Glass in Buildings: Design and Application
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Lecture – 67
Performance Testing for Facades – Part II

And, then you come to the last which is the proof load test.

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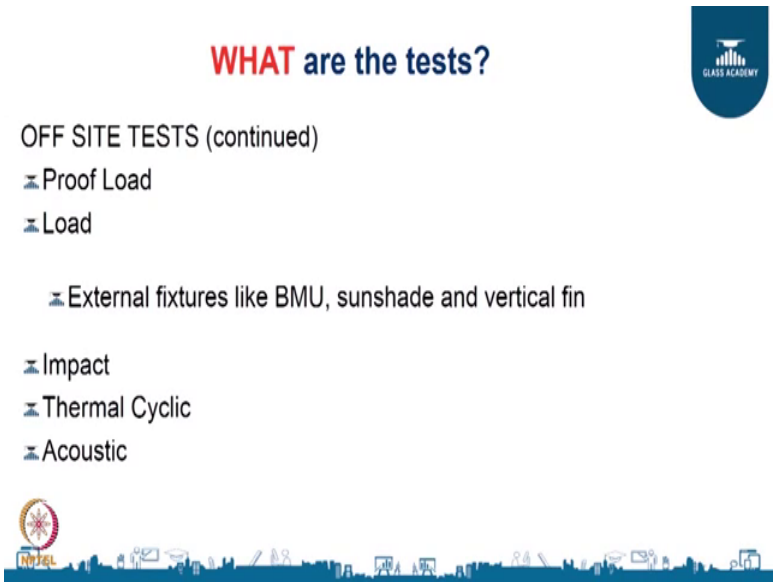

Proof load basically is the safety test let us say sample mock up is designed for 2 kPa windloads. So, what happens is that nowadays we find unexpected you know levels of activity in winds, the cyclonic pattern is different weather patterns are changing and the windloads are increasing in certain areas. So, this is the safety test basically which is to put 1.5 times or 100 and 50 percent the design load pressure on the curtain wall on the positive and the negative. There are no measurements, it is again a visual just to see if all the elements in the curtain wall are there and the integrity of that entire structure is there physically.

So, it is very important to ensure that in the worst combust scenario the glass does not fly off or the system does not buckle or the hardware does not give up. So, the proof load is a very critical test to put it on worst combust scenario and then if that passes then you are absolutely sure that whatever happens this thing is not going to fall down.

And, then you have you know the building maintenance unit BMU you must have seen people hanging coming down in a building to clean it on the using a gondola. So, you also have a BMU pull out because these tall buildings when the gondola comes down from the roof it because of the winds it is start to sway. And in order to avoid the sway they put in pins every 20 feet and the wire, the steel wire is actually locked into that BMU pin so that does not sway. So, that is exerting certain loads on that pin and then in turn getting transferred to the curtain wall of the façade.

So, what we do is actually physically you know the pin is fixed in the sample and you do a load test on all the five directions – left, right, top, bottom and outwards to ensure that the same amount of load which is actually transferring itself from the gondola we replicated by adding certain safety factors to that. So, around 2.5 kilo Newton of load is added and pulled in all directions, the pin should not give wave, neither should the curtain wall move too much and it should not be able to they should not be any damage to the curtain wall.

Then, we do an impact, an impact and I just to simulate let us say there are you have the vision panel if you look at the curtain wall or a facade from inside the building, you have up to the seal level you may have a opaque structure I mean I can have a glass which is which is not visible, but from here till the wall sealing you will have a vision panel. So, or some of the buildings right from the floor to the top you have vision panel that is the glass is clear glass or reflective glass.

So, what happens if somebody walking on the corridor tips and falls on the glass. The impact of the person falling how much of joules of load is energy is getting impacted and whether the glass panel is able to take that load. So, we simulate by adding by dropping a weight which is hanging from the roof we pull it back and then let it fall and that creates a certain amount of kilo Newton's of impact and with that impact the glass should not shatter. So, that is the pass-fail criteria again.

Thermal cyclic test is also becoming very important in a country like India where in certain areas say up north in Delhi and UP and all these Punjab in those areas where the temperature difference in during the winters and the high temperatures during the summer is quite very very extreme.

So, what happens is because of this the wind the climatic conditions there are certain

amount of linear expansion and contraction. So, because the curtain wall or a facade has glass, it has aluminium, it has rubber, it has gaskets, it has silicone and all these things are expanding and contracting because of the temperature. So, we need to create a similar such kind of conditions. So, what we do is to have a curtain wall sample and we have an insulated box let say one and half floors high or two floors high and this box is the actual outside in a real life situation and we create an atmospheric condition in side that box and that is in turn affecting the curtain wall from the outside.

So, we come down you know chill it chill the box and bring the temperature down to let say 5 degrees or 3 degrees and then you increase it to 50 degrees, hold it for 6 hours come back to normal temperature atmospheric chill it down to 2 degrees hold it for 6 hours and then come back to normal. Like this you continue over a period of 3 or 4 days you have 3 cycles or 6 cycles and then after you do this you do a repeat of air and water just to check whether with all these expansion and contraction whether there are any holes which are appeared in the curtain wall. And if so, why and what is to be done to correct it?

Of course, acoustics you all know we have huge high rise buildings on main roads and the noise outside is pretty high and in generally an office or a house needs certain amount of low audio, I mean sound noise inside. So, you actually can measure how much of noise is coming through the facade and what can be done to reduce that sound. So, using the right kind of a glass, the right kind of a system and gaskets you can cut down quite drastically the amount of noise that is coming into the building. So, that is also you know you can simulate it by creating noise outside have a sample and measure the noise from the inside. So, acoustic testing is slowly gaining popularity in India.

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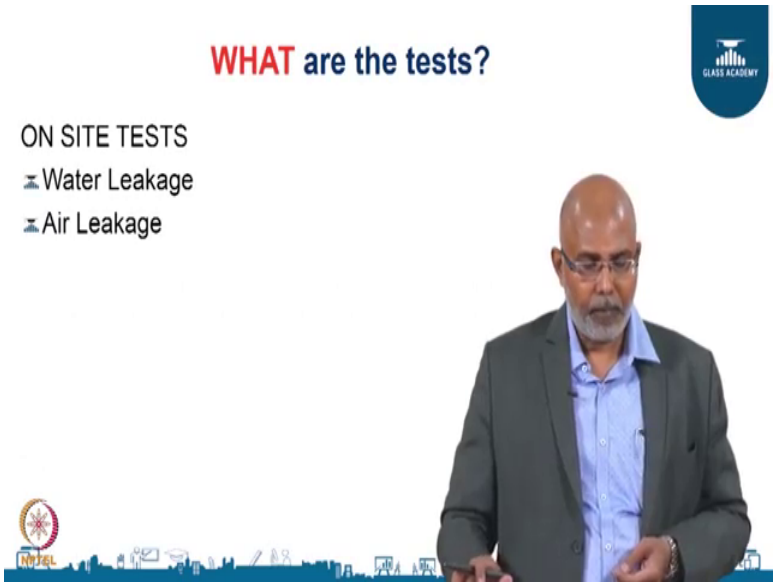

Now, on site; now once this offsite is done at the lab and everything is passed the architect in the consultants says, the sample is good to go, start production and then start installations. So, in order to ensure that the same kind of a care is taken at the site and to ensure the quality we do there are specifications again for checking the water and air at the site.

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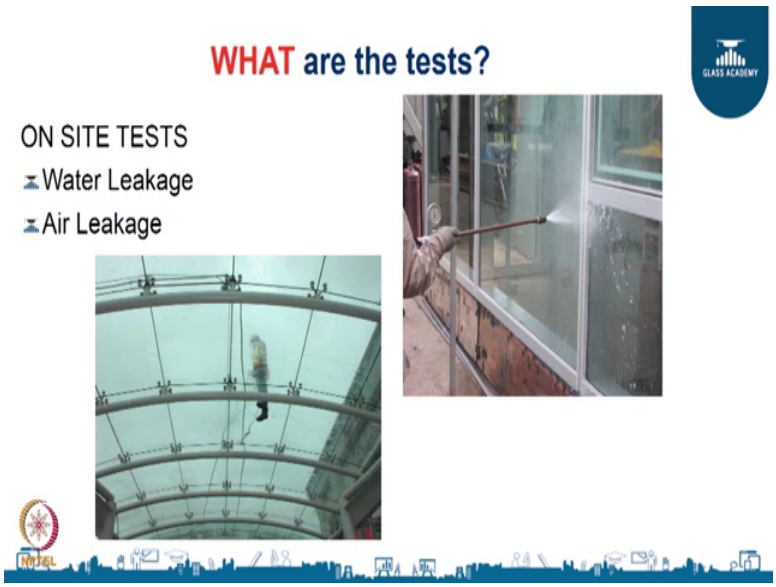

So, for water you have a specific nozzle as per AAMA 501.2 and there is a pressure gauge which is a calculated pressure gauge and we have a high pressure of water sprayed

in a particular pattern through this specified nozzle on the vertical and horizontal grooves and this is a random sample that will be selected by the architect, nobody knows which area is going to be tested, it could be any area. So, this testing starts and then only the vertical all the grooves are tested and typical sample is 3 meter by 3 meter and it takes about an hour and half to check all the vertical and horizontal joints of that particular sample and the people are standing inside the building and observing it obviously, the pass-fail criterias that no water should come inside.

And, for an air leakage in order to maintain do the air testing at site we need to build a small temporary chamber using a plywood, very thin plywood and then have a blowers connected there have a manometer to measure the differential pressure and have the spray of array of nozzles from outside just like we do it in the lab for 15 minutes. And check for water if it is a window and you have a airflow meter on the blower and that will measure the leak through the sample at the site. So, these two things are again done just to counter check whether it is matching with what has happened when the lab test was completed.

This is very essential, specially the water test is very essential for skylights which are used in public spaces because even a small hole on the top can lead to a lot of leakage in water and cause accidents on you know people slipping and falling or you know damage to property or the interiors of the building. So, onsite water tests are very important to ensure that consistency of delivery at the site can be ensured by the fabricator.

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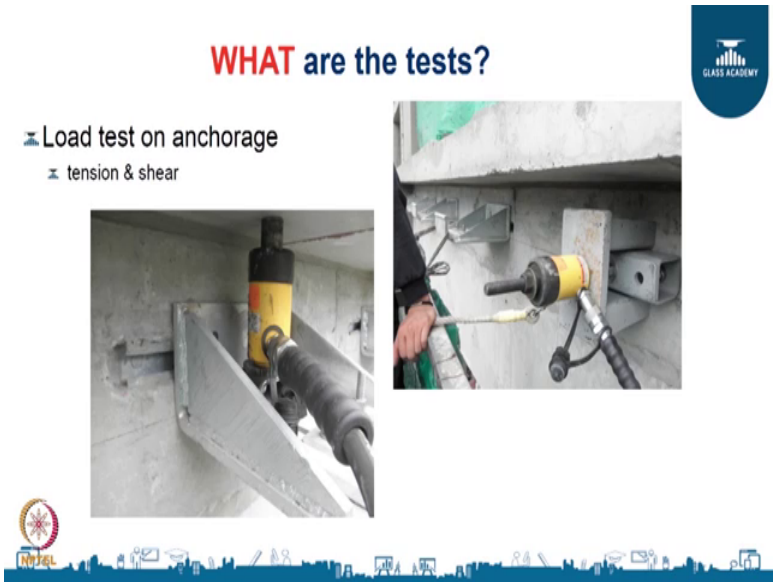

Then load test, basically you have the you know expansion bolts which are anchored into the concrete and those of the anchors which are holding the brackets and the entire facade is mounted onto these brackets. So, these lot of load on the particular anchor bolts. So, there are test to pull out and see whether the tests are able to the anchor bolts are able to take the load. So, those bolts are tested, on even those channels which are casting channels.

Nowadays people are casting the channels into the concrete whereas, when the concrete is cast and then the bolts are you know slit into the channel and then the bracket is installed on that particular channel. So, we do a pull out test and see whether channel is able to take that design load and there is no you know failure over there. And, also the shearing of that, you push the thing on the side and ensure that the bloat does not shear off because of the load vertical dead load.

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Now, which are the standards to apply? Now the most prominent standards in the world now, being used by consultants is the American standard which is the ASTM or AAMA or the Australian New Zealand standard ASNZ or the British European standard BS EN. Now, which standards are good which is bad I would say all of them are equally good and they have evolved over a period of time based on the requirements and based on the experience of these people had and they have improved constantly and upgraded constantly.

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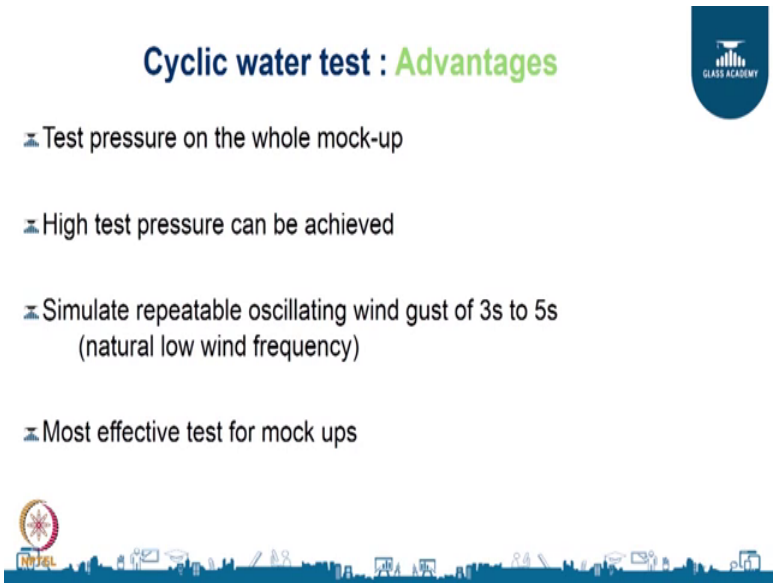

So, in that sense every test whichever standards you follow; you follow any standard and you get a product which is pass the standards you can be assured that you know there is going to be you are getting a good value for that product. Now, advantages in the cyclical test that we explained earlier is that the test pressure is on the entire mock up the every square inch of that mock up is got the uniform pressure which is created in the chamber unlike dynamic where the pressure is high in the periphery and then as you go away at a distance it is drop because it is an open to sky.

So, here you have a uniform pressure on the entire sample and you can go up to much higher pressures to test it and the it is gusts actually the 3 to 5 seconds is almost like a natural low wind frequency which being repeated and it is a very effective for mock ups it is a very difficult specification. And if the water passes in cyclic test it is actually a very good you know result for the you know for the designer and commendable because it is very stringent.

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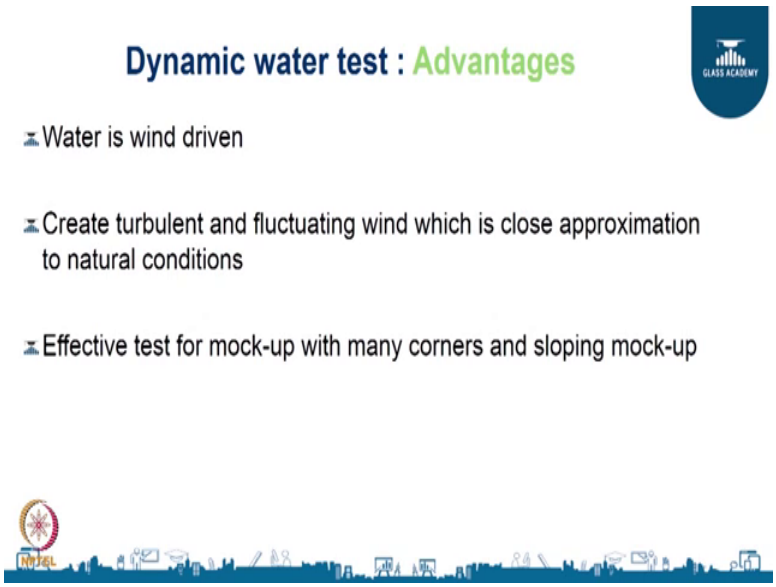

Dynamic is you know water is wind driven. So, it simulates the cyclonic kind of (Refer Time: 12:38) it creates a turbulence and fluctuating window which is a close to the natural conditions and it is effective for mock ups which have slope proofs and external features and lot of corners where it is very difficult to have a uniform spray of water in uniform pressure. It will be better to have a dynamic which is you know covering the wind and you have wind going through this corners and creating their own you know turbulence and that in turn tests how good the sample is in terms of water resistance.

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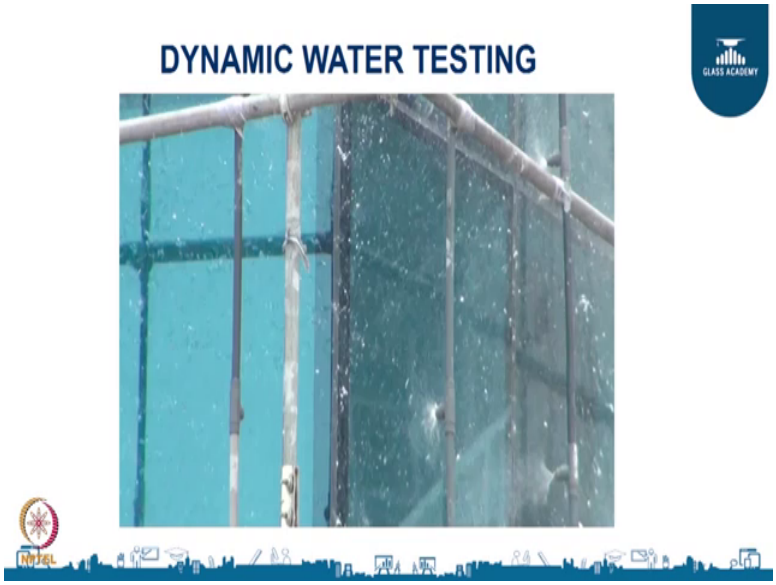

So, there are videos which are attached to show you the static water, the dynamic water, the seismic movement and the structural you I mean, you will be able to understand better when you see the pictures.

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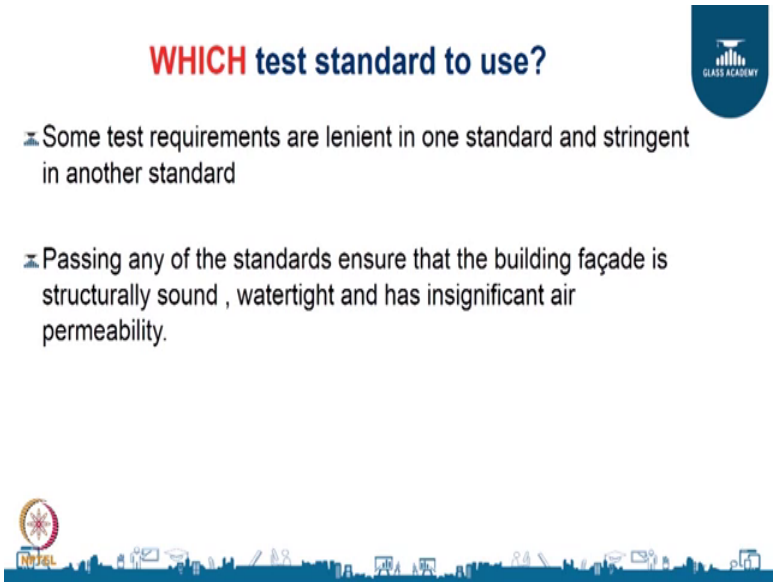

Which standards to use some of them are lenient in one particular area and, but there are very stringent in the next. So, in the in essence you know you pass any standard it does not matter which standard it is, you will end the end up with the very structurally sound a watertight and a highly efficient air efficient energy efficient façade.

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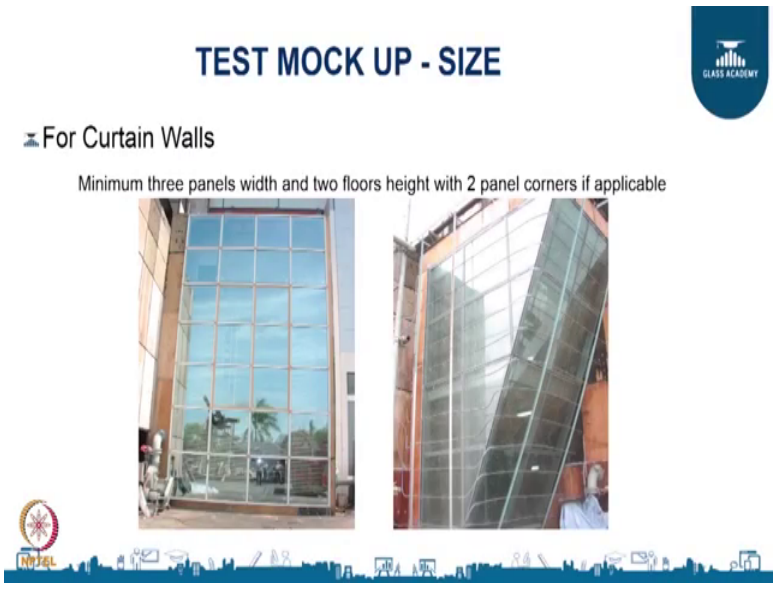

Now, coming to the mock up size, what should be the mock up size? The specifications say's the minimum of three panels three panels width and two floor height. So, that is the minimum size that should be tested and sometimes the consultants also asked for a

corner because the corner is the very critical joint is three panel width with 2 panels in the corner. So, this becomes the minimum size for a mock up sample.

There are some pictures of mock up samples just to show you how it look in the this is at the laboratory it is not the real building the sample is at the lab. This is constructed at the lab to test it and it is exact replica of what is happening in the site the same design, the same profiles, the same element, the same screw bolt, nut, gaskets, glass which is used in the building which going to be tested. So, this is how it look as a sample.

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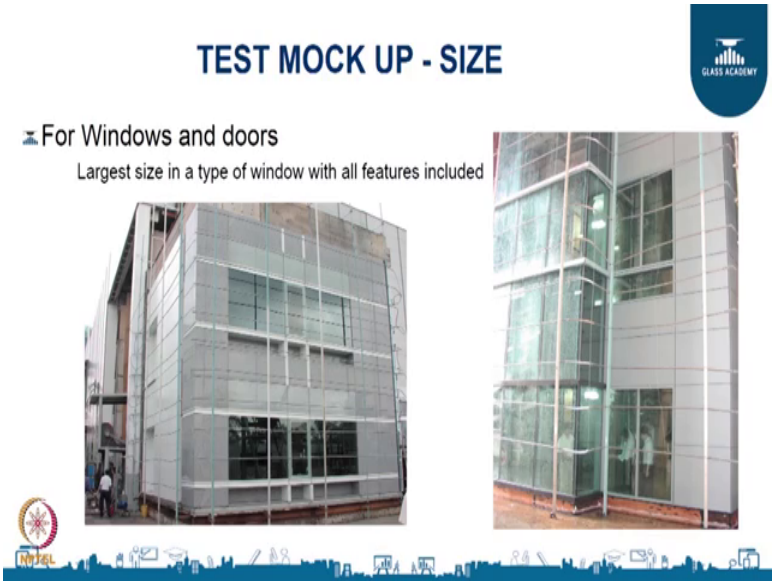

So, for the windows and doors the largest window in that particular project using the same profile, if you have small windows big windows and all of them are using the same profile the same glass thickness when test the largest. So, that all the smaller windows are automatically passed along with that.

So, this is the typical sample of a building with the aluminuim composite panel, the window, the external elements everything fixed this is the mock up for testing as a sample. This is another sample where you have a fixed glazing curtain wall with the window and aluminuim composite panel and people are standing inside the sample and there is a water test going on in there seeing if there is any leak through the window.

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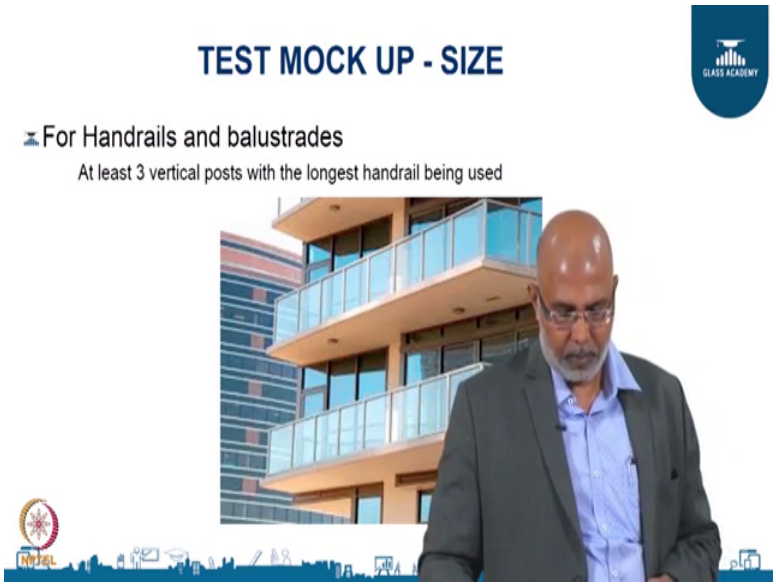

And, for balustrades and handrails at least 3 vertical posts, the sample should be having 3 vertical posts. If there are vertical posts, nowadays you have a lot of windows I mean the handrails where you just have just glass held in the bottom with aluminium clamping system. So, in that you need only with the largest glass panel to be tested, one panel. When there are so, handrails or balustrades with vertical stainless steel vertical hole or you know balustrades and then there is a handrail, then you need to have at least three verticals on that sample.

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So, what are the common failures that we see during the test?

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Now, typical failures will be water leakage where you see here waters leaking through the openables, droplets coming in through the joints. So, these are typical fabrication issues which can be addressed either because there is not cut it properly or sometimes it is a design problem. For example, over here there probably not enough drain holes on the window shutter on the outside so, the waters overflowing into the inside of the building.

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So, water leakages are very dangerous and totally avoidable if the design is good and the

fabrication is good you can avoid any kind of water coming into the building because it is very difficult to identify where it is coming in from. For example, you see the small screw which has been put into the aluminium frame, now whenever there is a screw to be put they usually use silicone on the screw and then tighten it so that the silicon close the little holes which are created over there. Now, here the screw has been put without that silicone and this water dripping in through that little hole. So, this is again an example of bad fabrication.

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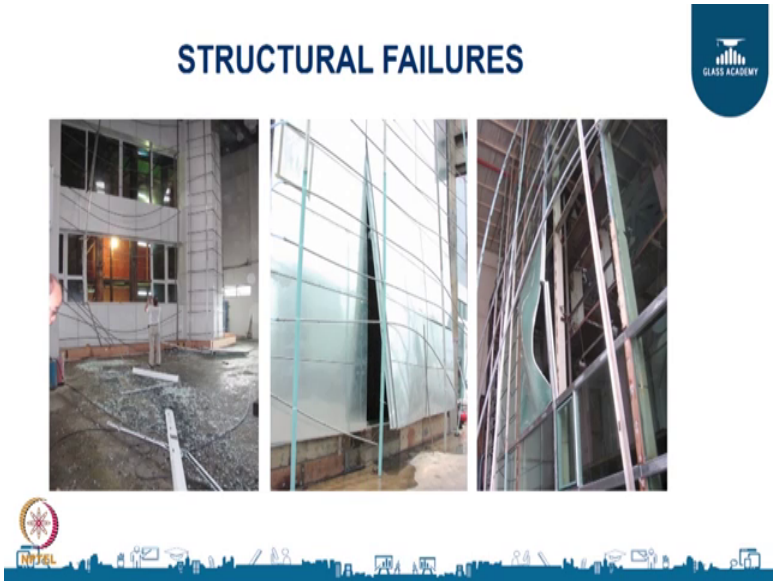

And, then you have structural failures here. The glass entire glass is blown out it is not able to hold tight. So, the wind loads this will really happen in the building if suppose this is the 30 storied or 50 storied building can you imagine what will happen when the glass shatters and even a small piece of 2 square inches of glass falls from a 30 or 40 storage building it comes down like a bullet and if treats somebody on the head it is going to for sure break is skull.

Here you see the aluminium given way because of the structural load it is not able to take the load. Panel is come out of the mock up sample.

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These are typical failures that we see and then corrective action needs to be taken to ensure that this does not happen in the real building. Reinforcements are done; the aluminuim itself is buckled because of the wind loads.

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Or you have typical situation where the glass panel is delaminated come out the composite the back pan (Refer Time: 18:42) which is there in the curtain wall is come off, not been anchored the aluminium sheared off from the bracket by just thrown out because the thickness of the aluminium is not adequate.

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At the point where it is anchored the bracket is come out of this hole lock because the whole system is moved out, the it is deal I am taken the here you see the bracket is you know totally gone, distorted and the lock which is supposed to be here hooked in here it is actually slipped out and come out so, this is the slab. So, this whole curtain wall is come out by so much here the glass is blown out because these are typical structural failures that you see.

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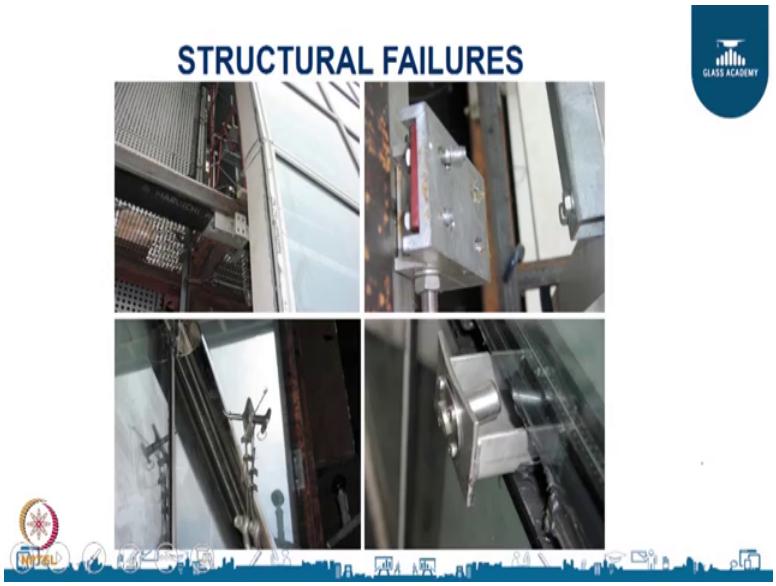

The pin is sheared or locking pin. So, these are some of the failures that we see and at the end of the day any product that we use in our lives, we use it after it is been tested. So, that is how these products become iconic, you know the what is the difference between successful product, iconic brand, cheap one it is the consistency with it performs. And how do you achieve the consistency it is by putting it through a rigorous test so that under normal conditions it performs beautifully.

So, at the end of the day facade is like any other product it is designed to do certain things and there are clear established parameters. All we need to do is to measure that and see whether the performance of that particular facade is matching the parameters that are been specified and if it is then you get a good product.

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