Pavement Materials
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Lecture: 12
Production and Storage of Aggregates

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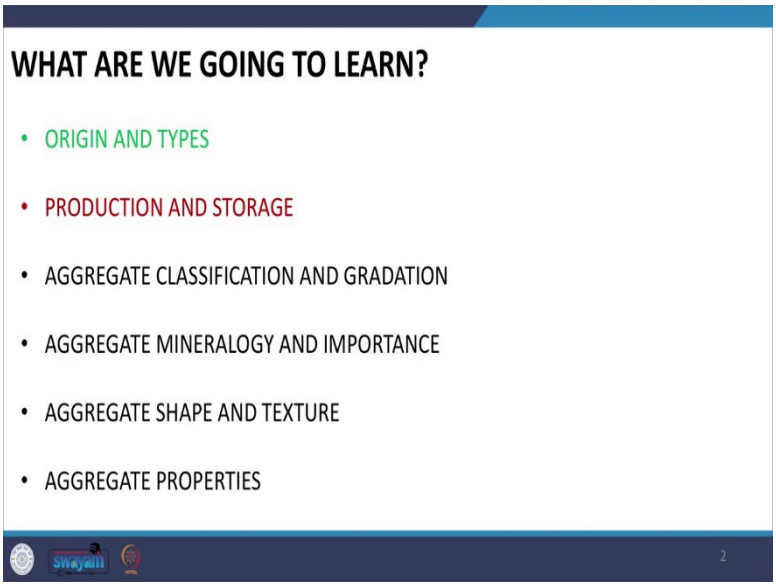

Hello everyone, if you remember in the last presentation, we discussed about the Origin and types of different aggregate or rocks. Today, we are going to discuss about the production and storage of aggregates. So, by now, we understand what aggregates are? We understand that aggregates are important construction materials.

And we also understand that aggregates are actually obtained from the parent rock and as I mentioned in the previous presentation, that they are further processed, so, that we can reduce the size of these rocks and convert them into sizes which are desirable for construction of different layers. Now, this process of breaking down of aggregates or breaking the size of the aggregates or rocks into smaller sizes indicates the production process. So, the production involves breaking the rocks into small sizes.

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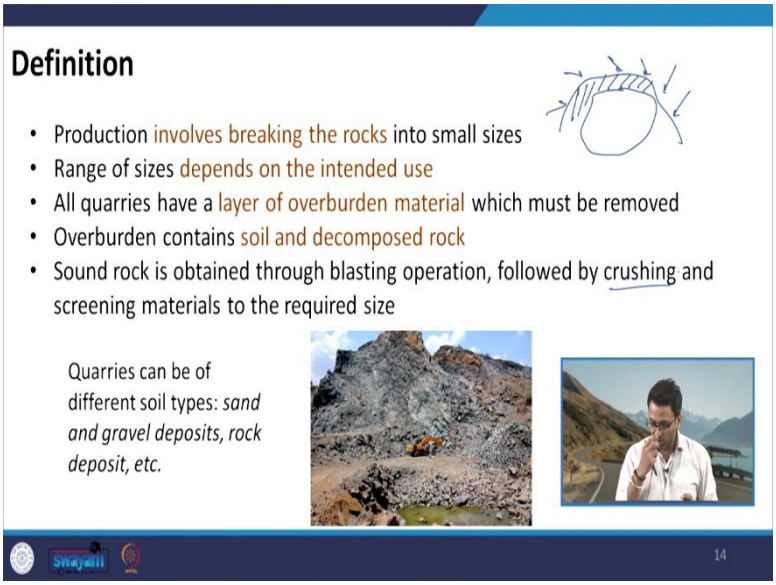

Now, the question is, what is the desirable size which I want the rock to be converted to? The range of the sizes, it depends on factors various factors, which is a function on the intended use. For example, if I am talking about the aggregates that are used in pavement layers, such as base and sub bases, there I can permit larger size of aggregate.

So, which means that the size requirement of aggregate in the base and sub base layers are different from the size requirement of aggregates that are typically used in the top layer. Similarly, the size requirement of aggregates in an asphalt mixture can be different from the size requirement of an aggregate in a concrete mix.

Similarly, even in the asphalt mix depending on the properties which is desirable, the size of the aggregates requirement can change. This process of converting or breaking the rocks into smaller sizes, it happens through quarrying operation and all quarries, I will show you a typical picture of a quarry, they have a layer of overburden material, which first must be removed before we encounter the material from which we want to use as construction aggregates. So, these overburden materials because once a rock has formed the upper surface suppose, if a rock is formed, the upper layer of this rock will be subjected to weathering action, different environmental condition, there will be movement of water.

So, the top surface to some depth, they are weaker in nature and they may contain soil and decomposed rock. So, if I want to encounter this core material, which is stronger in nature, I have to first remove the weaker top surface. The sound rock they are obtained through blasting operation. Now, after blasting operation the rock get converted into again larger size of aggregate chunks and during this process, the weaker aggregate particles also gets broken down.

And we will see that further again we will use some process to remove more weaker particles from the blasted rock which we have just obtained. And this is followed once we have obtained the core

rock or the desired material, we will crush the material to the required size and after crushing we will screen the materials.

So, that we can store them in further different sizes and this process is called as fractionating the aggregate particles. So, even after crushing the aggregates breaks down into sizes which is variable. We have aggregates of different sizes which we obtain after screening these materials of different sizes. We can store them separately with some size range together again let us say coarse materials together fine materials together and so on.

So, that we can conveniently use it during the construction process. This is a typical example of a quarry, where you can see that this has a good deposit of rock, this rock is further broken-down using blasting operation and the materials can be dumped in truck, they can be brought to the crusher and then they can be crushed and further screened to obtain the required material.

Of course, this is just one example and quarry can be of different soil types we can have a sand and gravel deposit quarry we can have a rock deposit quarry and so on. So, again quarry can also be variable and all the quarries will have their own form of rock or own form of soil material which will be used for construction.

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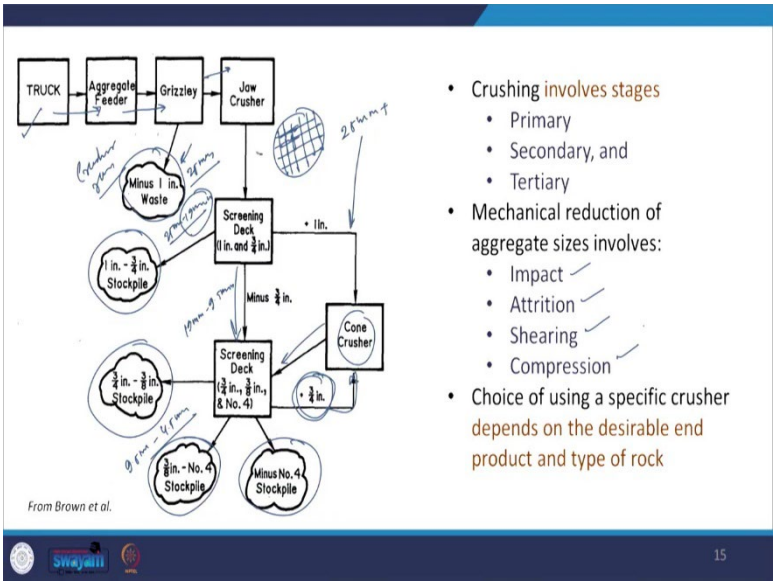

This is a simple flowchart explaining the process of quarrying and crushing and then further screening the aggregate particles. So, let us just try to understand this flowchart again, again as I said that the actual process is more involving, but this is a basic outline, which will help us to visualize what is actually happening during the process. So, once the blasting operation has taken place, the trucks will collect the material. Now, this material will go to the aggregate feeder from the aggregate feeder it will go to grizzley. So, a grizzley is basically as I said we will further use technique to remove some weak material.

So, grizzley is basically used for scalping the weak material and the material, which is removed from grizzley they are definitely not used for typically for surface layer materials as I said, but sometimes they are stored separately and to produce lower grade materials. For example, like they are also called as Crusher run material.

So, they are stored to produce lower grade material which can be used for some other form of construction after it passes. So, grizzley has some set of seeds which continuously vibrates, and this is how it removes the weak particles. And after passing through grizzley we have the strong rock particles, which goes to the jaw crusher. So, jaw crusher here is the primary Crusher where the first set of desirable material will go.

So, this jaw crusher has mechanisms which will break down the larger aggregate particles into smaller aggregate particles. So, before here, just again one more important point in the grizzley that, we typically remove aggregate which is less than 1 inches or like 25 mm in size. So, from the jaw crusher, the materials which has been crushed, they will be sent to a screening deck.

Now, the screening deck it contains set of sieves, which has square openings, I hope that we all understand what sieves are. So, for example, this is a typical sieve, which contains square openings of different sizes. So, the crushed material, it passes through a set of such screening deck having different sizes and we can now separate let us say materials between 25 mm to 19 mm.

So, there will be a screening deck so there will be a 25 mm sieve and there will be a 19 mm sieves. So, whatever material passes 25 mm and retain on 19 mm they will be separated and they will be stockpiled. So, we will have one set ready for the width size ranging from 25 mm to let us say 19 mm. After the primary crushing which is shown as a jaw crusher here, there will be materials which will be more than 25 mm in size. So, 25 to 19 mm stored. So, 25 mm plus material, the sizes which are more than 25 mm, they will be sent to the secondary crusher which is shown as a cone crusher here.

So, in the cone crusher again further crushing will take place of these material which is more than 25 mm. What happens to the material which is less than 19 mm, so less than 19 mm material is further sent to another set of screening deck which will have again some set of sieves to further fractionate the crust material for example, we can have a screening deck between 19 mm to 9.5 Mm. So, materials which have passed 19 mm and is retained on 9.5 mm they will again be stockpiled separately. So, we will have one more stockpile here. Now, this the sizes in the stockpile can vary depending on the use or depending on the objective of using this material.

So, this is just an example further we can have more screening decks for example, we can have a screening deck which is has material passing 9.5 mm and retained on 4.5 mm. So, we can have another stockpile and then materials which are smaller than 4.5 mm and down to filler material all stone dust they can be stocked together.

So, we can create the number of stockpiles depending on the desired criteria, more number of stockpiles can be created, even lesser number of stockpiles can be created. But if more number of stockpiles are created, there will be more control during the mix design process. The materials which are larger than 19 mm, they are again sent to the cone crusher to further reduce the size and again the process of screening will take place.

So, this is a chain process where we are crushing and we are screening we are crushing and we are screening. And the choice of this crusher depends on various factors which we will be discussing and different types of crusher will have a tendency to produce different types of aggregates shape and sizes. So, crushing usually involves different stages, it can be a primary crusher, then secondary crusher and tertiary crusher. Crushing stage, whatever be the crushing stage, these crusher they involve various mechanisms to reduce the size of the aggregate particles and this includes impact, attrition, shearing and compression.

For example, in the impact form of crushing system, we apply impact to the aggregate particle to break it into smaller sizes. In attrition in shearing, it is more of a rubbing type of action which takes place to reduce the size of the particle. In compression, we are not putting an impact load, but we are pressing the particle hard enough so that it breaks into a smaller sizes. And in fact, most of these crushers, they use a combination of this mechanical reduction process not always only a single process is used in the crusher.

The choice of using a specific crusher as I said depends on the desirable end product and also the type of rock if we have it rock which requires only let us say impact compaction for breaking then of course an impact compactor will be used and so on. So, depending on the type of rock and the desirable product when I see desirable product, some of the crushers have better control on the final shape of the aggregates. For example, cone crusher has better control in producing angular aggregates. So, if I am desiring to have angular aggregates, then I will employ a cone crusher. Likewise, we can have various other factors depending on which the crusher can be appropriately chosen.

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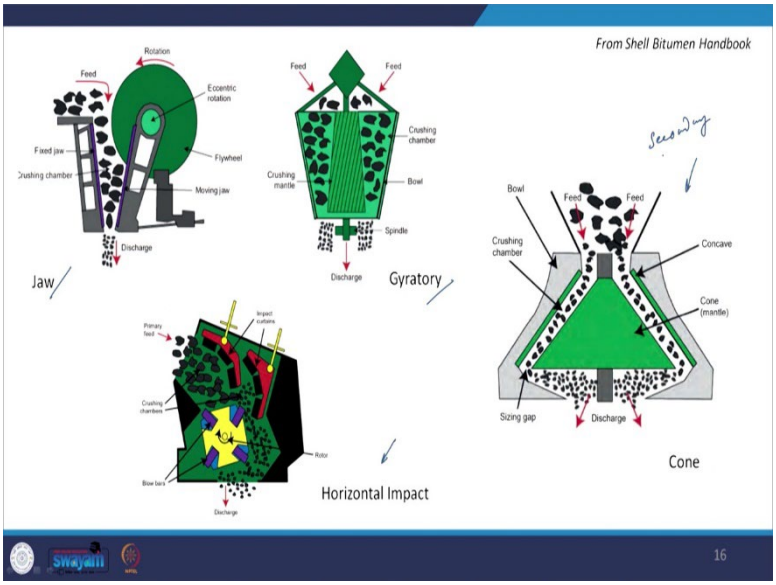

So, these are some pictures of different types of Crusher, which you can see here. For example, we can have a Jaw crusher, which are mostly compression type of crushers and we also have Gyratory crushers which are also compression type of crushers and they are usually used for primary crushing, and since they are used in primary crushing, we have less control over the shape of the these aggregates which are desired. This is an example of a Horizontal impact crusher, here we have more control on shape in comparison to the jaw and gyratory crusher, but again, the cost per production using the impact crusher is a little higher.

This is an example of a Cone crusher here, and a cone crusher has better control over the shape and they are mostly used as secondary and tertiary crushers. As we discussed that crushers can also have an impact on the shape and shape is again related to the performance of the mixtures. And specifically, we will be discussing later the shape has a very predominant role on the performance of asphalt mixtures.

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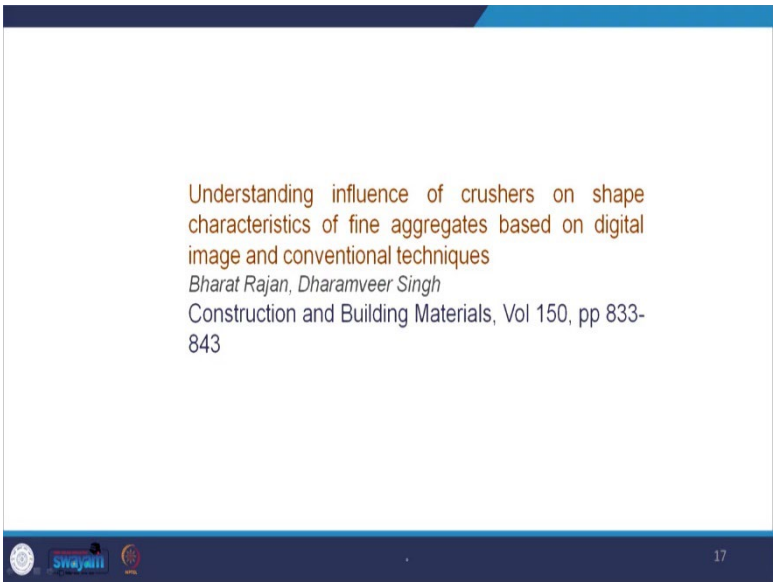

So, this is one paper which can be referred to understand that when we obtain aggregates through different process, so, how the production process itself can influence the properties of the mixtures. So, this paper can be referred if anyone is interested, coming to the storage and sampling. So, what happens once the crushing operation has completed as we were discussing that we have screening index through which stockpiles are created.

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So, these stockpiles they are loaded into trucks and they are brought to the plant and they are stored there or it can be a continuous process of crushing, loading and then storage or making stockpiles. So, these are some pictures taken from different plants you can see you have mountain type structures here.

So, these mountain type structure they comprises of aggregates of some narrow size ranges for example, typically let us say, if you talk about a hot mix plant, we can have stockpiles which is say 26.5 mm to somewhere like 19 mm stockpile, we can have a stockpile from 19 mm to 10 mm, we can have stockpile from 10 mm to maybe 4.75 or 6.3 mm, we can have stockpile less than 4.75 mm.

So, usually different types of fractionation technique can be adopted to store the aggregate particles, but they are mostly stored as stockpiles. Now, the storing process can be different in different types of plant the way of quality control they are using. Because what happens that if it is a rainy season, then these open stockpiles can get completely wet. And if the stockpiles have huge moisture content, large amount of moisture content, they cannot be directly used for construction. So, they will need more heat for drying, which again can be a costly process because we have to use more fuel.

So, certain quality control measures can be adopted in the plant to safeguard the aggregate stockpile, specifically during the rainy seasons. So, these are again some random pictures, you can see that we have stockpiles here of different sizes. We again have some smaller and bigger stockpiles here.

And this is basically a wrapped stockpile, a fine wrap stockpile taken from one of the hot mix plant and this was taken during the rainy seasons and I am not sure if it is very clear from the picture that this stockpile is very wet now has a lot of moisture and therefore, it specifically wrapped when it is wrapped we cannot use it very easily even because you know high temperature drying is also not permissible for wrap aggregates.

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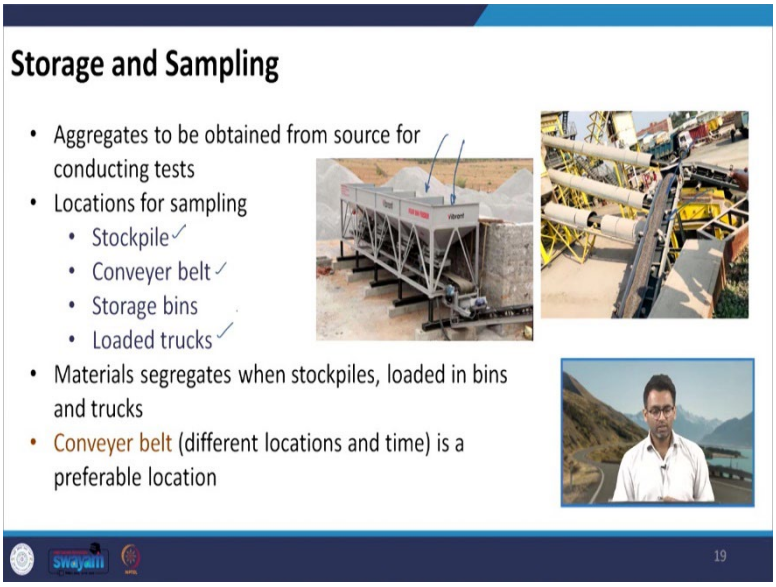

We will talk about sampling. Now, once these aggregates have been stored, we have crushed we have obtained the aggregate our final aim is to use these aggregates in the construction process. Now, depending on the type of layer the requirement of the aggregate changes. So, if we talk about a flexible pavement construction, ideally, we have better material at the top and relatively inferior material at the bottom. So, the strength requirement or the limits to the strength requirement can be different in different layers. Now, for any specific layer, if we have to select the aggregate, then we have to conduct some laboratory test.

So, these laboratory tests which we will be doing, it will require not the entire stockpile of course, but a part of the stockpile or a part of the fractionated material which I have just created in the plant. The question is that from where do I take this material, do the test so, that the results will represent the entire stockpile, because, in the lab we only use limited amount of material for testing. Therefore, sampling of the material is also very important of before we can conduct a test on the aggregates. There are various locations of sampling from where aggregates can be taken.

For example, aggregates can be taken from the stockpile which we have just created in the plant, it can be taken from conveyor belt. So, conveyor belt are something like this, which you can see here. So, we have some feeder bins. So, you can see some feeder bins here, storage bins. So, from the storage bins, the aggregates are taken for drying through the conveyor belt. So, again we can take from the storage bins, we can also take from the conveyor belt, we can also take from loaded trucks. So, when the truck is bringing the material we can take it from the loaded truck also. Now, the most

ideal location among these four location is the conveyor belt where the amount of segregation will be less.

For example, if you are storing the material in stockpile, depending on the size of the material, it may happen that the material will start running down. So, you will have coarser material on one side final material on the other parts. So, therefore, sampling becomes more difficult.

So, you have to adopt some good practices to do sampling if you are targeting for stockpiles, otherwise conveyor belt is a suitable option from where the material can be taken for testing and even in the conveyor belt we can take the material from a particular location at different times and we can also take material from different locations of the conveyor belt for testing in the laboratory.

Well with this we complete this presentation and here if you can recall that we have discussed about the storage of the aggregate particles and we have also discussed about the production process of the aggregate particles. In the next presentation we will continue discussing about various other aspects of aggregates and we will specifically focus on the classification of the aggregates and how aggregate grading is done for use in a bituminous mixture or a concrete mixture. Thank you.