Energy Efficiency, Acoustics & Daylighting in Building
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Lecture - 26
Passive Concepts

So, we will discuss some other passive concepts actually which are which you can add to the building some are very easily; some can be done very easily. For example, I was mentioning about texture other day, that can be done very easily you can choose the surface finish or the colour such that the alpha value is minimal right. So, those are simple things to be done, but there could be something little bit you know more complex thing also can be done.

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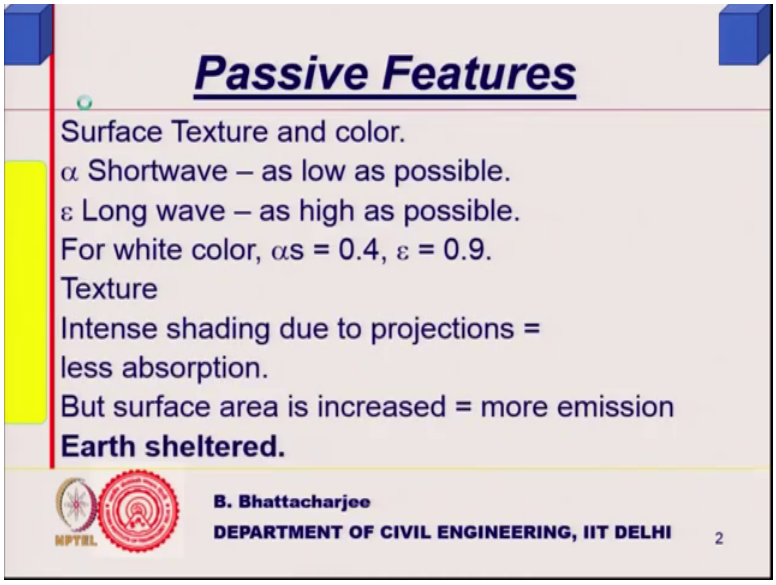

So, this is what I was mentioning other day surface texture and colour right; short wave absorptivity should be as low as possible, long wave emissivity should be as high as possible right. So, for white wash surface alpha is very small 0.4 or so, quite small and epsilon is 0.9. So, now, if there is a paint which it performs even better than this that would be a favourable thing ah.

Intense shading due to projection is possible less absorption. So, as I was saying (Refer Time: 01:33) I have a I have a diagram no not here maybe somewhere there is a diagram

I will come back to this once I will come back later on; this I will come back later on yeah this is the kind of texture for example, if I have a surface which is textured like this.

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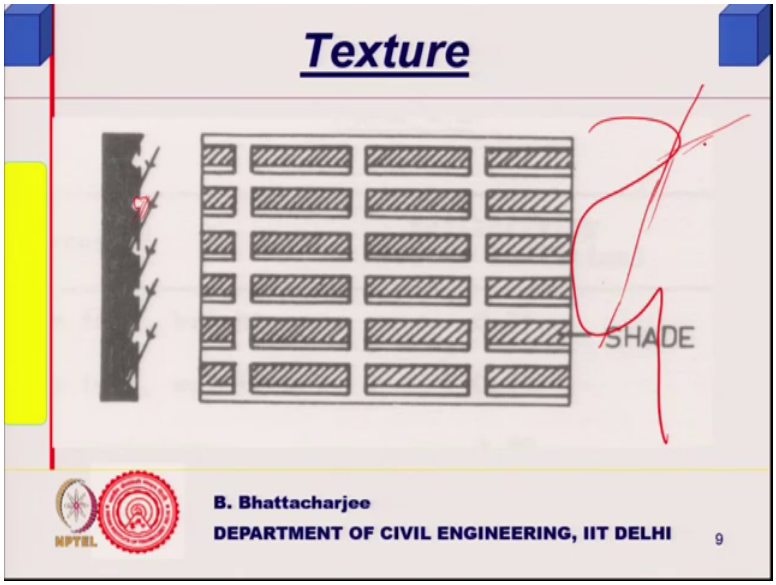

Some projections some projections and then; that means, it is something like this.

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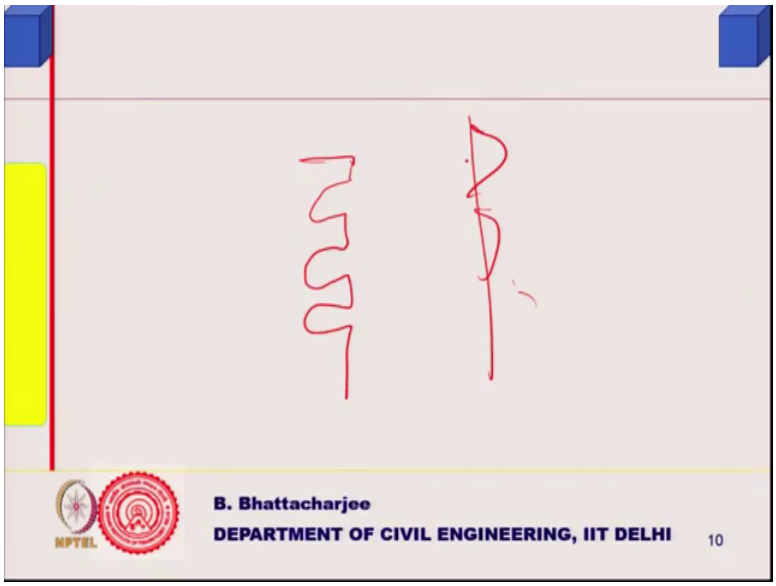

You know it is something like this something like this I am just I am just making it or simply put some stones here stone finish; finished stones they do of course, grid finish which has got other problems. What they do is they make the sand mortar put a plaster

and give you acid wash; so, that aggregate gets exposed plaster which slightly you know larger size aggregates also involved in that that is around 5 mm.

Now if it is 2 porous it might actually allow water to get trapped and if it is over a structural member like a enforced concrete member, holding the water would mean that in the long term there is a possibility of deterioration corrosion and all that. So, one has to be careful about using those, but if you have a brick surface; brick surface and you texture it put a mortar, but put also stones on top of it. So, this will be a texture surface and such textures surface you know some portion; this portion solar radiation will be received, this portion will not receive solar probe radiation right.

Because this will be blocked, it will be blocked, it will be blocked this portion will not received this is the portion which is you know only some portion here in this hole; I mean if I accelerate it something like the suns ray will be will not be receiving in this area right. Of course, when it is inclined like this depending upon the suns orientation, but while radiating; emitting radiation whole of the surface will be involved. Effective surface area is much larger for emission or convection, but for absorption effective surface area is less.

So, textured surfaces can be very useful; they can reduce the amount of you know amount of solar radiation intake; it can it can actually reduce. So, texture as I said texture and you know like texture is texture intense shading due to projection less absorption that is possible and for emission surface area is increased. So, therefore, there is a possibility we can make earth shelters structure we will come to that basement and similar ones we will come to that sometime later on.

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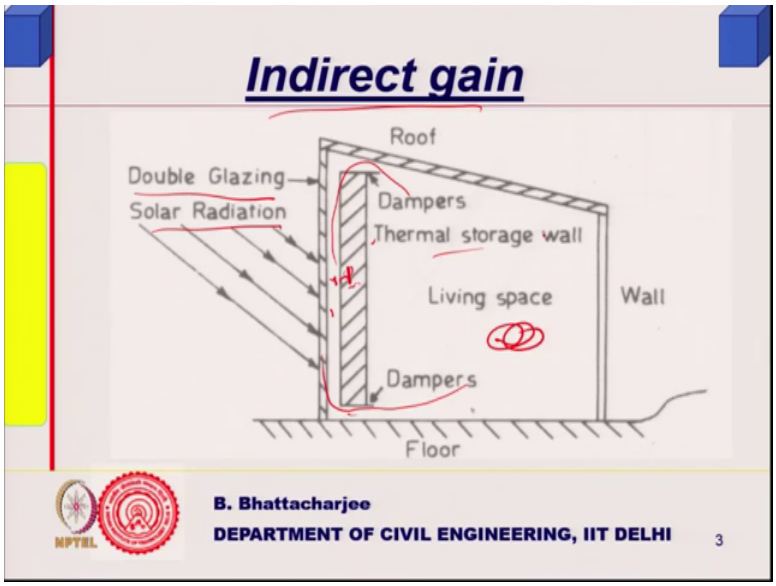

Now, you see in it is a wall in fact, for solar gain developed in France right Thrombe Michael Wall; I am sure that must be used in quite a bit I am not sure whether they use it these days or not, but this is a concept that was developed there you have a glazing. So, you have a glazing that is glass as I mentioned earlier glass is transparent to solar radiation, but it is opaque to long wave radiation.

So, you can use lot of glass in such areas such climatic situations subtropical condition because it will allow lot of heat to come in and get trapped. Or for that matter cold climatic zone in Indian subcontinent you can use them there as well. So, the problem is when you have glass it absorbs the radiation alright, but since its thin it you know it is useful only at that period of time, but cold day time when the sun is available it is not really worthwhile to use the sun only at that period of time when sun is available outside right. You should be able to use it when it becomes cold in the night, store it for some period of time.

So, this is the you know this is what we call indirect gain into this space. So, you have a glazing, the solar radiation fall onto this glass and there is a wall which has got high thermal capacity even if you use a brickwork or something like that. And I mean this is of course, you have to have some holes in them through a damper; damper which can close or open right. So, what will happen is this portion it will get heated up and this will also heat up this wall.

The solar radiation will pass through this and it will heat up the wall as well and this air here also will get heated up. So, hot air will have a tendency to move like this and cold air from the room will dry. And this since this gets heated up it stores up the heat and it can supply later also rather than.

In fact, as I was telling you in European scenario I am not sure about the France part of it because I was I visited only for a short period of time, but let us say bordering France Switzerland; that Geneva and those areas they have bright sunshine in summer and they have big glass windows and all that. And if you are sitting you know in the afternoon I mean the day is very long in summer.

So, sun will set around 9 P.M and maybe 10 sometimes around you know at that time. So, 7, 8 P.M; the western west facing if it is a glass southwest facing then it absorbs a lot of heat and in fact, it becomes pretty warm and it you feel a discomfort because of the heat because they do not have fans it is not designed for you know for heating external heating; it is all designed to keep it warm during winter because the winter is dominant scenario there. So, temperature within the space can go pretty high right.

Now, in such situation storing that heat would be useful; store it and maybe use it in the night when things cooler night means is a small night still and if it is sunny like Ladakh, which is sunny even in winter it is quite a bit of sunny; it would be a good thing to store that heat and use it in the night. Ladakh is cold and sunny, in fact, what is said is that if you stand and on the south facing let say east.

So, on your right is a south and left is a north weather. So, you can have as sun burnt on this side and [laugher] frostbite on the other side because there is all snow around. So, it is it is very sunny, but lot of snow and in fact, this is this is a this is if you if you by chance visit even place like place like Rohtang pass and similar ones, you will get sun burnt in if in summer time if you going because lot of reflection from the snow.

So, wherever sun if you sun is there on that side I mean if you are if you have a bald head like me and you are on that side you might get lot of black spots on your head and faces and all that one side of your face. So, but this is useful you can store that heat and use it in the later part of the day. So, this is called that is why it is called indirect gain; this called indirect gain thermal storage well wall; so that is that is indirect gain right.

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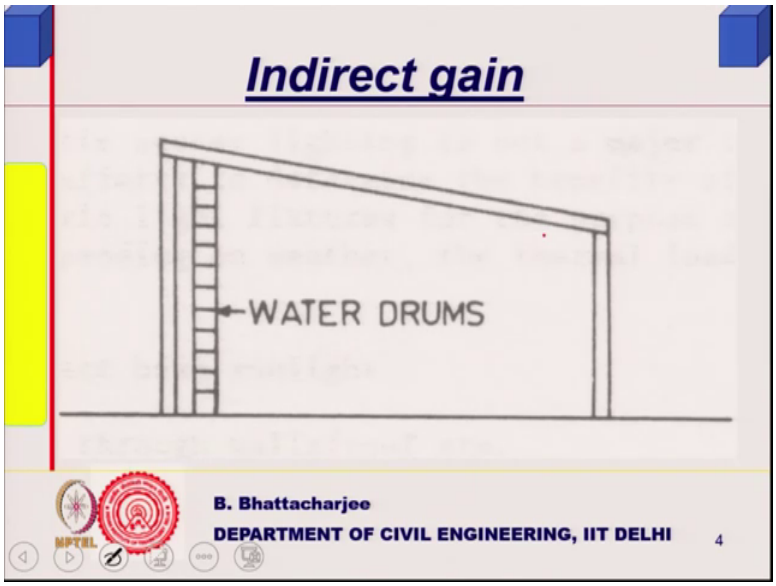

Now, well people have tried this kind of thing put water drums because why water has got high thermal capacity; high thermal capacity, you know water has got high thermal capacity so, but these are not very practical things really making brick work is fine water will have other kind of problems; if it is tropical scenario and you might have a summer scenario of course, tropical scenario you do not do that you might have mosquitoes also. So, if it is little bit open (Refer Time: 09:31) also, but; however, this is the idea.

This is called a trans wall; what is this actually what is the what is the problem with this kind of wall? It will also block the light direct solar radiation alright but block also the light, but supposing I put something like this a trans wall where I have got water.

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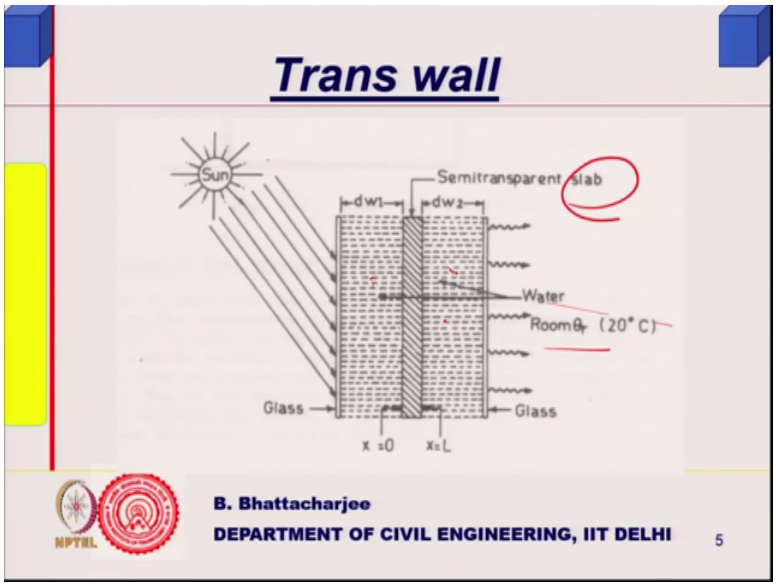

And this is a semi transparent it is not a slab is not the right terminology. Actually semi transparent panel translucent panel right made of let say perspex sheet polymers plastic translucent polymers. So, what will happen? The suns ray will pass through this the light will pass through it, but this will be also stored in the water and light will pass.

So, this is transparent light will pass and it will act like a same wall that we are talking about, but again this complicated construction actually I am not sure how much it is feasible it can be a onetime demonstration sort of thing, but in functional building using these are not very easy well first one is not that difficult to utilize the other ones are not very easy you can you know

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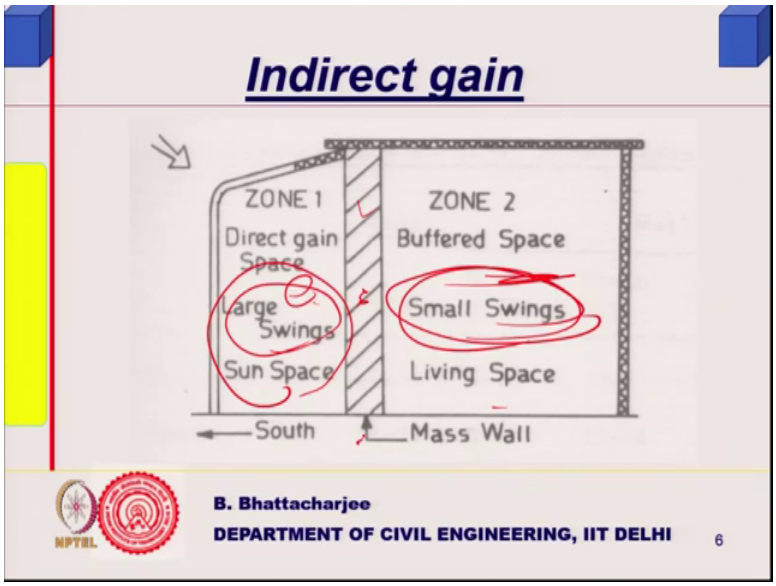

This is again indirect gain, this is the space which get directly heated then there is a wall this is a buffer space you know this gets heated up and then it heats up this space. So, swing will be less in this one otherwise this will have high swing; when solar radiation is being received, its temperature will go high up and later on later on in the part in the night part when temperature is down; the swing will be pretty high swing will be small here. So, this could be your living space mass is somewhere here. So, this sort of sort of concepts can be utilized.

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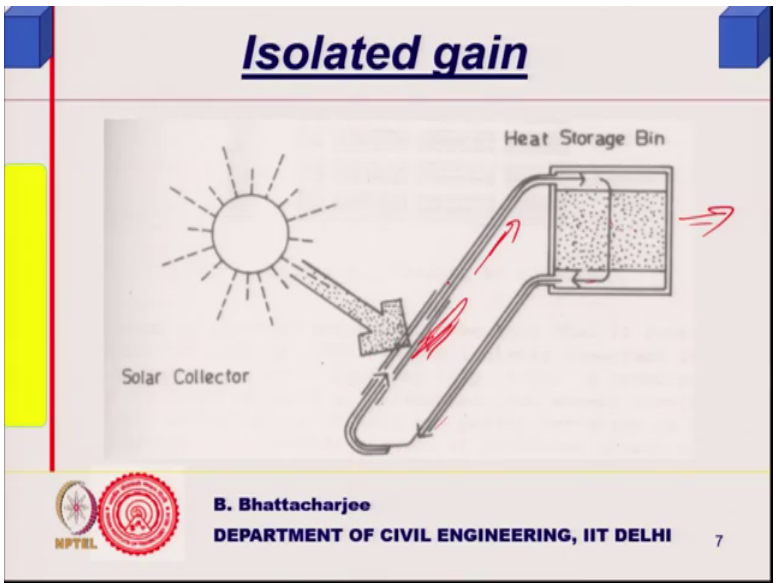

And isolated gain is what we use in you know flat plate collector or today you have got all those photo collecting panels. They actually collect and they are of course, they generate electricity this one is a good old days they will simply heat up the water. So, this is a collector which will receive the; so, you know which will receive the which will receive the suns radiation.

And the water because of thermo syphonic effect; warm water could not by due to convection level tendency to move up. And here you have a kind of you know heat storage some mass where hot water will be stored right and the cold water hot water is at the top; this heat will be dissipated outside or used for some other purpose maybe for swimming pool; partially cooling heating the swimming pool water or similar sort of things circulation in using together to build hot water services in the building and the cold water then so, this is called isolated gain.

So, first one was indirect gain you know; so if you have seen the direct gain, indirect gain. So, direct in this is this is actually if you leave the damper out I will have I mean this sorry wall out; I will have direct gain this is indirect gain, this is also all indirect gain and this is direct gain in this zone indirect gain is here and this is isolated gain somewhere away I am doing. So, this kind of concepts can be utilized in some manner.

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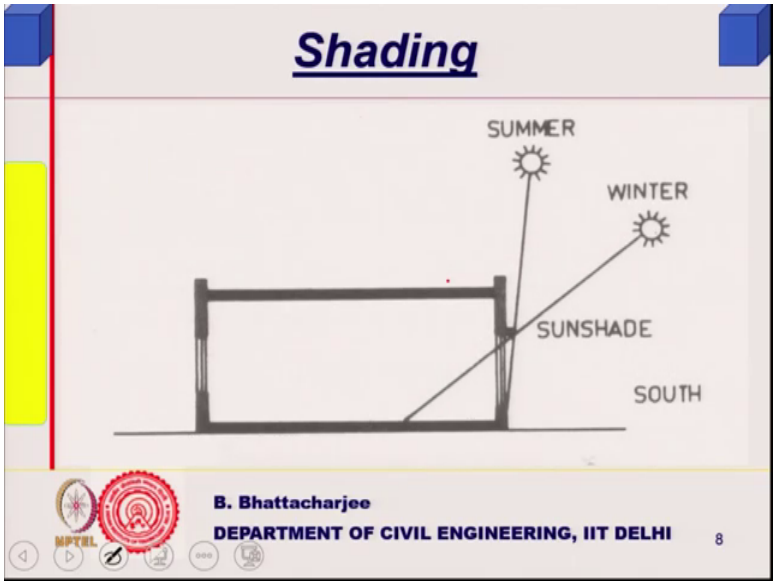

Shading already we talked about these are passive features shading already I have given you the concepts; I think I will not mention this any further, texture also I have mentioned you mentioned to you.

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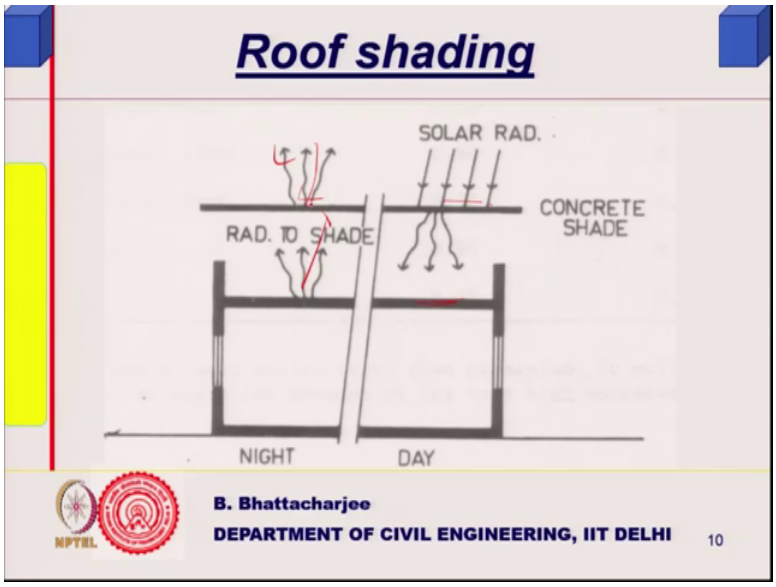

Then people thought that they can do some sort of shading in the roof right shading in the roof. So, for example, you know some sort of concrete shade; so, this solar radiation will block, but this again feasibility is big question; feasibility of this kind of concepts extra cost will be involved. But there are people who tried this out and put them in books; so, I thought I should tell you some things you never know where someone will innovate and do what. So, this is just giving you introduction to all this once right.

So, this will actually block the suns radiation; this will block the suns radiation and night this will actually radiate to outside. This will get heated up during day time anyway night actually you know this will radiate out, this will get cooled faster. So, some radiation to the shade will occur and roof shading can because we have been talking about shading the windows, but something somebody feels like shading the roof that is also is a possibility that is also a possible possibility right.

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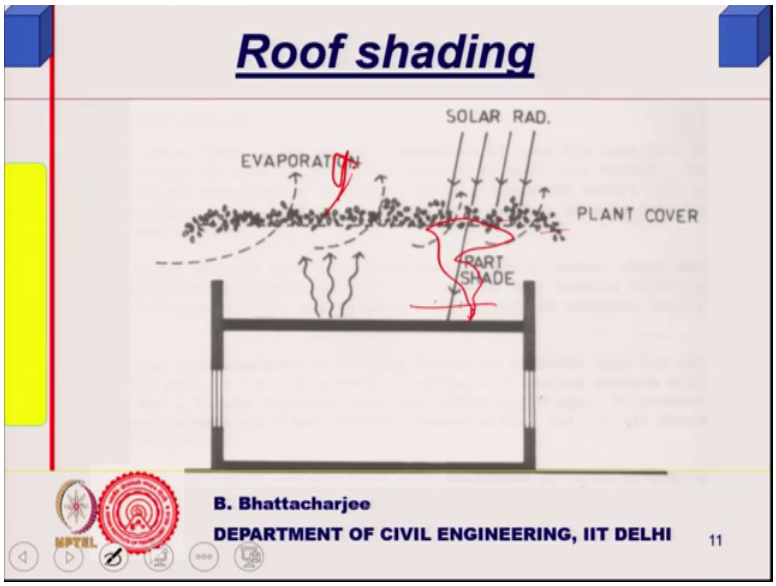

You can put some plantation there roof garden; you have to be careful because lot of water waterproofing becomes very important in such areas because you have to roof garden you can do it you can maintain it and it will cool. Because there will be lot of evaporation from the plants and; obviously, it will do cooling. And if you do it slightly at higher level with a gap right; this will shade or something like this you know plant starts from here; it occupies more area at the top your flower pots and things like that or maybe even vegetables or whatever it is.

So, the top would allow suns radiation, but block part of it will be a shading, but lot of evaporations. So, this cooling is possible, but you have to design the system issues of protecting the structural members waterproofing, drainage of water this becomes important and most important water should be available to you. Because you know there is some places in tropical areas, dry areas rainfall vary being very low the water availability might be a question.

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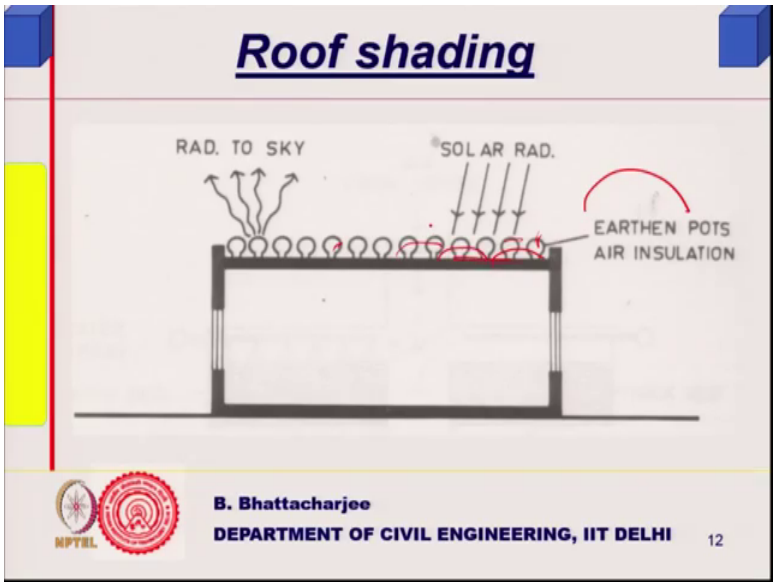

So, these are, but roof shading is possible some people thought they will use inverter earthen pots, but in both the cases actually access to the roof is maybe there, but it will not be utilized. Because you know you cannot utilize the roof for any other purpose and if you put this also this an earthen pots; you know earthen pots right.

Water jars earthen water just inverted put inverted and this will this will do what? This will almost act like an insulation because there are lot of air voids, large air voids within the pot. So, (Refer Time: 16:01) insulation large surface area it is a kind of texturing. So, receiving area solar radiation receiving area will be relatively effectively less and emitting area is high right or convective losses can be over from the large it will actually protect the protect the roof from solar radiation. So, this is, but again breaking this you know it might get broken maintenance is not in the ease one has to be careful.

So, but it can you know somebody can use it like this ah; somebody can use like this right. Saucers; earthen saucers inverted earthen saucers that might be a more feasible what you know earth earthen made of made of what we call vitrified you know like a vitrified; vitrified clay product right burnt clay products. So, burnt clay earthen saucer if you put it inverted at the rooftop smaller ones; they might still be more useful than this kind of a ok; one can innovate on them one can innovate of them right. So, these are some of them.

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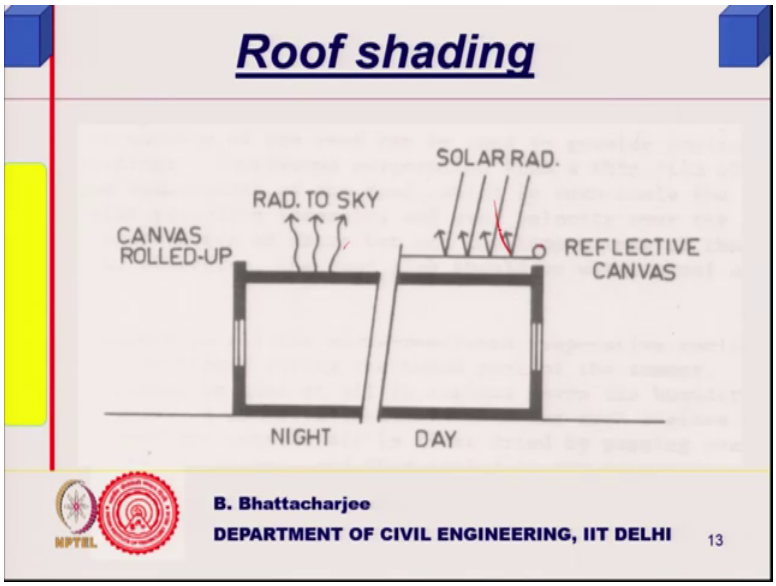

Roof shading by some canvas or something during daytime you block it you know you can roll it up as if you can roll it up. So, night you open it up daytime you put it solar radiation will block, night you open it up. Now that becomes you have to the occupant has to be now trained and their involvement also comes into picture in this kind of scenarios right.

So, reflective canvas you can put it can be white painted. So, that it reflects quite a bit, but then somebody has to do this job every day you know and night remove it, night you do not remove it could be blocking the heat radiation going out. So, one has to be careful about this.

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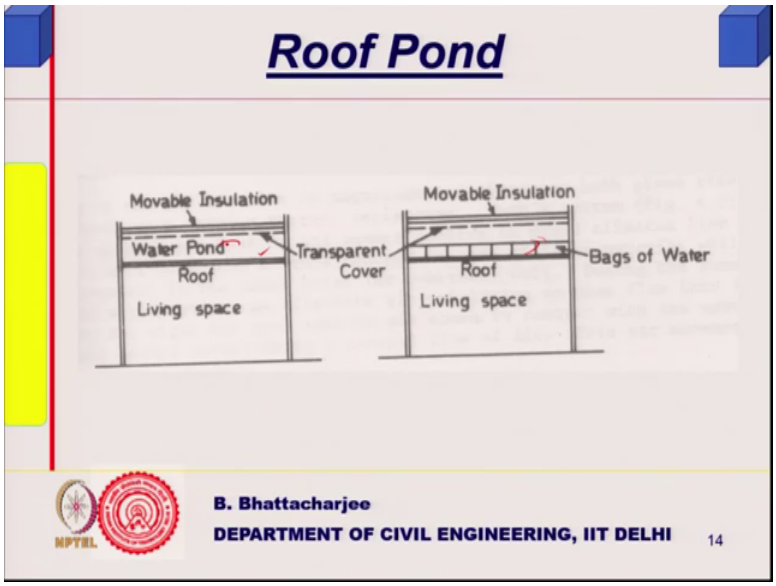

Roof pond some people also some there lot of lot of research paper came on that in 1980s. So, you put a water or put gunny wet gunny bags or put gunny bags on top of the roof and then wet them every day, but again waterproofing and all those issues will be there. You have to have water available otherwise there is a problem. In fact, this is traditional in Northern India; they will wash the balconies and those areas every summer afternoon right.

So, actually it is meant for evaporative cooling also; so, this is one thing. It might be the water pond and cover it up with a transparent cover and some movable insulation right. So, this is your bags of water could be there or water pond could be there and then transparent cover through which light will come and movable insulation daytime you put in the insulation, night you remove it. So, therefore, what this will store the heat this water will store the heat will not allow to go in, but night it will radiate back and also part of it will be inside the room if it is a hot dry desert climate, it might be fairly useful thing or hot dry desert scenario, but then you got to have water that is and then waterproofing of the roof this also you know.

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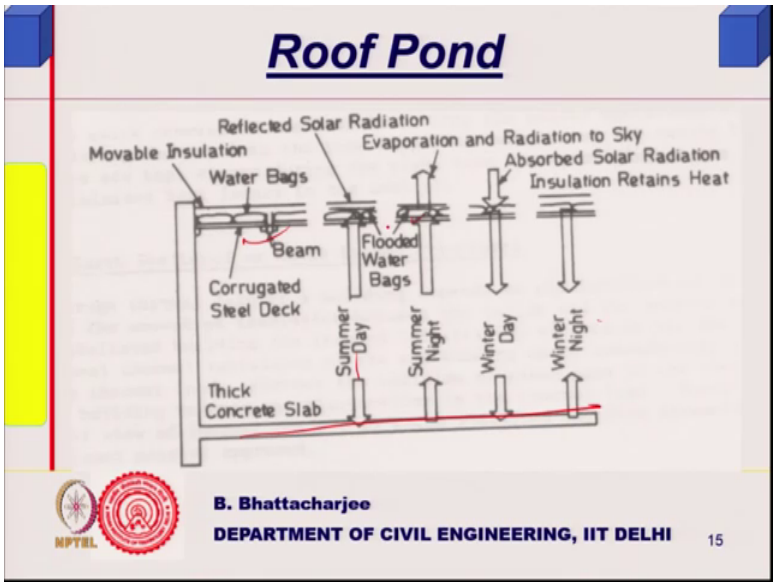

So, all kind of things water bags here you know flooded I mean water bags filled water bags filled with their ah; so, absorb solar radiation; this is this is the concrete structural slab summer daytime. I mean this same thing is shown in different manner with all the mechanism that is possible. Now remember all of this will involve additional cost and it has to be justified including the life cycle cost the maintenance cost; so, this is what is.

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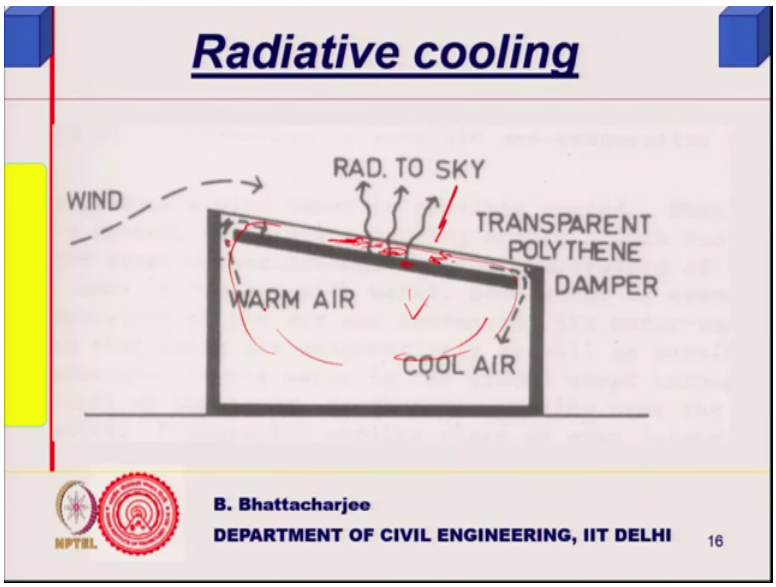

Ah The other kind of thing is you have a instead of that wall I was talking about; now you have something in the roof itself you know you had a wall the transparent polythene

or something which will allow suns radiation to come in and you have sort of holes here in the slab. So, hot air gets heated up here, wind can also facilitate this cooling in the night.

And daytime whatever solar radiation is received this is actually trapped here, this is stored here and then later on in the night it actually transfers hot air; warm air from the room can come in the night. And then cool air from this one because night this will radiate to the sky and cool it down the air here will be cooler and then this can circulation can cool in the night easily.

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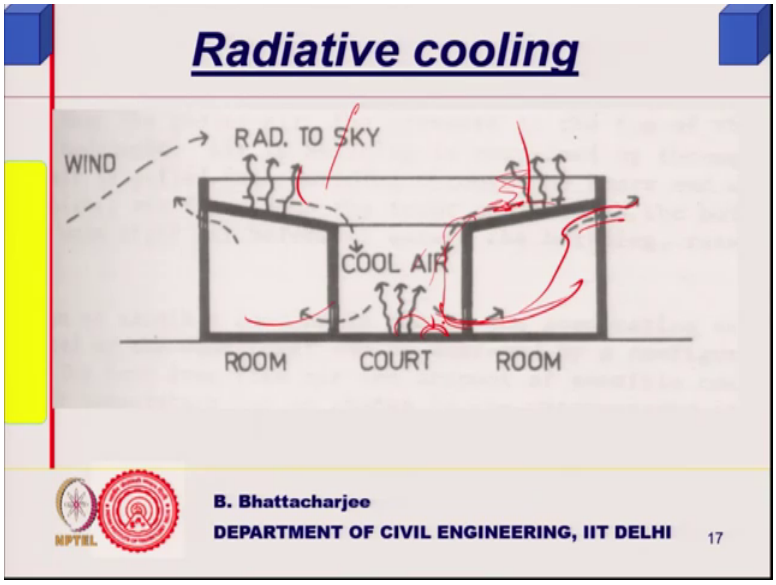

So, radiative cooling is possible; you can have something like this in the night radiation occurs the cool air will come here move through this through the courtyard. So, courtyard plan can be effective because in the night it can do easy cooling; cool air here because this should radiate out cool air here will have a tendency to move like this and you have openings here openings there it will actually cool faster in the night.

And you can have a water pond which is normally done; if you have seen houses in Northern India Haryana part of Haryana, Rajasthan etcetera; I am not sure in Punjab perhaps also is there; you will find that they have courtyard type of plan in traditional housing you will find courtyard type of plans and you will have somewhere they will be washing their utensils. So, sort of a would be there and its actually also helps in radiative

cooling; radiative cooling this is used in middle east quite a bit, this used in middle east quite a bit.

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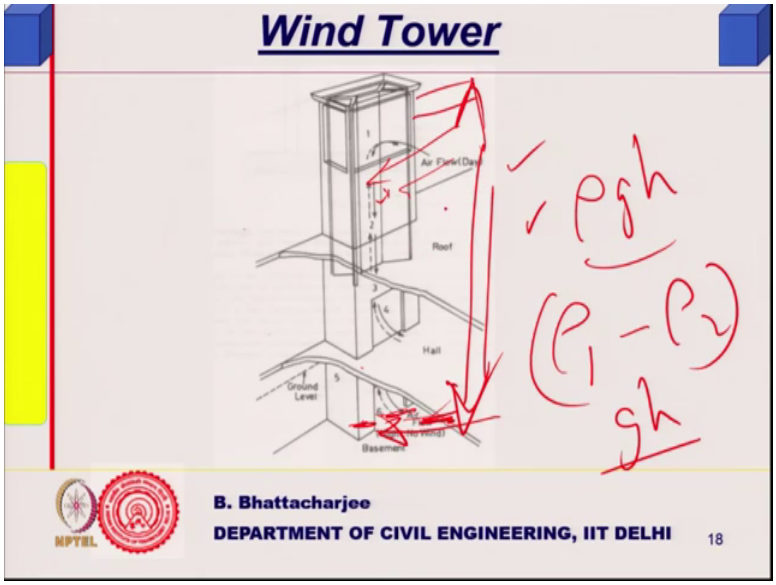

So, is a wind tower right. So, basically you know stack effect depending upon stack effect is what rho g h is a pressure at this point. So, depending upon the height we will discuss this sometime when you talk of ventilation; rho g h. Now here rho outside and rho inside would be different right; depending upon the outside air condition.

Because this will receive if it receives radiation and gets heated up the inside air will be also heated up; inside air also will be heated up right. So, inside air also will get heated up. So, if it is rho 1 minus rho 2 into g into h g into h is a height. Now, if the inside air is warm what will happen? Rho is less; if inside air is you know if it is warm then rho is less. So, rho g h at this point of outside rho g h is higher, inside there is rho is less. So, the pressure here is less; so, there will be flow along this direction.

When outside air is warm and inside air is still cool; the flow will be in the reverse direction. In other words you know; so, during the during day and night this feature this you know the air movement will be different. So, for example, night of course, both wind condition; if there is an external wind it will all change. External will wind it will all change; day time what happens is outside air is it tends to become warmer; inside it will require some time to get heated up this chimney sort of thing or the tower; it would require some time to heat it up.

So, if outside warm is air is warmer then density rho g h here is rho 2 will be less here. So, pressure the movement will be along this direction. So, dark line shows air flow during daytime right; dark line flows air flow during daytime. Inside is cool it is yet to get heated up outside air gets heated up. So, what will happen the outside hot air enters here and it becomes cool and then moves out through these areas and cools the room.

So, for example, this one floor this is another four floor it will cool down both the floors. In the night what will happen because by the daytime evening this has all got heated up and inside the stack also or inside the tower, the air is also quite warm compared to the outside which is now cooled down. So, the whole thing is that pressure here will be more, the direction of the movement; so, dotted line shows the movement in the night time.

So, the cool air from outside enters there then cool air from outside enters here and gets out taking the heat from the wall itself. And in the process eventually by the morning they the wall and inside air is all cool outside it starts heating up. So, this tower can be effectively utilized; if there is a wind, it will depend on the along the windward direction the pressure tends to; supposing this is the wind direction this will actually disturb the whole flow. Because there of course, the 4 all 4 openings there are 4 openings here, there are 4 openings there is no opening here there some opening, there some opening there.

Now, if there is a windward direction is this actually it will push. So, it will add during daytime, but night it will actually oppose the movement; oppose the movement. So, actually what we call neutral planes shifts, neutral plane you know where the where the pressure is 0; outside and inside pressure is by I mean same that shifts because of the wind direction. So, there is no wind condition wind condition this will get disturbed.

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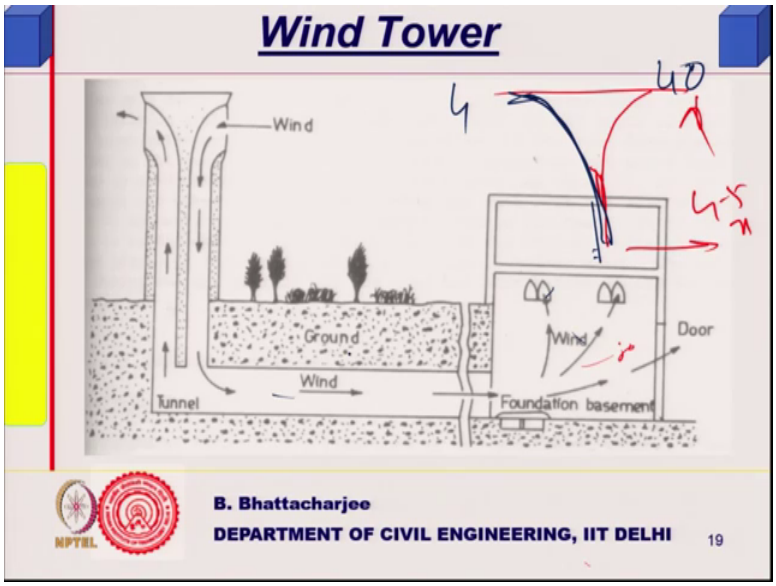

So, this is wind tower scenario; this wind tower scenario right wind tower scenario and you can actually use below the ground similar tower right. If there is a wind blowing it will take it in this manner, this is your space to be utilized basement. And you see the one thing temperature below the ground, temperature below the ground is usually constant; below 4 meter down you go, it remains close to 20 degree centigrade, 20 degree centigrade.

So, the temperature in summer surface will be something like this here it is 20 right some constant below some 4, 5 meter height; 4 to 5 meter height it will not change. And you go in winter if you if you look at winter; in winter if you look at it in winter it will be other around this is cold this is cold, but here it is a still same you know this might be 4, this must be 40 this is still remain same.

So, you can make use the ground this is forcing the air to move through below the ground and using that for you know thermal comfort inside this. You might have openings here switch will allow flow, but you can even make a fan to drive this, but then you go to add the cost; add the cost because you know all the rodents might make their holes and homes there all these issues we are all look into.

So, this feasibility of these are questionable, but while you know they used the thermal what they call is you know geothermal heat that has been utilized in cities. For example, with the aquifer level the temperature remains by and large constant. So, top you might

have snow or it has cooled down, but aquifer water temperature is relatively high; Canada they have actually used cities to really heat up.

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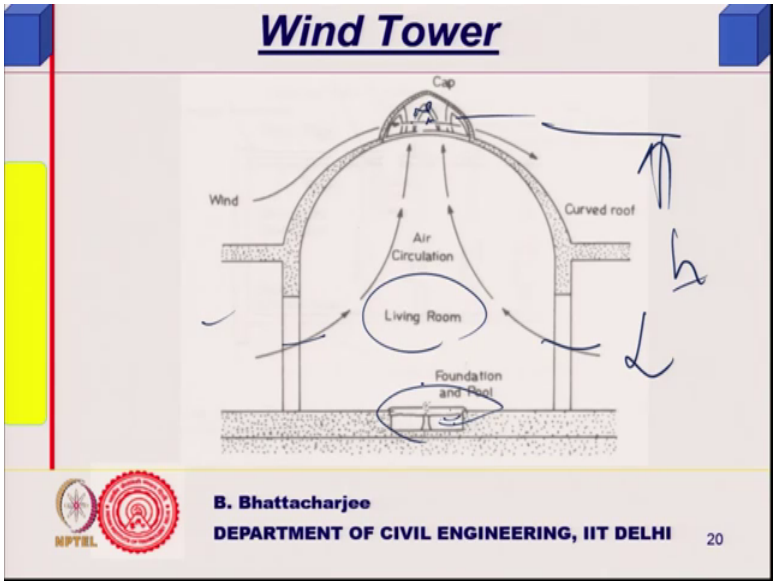

So, this is this is another concept using hot tunnel; hot tunnel and this is again used in middle east Iran etcetera quite a bit, you have a you know like living room air circulation you have a tower here openings here at the top crown; crown you will have a openings. So, same sort of a this height is important here now there is a entry here is an entry this height. So, same stack effect will be there rho g h outside here and inside here, but here the openings are at the crown actually openings are at the crown.

So, this height h will dictate how much flow take place same day time and night time circulation similar when I as I discussed earlier. And you might have a foundation and air pool and pool of water here for evaporative cooling might use.

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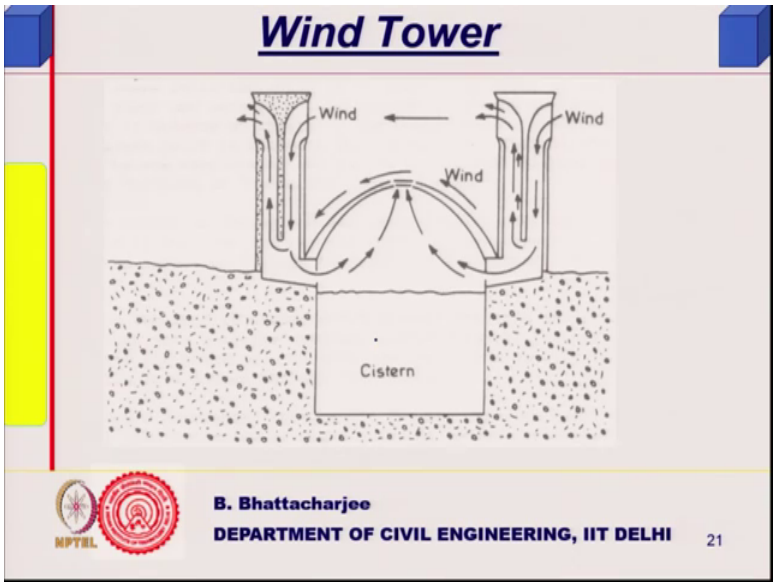

So, these kind of things are used in middle east traditionally; together with this there is a cistern there is a wind tower and you know like make this wind to flow this is all possible. I think will just quickly break and look into a few of this few of the system there is a.

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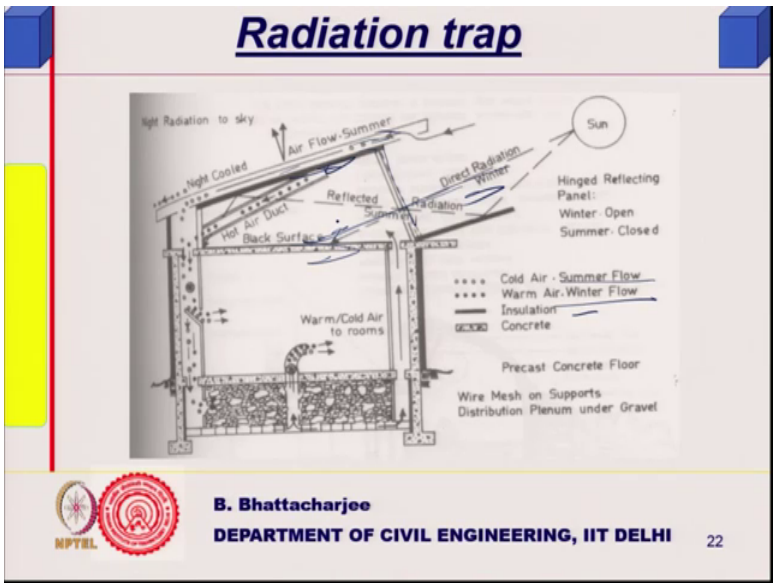

So, coming back to this then there are similar other concepts like radiation trap. So, this one is you know direct radiation comes in here; now this is this is just you know the summer this would be this is movable this is movable. So, this there are there are sort of

airflow pipe sort of it is possible. I mean basically keeping hole there this is the blackened surface which can receive radiation during winter.

So, during summer winter time this is open this gas radiation; in summer time you close this down and that sort of thing and you know like. So, cold air summer flow, warm air winter flow etcetera the insulation is there; this is an insulation. So, summer when it comes down you will have it will block and it is also an insulation will not allow it to come in. Winter you open it up so, that radiation comes in; so, you can trap the radiation during winter summer you may allow [vocalized-noise; so, this another also similar.

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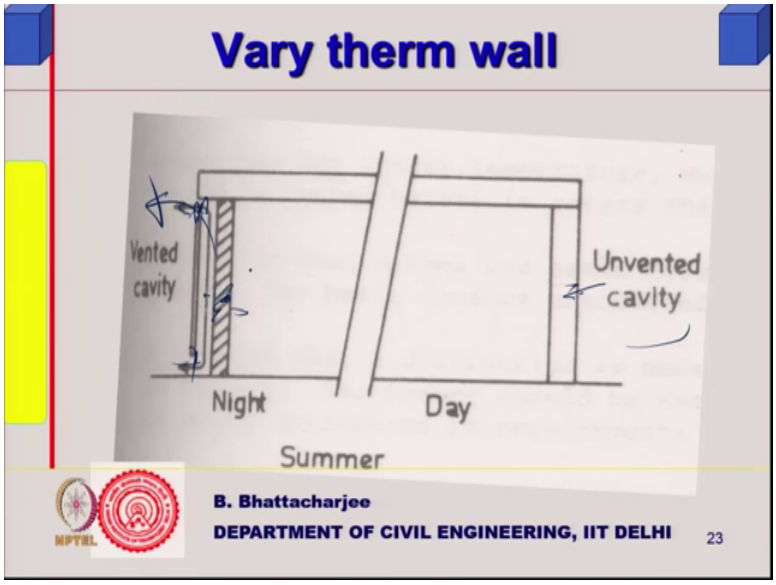

Now this is a simple wall, this is a simple wall this wall has you see the same wall you have to actually use it user occupant has to make you know you make use of this actually. It is something like this you have a thick portion here thick wall and there is a thin leaf outside. And this there is a opening there are slits here which you can close or open.

So, during daytime this you close ; so, it will act like an air gap cavity wall. So, no sun radiation can come in unvented cavity there is no vent. Night you open this up; so, what will happen daytime this portion would have got heated up anyway its received radiation; night you want to open it up cool air will move along this direction and take you at the heat from the room as well. So, cool it faster; so, this is called Vary therm wall; this is

this was one of the features put in those building, but you have to maintain them maintenance is an issue.

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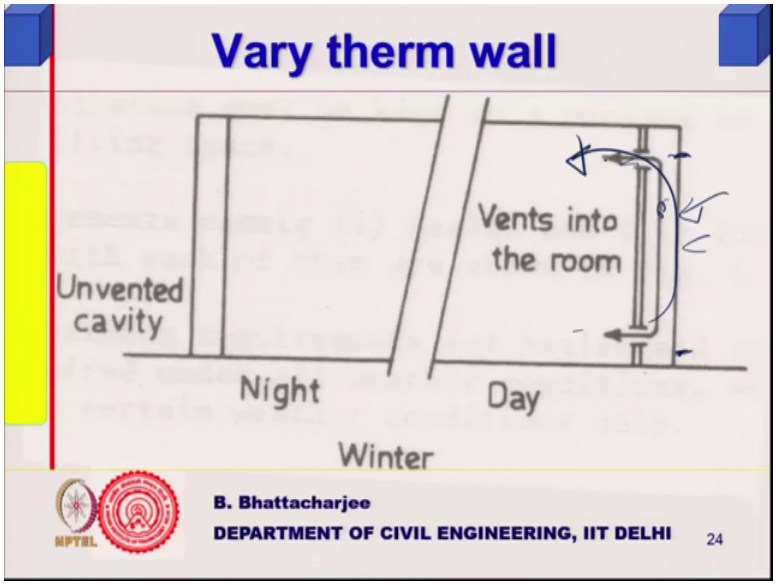

Similarly unvented you know; similarly, if it is a winter condition that was for the summer when winter condition what you want? Daytime you have this is a leaf and this is the wall; daytime allow the radiation to fall in this will heat it up. So, hot air moves in along this direction into the room; night you close it. So, that it becomes an insulation whatever it has gone in it cannot go. So, the same wall same wall can be used for example, south facing wall where you receive lot of radiation in summer I mean winter sorry not in summer might use this kind of thing.

So, depending upon the situation orientation etcetera; if you summer time you should be able to open this right and winter time you should able to open this. So, there will be kind of movable slits available actually which you can open or flaps which you open or close and this vary Therm wall can be made used for summer or winter time scenario.

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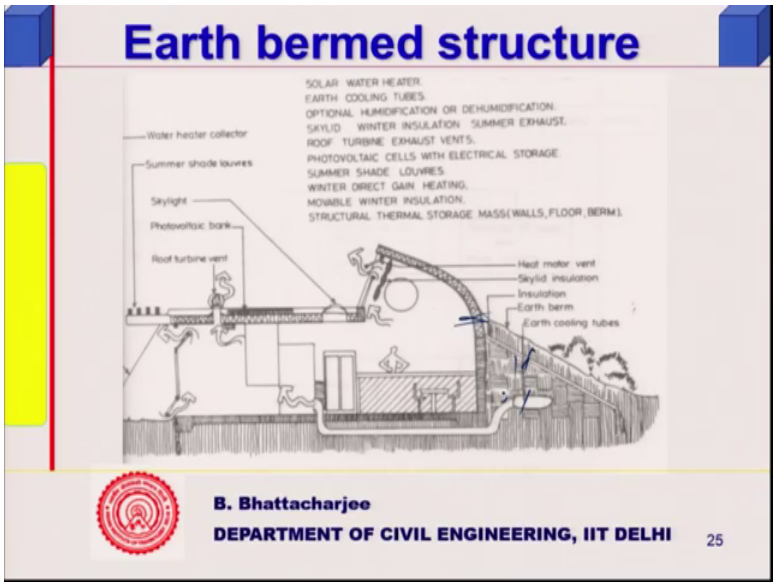

Earth as I said 4 degrees you know like if you go 4 meter below temperature do not change. So, anything below basement is always comfortable, but issues are other issues; you normally have you know water proofing I mean water seepage problem in this one. So, unless you have design the system properly and fire protection basement fire protection, you know it has to have sprinklers and similar sort of thing right; so, those becomes also important issue.

So, earth bermed structures because below the earth temperature is nearly constant; below some degrees in some 4, 5 meters. At the top whatever changes are occurring bottom temperature do not change that much. So, in summer it remains cool; in winter it actually remains warm compared to outside. And if you have glass or something like that other features you can always mix up, this is the earth; this is the earth. So, partially it can be sheltered through earth and all that.

So, I think these are some of those special features would like to I would like to introduce to you. Next time, I think I will talk about some of the overall design scenario then look into ventilation.