Glass in buildings Design and Application.
Prof. Mr. Tanmay Tathagat
Department of Civil Engineering
Indian Institute of Technology Madras

Lecture - 24
Daylighting Strategies/Techniques - I

Hello and welcome to our new course daylighting design guideline course we will discuss guidelines and strategies for daylighting. A lot of these can be applied during early stage of design development and can be refined further as you go along we will focus a lot on thumb rules and basic approach to day lighting, which can then be further refined through simulation analysis and integrated with other design systems for lighting or dynamic facades.

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The learning objectives of this presentation are to enumerate, what are the guidelines for overall building design, list the key strategies for day lighting shading which are integrated, and understand application in design through some very famous examples of buildings that have successfully demonstrated.

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This course has two modules will be covering daylight strategies for buildings and side lighting separately under each one of these things.

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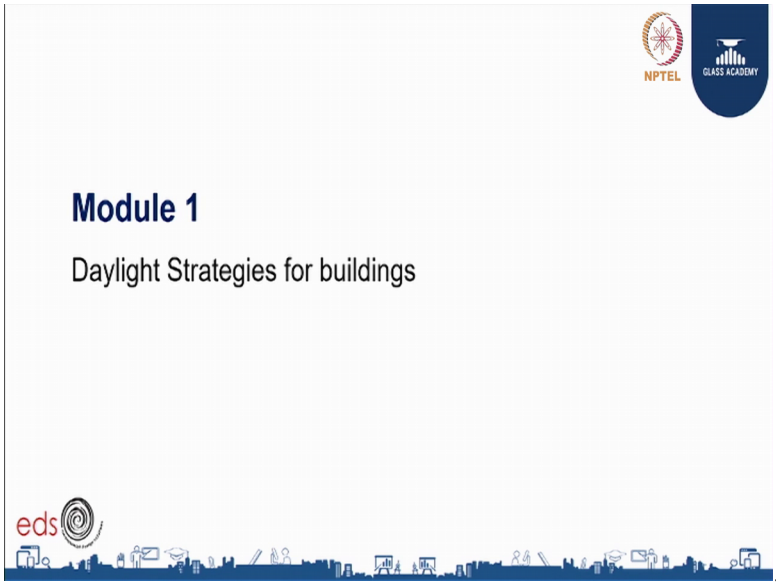

This module we will discuss guidelines that are applicable to the overall building design, to ensure adequate day lighting and the day lighting principles that we want to achieve which we discussed in the previous session.

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So, the first objective is to have optimal lighting without glare. We can derive in our absolution for any given problem if we have a clear idea of the intent. So, here the goal is to have sufficient amount of high quality light without glare number 1.

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Number 2 to get enough daylight into the deeper areas since typically there is too little light at the back of the room and too much near the windows or on the facade of the building.

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Next is to look at how do you reduce a prevent the severe direct glare from windows and skylights; this glare is aggravated if the walls adjacent to the windows are not illuminated and therefore, they appear quite dark. So, you get a big contrast in your field of view.

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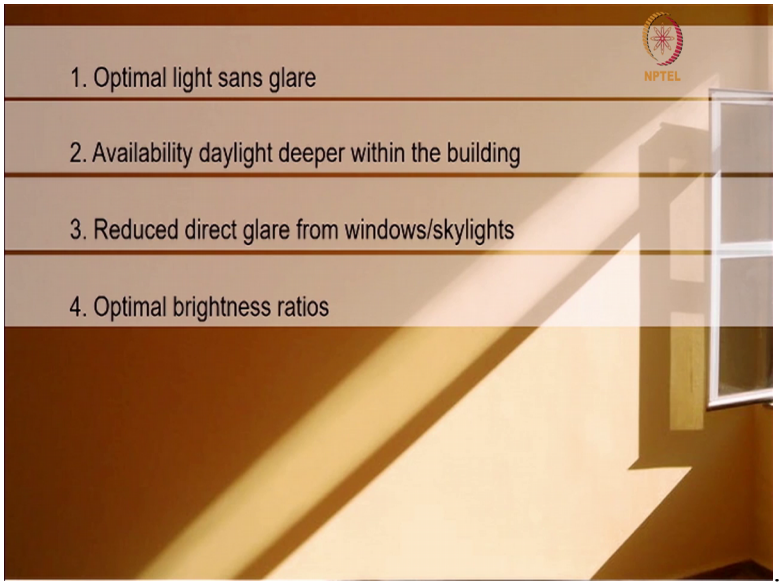

Another objective is to look at the optimal brightness ratio, to prevent excessive difference between the very bright and very dark parts of your view for example, what

you can see in this image. This beam of light creates a puddle of light over an on the wall, which creates this very dark and a very bright spot.

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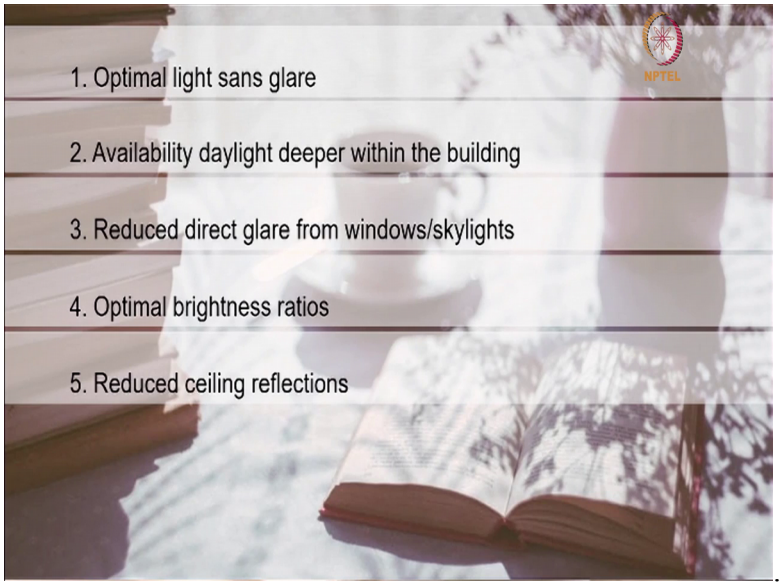

It is also to prevent the ceiling reflection, which is created by overhead opening. So, very often when you have skylights, you can create you will get a situation where there is a shadow over a book or you get your reflection off of the ceiling into the into the task or into your desktop, which can create a discomfort usual discomfort.

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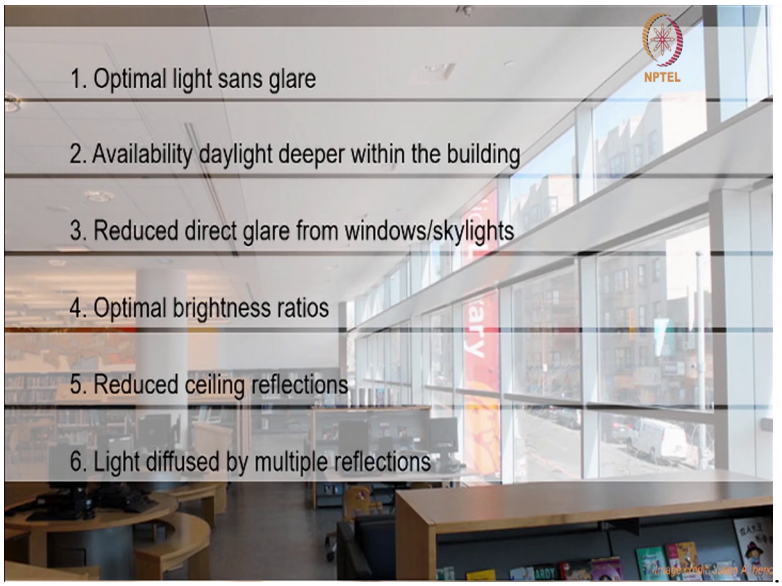

And finally to maximize aesthetic potential of daylight in areas, not assigned for critical visual tasks so, which is a another interesting function of light and daylight.

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To achieve these goals, it is necessary to start early into the design process right from the concept. If you look at the gift that we have of being in India where most of the most of the country, most of this most parts of the country receive so, much abundant daylight, that it would almost be criminal to design a building that does not incorporate a sufficient daylight or where we are necessarily required to switch on lights during the daytime. The process of thinking about daylight into the space especially for commercial buildings, for officers, for schools, for hospitals for places where you require daylight throughout the day is part of the first design intent and it is true for any other passive means.

So, if you look at a building that is thermally comfortable, if you want to look at integrating windows and openings for ventilation or for passive heating or cooling then this has to start early in the design. But in order to do that a very often we have to look at what is the what are the basic thumb rules, what are the basic design approaches that we can start off with. So, here I am going to start with strategies that are applicable to the overall building. Please note that these are high level design guidelines these are appropriate to be applied when the building is you are thinking about the form and when several options are available.

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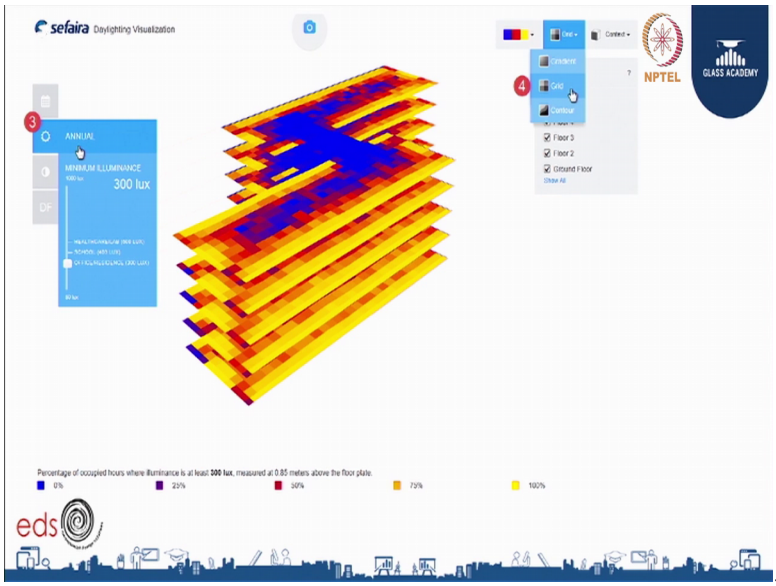

So, these options can be incorporated further into design development through simulation tools, which will be available to you as you develop the overall form. So, that is the idea.

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The first aspect we are going to look at is building orientation then we look at the form space planning and color. The number 1 and the most important thumb rule is the north south thumb rule. Determine the right latitude of the project and this will help us figure out what is the right orientation.

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For northern latitudes the south facade is exposed to the sun throughout the day and the north is exposed to the sun in case you are in the southern hemisphere.

So, this is crucial because it will tell us where to put the shade, what should be the predominant orientation of the building.

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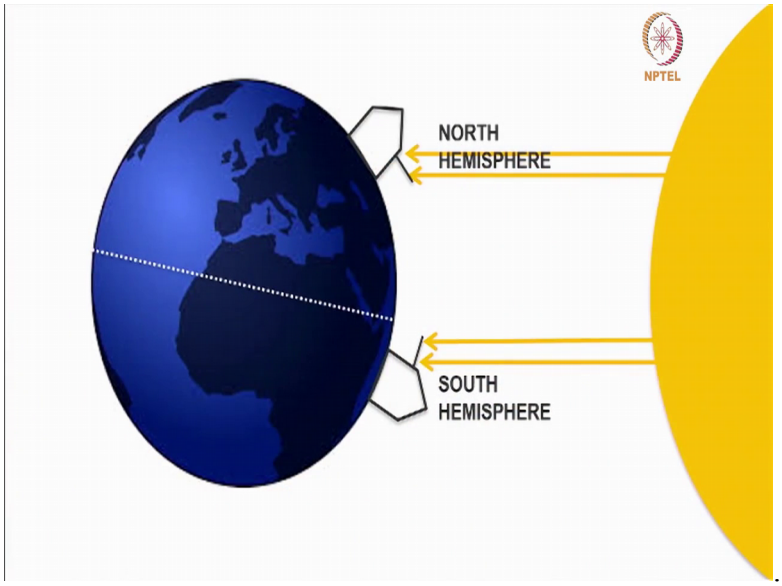

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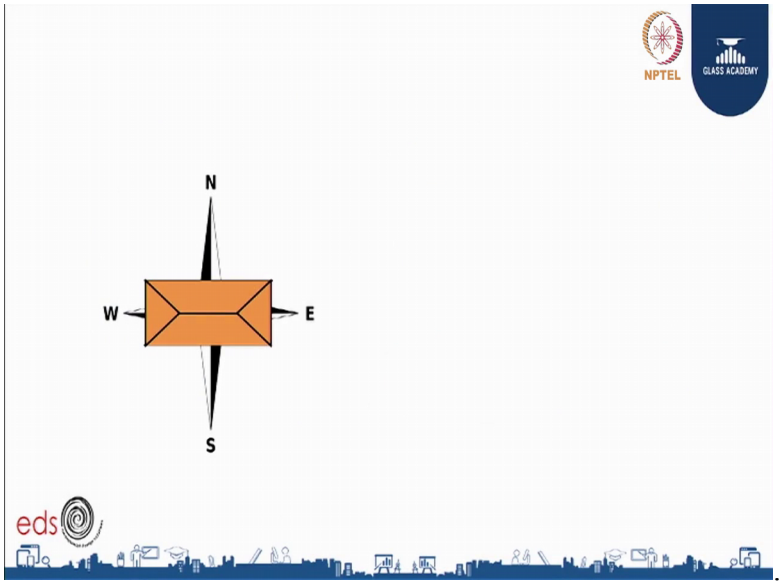

And as you can see that the shape of the building whether we want to make a building that faces more towards the north or the larger part of our facade faces south will be dependent on where we are located.

So, we must orient the building to maximize solar exposure during the day this means or in the building to the north south axis.

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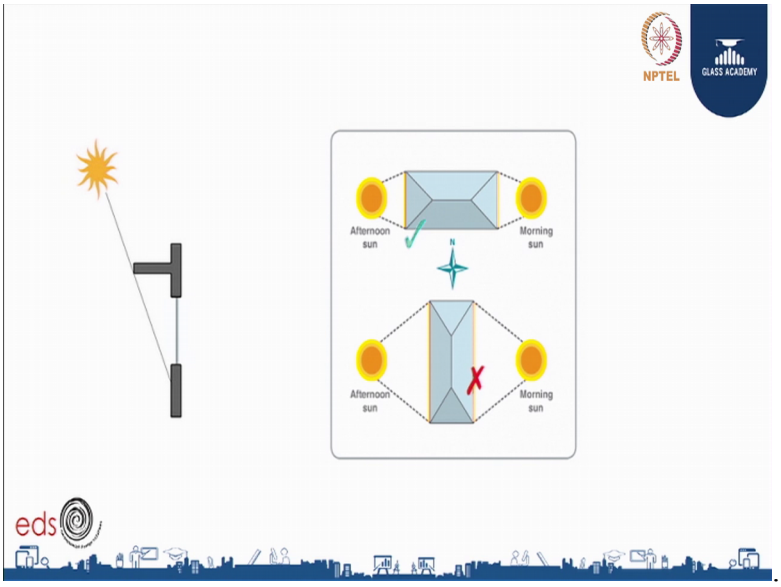

During the day the sun is at the higher altitude and hence it is easier to control the direct radiation with the help of a simple horizontal shading device or a simple overhang. Well during the monsoon and evenings the sun it as at a lower altitude and hence the chance of

a glare is very high. So, we want to orient the building where we are able to get maximum radiation, which is easy to manage and control in terms of shading.

So, we get the daylight, but we can avoid direct sun into the space. If you do an orientation where the larger parts of the building as you can see here face east or west then the rising sun or the setting sun are very low in their altitudes and you will get streaming sun into the building. And that is a very problematic situation, because to control the sun coming at that low angle, you will almost need to block it completely you will need a screen or you need blinds, and that will create problem with day lighting.

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In terms of building form, the most important aspect is how much floor area has access to daylight.

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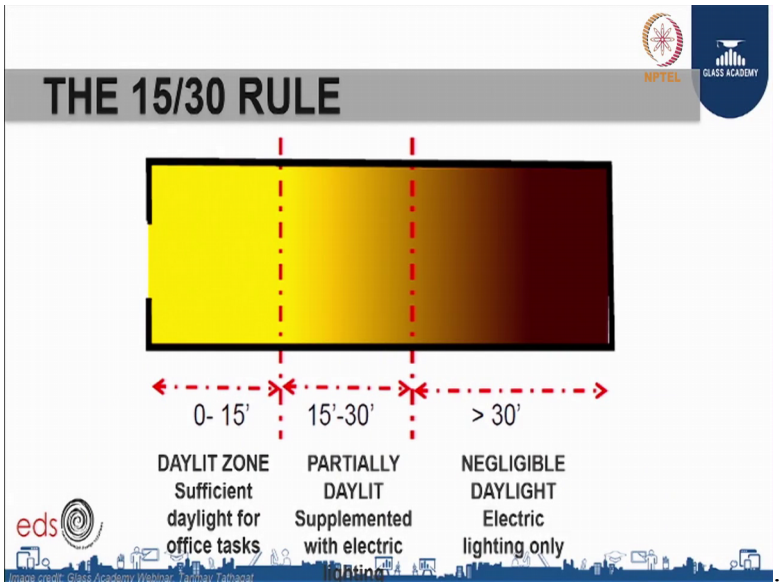

So, the next rule is the 15/30 rule in a typical design process this yields a basic shape of the building, which says that for a space with ceiling of a height say about 3 to 4 meters or 9 to 12 feet whatever units you use. The area within the first 5 meters more or less the first 15 feet from the window or fenestration will be completely daylight and another 3 to 5 meters up to 15 feet, beyond that can be partially daylight where supplementary electric lighting would be required anything beyond that will be will have to rely on electric lighting.

Now, this is of the most optimum condition given that you have a daylight window up near the ceiling and which reflects the light inside. In most cases the basic thumb rule will be determined by the height of the window and the availability of shading device, but you can almost take it as a given that beyond 30 feet even any of these systems with beyond 10 meters it will be difficult to get light from just one side from a window.

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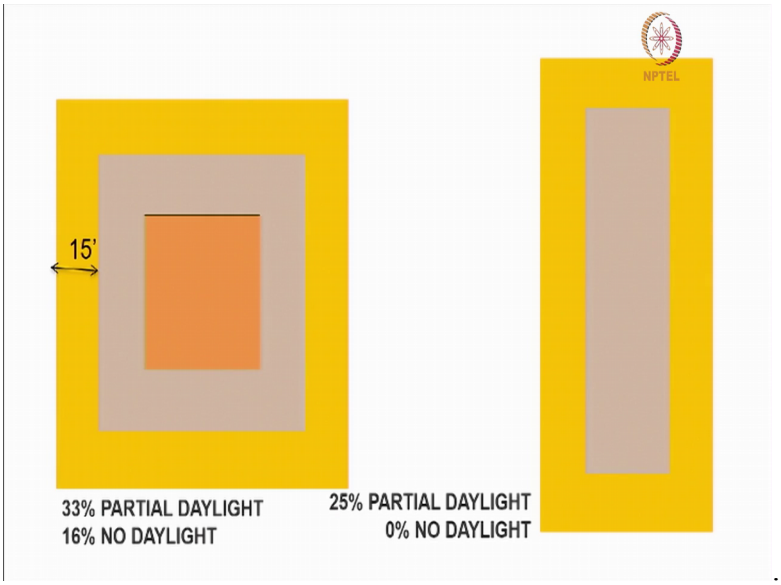

So, if you look at a square shaped building floor plan, let us say this is a 10000 square foot building with the you know with the 15 feet as we said as the light area, and the first 5 meters giving us that that day lighting. You will find that in this kind of a shape 33 percent of my area. So, excluding the central part is partially daylight and the central part has no daylight at all right. If we look at a rectangular building for the same area for the same floor plate, about 25 percent of the area has partial day lighting but there is no area of the building that does not get any daylight.

So, by introducing you know by changing the shape of the building with the same area, you have changed the amount of daylight available for the floor plate or for the people in the in the space. And this can be further addressed if you want to go with the square shape by adding atrium in the middle. So, if you create a light well or an atrium in the center of the building in a square plan or any other plan where, the areas are beyond 10 meters in that case you can mitigate that and this can be then be a much better daylight and almost eliminate the requirement for day lighting on a on a normal of electric lighting or for artificial lighting.

The next thumb rule is for the design of atrium. So, atrium tends to have a common design element in a mall or in many other commercial buildings now, this rule we analyze and decide upon the atrium geometry versus the reflectance of wall, which will be effective in achieving the form of the atrium right during early design stage.

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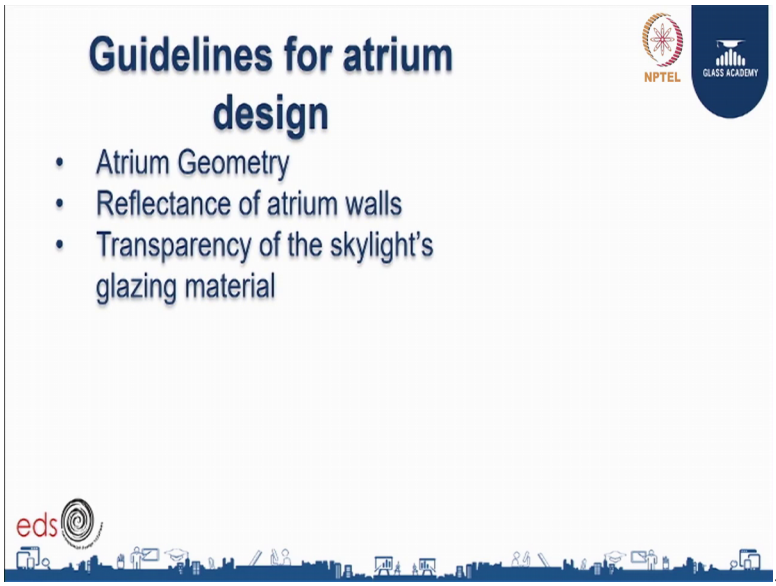

So, an atrium is typically an enclosed space located either in the send entrance to the building or in the center, and there are surrounding areas that look into the atrium.

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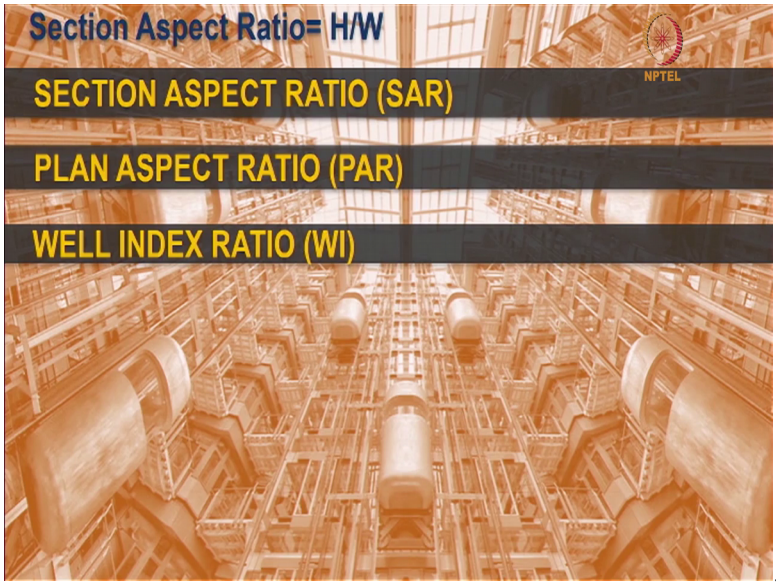

An atrium is typically public and if you look at the geometry reflectance and transparency, you need to understand a few key terms. So, these terms include the section aspect ratio of the of the atrium, the plan aspect ratio and the well index ratio.

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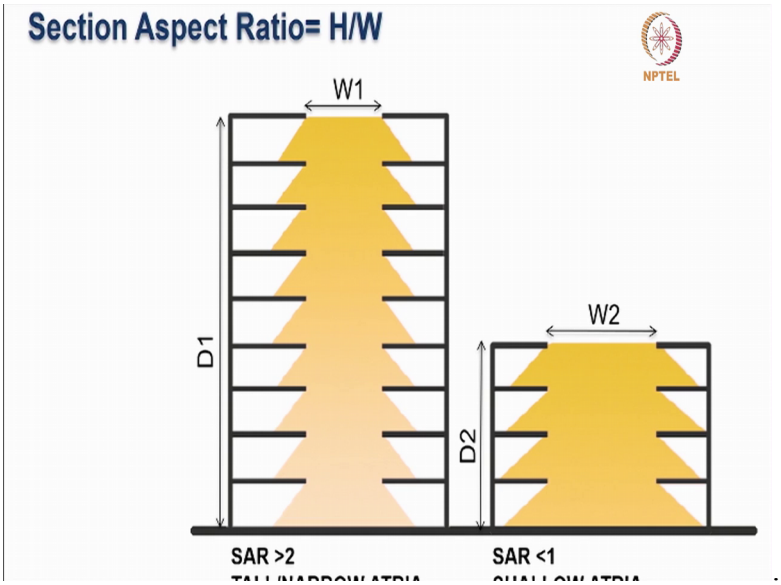

The section aspect ratio is the ratio of height to the width of the atrium. It determines the sectional proportion and with an atrium of this section aspect ratio of more than two is called a narrow atrium and anything less than one is a shallow atrium. So, as you can see that the lower floor gets more daylight in case of shallow atrium.

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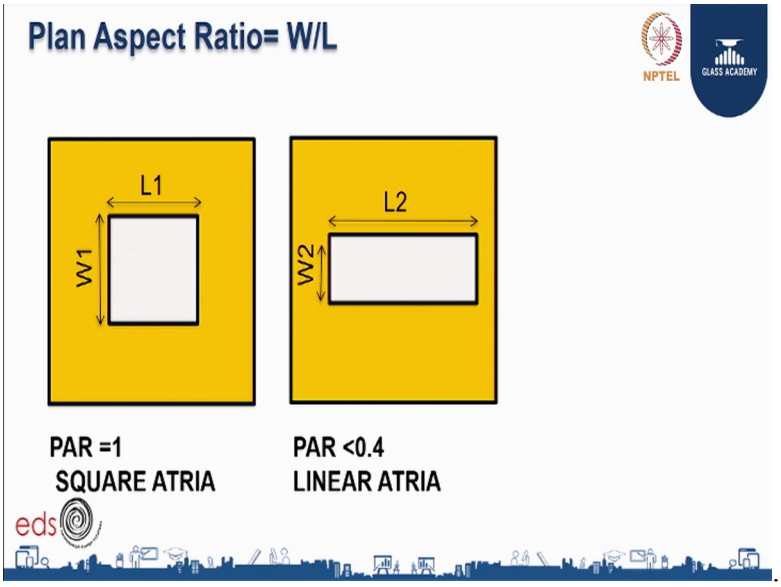

The plan aspect ratio is the proportion of the atrium of the height and width in the plan. So, anything which is less than 0.4 is defined as a linear atrium.

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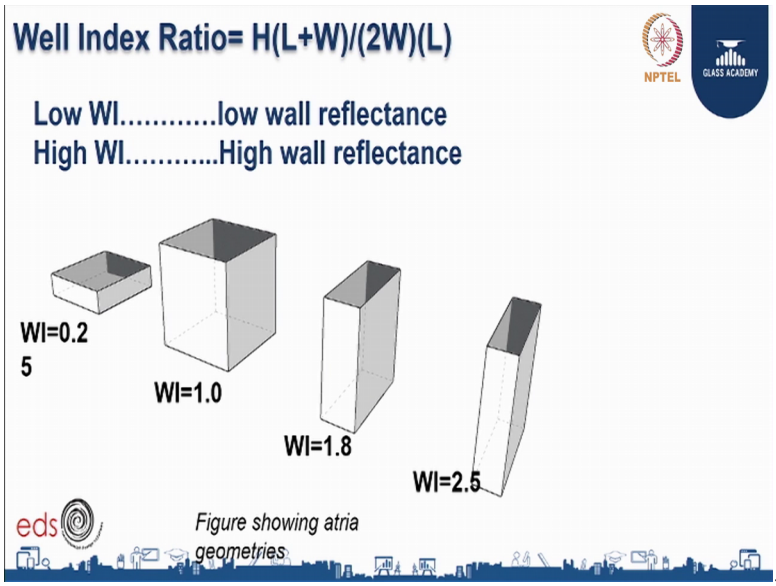

The well index ratio is the well index ratio is the appropriate index for determining the effect of geometry on the daylighting and the efficacy of the daylighting.

So, if the well index ratio is less, there is less wall reflectance and get enough day lighting till the 4. So, if the well index is more the wall reflectance should be increased to get more day lighting. So, as we get deeper and deeper the importance of the surfaces that are around the atrium becomes more prominent.

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So, the moment we increase we have a deeper atrium, we need more reflectance to get the same amount of lighting. The translucency offered by glazing material is also very important because the top of the atrium is where the light comes from. So, the skylight on the right has a stained glass and it gets in much less light compared to one on the right on the left. Therefore, if we have the same amount of overall light that we want inside we need a larger area in the second case.

The next thumb rule is about day lighting guideline for a master plan. And in urban master plan level when designing for efficient day lighting these thumb rules will help us better planning of spaces between the buildings for an effective light penetration inside our inside our spaces.

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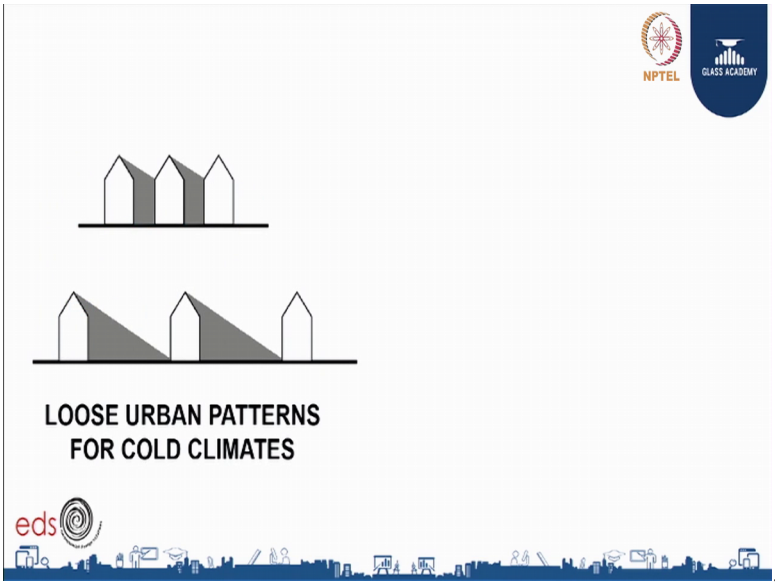

The first one is to have a dense urban pattern to reduce glare and direct heat in hot climates and lose urban plan patterns in cold climates, to allow direct sunlight penetration into the building.

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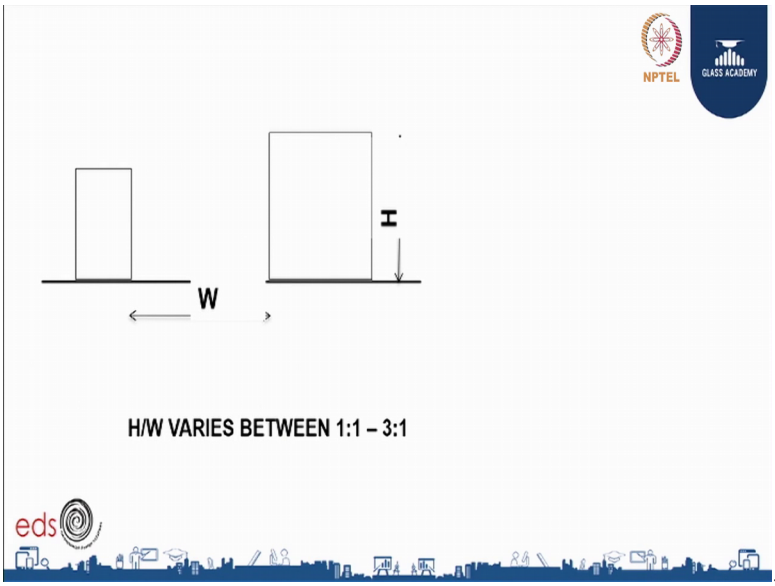

There are many ways to determine the street wets for given building height or vice versa. Though in most case the building height to street width ratio varies between 1 is to 1 to 3 is to 1 depending upon the climate and density of the site.

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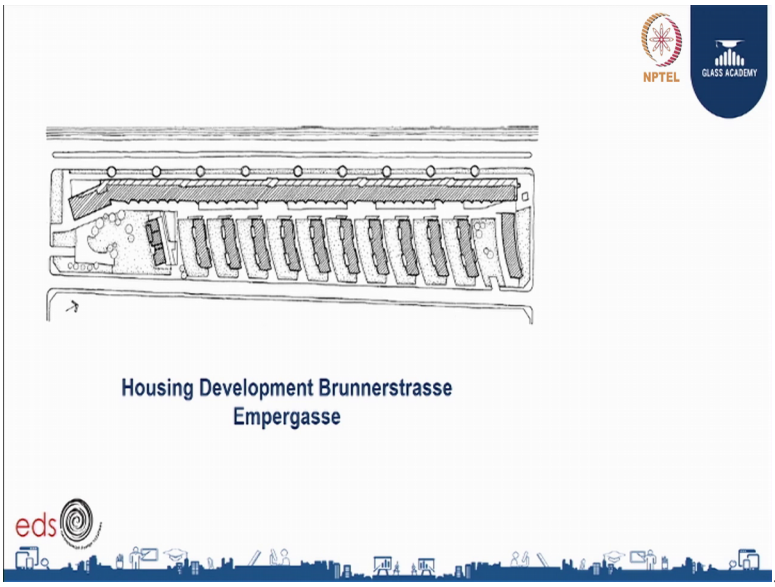

Try to keep taller buildings towards east or west. So, that they cut off the harsh glare and from smaller buildings. Also try to house facilities with like storage and services in these buildings, the housing development for example, here in Brunnerstrasse in Vienna is a perfect example of the main housing units are broken into smaller building units and

faced north south, where on a long linear strip the buildings face east west and that house all the services and ancillary services.

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So, the concept of a solar envelope was divided was developed by Ralph Knowles and can be accessed for more sophisticated solar access at city level.

So, the solar envelope guarantees solar access to properties by regulating construction limits, and they are derived from the suns relative motion buildings within then the soul envelope would not shadow adjacent properties during the predefined period of time, and usually it is critical energy receiving period during the years these guidelines are especially effective in a city planning level.

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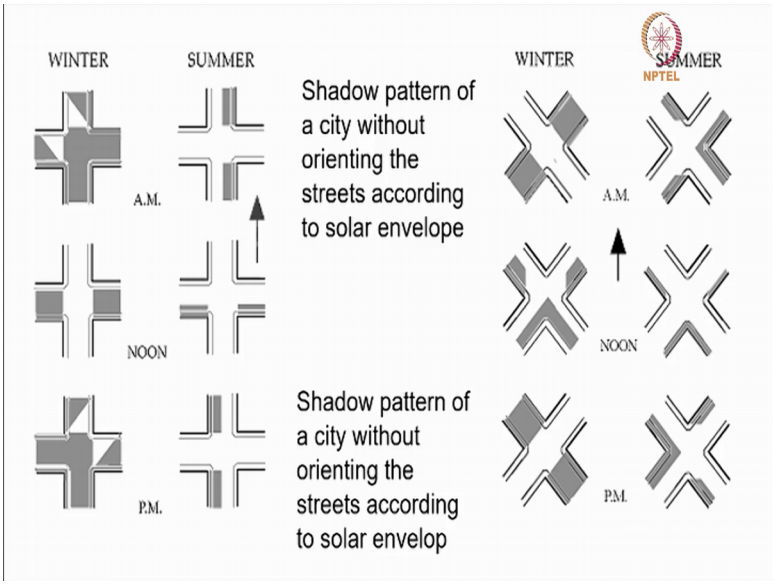

So, you can look at how the placement of the streets and the effect of the orientation and the distance between the buildings can have on the overall city planning.

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Colors play a major role in distributing reflectance of light. And you can you can refer to there are many texts and resources that are available that we talked about, where you can understand more details, but the basic understanding of lighter colors reflecting more and darker colors to absorb more is something that we need to follow depending on the width and the issue of glare or light access.

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So, it is better to use light colors both indoors and outdoors for better and deeper reflectance, but they could often clear cause glare, if they are in a direct field of view from an adjacent building. So, in this image you can see light colored walls reflect highly by the dark color absorbs this giving a very different proportion and sense of space.

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