Glass in buildings: Design and Application

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Lecture – 42
Glass in Passive Fire Protection

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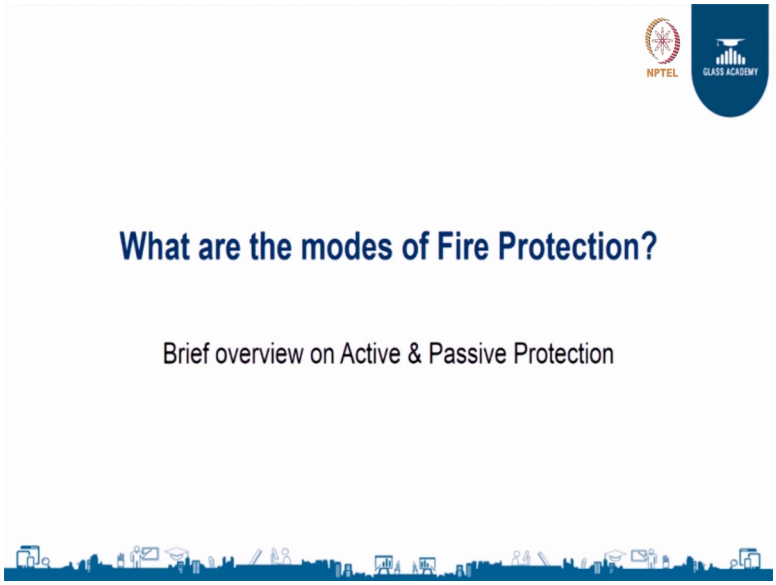

So, we started the session by discussing, what are the different modes of fire protection. This part of the presentation will include a brief overview on active and passive fire protection.

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So, when I will talk about fire protection, I am sure there are a few things which strike your mind right away.

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Some of which are fire extinguishers; I am sure you would that is one thing which you would have thought about when we now that we talk about fire protection smoke alarms, water sprinklers and fire buckets.

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These are some things which we see in a common living spaces, and which is something that we associate with when we talk about fire protection.

These are called the active fire protection systems, they are called active protection systems because they jump into action during a fire, but then for them to function well in fire protection of other for these protection systems to cut down the fire or to kill the fire we will require a trigger signal. So, I will go back and explain to you with each example. So, let us take an example of a smoke alarm; in this case the trigger signal here would be

the smoke rising from a fire, and causing a temperature rise in the sensors within the smoke alarms. Or for example a water sprinkler; the trigger signal in this case would be again the temperature from a fire rising up to the sensor and then it is sending an information to the receiver. Thereby triggering a signal, there by triggering a reaction which is the water being sprinkled in the place where there is a fire. So, if you look at all these examples these includes systems of fire protection which require a trigger signal to function.

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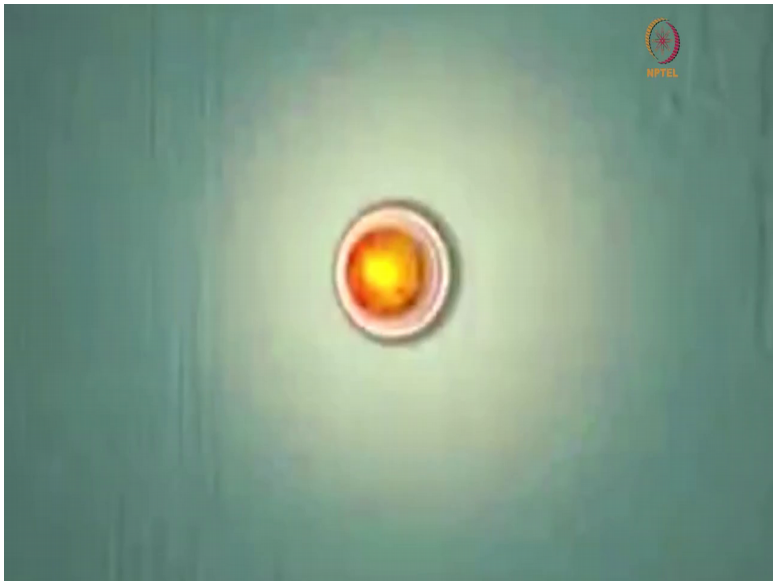

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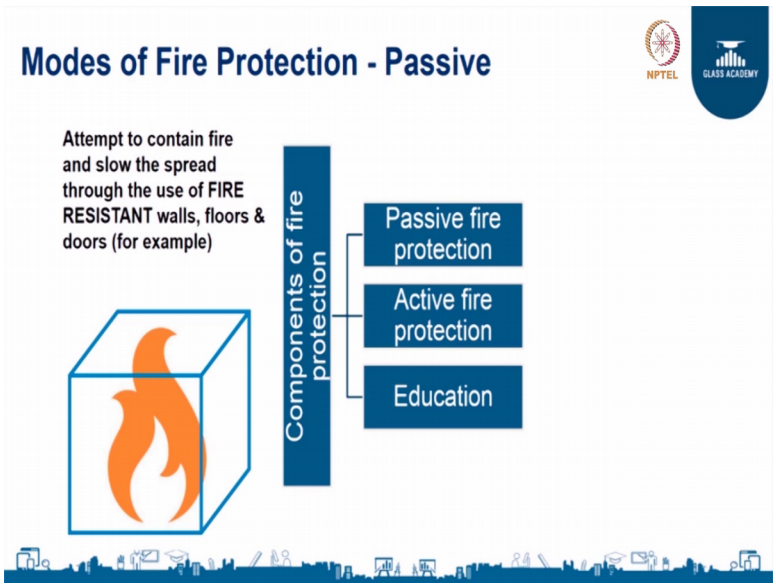

So, they work or they function in the case of fire in a very active way. So obviously, if this comprises of the all the active protection systems the other kind of protection system is going to be called the passive protection systems. So, the passive protection system consists of methods, which are through which we can contain fire, and slow the spread of fire to this to the source of the fire ye. So, if one kind of fire protection is called the active protection systems then the other kind is supposed to be called the passive fire protection system.

On the contrary to an active protection system, in a passive protection, fire protection in a passive fire protection system. It involves methods or attempts to contain fire and slow the spread through the use of fire resistance walls, floors and doors. For example, if we know that the fire is going to begin in a particular area of occupancy, then what we are trying to do is we try to contain the fire within that particular area of occupancy. So, that it does not spread to other parts of the building, but if you look at the main components or the main modes of fire protection it includes passive protection, active protection and education. So, do you know what it means; it means that an ideal building is one which has active protection and passive protection in its place. So, that in case of a fire, the fire can be contained to it is point of origin and through active protection systems the fire can be cut down within the source itself.

So, if we have to take a typical example, if let us say if we have to take the example of a data server room. The fire would begin in the data server room, we all know that because of all the kind of equipments and the equipments in within that space. So, there is a high possibility of a fire being fire hazard happening inside a data server room. So, in such cases it is very important to enclose the data server room or if you are to take a different example, let us look at in example of a. So, the other type of fire protection is called the passive protection system. Passive protection system involves attempts to contain and slow the spread of fire using fire resistant walls, and floors, and doors. Let me explain this to you with an example of a ICU in a hospital.

Now, we know that an ICU in a hospital is a near is a place, where patients are kept under strict watch. Now it is it is very difficult to move a patient from the ICU of an hospital; outside in case there was a fire hazard in the hospital. So, it is very important to protect the hospital premises from fire spread. It is very important let us say in the example of a bank or a hospital or a data server room; to make sure that the fire

contained is contained within this, within the place where it has originated. So, passive protection system involves the use of fire, involves the use of glass in fire resistant walls, floors and doors.

So, if you have to take the typical example of any floor area, it would mean using fire resistant materials in the doors, in the walls, and in the floors. So, that there is no way the fire would spread to other parts of the building. So, it is all about containing the fire in it is place of origin.

But if you look at the different components of fire protection there are 3. They are passive protection, active protection and education. Do you know what it means? It means that in any ideal living space it is very important to ensure the best of both passive and active protection system. If you have to look at the same example of a hospital premises it is very important to use fire resistant materials in the walls, floors and the door.

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So, that the fire does not spread to different parts of the building. At the same time, it is important to have the right active protection system in place so, that when the fire originates it can be killed at the source itself. Now, before we go forward on in detail on the types or the different types of fire resistant glass.

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Let us look at some of the common myths, when it comes to the use and the application of these products. So, I will take you into some of the very common misconceptions, most of them have regarding fire resistant glass. So, some of the common myths regarding fire resistant glass are that; there are also lot of other types of processed or value added glass that is generally available. Although they are not used for the fire resistant applications, each product find it is own application in different applications.

So, it is not advised to use a product which is made to withstand impact loads like, let us say high thermal stress coefficient. It does not mean that these products can right away be used as a fire resistant glass. Actually safety glass can only provide impact safety or in other words it only provides resistance to structural or physical stress. So, it does not mean that we can use any type of safety glass as a fire resistant glass. Also I would like to give you another example of a tempered glass, which is only a safety glass because or it is called a safety glass because it breaks into small granules or upon impact or upon temperature rise.

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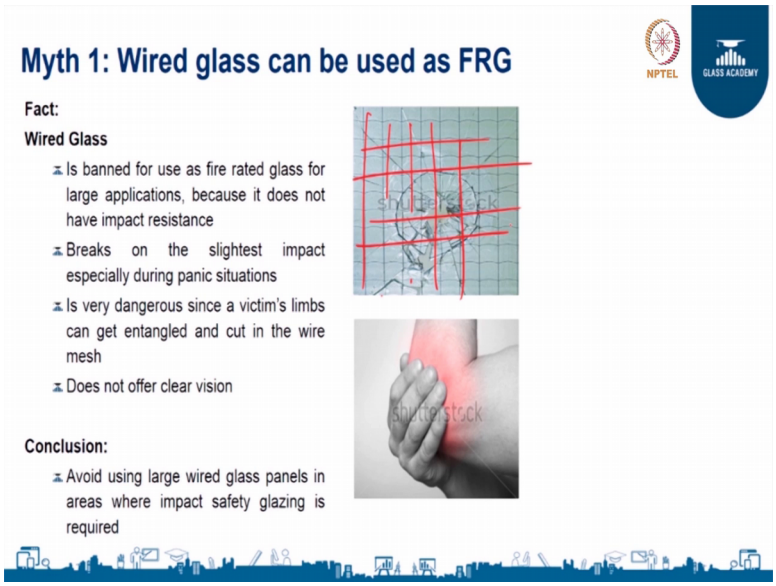

So, in a way it cannot be related to a fire resistant glass and it cannot be used in a place where one really need to use a fire resistant glass. These are some of the common myths regarding FRG. I will take you in to more details in the coming slides. The first myth that I am going to talk about is called it is about how wired glass cannot be used as a fire resistant glass. It is a widely believed myth that wired glass is also a type of fire resistant glass. Wired glass is banned for use in a fire rated application because it has no impact resistance. A wired glass is generally an annealed glass with a thick wire mesh in between. So, it involves it the manufacturing process itself involves float glass, annealed float glass coming onto the line in which a wire mesh is fed into the rock glass which is in the molten state.

So, there is no kind of value addition that is being added in terms of it is strength or impact resistance. As a result, when someone uses a wired glass in a fire rated application many a times what happens is that; it becomes very dangerous for the people in the vicinity, because as people aggress through fire exits. There is a possibility that the victims limbs can get entangled in the wire mesh and it can cause a lot of damage and pain and also a wire resistant glass does not offer a clear vision. So, I will show you a image of a wired glass for your better understanding, so what you see on the top that is a wired glass. You can see the you can notice the wire mesh which is being fed into the annealed glass.

So, as a result what happens is when you use such glass products in a door, and when someone is trying to open the door during a fire which happens to be high panic situation. There is heavy there is a high possibility that the victim limbs can get entangled in the wire mesh. And these are all annealed glasses which we are taking about.

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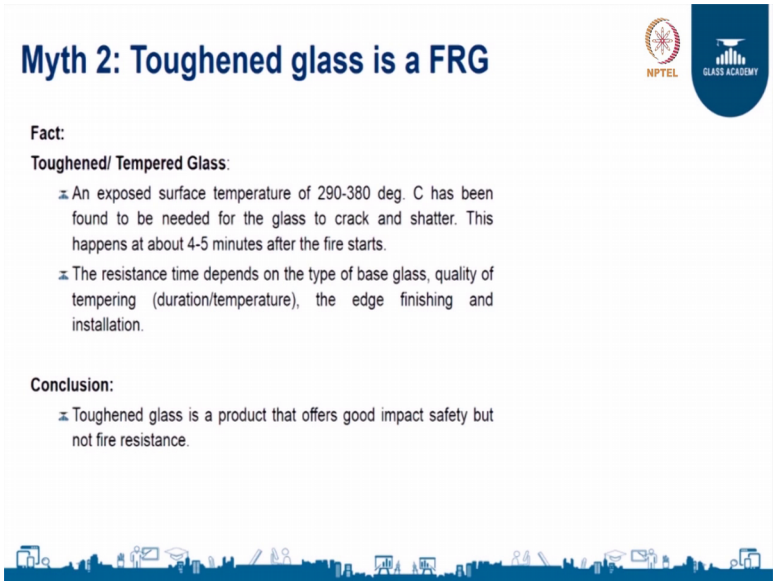

So, annealed glasses per say do not have very low impact resistance. So, this glass is cracks and yields, and makes way for the limbs to get entangled in the wire mesh; which can cause or which can put the victim in a lot of pain and damage. The other myth is that a typical toughened or a tempered glass can also be used as a fire resistant glass, which is not the case, because a tempered glass can only with stand a maximum temperature of 380-degree C. So, and during a typical fire we observe that the temperatures can go up to 1200 degree Celsius. So, if you have to look at it the tempered glass would typically break 4 to 5 minutes into the inception of into the initiation of a fire.

And also the resistance time of each tempered glass depends on what the type of base glass that is used, what is the quality of the tempering and so many other parameters.

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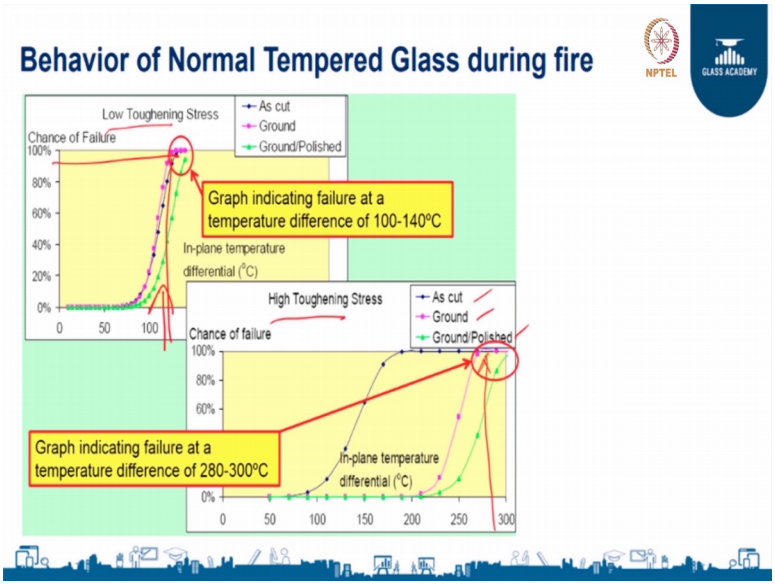

So, the conclusion here is that; a toughened glass can only provide a good impact safety, it can take impact loads, it can break it breaks into small pieces, it does not cause any harm in case of any impact, but when it comes to fire resistance; a toughened glass is not the right choice of a product. So, in order to prove this point, I am going to be showing you a graph, which will show you the which is which will plot the temperature rise in a glass against this chance of failure.

So, here you see 2 graphs, I will take you through the graphs in detail, on the x axis you see the temperature differential in the glass, which has been mentioned in degree Celsius. So, it is in increments of 50 degree Celsius and on the y axis you see the chances of failures when there is a temperature differential.

So, the temperature differential is the increase in the temperature of the glass, before after a fire, and during a fire, and before the initiation of a fire. So, it is always going to be at room temperature for interior applications. So, as the temperature progresses during a fire, what are the chances that a typical normal tempered glass would break. Now, you see 3 curves in the graph one curve is blue, which is the graph which is the plot for a for a tempered glass, when tempered with without any polishing done on the edges; against you see a pink colour curve in which the a glasses cut it is edges are grounded, in order to give it good stress concentration. And then the third type is a is the green curve which

is a glass which is cut it is edges are grounded, it s edges are polished and then subjected to tempering.

Now, if you look at the graph it says that at the temperature differential of 100 degrees. So, let us say at the room temperature is going to be 25 degrees and if there was a fire in the temperature of the glass was about to reach a 125 degrees. Then there is a high possibility that is close to 90 percent chance of the glass breaking in such cases. This is for again as I say it is a low toughening stress. So, when a glass is toughened or subjected to a normal toughening process, by the time the temperature differential reaches 100 percent 100 degrees. There is a high chance of the glass breakage it says a 90 percent chance.

Now, again if you look at the high toughening stresses; again if you have to look at the 3 different types of edge finishers that they have mentioned. You will observe that a ground and polished that is a glass, which is cut the edges are grounded and the edges are polished and then subjected to very high toughening stress. Even at such high toughening stresses the glass has a 100 percent chance of failure, at around 280 to 300 degrees. So, which means that a normal tempered glass will is bound to break at a temperature of close to 300 degrees. And it and it and it does not serve the purpose for when we when one starts using the same in a fire rated application.

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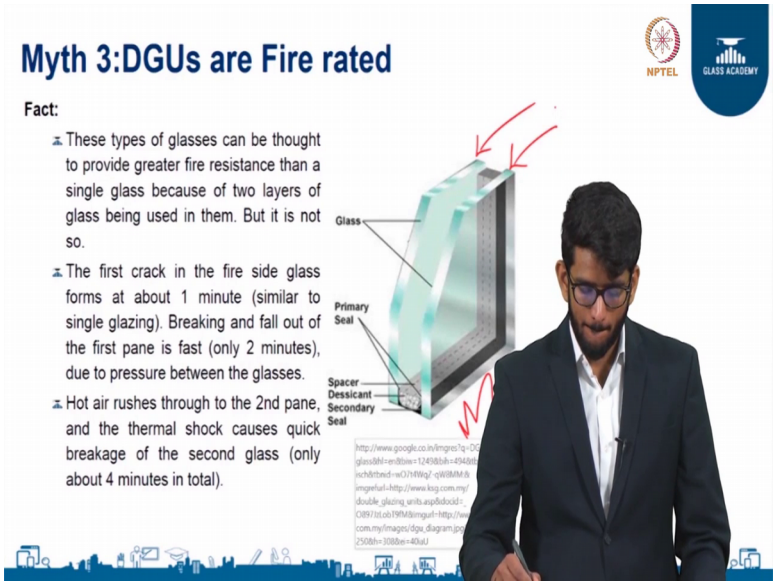

The next myth that I am going to be taking you through is the myth is a misconception that; a double glazed unit can also be used in a fire rated application. The main reason of such a misconception is that; is that is the fact that a double glazed unit comprises of 2 layers of glass being used. We all know what a double glazed unit it comprises of 2 layer, 2 pieces of glass which are combined to form a single unit with an air gap in between. So, it is only bound to create a misconception that if you have 2 pieces of glass one way in the other. Then the fire resistance of 2 glasses add up to each other add up and then you achieve a greater fire resistance.

But it is not the case I will take I will explain why; because if you see the first crack in the fireside glass. So, let us consider the example of double glazed unit. If there was a fire on one side, the first glass on the fires the first crack in the fire side glass will happen around 1 minute into the fire. And you know the glass particles will just fall out because double glazed units use tempered glass. And we all saw in the previous slide that a tempered glass will break if it is a low toughening stress it will break at a temperature differential of 100 degrees. If it is a high toughening stress, then it will break at around 300 degrees so give it 3 to 4 minutes.

So, if you look it at typical DGU the first glass pane is going to break in 3 to 4 minutes, and the next glass pane will break immediately. That is because the hot air will pass through the second pane and it will cause a thermal shock, which will cause a quick breakage of the second glass.

So, if you look at it if the first glass breaks in say 4 minutes, and the second glass behind it will also break more or less within the same duration because of the thermal shock. I have a very nice animation to show you how it functions. So, to explain why a double glazed unit cannot be used for fire rated application. Here I have an animation of what a double glazed unit looks like. So, you come it comprises of 2 layers of glass with the with a air gap in between. So, it is only natural that people assume that if you have 2 layers of glass and if you have 2 layers of highly toughened glass then the fire resistance of each will add up, and you will obtain a higher fire resistance from the combined unit, but that is not the case.

So, let us take an example of the same, and let us assume; if there was a fire on one side; if there was a so let us assume if there was a fire on one side, and this one happens to be your tempered glass.

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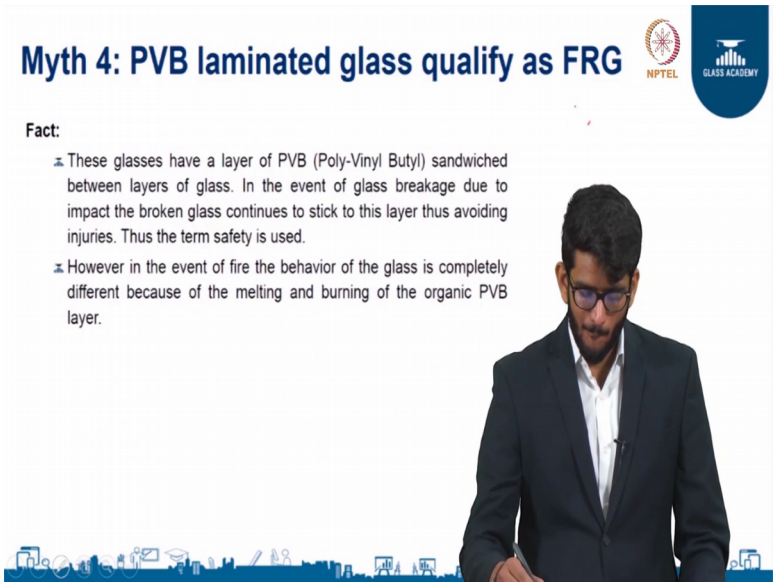

There is a high possibility or we know for sure, that if it is a low toughening stress the glass will break in at a temperature differential 100 degrees. And if it is a high toughening stress then the glass will break at a temperature differential 200 to 300 degrees. So, let us give it a maximum you know let us give it a (Refer Time: 18:31) and say that it would break within 4 minutes into the fire.

Now, we assume or it will be a common misconception that the glass behind will also with stand for 4 minutes in case of the fire, but that is not the case. What happens is that when the first glass breaks it let us say a hot air gushing through to into the second glass. And as a result this second glass will have a higher thermal stress, because all this while it was at a relatively lower temperature. And when this hot air gushing after the breakage of the first glass, it is only a matter of one or 2 minutes when the second glass are also break. So, as a result you will only see that the whole system can with stand only for say roughly 5 to 6 minutes. So, it is not advisable to recommend double glazed units for fire rated applications.

The next misconception that I am going to take you through is the use of PVB laminated glass, which people believe qualify as a fire resistance glass, because at the end of the

day it is a laminated glass. And it is called or referred to as safety glass in the markets. But what people fail to understand is that a PVB laminated glass comprises of layers of Poly Vinyl Butyl. Which is sandwiched in between the layers of glass, as a result what happens is that when someone the whole purpose of adding a layer of poly vinyl butyl in as a sandwich in between the 2 layers of glass, is to make sure that if there is an impact on the glass. The broken glass pieces stick to this inter layer thus avoiding injuries. So, that is how the term safety glass was coined.

But in the event of a fire this can be a complete disadvantage because a poly vinyl butyl is an organic layer. And it will start burning it is a combustible material, very nice animation to take you through this let me show you a.

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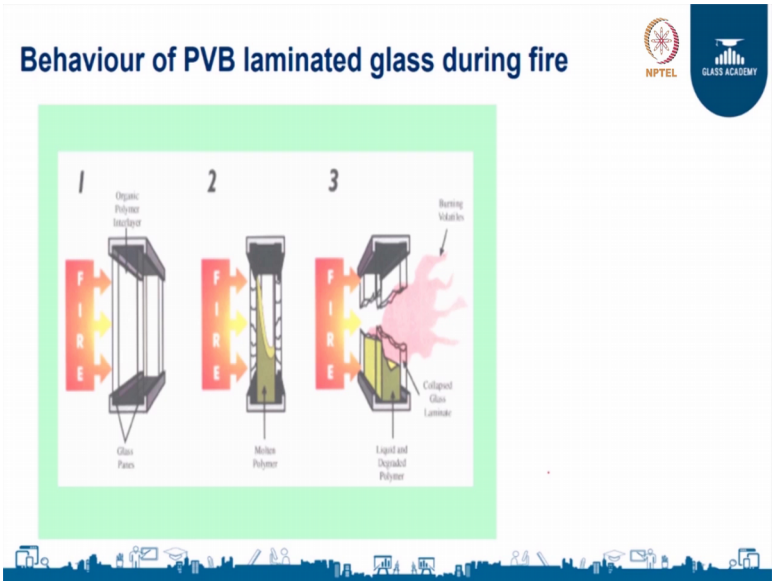

So, what happens is if you see on the left you see an organic polymer interlayer between 2 layers of glass. And in the case of a fire what happens is that the polymer in between starts to melt. And as a result when and as a result of the heat buildup within the interlayer and also because of the temperature differential, there is a high possibility that the glass will just explode and shatter. And also it will release a lot of volatile components, which can be which can cause suffocation within an area of occupancy.

So, you can imagine if someone wants to use a safety glass, PVB interlayer impact safety glass. So, if someone wants to use a PVB laminated glass so you can see in the third case that during a fire there is a possibility that the molten inter layers can cause a temperature

rise, at the same time the temperature differential on the glass can cause it to shatter and explode. As a result, it can also release a lot of burning volatile. Which can cause a lot suffocation to the people stuck in the vicinity of the PVB laminated glasses which can be very dangerous and also cause a lot of panic during fire in any building.

So, to conclude the performance of glass is based on 3 criteria's thermal stresses, softening and thermal expansion. We just discussed thermal stress it is when there is a temperature differential in the glass. And it just starts to break or shatter into pieces.

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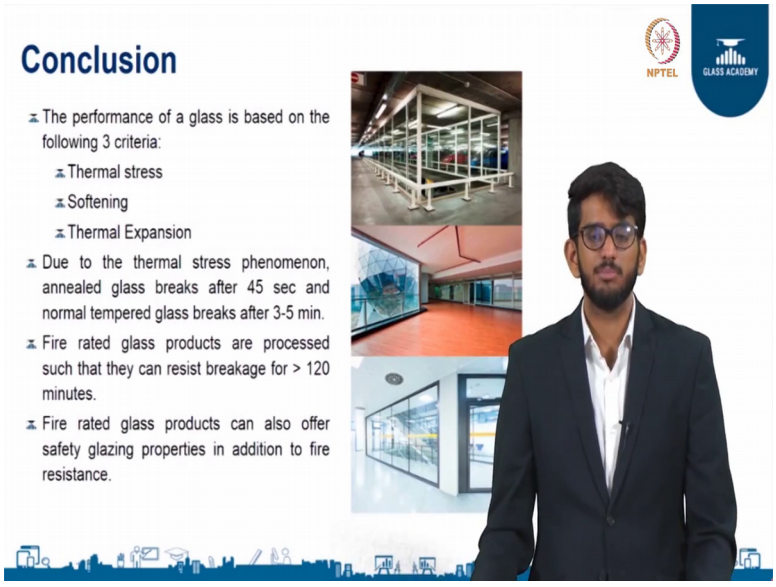

So, to conclude the performance of a glass is based on 3 criterias they are thermal stresses, softening and thermal expansion. We discussed thermal stress and we have seen we just saw examples of how glasses can shatter when they have a higher thermal stress temperature differential.

In some cases this temperature differential does not cause an immediate breakage in glass; rather it causes something called softening. So, the glass starts to attain a viscoelastic state and starts to soften and flow down. And the third criteria, the third performance. The third criteria on which a performance of a glass can be judged is definitely thermal expansion, because we are talking about close to 1200 degree. So, there is bound to be lot of expansion in the system, let us say a glass or the frame which holds the glass itself. So, due to the thermal stress phenomenon a fire resistant glass, an annealed glass normal annealed glass break at 45 seconds to 1 minute is what we saw.

Tempered glass will break within 3 to 5 minutes, if you remember the graph that I showed you.

Also if you are looking at fire resistance, fire resistance applications which require fire resistant products. The rating that you generally require is 2 hours a 120 minutes. So, here we are talking about the use of the misuse of glass which can only with stand 5 minutes of fire for applications, which require up to 2 hours of fire protection. So, yeah so the next part of the session is it is going to be about how, you know how specialty fire resistant glasses are classified, where they find application, what the norms are.

Ah, but it is also interesting to know that a fire resistant glass can also offer other benefits, which are very typically see in the other value added products like a laminated glass, or a tempered glass. Fire resistant glasses can also offer safety glazing properties. And also in addition to this it can also offer you a tempered glass advantage so that even if someone wants to, even if the glass was to with stand an impact load it would still break into small shatters. So, it is at the end of the day, it is about finding the best of every other product and then combining it into a product which best suits the application.