INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
NPTEL
NPTEL ONLINE CERTIFICATION COURSE

Mechanical Operations

Lecture-09
Industrial screening equipment

With
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Welcome to the fourth lecture of week 2 of mechanical operations course and this lecture consists of, and this lecture includes the industrial screening equipment.

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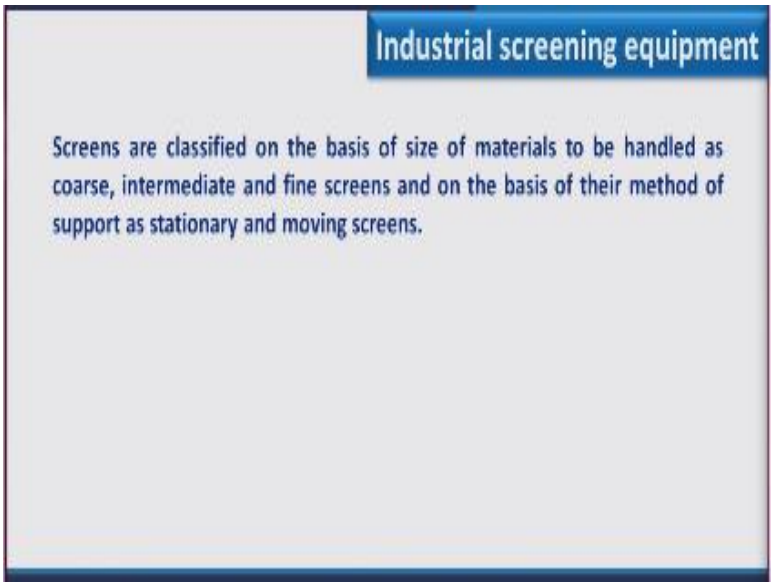

So screens are classified on the basis of size of materials to be handled as coarse, intermediate and fine screening and on the basis of their method of support as stationary and moving screen.

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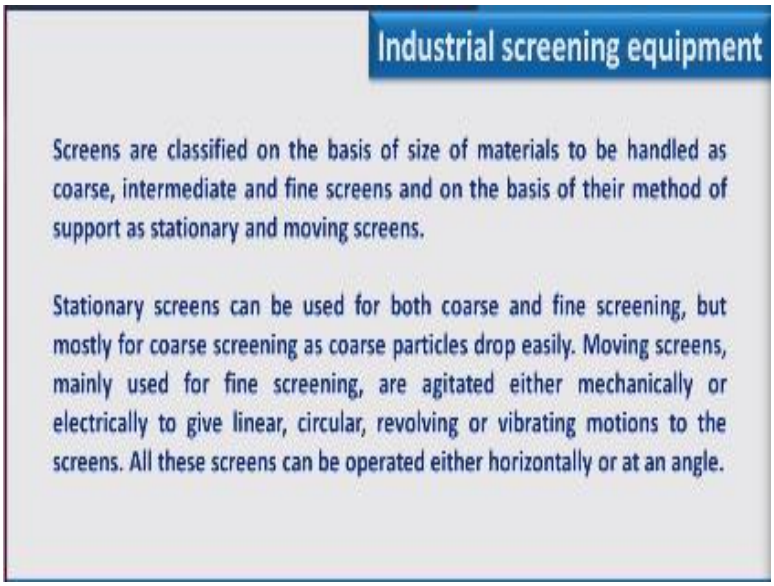

So here you see we have classified in terms of size of material it handles as well as its operation whether it is operated at stationary position or in moving position.

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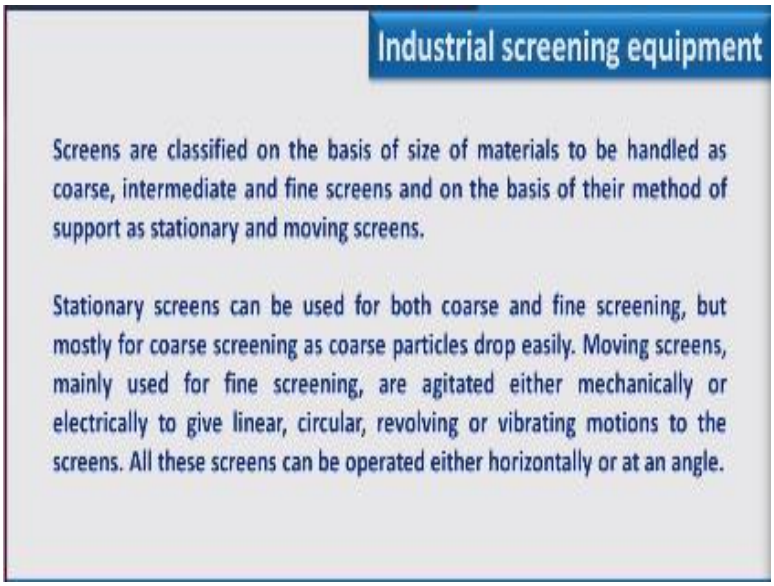

Stationary screens can be used for both coarse and fine screening, but mostly for coarse screening as coarse particles drop easily. Moving screens mainly used for fine screening are agitated either mechanically or electrically to give linear, circular, revolving or vibrating motions to the screens. All these screens can be operated either horizontally or at an angle. So there are a number of types of mechanical screening equipment that cause segregation.

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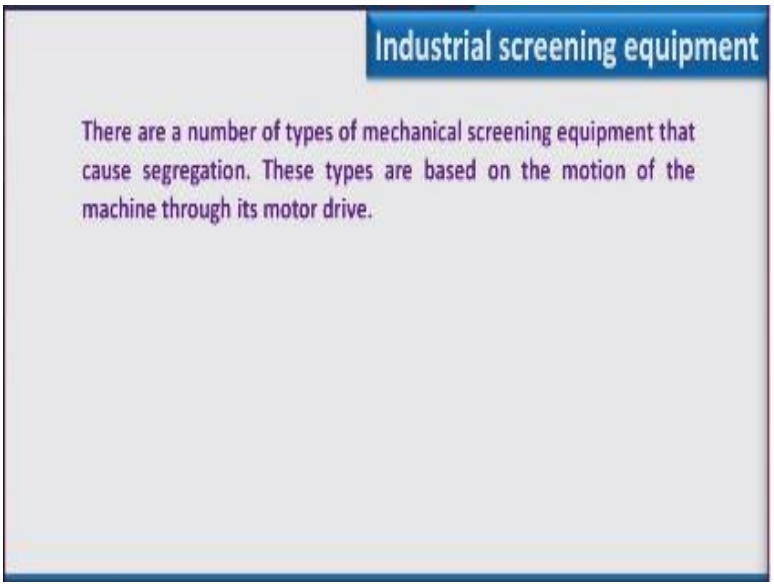

These types are based on motion of the machine through its motor drive, there are number of screens which are shown as.

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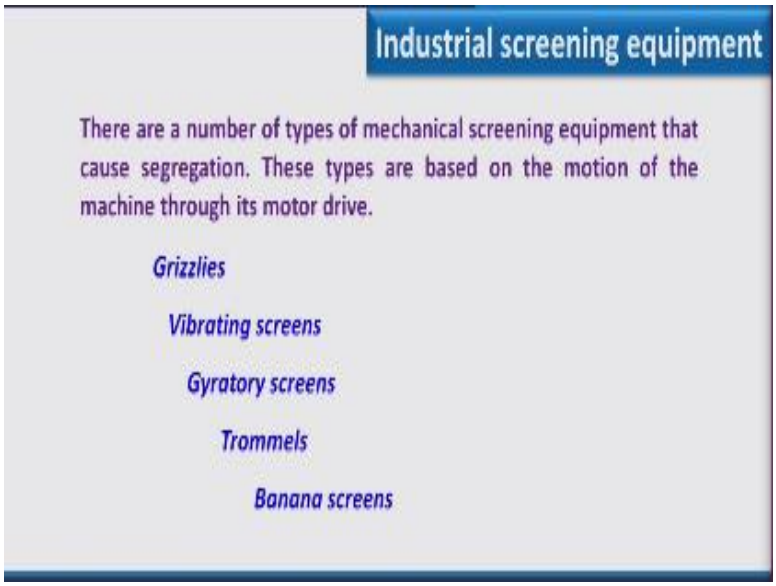

First is grizzlies, second is vibrating screens, third is gyratory screens, trommels and finally we have banana screens. So we will discuss these screens one by one. First of all we will focus on grizzlies. So grizzlies are most rough type of industrial screens. The material consists of large percent of coarse particle is separated using grizzly screen; these are usually used for screening large size of rocks of 20 to 300 mm and above.

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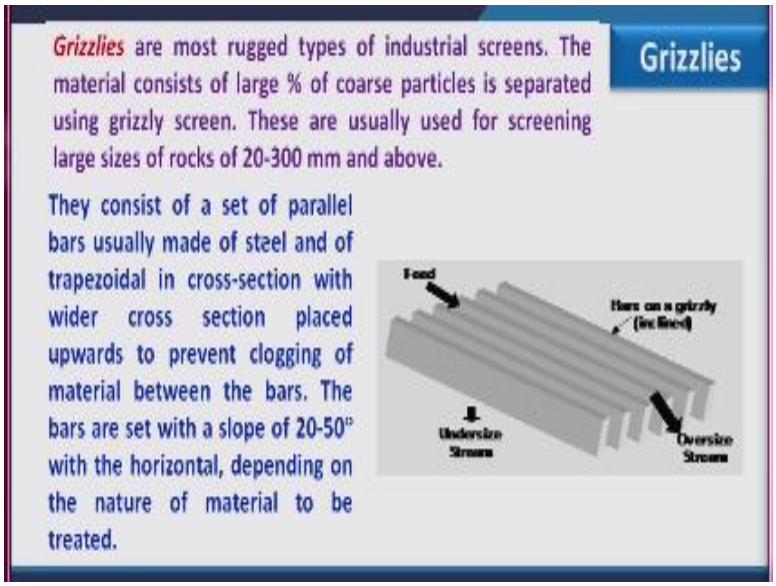

So if you see this is the view of grizzly, they consist of set of parallel bar usually made of steel and of trapezoidal in cross-section where wider section is placed at the top and smaller section between two bar will available at the bottom. The bar are set with the slope of 20 to 50 degree with the horizontal depending on the nature of material to be treated. So if you see this figure here I am having feed at one end and these bar are continuously move backward and forward due to that movement the material pass through it.

And in some other grizzly these bar are in standing position and material is continuously falling in this and gets separated. Over size is collected or over size will remain at the top and smaller under size particle will pass through the opening between bars.

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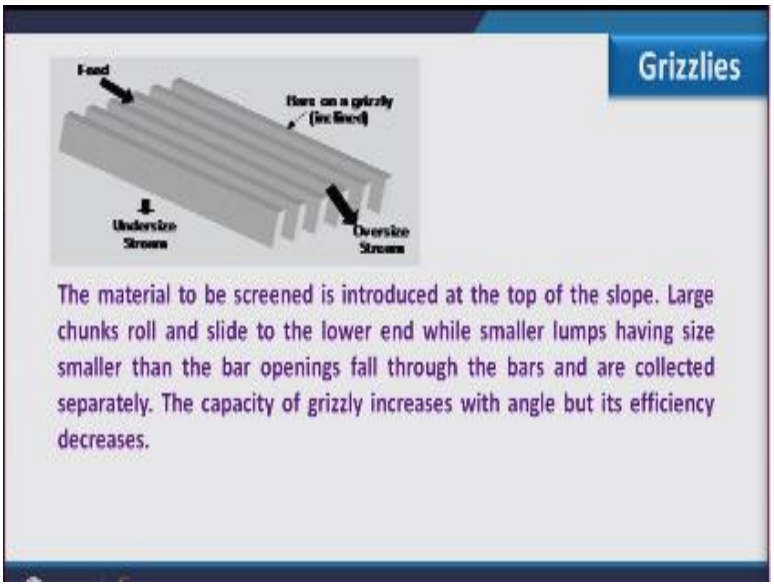

So if you see the grizzly the material to be screened is introduced at the top of the slope large chunks rolls and slide to lower end, so large or coarser particle will slide over here and they fall from this side to the lower end, while smaller lumps having size is smaller than the bar opening fall through the bars and are collected separately. The capacity of grizzly increases with angle but its efficiency decreases.

So the largest application of grizzly is in the separation of under size from a feed to primary crusher. So when we have to use the feed for primary crusher we can place the grizzly above to it. So after continuous separation of material, the feed can be entered into the primary crusher through grizzly.

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So here I have shows the photographic view of this, so you can see this is the grizzly where feed is continuously falling to this and here we have the gap, so above we have larger area of trapezoid and bottom we have the smaller section of trapezoid. So material which is falling into this, if it is coarser than this opening it will remain over it and material which is finer then the opening will be passed through these open section.

So here again I am having one photographic view of this for detail you can study these websites about these equipment.

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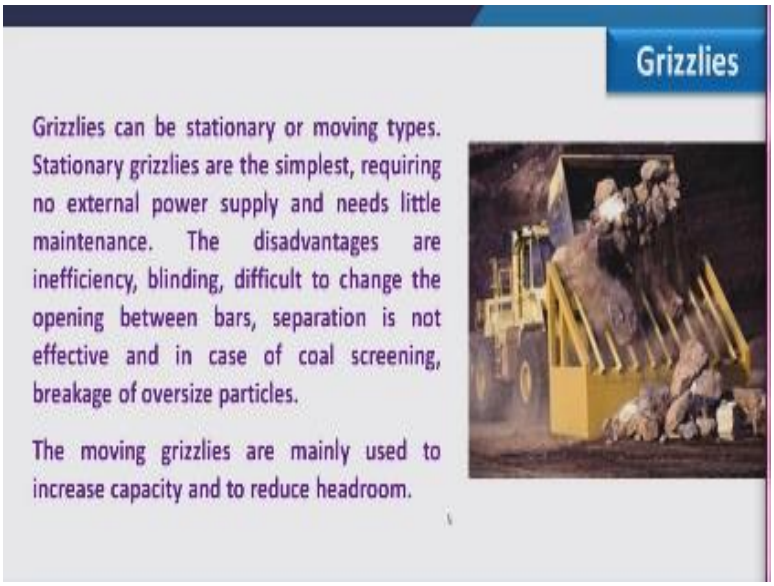

So grizzlies can be stationary or moving types, stationary grizzlies are simplest requiring no external power supply and needs little maintenance. So if you see this figure, here in this figure the material is falling on the grizzly and the coarser material is collected at the lower end of the grizzly and fine is collected at the bottom. So if I consider this particular grizzly it is nothing but the stationary so there is no power consumption in this type of grizzlies. However it has some disadvantages which are inefficiency, blinding, difficulty to change the opening between bar because they are fixed, separation is not effective and in case of coal screening breakage of oversize particles may occur.

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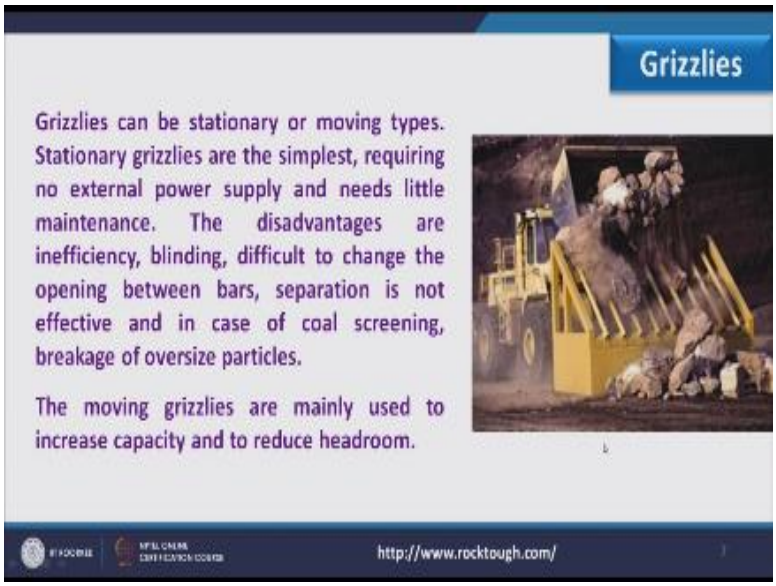

On the other hand the moving Grizzlies are mainly used to increase capacity and to reduce headroom.

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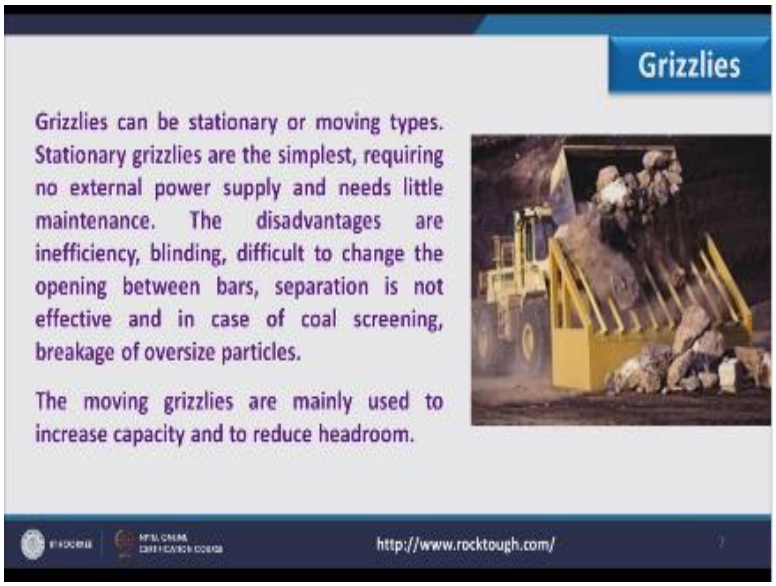

So here you see this is the stationary grizzlies and if we operate this with the motor it means it continuously in a moving position, moving position it means what? These bar will move backward and forward and using this action the material will pass through the screen. So it has lesser headroom, we also call this as dead zones. And next we have the vibrating screen, you can see these screen in this photograph.

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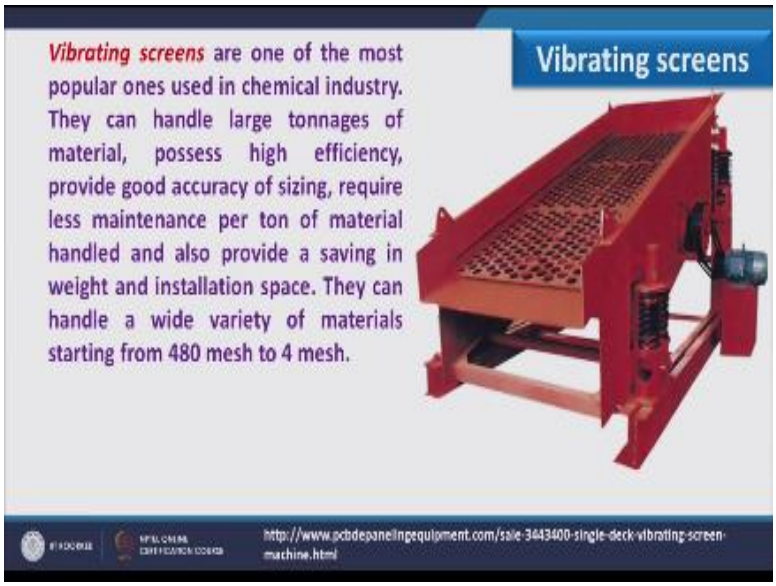

For detail you can go through this website, so here in this screen material is available over here and due to the vibration motion the screening takes place and how the vibration takes place, using these motor. So vibrating screens are one of the most popular ones used in chemical industry, they can handle large tonnages of material, possess high efficiency, provide good accuracy of sizing, require less maintenance per ton of material handled and also provide a saving in weight and installation space, they can handle a wide variety of materials.

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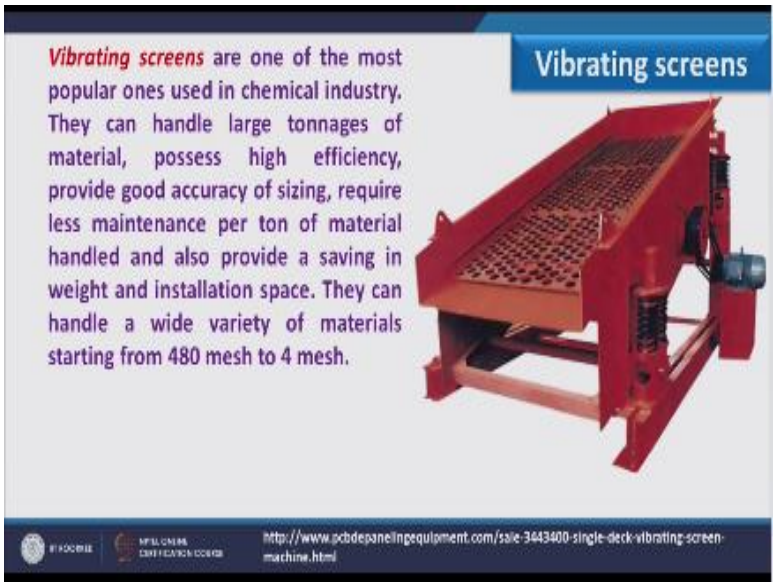

Starting from 480 mesh to 4 mesh so these are mostly used in chemical processes, chemical industry. Generally vibrating screens consist of a plain screening surface which is made to vibrate rapidly by some mechanism. So here we have this screen which continuously vibrates.

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So the screening surface are set to multi-deck fashion, for example if I show this screen.

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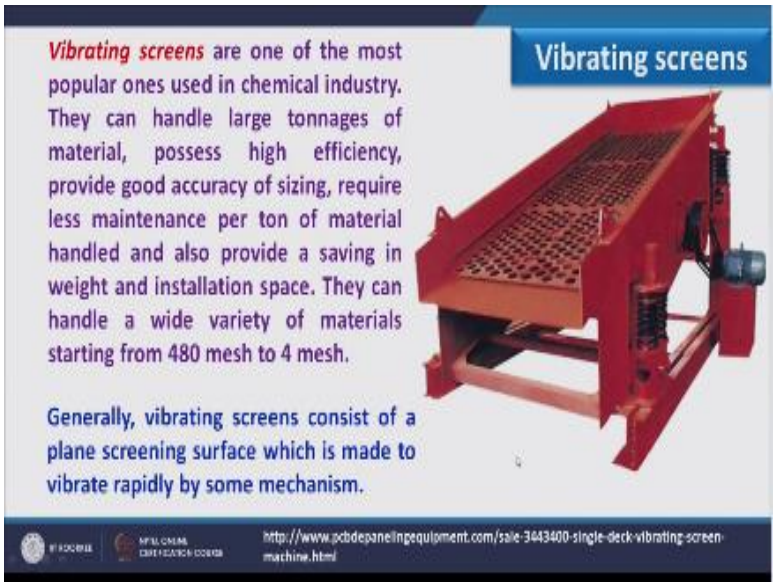

It has only single screen, single set where the material can pass or material can retain.

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If I consider the multi-deck it means 3, 4 screens of different sizes are placed one over another. So we call it multi-deck screen which has single or upto four decks, either horizontally or inclined its steeper inclination results in optimum separation of fine particle. So this is the complete assembly of vibrating screen where I am having different sections of a screen and as far as size is concerned it is very compact in comparison to grizzlies or screen of a similar type.

So material to be screen is introduced at the top of upper screen and here if I consider multi-deck screen so you can understand at the top it has the coarsest or largest opening as we keep on moving downward the opening will keep on decreasing. So material to be screened is introduced at the top of the upper screen, the particles retain why this is screen are recovered at the toe of a screen slope like here and the particles passing though the screen either fall on lower screen or further separation or are collected separately at bottom.

So in this way material is handled, vibrating motion is generally produced by vibrating mechanism either mechanically or electrically directly applied to the screening surface or to the screen box.

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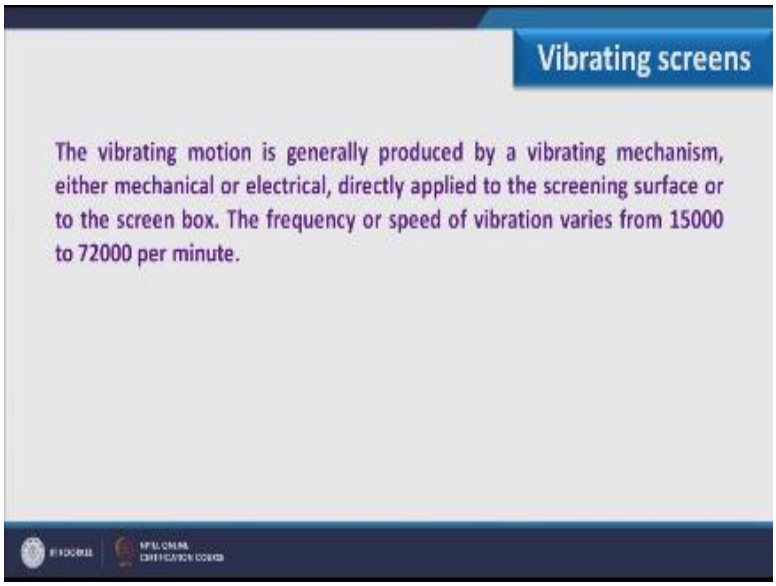

The frequency or speed of vibration varies from 15,000 to 72,000 per minute. So you can imagine the vibration which is available in vibrating screen so obviously it will have more possibility to pass the material from screen.

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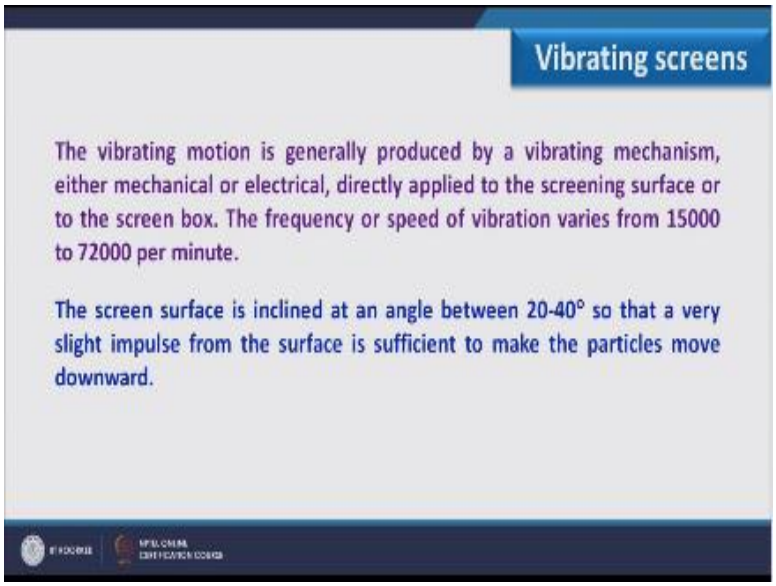

The screen surface is inclined at an angle between 20 to 40 degree so that a very slight impulse from the surface is sufficient to make the particles move downward because it has vibration, and along with this the inclination will place a role for material to pass from top to bottom of a particular screen. As for as benefits of vibrating screens are concerned these are, it does not have dead areas.

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It has a smooth and quiet operation, exact sizing, high output, simple structure, easy maintenance, low energy consumption, full enclosed structure, high screening efficiency and long life. These are some of the benefits of vibrating screen, due to this the utility of such type of screen is maximum in chemical industries.

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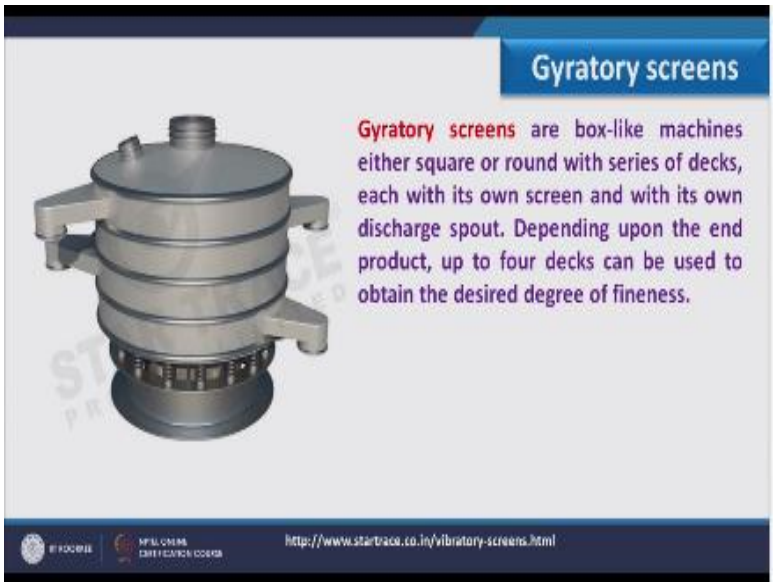

And third we have the gyratory screen, gyratory screens are box like machine like here if we see this is nothing but a photographic view of gyratory screen, in detail you can study this you can go through this link. So gyratory screens are box like machines either square or round with series of decks. So here you see we are having series of decks and each deck is having its individual screen surface as well as the outlet. So these gyrator screens consists of series of deck either with its own screen or with its own discharge spout. Depending upon the end product up to four decks can be used to obtain the desire degree of fineness.

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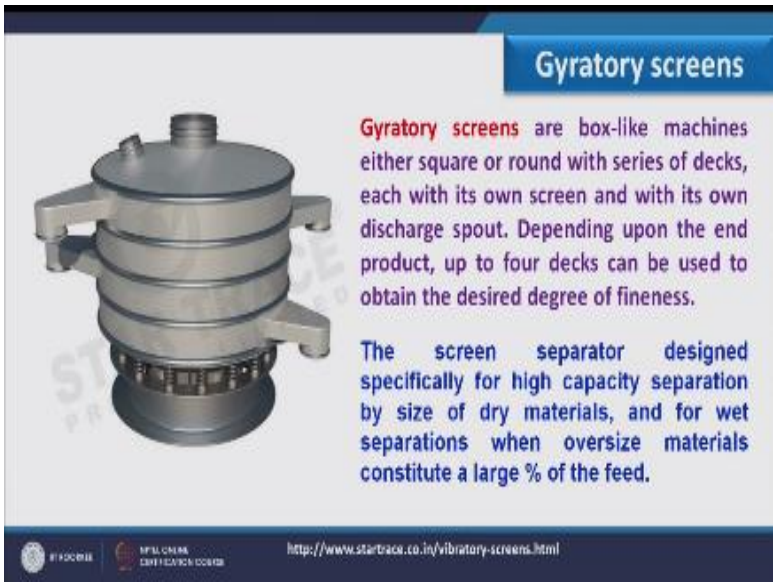

So these are the gyratory screen, the screen separator design specifically for high capacity separation by size of dry material and for wet separation when oversize material constitute a large percent of feed, so those can be used in gyratory screens. These decks which are available in gyratory screen it will have the gyratory motion and the motion is up to 1450 cycles per minute.

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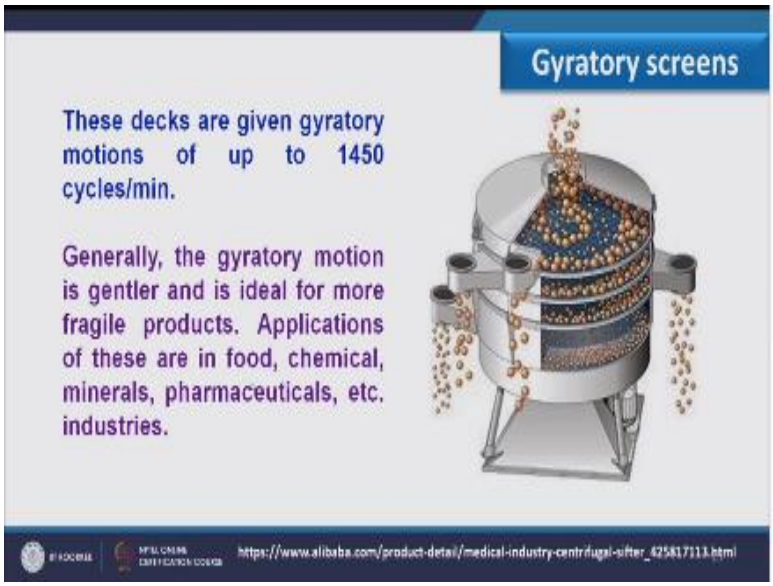

So here the cut view of the screen is shown where we have the largest feed from the top and due to this gyratory motion, I hope you understand what is gyratory motion, it is the circular one plane, so gyratory motion takes place and due to this we have a smaller particle will keep on falling and the coarsest particle will be available at the top and from the discharge spout the particle can be collected. So as for as gyration is concerned it has 1450 cycles per minute. Generally gyratory motions is gentler and is ideal for more fragile products. Application of these are in food, chemical, mineral, pharmaceutical industries.

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And now we have the trommels, what are the trommels? Trommels are revolving screens usually cylindrical or conical in shape open at both ends and are normally inclined.

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At 5 to 10 with the horizontal. Here 5 to 10 is basically the degree. At which inclination of trommel is made with the horizontal, they are rotated about their axis at around 15 to 20 rpm. So if you see the trommel this is.

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Nothing but a cylindrical type of machine and as far as its surface is concerned it has a particular screen opening, so feed which we have to separate is falling, is fed into this trommel and this starts rotating and due to this rotation the screening takes place so finer particle will pass through the screen and coarser particle will stay inside the cylinder only. So trommels are relatively low capacity and low efficiency machine, they are however quite efficient for coarse particles from 6 to 55 mm.

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And screening can be carried out dry or wet. So if you considered the trommel these are nothing but a simple cylinder having surface in terms of screen.

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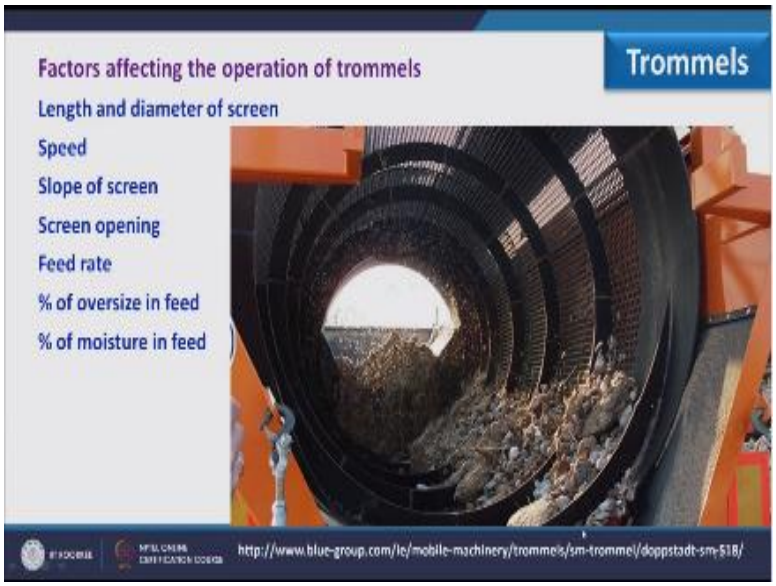

So here if you see this photograph here we have this feed inside this and due to continuous rotation the screening takes place and in detail about this you can go through this link. Now I will discuss the factors which are affecting the operation of trommels and these are.

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Length and diameter of a screen, speed of rotation, slope of a screen, screen opening, feed rate, percent of oversize in feed and percent of moisture in feed. So all these factors are affecting the performance of trommels.

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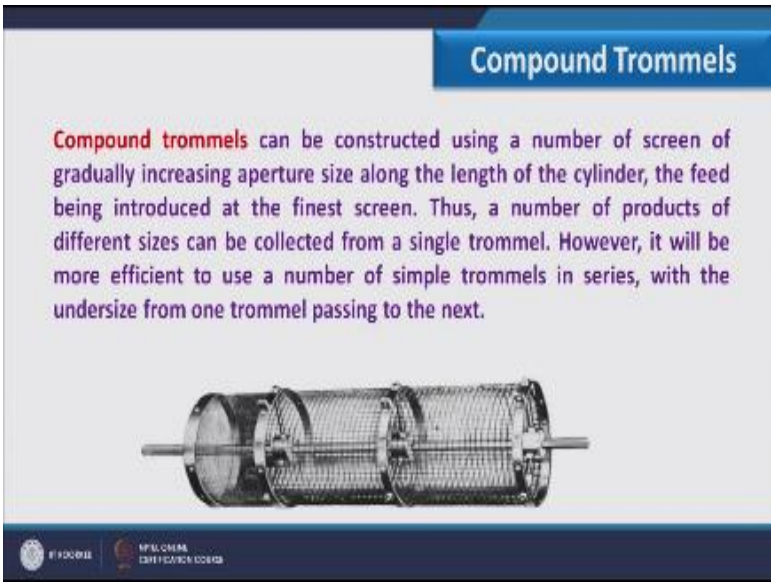

Now as far as trommels are concerned these are usually of two types, first is compound trommels, the compound trommels can be constructed using a number of screen of gradually increasing aperture size along the length of the cylinder. So if you see this image this is the compound trommel where screen of different sizes are placed in series. So here if you see from finest to coarsest the screens are arranged and if we put the material we put the material at this end where I am having the finest opening, that is obviously opposite to whatever we feed the material either in vibrating screen or in gyratory screen.

Here we put the material at finest size because when it will enter into the finest zone the coarsest particle will retain on the screen to be separated in the subsequent section and the finest particle will pass in first section only.

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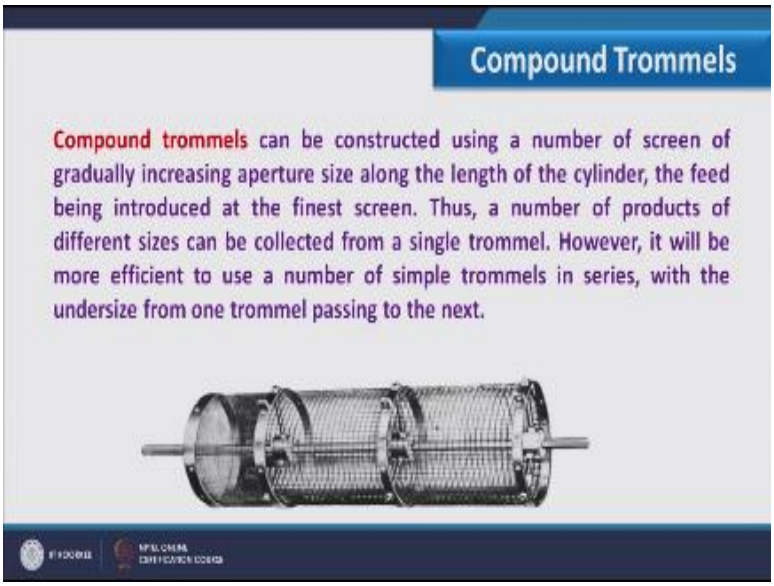

Therefore, such type of screen consist of different aperture sizes which are placed in increasing order along the length of the cylinder and feed is introduced at the finest screen. Thus a number of products of different sizes can be collected from a single trommel, however it will be more efficient to use a number of simple trommels in series with undersize from one trommel passing to the next, so this is the structure and working of a compound trommel. Another trommel we are having is the concentric trommel, about this you can read, you can go through this link.

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And if you see this is basically the concentric trommel in which all cylinder of different diameter are placed at one shaft.

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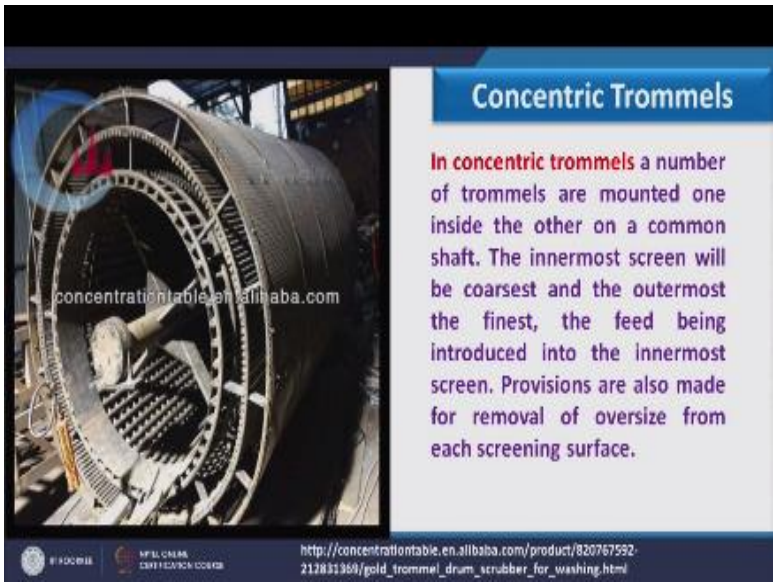

So in concentric trommels a number of trommels are mounted one inside the other on a common shaft, the innermost screen will be coarsest and the outermost would be the finest and feed is being introduced into the innermost screen. Provisions are also made for removal of oversize from each screen surface so it is different than the compound screen.

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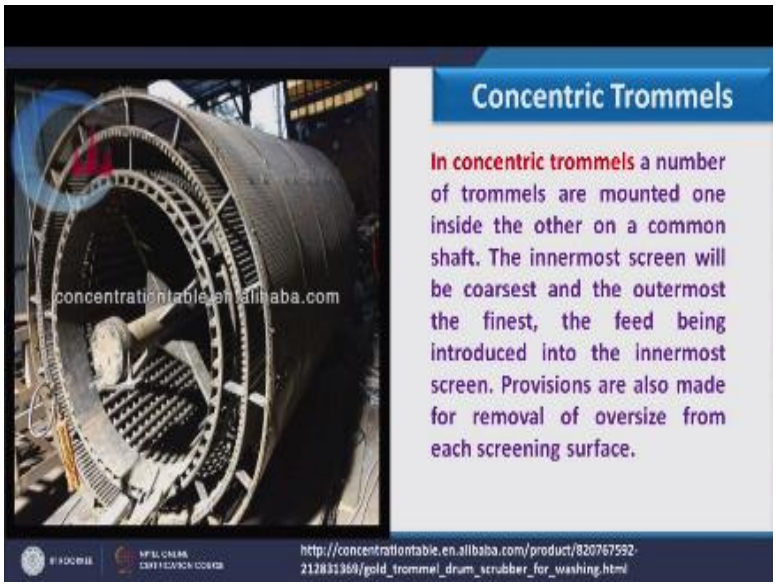

In compound trommel different screens are arranged in a series however in concentric trommels screens are arranged in parallel to one another and if you see this is the.

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Portable trommel screen, the link is available over here for detailed study of this particular screen, so if you see this here we have the feeder in which continuously feed is entering into this and then after this it will enter into this trommel, the continuous rotation of trommels takes place and due to this finer particle is collected and due to this belt conveyer the finer particle are collected at one side and the oversize is collected to another side due to the belt conveyer, so it is portable screen.

Which can be taken to any place where the such type of screen is required, and finally we have the banana screen.

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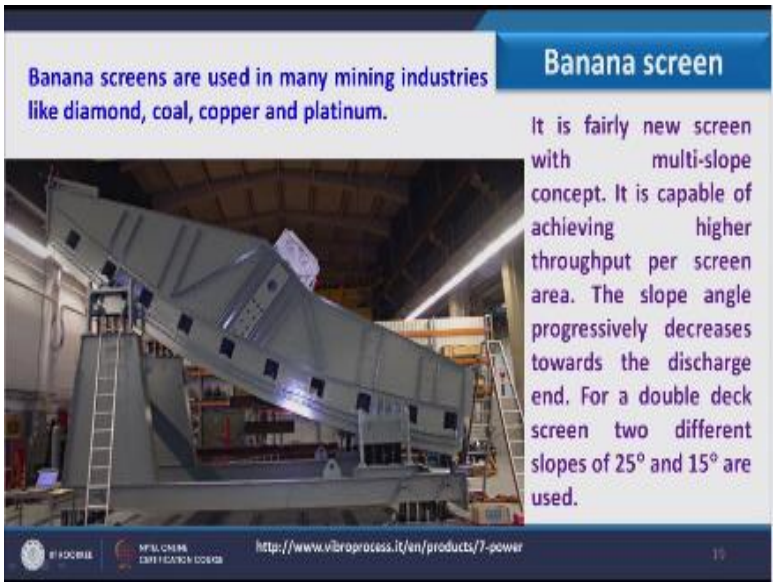

The banana screens are used in many mining industries like diamond, coal, copper and platinum. If you see their structure it looks like banana, here the angle of inclination is continuously changing so it is fairly new screen with multi slope concept.

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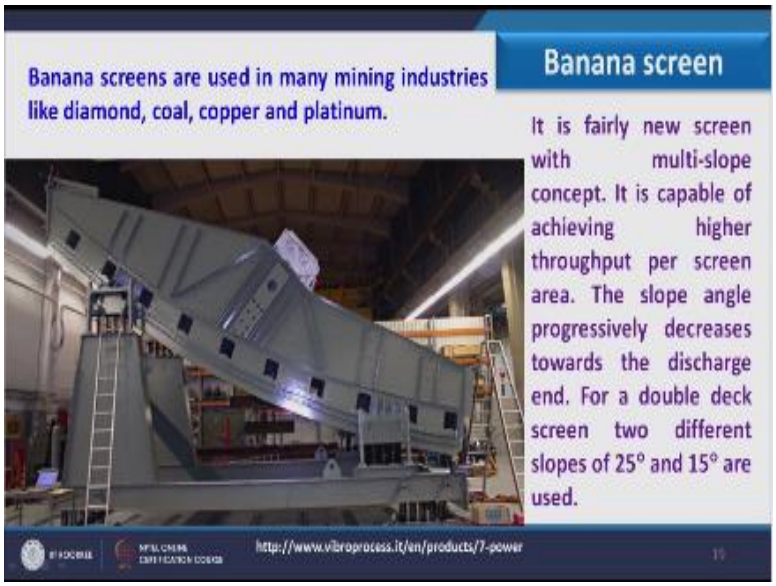

It is capable of achieving higher throughput per screen area, the slope angle progressively decreases towards the discharge end. For a doubled deck screen two different slope of 25 degree and 15 degree are used so when we consider the top section it has more slope then the material keeps on moving towards downward the slope will keep on decreasing so if we consider the banana screen it has basically.

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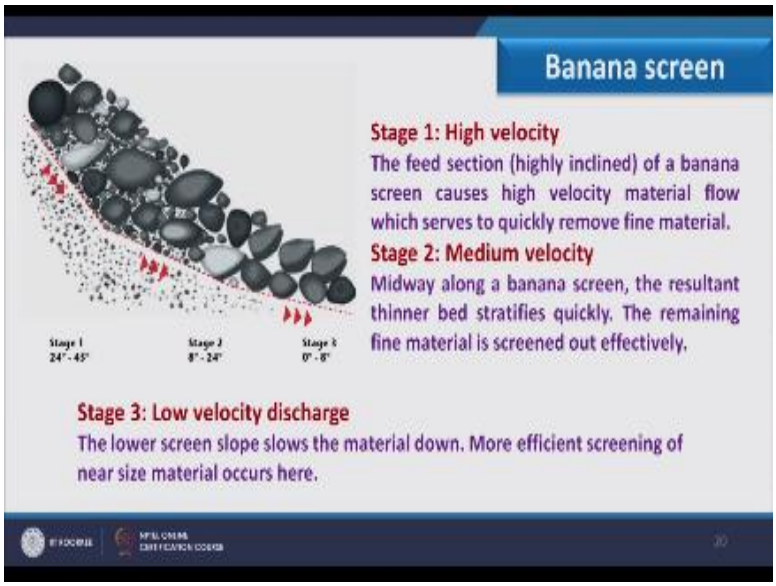

Three stages, stage one where 24 to 45 degrees maintain, stage two where 8 to 24 degree is maintain and stage three where 0 to 8 degree inclination is maintain. So what happens in stage one, it gives the high velocity, the feed section highly inclined of the banana screen causes high velocity material flow which serves to quickly remove fine material. Stage two has medium velocity so mid way along a banana screen the resultant thinner bed stratifies quickly the remaining fine material is screened out effectively.

And in third stage it has lower velocity discharge, the lower screen slope slows the material down more efficient screening of near size particles occurs here, so here due to this change in inclination these are used in industry significantly in the present days so here the photographic view of this is shown.

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This is the slightly side view of this and this is the front view so if you see this particular section it is almost with the 0 inclination, in detail you can go through this link, so here in this particular lecture we have discussed five different screens, the comparative analysis comparative study of this is shown in the slide.

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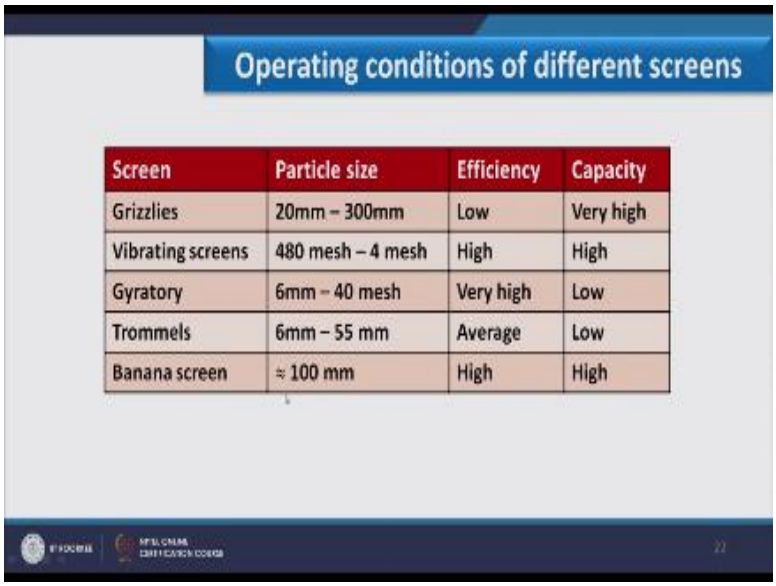

Where for grizzles we can handle particle size from 20 to 300 mm its efficiency is low but capacity is very high. For vibrating screen particle size moves from 480 mesh to 4 mesh efficiency high, capacity is also high. Gyratory screen it handles particle size from 6mm to 40 mesh efficiency very high but capacity is low. Trommels it handles particle from 6mm to 55 mm, efficiency average, capacity low, and banana screen it gives the size of equivalent to 100mm efficiency high and capacity is high.

So whatever size of material, size of particle you want accordingly we can choose the suitable screen for that purpose, so now I am having the summary of this lecture. In this particular lecture industrial screening equipment were discussed.

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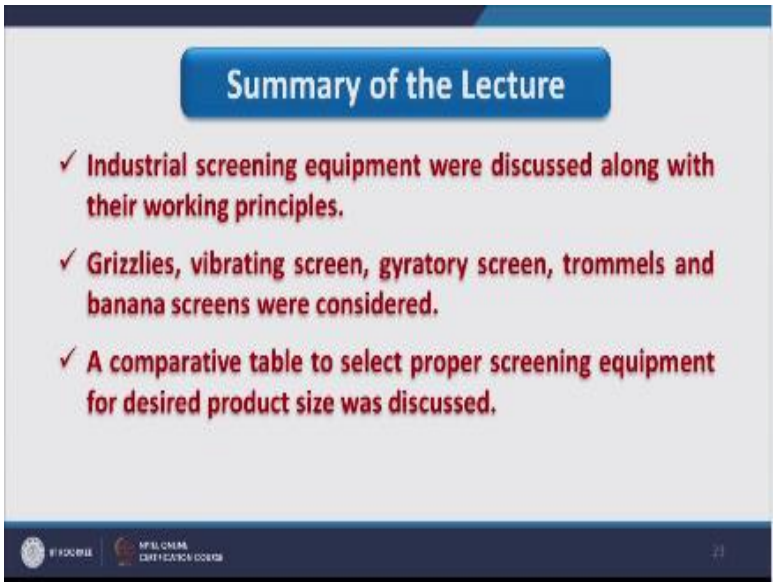

Along with their working principles, grizzles, vibrating screens, gyratory screens, trommels and banana screens were considered and finally a comparative table to select proper screening equipment for desired product size was discussed.

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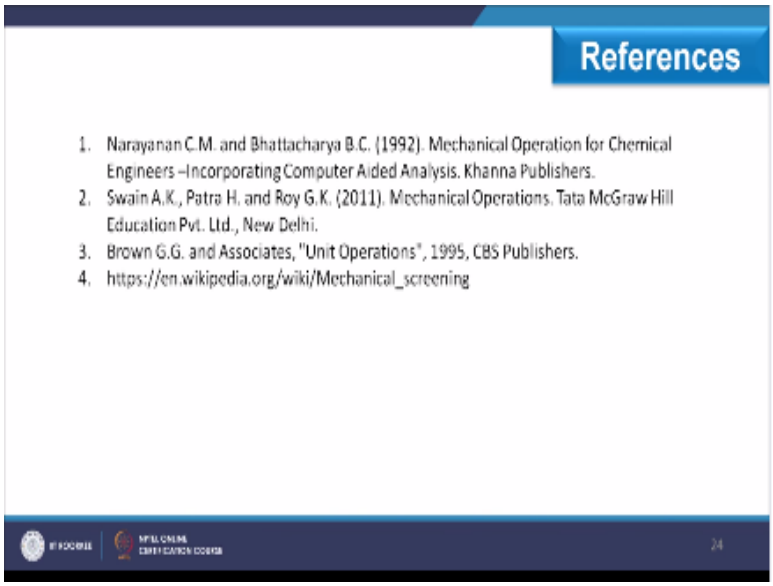

And these are the references, you can go through these references for detailing of these equipment and that is all for this lecture, thank you.

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