Energy Efficient Architecture

Lecture 4

Isolated Gain

Now moving on to isolated gain, an isolated gain system has its integral parts separate from the main living area of a house. Examples are a sunroom and a convective loop through an air collector to a storage system in the house. The ability to isolate the system from the primary living areas is the point of distinction for this type of system.

As you see in this picture, what isolated gain is, it is an isolated element in the picture which is connected to the main living area which is heated up and that hot air has been transferred to different spaces and vents which we will be seeing in detail in this presentation as follows. The isolated gain system will utilize 15-30% of the sunlight striking the glazing toward heating the adjoining living areas. Solar energy is also retained in the sunroom itself. As you see in this picture, this is the sun room which is been added as external and it is attached to the living area. This utilizes 15-30% of the solar radiation. The solar radiation falls here and heats up the space which eventually heats up the living area adjacent to the room and by this; it reduces almost 15-30% of your energy bills by passive solar heating system. Sunrooms or solar greenhouse employ a combination of direct gain and indirect gain system features. Sunlight entering the room is retained in the thermal mass and air of the room. Sunlight is brought into the house by means of conduction through a shared mass wall in the rear of the sunroom, or by vents that permit the air between the sunroom and living space to be exchanged by convection.

This is a sunroom which is completely glazed which is attached to the main living area. This gets heated up and as you see, there are small vents on the top and lower bottom of the main living room wall which is made out of thermal mass which is connected to the sun space. The heated up air from the sunroom gets first heated up and then hot air rises and because of the presence of small vent on top of the main living area which is made by thermal mass. the hot air gets transmitted from the sun space to the main living area and the cold air which is already present in the living area is being transferred back to the sun space is preheated by the lower vent which is provided as you see. This process happens by radiation and convection. The use of south facing air collector to naturally collect air into a storage area is a variation on the active solar system air collector. These are passive collectors. When you are getting fresh air as we saw in the previous presentation, each person needs 8-15l of fresh air per second. So we need to collect this type of fresh air for a passive heating house for southern fazard because southern direction is the one which is going to heated up the most. So collecting air from the heated up surface will increase the temperature of the air and will reduce the usage of room radiators and room heaters. Convective air collectors are located lower than the storage area so that the heated air generated in the collector naturally rises into the storage area and is placed by return air from the lower cooler section of the storage area. As we saw in the previous image the collected up hot air is kept in the lower bottom and then the openings are made in such a way, the hot air will rise and it will go to the different area which is need of this hot air, the cold air which is present in the unused spaces will again come through this vents which is present in the lower bottom of the room and it will come again to get heated up preheated. This is done by convective air collectors. Heat can be released from the storage area either by opening vents that access the storage by mechanical means (fans) or by conduction if the storage is built into the house. You must have seen small vents which is present in lower areas. Nowadays in schools or in commercial complexes

you must have observed plastic opening in which slits made. That is also a type of fan that can be installed or some other mechanical system to suck out this type of cold air and preheated and it is lent in by the small vent which is present on the top of the wall unit. This is how it is done. during the day it gets heated up, there is small vents which lets in hot air inside the upper vent which is being used and the cold air which is present in bottom due to high density gets escaped through the bottom and then it is again heated up in the sunspace and again the heated up air gets inside the living room. So it is like a continuous cycle which keeps happening. During the night when there is no sun, the outside temperature is very low. So what you need to do is you need to maintain whatever the heat which you have gained during the day time because of the presence of solar radiation. So to maintain or trap this heat within, you are closing these two vents which will protect you from losing whatever hot air which is gained in the morning to be lost. So this wall is mainly made of thermal mass. Even though there is lesser temperature on the outdoor here and there is good temperature here, there is prevents from losing temperature, prevents from losing heat that has been already stored. It traps in heat and it keep radiates during the night.

Sunrooms

Sunrooms can feature sloped and or overhead glass; a sunroom will function adequately without overhead or sloped glazing. It is important to use adequate ventilation to let the heat out. whatever you are adding to your main living room, you are heating up and you are taking up the hot air as much as important of taking up hot air is it should also be ventilation to take out the that is being used or cold air that needs to be recirculated or else you are breathing in whatever the air that is coming but it is not going outside. So you have to consider both the openings which are whatever the air which comes in must be equal to the air that is going out to meet to the fresh air requirement. The sunroom has some advantages as an isolated gain approach in that it can provide additional usage space to the house and plants can be grown in it quite effectively. sunspace is not only benefited just for having hot air and using passive solar heating but it is also a great space, extended living room for people to hang out or even to grow plant, it is an ideal space and it can form like greenhouse effect and provide a good quality air for the windows. This is a typical image for sunroom. Here you can observe furniture in which people are using as extended living room and also there is lot of greenery that is giving out fresh air. Even though they are inside the home, they don’t feel actually inside, we feel much connected to the outdoor. A thermal wall on the back of the sunroom against the living space will function like the indirect gain thermal mass wall. The thermal wall which is present between the sun space which is the glazed building and the living space, the wall has to be made by thermal mass by the material which has high heat storage capacity to trap in the heat. With a thermal wall in the sunroom, the extra heat during the day can be brought into the living space via high and low vents like in the indirect gain thermal wall. As you said before it is the same thing in which the sun room, you need to keep small ventilation to take over the hot air which is being preheated due to glazing and falling of the solar radiation on the thermal mass. More elaborate use of the heated air generated in the sunspace can be designed into this system, such as transforming the hot air into thermal mass located in another part of the house. this system can be elaborated just not only for the living room but it can be made use throughout the residents by using different system to take out the hot air and it can be raised up due to the temperature difference and it can be raised into ducts to connect and this hot preheated air can be used to different rooms which is already cooler. So each radiator capacity chosen can be reduced because of passive design strategy.

Isolated gain rules of thumb for sunrooms: Use dark colour for the external wall in the sunspace. As we know dark colour absorbs more solar radiation so the thermal mass wall which is present that is adjacent to the sun room and the living room must be painted in dark colour to absorb more solar radiation. The thickness of the thermal wall should be 8-12inches for adobe or earth materials, 10-14inches for brick, and 12-18inches for dense concrete. All these inch, there is difference in different material due to thermal capacity and different material property by which we are differing the thickness of the material. Withdraw excess heat in the sunroom (if not used for warm weather plants) until the room reaches 45 degrees and put the excess heat into thermal mass materials in other parts of the house. when the centre room cannot be made into fixed element or non open able even though if it is very cold country, the sunrays which is falling on the glazed surface and due to the presence of dark painted thermal mass wall the temperature within the sunroom can go up to 45 degree Celsius which is very very hot for the adjacent room to that high temperature. When it reaches such high temperature the aperture should be designed such a way it can be opened out to let out the hot radiation. For a sunroom with a masonry thermal wall, use 0.30 square feet of south glazing for each square foot of living space floor area. If a water wall is used between the sunroom and living space instead of masonry, use 0.20 square feet of south facing glass for each square foot of living area. This is also different due to the difference of thermal conductivity and heat storage capacity of water and concrete. Have a ventilation system for summer months. You also need to think about summer months and we should not be eliminating it because it might make your living room even as hot as a cling. If overhead glass is used in sunroom, use heat reflecting glass and or shading systems in the overhead areas. During summer months, the sun is going to go high and if you are having sunroom with lot of glazing over headed, it is good to have a coating of reflective material which can be used to reflect the solar radiation which will be falling on horizontal surface more during the summer months.

What is the difference between sunroom and solarium? A solarium features a modern style of architecture and is comprised of a glass roof and walls. Solariums are frequently completely enclosed by glass and are sometimes referred to as a conservatory. It is almost like a conservatory, all the surfaces are covered with glass. But sunroom need not be same as solarium because only the vertical surface can be glass and the top roof can be made just by masonry, it is like the major difference between these two categories. This glass structure can sometimes be that of a freestanding greenhouse or a structure that is attached to the house with a glass roof. The intent is generally to capture as much light as possible. This is like a greenhouse block which you are adding to your existing house. The main usage is for the users to enjoy during the winter months and to trap as much as direct sunlight as possible and it can deflect the sunrays inside to make your living room much brighter. So solarium is often used in commercial applications such as restaurants, hospitals and sanatoriums so that patrons can enjoy the benefits of the sun without being exposed to the elements. Solarium since being a closed glass block even patients who cannot be directly exposed to the outside harsh climatic conditions, they can come out and feel connected to the outdoor even if they are not completely outside.

Advantages and Disadvantages: A solarium's advantage is a complete enclosure of glass, an impressive structure with lot of glass. Its main advantage and selling features is an unobstructed view of your outdoor space and sky through a glass roof. As you see in this picture, the main advantage is completely covered with glass. Even though you are inside on a heated up air you will feel like you are outside and you will appreciate the outdoor condition and you will feel more connected to it. Solariums have some drawbacks though. The grass roof demands maintenance and cleaning due to the glass roof. Often, custom blinds are

also needed for relief from the sun coming through the roof. The glass roof is also subject to seal failure and very energy inefficient compared to thermally insulated roof. As you see, this solarium is placed here and some guys are climbing to clean the roof. Cleaning is major aspect because roof is made of glass whereas if it is a sunroom we can choose in such a way only the vertical fazard is completely as it is more accessible to clean and also to maintain protect from the harsh summer solar radiations. More solariums cannot properly connect to many homes structurally or architecturally. Lastly a glass roof can add considerably cost, sometimes more than twice as much as a sunroom. Even despite of cost aspect, it is very expensive compared to normal masonry structure, putting a glass and supporting it structurally. it should also blend with architectural style of existing home which is also made very difficult because of which it is adding additional cost in making solarium more than sunrooms.

Sunroom Vs Solarium: Advantages and Disadvantages are a sunroom has many advantages over a solarium such as, Seasonal to true year round use. It can be chosen if you are having same climate throughout the year. In that way, solarium is much better because even the roof is going to be made out of glass, Thermo insulated solid roof, Operating windows with full screens, Privacy from outside noise, maintenance free. It eliminates outside noise and outside harsh climatic conditions and also maintenance is very less compared to the other. And it is also thermally insulated solid roof which also reduces cost aspect. Easily attached to many styles of homes. As we see here, it is made out of masonry and just this is made out of glass. So it is easy maintenance and cost is less and you are eliminated from the outside noise as well. A sunroom's disadvantage is that it does not have full glass view of the sky. A sunroom does not have masonry wall so you cannot feel like you are outside as you cannot see the sky. Even though if you are on sun room you will feel you are more connected to it but you are not feeling completely because the sky or overhead is not completely exposed. A solarium's advantage is a complete enclosure of glass, an impressive structure, with lot of glass. Its main advantage and selling features is an unobstructed view of your outdoor space and sky through a glass roof. That is for solarium. The one that we previously saw was sun room and solarium since it is completely covered with glass the main aestipical point is the main selling point for this design. Solarium has some drawbacks though. The glass roof demands constant maintenance and cleaning due to the glass roof. The glass roof is also subject to seal failure and very energy inefficient compared to thermally insulated roof. As you see there must be lot of heat losses which is happening due to air tightness and the air gap which is happening between each glass element and its connection and is also very expensive.

Maintenance vs. upkeep: coming to sunroom, are virtually maintenance free, easy to clean glass as needed, four season sunrooms (also known as year round sunrooms) usually are built of vinyl which insulates much better that other sunroom materials such as aluminum. These are some of the advantage and how easy sunroom can be maintained over solarium. Coming to solarium, the glass roof is next to impossible to keep clean unless you have a weekly cleaning service. Glass roof shows snow, ice, acid rain, birds, leaves, twigs, shingle residue, hail and more. even though there is good point of choosing solarium having glass on top of your over head but still there is lot of maintenance issue which is been has to be considered for making solarium. Glass roof is highly subjected to seal failure relative to the glass on the walls. When you consider the same material glass which has been laid on horizontally or vertically, the glass which is laid on horizontal surface is subjected to more failure compared to the ones that has been laid on vertical surfaces. Roof framing is typically constructed on high conductive aluminum and requires a painted finish, which will fade and wear over time. Overall the maintenance is

very high because you need to constantly paint the framing and maintain it on the same position as it was once before.

Roof Trap Radiation

Moving on to roof trap radiation, what is roof trap radiation? On the desire to incorporate passive solar heating in the system for the winter, Givoni (1977) has proposed a passive solar heating and nocturnal radiant cooling system called a roof radiation trap for buildings with concrete roofs. As you see, this is the roof made with concrete with the aim of trapping the solar radiation on the horizontal surface and maintaining the heat which has been falling on the roof surface and to heat up passive heating techniques to warm up the space within the built environment. The radiation trap consists of an inclined fixed insulation layer rising to the south, above the concrete roof. Painted corrugated metal sheets (the nocturnal radiators) are installed above the insulation, forming a channel for outdoor air flow under the radiator during the night. This is how it is. When there is metal sheet which is placed on the south to trap good amount of solar radiation and there is lot of fans and ducts which is taking out the hot air which is trapped inside and to reduce during the summer months and during nights.

Summer scenario: In summer, when radiation trap is used for cooling, penetration of solar radiation is prevented by the closed insulation panel. At night the painted metal layer is cooled by outgoing radiation and the air under the corrugations is blown either into the building or through a gravel bed, which provides thermal storage. As you see there is movable insulation system which is closed during the night which can prevent from hot air which is present here to escape during the night and due to nocturnal radiation, radiant cooling systems. This is for the summer condition.

Winter scenario: In winter, in the heating mode, the hinged panel in the southern gap is opened during the day, allowing solar penetration through the glazing and its absorption in the black painted concrete roof. The panel is closed during the night, insulating the glazing and the concrete roof serves as a radiant heating panel for the space below. Thus, in winter, the concrete roof acts as a horizontal Trombe wall. How we say in Trombe wall, it is very similar to it but it acts horizontally in which movable planes are used so it is opened in the morning to let in the solar radiation and during the night when the insulation is very less, the insulation is completely closed to trap in the solar radiation which was fallen during the day time.

Roof pond system: Six to twelve inches of water are contained on a flat roof. this system is best for cooling in low humidity climates but can be modified to work in high humidity climates (effectively provides heat in southern US latitudes during the heating season for one story or upper stories of buildings). This is basically what it is. This is creating a pond in which water is filled. As we know water has good heat storage capacity, it can trap good amount of heat and it can send it to the interiors and during the night, the movable insulation panels can be closed to use the heat which has been trapped by the water.