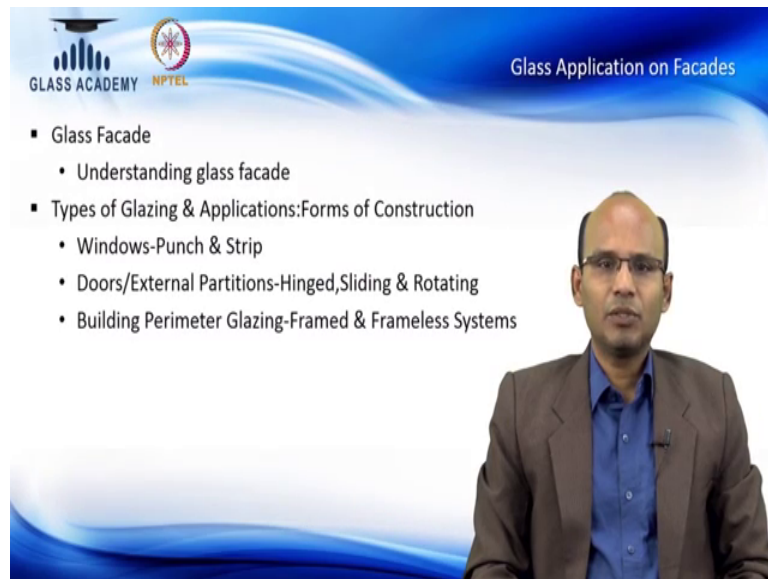


Glass in buildings : Design and Application
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Department of Civil Engineering
Indian Institute of Technology, Madras

Lecture – 55
Glass Application on Facades

Hello everyone. My name is Rajan Govind.

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The slide features a blue and white wavy background. In the top left corner, there are logos for 'GLASS ACADEMY' and 'NPTEL'. The title 'Glass Application on Facades' is in the top right. A bulleted list is on the left, and a video inset of the professor is on the right.

- Glass Facade
 - Understanding glass facade
- Types of Glazing & Applications: Forms of Construction
 - Windows-Punch & Strip
 - Doors/External Partitions-Hinged, Sliding & Rotating
 - Building Perimeter Glazing-Framed & Frameless Systems

I will be taking through the session in 2 parts basically starting from a Glass Application and Designs, and then little more detail on Engineering and Design Aspect of this. First of all, glass facade as we can define in many different ways, understanding the glass facade required multidiscipline skills, little architectural, engineering skills to understand the designs. And glass facade is been applied in many different forms in buildings such as small as like a glass windows or maybe large application in commercial buildings.

So, this section we will be taking through many different forms of construction, design aspects and the design widely where is where it is been applied.

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Glass Facade

Understanding Glass Facade

Architects increasingly seek to bring natural environmental factors into the interior of buildings by maximizing natural daylight. This is achieved through the use of larger glazed areas in façades and roofs, and entirely glazed façades, where the glass is a structural component of the building.

In hot climates, reliance on air conditioning, which would otherwise be increased by such larger glazed areas, is mitigated by the use of advanced solar control glass, allowing the sun's light into buildings, while blocking much of its heat.

In cold climates, low-emissivity glass reduces heat loss, while allowing high levels of valuable free solar gain to heat buildings without significant loss in natural light. However, in the summer, unless combined with solar control glass, it can become uncomfortably hot.

Understanding the glass facade architects perspective, the glass facade glass is one of the fascinating material, they like to use in many different forms in the building; it may be from as small as like a window application or maybe a very large like a glass building application. And is increasingly becoming common to use the material because of the light rays, and highly transparent and technically advanced building materials.

However, use of glass need some basic engineering and design knowledge from architectural perspective to the structural engineering perspective. Glass facade is used there is no limitation, we can use in hot climate or cold climate or various different climates because of the availability in many different forms. So, we will be take through the basic understanding of the glass as well as some design aspect of it.

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Types of Glazing & Applications: Forms of Construction

Windows-Punch & Strip

Windows:

A window is an opening in a wall, door, roof that allows the passage of light, if not closed or sealed, allows air and sound.

Modern windows are usually glazed or covered in some other transparent or translucent material. Windows are held in place by frames. Many glazed windows may be opened, to allow ventilation



We will be showing this application of the glass in various different forms in buildings. For example, you can see we going to show about window application. As we know window is part of the essential part of the building you it may be a residential commercial. Windows primarily bring the day lights to the interior space. So, without that you will be surrounded by enclosed space without any connection to the external environmental. So, the modern windows use many different glass types like insulated glass, high performance glass, safety glass this many different forms used in window application.

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Types of Glazing & Applications: Forms of Construction

Windows-Punch & Strip

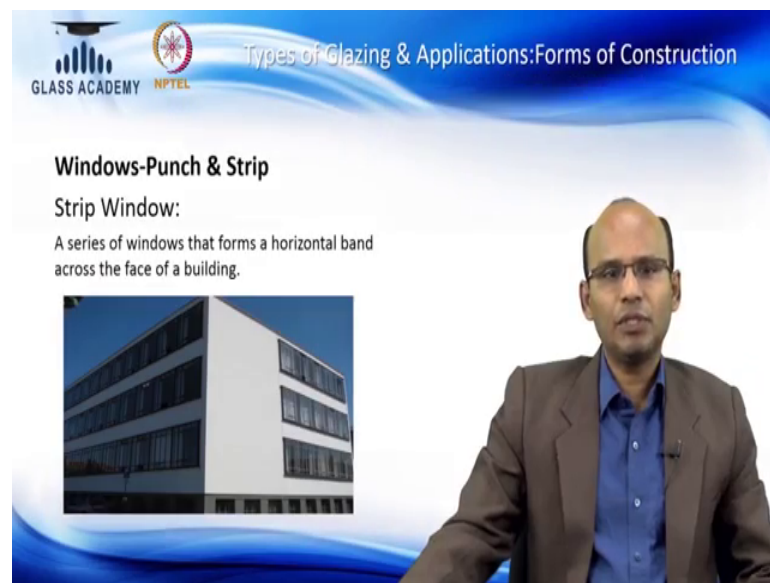
Punch Window:

Square or rectangular windows consisting of one or more pieces of glass surrounded by window framing. Punched windows usually "dot" the building façade unlike the ribbons of window wall. Punched windows can be quite large, and can constitute a significant façade feature.



As you can see in the picture window could be in many different forms, it could be square or rectangle or circular window or like a ribbon window continuously on building. And many different ways it is primarily defined by the architectural of the intent of the building, but the basic design intend is the same when we have a windows. You need to have some framing around the glass panels, and it need to be integrated well with a building envelope so that it does perform it is structural and weather requirements.

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The slide features a blue header with the text "Types of Glazing & Applications: Forms of Construction" and logos for "GLASS ACADEMY" and "NPTEL". Below the header, the text "Windows-Punch & Strip" is displayed. Underneath, "Strip Window:" is followed by the definition: "A series of windows that forms a horizontal band across the face of a building." To the left of the presenter is a photograph of a modern building with a prominent horizontal band of windows. On the right side of the slide, a man in a brown suit and blue shirt is speaking.

Windows we defining windows primarily in how it is getting applied, as you can see we call this as strip window. Strip window is showing it windows is applied used in large continuous like a ribbon type of windows, or rather than a square or a rectangular shaped points to windows. In this application the construction design is slightly different from the previous forms of typical windows. So, this is have a continuous frame top and bottom to support the glass, and it has some vertical in between members to support the glass. So, this design is slightly varied from the previous window concept.

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Types of Glazing & Applications: Forms of Construction

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Figure shows Difference B/W Punch & Strip Window

The followings are the different types of windows in the building

- 1) Fixed Window
- 2) Operable Window
 - i) Top Hung Operable window
 - ii) Side Hung operable Window

And this slide is showing the architectural terminology they used to punch the windows. As you can see the windows are punched from external envelope of the building. For many different reasons it gives some good architectural intent. At the same time, it is protected from the external direct exposure to rain and sunlight so, it has some shading. So, what you can see here it is called punched window is punched from the building envelope to little inside. And this is showing in a strip window which is in continuous format where the glazing is taken throughout the building in ribbon format.

And there are also the various features we need to be looking in the windows primarily is giving 2 functions. It brings a day light and it has to perform for ventilation. For ventilation the windows need to be able to open so, you will get a fresh air. So, ventilation is secondary primary requirement for functional aspect. So, we have to make sure the window able to open to bring the fresh air; when it try to open then design functional you have to make sure it is engineered and designed to perform functions.


So, we call in operable it could be open from the top or it could be side open. So, the 2 different primarily window opening; is either it could be hanging from the top you could open from the top, is commonly used in residential buildings we you can open from the side ways.

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Types of Glazing & Applications: Forms of Construction

<p>Fixed Window</p> <p>A window that cannot be opened, whose function is limited to allowing light to enter</p> <p>This type of window is used in situations where light or vision alone is needed as no ventilation is possible windows without the use of trickle vents</p>	<p>Operable windows</p> <p>Windows that can be opened and closed as desired by the occupant to provide better control of office space condition</p> <p>provides free cooling with use of fans operates as a back-up ventilation system</p>
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And this slide is showing various different form of window application in being a residential building or commercial building. In there are it is primarily defined by architecture and as well as a function requirement.

When you have a fixed window this is glass is fixed surrounded by the structural member; which is mainly aluminium frames to hold the glass, and is being fixed with the concrete openings. And operable windows as I mentioned it mainly in 2 different forms to open the windows; if you have a large window where the glass is opened from the top, it is called top hung window which is hanging from the top. We can see it is open from the top. And also there is most commonly used the windows we could see in majority of the building residential building especially. This type of windows is being used, these windows it give a good ventilation and it will give unobstructed view. So, the many ways as in residential this is one of the most preferable form of opening windows.

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Types of Glazing & Applications: Forms of Construction

Doors/External Partitions

1) Hinged Door

Most doors are hinged along one side to allow the door to pivot away from the doorway in one direction, but not the other. The axis of rotation is usually vertical.

A swing door has special double-action hinges that allow it to open either outwards or inwards, and is usually sprung to keep it closed.



We will try to go little further the glasses application is one is windows and the other one is could be external partition partitions meaning external wall, a glazed external wall, could be doors. There are many different application of the glazing in the form of windows, doors or external wall and many different ways. When we say door application is primarily to give access to the internal space it being a maybe a commercial shop, may be a residential window which is accessing to the open areas like, living room to balcony application where we call is a glass door.

And the when we have door construction is basically a glass door which is has 3 different forms. We can see it has to be able to open in vertical hinges or it could be a slide open. When we have a slide open you could see the door is fixed on the slide side, when it have a sliding it is rolling on the track. When it is rotating door you can see some pictures; is mainly used on hotel entrances, you maybe see a revolving door or rotating doors. So, the door is in many different ways it depends on the applications.

What you can see in this picture? This is side hinged door is the main entrance of this building you can see here. The door is fixed on the side so, it is a hinged door which is giving entrance to the building, and it has framed with the glass. So, this is one way of doing main entrance door which is hinged on this side and it gives large openings, and is essentially used in entrance to commercial building or may be a hotel entrances.

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Types of Glazing & Applications: Forms of Construction

Doors/External Partitions

ii) Sliding Door

A sliding glass door is a type of sliding door in architecture and construction, is a large glass window opening in a structure that provide door access from a room to the outdoors, fresh air, and copious natural light.

It is often useful to have doors which slide along tracks, often for space or aesthetic considerations.



There is another form of door is called sliding door, which is quite popularly used in large residential; where from access from living room to balcony or maybe living room to external spaces; being a garden is been used to here. You could see here the door big piece of glass this much glass panel is sliding on this frame. It will have a track on top and bottom, and this framed glazed panle is sliding on this. So, this is one way of applying into sliding door; which has much larger functional requirement like, ventilation access to external and protection from environment, and is used to close the space, if it is in air conditioned space.

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Types of Glazing & Applications: Forms of Construction

Doors/External Partitions

iii) Rotating door

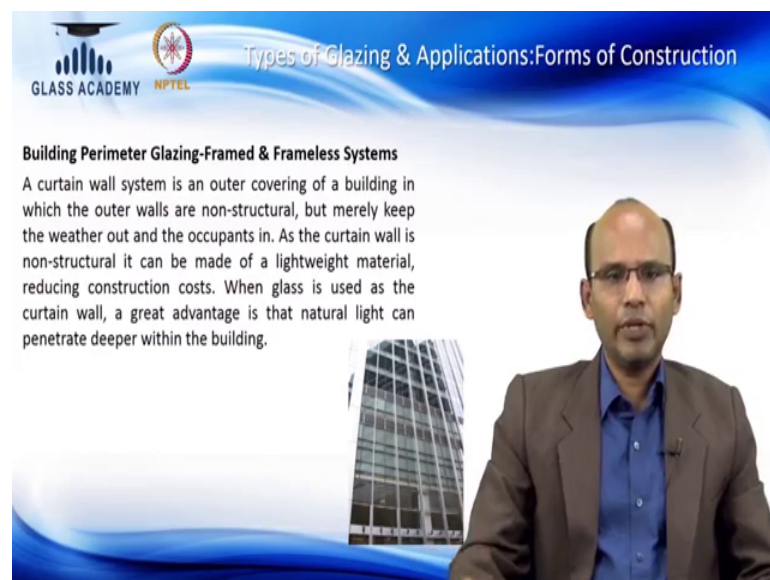
A revolving door has several wings or leaves, generally four, radiating from a central shaft, forming compartments that rotate about a vertical axis. A revolving door allows people to pass in both directions without colliding, and forms an airlock maintaining a seal between inside and out.



This is different form of door application, which is mainly used in large commercial buildings entrances or in the hotel buildings is revolving door or rotating door, the door has a central spindle here, and all this leaves has a framed support here, it could be aluminium framed support or sometime it may be a stainless steel framed. And this is rotating with the motor driven here at this detail. And it has automatic sensor.

So, then it sense the people moving and it will rotate. So, this is quite commonly used in hotel buildings or where there is a large traffic. The main purpose of this door this kind of doors are it gives a good protection from external to internal spaces. If it is too hot outside, when the doors open your internal air condition air got lost. So, that will prevent this so, it is mainly for good thermal performance to give the internal spaces.

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Types of Glazing & Applications: Forms of Construction

Building Perimeter Glazing-Framed & Frameless Systems

A curtain wall system is an outer covering of a building in which the outer walls are non-structural, but merely keep the weather out and the occupants in. As the curtain wall is non-structural it can be made of a lightweight material, reducing construction costs. When glass is used as the curtain wall, a great advantage is that natural light can penetrate deeper within the building.

So, going beyond the windows door application, this we are going to see the glass facade application. The glass is been widely used on main envelope of the building or main facades of the building in olden days we used to have bricks and walls with a small glass panels that is called windows. Here we are looking on glass is used to primarily on the building envelope or glass building, you may be seeing quite commonly on a high rises tall building; which is commonly used for many different reason like such as architectural design intend is flexible material we can use as it gives a lightweight construction it. So, that the overall weight of the building is reduced. And it gives a light

good internal comfort there are many functional aspect that brings to the glazing application.

So, we are going to see it is called glazing is used by with a framed or frameless. You can see in this picture there are vertical elements, mainly predominantly using aluminium frames; which is supporting the glass. Or sometime it could be also used without frames; which is called frameless glass like a glass boxes, or glass entrances mainly used on the large volume spaces; where you want to have a highly transparent glazing; where it is used minimum frames or sometime no frames. So, we define either framed and frameless system. The engineering design is very different from framed system to frameless system, and we will be taking little further on detail.

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Types of Glazing & Applications: Forms of Construction

Building Perimeter Glazing-Framed & Frameless Systems

The followings are the different types of Curtainwall systems

1)Framed Curtain wall System

Framed systems support the glass continuously along two or four sides. There are many variations of framed systems, most of which fall into two general categories

- a)Unitized CW System
- b)Stick CW System

2)Frame less Curtain wall system

Frameless systems utilize glass panes that are fixed to a structural system at discrete points, usually near the corners of the glass panel (point-fixed). The glass is directly supported without the use of perimeter framing elements. Glass used in point-fixed applications is typically heat-treated.

- a)Spider Glazing

Framed system if you are primarily talking about framed system it can be categorised as unitized curtain wall system or prefabricated panellized system, or stick curtain wall system. As industry (Refer Time: 12:47) curtain wall glazing which is meaning, the glass is going continuously on the building envelope seamlessly from top to bottom of the building is called curtain wall glazing.

In terms of construction it can be defined as unitized curtain wall glazing system, or it can be defined as a stick curtain wall system. And another form of construction is frameless glazing system. Frameless glazing system is primarily used on building

entrances, triple height spaces, large volume spaces, or maybe a soft end spaces; where the frameless glazing system is widely used.

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Types of Glazing & Applications: Forms of Construction

Building Perimeter Glazing- Framed & Frameless Systems

- **Unitized Curtainwall system**

It entails factory fabrication and assembly of panels and may include factory glazing. These completed units are hung on the building structure to form the building enclosure. Unitized curtain wall has the advantages of: speed; lower field installation costs; and quality control within an interior climate controlled environment.

Here we are explaining one form of construction framed glazing system. So, this slide is talking about framed glazing system; which is one way of construction is unitized curtain wall system. Or it is prefabricated panellized system. What you could see here in this picture? This panels prefabricated in the factory and delivered to the site, and it is getting fixed to the building some bracketing arrangement. So, that is same thing is explained here is called a panellized system or prefabricated glazing system. It need to have external framing to support the glass, and there are arrangements to fix the panels to the building with fixing and anchorages; which we will explain to you shortly.

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Types of Glazing & Applications: Forms of Construction

Building Perimeter Glazing-Framed & Frameless Systems

Strip Curtain Wall system

The vast majority of curtain walls are installed long pieces between floors vertically and between vertical members horizontally. Framing members may be fabricated in a shop, but all installation and glazing is typically performed at the jobsite.

That is another way of construction of this kind of a glazing system. It is called the strip glazing a curtain wall system. In here you can see here it is a panel not necessarily continuously going vertically on the building. It maybe panel covering only the floor height, it could have beam in between this panels. So, this is another way of called ribbon glazing or strip curtain wall glazing. Mainly we are calling this terminology, because it is going in a strips it is not vertically continuing and it is only continuously horizontally continuous in the building.

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GLASS ACADEMY NPTEL

Types of Glazing & Applications: Forms of Construction

Building Perimeter Glazing-Framed & Frameless Systems

▪ **Spider Glazing**

Spider glazing is usually installed in an Area where maximum visibility is required and the systems are chosen based upon the height opening available. Fully spider fitting frameless glass curtain walls, connect glass together in an open space using various types of light steel structures via various types of spider fitting members to form flexible and unobstructed curtain wall facade.

Advantages of Spider Glass:

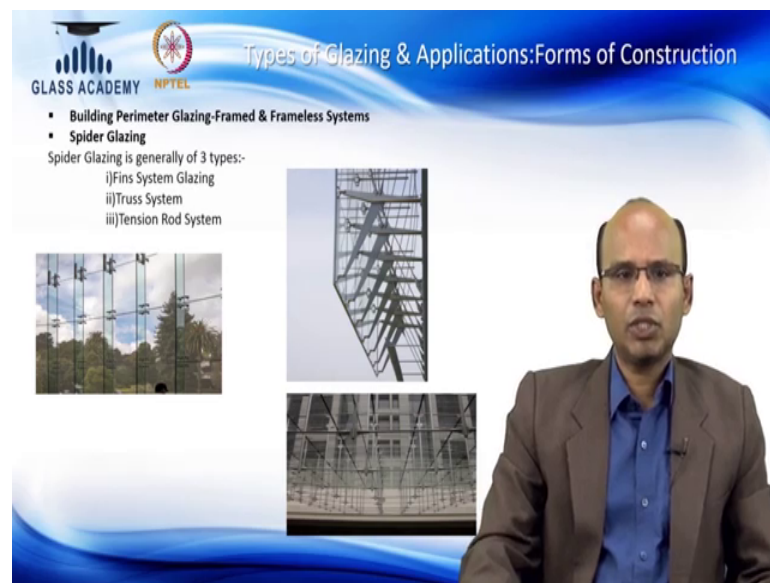
- Large and fully smooth glazed area
- Doors and windows can be inserted in a spider glass facade
- Excellent adaptation to local requirements.
- Full daylight on all sides.
- Double and single glazing.
- Good thermal insulation with 16mm airspace in double glazing.
- A solution to more and more structural needs.

There is another form of glazing system we were this slide is talking about frameless glazing system. Or in a way, it sometime called the spider glazing or point fixed glazing,

the many terminology used, but to define the frameless glazing system. In this glazing there is; no vertical or horizontal frames or it may be a very minimum amount of frames. You could have a highly transparent glazing using either glass fins or point supporter using some stainless steel hardware. In advantages of this glazing; is it covers a large volume like entrances of the building, where you need unobstructed view to external to internal.

And is able to integrate the doors entrances much easier, and it brings lot of daylight to the internal spaces, there is no minimum interruptions. And it can also used with the different form of glazing like high performance safety glazing, and it gives more robust structural solution for large volume application like the vertical span is higher like 2 floor or 3 floor height this type of glazing is commonly used.

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And this picture is showing some different forms of frameless glazing system. As you can see here, it could be supported with the glass fins with this stainless steel fixing is called spider fixing or point fixing. So, glass is primarily supported on points rather than the continuous framing; this individual glass panel supported on 4 points. So, is called point supported system. It could be used on this; it could also be used on like a screens for architectural application or maybe a roofing application. It is roof skylight the glass is suspended with a tension cable system here. There is no steel or aluminium framing here rather it supported with the tension rod system.

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Summary

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

- Glass facade
 - Understanding glass facade
- Types of glazing and applications: Forms of construction
 - Windows - punch and strip
 - Doors/external partitions - hinged, sliding and rotating
 - Building perimeter glazing - framed and frameless systems

