Principles of Casting Technology
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Lecture – 09
Technology of Molding
Testing of molding sands

Welcome to the lecture on Testing of molding sands. Under the technology of mold making, today we will discuss about the testing of molding sands. What we have understood by this time is that when we are having the sand and we combined that with binder, then this sand along with the binder must be able to have the properties which are required for it, that it can give you a better property for the cast material. Those properties include like, it must have sufficient strength to with stand the metallostatic pressure. It must have sufficient amount of clay, that the binding ability is proper; it must have good toughness and moldability. There must be adequate amount of moisture and clay; like that there are certain routine testing programs which are carried out on the sand specimen.

Today we will discuss about different type of testing for the molding sand. Now in that we have these different tests apart from that also there are few tests then among them the tests which are important are grain size analysis that is for the fineness of the grain.

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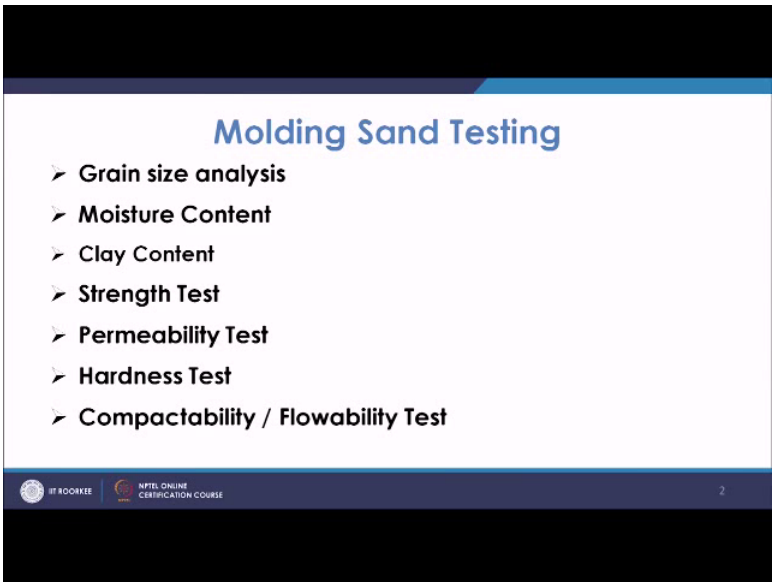

Grain size testing, then moisture content testing, clay content testing. Then we have to know what are the different strengths of these molding sand, like green strength, dry strength or compressive strength. Then, what is the permeability? And what is the testing procedure for testing the permeability then there is hardness test, for the mold, what is the hardness? There must be adequate hardness for the mold that also is to be tested compactability or flowability test. So, that tells that how the sand is flowable, and that is determined by the compactability test. Let us move to the testing procedures.

First is grain size analysis, you know grain size is very important in controlling the properties of the molding sand; the grain size may be fine or may be coarse. Now if you take the coarse sand, it has a good refractoriness value where as if you take a fine sand it has low refractoriness value; however, if you use the fine sand the casting surface will have a better finish. Whereas, with a coarse sand will have the coarse finish or the surface finish will be certainly in failure to what we can get in case of fine sands. There has to be adequate grain fineness, so that you get the optimum property of the molding material.

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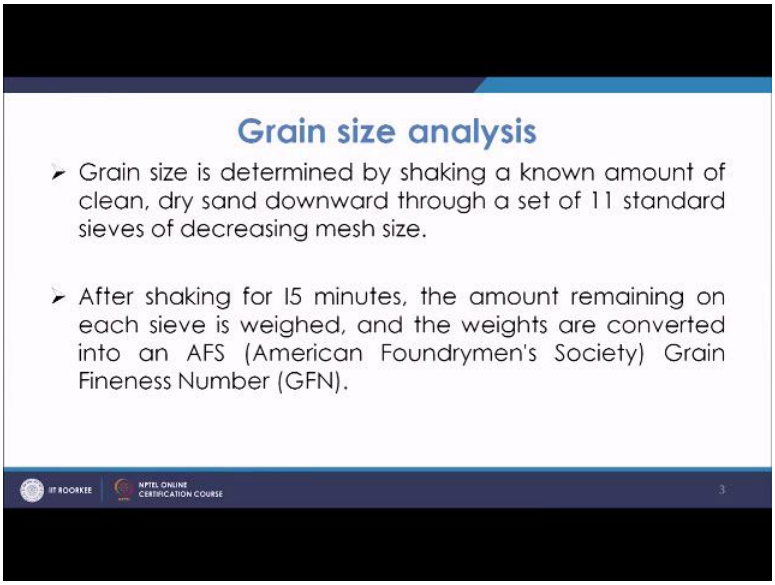

Now this test is carried out through a testing procedure which has some 11 standard sieves of decreasing mesh size, basically you have the sieve, in that at the top you have a sieve shaker, unit, where at the top you have different sieves, and at the end you have a pan.

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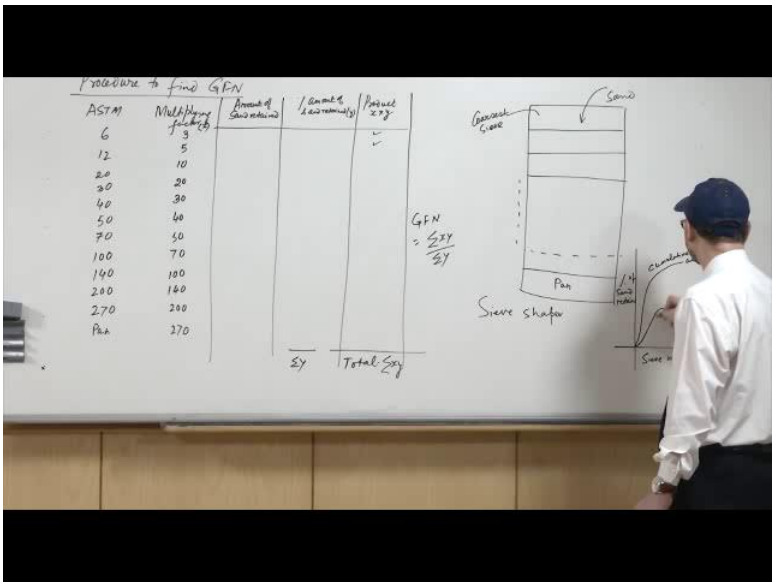

So, this is the coarsest sieve, and this is certainly the finest sieve here, and then you have a pan. Now what we do is, we keep the sand in this and then this unit is vibrated for some amount of time say 15 minutes, during the vibration the coarser particles remain at the top sieves, whereas the finer particles get sieved and they started coming gradually towards the bottom and in the end refined particles they will be coming in that pan.

This way if you take certain quantity of sand, then the quantities will be retained on these particular sieves. From these quantities the percentage amount of the quantity which is retained on each of the sieve is basically calculated. Then average sieve is given a multiplying factor, all these percentage quantities will be multiplied with that multiplying factor and then those products once you are adding them and dividing it by the total percentage. Total percentage will now certainly be close to 100 so that divided by nearly 100 gives you the grain fineness number.

This is basically defined by American Foundrymen's Society and that number is defined as grain fineness number. American Foundrymen's society has defined this grain fineness number, basically it depends upon, or it is defined in terms of a sieve of standard sieve is of 280 mm diameter with this grain fineness number talks about respective number of meshes. Basically the procedure is, procedure to find grain fineness number, for that you have different sieves, and basically as per the ASTM sieves number, you have different numbers. You have suppose - 6, 12, 20, 30, 40, 50, 70, 100,

140, 200, 270 and pan. What you see is, you have 11 sieves and then a pan. Now all these numbers, all these number sieves have a certain multiplying factor. So, multiplying factor for the sieves are for this it is 3, for this it is 5, for this it is 10 and then it goes like this 20 here, 30 here, 40 here, 50, 70, 100, 140, 200 and 270. These are the multiplying factors.

Now, what we do is once we compute or find the amount of sand which is retained here. So, you will have amount of sand retained. In that case, you may have certain amount of sand retained, then you will find percentage amount of sand retained. This will be, suppose you take this as x, and you will have this as y. So, you will find a product, in that case this product will be nothing but x into y, this x into y will be calculated for all these values and then you will have the total here, total that is summation xy. Basically, once you get that and this will be percentage amount of sand retained, it will be percentage y and that will be certainly close to 100. So, grain fineness number is calculated as summation of xy upon summation of y, summation of y is 100, that way we calculate these grain fineness number. Basically larger is the fineness number, a smaller will be the grain size, and a smaller value of the grain fineness number is indicative of the coarse grains of the sand.

Now there are certain points which should be known to you, you can draw a graph and see that how this distribution looks like. You may draw a curve showing percentage of sand retained, and this will be sieve number. If you draw this curve, you may have a curve like this, and if you find, this is frequency curve. And if you try to find the cumulative frequency curve, cumulative percentage curve, you may have such graph.

Now, what is the significance of such curve? This curve shows one peak. This is basically, typically a type of normal distribution curve with single peak, this tells that mostly the average grain size is here and you have some of the sand lesser than that and some more than that, but they are in a smaller quantities.

There may be even two peaks the curves may be like that, which is a bimodal peak, bimodal type of curve and basically in that it tells that is the mixture of some is very fine and some is very coarse. These type of curves are not desirable, basically you we must have a unimodal type of this frequency curve and this indicates that the size distribution is proper, it should not be either towards this end or that end too much, if it is towards

this end and this is the sieve number is less. It means there are coarse grains and if it is towards this side then it will be quite fine and in both case they are not going to give you the optimum type of properties. Then we have also to know the sand shape.

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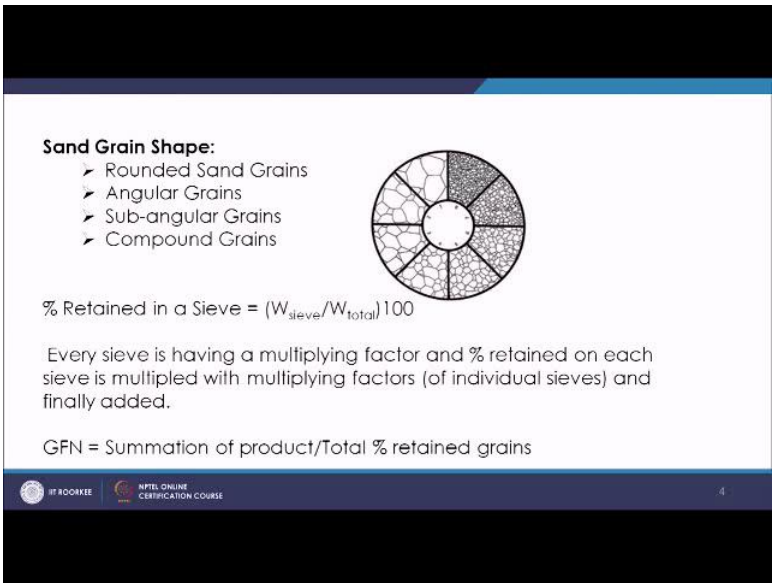

Next is Sand Grain Shape, now the sand grain shape as we have discussed in our earlier class the shape can be rounded, angular, sub angular and compound. That can be seen under the microscope, you can use the microscope to see what kind of shape it has, if the most of the grains are round, you can tell it as rounded sand grains, then you have angular, sub angular and then compound which is mixed of all that. Certainly it has the different properties depending upon the shape of the sand grains.

Next type of test is the moisture content. Moisture content is important, because if you have not adequate amount of moisture the binding strength will be affected, if you have more than required amount of moisture, it may lead to a lot of defects like, there may be formation of blow holes or pin holes. Because these will be trapped inside the casting, there are test which can say that what is the amount of moisture in a particular sand mold. It is determined by device called moisture teller.

What this moisture teller is, basically you have a device in that molding sand is kept and the acetylene gas or CaC2 is basically made in contact with this sand mold, once CaC2 is in touch with the moisture content of the sand after reacting it will produce acetylene gas, and this acetylene gas which will be liberated there will be certain pressure.

Depending upon the moisture content there will be pressure which will be shown because of the acetylene generated, and the pressure which is generated that can be correlated with the amount of moisture which is present. Based on that, you can find the moisture content of the sand.

The next method which is a review method is that see if it is moisture, and if the sample is heated to a temperature more than 100 degree C for large amount of time. It is ensured that all the moisture inside the specimen will be off will go away.

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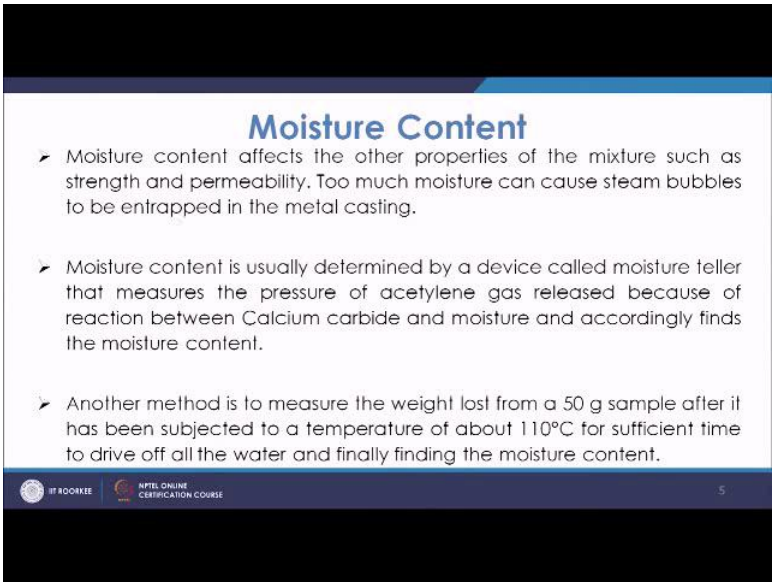

What is done is you have a sample of 50 gram and you are subjecting that 110 degree C for sufficient time so that all the moisture is driven off, and the difference in weight of the sample before and after the test can be used to find the moisture content of the sand. This way you can do the moisture testing.

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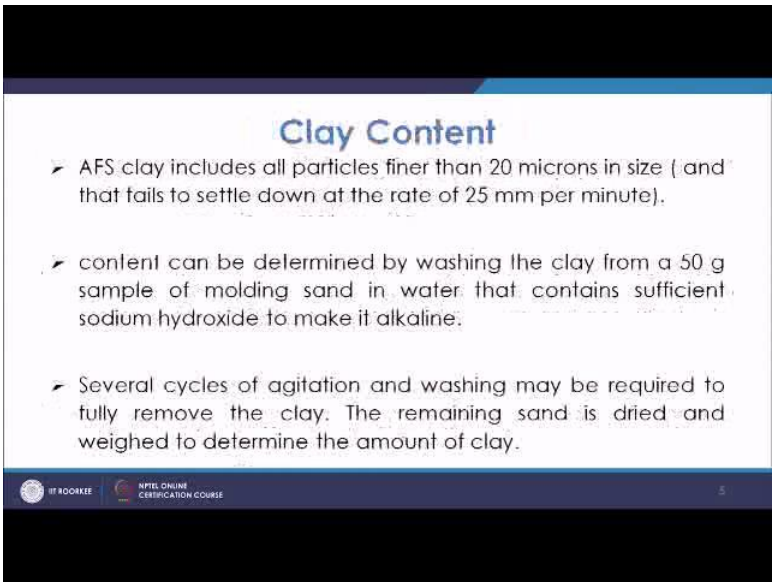

Then comes the amount of clay, now you know clay is a binder, which is getting coated on the sand and there is binding between the clay grains and that is how the sand grains are with each other. American Foundrymen's Society has defined the all the particles finer than 20 microns in size. There may be sand, there may clay or so. Or they may be other impurities, basically that is defined as clay.

Now another definition which is true for the clay is that it is failing to settle down at the rate of 25 mm per minute. Basically, if you try to suspend them in water it is not even able to settle down at the rate of 25 mm per minute. This concept is used to find the clay content in molding sand.

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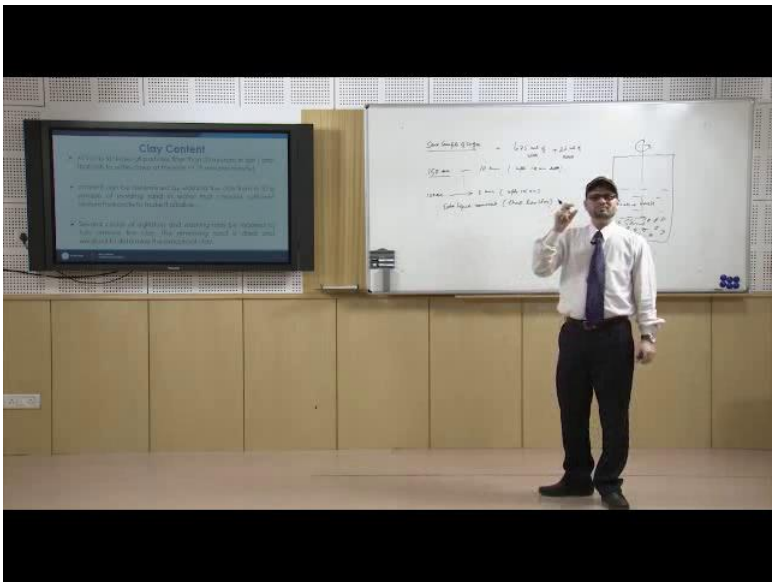

For that there is a test and that test is like this, in that test basically we have, what we do is the sand sample of 50 gram. You have the sand sample of 50 gram, basically it is dried. And then what you do is, in that basically 475 ml of water plus 25 ml of NaOH solution is prepared, and this is kept in that jar. In a jar basically you are keeping the sand and water plus NaOH solution.

Now what is done is, basically you are giving this level you are adding water into it and going up to 150 mm from the bottom. Then after closing the jar you are basically rotating it, vigorously you are shaking it. What happens all the clay particles are there they are basically dissolved in it for suppose 20 minutes or 15 minutes, then you are allowing it to settle for 10 minutes. So, after allowing it to settle for 10 minutes you will (Refer Time: 20:53) on the water up to suppose say 125 depth, and then this is continued for many number of times. Towards the end, and every time when you are disposing this extra water which is above the sand, you have this is the sand mass, and this is water. Now what you do is this 150 mm vertical length, later on initially you settle for 10 minutes up to 125 mm depth you are taking the water out, further after few repetitions this 150 mm, now you are living for 5 minutes and then further you are evacuating up to 125 mm.

Now what happens, the concept is that from 150 mm it must settle at the rate of 25 mm per minute, up to 125 mm if we take it out. Below 125 will be all other than clay like sand, but the clay will be still be dissolved in this 125 mm portion. This extra portion,

now extra liquid removed that has clay, because in 5 minutes it has not been able to settle up to 125 mm. So, this extra liquid which is removed that has clay, then what we do is all the sand mass that is taken out, dried and further it is weighed. And the difference in the weight of the mass it will be the amount of clay present. That is how the clay percent is found out. Basically depending upon the difference in settling rate of the clay, the clay content in the sand is determined using this method.

Then there are different types of strength test, what we discussed is that a mold must have adequate strength. Among that strength you have the green strength, you have the dry strength.

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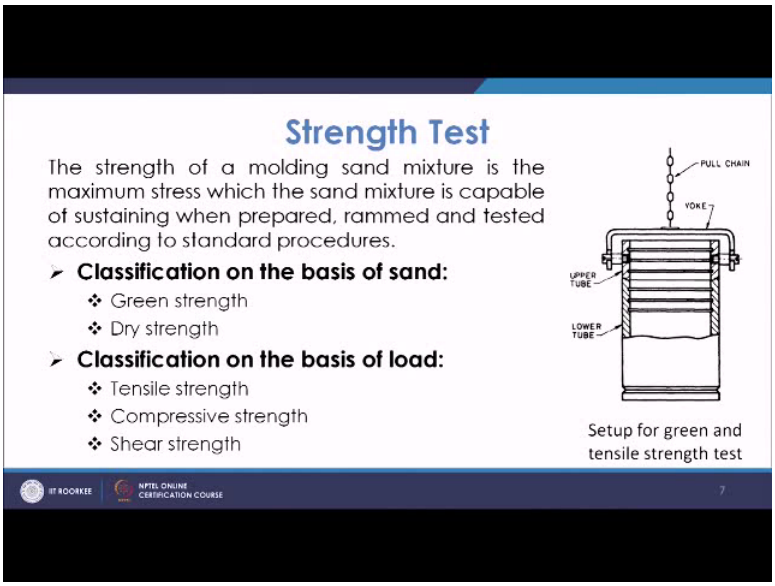

Green strength means, when the molding sand has moisture in it. And the dry strength is that when the moisture is driven off.

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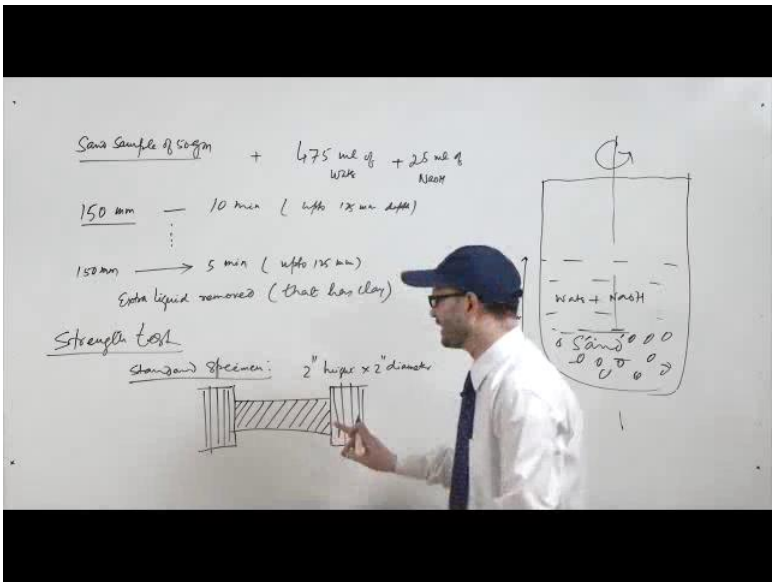

So, what you do is for these strength test, for strength test you have a standard tensile specimen, standard specimen and basically that is 2 inch height by 2 inch diameter, a cylindrical specimen is basically the standard specimen, you make a cylindrical specimen. Now this specimen basically you may have the grip on both the sides and these grips are basically used to have all the types of tests. Basically you may use the compressive test by compressing it from both the sides, you may have a holder to catch this at the points and then you may have the tensile test, or you may have the shear test on this specimen. There are different kinds of testing on the sand to find the strength either of tensile or compressive or shear nature.

Then permeability test, we know that permeability is the ability of the mold to allow the gases to escape through it. Permeability is very important because, if the permeability is poor the gas is keeping tendency will be less and that may lead to numerous gaseous defects. What you do here is permeability test is basically done using an apparatus where in the specimen through the specimen the air is allowed to pass at certain pressure and the time is recorded in how much time it is passing through it. A number is basically defined that number is known as permeability number, the permeability number will be V H upon P A T.

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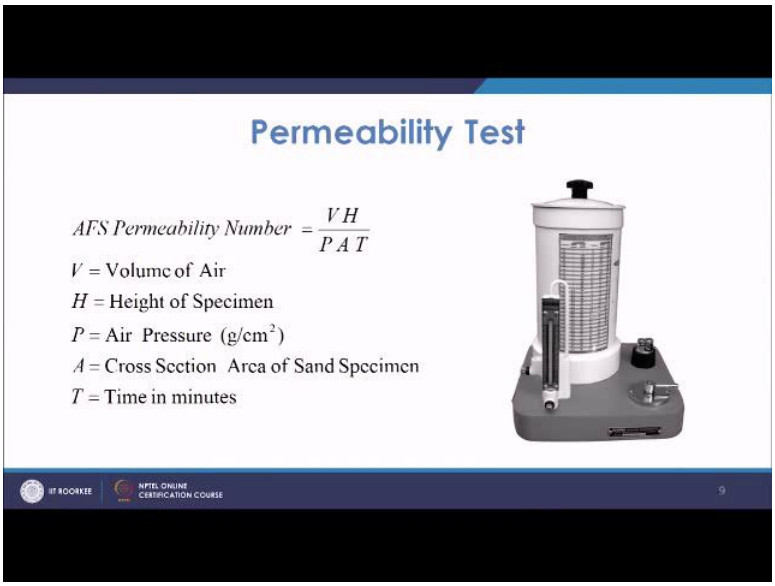

So, there is apparatus which talks about this finding the permeability and the permeability number is V H by P A T where V is the amount of volume of air which is going to pass through the standard specimen, H is the height of the specimen, if you have a standard specimen H and that is in centimeter, then P is at what pressure you are using, you may be using 10 gram per centimeter square pressure, A is cross sectional area of these specimen and time is, T is time in minutes.

Once we use this, all these values and put it this expression this V H by P A T it will tell us a number permeability number. That basically tells us, what is the permeability of the specimen; the sand sample has to be permeable, that it can allow the gasses to pass through it.

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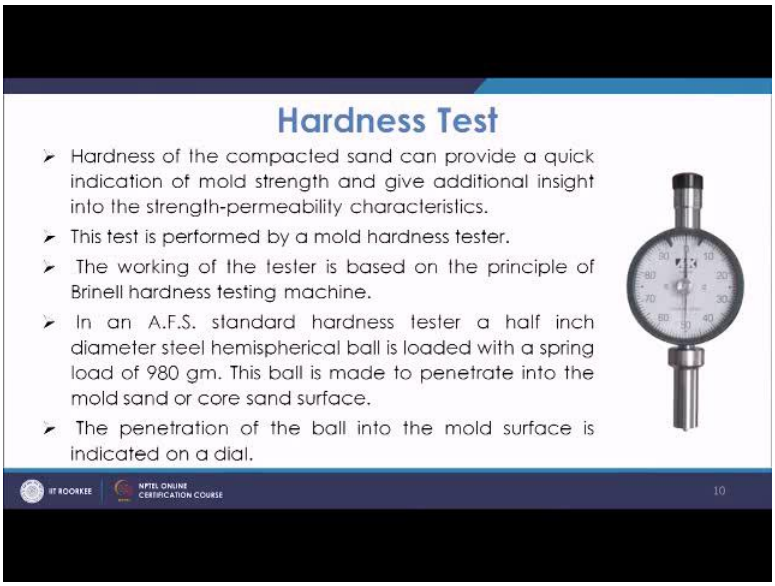

Then other tests are like hardness test. Hardness test also it is like such unit is available. That is a hardness tester, mold hardness tester, here also you have any indenter here at the end, it is allowed to fall on the sand and depending upon the impression it generates, and it is value is from 0 to 100 you can have the value of this mold hardness. How much it penetrates into the mold sand or core surface based on that, you will have the mold hardness number.

Compactability or flowability test, how much it can be compacted, for this test basically what we do is a fixed volume of loose sand is compacted under standard conditions and percentage reduction in volume represents the compactability.

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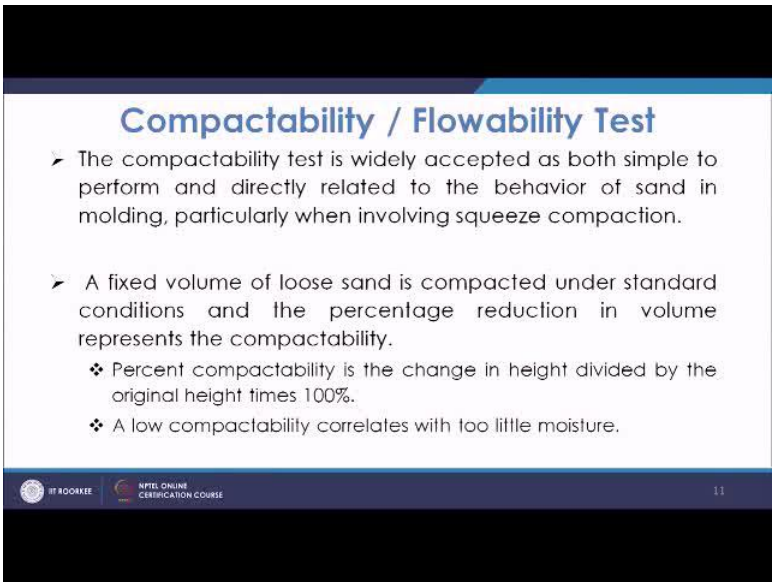

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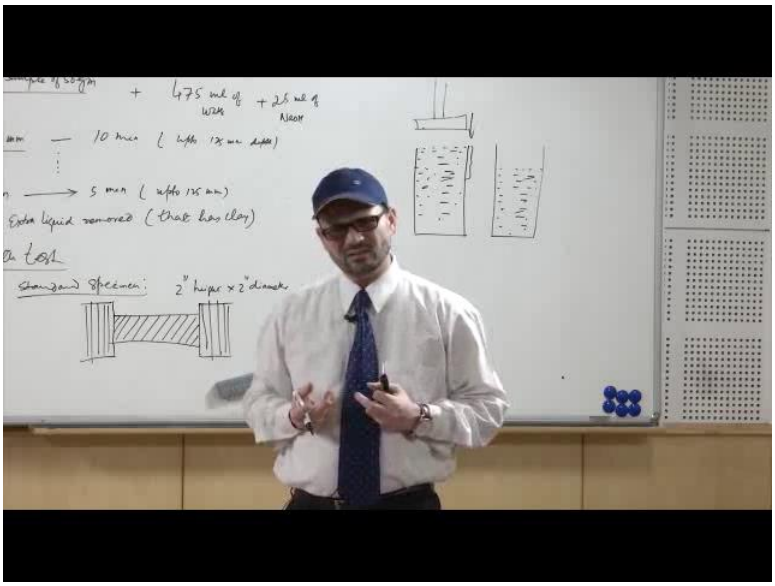

What is done is, you have a particular container or a cylinder in that there is a ram and once you fill whole through the, through this or along this container. And the ram is allowed to fall from the height, and once it will follow upon a three times, then after sometime at three after three times the mold molding sand may come to this height, whatever is the reduction depending upon that you find the compactability. Percentage reduction in volumes, basically this cross sectional area is same, percentage reduction in the height is the indicative of the compatability. This is how you find the compactability.

A low compactability correlates with too little moisture, if the moisture is more compactability will be more and if the moisture is less then compactability will be less. Apart from that you have even other tests like, loss of ignition test, that is basically indicative of how much there is combustible product which, in that basically you are heating up to about 1000 degree C for large amount of time so that the rate remains constant and then the difference will be the loss of ignition.

There are other tests like the toughness test or it is a shatter test where the sand sample is allowed to fall from certain height on this and will, and depending upon how much it is shattered, how much it is retained on a (Refer Time: 31:22) may sieve. You calculate that toughness number or shatter index number.

There are different kinds of tests which are to be carried out, before assuring that the molding sand which you have got has the adequate property to with stand the conditions of the molten metal which will be once it is poured inside the cast mold, and you then can ensure that there will be a good quality cast product.

Thank you.