there may be some permanent objects that have to be specifically placed at toll plazas and at any other locations. So, if some fixed projects are located inside the medium, they also get protected with the help of these traffic crash barriers, such as sign supports, lighting posts, and piers from potential vehicle impact. So, they should not get damaged by any vehicle that has gone out of control and comes onto the media. So, when properly designed and maintained, median barriers significantly enhance overall safety by minimizing crash severity and protecting both road users and roadside infrastructure.

So, this is an important feature that is present with traffic safety barriers and the one that is installed at the median, so-called median barriers. Now, depending on their performance, traffic safety barriers are mainly classified into three categories. The first one is the flexible one, which can absorb the impact energy to a maximum extent; the semi-rigid one is typically made up of steel beams, and we call them W beam crash barriers or tri-beam crash barriers, and the third category is the rigid one. You can see this is the one; this is an example showing the flexible type one, which is your cable or wired crash barriers that are there. This is your steel beam sort of crash barrier, which comes under the category of semi-rigid.

So, you can see this is a W-beam steel crash barrier, and then this is the third one, which is a rigid one, a concrete barrier. So, the primary difference among these three types of crash barriers lies in the amount of deflection they can exhibit upon impact. This exhibits the maximum amount of deflection, followed by the steel beam crash barriers and then the rigid ones. So, this is an example; you can see there is a median concrete crash barrier there. Now, when discussing the individual features of these three types of crash barriers—specifically the flexible one, the semi-rigid one, and the rigid one.

The flexible barrier system, such as a cable or wire type, which is shown in this particular example here, is the most yielding of traffic safety barriers because it is the most flexible

one. It contains and redirects vehicles while significantly deflecting. Now, for this particular deflection, there should be a clear space available on the side of these particular flexible barriers significantly upon the impact, which requires ample lateral clearance from fixed objects. So, it should be placed well away from any objects that are on this particular side so that it has the complete space for its deflection.

This design results in the lowest impact severity. So, this is the wonderful feature of these flexible type crash barriers for vehicle occupants: they absorb and dissipate crash energy effectively. So, they are very, very safe compared to the damage that can be caused specifically to the occupants of the vehicles. Then comes the semi-rigid one, which we most of the time see; these are the ones that are also very popular, specifically on all high-speed corridors. So, semi-rigid barrier types provide enough resistance to control the deflection of the longitudinal component. So, they have good strength to resist deflection because you can see there is an object, a tree, which is just on the backside of it.

So, you do not have much scope for its deflection. So, these are the ones that are able to control the deflection of the longitudinal within acceptable limits; yes, definitely a certain amount of deflection will be there, but it is effectively redirecting errant vehicles along the roadway. So, it gets deflected, and then with its help, the vehicle can be redirected onto the carriageway. So, steel beam crash barriers, as I mentioned, one is W-beam, sort of one, or the tri-beam, sort of one; crash barriers, W-beam guardrails, this is an example of it, are common examples of this type, combining both strength and flexibility to enhance safety. So, this falls under the category of semi-rigid barrier type. Then the last category is your rigid barriers, which are typically made of concrete, do not deflect when they are struck, and therefore result in the highest level of severity of impact among all three barrier types compared to the flexible and semi-rigid ones.

They are best suited for locations where we can expect only a small angle of impacts. So, a small level of impacts is expected where we can put this particular one, and they will help us separate out the vehicles in the two directions and other possibilities, such as narrow medians or shoulders commonly found in urban areas where you do not have much space to provide a good width of medians. These concrete barriers are very popular. Because rigid barriers sustain little to no damage upon impact, they require minimal maintenance, making them a durable and effective safety solution. However, if they are struck at high speed, the impact is very high, and the damage to the occupants is much greater compared to what we experience in the case of semi-rigid and flexible type crash barriers.

Now, the other category that comes is the road delineators. So, as the word itself says, here is delineation. So, that means any treatment which can help us to understand or improve the visibility of any feature. So, delineation mainly refers to devices or treatments such as paint and how that can be present in terms of any painted lines, raised pavement markers,

posts, reflectors, and contrasting pavement surfaces. So, what they are allowing us to help with is to improve the visibility.

Used to clearly outline the roadway and improve visibility and guidance for the road users. So, when the delineation is enhanced, it automatically enhances the visibility as well as the safety of the road users. So, a primary role of delineators is to show what different types of delineators you can see; this is how it looks during nighttime if properly assigned or placed on the road surface to provide drivers with visual guidance on the road alignment ahead, particularly at night, and they are very useful when you are driving at night. And we have a complete IRC specification, IRC 79, which is there for recommended practice for road delineators. They are quite useful and important in complex situations where there are sharp curves, horizontal curves, or vertical curves. Another important feature is specifically under adverse weather conditions, such as when it is raining, when there is fog, or when it is snowing; they help us a lot in enhancing the visibility of the roadside features.

So, road delineators are classified into four major categories again. What are those? These are roadway indicators, median markers, hazard markers, and object markers. So, these are four different categories that come under the road delineators. Now, let us look into the first one, which is roadway indicators. So, they are also called delineators or guide poles; you might have seen them placed at various locations. You can see here it is placed just near this particular curve, where there is normally a gap of around a maximum of 10 centimeters from the curve face to the face of this particular pole.

So, as you can see on the curbside, these guide posts are placed on the edge. So, roadway indicators called delineators or guide posts are typically mild steel posts that are coated with polyester powder for corrosion control. Designed with an ellipsoidal or a circular cross section, this must comply with the IRC 79 requirements that must be followed for this particular one. So, it says cross section and standing at a height of 80 to 90 centimeters above the ground. So, this is a typical requirement for what we call the guidepost or guide pose.

On high-speed interurban roads with heavy traffic, they are usually placed 50 to 70 meters apart. So, this specifically on high-speed corridors is placed at this particular distance. And on low-volume or rural roads in rolling or hilly terrains, instead of these steel ones, we can also use the concrete delineators. So that is another part; instead of this particular one, we can go for the concrete delineators because they are comparatively more economical than what you have with these mild steel posts. Now the other one, as mentioned, these are our median markers.

This is an example you can see here on the median curve where these are placed. This is another feature you can see along the medians, where the visibility of the edges is specifically noticeable during the nighttime. So, we call them flexible median markers or

retro-reflective safety devices. These are, as you can see, retroreflective sheeting; this is how it looks. So, designed to enhance the visibility of medians, as well as parapet wall structures, in some cases, they are placed at some parapet walls; also, there are bridges where, particularly during night time, you can see from this picture how the visibility is improved by the placing of these flexible median markers. Adverse weather conditions, because of their retro-reflective nature, ensure that even in adverse weather, visibility is very high.

So, these markers are provided with fluorescent yellow retro-reflective sheeting, which is there, and these sheetings are as per the requirements of the IS and the IRC specifications. So, with a recommended spacing of 2 meters in urban areas and 5 meters on inter-urban highways, these are typical spacing requirements. So, there is a smaller space of 2 meters in urban areas and in interurban areas because visibility is more challenging in urban areas. Now, typical dimensions of a flexible median marker include a minimum height of 180 mm, a width of 120 mm, and a body thickness of 6.5 mm; the reflective area should be a minimum of 90 square centimeters. So, these are some of the typical requirements as per IRC 79, which states the requirements for the row delineators. Now, this is another category which is our hazard marker is there. Hazard markers are used to identify and indicate obstructions; for example, you can see there is a narrow bridge. So, when you are approaching, there is an obstruction; there can be another obstruction; some pole may be there.

So, these hazard markers are placed in front and are painted in a specified manner. So, they are used to identify and indicate obstructions such as guardrails and abatements located adjacent to the carriageway, particularly at locations like culverts and bridges where the roadway narrows at these approaches. So, when it is approaching, the potential hazard in front of it, these hazard markers are placed. They consist of alternative black and yellow stripes; these are the yellow stripes at an angle of 45 degrees, and they direct the traffic in the direction it is guided to pass. So, this means the traffic needs to pass by here; this indicates that the traffic is to pass by this side.

So, in this particular manner in this direction the traffic should pass. So, this gives you a two-way marker sign. So, this should be avoided; the middle one is to be avoided, and the traffic can move in this direction. Now, even in their design part, you can see what the traditional widths are: 300 mm, 300 mm, which indicate the width of the strip, which is 100 mm in the case of this particular one. When two wave signs are present, this width is 200 mm, and a typical height is around 90 centimeters. So, these are some typical features of a hazard marker. So, they consist of alternating black and yellow stripes sloping downwards at an angle of 45 degrees towards the side of the obstruction on which traffic is to pass.

So, this is important; the placement is important because it helps guide drivers to safely navigate around the hazard. So, this is the upper part. We call them object hazard markers, which are put up where there are objects on the edges of the traveled way that can lead to crashes involving some vehicles. So, this forms another important category of road safety features under the road delineators, and the last one comes up as the object markers. So, it typically includes an aluminum-backed flexible prismatic reflective sheeting; you can see this is an example.

Having black and yellow stripes, these strips are there to improve visibility. And where do we prefer this particular one? You can rely on the beams and post of metal crash barriers. We had those crash barriers; the metal steel crash barriers were there. So, on the beam as well as on the post of it, we can put this particular one. At the periphery of the roundabout, you can specifically see where the noise of the traffic is, with islands pointing in that direction.

So, here it is pointing in this direction; it has to go in this direction. Traffic pulleys and toll booth structures, when these structures are in the middle of the road for a particular time, can have these object markers, exit points of the talon structures, and show how visibility is improved specifically because of these object markers during the nighttime. So, the flexible prismatic sheeting that we can see here is usually supplied in a continuous roll with screen-printed black arrows; these are present because it is yellow sheeting, and these black arrows are screen-printed once on a slight line pattern that is there. So, there are also some typical requirements, such as the width of an object marker, which is usually 30 centimeters, with a length generally not less than 40 to 50 centimeters, because it should be clearly visible from a far distance. So that it ensures full visibility of reflectors to the encroaching or approaching traffic. So, these are some of the salient features of road safety that broadly fall under the categories of your road signs, traffic safety barriers, and road delineators. Thank you so much.