Glass in buildings: Design and Applications
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Lecture - 44
Glass in Passive Fire Protection

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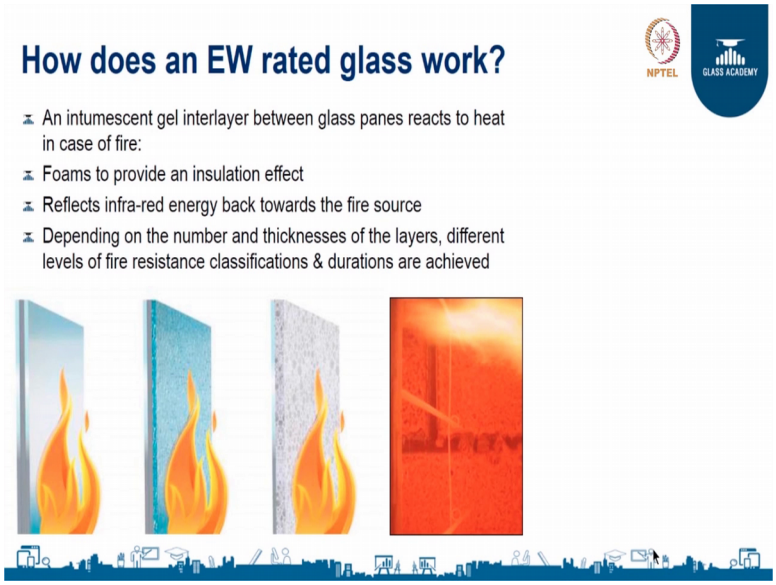

As you just saw in the video that we played, EW rated glass has much more advantages compared to any rated glass. In terms of cutting down the amount of heat radiation that passes through it. You would have also observed that the average temperature in the vicinity, and also the average temperature of the glass surface itself is much much lesser than what you see in any rated glass, when compared against near EW rated glass. The whole reason behind such a phenomenon is because we add something called an intumescent gel, and intumescent interlayer that is added between two layers of glass.

In the event of a fire, the interlayer in between the two panes of glass, start in reacting and start foaming up. So, typically to explain in a very graphic way, it comprises of two layers of glass with an interlayer in between. So, during a fire one of the glass pane breaks, and exposes the interlayer in between to the fire. And this interlayer in between starts foaming up, which is what you would have seen as a white reaction in the video that you just saw. So, based on the thickness of the interlayer, we are able to achieve and

also based on the quality of the base glass, and a lot of other parameters, we are able to achieve higher levels of fire protection.

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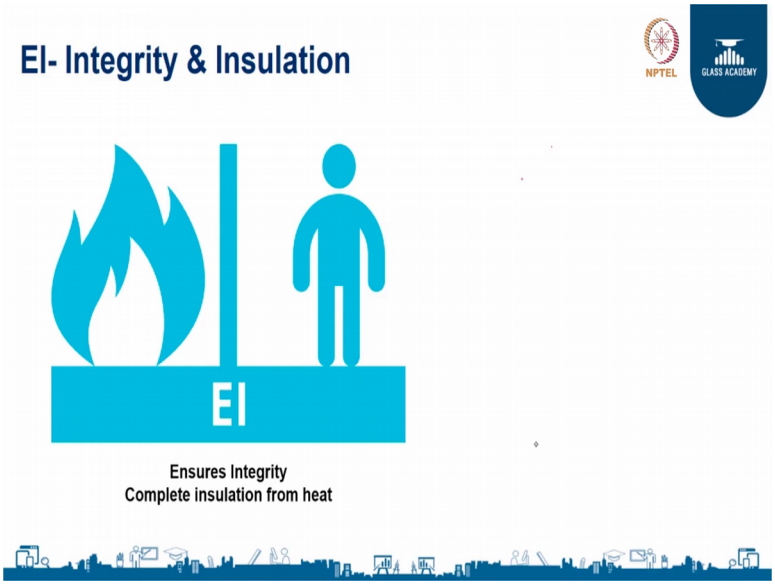

The third type of fire resistant glass is called EI, which stands for Integrity and Insulation. In an EI fire resistant glass, if you can observe the infographic, you can see that the whole infographic is in an icy blue colour, which means that there is absolutely no heat radiation passing through the glass or there is very minimal heat radiation passing through the glass. The person standing right next to the glass was shown to be standing very close the glass, and is no way trying to move away from it. This is because there is no potential risk or there is no hazards that could arise from radiant heat because of the insulating properties of the glass.

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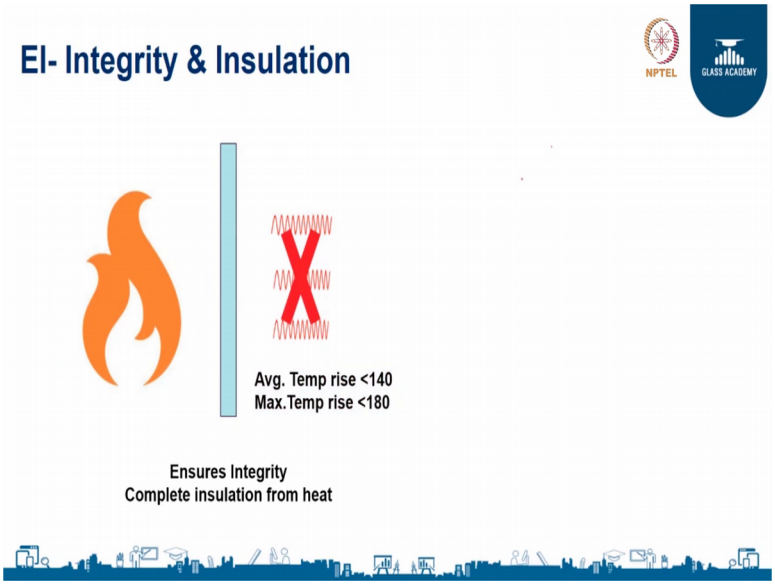

So, this is possible, because an EI glass comprises of multiple layers of glass and multiple layers of interlayer. So, during a fire, each interlayer jumps to action and absorbs all the heat as the intumescent reacts and foams up into an agent. So, if you look at the temperature values in an EI rated glass, the average temperature rise on the glass is never more than 140 degrees. And the maximum temperature rise is never more than 180 degrees.

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So, you can see through this infographic that in an EI glass most of the heat is just reflected back, there is absolutely no or very minimal heat transfer through the glass. As a result, it is the most, best fire resistant glass that is ever available. To conclude, there are three types of fire resistant glass. The E, EW, and EI, where E rated fire resistant glass stands for Integrity, which gives you the most basic property of a fire resistant glass, which is do not lose its integrity, do not lose its structural rigidity during a fire.

The second type of fire resistant glass is EW, which means for integrity and radiation control. An EW fire resistant glass comprises of two layers of glass with one layer of interlayer in between. These interlayers are called intumescent interlayers, so which means that they foam up during a fire. Any material, which foams up during temperature rise is called an intumescent. So, we pose such a material in between two layers of glass. As a result, what happens is during a fire, the intumescent absorbs most of the heat from the fire. As a result, there is no heat radiation left to be transmitted to the non-fire side.

And the third type of fire resistant glass is called an EI fire resistant glass, which has multiple layers of glass and multiple layers of gel. As a result, what happens is as the heat passes through each layer of gel. These the interlayers foam up and as a result there by cutting huge amount of radiation that could otherwise pass through the glass, and set ablaze all the combustible items in the vicinity.

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Next, I am going to take you through the National Building Code of India. And focus specifically on its part 4, which talks about fire and life safety. Since, it is a life safety product that we are talking about it is strictly worked by mandatory norms, which are mentioned in the official documents like the national building code. The national building code of India is a very comprehensive building code, which is released by the government of India. It focuses on providing guidelines to control and to regulate the building construction activities.

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So, if you look at the part 4 of the national building code, it talks about what are the requirements to ensure to prevent fire and also to ensure safety in relation to fire and the fire protection of building. It is very mandatory for any building that comes up in India, to adhere to the requirements that are mentioned in part 4. Again, the title of the part 4 of the national building code itself is fire and life safety.

So, it is prepared, the document itself is prepared by the bureau of Indian standards, which has close to 22 expert panels and around 1000 experts, who sit, and who work on this document. It was first published in 1970, and now currently we are at the 3rd revision, which is in 2016, and it was released in the month of January last year. So, I will take you through some of the requirements, which are mentioned in the national building code especially in the part 4 with respect to fire safety.

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So, the national building code defines each type of building based on the type of occupancies. So, based on the type of application, it is used for the type of use, type of the number of occupants or the kind of material, which are stored in these places. A building can be or any area of occupancy can be split into these type of occupancies. So, they range from residential, to educational, to institutional, to industrial buildings, to hazardous buildings, to storage buildings. So, as you can see a wide range of types of occupancies are covered in this table.

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First, I will take you through the fire resistance requirements, which are mandatory as per NBC for general exit areas. So, these are some mandatory requirements, which apply to all fire exits or general exits in any area of occupancy.

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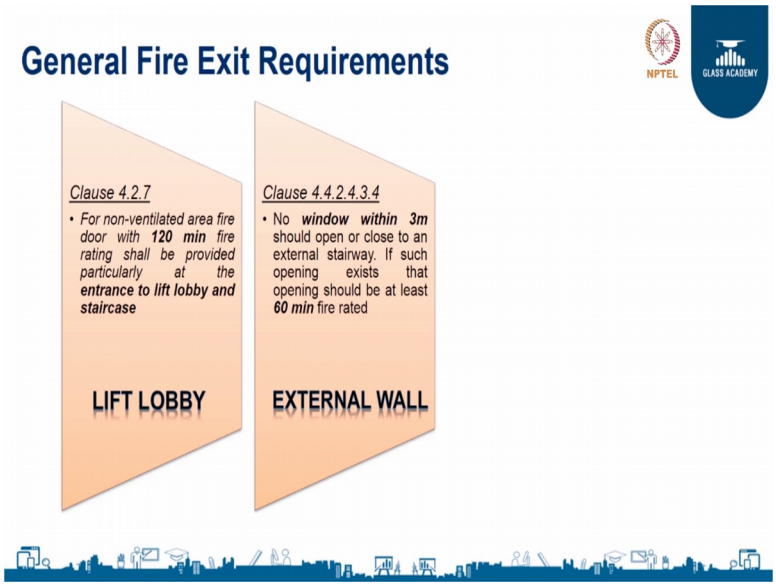

So, we will actually try to cover most of these occupancies, but I will try to focus on some core areas, which are mentioned in the national building code. The lift lobby of any building as per the national building code, I have the clause number written there, it is clearly mentioned that for a non-ventilated area a fire door of 120 minute fire resistant shall be used. So, now, you see how a fire resisted application, how people can arrive at you know, what type of fire resistant material to be used or what is a fire resistant system that we need to use.

So, you see the document clearly states that for a lift lobby application, one needs to use a 120 minute fire rated system. Again, we also need to make give emphasis on the fact that a fire resistant glass is never used as on its own. It is always a part of a system like for example, if you are going to be using a fire resistant door, the glass is a part of a system that comprises of several other parts, like the frames, like the styles, like the hardware's, like the fittings, like the gaskets. So, all of these materials come together to play a role in providing fire protection, so which is why it says, fire door with 120 minute fire ratings. And obviously, a fire door for 120 minute rating will use a fire resistant glass of equivalent or more fire resistance.

Similarly, it says that no window within 3 meter should open or close to an external stairway. So, as a result what happens, if you have any window opening to an external stairway, there is a possibility that the fire could spread out into the fire exit passage through this windows or if you have such windows, they should be at least 60 minute fire rated, because 60 minutes gives you enough time to evacuate all the occupants.

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So, here are four some examples of stairways, where you can use a fire resistant glass, you see an internal fire exit stairway. So, if you do not use a fire resistant glass or a fire resistant system, as I said you know fire resistant system comprising of fire resistant system in this areas, what happens is there is a possibility that the fire can get into the path of aggress or the exit stairway through, which people are evacuating. And as a result, it can bring people into the path of danger during a fire.

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Here is another example of stairway door, in which you can see that a fire resistant glass is used in a fire resistance system. Again, if we do not use a fire resistant system in this place, there is a possibility that the fire could spread from the area of occupancy into the fire exit passage. So, when people are being evacuated through this areas, if there was a fire spread into this region into this area of evacuation, then it hinders the whole evacuation process.

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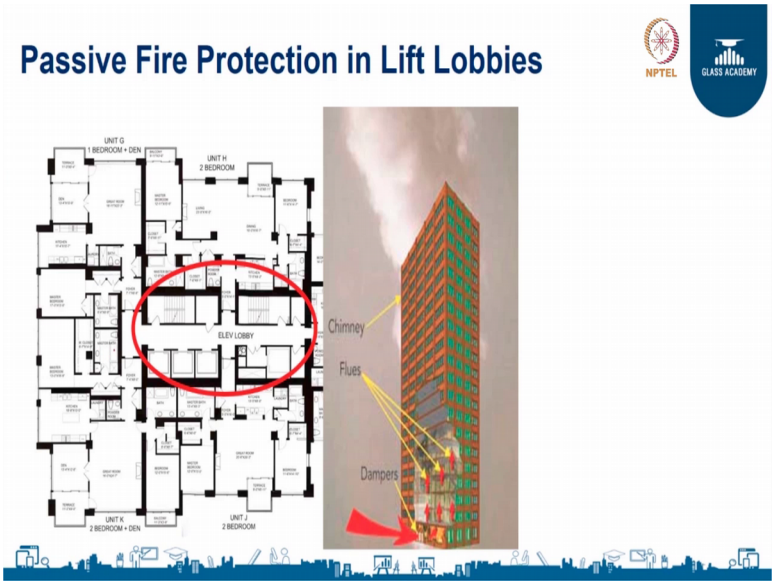

The next area, where one needs to pay focus on passive fire protection is in lift lobbies. So, if you look at the slide, you will see that I have given, I have mentioned the floor plan of a typical floor plan of a building, where there is a lift lobby an elevator lobby. Whereas, if you see on both sides of the building, on both sides of the lift lobby, you can see how the building, how the floor plan has been laid out you so typically in such a floor plan, you get out of the lift, and you walk into your area of occupancy. But, then there is no door or there is no fire resistant material, which forms a barrier between the lift lobby and the area of occupancy.

Now, let us imagine a typical scenario. A lift is always used in buildings, which has multiple floors. So, obviously the building is going to be a tall building, if not high riser, it is still going to be tall building at least with 4 or 5 floors. Now, if there is a lift lobby with no doors separating the main area of occupancy with the lobby, and god forbid if there was a fire to happen in any one of the areas of occupancy, there is a high possibility or there is a huge risk of the fire coming into the lift lobby, getting into the lift shaft, and going all across the building. Like, how you see on the right there the image, you see that the whole building act like a chimney, when the lift fire can spread through the lift shaft across all the floors. So, it is very important to make sure that the lift lobby region is always enclosed on both sides.

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I will show you some examples. So, what you see on the screen is a reference of a lift lobby, in which you see that there is a fire resistant door on the other side. So, the door is right here, so that is a fire resistant door. So, typically what happens is, when people exit from the lift, they walk to the left. And then, they open the door, and then they get into the area of occupancy.

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Now the advantage or the need to use a fire resistant door here is that this is the view from the other side from the area of occupancy. The need to use a fire resistant door is here is such that the fire will not spread from the main area of occupancy into the lift lobby, because there is a fire resistant door, which will prevent the fire to spread from the fireside to the protection side.

So, it will never go in to the lift lobby, and if you can prevent the fire from going the lift lobby, you can actually protect the entire building from being on fire. So, as now we go back to our basics. So, the whole point of passive fire protection is to make sure that the fire is restricted or be contained in to the point of source itself. So, the whole point of passive fire protection is to make sure that the fire does not spread. And, how we use fire resistant walls, and doors and floors to achieve this purpose.

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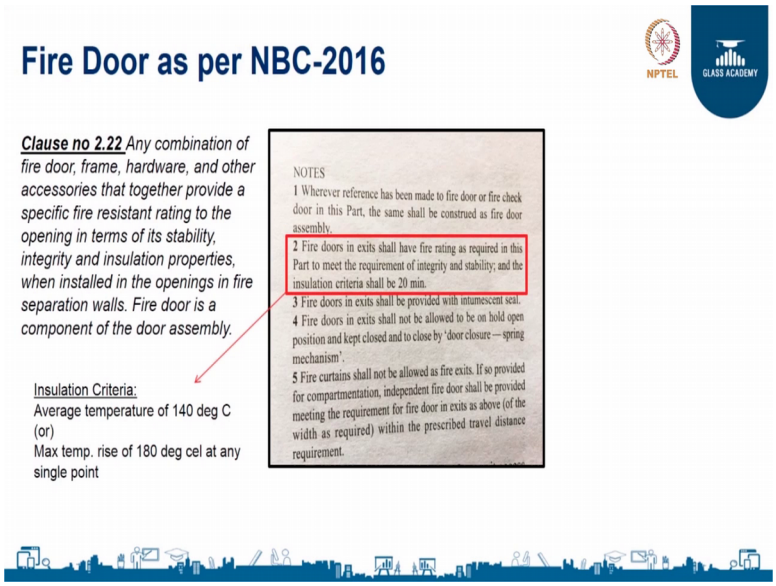

Next, I am going to be talking to you about the fire resistance requirements mandatory as per the NBC for fire door applications. So, if you can see, you can read the clause number there, it says that fire door in exits or if you see the image on the right, it has been highlighted in red. It says fire doors in exits shall have fire rating as required in part 4 to meet integrity and stability; and insulation for 20 minutes.

So, in some parts of the building code, it also says that all fire doors need to be insulated or it needs to be insulated for at least duration of 20 minutes. So, now we all know what EI stands for right, it stands for Integrity and Insulation. So, the building code states that irrespective of the area of application, where the fire door is fitted. All doors need to have an insulation for a duration of 20 minutes.

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Also all fire exit doors needs to have panic bars and door latching assembly. So, if you noticed, your fire doors in any mostly you would have seen it in your schools, colleges, public places, theatres, multiplex, shopping malls, you will have you would have seen fire exit doors, which have a panic bar. So, during a fire in a state of panic people can actually push the panic bar and just go out into the into the exit passages. And then find their way to the evacuation.

So, all fire doors need to be fitted with the if you can see the image on the bottom corner, here you can see that all door latching assembly incorporating an actuating member or a panic bar that releases the large bolt upon the application of force shall be a part of a fire exit door. And these doors shall need to be provided on exits, so that in a state of panic people can actually find the get to the into the passage of evacuation with ease.

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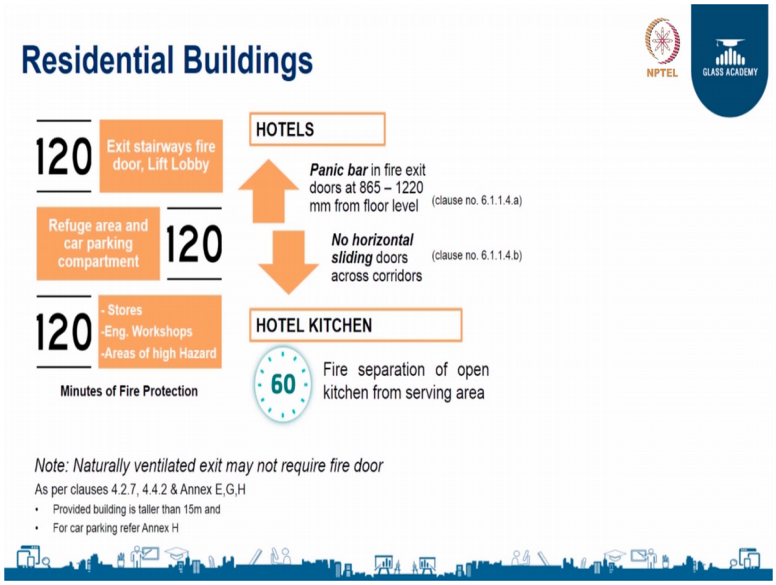

Next, I am going to be focusing on the fire resistance requirement mandatory as per the NBC with separate with regards to specific occupancies. So, in a residential building, the national building code state that exit stairways fire doors, and lift lobbies need to be fire rated for 120 minutes. As I explained, it is very important to enclose a lift lobby with a fire rated system. Otherwise, what happens is there is a possibility of the fire spreading from the non- fire side to the non-fire side. All for the fire to spread into the lift lobby, and then into the lift shaft, and then it will spread across the whole building.

Also it needs to be used in refuge areas, which is another main topic that I will be touching upon and also in car parking compartments. Again in hotels, I just spoke about panic bars. So, we also need to use fire resistant glass for 2 hours in hotels, but with panic bar in fire exits. And also in hotel kitchens now a days you see a lot of open kitchens, and live kitchen counters. The regulations are such that you one needs to use a 60 minute fire rated glass in such application. So, next time you visit a live kitchen counter, where you see a chef preparing a dish right behind a glass, please check you know if it is a 1 hour fire rated glass, because as per the regulation, it has to be a 1 hour fire rated system that has to be in place.

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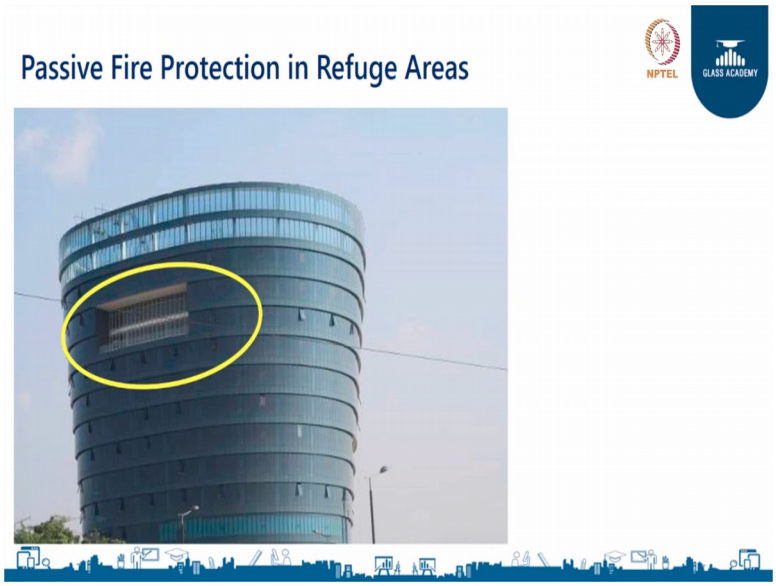

Next, I am going to be talking about passive fire protection in refuge areas. A refuge area is that part of a building is especially seen in high rise buildings, where you know if the fire was to start from a lower floors of a building, evacuation of the people on the top floors will become a challenge. So, it is a general practice to provide open corridors like what you see in the image, where people can come and gather at the place. And then later on they can be evacuated using lifts and cranes.

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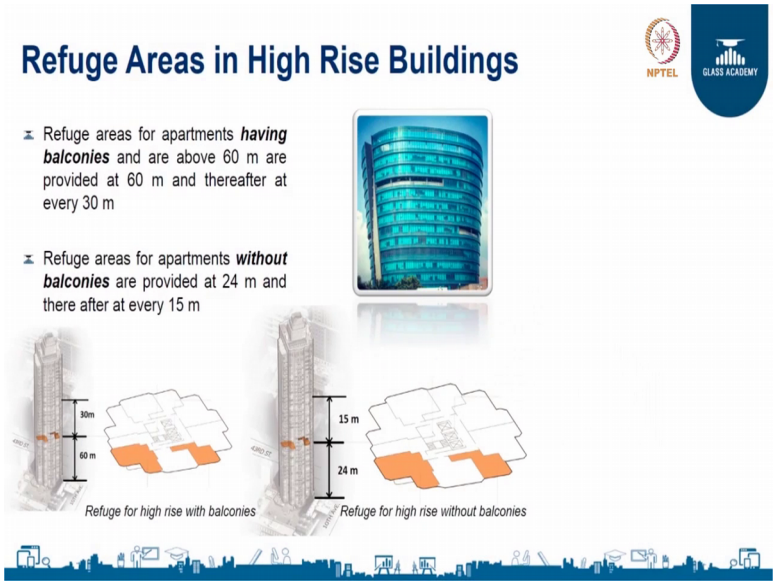

So, the reason why we need to look at this application is, because the building code says that every high rise building so if it is an apartment, and if it is an apartment that we are talking about, and if the apartment does not have a balcony. Then there needs to be a refuge terrace at every 60 meters at every 24 meters, and then at every subsequent 15 meters, so that at first 24 meters there is a refuge terrace, and then for every 15 meter, so that people on the higher floors have a chance during a fire. When the when an alarm goes off, they can all come to the refuge area and stand there take refuge there that is why, it is called a refuge area, where you known as the fire fighters try to shutdown the fire and then come up come up for rescue.

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Here are some examples of how glass is being used in refuge terrace. So, you can see if you do not use a fire resistant glass again, the why do why does one need to use a fire resistant glass in refuge area is, because there is a possibility that the fire can spread from the area of occupancy to the place, where people are taking refuge.

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The whole point of a refuge terrace is to make sure that people can be kept safe from the fire. So, it is very it is of paramount importance that we use the right type of materials in this areas right type of systems, so that you know people can take refuge in this area safely.

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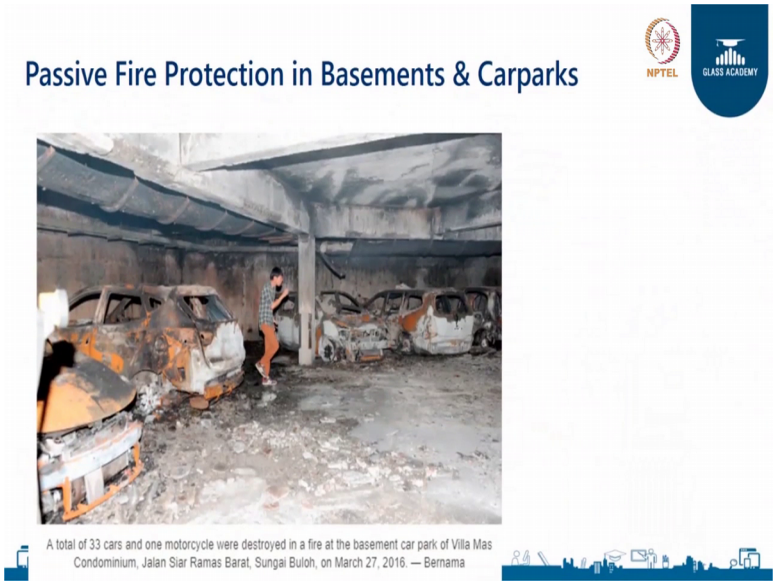

The other region that I am going to be talking about is the use of fire resistant materials in basements and car parks. So, here is a very recent article of fire accident in Malaysia, where you have seen that lot about 33 cars and 1 motorcycle were destroyed in a fire at

the basement in Malaysia, because that the fire spread from parts of the building all the way to the basements. And now a days we see a lot of mixed use buildings, high rise mixed use buildings coming up. As a result of which and there is very little land space left for parking, especially in dense countries in the Asian and southeast Asian region.

We see a lot of parking in basement parking provisions coming up. So, this parking go all the way up to 7 floors under the ground. So, as a result it is very important to make sure that there is no way that the fire can spread from an area of occupancy into these areas, because these are all narrow shafts that we are talking about and it is called stag pressure. So, as a pressure when there is a pressure difference fire has a tendency to go into region of low pressure, and then it just spreads violently into those areas.

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So, if you look at it, every basement will open up to a lift lobby, like you see in this image in the slide here, you can see the images here. So, this is the entry from a basement into a elevator or a lobby lift lobby. So, as again the same example, if we do not enclose a lift lobby, there is a possibility that the whole building itself can be on fire. As a result, it is of much importance to make sure that the lift lobby of any building, be it basement or be it the upper floors of be it a car park needs to be enclosed. And as a result, it says that it needs to be enclosed for a duration of 120 minutes as per Annex H-2.c, it says it needs be there it says 120 minutes.

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Next another very important area, which we need to look at is hospitals. As I said, the goals of fire protection or life safety, property protection and continuity of operation in that order. So, the third point, which is continuity of operations means that if there is a very important activity happening in a place, and if fire can cause the us to stop that activity, which is which should otherwise not be stopped or which should otherwise not be interrupted, then it becomes a major road block for us.

So, hospital is one such place, imagine all the people in the ICU's and the operation theatres these are these are activities, which cannot be interrupted at any point of time. So, as a result there are some places in hospital, where beyond life safety and property protection. The main focus is the continuity of operations that can be ensured.

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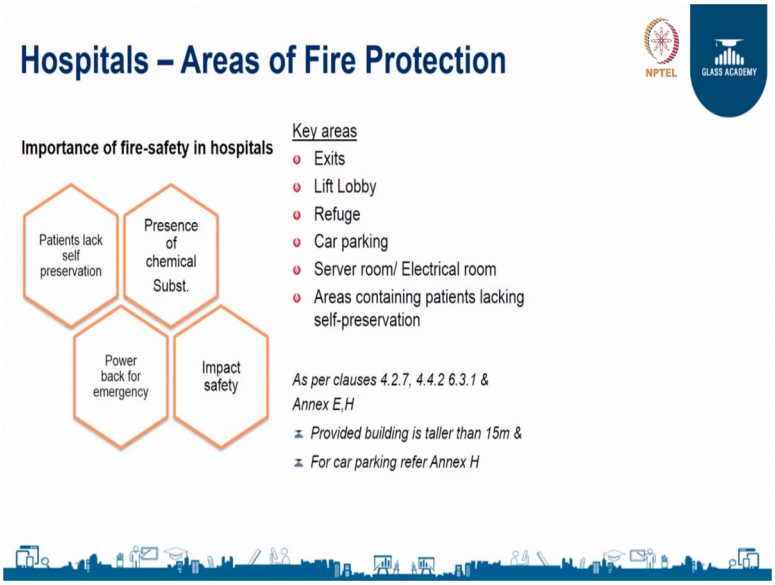

So, why is it important to ensure fire safety in hospitals, because patients lack self preservation that is one point. There is a lot of chemical substances that are inside the premises of hospital, which could otherwise be combustible. And also there is power back for emergency, and also impact safeties again one thing, because you see a lot of stretchers, and wheel chairs, and lot of traffic going in and out of a hospital. So, it is very important to assure the best of all of these in one application. So, the key areas in hospital, where we can use a fire resistant glass or where fire resistant is of paramount importance is fire exits, lift lobbies, refuge areas, car parks etcetera.

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And as per the national building code, again I have the clause number written on the left, we need to ensure 2 hours of fire protection in operation theatres, ICU's recovery rooms, and delivery rooms. So, if you see all these rooms, these are places where you can not interrupt the activity or interrupt the operation that is happening inside that place. So, you need to ensure that whatsoever happens that the fire does not come into these areas of hospital for at least a period of 2 hours.

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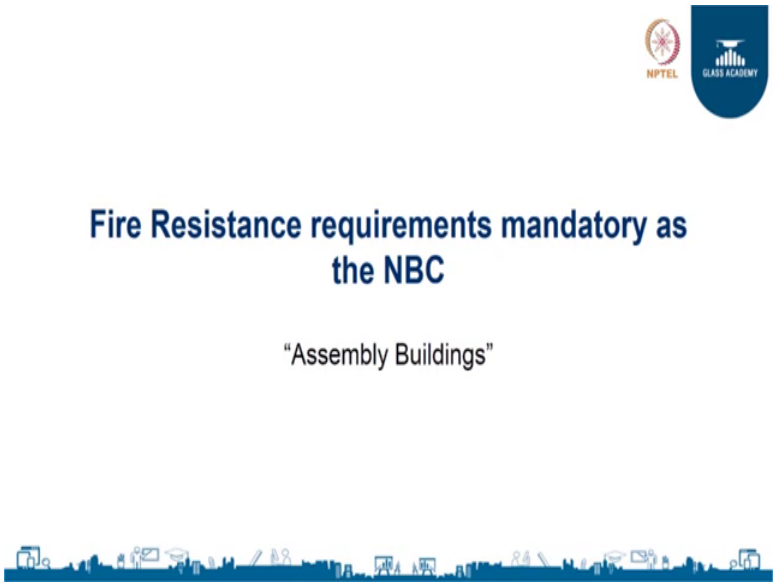

Next, I am going to be talking about the fire resistance requirements in assembly buildings. Assembly buildings are the type of buildings, where you have a lot of people gathering. So, you can take the examples of theatres or open theatres, where you can take the example of a marriage auditorium there are so many examples, where lot of people gathered. And if look at the national building code, it says more than 500 people, if they are gathered at the place, it becomes an assembly building.

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So, in an assembly building, again if you have so many people coming into a place, there is a high possibility that this has to be a lift lobby there. In order to take this people across several floors, you can take the example of a multiplex or a shopping mall, you also therefore there needs to be the adequate protection in the lift lobby region, in refuge areas, again if there are so many people coming in and out this definitely going to be car parking spaces, so we need to ensure right passive protection in the areas mentioned in this slide.

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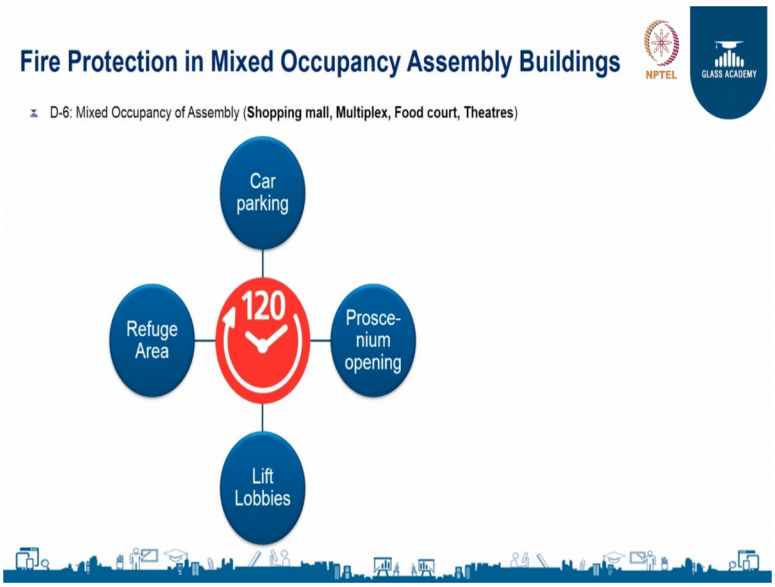

Also as I previously mentioned there is also lot of buildings, which are now coming up as mixed occupancy buildings. So, you have the same building having in which you have a shopping mall with the multiplex, and a food court, and theatres. So, these are called mixed use buildings. And again mixed use buildings all have lift lobbies, you see lifts and escalators, you see a lot of car parks, and you see and since these are all high rises there needs to be refuge areas, where people can come and assembly during the time of a fire. So, all these regions in the in the building need to be need to use a 2 hour fire resistant system, be it a glass door or a glass partition.

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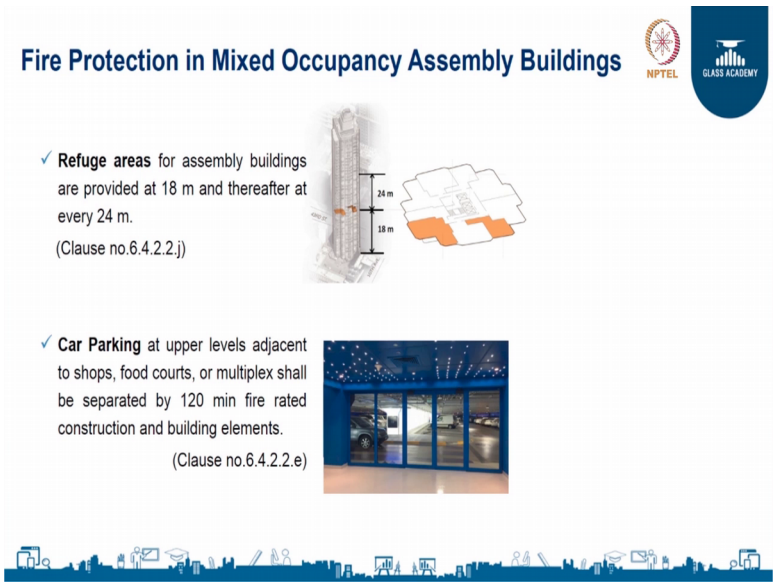

So, again refuge areas for assembly buildings should be provided at 18 meters and then at every 24 meters, like you see in this image. And at car parks should have the car parks at upper levels, it is not just in the basement at now a days you see car parks, you also see it in upper levels should be separated from the main area of occupancy with 120 minutes fire rated construction and elements. So, if you are to use, like you see here you see, you use a lot of glass in the car parks and basements. So, this glass and the whole system the fire is that the fire rated door in which the glass is used needs to be a 2 hour fire rated system.

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Next, very important area is the metro station. So, again in metro stations, you see more or less the same areas, but an interesting addition to the metro station would be control room and machine room. So, again it is going back to the continuity of operations. In a metro station one needs to ensure that the control room does there is no hindrance in the activities that happen in the control room. At the same time control room use a lot of glass, in order to have transparency. So, it is very important to use the fire resistant glass in the control room and also in the machine rooms.

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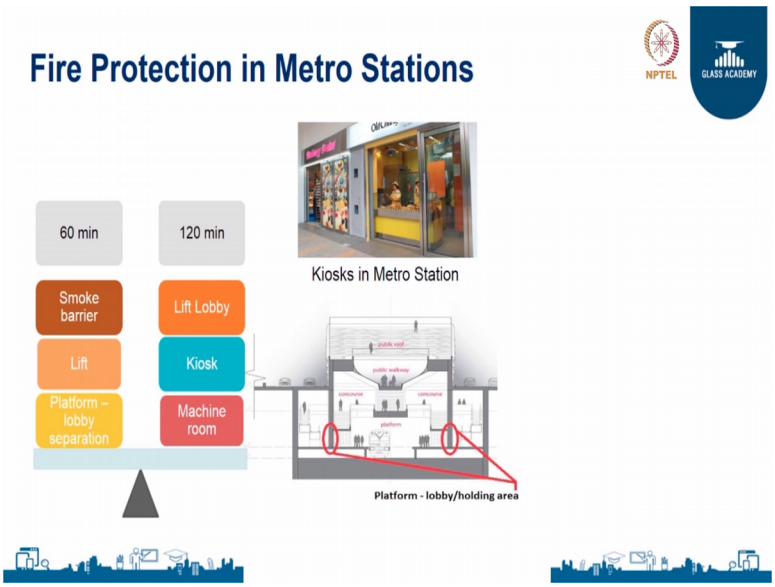

Also as per the regulations the Kiosks in metro stations, you need to use 2 hour fire rated glass. So, you can see the table there, it says that smoke barriers, and lifts, and platform lobby separations need to use 60 minutes fire rated glass. Whereas, the lift lobbies and kiosks need to use machine rooms, obviously the control rooms need to use lot of need to use 2 hour fire resistant glass.

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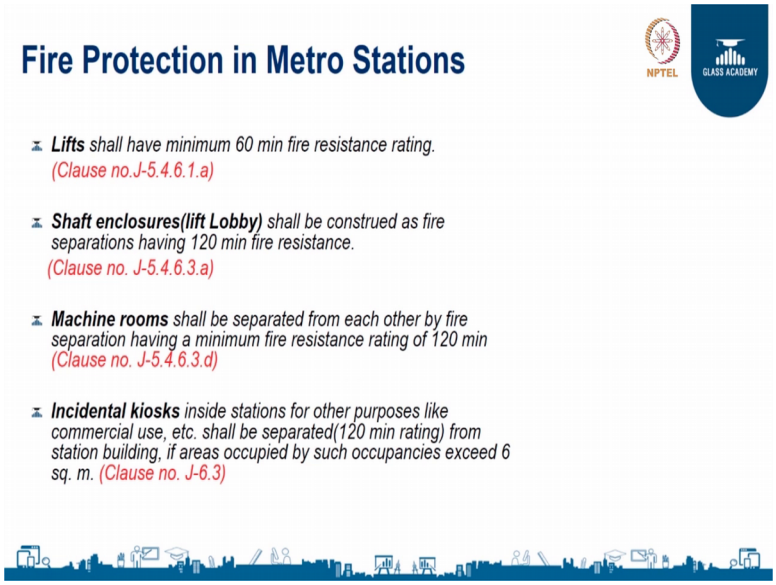

So, again repetition of what I said with their clause numbers, you see you see a combination of 60 minute and 120 minute fire protection requirements in metro stations. Mostly, as I said lift lobbies, machine rooms, control rooms, etcetera.

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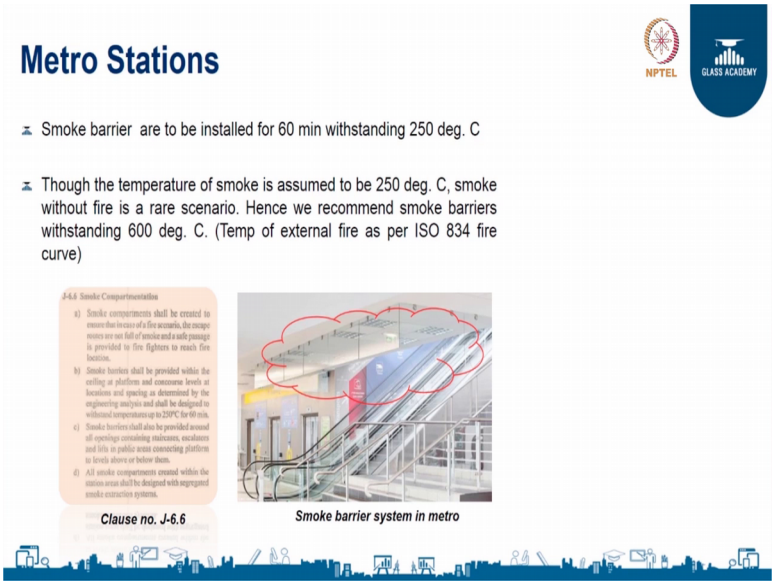

Also another interesting application of glass in a metro station is a smoke barrier, which you see in your concussions of your escalator. This is to make sure that the smoke can be diverted to the smoke extraction units. This smoke barriers are always installed smoke tested as per the smoke barrier systems. The smoke barriers are to be installed for 60 minutes of duration, which throughout which it can withstand a temperature differential of 250 degrees, but we see that there can never be smoke without fire.

As a result, it is always advised to test the smoke barrier system to withstand a temperature differential of up to 600 degrees which is also the, what is mentioned in the ISO standards. The ISO 834 curve says that an external fire will always have a temperature rise of 600 degrees. So, in a metro station, it is again smoke barrier systems, which find application. In addition to fire rated systems, because smoke and they cause a lot of panic, nobody can predict the kind of damage that could happen, when you have smoke that can reach up to temperature of 600 degrees itself.

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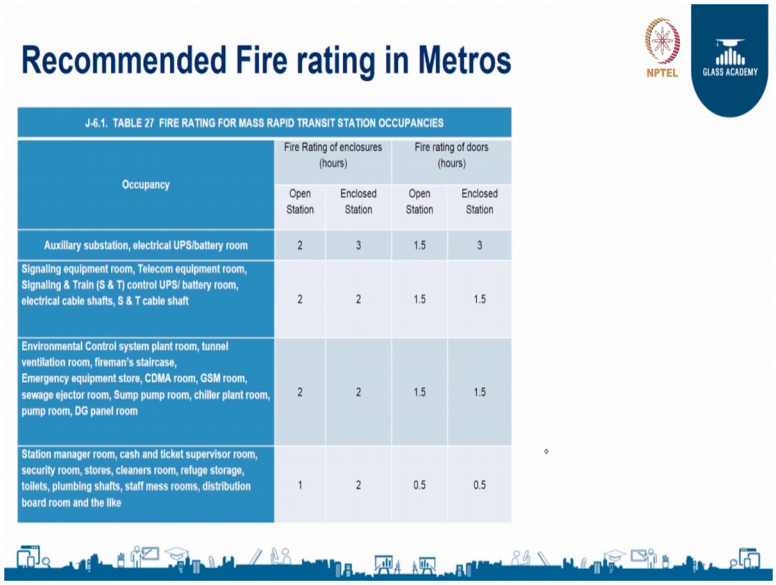

J-6.1. TABLE 27 FIRE RATING FOR MASS RAPID TRANSIT STATION OCCUPANCIES

Occupancy	Fire Rating of enclosures (hours)		Fire rating of doors (hours)	
	Open Station	Enclosed Station	Open Station	Enclosed Station
Auxillary substation, electrical UPS/battery room	2	3	1.5	3
Signaling equipment room, Telecom equipment room, Signaling & Train (S & T) control UPS/ battery room, electrical cable shafts, S & T cable shaft	2	2	1.5	1.5
Environmental Control system plant room, tunnel ventilation room, fireman's staircase, Emergency equipment store, CDMA room, GSM room, sewage ejector room, Sump pump room, chiller plant room, pump room, DG panel room	2	2	1.5	1.5
Station manager room, cash and ticket supervisor room, security room, stores, cleaners room, refuge storage, toilets, plumbing shafts, staff mess rooms, distribution board room and the like	1	2	0.5	0.5

These has some of the recommended fire rating in metros as per the national building code. So, again you can see a lot of machine rooms, and control rooms, and you see that the fire rating requirements are between 1 hour, and 2 hours, sometimes 3 hours as well.

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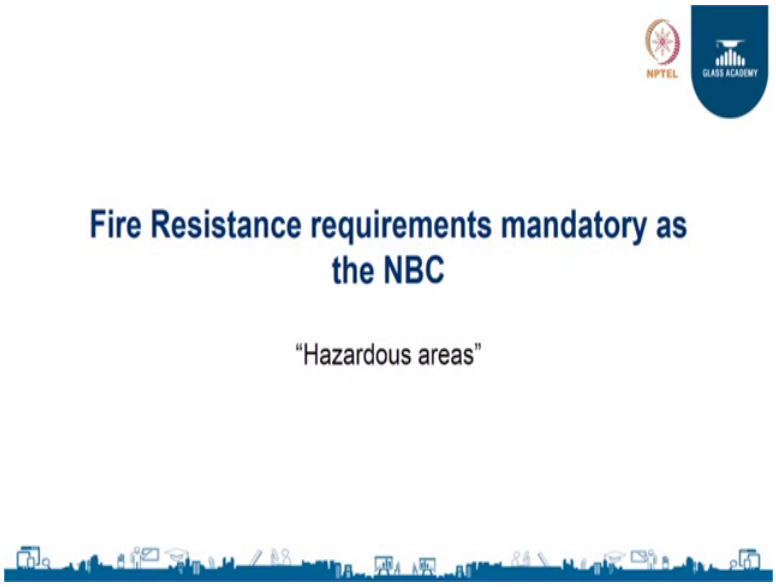

Finally, I will take you through the fire resistance requirements in hazardous areas, what qualifies as an hazardous area, hazardous areas are areas where possibly you can store hazardous chemicals or hazardous materials. Or possibly you have something like a boiler room or a fire command center such areas in buildings are called as or termed as

hazardous areas, they are been grouped under hazardous areas. So, since these are hazardous area, there is high possibility that you could face high temperature rise because of a due to fire because of the presence of chemicals or any other materials.

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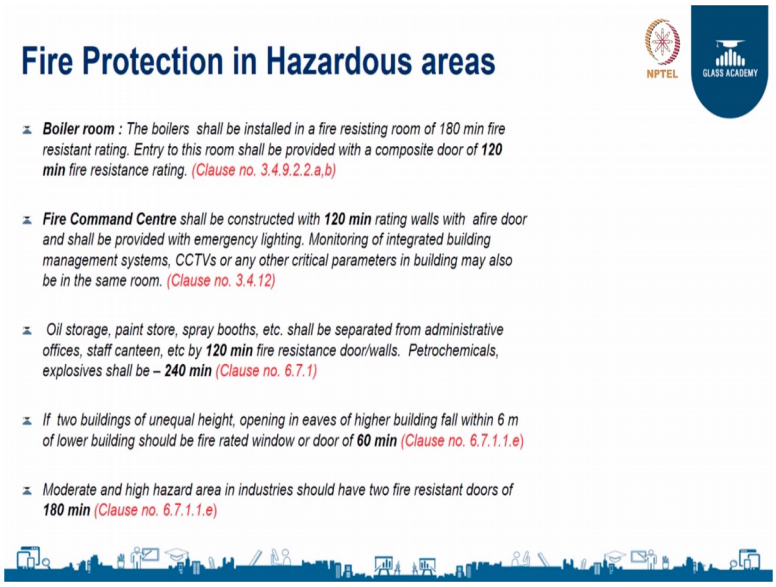

So, the hazardous areas includes rooms like the boiler room or rooms, where you could store oil paints or spray or chemicals or any such materials. Now, in such areas there is a high possibility that that can begin in such areas will be of high intensity. And it is very important that we look at longer duration of fire protection, which is clearly stated in the NBC as well. So, you see if you look at a boiler room, it clearly states for a 180 minute fire resistance rating or if you look at a command center nothing less than a 2 hour fire resistance rating.

So, again it depends on case to case basis, but if you look at a typical application, like a residence, you see an application in lift lobbies, you see application exit stairways. If you look at a hospital, it is going to be ICU's, and operation theatres. If you look at a metro station, it is going to be kiosks, and control rooms, and machine rooms. If you look at an industry, it is going to be hazardous areas, boiler rooms, storage rooms. So, again the applications are different based on how you know the fire of resistance, how fire could occur or how fire could spread in each of this application the duration of protection changes.

But, but if you look at it most commonly, it is within the in the lift lobby regions, where it is of utmost importance. We have seen incidents in the past like the in famous Grenfell tragedy or we have seen multiple incidents. Like for example, the address hotel fire in Dubai on the New Years Eve. So, these are all incidents where people have learned tough lessons based on the use of wrong choice of materials or due to poor planning. So, at the end of the day fire safety needs to be given utmost importance, we need to learned from incidents that have happened in different parts of the world. We need to adhere to the norms, which have been laid out by the legislatures by authorizing bodies. And respect these norms and make sure that we contribute to making this world a much more safer place.

Thank you so much. And I hope this session was very much useful to you.