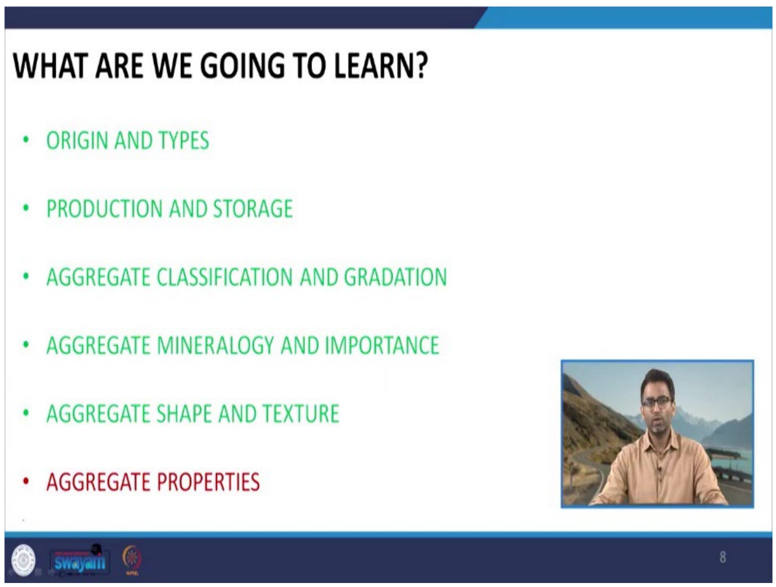
Pavement Materials
Professor Nikhil Saboo
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture: 18
Aggregate Properties (Part-2)

Hello everyone, in the last lecture, we started discussing about the properties of the aggregates. And we could discuss only about the impact value test, which is used to quantify the toughness characteristic of the mineral aggregates.

(Refer Slide Time: 0:52)



So, let us start discussing about other tests today, which are further used to quantify different other characteristics of the mineral aggregates that we use in pavement construction. Today, we will start with the Los Angeles Abrasion Value test, which is used to know about the resistance of the aggregates to abrasive forces.

So, this test is an indirect measure of abrasive strength of aggregates used in construction of roads. So, this abrasion can happen in different forms. Typically, it is assumed that this abrasion could be because of the movement of the vehicles because of the frictional forces, which act between the tire and the pavement surface that can cause abrasion of the aggregates especially on the surface of the pavement.

While the abrasion forces can also be induced during the production in the plant, when the aggregates are stockpiled, when the aggregates are dumped or when the mixture finally is taken to the field and compacted under the rollers. These Abrasive forces can cause different actions on the aggregate particles and these different durations were the abrasion of these different locations where the abrasion forces act they do not necessarily have the same effect on the properties of the aggregates. Again, like the impact value test, the Los Angeles Abrasion test is an empirical test and previous studies have not found a good correlation with the performance of the pavement.

Some studies have shown that rather than quantifying the abrasion resistance of the aggregate, this test gives some indication about the amount of dust which can get generated with the particular source of the aggregates. So, this happens specifically during the production when the aggregates are stockpiled.

So, during this stockpiling, since the aggregates has to travel considerable distance the aggregate particles collide with each other. And in during this process, sufficient amount of dust can be generated by the breakdown of particles and this dust finally, if it remains on the surface of the aggregates, it can cause poor adhesion between the bitumen and the aggregate surface in a hot mix asphalt, which can cause moisture damage related issue.

So, our discussion, has shifted from the abrasion resistance to moisture resistance. So, this is what researchers have indicated about this test, we will discuss one more test in the next slide, which is the micro deval test. And researchers have indicated that micro deval test in fact, is one of the test which gives good indication about the abrasion resistance.

And we will see how these two tests are different from each other. And we will also see the difference in the experimental setup for these two tests. If you look at the process, which we will be discussing shortly, in the next slide, we have a drum which rotates about the horizontal axis. And then inside this drum, we put some specific type of aggregate particles. This test is done on coarse aggregate not on fine aggregates.

So, we have different gradations of coarse aggregates depending on the type of mix, which we will put inside this drum, along with some abrasive charges, which you can see here, and these abrasive charges are put to induce artificial abrasion between the aggregate particles in the drum and this drum rotates about horizontal axis for a specific number of rotations that we will again discuss in the next slide when we discuss about the steps. So, these are some pictures of the Los Angeles Abrasion machine taken from the laboratory at IIT Roorkee. So, you can see that we have the cylinder which is placed inside the machine and the cylinder rotates about its horizontal axis.

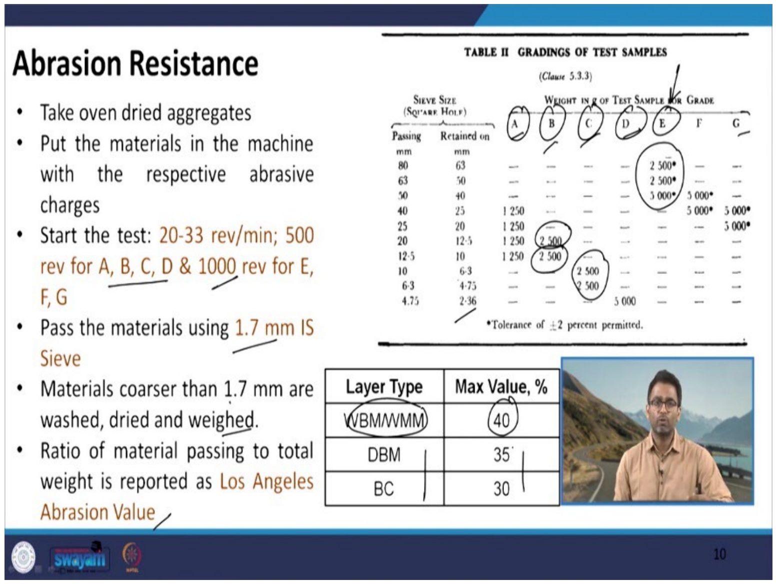
rotates about its horizontal axis.

(Refer Slide Time: 4:58)

This has an opening here, where the materials and abrasive charges are put this is one picture showing the different charges, I have two charges with me just to have a visual idea of how these charges looks like. So, you can see that these are spherical balls which are used as charges in the Los Angeles Abrasion machine.

Twelve charges should typically be available and the number of charges that we use, it depends on the type of gradation. For a while doing the test, you can see again the top of the cylinder, this is the opening from where we will put the material. So, after we open the cap, the material is put inside the aggregates and charges and then the test is actually done.

Refer Slide Time: 5:45)



So, talking about the steps of the Los Angeles Abrasion test, first we have to take oven dried aggregates. Now, the type of aggregates which we have to choose the size of aggregate which we have to take, it depends on the type of gradation, I will show you it in a table. So, what we will do after we choose the appropriate material, we will put this material inside the machine with the respective abrasive charges.

Now, again the choice of the number of abrasive charges, it is a function of aggregate gradation, then we will start the test this cylinder it rotates at an approximate speed of 20 to 33 revolutions per minute and then the number of revolutions depends on the gradation. So, you can see that here we have options from A to G. So, let us before I discuss the steps just have a look at this particular table you can see that we have materials up to 2.36 mm.

So, these can be considered as coarse type of aggregates and the choice of A, B, C and D depends on the layer we are trying to examine. For example, if it is a WBM layer then usually we select the gradation E here, if we are looking for dense graded mixtures like bituminous mixtures, we choose B, C or D here. So, then again after having the appropriate choice, the amount of material to be selected will change.

For example, if you see the gradation B, here we will take 5 kg total materials. So, 2500 grams will be aggregates ranging from 20 to 12.5 mm, whereas, 2500 grams will be materials ranging from 12.5 to 10 mm. Similarly, for C 5 kg material from 10 mm to 6.3 2.5 kg and 6.3 to 4.75 2.5 kg. For coarser gradations like as I said for WBM.

So, you have to use 2500-gram material ranging from 80 to 63 mm from 63 to 50 again 2.5 kg and then 5 kg from 50 to 40. So, likewise depending on the type of gradation you have to choose appropriate amount of material and then all the other parameters as I said that the number of revolutions for example, number of revolution is a function of the gradation for A, B, C and D we will use 500 revolutions, for E, F, G 1000 revolutions.

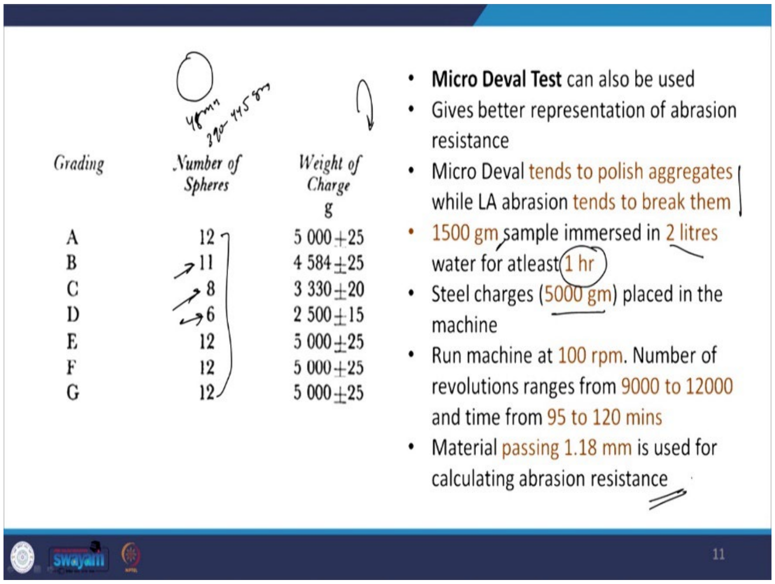
So, after the number of revolutions are completed, then you can imagine that these abrasive charges which are placed inside the machine, they will have a tendency to break down the aggregates because again the aggregate is also travelling inside it is colliding each other and also colliding the abrasive charges and in this process the particles will break down into smaller sizes.

So, after completing this number of revolution, we will take out the entire material and we will sieve it through 1.7 mm IS Sieve. So, here we expect that if the aggregates have high abrasion resistance, then less amount of breakdown will take place. So, lower quantity of material should pass through 1.7 mm and the amount of material passing through 1.7 mm is actually used to quantify the abrasion resistance.

So, material coarser than 1.7 mm are washed, dried and weighed. So, the ratio of material passing to the total weight is reported as the Los Angeles Abrasion Value in percentage. So, again just like impact value for different types of mixes, which are placed in different layers of the pavement, there are different specifications.

For example, for WBM and WMM which are placed as base layer typically, the maximum permitted value is 40 percent for DBM and BC it is 35 percent and 30 percent respectively. But here also I just like to reiterate, which I just mentioned in the last slide, that not necessarily that in aggregate having higher Los Angeles Abrasion Value will have poor performance. In fact, many times it has been found that even aggregates having higher abrasion value or Los Angeles Abrasion Value have shown good performance in the actual field.

(Refer Slide Time: 10:38)



Well, this shows the choice of number of aggregate charges and the corresponding weight. So, actually the diameter of this ball, which we take in Los Angeles Abrasion test is approximately 48 mm. So, this is the dia and the weight somewhere lies between 390 to 445 grams. So, that is the individual weight.

So, as I mentioned, ideally, twelve weight should be present that is the maximum number of weights that will be required corresponding to different gradation. However, like for example, for gradation D only 6 balls are required, for gradation C we have a requirement of 8 number of balls and for gradation B 11 number of balls should be taken. So, I hope again, this is clear to you that how this test is done, as I mentioned in lieu of Los Angeles abrasion test, another abrasion test which is called as Micro Deval test can also be used.

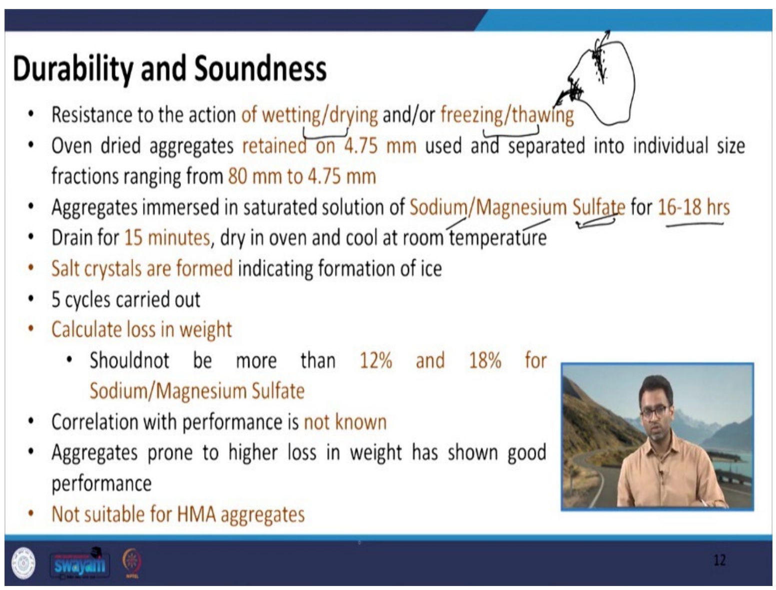
Previous studies have shown that this test gives better representation of abrasion resistance in contrast to Los Angeles Abrasion test, which gives indication related to the generation of fines. If you compare the effect of Micro Deval and Los Angeles Abrasion, Micro Deval abrasion it tends to polish the aggregates, while Los Angeles abrasion tends to break them. So, this is the primary difference in the effect of these tests on the aggregate particles. So, how is Micro Deval test different from Los Angeles test? This is also a similar type of abrasion test, but here we use 1500 gram of aggregates which is actually emerged in 2 liters of water for at least 1 hour.

So, here, this means that this test is carried out under water, so we have to take sufficient amount of water 2 liters and then place 1500 gram of aggregates keep it immersed in water and then place the entire thing inside the abrasion machine. Then here also we use steel charges. The total weight is 5000 gram which is placed along with the water and the aggregate materials, then we allow the machine to run. So, here also the machine rotates about the horizontal axis. So, the machine run at 100 rpm, and the number of revolutions it ranges depending on the size of the aggregates.

So, similar to Los Angeles abrasion, here also we have choice for different sizes of aggregates. So, the number of revolutions ranges from 9000 to 12,000. And the time again, depending on the size of the aggregate ranges from 95 to 120 minutes, after completion of the test or after completion of this abrasion process, we will take out the material and we will pass the material through 1.18 mm sieve. So, material passing 1.18 mm sieve is used to calculate the abrasion resistance here. So, I hope again, this test is also clear, and it is difference with Los Angeles abrasion test.

Now, we will discuss about the durability and soundness aspects of aggregate particles. In the durability and soundness test, what we are trying to do we are trying to assess the resistance of the aggregates to the action of wetting or drying cycles and or all freezing and thawing cycles.

(Refer Slide Time: 14:18)



So, specifically in cold weather regions what happens is that, because of this capillary rise of the water, the water can get freeze inside the pores of the aggregates or not only capillary rise the general movement of water and the formation of ice this water can get freeze within the pores of the aggregates.

And then when the temperature rises, this ice melts and it comes out of the pores and during when the cycle continues during this process, the phenomena can degrade some amount of material depending on the type of the aggregate some material can come out and the aggregates will have a tendency to lose their weight over a period of time, which is not desirable.

And therefore, this is what we are trying to measure here in the laboratory. So, I mean we will of course, comment on the suitability of this test method, but before that let us see the process. So, here oven aggregates retained on 4.75 mm sieve indicating that these are coarse aggregates they are used and separated into individual sizes ranging from 80 mm to 4.75 mm.

So, again this test is done on different sizes of aggregates and then we do the weighted average to quantify the resistance or the durability of the aggregates. So, here are these individual aggregates they are emerged in saturated solution of either Sodium Sulfate or Magnesium Sulfate. So, either of the two can be used to do the test for 16 to 18 hours typically, then what we will do, we will immerse it, then we will take it out, drain it for 15 minutes approximately.

So, that the entire water get washed away and then we will dry these materials in the oven and again cool it at room temperature. So, this is one cycle. So, what we are doing here we are immersing the aggregates in the Sodium Sulfate or Magnesium Sulfate solution keeping it there for 16 to 18 hours and during this process what happens the Sodium and this Magnesium Sulfate solution it reacts with the aggregates and they form the salts, salt crystals are formed if this is an aggregate.

So, in these pores this salt crystals will be formed and it will get deposited in the pores and I mean this is the purpose of doing tests that this is an indication of formation of ice or this is we are trying to replicate the process of formation of ice here by the formation of actual salt crystals.

So, this completes one cycle that salt crystals are formed, then we take out the material from the solution drain it off, so, that entire material get washed away and I am in the water the solution gets washed away then we will take this aggregate we will dry it in the oven until constant weight is reached.

And then we will cool it at room temperature and then again, this material what we will do we will again put it in the Sodium or Magnesium Sulfate solution do the entire process again. So, we will do it for typically five cycles. And after five cycles we will calculate how much weight is lost because what we are expecting when we are taking out the material from the solution draining it, draining it.

So, while draining it these crystals which are formed they will get washed away and during this process some if the aggregate particles have a tendency to break down under this section, some of these some of the aggregate particles also will get eroded along with the solution. So, there will be loss in weight.

So, after the end of five cycles, we want to see how much total loss in weight has taken place. And the specification says that the loss in weight should not be more than 12 percent if it is a Sodium Sulfate solution and 18 percent if it is a Magnesium Sulfate solution. The reason for two different numbers are that Magnesium Sulfate solution has harsher effect on the aggregate particles in comparison to Sodium Sulfate that is why the limit is on the higher side.

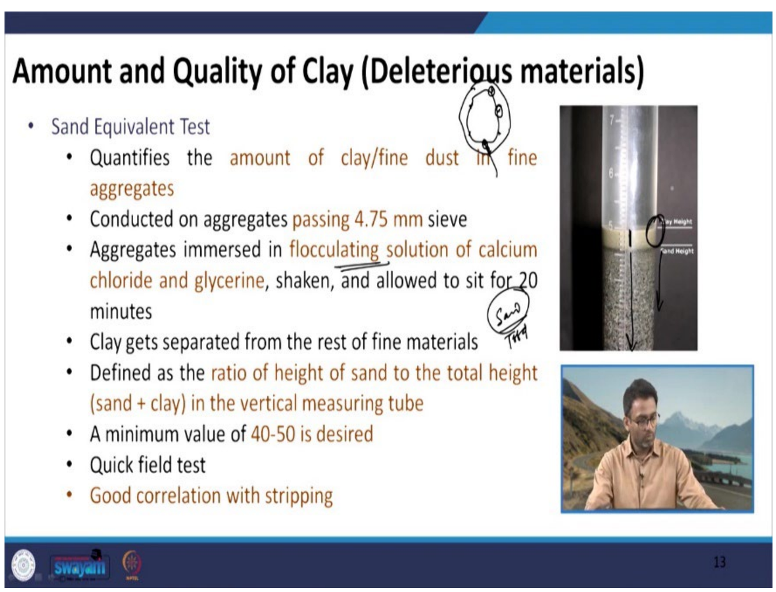
Again, a lot of debate has been done in the literature regarding the suitability of the test method. This test has been criticized by various researchers and researchers have found very poor correlation with the values of the soundness test and the actual performance. In fact, literature also mentions that the coefficient of variation which means the repeatability of this test in the laboratory is very poor. There are studies that have shown that the coefficient of variation can be as high as 40 percent. It has been found that even though aggregates show higher loss in this test, they give relatively good performance in the field.

So, again, the suitability of this test method is also questionable. Researchers have also debated and argued that specifically for hot mix asphalt or aggregates using bituminous mixtures this test is not very suitable. The reason being in the bituminous mixture the aggregates are already coated with bitumen.

Therefore, the chances of formation of exposure of these materials to water and then formation of ice crystals is very less or negligible and that is why conducting this test on HMA aggregates is questionable. However, this test is generally used only as a pass-fail criteria to select the aggregates.

And in India also the specification mentions that this test should be done only on those aggregates whose water absorption is more than 2 percent. Another aspect of this test is that for especially for carbonate aggregates, this sodium and Magnesium Sulfate can react with this with the surface of these aggregates and therefore, can sometimes give erroneous results to.

(Refer Slide Time: 21:02)



Now, we will discuss about another set of tests you can say which will help us to understand about the amount and quality of fine particles in the aggregate gradation especially the clay particles because we want to avoid excess amount of clay material in the aggregate structure. Especially, sometimes organic clays or clays of having certain minerals such as montmorillonite they are not very desirable because they are plastic in nature and in presence of water they can show large variation in the volume which may not be desirable for the structure.

That is why it is of interest to know that what amount of fine material which are typically passing 75 micron sieve are present in the aggregate structure and also what is the quality of these fine materials because not necessarily excess amount of fine materials will be harmful until and unless these have some undesirable properties. So, the first test is the Sand Equivalent Test. So, Sand Equivalent Test is used to quantify the amount of clay or fine dust in fine aggregates. So, this test is done on fine aggregates.

So, here what we do we take materials passing 4.75 mm sieve, the material passing 4.75 mm sieve is immersed in a flocculating solution. So, we prepare a special solution of a mixture of calcium chloride and glycerin. Once we prepare this solution, then we put the material inside the solution and we agitate it we shake it properly it is shaken either mechanically or manually and then we allow it to sit for 20 minutes.

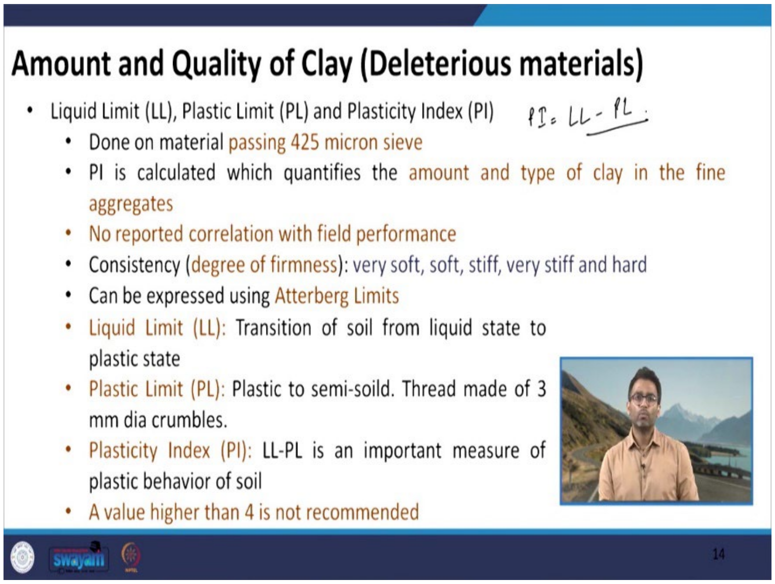
So, what happens when we allow it to sit for 20 minutes, because of the difference in density and size the clay particles get separated from the rest of the fine materials and inside the solution it will look something like this. So, the coarser material will go and settle at the bottom and the fine material will be at the top and you can see a clear difference that this is the amount of clay and then this is the amount of sand particle.

And then we calculate the sand equivalent value as the ratio of height of sand to the total height of the material in the measuring tube. Because we want less amount of clay or less amount of fine particles which means higher the sand equivalent value better it is because here we are trying to take the ratio of sand versus total.

So, sand higher is the sand better it is indirectly represented that the amount of clay or fine material is less usually most of the specification says that a minimum value of 40 to 50 is desired especially when we are using the aggregates for the production of hot mix asphalt. This is also considered as a quick field test and in fact this test has been found to be good in terms of its correlation with the stripping resistance of the aggregates. Why stripping resistance? Because you will see if you have an aggregate particle and if you have very fine materials.

So, these materials can lie on the surface of the aggregate and when the aggregate gets coated with bitumen these particles which are at the surface of the aggregate they disrupt the adhesion or the bond between the bitumen and the aggregate particle and therefore, this film can get broken especially in presence of water. So, lower are the amount of fines better will be the resistance to moisture. I hope this test is clear to you.

(Refer Slide Time: 25:00)



Well, we have other simple tests that are generally used in the study of soils to quantify the properties of the fine materials such as clay, a set of these tests are related to the Atterberg limits, where we are trying to find out the liquid limit plastic limit and plasticity index, which gives us indication about the plastic properties of the fine materials.

Now, since this is done as specially on very fine material, so, we take only materials passing through 425-micron sieve. So, using the liquid limited and plastic limit here what we are doing, we are calculating the plasticity index, which is the difference between liquid limit and plastic limit we will discuss about what is liquid limit and what is plastic limit and it helps us to quantify the amount and type of clay in the fine aggregates.

However, this particular test values like plasticity index or plastic limit and liquid limited they have no reported correlation with field performance. Here as I mentioned, we are trying to measure the consistency of the fine material where consistency is defined as the degree of firmness. So, we can say either the material is very soft, it is soft, it is stiff, it is very stiff or it is hard in nature. And here in this test, we are using the Atterberg limits. So, now, let us see the definition of each of these terms. So, what is liquid limit? Liquid limit gives us an indication about the transition of soil from the liquid state to the plastic state.

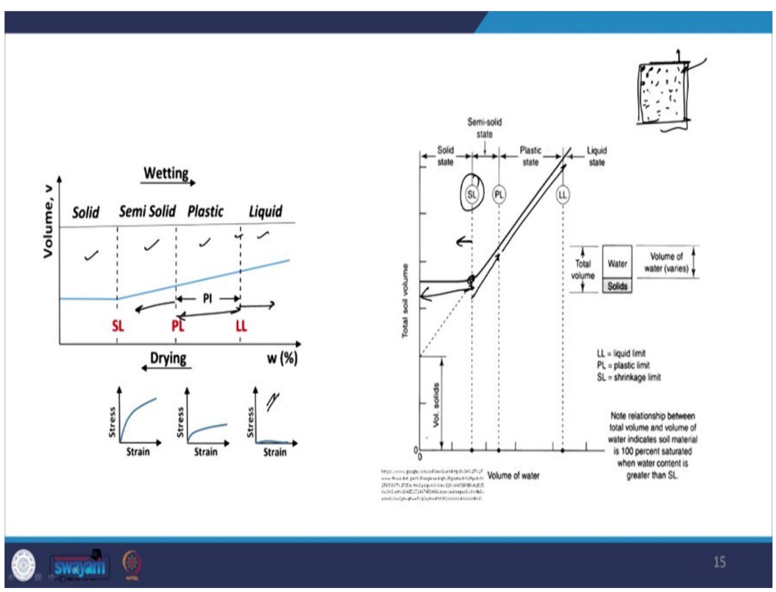
So, first we have to understand that any soil in presence of moisture, they undergoes a transition from one stage to another, because water has a predominant effect on fine materials, especially related to its flow and also related to its compaction characteristics and some materials in presence of water can show very huge change in their volume and this change is ideally not desired during the construction purpose. So, we are interested to see that how different find materials behave in presence of water and we want to avoid those fine materials, which are excessively plastic or excessively show changes in volume.

So, what is liquid limit? Liquid limit again is that particular point you can say or moisture content, where there is a transition of soil from liquid state to plastic state. So, which means the soil when we are giving any strain to the soil, the soil just starts to take the load beyond the liquid limit it does not take any load you give a strain there is no stress, but at the liquid limit it just starts to take up some load. So, in this way you can understand.

Then what is plastic limit? Again, plastic limit is that particular moisture content you can say or that particular zone where the soil will behave as a semi solid material rather than a liquid material at this moisture content. If you try to take a soil sample, make a thread with the soil sample of approximately 3 mm in dia this thread will crack or it will crumble.

So, that point indicates the plastic limit of the soil. Plasticity index on the other hand is just the difference between liquid limit and plastic limit and plasticity index actually is an important parameter which tells us about the plastic behavior of the soil depending on the magnitude, usually for top layers in the pavement construction a value higher than 4 is not recommended. The plasticity index should not be more than 4.

(Refer Slide Time: 28:50)



This picture shows the change in the behavior of the soil with change in moisture content, you see that look beyond liquid limit there is no stress when you apply a strain between a liquid limit and plastic limit the soil takes up some stress because just starts to take the load when it moves to the semi solid state it can take more stress here. So, these are the regions where the soil behave as solid, semi solid, plastic and liquid and this explains the change in volume of the soil with the change in volume of water. So, you can see that there is another limit called as shrinkage limit which we are not discussing.

So, shrinkage limit is that limit below which the change in amount of moisture does not change the volume of the soil because these water are occupied within the pores of the soil particles. So, if you take a unit volume you have soil particles and let us say there are pores available.

So, this is a constant volume. If you keep on increasing the water here first the water will go and settle in the pores, which means the volume is not changing, but once the soil gets saturated, the increase in moisture will increase the volume of the soil and this is the shrinkage limit beyond which the volume starts changing. So, you see up to shrinkage limit there is no change in volume of the soil, then after shrinkage limit up to plastic limit there is a change and again there is a change. So, this is just to show you how the volume changes with the change in volume of water.

(Refer Slide Time: 30:30)

Well, this is the Casagrande apparatus which is used to assess the liquid limit of the fine materials passing 425 microns sieve. So, what you do here, so, this is the apparatus, this apparatus has an inclined brass cup, inclined brass cup which is placed on a rubber base I will take a different color to explain. So, this is a rubber base and this is an inclined brass cup. So, this brass cup can be rotated using this handle like this in this direction. So, when this is rotated this brass cup will rise and they will rise to a gap of 1 centimeter approximately. What we do here?

First, we will take soil mix it with a particular amount of moisture let us say that moisture content is MC1. And then we will place the soil like this here then we will take the Casagrande groove, grooving tool. So, using this grooving tool we will make this groove if you see the cross section this groove will appear something like this something like this.

So, this groove is basically 8 mm in height approximately the bottom is 2 mm and the top is 11 mm approximately. So, this is a typical dimension for after we make the groove and then after we make the groove, we will use this handle we will rotate this handle after rotation what will happen the soil will try to come close to each other.

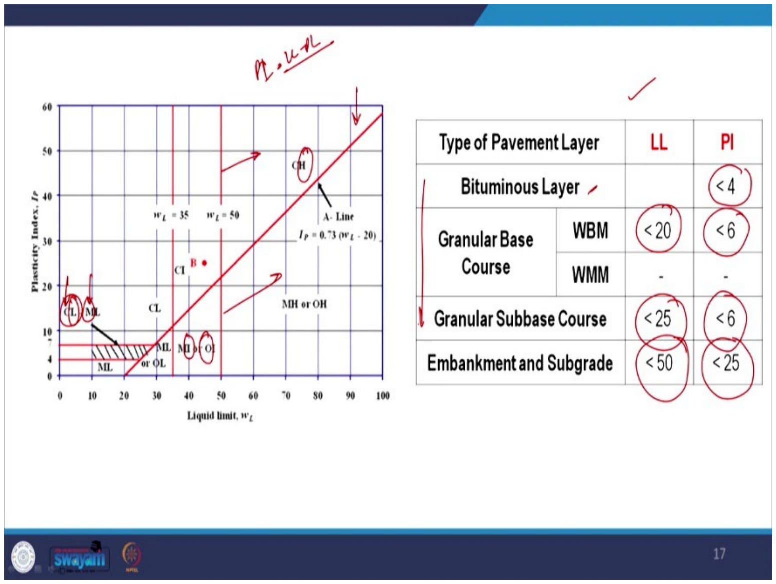
So, we will see until these closes by a length of 12 mm, we will stop there. So, we will start giving the number of flows and we will visually observe how the soil is moving. And once we find that the soil has come closer enough such that the length of closure is approximately 12 mm will stop and we will note down the number of flows let us say for MC1 it is N1 then what we will do will change the moisture content let us say we take another moisture content MC2 and then we again check the number of flows at which there is a 12 mm closure then we will change the moisture content again we will check.

So, finally what we will do we will plot the variation of number of flows and moisture content and this is in log scale, the number of flows required at higher moisture content will be less so, you will get a graph something like this and you see that what is the moisture content corresponding to 25 number of flows. What is that moisture content?

So, this moisture content is the liquid limit of the sample. So, this is how you determine the liquid limit well the experiment of plastic limit is very easy what you do here you will take a soil sample mix it with some quantity of water and then you will try to roll it on a glass bed and then you keep on changing the moisture content keep on making a thread and our aim here is to make it 3 mm thread.

And we will visually see that what is that moisture content at which the 3 mm thread will crumble visually if you have this sample, the crumble will be occur something like this, you will stop when you see that crumbling occurs and for that soil sample you will find out the moisture content by taking the weight after oven drying and wait before. So, that will give you the moisture content and that moisture content is the plastic limit.

(Refer Slide Time: 34:09)



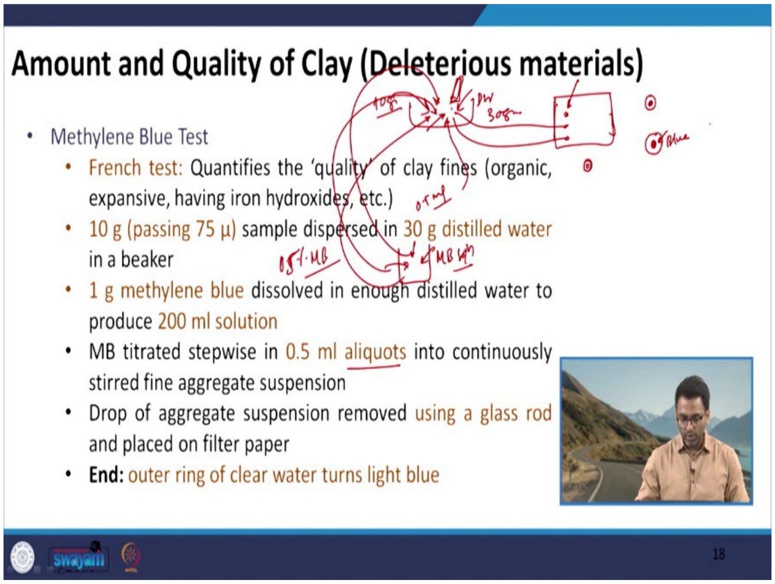
And plasticity index is just the difference between the liquid limit and plastic limit. And this plasticity index along with the liquid limit of the soil can be placed in this chart which is a standard A line chart or plasticity index chart and we will see that where our soil sample actually lies. I am not going to discuss in this lecture in detail about this chart but just to give you an idea that this chart has different locations to identify different types of soils. For example, here C indicates clay soil, M indicates silty soil.

So, O indicates organic soil and then the other alphabet like L it indicates low compressibility, I indicates intermediate compressibility whereas H indicates high compressibility. So, we want to avoid soil which are actually on the right extreme right side, because these are highly organic soil and since having high compressibility they will show larger changes in volume with change in moisture content.

Depending on the specification we have to choose the appropriate soil which lies in the specified range. Well this again is taken from the Ministry of road, transport and highways for different types of layer, if you see for bituminous layer, the court says that the plasticity index of fine material passing 425-micron sieve should be less than 4.

For granular base they have limits on liquid limit which should be less than 20 and plasticity index which should be less than 6, for granular sub base, it is 25 and 6. Whereas, for embankment in subgrade, it is 50 and 25 as you move down the pavement, the requirements gets more relaxed, you can use inferior type of material also.

(Refer Slide Time: 36:02)



Now, we will discuss about the next test which is not typically used in India, but is a French specification basically. So, this is a French test and in fact a very interesting and good test to quantify the quality of clay fines. So, this will not tell us about specifically about the amount of clay fines but it will say that, that though you have particles of smaller sizes in your mix.

So, let us see what is the quality is it really of poor quality or the quality is acceptable in nature. So, this quantifies the quality of clay fines it will tell us whether the clay fines are organic expensive having iron hydroxide characteristics etc. Here what we do we take 10 gram of soil sample passing 75-micron sieve. So, this test is carried out on filler particles basically.

And this 10-gram sample is dispersed in 30 gram of distilled water in a beaker. So, you take a beaker having distilled water, and 30-gram distilled water. And then you place 10 gram of soil sample passing 75-micron sieve, then we will make another solution, where 1-gram methylene blue is dissolved in enough distilled water to produce 200 ml solution.

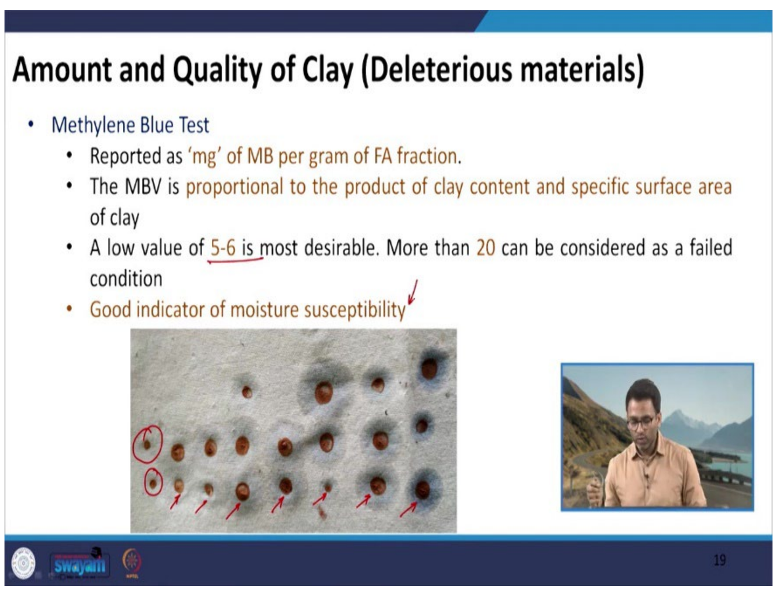
So, you can say that you will have 0.5 percent methylene blue here in the solution 0.5 percent. Then what we do from this solution of methylene blue which we have prepared, we will titrate the methylene blue using a burette and we will do it stepwise. In 0.5 ml aliquots and we will take 0.5 ml from this put it in this beaker and then we will continuously steering this beaker and after addition of this 0.5 ml aliquot this is done stepwise.

So, after doing each step, what you will do, you will take a drop of this aggregate suspension using a glass rod we will dip the glass rod here and after dipping the glass rod we will just put a mark we will just put this glass rod over this filter paper. Similarly, again then we will take another 0.5 ml put it inside continuously stir it again take a drop put the mark here again take 0.5 ml put the glass rod again put a mark here. So, we will keep on doing that and we will observe this mark this is what we are going to do and when should we stop because we are continuously adding 0.5 ml methylene blue solution inside this beaker having 10-gram filler and 30-gram distilled water.

So, when are we going to stop? So, we will stop, when we see that the outer ring of this drop turns light blue. So, initially, when you will put the drop, what you will see you will see a dark brown strain, dark strain here and a clear water strain on the outer side as we keep on increasing the methylene blue solutions. So, what is happening here, let us try to understand the fundamental the methylene if this is the soil particle, the methylene blue is trying to cover this soil particle.

So, when sufficient methylene blue is there, when it covers the entire surface area of this clay particle, then what will happen you will see that there is a dark spot and instead of clear water this is blue in color, the outer circle comes blue, which means the methylene blue solution has now entirely covered the surface of the soil particle which means finer is the soil particle specific surface area is more therefore, more amount of methylene blue will be required. This quantifies the specific surface area characteristics also of the clay particle.

(Refer Slide Time: 40:03)



This is what you see, I hope it is clear here that this is the initial time when you see clear mark, clear outer circle, you see slight blue, slight blue, and now it is very clear here, the mark blue is clear here. So, you will stop when you see a clear blue mark over the light blue mark on the outer circle.

So, that is when you will stop. So, this is finally reported and milligram of methylene blue per gram of fine aggregate fraction. So, as I mentioned, the amount of methylene blue which will be required is proportional to the product of clay content and specific surface area of the clay and therefore, a low value is desired. A low value will indicate that the surface area is more which means it is not extremely fine. So, a low value of 5 to 6 is most desirable. And if the value is more than 20, the sample can be considered as failed and should not be used for construction purposes.

And research has indicated that methylene blue value is just like the sand equivalent value is a very good indicator of moisture susceptibility. So, with this, we will stop here today and we will continue discussing about the aggregate properties. Our next presentation will be focused on discussing mainly about the specific gravity of the aggregates, which is a very important property, especially related to the mix design of bituminous mixture.

So, we will try to understand the concept of specific gravity more fundamentally. And we will also finally discuss about some of the stress strain behavior of the typical aggregate particles and then the tests that are used as input in the pavement design. When layers of these aggregate particles are used. Then we will meet in the next presentation. Thank you.