Glass Processing Technology
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Lecture - 54
Quality Testing_Part V

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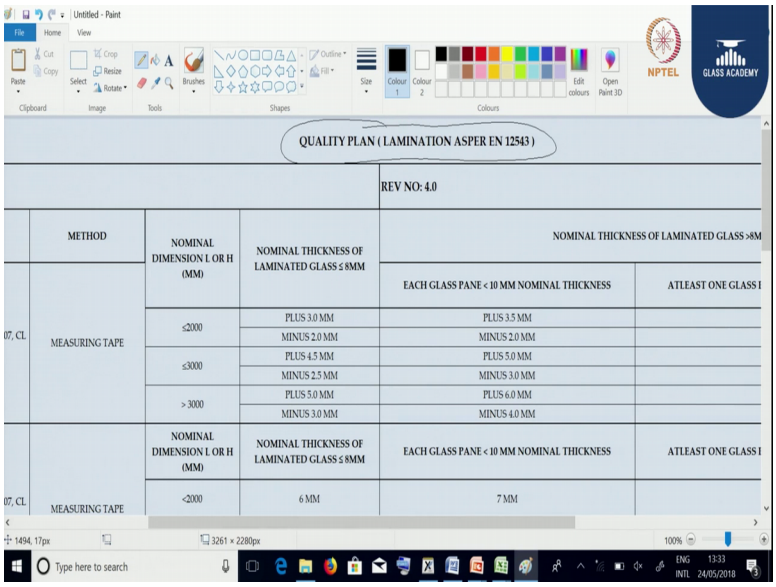

Now, we will understand the quality plans for the lamination and the standard what we follow is EN 12543.

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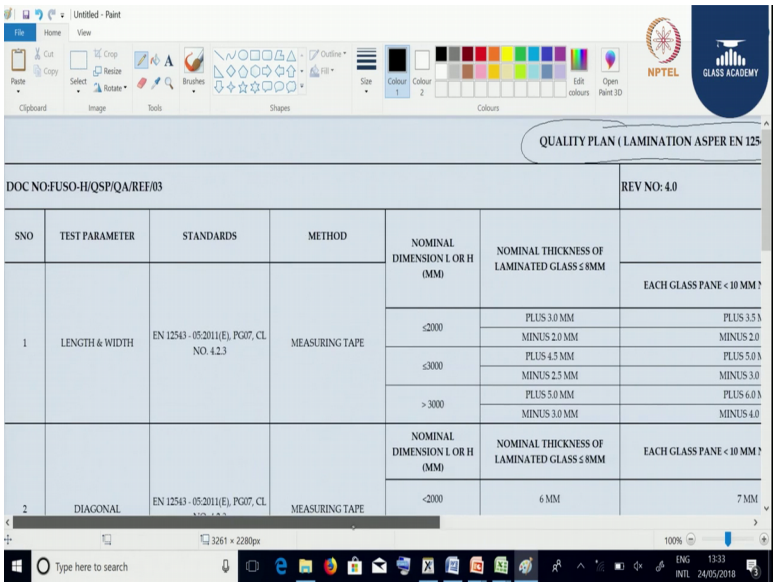

The test parameters what we use in lamination are Length and Width the standard what we are going to follow is EN 12543 part 5 page number 7 and clause number 4.2.3 and the method what we use is a measuring tape. Here, how we are going to measure the length and width tolerances?

If my panel size is less than or equal to 2000 and my nominal thickness of the laminated glass is less than or equal to 8 mm plus 3 mm is allowed or minus 2 mm is allowed or if nominal thickness of laminated glass is more than 8 mm that is each panel glass pane is less than 10 mm nominal thickness. Then plus 3.5 mm is allowed and minus 2 mm is allowed and for the at least one pane of glass is more than 10 mm thickness nominal thickness plus 5 mm is allowed and minus 2.5 mm is allowed.

In the similar way, if my panel size is less than or equal to 3000 mm and for the nominal thickness of the laminated glass less than or equal to 8 mm plus 4.5 mm is allowed and minus 2.5 mm is allowed and for each glass pane, less than 10 mm nominal thickness plus 5 mm is allowed or minus 3 mm is allowed. And for at least one glass pane, greater than or equal to 10 mm nominal thickness plus 4.5 mm is allowed and minus 3 mm is allowed.

In the similar way, if my panel size is more than 3000 mm and for the nominal thickness of the laminated glass less than or equal to 8 mm, plus 5 mm is allowed and minus 3 mm is allowed, as per the standard EN 1 2 5 4 3 and for the each pane of glass, less than 10

mm nominal thickness plus 6 mm is allowed and minus 4 mm is allowed. In the similar way if at least one glass pane is more than or equal to 10 mm nominal thickness plus 5 mm is allowed and minus 3.5 mm is allowed and the frequency of testing shall be 1 number in every 10 numbers.

The next test parameter what we are going to check is the diagonal and the standard what we follow is EN 1 2 5 4 3 part 5 and the tool what we use is a measuring tape if when dimension of the glass is less than 2000 and the nominal thickness of the laminated glass is less than or equal to 8 mm, 6 mm diagonal is allowable. And each glass pane less than 10 mm nominal thickness seven mm is allowed and for the each glass pane more than 10 mm nominal thickness, 9 mm is allowed. In the similar way, if my glass panel is less than 3000 mm diagonally and nominal thickness of the laminated glass is less than or equal to 8 mm, 8 mm is allowed and for each glass pane less than 10 mm nominal thickness, 9 mm is allowed and for at least one glass pane with the glass pane greater than or equal to 10 mm nominal thickness, 11 mm is allowed.

If my diagonal measurement is more than 3000 mm for the nominal thickness of the laminated glass less than or equal to 8 mm, 10 mm is allowed. For each glass pane less than 10 mm, nominal thickness 11 mm is allowed and for at least one glass pane more than 10 mm, nominal thickness 13 mm is allowed and the frequency of testing shall be 1 number in every 10 numbers.

The next test parameter that is the thickness, the standard what we follow is EN 12543 part 5 and the thickness where how we are going to measure is through the help of micro meter and we need to understand what is the interlayer thickness. If my interlayer thickness is less than 1 mm, the tolerance allowed is 0 plus or minus 0.4 mm. If my interlayer thickness is between 1 to 2 mm, the tolerance is plus or minus 0.5 mm. If my interlayer thickness is between 2 to 3 mm, the tolerance is plus or minus 0.6 mm. If my interlayer thickness is more than 3 mm, the tolerance is plus or minus 0.7 mm and this is also the frequency of testing shall be 1 number in every 10 pieces of glass.

Next, let us understand the next test parameter that is that is the displacement or the offset. The standard what we follow is EN 1 2 5 4 3 4 5 and generally we do we measure the displacement through visually or with the measuring tape. Here, also we need to understand the nominal dimensions the displacement is always dependent on the

dimensions of the glass. If my panel size is less than or equal to 1000 and the maximum displacement allowed is 2 mm, if my panel size is between 1 to 2000 mm, the displacement allowed is 3 mm. If my panel size is between 2 to 4 mm, the displacement allowed is 4 mm and if my panel size is more than 4000 mm, the maximum permissible displacement is allowed is 6 mm; this displacement we will be measuring for every glass.

Now, let us understand the spot defects and the standard what we follow is EN 1 2 5 4 3. This spot defects also we will do through visual or through measuring tape, here we need to understand size of the defect. What is the size of the defect first we need to understand. Size of the pane we need to understand and the number or density of the permissible defect. So, here we need to consider three parameters and if my size of the defect we need to understand whether the size of the defect is between 0.5 and 1 or it is between 1 to 3 and size of the panes.

Let us understand everything one by one. If the glass is having two panes of glasses are laminated and if my area is less than or equal to 1 square meter spot defects allowed are 1 and if my area is between 1 to 2 square meter, 2 are allowed and if my area is between 2 to 8 square meter, 1 square meter is allowed and if my area is more than 8 square meter, 1.2 per square meter is allowed.

Similarly way, lamination is done with the help of three panes and the area of the laminated glass is less than 1 square meter, then two spots defects are allowed. If the area is between 1 to 2 square meter, 3 spot defects are allowed. If the area is between two less than or equal to 8, 1.5 square meter is allowed and if it is more than 8 square meter, 1.8 per square meter is allowed. In the similar way, for 4 panes and 5 panes also we can understand these values and the frequency of testing, this spot defects shall be measured for every glass.

Now, let us understand the linear defects. The linear defects what we follow in the standard is EN 12543. The linear defects also we will understand through visual or measuring tape. Here also we need to see the area of the pane and the number of permissible defects. If you see the area of the pane is less than or less than or equal to 5 square meter and the number of permissible defects is more than 30 mm length, it is not allowed. For the area between 5 to 8 square meter only one number of permissible defect with more than 30 mm in length is allowed. If the area of the pane is more than 8 square

meter, two number of permissible defects with more than 30 mm length are allowed and the frequency of testing shall be for every glass.

Now, let us take the next test parameter that is the short interlayer that is known as PVB shrinkage. The standard what we follow is E I S 2 5 3. It is also through visual and measuring tape. Here, we need to understand if it is less than 3 mm from the edge, then only it is allowed, otherwise it is not allowed and the frequency of testing shall be for every glass. Along with all these parameters, here we need to focus on other water quality also in order to maintain the good adhesion between the glass and the PVB.

So, the water parameters like PH, TDS and conductivity that has to be taken care PH should be 6 to 8, TDS should be 0 to 20 milligram per liter and conductivity shall be 0 to 20 Microsiemen per Centimeter along with the water quality. We need to maintain the temperature and RH values also in the layup room. The temperature should be less than 25 degree centigrade and the RH should be less than 25 percent in order to have a good adhesion and the durability on the glass and the frequency of testing shall be the measurement of these water readings as well as there RH and temperature shall be three times per shift or based on the load production that we need to decide. Now, let us understand the defects that are going to arise in lamination process.

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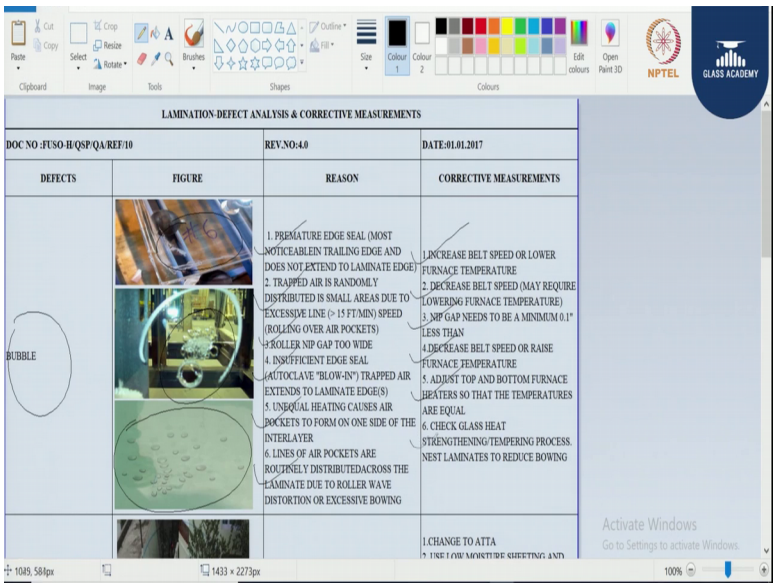

So, the general common defects are bubbles. You can see in figure the glass has got bubbles whether it is with respect to edge bubbles or whether it is with respect to whole

bubbles or on the surface of the glass. The reasons being premature edge seal most noticeable in trailing edge and does not extend to laminate edge or trapped air is randomly distributed in small areas due to excessive line, line speed. Or roller nip gap too wide or insufficient edge seal, trapped air extends to laminated edges or unequal heating causes air pockets to form on one side of the interlayer or lines of air pockets are routinely distributed across the laminated due to roller wave distortion or excessive bowing. So, these are the reasons that may cause the bubble defect to be appear on the glass.

The corrective measurements what we can do is increase the belt speed or lower furnace temperature; decrease the belt speed may require lowering furnace temperature. Nip gap needs to be a minimum 0.1 inch less than, decrease belt speed or raise the furnace temperature, adjust top and bottom furnace heaters so that the temperatures are equal, check glass heat strengthening or tempering process next laminates to reduce bowing.

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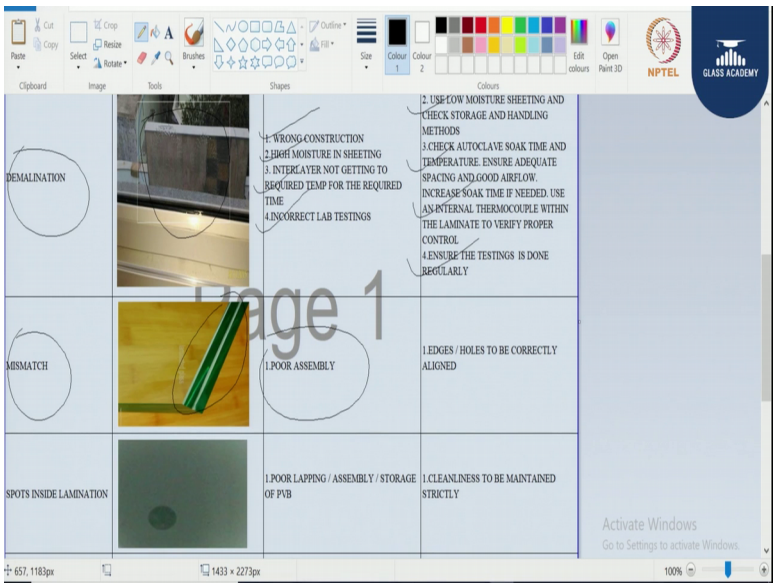

The next defect what we are going to is delamination means, the glasses got heavier bubbles which cause to delamination which defect is known as sunburst bubbles. The reason being wrong construction, the laminated glass consists of two panes of glasses shall be only annealed or H S H S or toughened. It should not be a combination of anyone of the above. The individual thickness of the glass panes should be equal or if required to be asymmetrical, it should be not more than 2 mm and third point the PVB

thickness that is required for laminated glasses it is generally is equal to the roller wave into 10.

So, the reasons for getting a delamination is because of wrong glass construction or higher moisture in sheeting, interlayer not getting to required temperature for the required time or incorrect lab testings. We can overcome this issues by change into the glass combinations like air side tin side, tin side air side. Use low moisture sheeting and check storage and handling methods, check autoclave soak time and temperature, ensure adequate spacing and good air flow. Increase soak time if needed. Use an internal thermocouple within the laminate to verify proper control, ensure the testing is done regularly. Through the lamination test bake test or boil test, we should ensure that the process parameters are maintained always.

And the next defect what we get is the mismatch or a displacement or offset. You can see the edges of the glass got mismatched. This is because of poor assembly can overcome this issue by matching the edges and holes to be correctly aligned.

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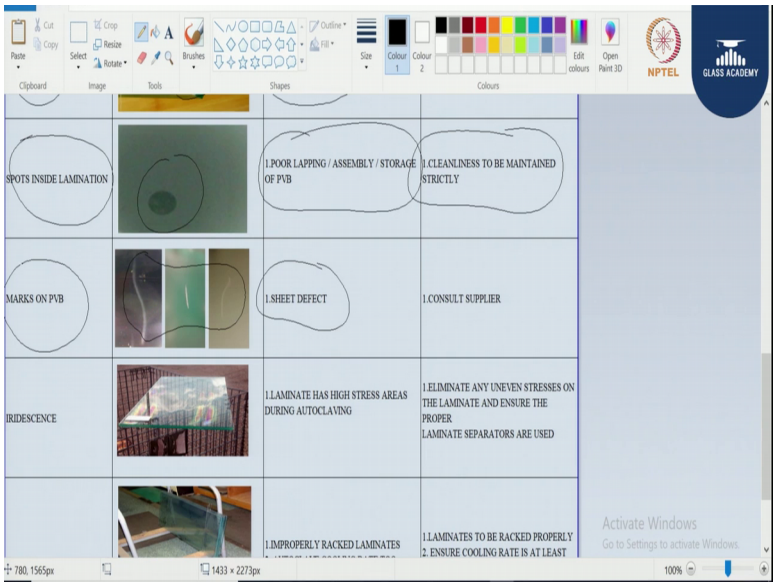

The next issue spots inside lamination, spots inside lamination. You can see the spot on the lamination this is because of poor lapping or assembly or storage of the PVB. We can overcome this issue by cleanliness to be maintained, we can overcome this issue by maintaining the layer clean.

Next defect what we are going to get is PVB layer itself. You can see the layer got this marks on the sheet. The sheet itself is defective. In such cases it should be consulted with the supplier. Next defect is known as iridescence, you can see the rainbow effect on the glass. The reason being laminate has high stress areas during the autoclaving. We can overcome this issue by eliminate any uneven stress on the laminate and ensure the proper laminate separators are used.

Next defect what is going to arise is high haze. You can find here in the figures there is a high haze on the glass. This is because of improperly racked laminates or autoclave cooling rate too slow or non uniform. We can overcome this issue by laminates to be racked properly; ensure cooling rate is at least 4 degree Fahrenheit per minute with good abstractor airflow. Now, we are going to see the test that we do for laminated glass. Let us take boil test.

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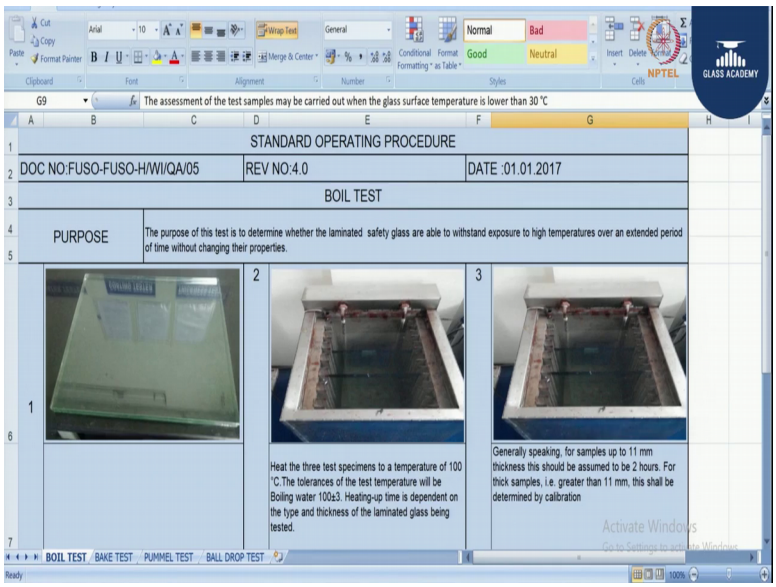

The purpose of this test is to determine whether the laminated safety glass are able to withstand exposure to high temperatures over an extended period of time without changing their properties.

The steps what we do is first we will be taking a laminated glass, first we will be taking a laminated glass and we need to have a boil test chamber. Here what we do is first will be placing the, we will be taking inside the boil test chamber we will be filling with water and we are going to keep the temperature of the water at 100 degree centigrade and we

will be placing these glass samples inside the water for 2 hours. We will be opening the glass you can see in the figure the temperatures. First figure will show you it is a laminated glass, the second figure will show you the glasses are kept inside the boil test chamber, the third figure you can see the temperature of the glass is maintained at 100 degree centigrade for 4 hours. In the fourth figure also, you can see the temperature and fifth you can see with the help of thermometer also you can measure out there is a 100 degrees the temperature of the water and once the two hours is completed at 100 degree centigrade we will be removing the glass from the boil test chamber and with the background we will be trying to inspect the glass for bubbles, haziness and discolouration.

The result what we can see is inspect the test specimen at a distance between 30 Centimeter to 50 Centimeter in front of a wide diffused background, record the number and extent of faults occurring in the interlayer in the form of bubbles, delamination, cloudiness, discolouration for each test specimen. Bubble area should not exceed 5 percent of the edge area that is 15 mm for less than 5 square meter glass and 20 mm for more than 5 square meter glass and maximum bubble dia shall not exceed 5 mm. A sample showing cracks shall be discarded and other test specimen shall be tested again.

Next, we will be understanding the next test that is used for temperature that is the bake test. In bake test what we are going to see is the purpose of this test is to determine whether the laminated safety glass is able to withstand exposure to high temperatures over an extended period of time without changing its properties.

First what will be do is we will be taking a bake test oven and inside the bake test oven, we will be placing the glasses at 100 degree centigrade for 16 hours then gradually every 1 hour we are going to increase the temperature by 10 degrees. For example, if I am keeping the glass at 100 degree centigrade for 16 hours, on the 17th hour, I will be keeping 110 degree centigrade; on the 18th hour, I will be keeping 120 degree centigrade, like that every hour I am going to increase 10 degree temperature and I will be taking out the glass inspecting and again placing back in the oven for bubbles or any discolouration.

At a particular temperature, the bubbles started to form. I will be noting the temperature the minimum temperature that glass has to withstand is 135 degree centigrade and

beyond 135, I need to see up to what level my glass is able to withstand. So, basically with the help of bake test, I am able to see the durability of the glass for a high temperature.

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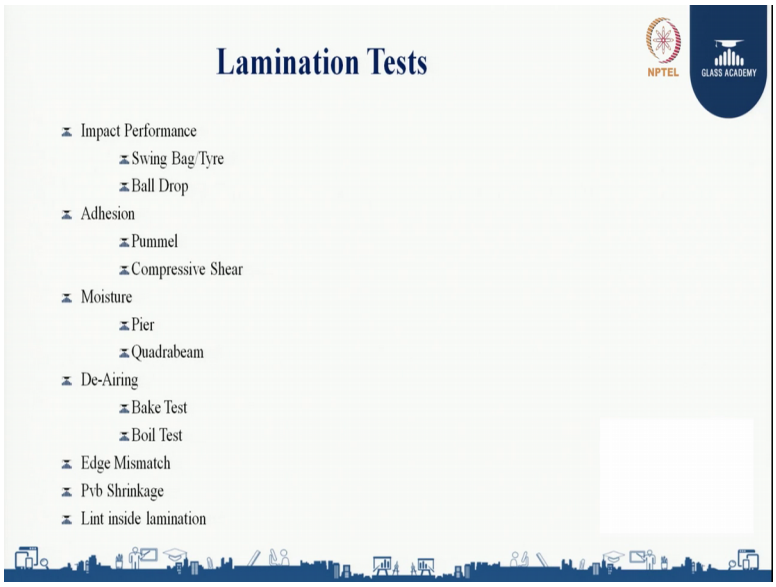

Now, we are going to see the lamination test. If you see basically we will be focusing on impact performance that is with respect to swing bag or tyre test and ball drop test or fracture adhesion test. When it comes to adhesion, we will be checking formal test and compressive shear test. When it comes to moisture, we will be checking with pier and quadrabeam test. When it comes to de airing, we will be checking bake test and boil test. Along with this, we will be checking edge mismatch, PVB shrinkage and lense lint or dust inside lamination, these are all visual inspections. Now, let us take each one by one.

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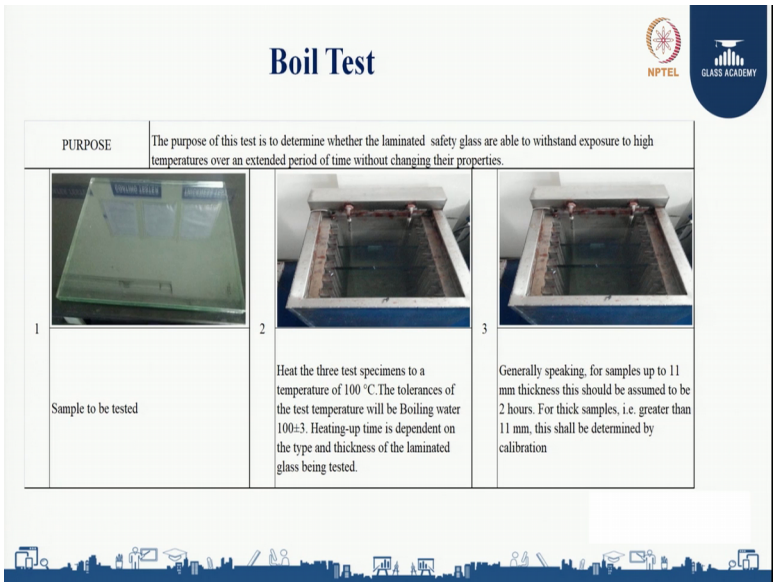

Boil test; the purpose of this test is to determine whether the laminated safety glass are able to withstand exposure to high temperature over an extended period of time without changing its properties. If you see first we need to take a sample which has to be tested after lamination, next we will be placing the sample in a boiling chamber of 100 degree centigrade. You can see in the second figure heat the 3 test specimen to a temperature of 100 degree centigrade, the tolerances of the test temperature will be boiling water 100 degree plus or minus 3 degree centigrade; heating time is dependent on the type and the thickness of the laminated glass being used.

Next, generally speaking for sample up to 11 mm thick, they should be assumed to be 2 hours. For the thick samples that is greater than eleven mm, they shall be determined by calibration. So, it is basically talking about the overall thickness of the lamination and duration of the temperature.

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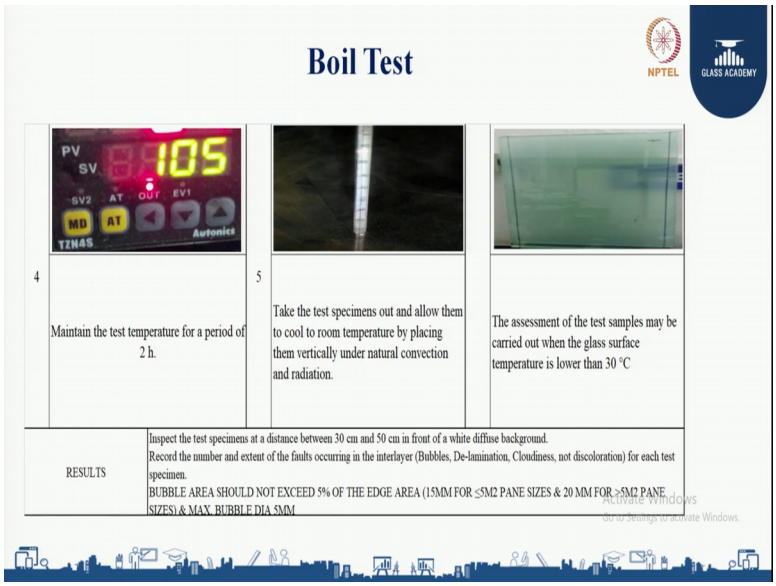

If you see in the fourth slide, it is saying maintain the test temperature for period of 2 hours; in the digital meter you can see now the temperature is say 200 degrees and we need to be maintain for 2 hours. Take the test specimen out and allow them to cool in the 5th figure you can see even with the help of thermometer also we can measure the boiling water temperature and once the glass has been boiled for 2 hours at 100 degree centigrade, now we need to take out the sample. Take the test specimens out and allow them to cool to room temperature by placing them vertically under natural convection and radiation system.

How we need to absorb or make a conclusion; the assessment of the test samples may be carried out when the glass surface temperature is lower than 30 degree centigrade and how we are going to conclude and give the result. Inspect the test specimen at a distance between 30 centimeter and 50 centimeter in front of a white diffused background, record the number and extent of the faults occurring in the interlayer that is in the form of bubbles, delamination, cloudiness, not discolouration. For each test specimen, bubble area should not exceed 5 percent of the edge area. In general 15 mm for less than 5 square meter panel size and 20 mm for more than 5 square meter panel size and the maximum dia of the bubble shall not exceed 5 mm. So, this is about boil test.

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Now, let us take one more test that is a Bake Test. The purpose of this test is to determine whether the laminated safety glass is able to withstand exposure to high temperatures over an extended period of time without changing their properties. If you see for this one, we need to make a test oven that is high temperature test may be carried out by using an oven. The tolerance of the test temperature will be 100 degrees plus or minus 2 degree centigrade. If you see in the second photograph, heat the test specimen to a temperature of 100 degrees. We need to place it into test oven and we need to heat the glasses at 100 degree centigrade for 16 hours.

In an oven, the heating of time is dependent on the load, type and the thickness of the laminated glass being tested. Maintain the test temperature for a period of 16 hours, we need to take samples of laminated glass, we need to place it inside an oven and we need to heat at 100 degree centigrade for 16 hours.

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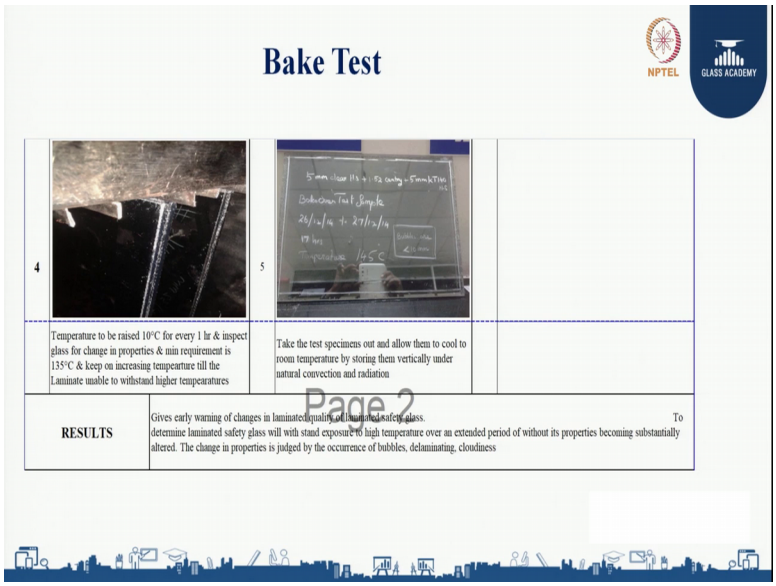

Temperature to be raised 10 degrees for every 1 hour and inspect the glass for change in properties, so, in if you see the fourth photo, what the procedure we need to make is suppose my glass is kept it 100 degree centigrade for 16 hours, then after 16 hours, I need to take out the glass changes in the properties of the glass. If there is no change again on the seventeenth hour, I will be increasing the temperature from 100 to 110 degree centigrade and I need to come continue this process till when I found that my lamination glass is unable to withstand the high temperature. So, the minimum requirement is 135 degree centigrade and we need to continue this process that is every hour 10 degree rise in temperature and inspection and until the laminated is able to withstand high temperature. So, basically this is a durability test for a laminated product.

Once the test is oven and when we see that the bubbles are started to form, we need to take out the sample and make a note of the temperature. If you see in the fifth photograph, the test specimen is taken out and allow to cool to room temperature and it is absorbed under a wide diffused background. You can see this specimen was able to withstand 145 degree centigrade. With the conclusion or the result, what we can find in bake test is bake test gives an early warning of changes in laminated quality of safety glass, determines laminated safety glass with extended exposure to high temperature over an extended period of time, its properties becomes sustainable substantially altered, the change in properties is judged by occurrence of bubbles delamination and cloudiness.

So, in order to summarize in bake test, we are going to take a samples and we are going to heat it at 100 degree centigrade for 16 hours, then every one hour we are going to raise the temperature by 10 degree centigrade and we need to inspect the glass every hour. We need to make a note when the bubbles are started to form. So, the minimum requirement is 135 degree centigrade and we need to keep on testing until my glass is not able to withstand high temperature and bubbles are getting started to form. So, this is a durability test and through this test, we are ensuring that how our laminated glass is able to withstand over a high temperature and extended period of time and the change in properties in the form of bubbles delamination and cloudiness we can found.

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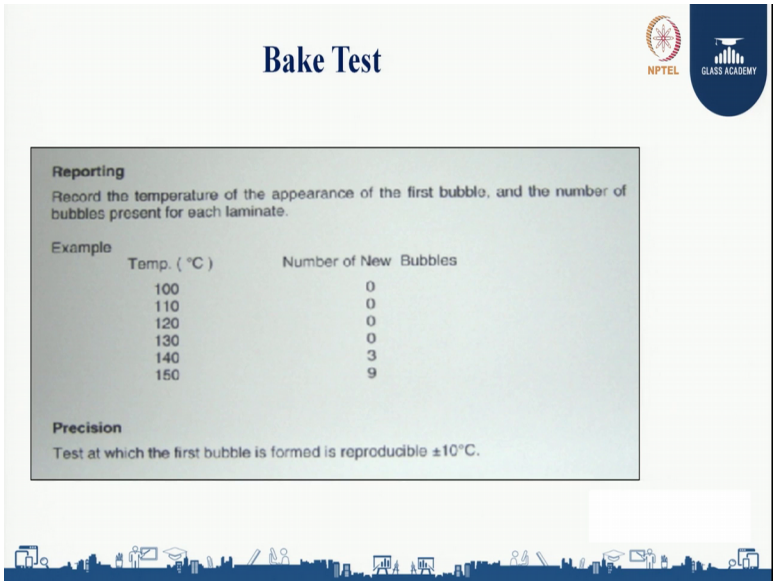

You can see in this report that the recording temperature of the appearance of the first bubble and the number of bubbles present for each laminate. For example, my temperature is at 100 degree centigrade and the number of bubbles were found to be 0, when I raised the temperature to 110 degree centigrade, the bubbles were still 0; at 120, 0; 130, 0; once 140 started, the I found there are three bubbles; at 150 there are 9 bubbles found. So, we need to understand the precision is test at which the first bubble is formed is reproducible at plus or minus 10 degree centigrade.

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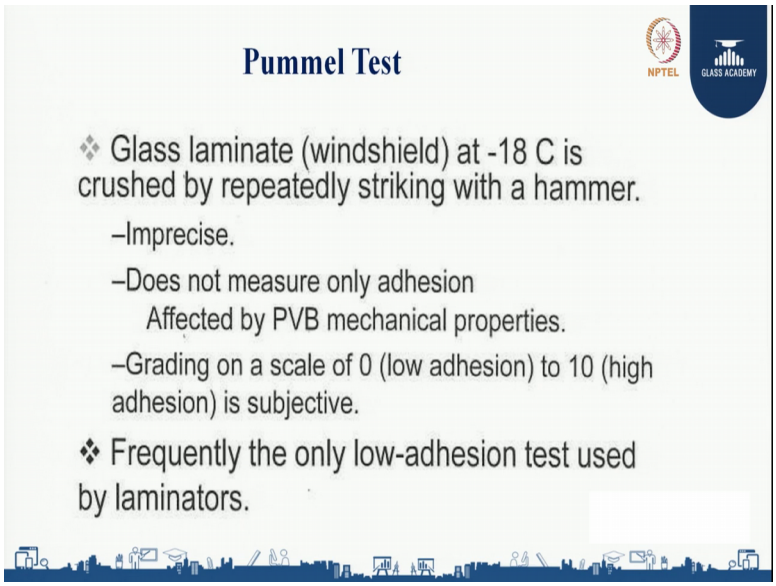

Now, let us take the Pummel test which is used for adhesion. So, this is the one more test that is used for laminated glass. So, Pummel test, the glass laminate at minus 18 degree centigrade is crushed by repeatedly striking with a hammer. The test is imprecise does not measures only adhesion affected by PVB mechanical properties, grading on a scale of 0 that is low adhesion to 10 that is the high adhesion and is subjective, frequently the only low adhesion test used by laminators.

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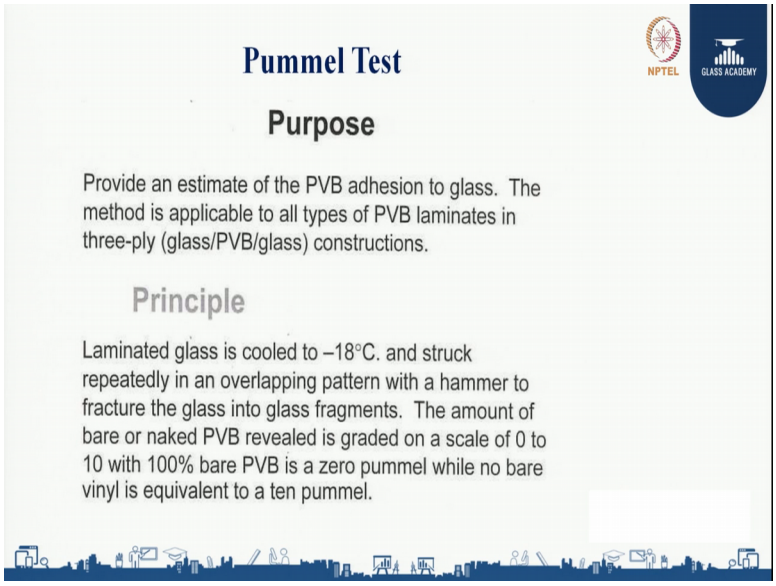

So, the purpose of this test is to provide an estimate of the PVB adhesion to the glass.

The method is applicable to all types of PVB laminates in three ply that is glass PVB and glass construction. The principle how it works is laminated glass is cooled to minus 18 degree centigrade for normal PVB and direct breakage for a sentryglas PVB and struck repeatedly in an overlapping pattern with a hammer to fracture the glass into small fragments. The amount of bare or naked PVB revealed is graded on a scale of 0 to 10 with 100 percent bare PVB is 0 pummel while no bare vinyl is equivalent to 10 pummel.

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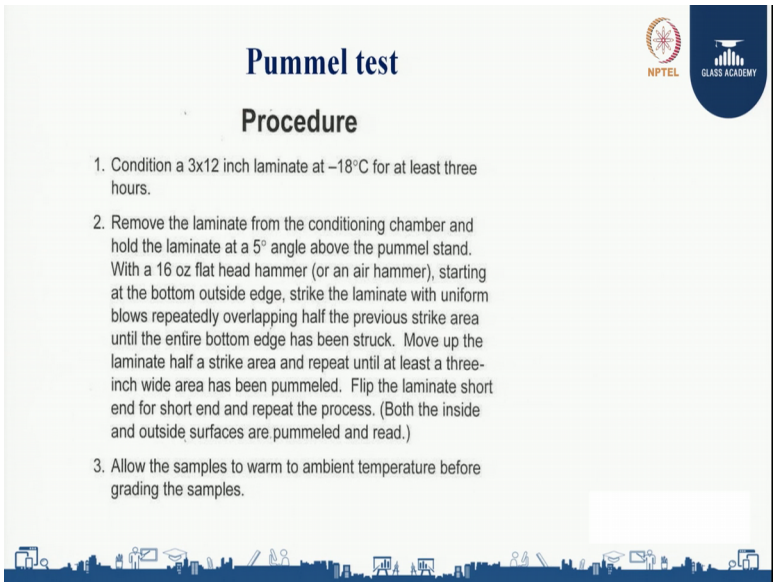

The procedure is 3 by 12 inch laminate at minus 18 degree centigrade for at least three hours is cooled, then remove the laminate from the conditioning chamber and hold the laminate at 5 degree angle above the pummel stand with a 16 oz flat head hammer or an air hammer; starting at the bottom outside edge. Strike the laminate with uniform blows repeatedly overlapping half the previous strike area until the entire bottom edge has been struck, move up the laminate half a strike area and repeat until at least a three inch wide area has been pummelled. Flip the laminate short end and repeat the process, both the inside and outside surfaces are pummelled and read. Allow the samples to warm to ambient temperature before grading the samples.

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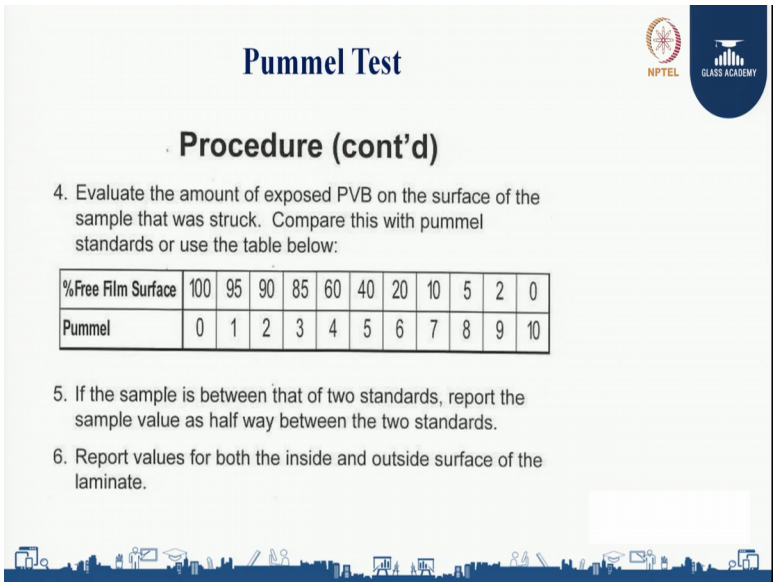

Evaluate the amount of exposed PVB on the surface of the sample that was struck, compare with this pummel standards or use the table below. For example, if 100 percent free film surface that is 100 percent is I am able to see the PVB it is graded as 0 pummel; when I am able to see 95 percent of the PVB, then it is graded as first pummel 1. 90 means, if the percentage of film surface is 90, it is graded as pummel 2. I am not able to see the PVB means it is graded as highest pummel. If the sample is between the two of the standards report the sample value as the half between the two standards. For example, if my pummel is matching between 5 and 6, it should be considered as 5 and half, report the values for both the inside and outside surface of the laminate.

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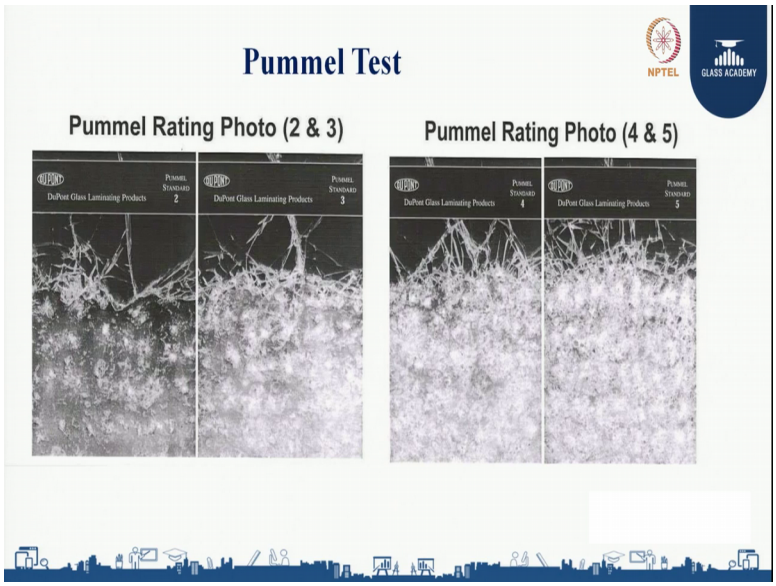

You can see in the photos this is the pummel rating photographs 2 and 3 where you can see you are able to see there is no adhesion between the glass and the PVB, the similarly you can see Pummel ratings photos 4 and 5, Pummel rating photo 6 and 7, Pummel rating photos 8 and 9.

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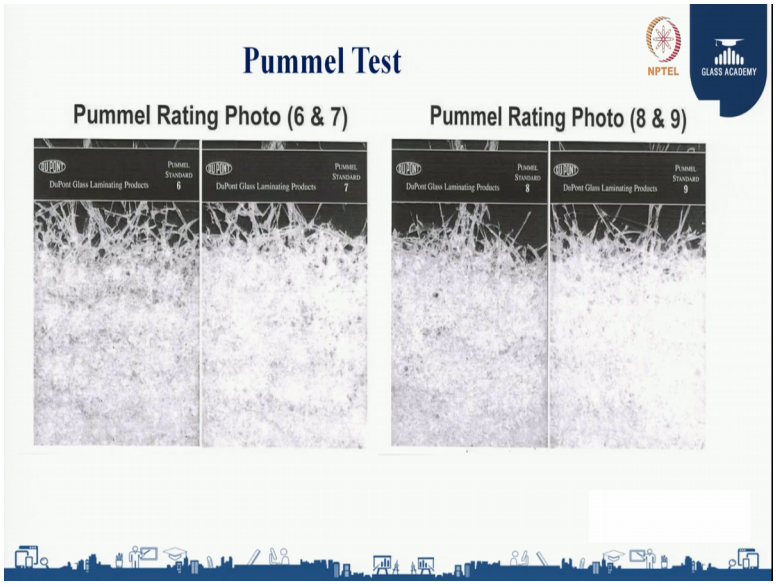

If you see nine which is the highest pummel rated graph, you can see there is a very good bonding between the glass and the PVB.

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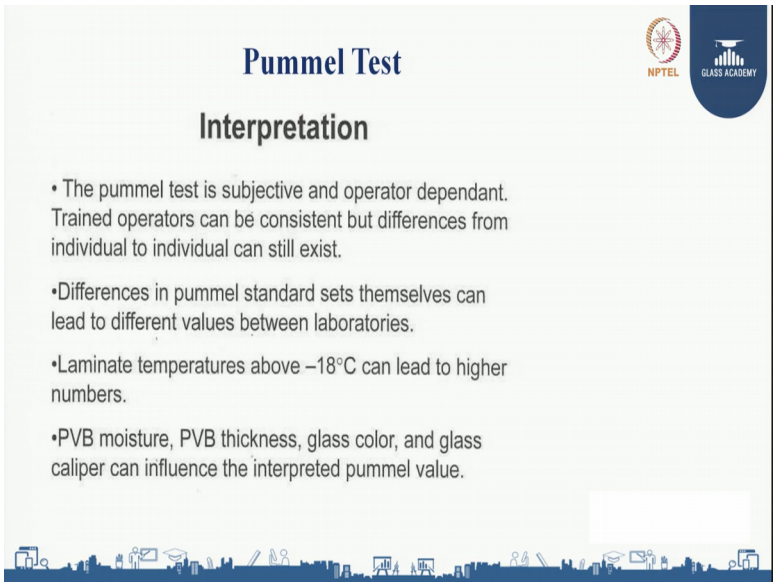

But this pummel test is not a standardised 1 because the pummel test is subjective and operator dependent; only trained operators can be consistent but differs from individual to individual can still exists.

Differences in pummel standard sets themselves can lead to a different values between laboratories. Laminate temperatures above minus 18 degree centigrade can lead to a higher number. PVB moisture, PVB thickness, glass colour and glass caliper can influence the interpreted pummel value. In order to make a pummel test for a sentry glass lamination we need to check in the laboratory the different types of glass combinations like air side tin side, tin side air side, air side tin side, air side air side. So, all the ATTA, TAAT, all these combinations we need to make sure and we need to assure that in a particular combination or glass construction we are having a good pummel. Generally, the suppliers can help you in finding the pummelling of your lamination product.

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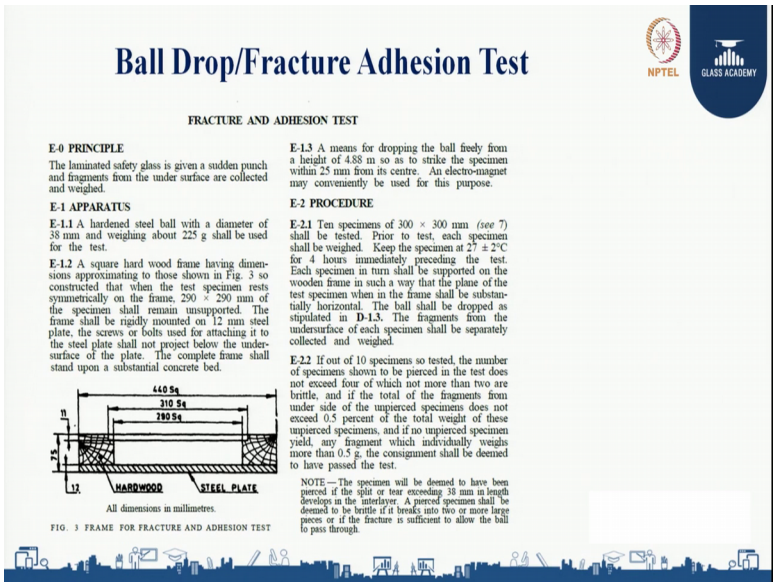

Next test what we do in our laboratory for lamination is the Ball Drop or Fracture Adhesion Test. So, the purpose of the ball drop or fracture adhesion test is the laminated glass is given a sudden punch and fragments from the under surface are collected and weighed. In order to setup this test we need to have a steel ball with a 38 mm dia weighing about 225 grams and we need to have a setup of square hardwood frame have an dimension approximately to those as you can see in the figure.

And the procedure is we need to drop a ball freely from a height of 4.88 meter so that it strikes the specimen within 25 mm from its centre. We need to in order to perform ball drop test we need to have 10 test specimens of 300 with 300 mm, prior to test each test specimen shall be weighed, keep this specimens at twenty seven degree centigrade for 4 hours immediately preceding the test. Each test specimen is turned shall be supported on a wooden frame as you can see in the figure.

Out of 10 specimens so tested the number of specimens shown to be pierced in test does not exceed more than two are brittle and if the total of the fragments from the underside of the unpierced specimen does not exceed 0.5 percent of the total weight of this unpierced specimens. And if no unpierced specimen yield any fragment which individually weighs more than 0.5 grams, the consignment shall be deemed to have passed the test. Basically, we need to understand when I drop a ball from a distance of 4.88, how the ball is going to perform on the laminate; whether it is going to penetrate or

it is going to stick or it is going to tear the PVB and we need to collect the number of fragments from underneath the laminate sample and we need to weigh and we need to check and the weight shall not exceed 0.5 percentage of the weight of the glass.

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You can see here this is the setup for ball drop test. We will be dropping 38 mm dia 225 gram ball from a distance of 4.88 meter and you can see in the second photograph how it is going to impact the laminated glass.

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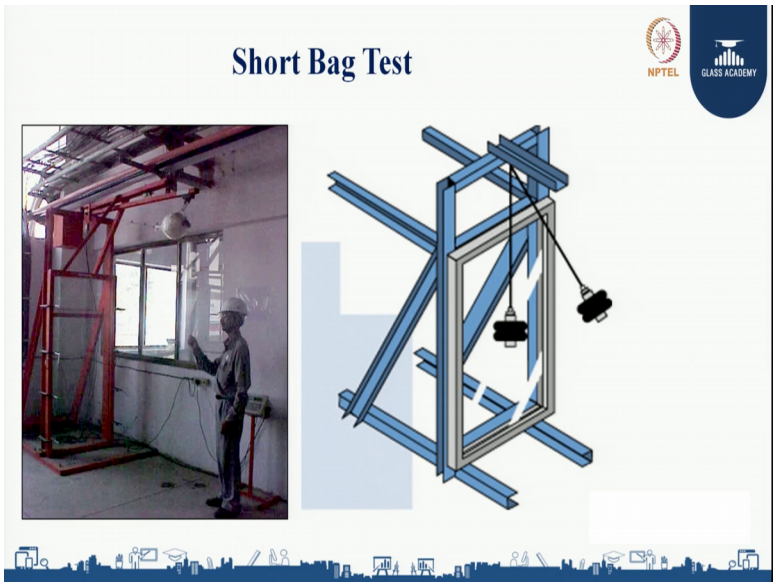

In a similar way, the other test what we do for lamination is the short bag test; you can

see in the photo the setup used for the short bag test.

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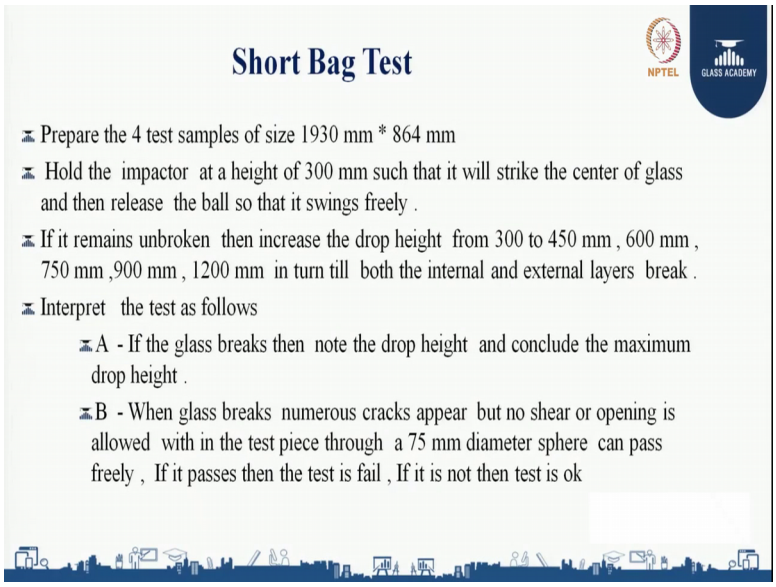

Here also, in order to perform this test we need to have 4 test samples of 1930 by 864 mm, we need to hold the impactor at a height of 300 mm such that it will strike the centre of the and centre and then release the ball so that it swings freely and if the glass remains unbroken and then increase the drop height from 300 to 450 in a similar way 600, 750, 900, 1200 in turn till both the internal and external layers break.

The interpretation of the result shall be A, if the glass breaks then note the drop height and conclude the maximum drop height; B, when the glass breaks numerous cracks appear, but no shear or opening is allowed within the test specimen through a 75 mm diameter, sphere can pass freely. If it passes, the test is fail. If it does not, then the test is ok, this is how we are going to do short bag test.

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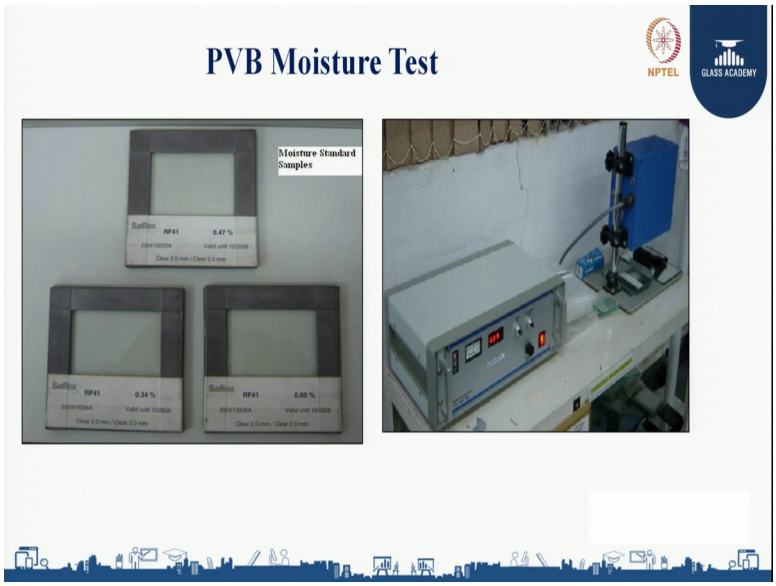

One more test that is used, that is the PVB moisture test. PVB moisture test, this is the equipment what we use for PVB moisture test, you can see here the moisture test.

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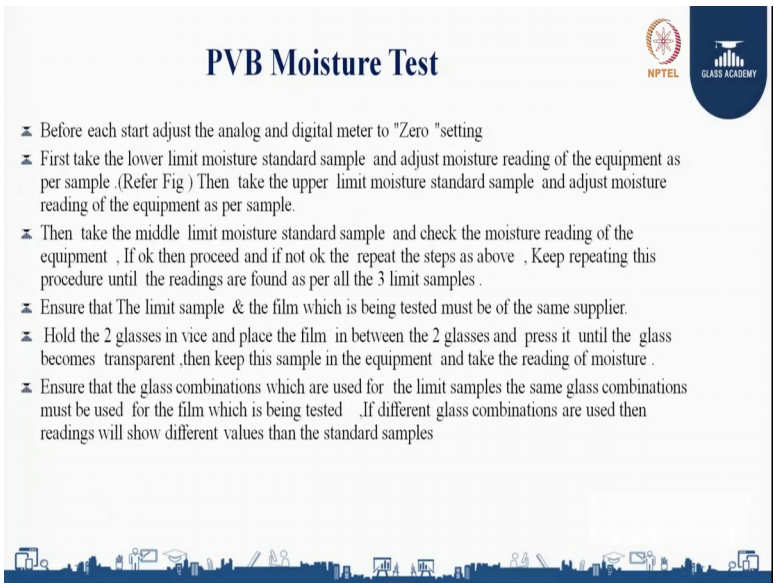

In order to perform this test, we need to adjust the analog and digital meter to 0 setting. First take the lower limit moisture standard sample and adjust moisture reading of the equipment as per sample then, the upper limit moisture standard sample and adjust the moisture reading of the equipment as per the sample. Then take the middle limit moisture standard sample and check the moisture reading of the equipment. If ok then proceed; if

not ok, then repeat the steps as above. Keep repeating this procedure until the readings are found as per all the three limit samples.

Ensure that the limit sample and the film which is being tested must be of the same supplier. Hold 2 glasses in vice in vertical place, hold the 2 glasses and place the film in between the 2 glasses and press it until the glass becomes a transparent then keep this sample in the equipment and take the reading of the moisture.

Ensure the glass combination which are used for the limit samples of the sample glass combinations must be used for the film which is being tested. If different glass combinations are used, the readings will follow different values than the standard samples. This is how we are going to stress the moisture levels in the PVB.

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You see here, there is just impact and there is no penetration to the glass. Just we can see the impact only. So, this is the good laminated product. If at all the ball is penetrating the glass and tearing the PVB and coming out of the other glass that is a poor laminated glass. Now in this case, the glass has impacted and just it is and there no tear to the PVB. So, this is one of the test that is applicable for a laminated product known as boil test. The purpose of this test is to check over an extended period of temperature how the laminated glass is going to perform with respect to bubbles, delamination and safety aspects. The SOP for this one is we have kept the laminated glasses at 100 degree centigrade for 2 hours inside the boiling water, you can see the temperature now it is 95

degree centigrade.

Now, we are going to open this boil test chamber. Now, we need to take out the glass and we need to inspect the glass for delamination or bubbles and discolouration. So, you are able to see there is no delamination and no discolouration and no bubbles found on the laminated glass. So, this boil test will determine the tearing process. Once the glass came out from the boil test chamber, we need to inspect the glass for the bubbles discolouration and delamination. Through this sample we are not able to find any delamination or discolouration and bubble and more over we are able to find the boil test will determine the de airing process of the lamination process.