

**Course Name – Pavement Construction Technology**  
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**Lecture – 44**

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 12, where we will discuss the design of recycled mixes. In this particular one, we will discuss the design of hot recycled mixes. At the outset, I would like to acknowledge the use of text, information, graphs, and images sourced from various textbooks, code standards, journal articles, reports, newsletters, and public domain searches. As we discussed in the previous lecture on recycling, specifically hot mix recycling, this is the process in which reclaimed asphalt pavement, often referred to as reclaimed bituminous material, is combined.

In the hot mix recycling process, reclaimed asphalt pavement material or reclaimed bituminous material is combined with new materials, including virgin aggregates, virgin binder, and sometimes a recycling agent, to produce hot mix asphalt, also known as recycled hot mix asphalt. Similar to conventional hot-mix asphalt, recycled mixes must be properly designed, as the requirements for conventional hot-mix asphalt also apply to our recycled mixes. Properly designed recycled mixes can exhibit properties comparable to those of conventional hot-mix asphalt, and in certain cases, they have been found to provide properties even superior to those of conventional hot-mix asphalt. Therefore, the design of recycled mixes aims to ensure that they meet the same requirements as those expected of mixes prepared with virgin materials.

When preparing a hot mix asphalt using virgin aggregates and virgin binder, there are specific requirements. Therefore, the same requirements are expected to be met by the recycled mixes as well. Their performance, if not better, should be on par with or superior to that of your virgin asphalt mixes. We have the guidelines, IRC 120:2015, on recommended practice for the recycling of bituminous pavements. Additionally, numerous documents are available that provide information on the recycling of hot mix asphalt, specifically one mentioned here, which pertains to hot mix recycling, as outlined in the Asphalt Institute's Manual Series Number.

Now, what are the key characteristics of reclaimed bituminous material or reclaimed asphalt pavement materials that are important to understand when designing recycled mixes? So, reclaimed in-situ bituminous material used for recycling typically exhibits the following characteristics. The RAP, which is obtained, or we can say the RBM, which is

obtained, what are the typical characteristics of that material? This aged binder is extracted from a surface that may have undergone aging for a long period. So, the binder that will be present in the RAP will be an aged binder. As a result, the bitumen becomes aged, oxidized, and hardened over time, resulting in a significantly higher viscosity. Therefore, they may have a much higher viscosity compared to the virgin binder and the fresh binder of the same grade used in the original construction.

So, when we pick up the VG 30 binder, we target a viscosity of 3000 poise; however, under aging conditions after a service life of 10 to 15 years, the viscosity may increase to around 40000 poise. Therefore, a significant amount of aging or hardening of the binder may occur. So, the RAP that will be there will have the aged binder. Then the second is the crushed aggregates. So, during the reclamation process, especially in cold milling, aggregates may undergo crushing.

In addition to this particular one, some crushing of the aggregate may occur during the service life of the mix, particularly under the application of traffic loads. So, this may alter their grading from what is in the original mix. Therefore, you may have information about the original mix that was constructed some years ago, and when you extract the RAP and check the gradation, you may find a significant difference between the gradation of the RAP and the gradation that was in the original virgin mix. Material variability in reclaimed bituminous material may exist in terms of aggregate gradation properties. If it is a big stretch, the source of the aggregate may have changed in that particular case, or the composition of the mix might have changed.

So, then you can experience a change in the aggregate gradation as well as a change in the properties of the aggregates. And if the stretches are far enough, the RAP may be extracted from different layers; if it is extracted from the wearing course or from your base and binder course, then the grade of the binder may also vary. And depending on the source of the material, it also changes during a particular stretch; you might be getting one length of construction aggregates from one source, and then after some time, the aggregates may come from a different source. In that case, the source variability will also come into play. Therefore, this material variability may be present with your representative.

Now, the usual four components involved in hot mix recycling are first the RAP, which is your reclaimed asphalt pavement, and the other one is reclaimed bituminous material. These are the synonyms that are widely used. We have virgin aggregates available if you need to add some. Additionally, virgin asphalt binder, which is also required, and a recycling agent may be incorporated. So, four key components of a recycled mix or recycling are the RAP, the virgin aggregate, the virgin binder, and the recycling agent.

The recycled mix design procedure consists of two main steps. What are the two main steps? One is the material evaluation, which involves assessing your specific RAP, as well

as your virgin aggregates and virgin binder. The next step is the mix design. Therefore, we will not discuss the evaluation of your virgin aggregates and binder, as this is standard and conventional design for virgin HMA mixes. Here, we will focus more on the evaluation of the RAP. The material evaluation's purpose is to assess the properties of the component materials, which may include RAP and virgin materials. Here, our main focus will be on RAP and developing an optimum blend that satisfies the mix requirements.

Ultimately, the blend of aggregates and binder meets the mix requirement. Second, these are the conventional steps in the case of any hot-mix asphalt. Second is the mix design, which focuses on determining the appropriate type and percentage of bituminous binder. Based on the results of the compacted trial mixes, we evaluate the mechanical properties and volumetric properties of the compacted mixes, and based on these, we provide the optimum content of our bitumen for the design of bituminous mixes. So, the main steps of the material evaluation and mix design process during the design of recycled mixes specifically involve what? First is the collection of representative field samples of RAPs.

So, the RAP may be lying there at some crusher plant. So, there may be different stockpiles. So, one part of your collection is there, your stockpiling is there, and then sampling is there. So, that exercise has to be done with the RAP. Second is to conduct laboratory tests to analyze the RAP composition; specifically, the important things are how much binder is present, what the consistency of the binder is, what the aggregate gradation is, and what the aggregate physical properties are, which may be required to ensure.

Determine the required quantities and sizes of virgin aggregates to be added. Now, there will be a target gradation for every mix. So, a share of aggregate gradation will be present from RAP. Now, you need to proportion virgin aggregates in a manner that the combination is able to achieve the desired aggregate gradation. Select the appropriate type and grade of virgin binder.

An already aged binder is present in the portion of the RAP that is introduced in recycled mixes, and then there are virgin aggregates that need the coating of the binder over them, as some binder may be required because the existing RAP may have insufficient aged binder. So, some more binder may be required to provide an extra film over it, along with the film over the virgin aggregates. In addition to that particular one, many times recycling agents are also used, or softeners are also used. Then, after this particular one is seen in a similar fashion as we do for conventional hot mix asphalt, we will prepare, compact, and test these trial mixes at different binder contents, and then finalize the optimum mix combination that meets our design requirements. So, these are the steps that are involved in the design of recycled mixes.

Now, coming to the collection specifically, stockpiling and sampling from RAP, some important steps need to be followed. First of all, avoid further crushing of milled RAP; use

it as is or screen to remove oversized particles, because in cold milling, a lot of fine material is already generated. So, it is always preferred that we use the RAP as it is instead of going for further crushing, because then more fines will be generated, and this will reduce the use of the RAP since you have to meet certain target gradation. So, most of the time we prefer to use RAP as it is, but definitely, if you are targeting a layer where some specified aggregate sizes are only mentioned and your RAP may have larger aggregate particle sizes, it needs to be crushed in that case. Keep stockpiles free of contaminants from the start.

This is important. There may be a distressed layer from which the milling has been done and the RAP has been stockpiled. So, it should not be treated as a waste because otherwise, if it is thrown, dumped, or stockpiled in an improper manner, it gets contaminated by dust, other waste, other aggregates, and soil at the site where it is stockpiled. So, care has to be taken in this particular manner. This should be treated as an important aggregate material. Control moisture; another factor we have discussed during the different hot mix recycling operations is that the amount of moisture present in the RAP is a big contributing factor to how much RAP can be introduced.

So, we always try to keep the moisture content in the RAP as low as possible. So, we will prefer that the stockpiles are covered and under shelters or in buildings, and we will prefer to have the conical-shaped piles of this particular rap there so that, with the help of it, water can be easily drained out on the sides. Limit stockpile height; also, we do not go for heights greater than 3 meters because otherwise, self-consolidation may occur and larger chunks may be formed. Maintain consistency; we can maintain consistency during stockpiling as well, because if you know that this material is coming from this particular project and this particular layer, then it can be stockpiled separately, and the one from the other project can be stockpiled separately. So, this will help us reduce the variability that may be present in the RAP.

So, well-managed RAP stockpiles generally show uniform gradation, bitumen content, and binder properties. So, it is very helpful for us in the recycled mix design. Important common steps, especially now that you have these stockpiled, are there. So, you need to collect the samples for material evaluation. Now, you can do the sampling at various locations, and you also have different frequency requirements.

So, it is recommended to ensure the quality of the RAP for that particular one; you can at least go for one sample per 1,000 tons of RAP, and at least 10 sets may be recommended to ensure statistical reliability. So, that is another reason that a minimum of 10 samples can be picked up to ensure statistical validity. So, sample collection and where do you collect these samples from? It can be collected directly from the pavements from where it is milled off. So, from there, we can collect from the pavement surface through coring or during milling, or from the transport trucks when it is milled and put in those trucks and tippers. So, the material can be collected directly from those tippers or once it has been stockpiled.

So, it can be collected from the stockpiles. Now, the important part is representative sampling. So, as the stockpile is there, you need to take out a good number of samples from different locations of the stockpile. So, it usually says you should obtain 5 to 10 representative samples from different locations within the stockpile, and it is always preferred to remove at least the top 15 centimeters of the material from the surface to minimize segregation. So, these are some general considerations that should be taken into account while you are collecting the samples from a stockpile to evaluate the RAP.

Sample preparation involves sieving the collected material, and any material retained on the 50 mm sieve is usually discarded. The larger sizes of wraps may be limited because there may be only a few sizes available, and a small share may be present. So, in that case, it is better to discard aggregate RAP sizes that are more than 2 inches. Now, once the sampling has been done, we need to proceed with the evaluation of the reclaimed asphalt pavement or the reclaimed bituminous material. And for this particular one, since we know that the binder that is present is already long-term aged, there may be some changes in the gradation of the aggregate that is present.

So, what we are trying to evaluate from this particular one is the binder properties, and we are also trying to evaluate the aggregate properties. Now, the binder properties indicate that with aging, the binder loses lighter fractions, resulting in increased viscosity of the binder in the RAP and reduced ductility. So, we just want to ensure the status of the viscosity of the binder over the RAP. Aggregate properties, as I mentioned, may change over time due to degradation from repeated traffic loads and environmental exposure. So, what initial gradation was there during the construction may indicate that there may be a significant change in the gradation that may happen.

So, the RAP needs to ensure the binder properties as well as the aggregate properties. Hence, determining the composition of RAP at the offset is very important. Standard practice involves evaluating aggregate gradation; what we require is aggregate gradation, and we most of the time require binder content and the viscosity of the aged binder at 60 degrees centigrade. Because we use viscosity at 60 degrees centigrade for our neat binder grading system, we prefer to determine the viscosity of the aged binder also at 60 degrees centigrade, and at least 5 representative samples should preferably be tested, with their mean values then used for further analysis. So, we can have a different number of samples at least, so as to work out the mean to have better confidence in the results.

Now, how to determine the amount of binder content and have the binder for the determination of its properties, specifically viscosity. So, to determine bitumen content and recover aggregates for gradation and property analysis, two common approaches are used. One is the ignition method, and the second is the solvent extraction method. Now we have the RAP with us. So, from there, we want to extract the binder to determine its gradation and certain physical properties.

We want to extract the binder to determine how much binder content is present and what the state of the binder is. So, two more thirds that are quite popular are the ignition method and the solvent extraction method. The first method is the ignition method, for which we have AASHTO specifications and ASTM specifications; it is also a widely used technique in which the wrapped samples are subjected to controlled burning at higher temperatures in a furnace to completely remove the bitumen, and the recovered aggregates are then used for gradation analysis and any other property determination. So, this is one way you can recover the aggregates, which you can further test for their physical properties or for their gradation; however, if you do not have the binder available, you can determine the binder content. So, you will get the binder content; the remaining weight of aggregates will give you the binder content.

You will have the aggregates, which you can see and get the gradation, and you can also determine some of the physical characteristics of the aggregate. The second is solvent extraction; here, the binder is extracted from the RAP with the help of some solvents. So, solvent extraction using trichloroethylene or other solvents has been in practice for many years; it is also quite effective in determining bitumen content because you are able to extract the binder from the aggregates. So, you have a solvent that has a binder and aggregates that are getting separated out. So, again, the aggregates that are separated out from the binder can be used for their gradation determination and for their physical properties, and then the solvent that contains the binder can have the binder extracted from it, and then it can be tested for its consistency, viscosity, or other properties.

So, now in this one, we have a possibility for the extraction of binder, also for its evaluation, and we get the binder content. So, it further allows for the recovery of bitumen from the solvent to determine its characteristics and viscosity. However, this specifically refers to the solvent extraction method, which has challenges due to the solvent used, including health and environmental concerns. There may be certain aggregate types depending on the type of solvent and the grade and state of the binder present; the solvent may not be completely able to extract the binder from the aggregate. So, there may be certain concerns in some peculiar types of recycled mixes.

Now, once you have recovered the aggregate, you can measure its gradation, and you can measure the physical properties of the aggregate. The other popular method is determining, as we know, that during the hot mixes for design, we need to know about the effective specific gravity of the aggregates so that we can work out the theoretical maximum specific gravity. So what can be done here? We can first work out the theoretical maximum specific gravity of a RAP mix. So, as per the conventional method, which is the rise method, it is there. So, for determination, if I want to determine whether it is an indirect method, I want to determine, say, a bulk specific gravity of the reclaimed bituminous material.

First, I will estimate or determine the theoretical maximum specific gravity using a rise method. There are many other methods. This is one example. By the rise method, you can work out the theoretical maximum specific gravity, and then, on the basis of the theoretical maximum specific gravity, you can work out the effective specific gravity of the aggregates, including RAP aggregates. Now, what is required in this particular one? You need to know the bitumen content in the RAP that you have already determined during the extraction process, whether it is the ignition process, the ignition method, or the solvent extraction method.

In both cases, you will be able to have your binder content in the RAP. So, you have binder content in the RAP; through your rise method, you have the theoretical maximum specific gravity. So, in that case, the only thing you require is to estimate the specific gravity of the binder. So that you can get the existing records available when the mix was designed. So, if that information is available to you, you can get the effective specific gravity of your rag aggregates, and then, from the already existing records, you can work out.

So, the other important thing is that you can know how much binder absorption there was. So, assumptions for bitumen absorption and binder specific gravity are required, and historical data for these values at each plant should be reviewed so that they can be used, allowing you to ensure how much change occurred in these parameters, specifically during the construction of these courses. So, these are some of the methods that can be used to estimate some of the characteristics. So, in that case, we can estimate the bulk specific gravity of the RAP as well because now we have the effective specific gravity with us. So, from the effective specific gravity and the percentage of bitumen absorbed in the aggregates, which we got from the historical records, we can work out the specific bulk gravity of RAP also.

Because the bulk specific gravity of rap is required, as we know, in the computations of volumetric calculations or during the mix design, such as VMA, where you need to determine the bulk specific gravity of the aggregates. So, the accuracy of these values highly depends upon the reliability of the estimated bitumen absorption because you need to work out from it. So, that is why even in earlier lectures we mentioned how we maintain the record of the different steps involved during the mix design is very important in later courses, even for recycling. Now, on the other end, we have done the evaluation of the aggregates in terms of gradation and some of the physical properties to get an idea about the bulk specific gravity of the RAP aggregates. Second, the important aspect is to check the viscosity of the RAP binder or the consistency of the binder present in the RAP.

So, for this one, as we mentioned, the solvent extraction method is to be used. Bitumen extraction is commonly performed, and it is mainly done using the centrifuge extraction method. Here, you can see this is a centrifuge extraction method, where in this particular one, the binder is extracted because the solvent goes off, and then in this particular one, the

binder is separated. However, in the conventional centrifuge extraction method, it may contain bitumen and ultra-fines passing through specifically because when the solvent is taken out from this combination of solvent and binder, some of the fines are also taken out. So, in that case, again, it must be removed by using a secondary high-speed centrifuge.

This is a high-speed centrifuge, where these fines are again recovered from it, because otherwise it will always lead to higher binder content in the RAP. So, in addition to the standard centrifuge extractor, a high-speed centrifuge is required for removing the ultrafines from your solvent, which are used in this particular one. And now you have this particular one where the binder is getting dissolved in the solvent. So now, from the solvent, you need to recover the binder.

So, what did you do? You took the rap. You had the solvent, you put the solvent through it, and that solvent, along with the binder, was extracted first through the standard centrifuge. Now, this solvent, along with the binder, may have some fines; small fines are present. So, that again needs to be separated out by this high-speed centrifuge. So now you have a solvent with the binder itself. Now, from that solvent-containing binder, you need to extract the binder.

So, for this particular one, various methods are used; one of the methods is specified by ASTM D 5404, which uses a rotary evaporator. So, in this one, you are able to recover the binder from the solvent, which can be further used for any measurement; it may be viscosity, ductility, or softening point. The most important one is the viscosity at 60 degrees centigrade, and specifically why 60 degrees centigrade, because we need to work out the grade and quantity of virgin, specifically the grade of the virgin binder, which is to be added to the recycled mix, is worked out on the basis of the viscosity of RAP binder at 60 degrees centigrade. Now, the viscosity of the aged binder is needed to determine the quantity grade of the new binder for the recycled mix; we have these standard vacuum capillary viscometers through which we can work it out. Many times, recycling agents are also used; key purposes of these recycling agents are to restore the properties of aged bituminous binder to a consistency suitable for the intended construction, because, as I mentioned, their viscosities may be very high compared to the viscosity of virgin binders, to regenerate the recycled HMA mix, because the binder is already hardened.

So, we need to regenerate those binders to their optimum durability. So, for that particular one, the recycling agents may be used, and even in some cases, the RAP may have a lower binder content compared to what is to be in the new mix that we are trying to create. So, we need to put up the additional binder as well, so that the regenerating agent can form to meet that particular additional binder requirement. Finally, to give the required amount of binder that is necessary for the mix design parameters. Now, once you have determined the viscosity of the recovered binder at 60 degrees centigrade.

So, what should be said is that a RAP percentage is used. So, what should the percent grade of the new binder be? So, there are certain general principles that are widely used based on experience. One says that if we are designing any recycled mixes, only 20 percent of RAP is being incorporated. Then, generally we can keep the grade of the neat binder the same as we are doing for a virgin mix. So, you do not need to change the grade. So, if you say in a particular region you are using VG 30 binder and a mix is prepared with 20 percent RAP, you can go with VG 30 grade itself; there is no need to change the grade.

In other cases, it says that if the range of the RAP is from 21 to 30 percent, then one can go for a softer grade compared to the others. So, if, as I mentioned, I am using VG 30 and I am going to use RAP in the range of 21 to 30 percent, then in that case, for the virgin binder, I can go for a softer grade, like VG 20, as per our codal requirements. So, what grade is to be used is already stated in our IRC 111, which says in what regions you can go with which grade. So, once that needs to be decided, then based on how much RAP is incorporated, if it is less than 20 percent, there is no requirement to change the grade of the binder; most of the time, this is generally what is adopted in most of the designs of recycled mixes. It is good enough that you determine the grade we will see in the next slide; we can measure the viscosity, and we can determine that as well, but these are some of the thumb rules we can mention.

So, if it's 21 to 30 percent, then you work out with one softer grade. So, if in one region I am using VG 40 and I am using, say, 25 percent of RAP, then for the new binder, I can prefer to go for a VG 30 binder. Now, if this is not working, we can also determine the grade of virgin binder. This is for that particular one; we have blending charts that are there. This is a blending chart that has been shown, and what is required to make use of this blending chart. You can see there is a log-log viscosity presented on the y-axis, and this is the percentage of new asphalt binder with respect to the total binder.

So, how much does it say 40 mean? 40 percent of the total binder; 40 percent is new, if it says 80, it means 80 percent is new binder and 20 percent is what we are getting from the RAP. So, to make use of this blending chart, what one requires is the target viscosity, which is specific to the grade specified for the selected project. So, in one region, if I am looking for Vg 40, then my target viscosity may be 4000 poise, because that is the target viscosity for this particular grade. So, I combined the virgin as well as the aged binder; this should be my target viscosity. So, the blending chart relates the viscosity of the aged RAP binder to the proportion of the virgin binder in the recycled mix to determine the virgin binder grade.

And so this is what it is; it is preferred, but through this particular one, it is also said that if you, I will give an example of it. Say, for example, it is a small, simple explanation which has been created, say, if the viscosity of a binder in a RAP is around 80,000 poise. So, this has been shown here, at around 80,000 poise. Sorry, this is the target one; this is the binder,

and the viscosity of the aged binder is shown here. And my target is to have a mix in a particular region for which the VG 20 binder is to be used.

So, my target viscosity will be 2000 poise because I prefer to use a Vg 20 binder. Now, if the RAP content of this particular RAP mix is 25 percent. So, when I did this solvent extraction method or ignition method, I found that the amount of binder present in the RAP is 3.8 percent. So, in the total recycled mix, 25 percent is coming from the RAP, and the remaining 75 percent is from your virgin mix.

Now, this 25 percent is giving me a 3.8 percent binder. So, if I know that the target demand of my binder may be, say, 5 percent, I am giving just an example to make use of this blending chart. So, the binder that will be obtained from the RAP will be 3.8 percent, along with the shear it has, which is 25 percent in the recycled mix. So, I will get 0.95 percent binder from the RAP, and what will be my requirement, because I am looking for a target of 5 percent binder content? So, the remaining 4.05 is to be the new binder. So, that shows that this is about 81 percent. So, here I can show that this is my percentage of new binder with respect to the total binder of 81, and this is the viscosity of my aged binder; this is my target viscosity. So, what will I do? I will connect this particular one on the blending chart; the target viscosity with this percentage of new binder, and this point B is marked. So, this is how I get B; then I join a line from this aged binder viscosity passing through this point, and it is extended here. What the viscosity I get from here is to be the viscosity of my virgin binder.

So, if I can see, for example, if I am getting somewhere around 800 poise. So, in that case, I can use VG 10 because VG 10 is 1000 plus or minus 20. So, in that case, plus or minus 200. So, in that case, you can use the VG 10 binder. So, this is how this blending chart is worked out to determine the grade of the virgin binder. But in addition to this, it is always stated that it is preferred that the selected grade should not be more than two grades softer than the normally specified.

So, it should not happen that if a VG 40 is to be used in a region, you are going down to VG 10, only two grades softer. I have gone from VG 30 to VG 20, but no more than that. So, even when you are using a blending chart, if you get a viscosity that is very, very low, normally there should not be a reduction of more than two grades of the binder according to the experience it indicates. Now, we have the amount. If we are aware of the grade of the binder that is required, the amount of RAP we are using, and the gradation we are using, then we will proceed with the mix design in the standard manner.

So, here, since we are currently following the Marshall method of mix design, the same IRC 111-2009 will be used, and the parameters defined by it have to be ensured for the recycled mixes as well. So, the first aggregates extracted from RAP are treated as one of the constituents, and they need to be blended with the virgin aggregates to achieve whatever

design gradation you have. So, this blending has to be performed from the RAP gradation and the gradation of your virgin aggregates to get the desired aggregate gradation. And then, when you are preparing the laboratory specimens, some key considerations are required. One is in the laboratory; mix RAP that is usually preheated in a pan for no more than one hour.

This is usual because you already have the aged binder over this particular one for the mixing temperatures. While virgin aggregate is heated to about 10 degrees higher than the mixing temperatures, it is then mixed in this particular one. The RAP and virgin aggregates are first dry mixed so that, through conduction, the RAP gets further warmed up, followed by the addition of the required amount of virgin binder. So, whatever is deficient, as in the previous example, we have seen that what we have from the RAP, the remaining is to be the new percentage of the virgin binder, and the grade has already been decided from the blending chart. So, now we have added the additional virgin binder to it, and then we need to compact it using our standard procedure.

So, this is to say that in the first case, the target was 5 percent; then we can work with different binder contents and prepare compacted specimens at different binder contents. These compacted specimens now need to be evaluated for volumetric properties and mechanical properties in a similar fashion to how we did for the virgin mixes as well. And from that particular one, we decide on the optimum combination, specifically the binder content for those percentages of rep. So, this is the important aspect, specifically in recycled mixes: the evaluation of the RAP in terms of its gradation and its properties, which may be required during volumetric measurements. Second is the binder content determination, the right amount of binder content that we get from the ignition method, as well as from the solvent extraction method.

If lower percentages of RAP are used, then, as mentioned, if less than 20 percent of RAP is used, you can directly go for the same grade. If more is in the range of 20 to 30, you can go for one of the software grades or use the blending charts, and then from the blending charts, you can determine your virgin binder grade. So, you prepare specimens of recycled mixes at different binder contents, evaluate them for volumetric and material parameters as we did for the conventional mixes, to finally get the optimum binder content for recycled mixes as well. So, this is all about the design of recycled mixes. Thank you so much.