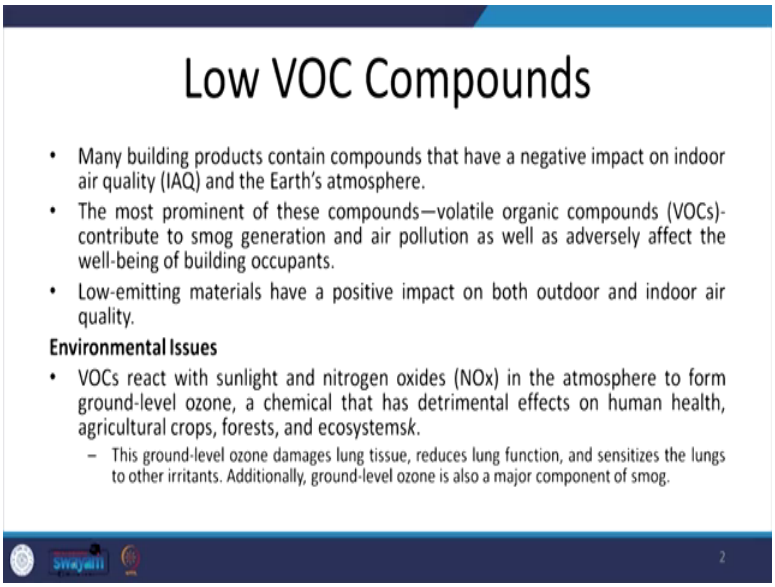
Sustainable Architecture
Prof. Avlokita Agrawal
Department of Architecture and Planning
Indian Institute of Technology, Roorkee

Lecture - 43
Indoor Environmental Quality- III

Good morning, welcome to this lecture as part of this ongoing online course on Sustainable Architecture. And in this week we have been discussing about the indoor air quality for sustainable buildings or green buildings. So, when we talk about the Indoor Air Quality or rather Indoor Environment Quality, there are several parameters which in the first lecture of this week we have already seen.

In the previous lecture, we discussed about the ventilation as part of the indoor air quality. But that is not all. There are several other factors and features which we have already seen. So, in today's lecture we will largely be discussing about the VOC of the materials, the finishes which are going to be used.

(Refer Slide Time: 01:14)



So, we are discussing about how to limit the VOC compounds inside the building. Now, what is VOC? VOC is Volatile Organic Compounds and they contribute to smoke generation and also air pollution. And they also adversely affect the well-being of human beings or the buildings occupants. So, VOC has been found after a lot of research that they contribute towards the towards several illnesses in human beings. So, they are the prime

reason why we have certain specific types of diseases and they are found mainly related to the respiratory problems.

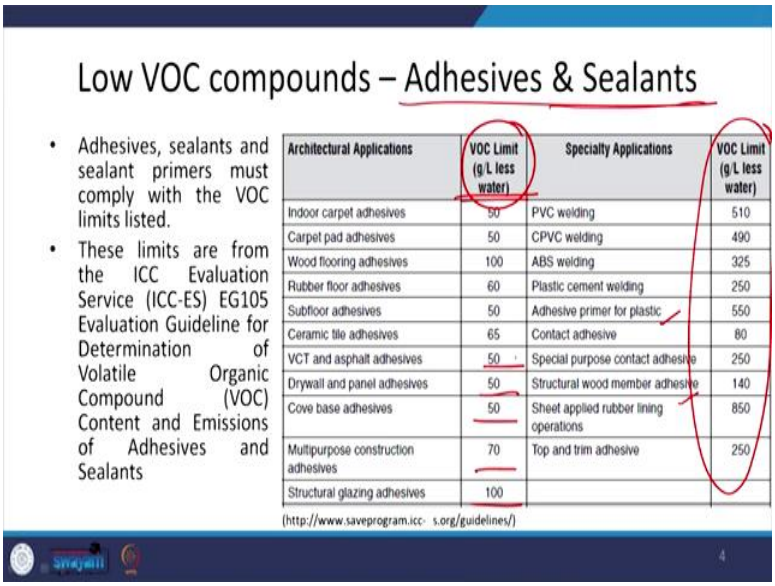
So, for any building to be a sustainable building a green building VOC compounds should be limited so that not only is the environment good, but it is good for the human beings or buildings occupants. So, the intent is to reduce the VOC compounds in the building interior that is by selecting the materials carefully. So, certain materials emit more VOC compounds while others they emit less VOC compounds. So, we have to reduce the VOC compound by selecting appropriate material.

Now, the environmental issue because of VOC compound is that VOC they react with sunlight and nitrogen oxides in the atmosphere and they form a ground level ozone. And this particular ground level ozone has negative effects on human health and well being and not just human health and well being but also agriculture crops, forests and ecosystem at a large.

So, it is not just in building interiors that we should be limiting it that is prime for human health, but at a larger level of the ecosystem level also the VOC compounds should be controlled they should be limited. Now, if we look at the economic issues because of VOC compounds we can directly relate the health hazards to human beings with that of economic losses.

So, if the buildings occupants are not healthy and they are not in high spirits, in good health, the illnesses will cause them or will lead to more absenteeism because of the illness related issues and that will be a detrimental effect on economy. So, the materials which have high VOC content should be reduced for economic reasons as well. And overall a low VOC compound building will improve the productivity of the occupants.

(Refer Slide Time: 04:23)

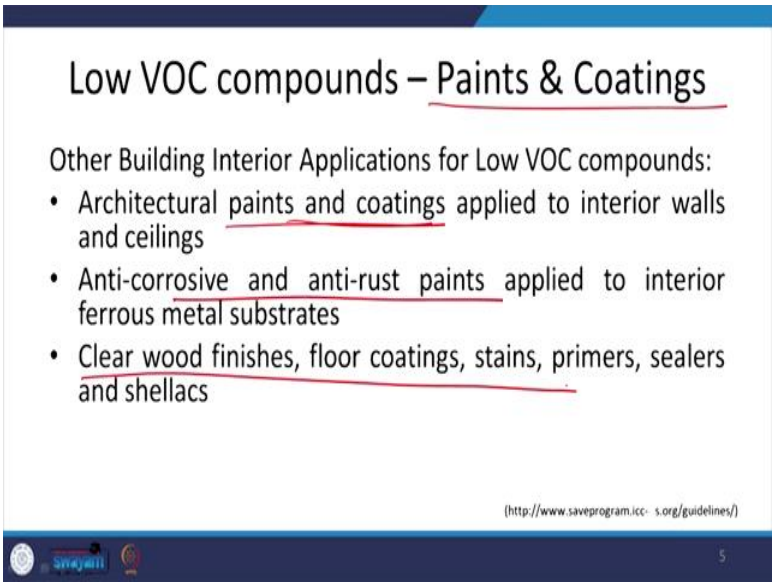


So, how do we decide that what compounds should be used and how much are the VOC limits for different types of materials? So, there are different agencies, organizations across the world. The one from which the data is commonly used is called ICC Evaluation Service, ICC ES. And they publish the guideline or the values for the cutoff limits of VOC compounds for different materials.

See often most of the green building rating systems refer to these organizations, it is not the only one, but the data from ICC ES is commonly used by several green building rating programs. So, they take out a limit which can clearly be seen here. So, for different categories of the products for example, adhesives and sealants, the VOC limits in grams per liters are specified.

So, for different types of diesels which are going to be used, for different types of processes like welding for using as a primer for plastics, for using as a special purpose adhesives. So, for adhesives and sealants these VOC limits have been specified. When we go on to select a particular adhesive or sealant we check the manufacturers label and then from there we can find out about the VOC limit of that particular product and choose a product which has VOC less than the specified limit.

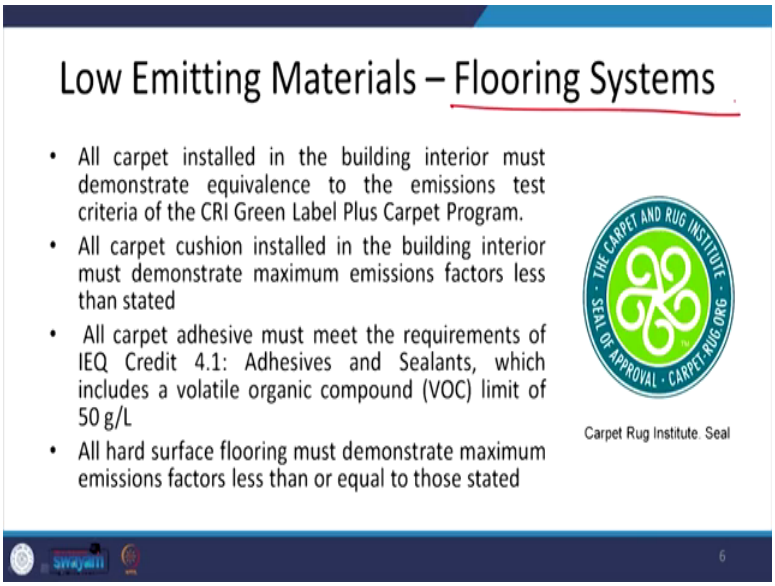
(Refer Slide Time: 06:06)



Similarly, for other products for example, paints and coatings they are associated with very high VOC compounds. You must have already seen that there are several paints in the market which are which have come up which have low VOC compounds; such paints they need to be selected carefully. The limits for paints and coatings are also to be found from the database.

Now, here we have to carefully select the architectural paints and coatings. The anti corrosive and anti rust paints often have higher VOC compounds as compared to the architectural paints, the paints which are applied on walls. So, not just the paints on walls, but also the anti corrosive and anti rust paints or even the clear wood finishes, the floor coatings stains primer sealer and shellacs, all of these they have the VOC limits specified prescribed.

(Refer Slide Time: 07:11)



So, we select the products carefully. We also have to be careful about the flooring systems, so what kind of flooring system is going to be used? In India carpeting is not a very common feature, we often have floors which are not carpeted. However, in the European context or in the western context where it is coming from a cold climate the carpets are essential.

And carpets because of the adhesives which are used, because of the sealants which are used along with the carpets they are associated with very high VOC. So, in case we are going for the flooring system where carpets are being installed we have to take at most care of what are the adhesives and sealants being used along with the carpets.

(Refer Slide Time: 08:00)

We also have composite wood and agrifiber products. So, because of the sustainability aspect where we encourage the use of composite wood and agrifiber products because they are more sustainable, they do not threaten the forests. And they also low on embodied energy because of all these benefits the composite wood and agrifiber products are being promoted these days.

But, these composite wood and agrifiber products, they are bound together with the help of a synthetic product which is like an adhesive. And it binds this wood and agrifiber together to form it in the form of a proper product, again it slowly releases the VOC this adhesives.

So, what kind of synthetic mix has been used in the composite wood and agrifiber product that has to be properly identified and the composite wood and agrifiber product be carefully chosen. So, we cannot just go ahead and buy any composite wood just because it would prove out to be sustainable it might come with a lot of health hazard for the building occupants, so we take care of that.

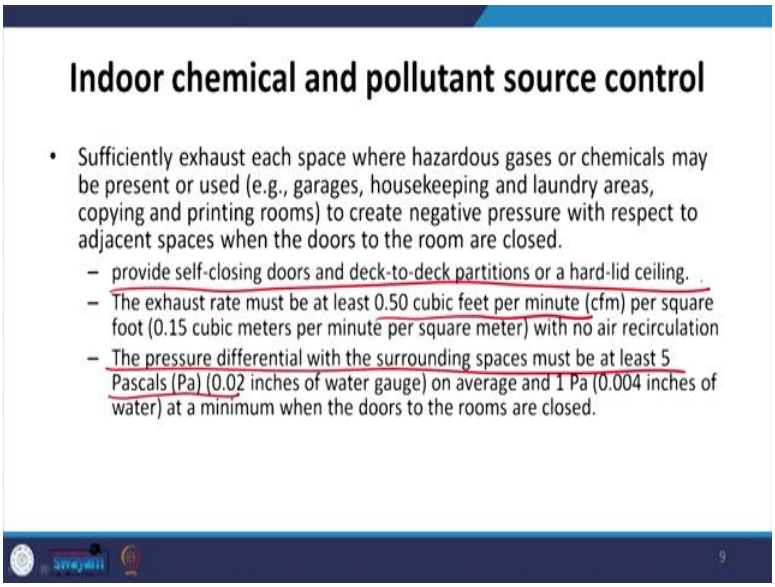
Besides selecting the materials we also have to control the indoor chemical and pollutants and that is at source itself. So, there may be certain processes in the buildings which release these chemicals and pollutants, not necessarily VOC here, but hazardous materials. So, one very common activity which takes place in our office buildings is photocopy.

So, we have these photocopier machines and the ink that is going in these photocopier machines is very harmful for the human health. So, if we constantly get exposed to the photocopier machine and the chemicals which are going in it will in the long run cause the health hazard. So, so this is a point source we know where what the source is. So, the intent of this is to minimize the exposure of building occupants to these potentially hazardous particulates and chemical pollutants.

And what we would do is? We can we can control we can limit this chemical pollution, these pollutants by designing the space in such a manner that the pollutants are either directly exhausted out. And they do not come in contact with the human beings, the buildings occupants or they are absorbed at the source itself. So, what we can do is? We can employ permanent entryway systems.

Now, this is at the entryway not for the point source. But at the entryway the permanent entryway systems can be employed which will capture the dirt and particulates which are entering the building from the outside from the exterior entrance. So, we design and we install propagates and drills and slotted systems that allow for cleaning underneath or even the rollout mats are acceptable if they are maintained on a weekly basis.

(Refer Slide Time: 11:32)



If they are not being maintained then they would rather absorb more dirt more pollutants and keep them there. In addition to that what I was mentioning about the photocopier machine it has to be such spaces, they have to be sufficiently exhausted. So, that the

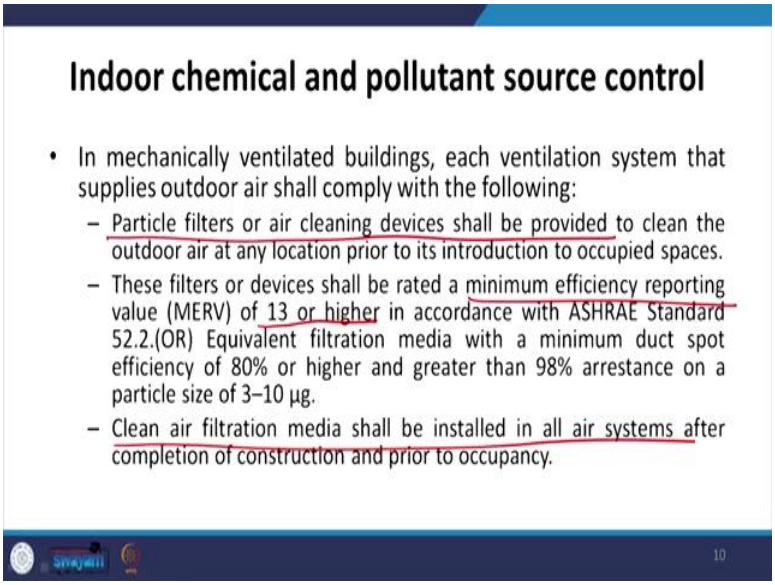
hazardous gas or chemical whatever is present or is being produced it is directly exhausted out and in the process of exhaustion it is also absorbed by the filter.

So, other spaces which are similar to this photocopier machine and the space are garages. The areas where all the housekeeping stuff is kept, the laundry areas, because the chemicals which are used for washing clothes, the laundry, they are emitted in huge volumes. And so, similar areas they need to be properly, sufficiently exhausted. And the exhaust rates are specified depending upon the areas and also the concentration of the hazardous chemical, the pollutant.

So, the exhaust rates they must be at least 0.5 cubic feet per minute. So, 0.5 cfm per square foot has to be ensured and this air should not be recirculated, it is only the exhaust. This exhaust should not be mixed with the incoming air. Also the pressure differential with the surroundings surrounding spaces must be at least 5 Pascal's. So, that the hazardous chemicals from these areas are not transferred onto the other habitable areas.

To ensure this besides maintaining the pressure difference self closing doors and deck to deck partitions are also to be provided. So, this has to be done to ensure that the chemicals or the pollutants, the hazardous chemicals, they are controlled and they are directly exhausted outside. The intent is that human beings, the buildings occupants should not be exposed to such pollutants and hazardous chemicals.

(Refer Slide Time: 13:35)



In case we have a mechanically ventilated building the ventilation system has to comply with certain prescriptive requirements. First is particle filter or air cleaning device shall be provided to clean the outdoor air and that is at any location before it is allowed inside the occupied spaces. So, it is not only for the hazardous chemicals or pollutants, but in general whenever the outdoor air is being brought inside it should be properly cleaned and filtered.

Also the minimum efficiency which has to be reported the MERV value as we say for these filters or devices it should be at least 13 or higher. This is in accordance with the ASHRAE standards and it has to be maintained. Also the clean air filtration media shall be installed in all air systems. So, not just where the hazardous chemicals are being produced inside the building, but also when the outdoor air is being brought inside, the air should be cleaned properly, the dirt, the pollutants from outside should not be allowed to enter inside.

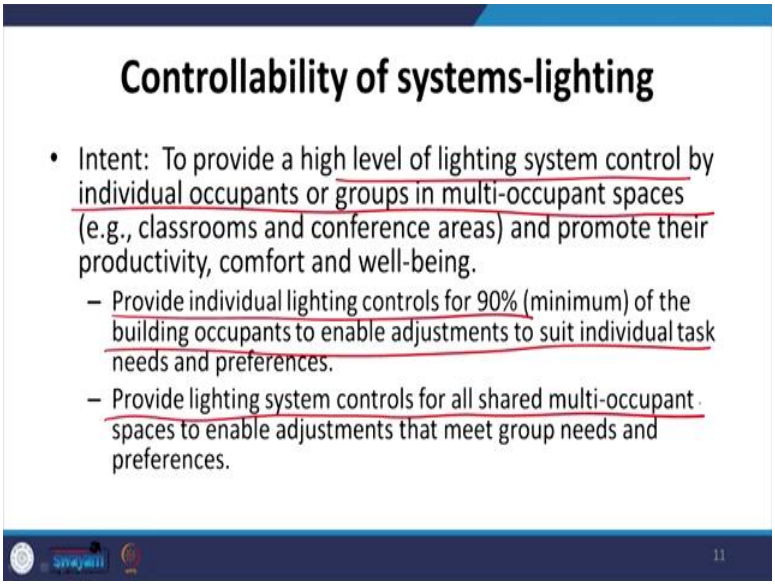
This is being done, the intent is to ensure that the buildings occupants, the human beings who are inside the building are not exposed to pollutants and they remain healthy and sound. Now, besides this indoor environment quality where we have largely focused upon how much of air should be brought in, the air should be cleaned the hazardous chemicals and pollutants should be exhausted and filtered and humans should have good air.

So far ,we have just been talking about the quality of air, but indoor environment quality is not just about the quality of air or clean air we need many other things to feel comfortable in an environment. So, the other thing which we need is the lighting; we also need to have proper acoustics, we need to have thermal comfort. Now, all these we will discuss a little later how to design these systems? What are the limits we have already talked about thermal comfort; we have already talked about the lighting requirements as part of this course in previous lectures. But, besides having good light and comfortable thermal environment we also have to ensure that the occupants are able to control these systems. Because, all the time all the building occupants will not be comfortable at the same level of lighting or thermal comfort, quality of air would be appreciated.

But one occupant might like might prefer to work in little lower levels of lighting while others may want a lot of bright light. So, how should we ensure that there is lighting which is sufficient for all occupants and there needs. To ensure that, we have to ensure, that the minimum lighting requirement as per the code here in our case it is NBC. So, the minimum

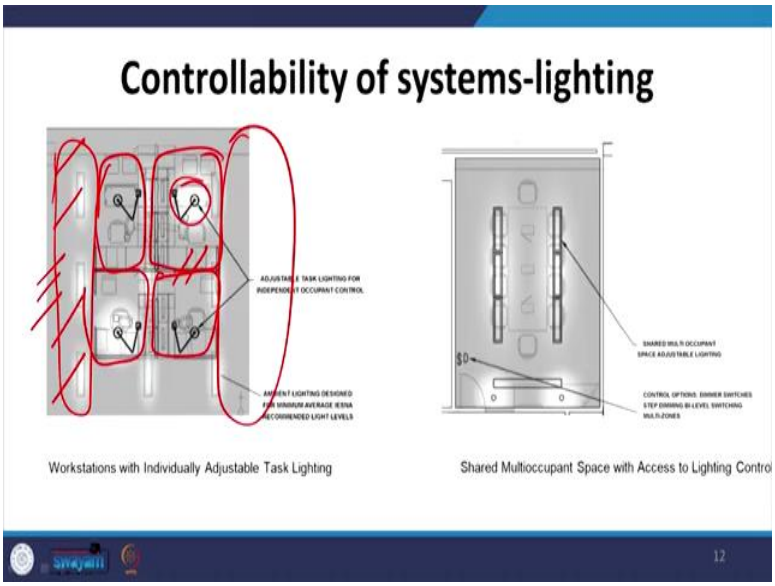
lighting requirement as per NBC are being provided for. But in addition to that there is a control of the lighting system which is available in the hands of the occupants.

(Refer Slide Time: 17:38)



So the intent is to provide a high level of lighting system control by individual occupants or groups in multi occupant spaces. And this is necessary to promote the productivity, comfort and well being of the occupants. So, how do we do it? We provide individual lighting controls for 90 percent that is the minimum, 90 percent of the building occupants to enable adjustments to suit their individual tasks their needs as well as preferences. So, we provide lighting system controls for all shared multi occupant spaces to enable adjustments.

(Refer Slide Time: 18:21)

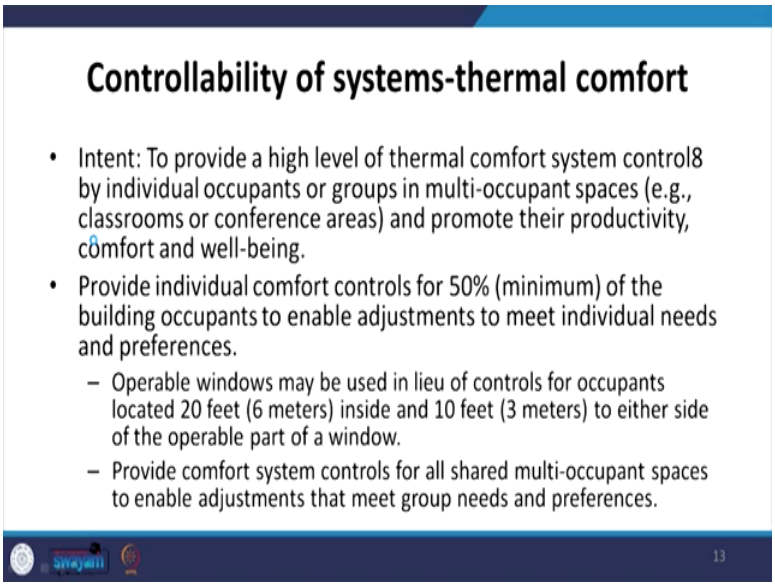


So, how can we do that? To ensure that everybody is able to control their personal space or environment in an open plan office. For example, that is the most difficult one to handle, because there are multi multiple occupants and everybody might have a different preference. So, the common lighting is designed as per the NBC's requirement.

So, the common areas the circulation areas they will have the minimum NBC requirements being fulfilled. However, in the space which is personalized the occupants are given the control where they can control the desk lighting which is the task lighting they can have more light or less light.

So, the simple thing to do is segregate the common area lighting and the task lighting distinctly. And the controls to task lighting can be in the hands of occupants. So, this would ensure that the minimum circulation, the minimum amount of light which is required in the circulation area is also there. However, the individual controls are also given in the hands of occupants.

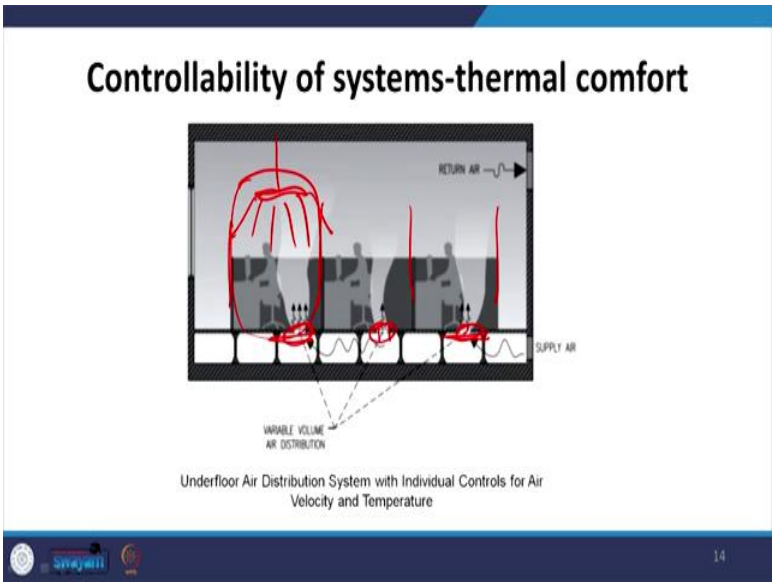
(Refer Slide Time: 19:43)



The similar thing is to be done with thermal comfort systems. So, often you might have seen that in large open plan offices some portion of the office would remain very cool because it is close to a lot of supply ducts while certain portion will become a hot area where the cooling does not reach. So, there is a variability.

So, one is that this air conditioning system or the thermal comfort system we design in such a manner that the space is uniformly maintained. In addition to that even when that is done some occupants will complain that oh we are feeling too cold and others would complain that it is still very warm. So, to ensure that, similar to what we have done for lighting the similar kind of control needs to be provided for thermal comfort.

(Refer Slide Time: 20:46)



So, how do we do that? We can do that by designing innovative systems. For example, this is an under deck mechanical duct, the supply air duct. Here for each workspace which is an individual workspace an opening of the supply air is being given. Now, depending upon the requirement of the user the occupant the user can control the opening how much of the air is being supplied in.

So, this is totally user control, the occupant control; if I feel warmer I may have more air supplied in, if I feel cooler I may reduce or I may totally block. The overall environment of the space, indoor environment of the space will be maintained at certain temperature as per the codes. However, individual controls will also be provided to the buildings occupants not just this much that you are able to control the supply duct.

In addition to that there may also be a ceiling fan which can be controlled. So, if I feel warmer I may turn on the fan which is only for my space and some such functions. So, here the intent is to control, to allow the controls in the hands of occupants both for lighting as well as thermal comfort.

So, we would stop here for this particular lecture and in the next lecture we would talk about the thermal comfort design. So, when we are talking about the controllability of systems for thermal comfort how do we ensure that thermal comfort is achieved in a building design? So, we would see that in the next lecture and see you then thank you for being with us today.