

Glass in buildings : Design and Application
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Lecture – 64
Facade - Factory Operations

Good morning all. As a part of this program today we will go for a factory visit, where all the facade elements, various elements of the pertaining the facade. We will see the details of fabrication, assembly and making ready to send to the site for fixing. This facade element, we have today to cover main systems like unitised, semi unitised and window.

First, we will see the production of unitised panels where various elements and various process we will show you.

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And we will show you a panel where what are the process it gone through and it is ready to dispatch.

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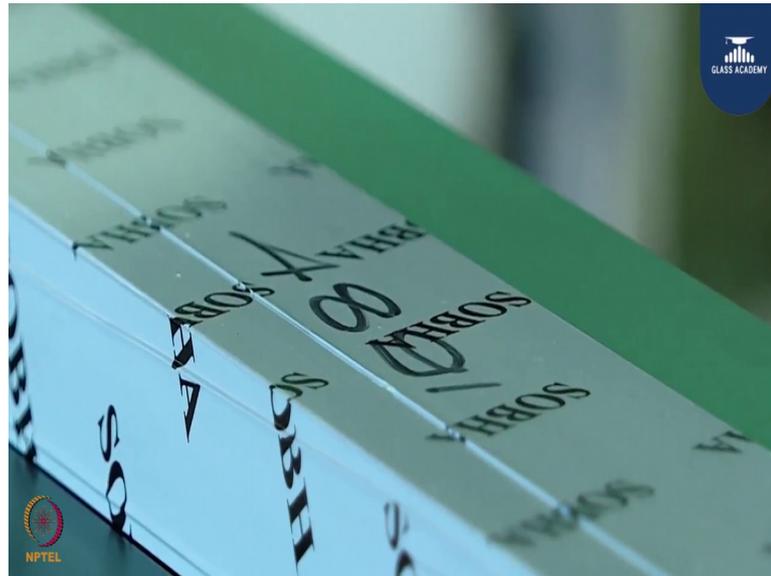


This if you see the panel cut they are doing the cutting of the main members namely, the main members of this. Unitised panel assembly is mullion, where it will be always a vertical member and there will be horizontal member called transom. And there will be adaptors and finally, there will be a bonding that is the most important process in this kind of work.

You can see mullions they are cutting for the required length. You can see 2 mullions kept together known as male mullion and female mullion. In the concept of unitised construction the panels will go fully finished to site, where it is produced by interlocking method that is why we have male mullion and female mullion. Usually, the male mullion will be on the left side and female mullion on the right side.

So, during the course of erection it will be just like tiling, where panels will be keep on mounding one after another.

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Inserting into one another, they are saying the; they are doing the required cutting of the panel.

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Here unlike windows we require straight cuttings. Usually, in window construction we will have roll might at 45 degree cutting here unlike that in unitised and semi unitised construction.

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Always the cutting will be straight. So, they are preparing the first panel we will go through the process all are requested to watch cleanly.

After cutting the horizontal members will go for a milling. This is called n milling where 2 blades used to cut out some of the portion so, that it can be assembled with the vertical member easily.

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They are doing the necessary marking locations of the horizontal transom where it is changing for project to project, in certain panels there will not be transom at all, where

we will express the hole floor height as a single glass. But, certain areas where we have vision panel and spandrel panel there will be definitely a horizontal member. This member is known as transom and we need to have marked the position and do the assembly.

In unitised construction usually it will be floor to floor. So, in a commercial building usually it will be 4 to 4.2 meter. So, always you can see the mullions will be around 4 meter plus. As I told you a unitised panel assembly will consist of 2 mullions, namely one female mullion, one male mullion. There will be number of horizontals definitely there will be 2 horizontals that end both ends, one will be the bottom it is known as the seal transom and one will be on top it is known as the head transom.

And according to the requirement of the project either one or 2 intermediate transom will be there. Usually, one of this particular compartment will be used for spandrel panel where machine is subtracted, namely inside there is a drop beam we have to hide that by glass. So, there will be a preparation for spandrel panel also.

They are doing the preparation to receive the transoms at exact locations.

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So, it is going to another process.

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We call it as copy routing where the mullion and transom will be doing required cut outs holes. If you see the unitised construction is kind of a drainage system where all the water management doing through the system only. So, the external the area is known as wet chamber and the internal area is called as known as dry chamber.

So, we need to do all kind of drainage arrangement from the wet chamber. Really if you see the system may absorb water from the atmosphere, and it will drain out rather than resisting in the first primary barrier itself.

So, all kind of drainages we have to organise through the system for that drainage holes slots will be made. In addition to that the connection between transoms and mullion we may need to do the screw concoctions for that also we will be doing necessary arrangements. The machine is known as copy routing router and it is very useful in the aluminium industry façade industry.

We know what kind of shape is to be done that kind of shapes slot will be kept on top and the router will moves through that. So, it would be copied on the members either mullion or transom. If you see the detailing the particular slotting they are doing on the wet chamber means wet portion external portion of the system.

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If you see the pair of mullions there, middle portion is a portion is cut out for around 2 meter length that is to receive operable panel. This particular panel is at vision area there is an operable panel also. Every panel may not have operable panels because as for the building norms we may have to provide 5 percent of the operable panels. So, every 10 panel, 1 or 2 panel there will be operable panels this particular panel is having a operable at the middle portion.

Now, they are preparing for the assembly.

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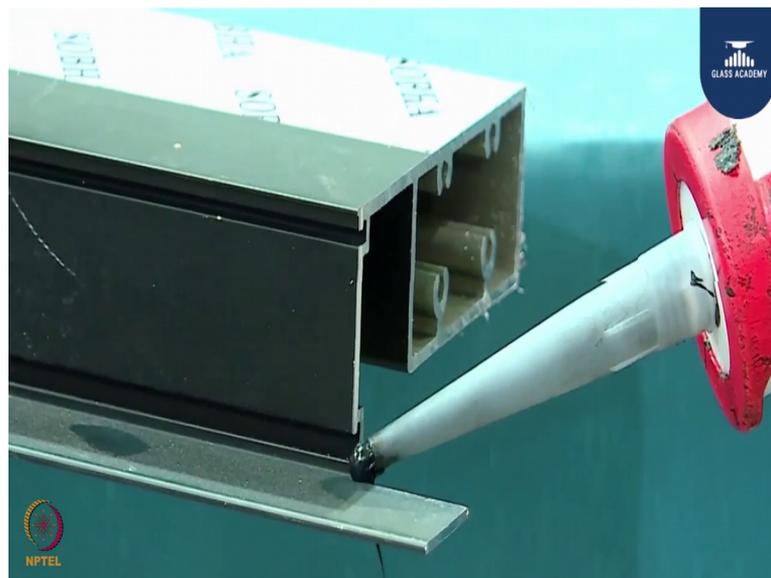


Male mullion is here, the other side you can see the female mullion, they are making cut-outs to assemble to facilitate the assembly. When we talk about unitised system we have various systems in place to facilitate various grid size to facilitate various floor heights. But, essentially for every system there will be a pair of mullions and number of transoms and glass.

And here all this process involve the assembly plus finally, it is go through a process called bonding that in the due course we are showing that that is the most important in this process. These are all screw hole preparations which is they are preparing little slanted because when we tie it will come closer and closer.

Now, one most important aspect what they are doing is when we are doing the assembly mullion.

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And transom they are touch touching each other at the same time there should be air proof and water proof. So, the phase where they are touching each other will be sealed with structural silicone. So, after assembly it will be intact there not be any air infiltration and water infiltration. Now, they are going for the assembly.

From the assembly you can see essentially there is a seal transom, there is a head transom and 2 intermediate transoms which one will be for the spandrel panel and the bigger area for the operable panel. So, we can say this panel have a vision panel when

operable panel and a spandrel panel.

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As I told you earlier there will be head transom and seal transom at the edges it will be always half, but intermediate transoms will be full because it no need to receive any other panel. So now, they are connecting to intermediate transoms which facilitate spandrel panel and operable panel.

The particular dimensions and thickness everything will be designed by the structural requirements. The main criteria for the decision making is the floor to floor height and the grid at what kind of lines we are planning may be at 4 feet or 5 feet, 6 feet we have to express the glass. If you want to express the big class may go up to 6 feet, where every 6 feet there will be a vertical mullions.

So, that particular that plus the prevailing wind load of that particular area as per the IS code. Wind code will give you the necessary wind load is to be taken for design criteria and we have to design around 20-30 percent safety factor.

So, this major 3 criteria for the decision or design of the particular cross section measurements where more deeper will give you more section modulus and more thickness will give you more strength. So, this system will be selected according to this requirement of floor to floor height, prevailing wind load as per the wind code and what kind of grid we want to provide.

You can see once again that research deformation is for to receive the operable panel. Usually, operable panel will be provided at 1.2 meter from the floor level. So, that it is safe to operate and there is no safety threat and what they are inserting or the gaskets, it is play a major role in the facade industry where glass we cannot directly touch or mound on the metals where breakage will be a major problem.

So, every contact between glass and aluminium is avoided by providing necessary gaskets and these gaskets play very important role in avoiding leakages and their infiltration. So, when we press the glass unit against the aluminium system it will give you pressure which will eliminate this water leakage and air leakage.

And suppose you want to keep the ambience pressure inside and outside same we call it as pressure equalisation. So, necessary hidden holes are given in the system towards outside and inside which is not in one line which is tagged so, that water will not leak. So, there will be air passage in small quantity.

So, whenever there is a pressure drop inside air will be sucked automatically through these small holes to give the pressure equal on both side: inside and outside. So, there joint already 1 mid transom, they are making necessary fasteners in the system if you see properly that positions also well defined. So, when you call it as a system the transom will give you screw ports or the location of the screws are all decided earlier, it is in the exclusion itself there is no uncertainty in that.

They are going to assemble the second intermediate transom. You see a necessary special shape is already drawn on the transom so that when it sit itself it will very easy to assemble. And that is screws going in the exact location where there will be a receiver on the transom itself.

These are all taken care in the design itself, they have done the screw holes in exact locations where transom will come and transom will come with its own screw locations where it will there is a receiver, within the transom there will be a receiver. Now, they are doing the second intermediate transom.

Now finally, coming to the last one, now after assembly we call it as a naked panel where all the assembly is done gaskets are inserted and you can see chambers 1, 2, 3, this is ready to receive glasses. And you see that space is provided to receive the glasses to glue

it. Actually the entire process is called a structural glazing where there is no mechanical fastening between the glass and the system. You see that space is already created where glass will be in contact with the system for a particular space that is also well defined, that space is also well defined we call it as silicone bite.

So, what is a silicone bite? It is the necessary contact width between the glass and the system when you see from the top. In the top view it is the width of the contact between the glass and the aluminium members namely mullion and transom that will impart strength to the glass for holding it in its a position.

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And the thickness of the bonding is called glue line that is also from the manufacture there is a specification, in ideal conditions it should be around 5 to 8 millimeter, usually we will use 6 millimeter. This will facilitate the application where the silicone bite width of the contact is as per the design it should be around 10 to 15 millimeter all around and the thickness of the application usually it is 6 millimeter. So, that the silicone gun application is feasible.

Now, they are doing the operable panel assembly separately where it is all members are crimp and it is ready to receive. It will be fixed mechanically within the system the middle portion where it is prepared already and here also there will be a glass bonding that process is called a structural bonding. Every panel may not have the operable panel usually I told you it will be around 5 percent to 10 percent.

So, every tenth panel or every twentieth panel, there will be a operable panel. This is for if it is an ac building this is for fire norms when there is a fire smoke we can keep panel open. So, that smoke can escape you can get the fresh air or in the winter we can keep the operable panel in open condition. So, that ambience cold air can come in. So, you can save the AC energy.

So, in totality a unitised panel assembly require mullions female and male transoms, seal transom and head transom and intermediate transoms as per the design requirement and all kind of gaskets. And we have operable panel and finally, we have glass for all this and behind where we do not want to express the glass as a vision panel there will be a spandrel preparation. Spandrel is nothing, but a preparation of 2 inch thick chamber having rock hole in it or glass hole in it to enhance the thermal energy requirements so that the conduction of energy the transfer of energy will be as less as possible.

Usually, spandrel will be provided where there will be a drop beam and you do not want to express as a drop beam and from the external elevation. So, when you feel it from the external elevation it will be a continuous glass façade, but in that particular behind that particular glass there will be a drop beam.

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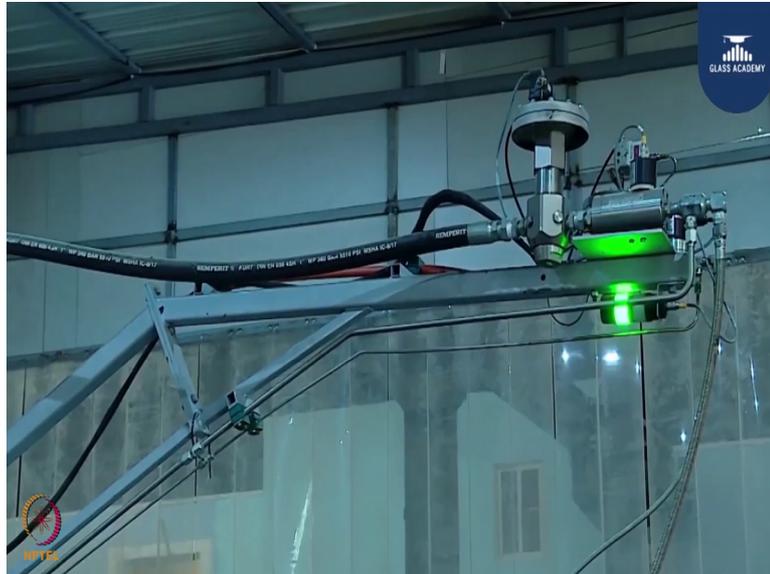


So, that will support give us chance for fixing also.

Now, this particular panel is coming for bonding or any other panel is coming for

bonding this is a bonding chamber where structural silicone is used as the bonding material.

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Many people call it as glue actually it is a structural silicone, where it is a 2 part system where a main body will be in that blue chamber, the other one will be in the white chamber.

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That white chamber is nothing, but a catalyst where it will be around 10 percent of the main body and it will be kept separately. When it is coming for application the particular

no seal it will mix together and before coming for the actual gun application it will become a very homogeneous material. And it start like concrete it will start setting and within one hour it will give you strength to handle the panels and within 24 hour it will attain it is total strength.

So, instead of that unitised panel bonding now they have take they have taken a semi unitised panel small semi unitised panel where we call it as glass frame assembly. You can see a glass frame, it is ready to receive the glass for bonding. This is a may be 1 meter by 1.5 meter glass which will be used in semi unitised construction where a glass frame is done.

A phase is created already where they are applying a tape it is called Norton tape, it is a self adhesive tape. The purpose of the tape is initially before applying the structural silicone it has to hold the glass in position. At the same time this particular tape width and thickness will decide the size of the bonding, contact these bonding size of the bonding nothing, but the contact between the glass and the aluminium frame.

Here a space of around 25 millimeter was there in that they are applying a tape of 10 millimeter wide. So, a valance space of 15 millimeter is created for the bonding.

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And that tape thickness is 6 millimeter. So, the frame will hold the glass 6 millimeter away so, that a space is created for application of structural sealant through the 6

millimeter.

So, in this particular case when we do the bonding there will be a silicone bite of around 15 millimeter and there will be a glue line, the thickness is known as glue line, there is glue line of 6 millimeter. So, this self adhesive tape double sided tape play a very important role in the bonding where while bonding the like concrete it is a very weak material, it cannot hold the glass in position or we cannot ensure the uniformity of thickness of application. So, this tape will ensure the thickness of the application plus valance space will be created for the silicone bite.

Here you can see they are doing the cleaning necessary cleaning is to be done, thorough cleaning is to be done like any other concrete activity. It is almost like concreting activity where we have to clean the frame formwork and their area where concrete is coming in contact.

Now, they are applying very mild soap application to have a complete cleaning of the surface of the glass which is going to be in contact with the frame. And they have to apply certain primer for enhancing the adhesion. And always they apply in double layer so, that little bit left out will be covered by the second application.

Now, a frame is prepared fully now the glass is under preparation to see the way they are applying the primer at the edges around one inch where glass will be in contact with the frame. So, a semi unitised glass frame with the necessary tapes created space for the bonding. Then this will be attached to the glass the primary bonding is nothing but the double sided tape this is nothing but a primer application on the frame also. You see the outside space is created 15 millimeter by thickness of the tape around 6 millimeter, space is created for bonding.

Now, glass will be placed on top of that, both panels are prepared now with the necessary primer application. Primer requirement is depending on the surface of the aluminium, for powder coating there is a primer and there is if it is anodized finish there is another primer in both cases we have to apply the primer. So, that it will facilitate the bonding better.

This is the bonding machine as I told you earlier it is a 2 part silicone bonding machine where both the parts are kept there that big drum is carrying the body and the white small

drum is carrying the catalyst. Body will be white in colour, catalyst should be black in colour in the gun always it will be white.

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And while application it is mixing through the nozzle only.

Now, the light showing red means it is not properly mixed and you can see uniformity is not there. Now, the sensor showing green means the entire material coming through is thoroughly mixed as per the ratio usually we will keep 10 percent of the catalyst.

And you can see a uniform black colour and you will not start the bonding like that. We will have to test before starting of every bonding activity because this is a very important. It is nothing other than like a quantity very very important activity, they will do a butterfly test where this particular uniform homogeneous mix will be applied on a paper. It is applied and thoroughly they will skew it.

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There will skew it into very thin thickness and they will open it, they will watch whether it is giving a very very uniform colour black. If any white patches or white dots means the mixing is not proper then they have to again remove the material and they have to see the mix once again.

And now they are doing the snap test it is like a cube test, it is like a cube test in quantity where snap test is done. They will keep a rod in that and within 5 minutes it has to carry it is own load and within 1 hour it should be giving a reasonable strength.

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So, that is the second test before bonding.

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Now, they are they can start the bonding again they are applying a final primer. You can see the space is already created between the frame and the glass through that 6 millimeter they are applying the mix. It will go in pressure and it will occupy the entire space. So, almost 15 millimeter in width and the 6 millimeter in depth silicone will be applied, structural silicone will be applied. See it is by pressure is going inside all 4 sides.

Now, they are removing the surplus while this process certain space inside balance also it will be filled. So, the where they are wiping out it will go inside and inside and whatever inside void also will be filled. Whatever voids inside is a inferior quality, we cannot leave the space inside, then bonding strength will be less, even though we are usually keeping 30-40 percent of actual safety here.

Suppose, say silicone bite of 10 mm required we will doing around 14-15 millimeter silicone bite because to give allowance for the manual errors. Now, the field bonding is done surplus is removed we can leave this panel for 1 hour for curing.

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Now, we are coming back to the earlier panel or another panel unitised where a single glass unitised panel. You can see a single floor to floor unitised panel around 4.2 meter, male mullion, female mullion, head transom, seal transom. A space is created this is for full glass you can see the offsets on all around that is the space created for the bonding.

Now, they are applying masking tape to protect the aluminium from the surplus spill over, it is not for any other purpose masking tape is done wherever we do not want to spill the silicone, later it will be very difficult to play. So, they are protecting the aluminium first there is a protection tape already, but they are doing one more masking tape to this is the best way to protect.

Now, they are applying Norton tape, it is very important double sided tape they are applying to ensure 2 things, one is the thickness of the application. They are ensuring by this what is the thickness of application? Thickness of application is nothing, but the thickness of the tape. It is a 6 millimeter tape they are applying and they are place the glass on top of that.

So, already a wide space is created of 6 millimeter. You see they will apply all around. I think there is a mid transom also I told you earlier it is top transom and sealant head, now there is a mid transom also there is a small space for spandrel panel.

Now, all the periphery they are applying the double sided tape. The purpose is to decide

the application thickness, indirectly it will decide the width of the application also where silicone will be in contact with the frame.

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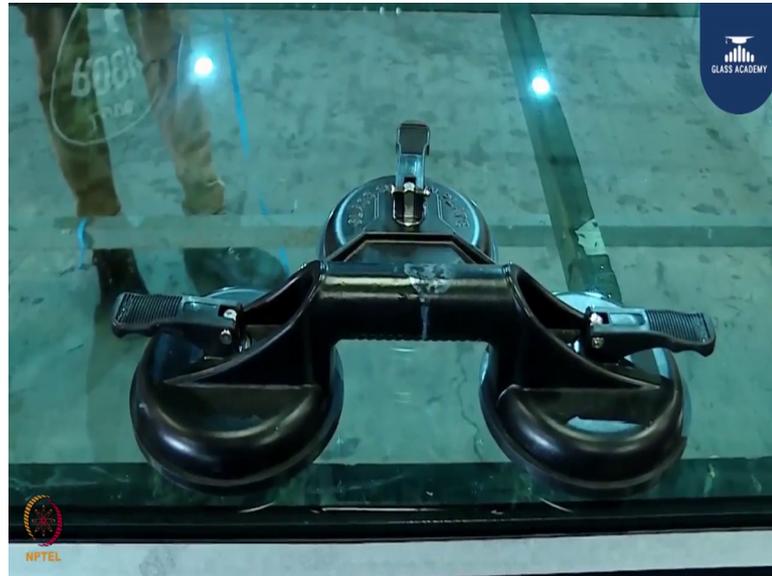
It is a big glass they are removing the protection tape from the glass first to facilitates the proper adhesion. Proper cleaning is to be done it is a double glazed unit DGU, where surplus earlier silicone application and all we have to remove. They have to away thorough cleaning on top of this thorough cleaning of the periphery. This is a particular panel without operable panel. So, we have a vision panel of around 3 meter and a spandrel panel of around 0.6. So, this is a single panel having a big glass and a small spandrel panel.

They have to look for the edges where glass in contact with the aluminium member bonding is happening there. So now, they are going for the cleaning and primer application. They have to clean the edge of the double glazed unit also because this edge also going to be in contact with the structural silicone.

Now, they have to apply the primer on the other side, they are using the vacuum catchers to hold the glasses. You see the double sided tape with coming with a tape on top of that, that they will remove on due course. Now, they are checking whether correctness we have to leave 6 millimeter all around uniformly and space 6 milli all around they have to leave as per the system. This in facilitate for application gun application of the silicone.

Now, they will make sure that all around you are getting the same space that glue is a protection tape from the double sided tape that is to be removed first then only proper adhesion will be there.

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Now, panel is getting ready with the primary adhesion of double sided tape. You can see the periphery that black border it is nothing, but space created for the bonding now.

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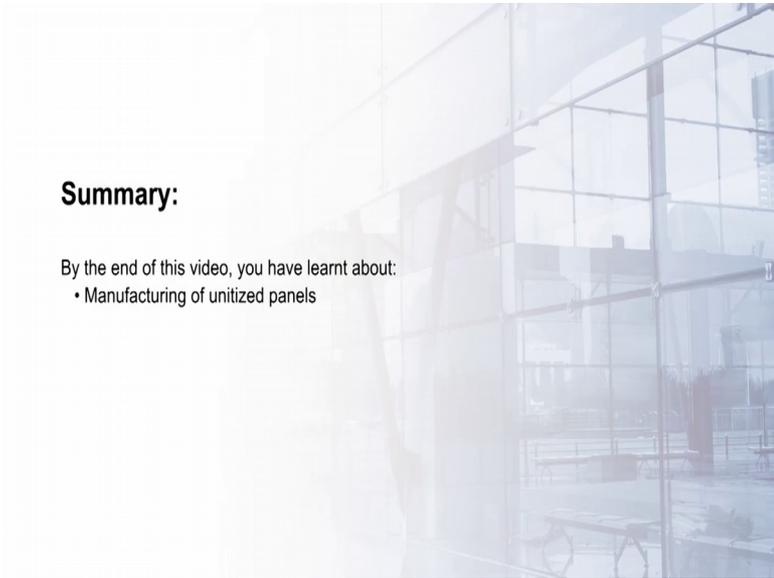
This panel is fully ready for bonding; you see black border all around it is ready to receive the silicone.

Now, they are applying masking the tape on top of the glass to avoid spill over, so that you will see a sharp glue line. If you see this panel from top they are applying is the primary bonding only, but they have to do the real application from the backside. They have to reverse the panel and they have to do the application for the silicone actually silicone bite.

This phase they are doing this application is to avoid breaking of the glass due to expansion. So, it is within a confine frame, when glass expands it will go and touch the metal frame. To avoid that we bring glass 6 millimeter shot and all around there will be a silicone application that silicone is flexible it can expand or contract at the 50 percent of it is width

So, when we do a 6 millimeter silicone there it can go plus or minus 3 millimeter. So, thermal expansion up to 3 millimeter is protected, it will give space for glass to expand or contract without leaving from it. In the actual application of structural silicone is on the bottom where space is already created that I will show you on due course.

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Summary:

By the end of this video, you have learnt about:

- Manufacturing of unitized panels