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A very warm welcome to all of you. I am Rajan Choudhary, a Professor in the Department of Civil Engineering at the Indian Institute of Technology, Guwahati, and the instructor for the NPTEL MOOC course, Pavement Construction and Technology, funded by the Ministry of Education, Government of India. Today's lecture will be under module 11. Where will we discuss the typical treatment and maintenance activities for bituminous pavements? In our previous lectures, we have discussed the different types of distresses that can occur on bituminous pavements, what the possible causes are, and how they can be treated. In today's lecture, we will specifically discuss some of the maintenance and treatment activities that are carried out for bituminous pavements. Now, 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.

We have discussed the pavement distresses. We have discussed the types of distresses that can be classified into four different categories, as well as the possible causes and treatments that can be effective for those distresses. So, if we talk about pavement distresses, based on our experience and the knowledge we have gained, we can say that distresses in bituminous pavements can be greatly minimized. How can it be greatly minimized? By effective surface and subsurface drainage, drainage forms a very important aspect of the flexible pavement structure, including both the surface and subsurface drainage.

So, if good or adequate subsurface and surface drainage is provided, it can be considered a lifeline of your flexible or bituminous pavement. Proper design with adequate strength and thickness is essential; we have discussed that the different layers to be considered in the bituminous pavement, along with their thickness and strength, play a very significant role. So, the design has to be appropriate to accommodate the traffic that will occur during the design life of that road structure. A strict quality control in the construction of pavement layers, including your subgrade, is essential. So, this is another aspect: you have a good design, you are incorporating different materials, but then you need to have strict control over the different aspects, quality control aspects, and quality assurance aspects to achieve what you have designed and what you are expecting.

And finally, adequate maintenance requires determining what type of maintenance and at what interval a job has to be undertaken to upkeep your pavement structure. So, we will specifically discuss in today's talk the different maintenance and treatments that are

required for bituminous pavements. So, pavement deterioration is mainly influenced by the factors that play a role in it: the traffic loads, the weather, the climatic conditions, the individual material qualities, the materials we have used, the pavement thickness, whether we have a strong pavement crust to support the load, traffic load, construction practices that have been followed, and the effectiveness of past maintenance, because that is again why we will discuss more about the maintenance aspect. Early detection and timely repair of surface distresses can prevent or delay further damage. So, we have seen this in earlier distresses, like hairline cracks that appear on a bituminous pavement structure; if they are detected and sealed during the initial period, it can prevent further damage.

It prevents further damage to your structure, similar to ravelling and other distresses, where some initial signs are present. So, at that moment in time, it is important that we are able to deduce it and work out a proper repair for those distresses. The performance of a pavement highly depends on the type, timing, and quality of maintenance. So, even for a particular distress, is what the maintenance we have suggested good enough for that particular one? So, that is an important aspect because, as I mentioned, if there is some fatigue cracking, and if you are going for a thin overlay, it will not serve the purpose. So, the type is important.

The timing when I can go for a small micro surfacing application or a slurry seal application is if my cracks are of smaller width, but when the cracks have gotten bigger, then it may not serve the purpose here. And again, the quality of the maintenance activities is also important to ensure you get what you desire after the maintenance of a particular surface. So, correct identification of defects and their causes is vital this is important for selecting appropriate methods and maintenance studies. So, this is what we discussed previously: we need to work out what defects are present and what the possible causes may be so that it helps us decide the maintenance activities. Payment maintenance mainly refers to the activities carried out to preserve what includes the activities or treatments that are carried out to maintain a pavement under normal traffic and environmental conditions as close as possible to its original construction state, which is definitely an ideal situation; however, in due course of time, the condition or serviceability will decline.

But still, we are trying to keep our maintenance activity as close as what is expected to be in the original state of construction. Timely upkeep and maintenance of bituminous surfacing offer significant benefits in preserving road assets because these assets are part of our transportation or road structure. As per IRC 82, 2023 states that these timely maintenance activities help us slow the rate of deterioration and provide us with a longer pavement life. Lower vehicle operating costs because you are able to keep the standards of our roads high. Reduced crash rates, if the surface is maintained to a good quality, with good skid resistance and good smoothness, will definitely increase the chances.

Upkeep is of road furniture as well, not only the road surface; it is the road furniture as well. It may be regarding your signage, it may be regarding your markings, so upkeep of your road furniture is also involved, and this upkeep and maintenance of your road furniture and road surface conditions help to bring down the accident rates as well. All-weather, traffic-worthy roads are there, so the roads are usable under all different weather conditions. Savings in restoration and reconstruction costs, if we are able to keep them and maintain them, and if we are able to delay those, are definitely beneficial; otherwise, when major rehabilitation or reconstruction has to be done, the costs incurred are very high compared to these maintenance jobs. Delays in maintenance, or what we can call deferred maintenance, increase both the extent and severity of the distresses many times because we may not be aware of or have not inspected our road sections, or there may be some shortage of funds or other issues that have caused us to defer our maintenance.

Then, it may definitely land up in a situation where a lot of cost may be incurred in its rehabilitation or reconstruction. With the rapid rise in construction costs, effective maintenance has become even more critical. Even in maintenance, the type of maintenance suitable for a particular job is also important. So, in terms of monetary aspects, it says that timely and regular road maintenance can yield an economic rate of return of about 15 to 20 percent depending on the road category and the traffic volume that applies to it. This is the information provided as per codal specifications.

Moreover, it helps to defer the need for costly rehabilitation by prioritizing preventive maintenance jobs or maintenance activities. So, the primary purpose of maintenance is to correct distress-related deficiencies, protect our investment in the road asset, and provide a smooth, safe roadway for road users. So, the maintenance we will ultimately do is based on what we are trying to achieve: we want to protect our road asset, provide a smooth and safe roadway, and avoid or correct the distress-related deficiencies that are present. So, broadly, the maintenance or treatment activities are usually classified under three main categories. The first one is routine maintenance, the second one is preventive maintenance, and the third one is periodic maintenance or periodic renewals.

We will discuss these, and we will discuss the different kinds of treatments and activities that are done under these three major categories of maintenance. So, first, we begin with the routine maintenance. Routine maintenance, as the word itself says, refers to the day-to-day work. Especially required to preserve a pavement and keep it as close to its constructed condition. So, we want to keep the surface in a serviceable condition that is as close as possible to the newly constructed condition.

So, it is carried out throughout the year by road maintenance staff, and what it typically may include is the pavement upkeep, specifically one major job that comes under routine

maintenance if there is any pothole formation. So, that particular pothole patching has to be done immediately because that may create a lot of distress, may damage the nearby pavement structure, and may further deteriorate your pavement structure. So that is why immediately an important aspect is to work out where any pothole patching is required. Second is surface markings. As I mentioned, it is not only the pavement surface; it is the road furniture.

Surface markings and the upkeep of pavement markings on bituminous surfaces guide users and enhance safety. Therefore, wherever there is a requirement for pavement markings, it must be addressed immediately. Traffic aids, as I mentioned, include road furniture in terms of signboards, kilometer stones, and other roadside furniture; your crash barriers and delineators, all of which must be maintained or ensured regularly. Structures, specifically the care of your structures such as culverts, bridges, earth-retaining structures, and parapet walls, ensure safety and functional infrastructure. So, all these checks are usually done regularly under your routine maintenance activities.

Then comes the second important maintenance job, which is your preventive maintenance activity. So, preventive maintenance consists of activities carried out while the pavement is still in fair to good structural condition. So, it is still in fair to good structural condition, but it is carried out with the objective of protecting it or slowing the rate of deterioration because some distresses may appear in due course of time. So, we are trying to slow down the rate of deterioration and extend its functionality. If we slow down, that means we are extending its service life or functional life.

By doing it, you help to delay the need for periodic maintenance. So, the third category, which was periodic maintenance, is expected to require this particular renewal code after this many years. So, if I perform preventive maintenance properly at timely intervals, then I can delay my requirement for periodic maintenance, and even the major rehabilitation is delayed in that case within the pavement's design life. Now, what are the typical treatments or activities that are generally done under the preventive maintenance heading is crack sealing or crack filling. This is one of the fog seal applications: fog seal, slurry seal, micro-surfacing, surface dressing, and thin overlays.

We will discuss these different activities, which are taken up under preventive maintenance or treatment, one by one. So, first of all, crack sealing, as the word itself says, is the sealing of cracks. So, it is a maintenance activity that involves first cleaning any cracks. So, any debris or foreign material present in the crack should be cleaned up for treatment, and then a proper sealant has to be selected to fill the crack, which needs to be sealed up. So that no further water ingress occurs through those particular ones, neither should non-compressible material go inside these cracks.

So, this crack sealing activity has to be carried out under the preventive maintenance job, and this will help us delay our distresses. It is particularly used for working cracks that open and close with temperature variations, specifically the cracks that are smaller in width. So, typical sealant requirements: now, what type of crack sealants can be used? This is another important aspect. So, what we require and expect from any crack sealant is strong adhesion to the crack sides. So, it should show good adhesion so that there is no separation of the sealant from the adjacent material.

Elasticity to accommodate expansion and contraction is important because if there are changes, certain cracks may occur during cold weather, and there may be some shrinkage as well as slight expansion in hot weather. So, these cracks should be flexible and elastic enough to accommodate a small amount of expansion and contraction. It's easy for application because there may be small jobs that are spread along the section. So, the application of these crack sealants to the cracks should be an easy process. Resistance to softening in hot weather; if they get softened, then they may be picked up by the vehicle tires.

So, that even reduces your skid resistance and resistance to tracking under traffic. So, this is another reason because they should not create a problem for the vehicle users in that case. Sealants are typically elastomeric modified bituminous materials, which can soften when heated and harden upon cooling. Modified bitumen, as well as rubberized bitumen binders, are some of the more popular sealants used for sealing cracks during preventive maintenance jobs. Now, IRC 82 also provides guidelines on when this crack sealing can be done, for what kinds of cases it can be applied, where, and what purpose it serves.

So, here you can see this is a table that has been taken from IRC 82 2023, which outlines the conditions that can be addressed through this crack sealing. We can address longitudinal cracking, minor block cracking, which includes your shrinkage cracks or thermal cracks, especially shrinkage cracks, and transverse cracking. So, small cracks can be taken up in that case, but there are no structural benefits. We do not gain any structural benefit from this particular one; any structural failure, such as fatigue cracking, is present. So, again it will happen because your pavement has adequate strength.

So, if there is extensive deterioration, then this crack in the ceiling will not occur. Work out that you have to work out for some structural evaluation and some other pavement treatment activities. So, it gives us guidelines on what types of situations it can be useful in specifically and what considerations should be taken into account during warm and dry weather conditions; proper crack cleaning is essential for a good bond with the existing material. Similarly, another popular material or technique for treatment under prevention is the fog seal. So, it is again a preventive maintenance treatment applied to oxidize specifically the surfaces that have oxidized, or I can say hungry surfaces, or the revolting surfaces that are there.

So, those that are approaching the ravelling loss of fines, and what is there? Here, it is an application of a slow-setting bituminous emulsion. A diluted one is sprayed directly on the pavement surface, and there are no aggregates in it. So, it is a thin application of a bituminous emulsion over the surface. So, it will address the challenges specifically related to the lack of binder and hungry surfaces; fine cracks may be present, or some initiation of loss of fine aggregates, which is ravelling, is happening. So those kinds of challenges can be addressed with the application of fog spray.

The main advantages are its low cost and the postponement of the need for surface treatments for at least 1 to 2 years. So, this is how it saves money if it delays the requirement of any periodic treatment in that case. So, it typically seals the pavement surface. Inhibits raveling because you are putting a binder on your existing surface. Regenerates the hardened because you are using these emulsion soft binders, and it regenerates your oxidized and aged binder.

Provide delineation to pavement edges and shoulders because if you do it on main carriageways, it can very well separate out, and it can give you a good view of your main carriageway compared to your shoulders or pavement edges. Application rates depend upon how much application has to be done. This depends on what type of surface structure is present because a higher application should not be done. In that case, there can be a loss of skid resistance because it is only an application of a bituminous binder. If a larger quantity is applied, then this surface may become slippery.

So, it is always better to use multiple applications to see whether your purpose is fulfilled, and your skid resistance is adequate. Hampered also. The emulsion should fill only the voids between the exposed aggregates. That is why the dry or hungry surfaces are there, or the surfaces that are prone to ravelling. Excessive application can create a slippery surface.

Particularly on high-speed roads, if it happens that in certain cases when the application is done and it is found that at a few locations the surface has become slippery, then we can go for an application of sharp sand, which is applied and rolled to improve the skid resistance. So, this is another way to pick up the excess binder that is there. So, quite suitable for parking lots and specifically low-speed road sections, this kind of treatment with fog seal is quite useful and has been proven beneficial. The conditions as per IRC-82 that are suitable for the application of fog seal state that longitudinal transfers and block cracking are good enough to be treated by fog seal. Bitumen aging, oxidation, and hardening of those surfaces or conditions can also be treated with the help of fog seal.

Some initiation of unraveling. Loose materials must be there, but yes, definitely, whenever the surface needs to be prepared, it needs to be clean of any loose material, debris, or foreign material present. No structural improvement is there, and it is usually not recommended for high-traffic roads or highways; some challenges may arise with respect

to the skid resistance. So, there are already some surfaces with poor skid resistance, and the application of fog spray may further hamper the situation. So, since it is an application of an emulsion, we need to give some curing time before it is opened to traffic; usually, 2 to 4 hours is a typical time for these kinds of preventive activities. Preventive activity or treatment is the application of a slurry seal.

And here, in the case of fog spray, it was only a binder; here it consists of fine mineral aggregates, and slow-setting cationic bitumen emulsion, specifically SS2 grade, is used along with water and some additives that may or may not be used. So, the components are proportioned; we have dedicated guidelines, specifically IRC-SP:81, which provides us with guidelines for the slurry seals and the microsurfacing. We have the MoRTH specifications for road and bridge works, which also provide detailed guidelines on the composition and application of the slurry seals. So, the components are proportioned, mixed, and uniformly applied over a prepared surface using a self-propelled slurry seal machine. So, this is important; it should be applied through a slurry seal machine to get the desired benefits.

Now, what are the key features, or what are the key benefits associated with it? It has a free-flowing consistency similar to cement concrete. So, the application is easy with this slurry seal. Seals low-severity surface cracks. So, cracks with a low severity of around 3 mm to 5 mm can be sealed with this particular one. It waterproofs the pavement structure, has a high binder content, and waterproofs your surface as well.

Improves skid resistance on roads typically up to speeds of 60 kilometers per hour, so it can be used in urban sections or low-speed roads where low volumes of traffic are present. And you can see that there are three types of slurry seals which have been recommended by MoRTH depending upon the thickness of these applications. The type 1 is for a thickness of 2 to 3 mm, type 2 is for 4 to 6 mm, type 3 is for 6 to 8 mm, and here you can see the dimensions for what types of cracks up to 4 to 6 mm thickness of these slurry seals can be used, and this is how much quantity of slurry seal is available. And how much residual binder you can see a high content of residual binder is specifically present in these slurry seals. So, with a typical thickness under 10 mm, we can see that 6 to 8 mm is the maximum thickness that is quite suited for city roads and city streets while preserving curves.

Now, what additional advantages are there in these thin applications, which are less than even 1 centimeter, when you apply this particular one specifically on urban streets? Then your concerns related to your curves and medians arise because if you increase the amount of your height, your drainage and roadside features get disturbed. So, these thin applications help to preserve your pavement structures, and they do not affect your existing curves, medians, or drainage. So, the other conditions that can be addressed as per our codal requirements state that longitudinal transfers and block cracking can be addressed by

this particular one: ravelling, weathering, and loose materials; there is always frictional loss. Now, here we have an aggregate application in the case of fog seal, where we were not allowed because this surface already had some concerns related to skid resistance. But here it says that if some friction loss is present, then this could also add to or improve the skid resistance.

It will help us reduce moisture infiltration, and it will also help us in the case of oxidized or hardened binder. But definitely, it is a very thin application with no addition to the structural capacity that occurs. Now, again, the construction conditions are as I said. The correct type of maintenance, the correct time of maintenance, the correct type of treatment, the correct time of maintenance, and the correct application or the correct quality of it all; these are important aspects. So, whenever these applications are to be made, it is the structural conditions and construction conditions that are well mentioned: the surface must be clean, aggregates must be clean, angular, durable, well-graded, and uniformly preferred as 100 percent crushed aggregates.

Then, only the desired benefits can be achieved through these preventive maintenance treatments. Now, the other very popular kind of surface treatment that comes under the preventive category is micro surfacing. So, it is a pavement treatment composed of what we usually use: polymer-modified emulsified asphalt. Mineral aggregates are used, mineral filler is used, water and additives are used, and their application is very similar to that in the case of slurry seals. So, here it is mainly used on structurally sound pavements because, again, these are thin applications; they do not add to the structural strength of your pavement.

Showing what kind of situations it can address: premature aging, cracking, aggregate loss, or polishing. So, the key features of it are that it uses polymer-modified or rubber-modified bituminous emulsions. This is one important feature compared to slurry seals. Second, two types are usually specified, whereas in slurry seals, three types of slurry seals are specified. Here, usually two types are specified: one is 4 to 6 mm, and the second is 6 to 8 mm, along with the details as per MoRTH 2013 specifications.

The details include the requirements for different components, such as the aggregates and the binder; the residual binder is given along with it. It mentions that for 6 to 8 mm, it can be sufficient for roads carrying commercial vehicles. Commercial vehicles are usually the ones that have a laden weight of more than 3 tons. So, commercial vehicles in the range of 1500 to 4500 are commercial vehicles per day.

Then this one is good enough, and this 4 to 6 mm is good enough. So, they can cater specifically to medium and, in some cases, high-volume traffic as well. Prevents ravelling and oxidation, enhances surface friction, fills minor irregularities and wheel ruts because of the thickness of micro-surfacing, and many times there may be two applications of

micro-surfacing, which can be done depending on the requirement; this is an additional advantage. Again, the caudal specification says it can be helpful to address longitudinal and transverse cracking; the micro surfacing, the raveling, and the weathering can be addressed; even bleeding can be addressed, where we can slightly adjust the binder content as well. Friction loss can be addressed through this particular method.

Moisture infiltration can be significantly reduced with this one. But again, it says it adds limited structural capacity because that is of a very low thickness, less than 10 mm. So, temporary seals can seal the fatigue cracks, but yes, if there is an inadequate structure causing the fatigue cracking, it will occur again. But yes, because if those cracks are not sealed, then water will go down, and this will exaggerate and reduce the time available for your major rehabilitation or for some periodic renewals that are required. So, this at least delays or reduces the progression of your distress. Then, the other kind of preventive maintenance treatment is surface tracing.

Now, in this particular case, it is quite a cost-effective preventive maintenance treatment that is available. And here this serves both the purpose of preventive maintenance and periodic renewals or periodic maintenance. So where some of these are planned for regular intervals. So surface dressings are used, and micro surfacing is used in periodic renewals; we will discuss this in the upcoming slides. It involves surface dressing; we already discussed that it involves spraying a viscosity grade binder or a rapid-setting cationic emulsion on a prepared surface, followed by an application of your cover aggregates or key aggregates, and then rolling has to be done to embed these key aggregates into your bituminous binder film.

So, it can be applied in a single coat or in two coats. We discussed this earlier. So, surface dressing can be in one coat or two coats, but at that time, we ensured that if it had to be applied in two coats, definitely the first coat needed to be opened for traffic for at least two to three weeks. And whenever the second coat is done, we preferably use smaller sizes of aggregates in the second coat of surface dressing. What are the key benefits that are usually associated with the use of surface dressing? It seals the pavement and prevents water ingress because you are applying a bituminous binder layer over the existing pavement, and it protects the bitumen from oxidation, enhancing skid resistance.

Key aggregates are present; chips are on top of it. So, it provides a good macro texture to your surface and extends the pavement's life because it delays the progression of your distress. As per the caudal specifications, it says it is good for addressing longitudinal, transverse, and block cracking; raveling and weathering can be well addressed through this particular one; bleeding, roughness, friction loss, and moisture infiltration are also some of the aspects that can be very well addressed. Simultaneously, it states that structural failures cannot be addressed through the application of surface dressing, and if extensive

deterioration or fatigue cracking is present, then they do not add to your structural capacity. So, this is again an important aspect that needs to be taken care of.

Now, thereafter, the other application is in terms of some thin overlays. Thin overlays can be used for certain mixes, such as the close-graded premixed carpet, semi-dense bituminous concrete, or bituminous concrete; these are three specific thin overlays that can be applied, and again, the thickness is usually less than 20 mm. So, these will not add to your structural strength, but they can help you preserve your pavement structure. So, thin overlays are mainly non-structural layers designed to protect existing pavements without significantly increasing structural capacity. To a certain extent, it is helpful because it adds to it, but it should not be considered as a structural overlay. Typically applied over structurally adequate pavements, this is an important aspect, and when we go for the complete application of these thin overlays, it means the existing one has been distressed.

A good part is that we can mill it and reuse it or recycle it. So, milling is recommended when the surface shows moderate to severe raveling and low to medium severity of longitudinal or transverse cracking. When we go for these thin old layers, it is good enough that we mill the existing surface, and it can be recycled. Composition and thickness of normally plant mixed asphalt, cement, and aggregate typically have a maximum thickness ranging from 20 to 40 mm, commonly 30 to 40 mm for hot mix asphalt or bituminous concrete, but usually thin overlays mean around 1 inch to one and a half inches. Common mix types include both cold and hot mixes, which can be used for thin overlays; dense or semi-dense bituminous concrete, open-graded, close-graded premixed carpet, or stone matrix asphalt. Now, it serves as preventive maintenance, definitely improves functional quality, enhances riding quality, helps us improve the smoothness of the surface, and protects the pavement surface.

So, this is basically where the thin overlays are. And then what are the conditions under which it can be addressed, and how can it be useful for addressing it? Longitudinal and transverse cracking is present, raveling is present, bleeding, roughness, friction loss, and block cracking may perform better with additional milling, and structural rutting definitely cannot be stopped with this particular treatment, but to a certain extent, it will improve riding quality and provide smoother surface performance. Now, the important things to be noted down are if you have, say, surfaces initially showing some signs of fine cracks or some signs of raveling. So, why wait to go for thin overlays in the beginning? We can apply foxes in that case, and if only raveling is present and only some fine cracks have developed in some places, we will go for an application of crack sealing in that case. If we are going to delay it, we ultimately have to end up with more costs when these are certain treatments that will involve a greater amount of money.

So that is why it is said that a good inspection is required to timely figure out what type of maintenance activities can be done so that they can be carried out at a lower cost and will

be more effective in that case. Now, the third one is the periodic maintenance or periodic renewals that are there. Now, these are usually certain activities that are planned in advance, so that we can say these are the periodic renewals or periodic activities that are present. So, they consist of regular work performed every few years because we can understand in due course of time that in, say, 5 to 7 years of life, your binder will age, there may be chances of fine cracks, and there will be a loss of fine aggregates. So, an application of micro surfacing will be a good measure during the periodic renewals.

So, these are certain regular activities that are planned at some regular intervals. A few years to prevent pavement deterioration and defer the need for major rehabilitation. These operations are carried out either at predetermined intervals, scheduled, or based on pavement condition and performance. This is important because certain activities may be planned at, say, an interval of 5 years, but it is good enough from inspection if we feel that this needs to be done before that particular period; it has to be carried out. Otherwise, if we are going to wait for that period of time, the distress will be extended or will become more severe by then. So, this periodic renewal at that time, which was decided earlier, may not be sufficient to address those distresses.

So, the timing and type of maintenance depend on the road category; specifically, what types of categories are there: high-speed roads, urban sections, or roads with low traffic? Traffic volume and climatic conditions under which it has to serve have primary goals of improving riding quality and slowing permanent deformation. So, these are the primary goals of the periodic renewals. What are the common treatments included under these periodic maintenance activities or periodic renewals? It can be a single or double-coated surface dressing that can be applied. A thin premixed carpet, a slurry seal, one or two coats of slurry seal, applications of microsurfacing, more than one application of microsurfacing, mixed seal may be present, stone matrix asphalt application may be present, semi-dense or dense bituminous concrete, hot or cold mix of bituminous concrete. So, these are the different kinds of treatments that are usually planned under the periodic maintenance or periodic renewal activities.

Now, as for the other maintenance activities, similarly, for periodic renewals and treatments, they help to preserve the original pavement qualities. Prevent deterioration and ensure that the pavement meets the ongoing and future traffic demands throughout its design life. Some of the key points of periodic renewals include, first of all, timely detection and repair of visible distress. So, this is one part if we are able to do this under the periodic renewals: timely detection and repair of visible hairline cracks and raveling to prevent major surface damage and costly repairs. Another is inspection-based planning; as I said, there will be one time-based, and the other one is inspection-based.

So, the inspection-based planning is very important, and this inspection can be done preferably twice a year: once before the monsoon and once after the monsoon. So, periodic

inspections, along with specific special inspections, especially before and after rains, are important because these are the two key periods when you can see if certain cracks are present before the monsoon. It is better to address or treat those issues before the monsoon, and then we can see how the cracks or any other distresses or treatments have performed under that particular rainy period to identify stretches needing pothole repair, patching, or other remedial measures. So, this inspection-based planning is very important for periodic renewals. The selection of renewal specifications, as we mentioned, includes a good amount of options: micro surfacing, stone matrix asphalt, bituminous concrete, and slurry seal.

So, which type, depending on the existing condition of this road, can the periodic renewals be planned in that case? Profile correction is necessary whenever, many times in the due course of time, the profile may get disturbed, mainly in terms of your superelevation and camber. Since these renewal codes are thin, they should not be considered for your profile correction. So it is very important that before these treatments are made, certain profile corrective codes can be applied over the surface that match your existing surface. So, traffic may flatten camber and superelevation. So, a suitable levelling or profile correction course is to be applied before any treatment and renewal is done.

So, these are certain important aspects that need to be taken care of when we are looking into these treatments or maintenance for the bituminous pavements. Thank you, all of you.