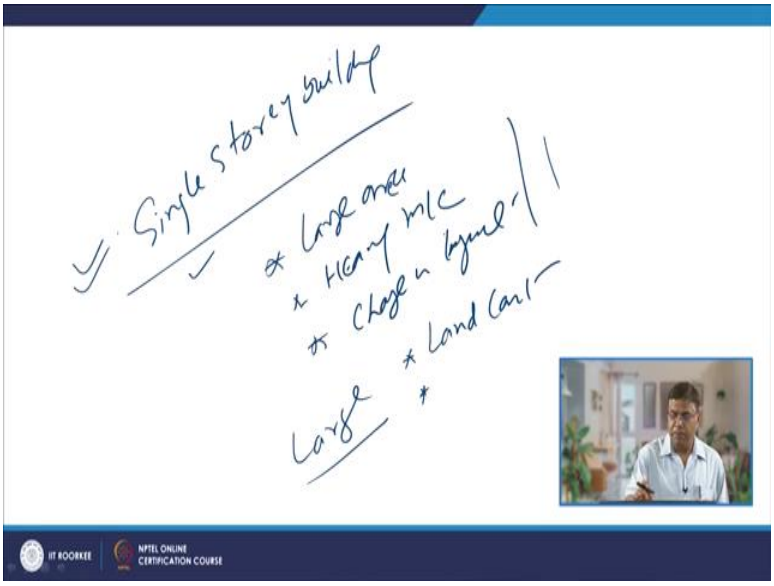
Principle of Industrial Engineering
Professor. D.K Dwivedi
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee
Lecture - 25
Organization of Facility and Material Handling

Hello, I welcome you all in this presentation, relative to the subject Principles of Industrial Engineering. And you know, we are talking about the Organization of the Facilities in a plant which is significantly affected by the, the plant building design. Apart from the other things which need to be accommodated like the, the facilities for the workers, the kind of ventilation, the kind of climatic conditions to be mentioned, to be realized, and the ventilation related things, and the lighting. So, and this is affected by the kind of type of the buildings, which are there.

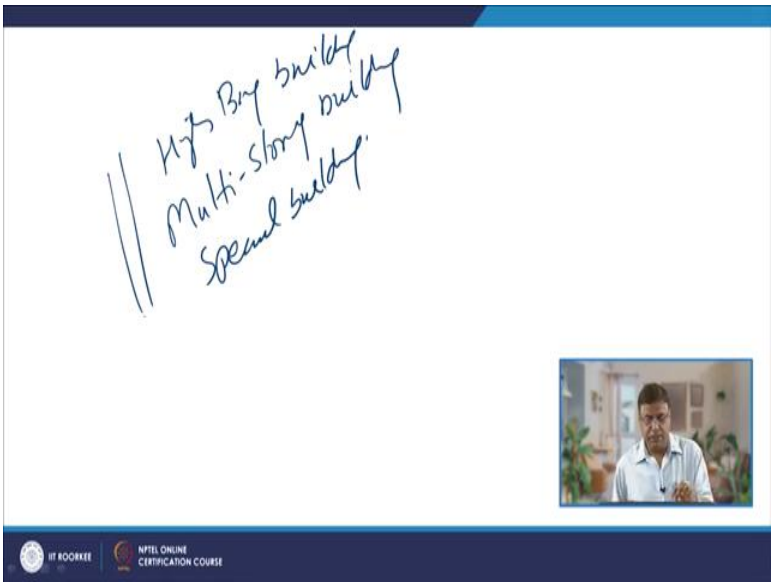
(Refer Slide Time: 01:15)



What we have seen is, there are various benefits of using the single storey building. And we have seen that, when very heavy machines and heavy products are to be handled during the course of the manufacturing, minimum vibrations, minimum vibrations, large area requirement, large area, heavy machines, and the frequent change, change in layout is needed. So, these things are easily accommodated in case of the single storey building. But for this we need a very large area.

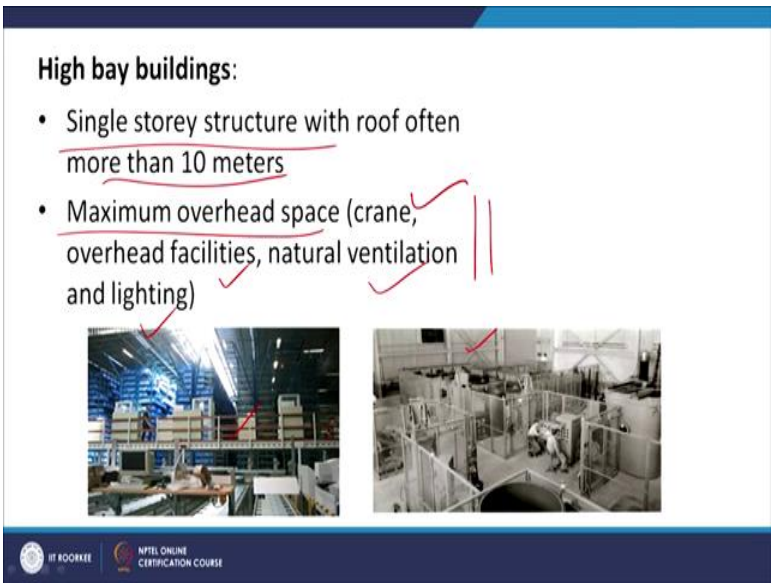
So, it is justified or good when the land cost is low. But there are other undesirable, few undesirable features also related with this single story type of the building.

(Refer Slide Time: 02:21)



Now, in this presentation we will see the multi storey building, high bay building, special building. So, each of these offer different types of the benefits and the structures. And therefore, these suit under the different conditions.

(Refer Slide Time: 02:55)

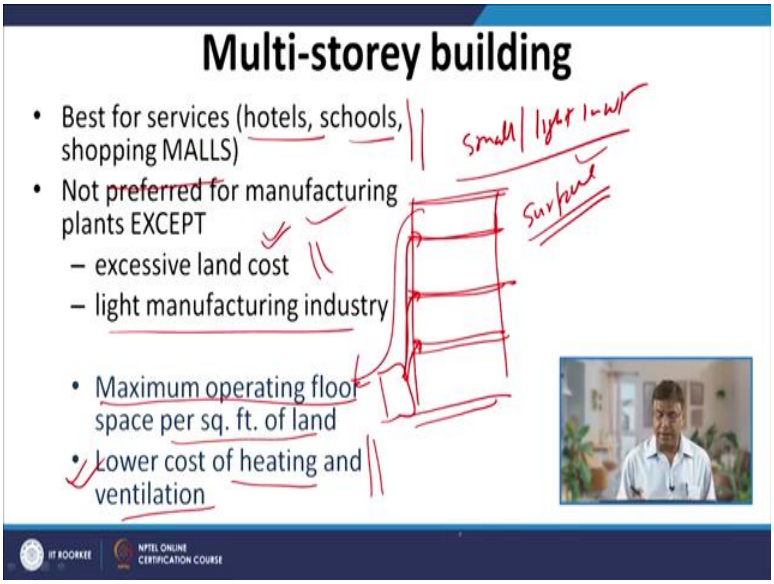


Say in case of the high bay building, it is a single storey structure. But very long roof is available, say more than 10 meters and the maximum, it provides the maximum overhead space

for use of the cranes, overhead facilities, it provides very good ventilation, and the natural lighting.

So, when the heavy structures need to be moved or used in the building or lot of overhead space is needed for efficient material handling, then high bay buildings are found to be useful. This is one typical example of the high bay building and this is another example of the high bay building.

(Refer Slide Time: 03:57)



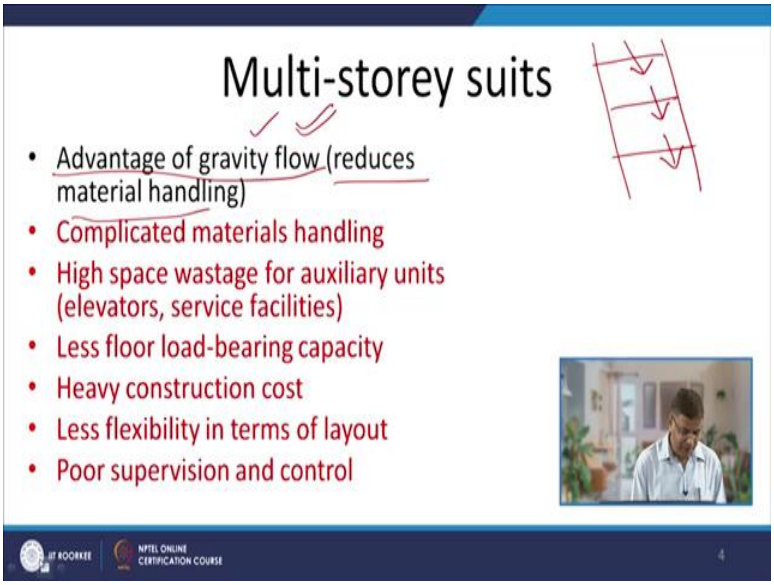
Now we will see, the multi storey buildings. In case of the multi story building, this does not suit the for the manufacturing conditions, for manufacturing industry or manufacturing plants; except when the product to be manufactured is very small, light in weight. Then this kind of the buildings can be used. Otherwise, these types of the buildings are best suited, this kind of the buildings are best suited for the hotels, schools, shopping malls.

These are not preferred for manufacturing plants; except under the conditions when the land cost is very high and the multi storey building will be able to, will be good enough to manufacture the light and small size components. So, the light manufacturing industry and on the conditions, when the land cost is very high the multi storey building for the small and light size products can be used, where not very heavy machineries is required for the manufacturing or for the smooth functioning of the plant.

In this case this, this type of the building offers the maximum operating floor area, for per square feet of the land because for the same land we can have the number of floors where the different activities will be going on. So, it offers the maximum floor space per square feet of the land. And in this case also, the heating and ventilation is very efficient, the cost of heating and the ventilation is effective. So, here we can have one plant for the air conditioning of the multi storey building and the, through the ducts that different floors are connected for air conditioning purpose.

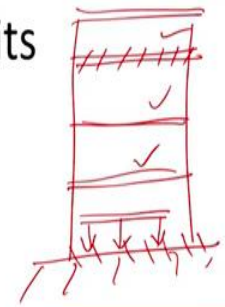
So, the surface area exposed to the environment in, of the building is less, in case of the multi storey buildings. And that is why, what we noticed that the control of the ambience and the environment within the multi storey plant building will be easier, and that is why it will be leading, it will be leading to the lower cost of heating and ventilation.

(Refer Slide Time: 06:48)



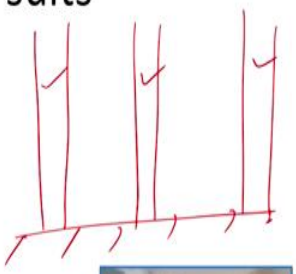
Multi-storey suits

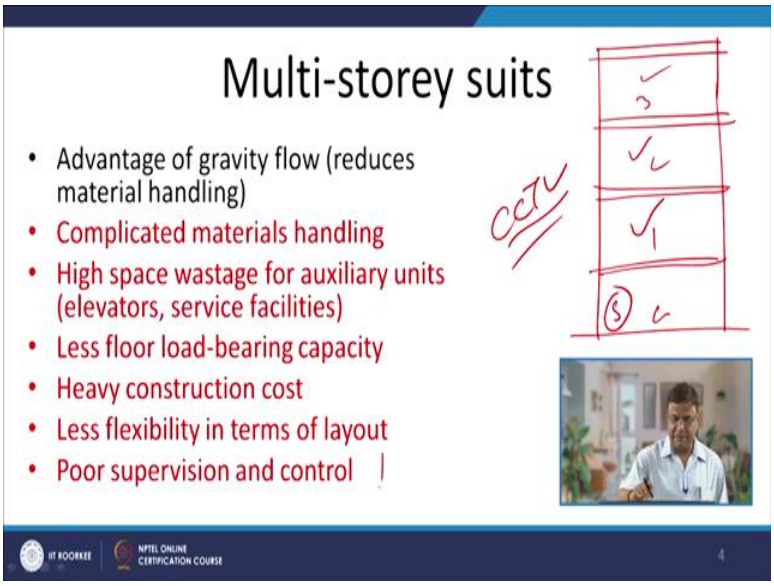
- Advantage of gravity flow (reduces material handling)
- Complicated materials handling
- High space wastage for auxiliary units (elevators, service facilities)
- Less floor load-bearing capacity
- Heavy construction cost
- Less flexibility in terms of layout
- Poor supervision and control



Multi-storey suits

- Advantage of gravity flow (reduces material handling)
- Complicated materials handling
- High space wastage for auxiliary units (elevators, service facilities)
- Less floor load-bearing capacity
- Heavy construction cost
- Less flexibility in terms of layout
- Poor supervision and control





Apart from the above 2 advantages, it also offers the advantage of the gravity flow. Since, there are various levels, various floors at the different levels. So, if possible, we can use the, the movement of the material under the gravity conditions. Like, shoots and all those things can be used for the movement of the raw material or semi finished products or the finished product, from 1 level to another. So, that in turn can help to reduce the material handling cost.

So, it multi storey building design can offer the advantage of the gravity, a use of the gravity for the material handling purpose. Apart from those benefits, there are few undesirable and negative features related with the multi storey building. Like in this case, it is difficult to design the flow of the material and that is why, the material handling is difficult in case of the multi storey buildings. Further, very high waste, space wastage for the auxiliary units in case of the like, elevators and the service facilities, lot of space is wasted.

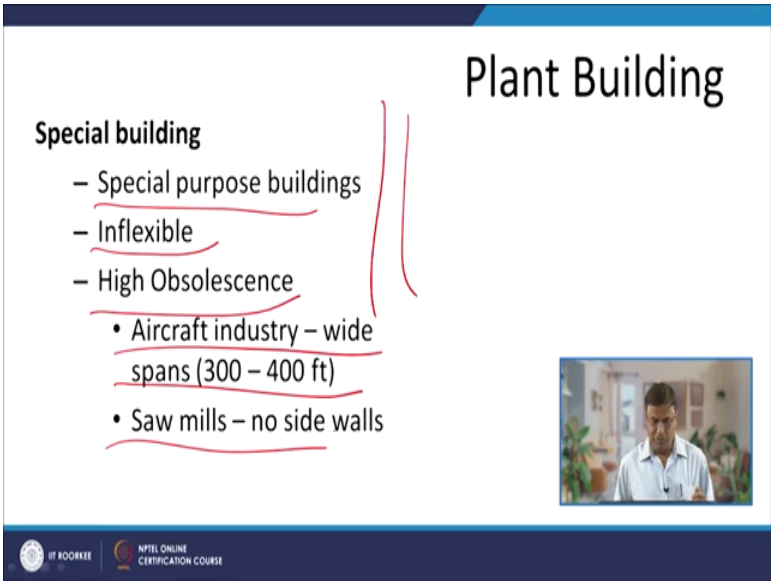
And the less floor load bearing capacity means, the building, the multi storey building will have 1 foundation, than the different floors will be housing the different machines. And so, these floors are not considered to be as strong as the, the ground floor to accommodate the heavy machines, with regard to the load bearing capacity. So, the ground floor will be offering the much better load bearing capacity, as compare to the floors at the higher level. And that is why, the less floor load bearing capacity, the construction cost is high.

Of course, it will be greater than that of the single storey building. And there is a less flexibility in terms of the layout change. Like, because in multi storey buildings we have the fixed place of the columns and in the current condition, the current layout may be good, but subsequently if the change of the layout is needed, then these columns will be putting in the restrictions towards the change in layout. So, somewhat lesser flexibility is offered in terms of the change in layout, in case of the multi storey buildings.

And since, the work will be undertaken at the different floors, so these will not be there, the kind of the activities being undertaken at the different floors. Like, the ground floor, first floor, second floor, third floor. So, activities being taken if there is a supervisor then, he may not have very good control over the kind of activities, which are being done at the first second and third floor. However nowadays, we have the CCTV kind of the arrangements.

So, workers sit, the supervisors sitting in the ground floor can easily check the, the kind of status or the things or activities which are going on under the, at any floor. So, these are some of the negative aspects or the disadvantages related to the multi storey building.

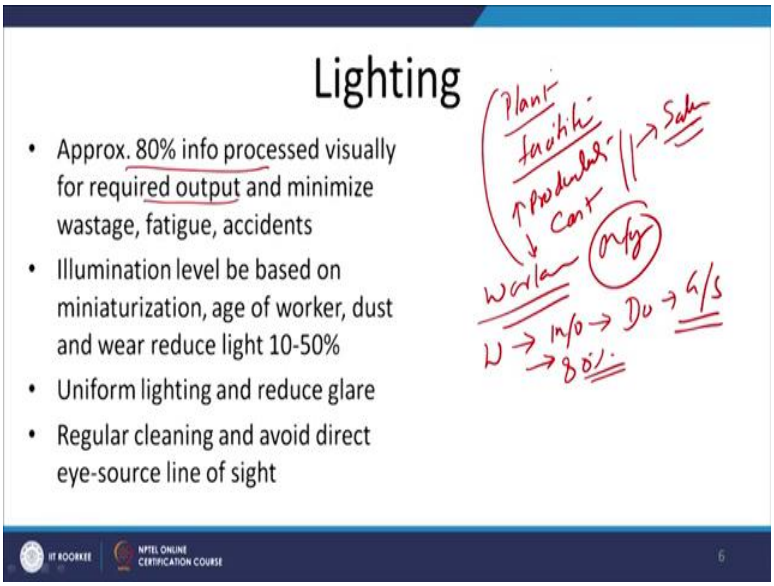
(Refer Slide Time: 10:37)

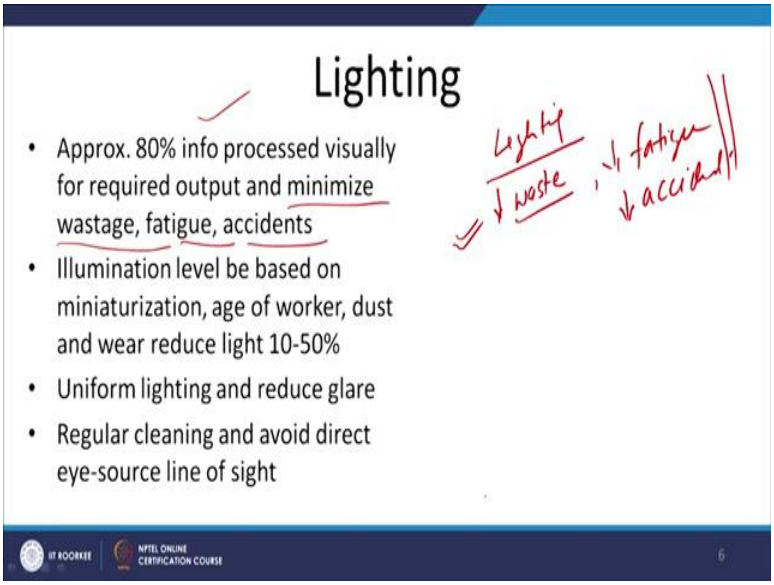


Apart from that, there is like a special buildings, special purpose buildings which are considered to be inflexible these are designed to serve a particular kind of purpose. And once, these are not in use, then their obsolescence possibilities are also high. Example of such kind of the buildings

is like, the building which is design to accommodate the aircrafts. In aircraft industry, they are having very wide expand, so that they can accommodate the aircrafts. And like some is having just the ceiling or the, the roof to accommodate the machine and the sides, in the sides there is no wall. So, these are the special cases as far as the building design is concerned.

(Refer Slide Time: 11:28)



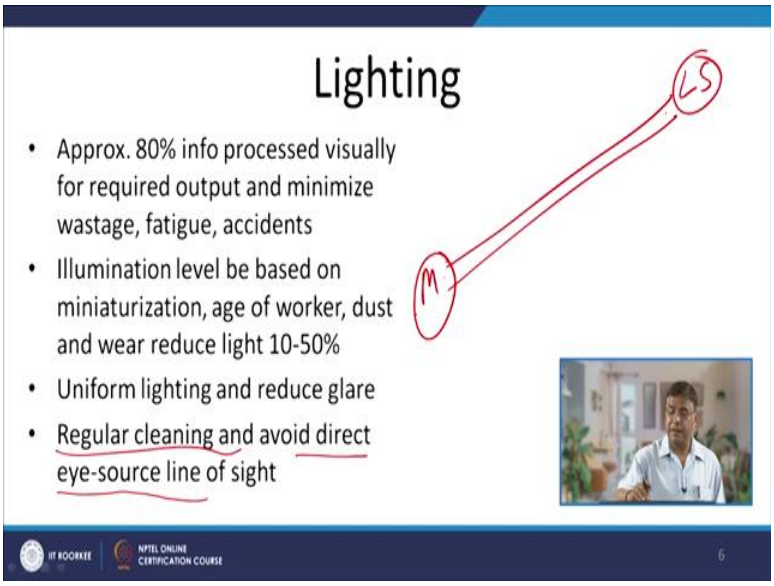


Lighting

- Approx. 80% info processed visually for required output and minimize wastage, fatigue, accidents
- Illumination level be based on miniaturization, age of worker, dust and wear reduce light 10-50%
- Uniform lighting and reduce glare
- Regular cleaning and avoid direct eye-source line of sight

Lighting

- Approx. 80% info processed visually for required output and minimize wastage, fatigue, accidents
- Illumination level be based on miniaturization, age of worker, dust and wear reduce light 10-50%
- Uniform lighting and reduce glare
- Regular cleaning and avoid direct eye-source line of sight



As I said the goal of any organization is to have the plant. And it is facilities, such that the productivity is increased, wastage is reduced and whatever goods and services are there they are produced at the minimum cost, so that the sales of the goods and services can be enhanced. In this regard, it is important that what our workers are being used to for producing the goods and services, they get enough lighting for efficient working.

Why, because whatever information worker will be using during the manufacturing, basically, worker gets the information, information processed by the worker to do the job. And this in turn, results in the goods and services. So, this information which the worker will be receiving, 80 percent of the time is received visually. Like he will be seeing some data, he will be reading the instructions, he will be seeing the job. So, most of the time the information that a worker uses to do the job is he gets through the visualization.

So approximately, 80 percent information is processed visually, for doing the things or to do to produce the required output. So, it is very important that whatever, to have the good visual effects to get the information and to do the job accordingly. It is important that there is enough lighting and if there is enough lighting, then the worker will be able to do the job with the perfections, which will be reducing the waste. It will be reducing the fatigue of the worker in reading or interpreting the information, it will also help in reducing the accidents.

So, if there is enough lighting to see that job, to see the instructions, to read the information which is there on the monitor or on the displays, then he can effectively get and understand the information and do the expected job. If it is not so, then it will mean, it will increase the wastage, increase the fatigue, increase the accidents, and proper lighting will help to minimize all these.

So, appropriate level of the lighting has to be maintained. And that will depend upon the size of the job, size or the kind of the instructions the extent of the instructions that need to be interpreted or in need to be understood and he has to read those instructions, or the kind of that data he has to see through the different displays. So, as per the size of these things, and as per the age of the worker, the illumination or the lighting primarily depends upon required, primarily depends upon the size and the age of the worker.

And we know that, when we install the new lighting system, the light is excellent gradually the illumination will keep on decreasing. Why, because there will be the dust there will be wear on those lighting systems and that can reduce the elimination by 10 to 50 percent. So, this factor also should be kept in mind when lighting system is designed.

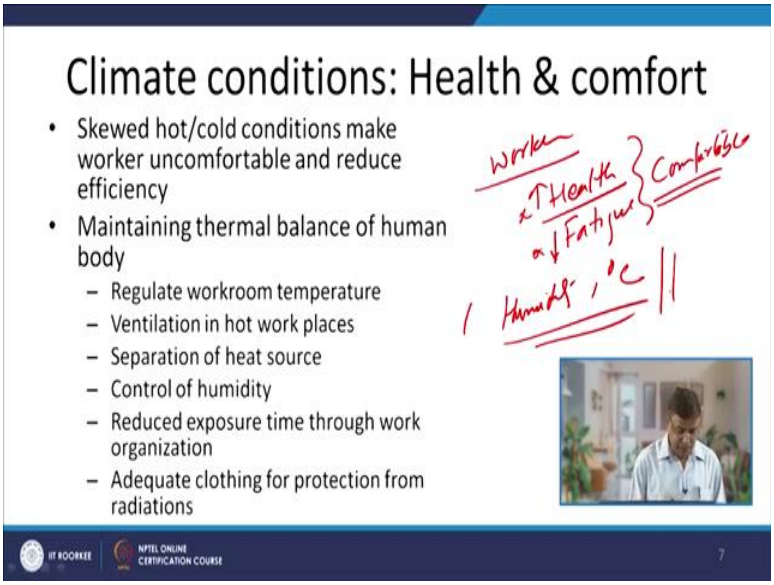
So, as per the age of the workers and the size of the job means, with the increase of miniaturization or reduction in the job size, the lighting should be increased. And likewise, with the increase in the age of the worker the lighting should be increased. Apart from that, the dusting and the gradual wear on of the lighting system should also be kept in mind, while designing the lighting system because it will be reducing the illumination level.

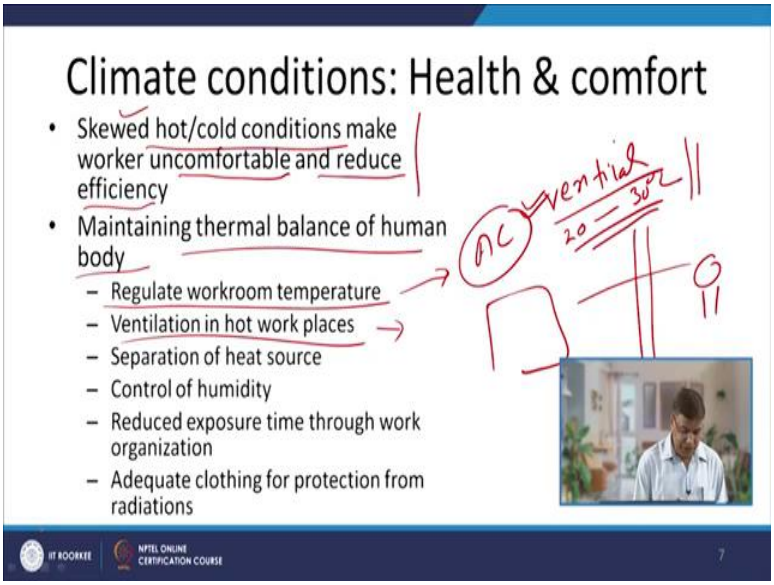
Then, it is also important that, the whatever the lighting is designed it, the lighting is spread uniformly. So, uniform lighting and there is no glare, because no very high contrast in terms of the lighting, or very high glare can increase the accidents due to the reduced visibility. So, in order to provide the efficient and high productivity environment, free from the accidents, the uniform lighting free from the glare should be provided. And then, since there is a huge reduction in the illumination level with, due to the dusting and due to the wear and tear, so the regular cleaning of the lighting system should be done.

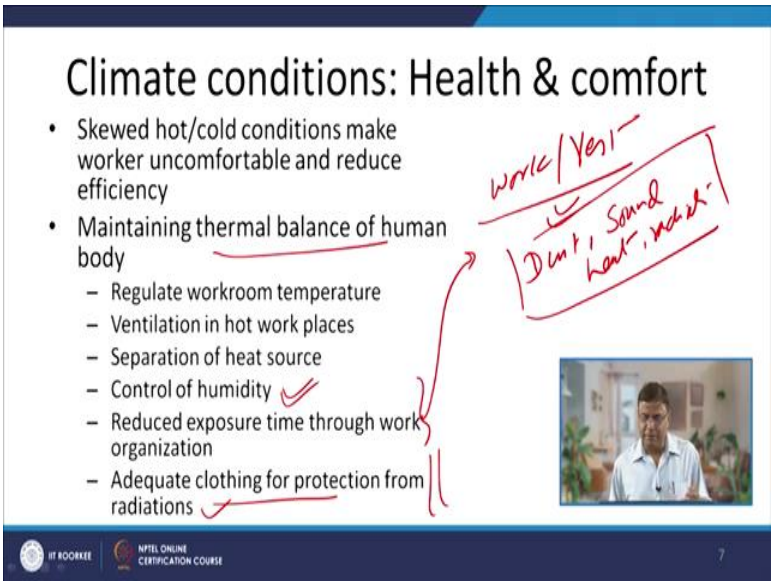
And apart from that, to avoid the glare kind of the effect direct eye source, direct eye to the light source should be avoided, means the eyes should not be in the direct line of the sights of the, line

of sight of the light source. So here, is the light source and here is the worker. So, this kind of the, this kind of the direct line of the sight; the light should not be there in the direct line of the sight of the workers, to avoid the kind of the glaring effect.

(Refer Slide Time: 18:12)







The now, the another important aspect in arrangement of the facilities and having the conditions which will help to increase the productivity and the reduced, reduce the cost, it is important that whatever worker is there he is in the good health and he does not feel the fatigue. So, there is no, minimum fatigue and the good health. For this, it is necessary that the comfortable working environment is provided.

And for that what we need, we need to provide the, the kind of the climate conditions with regard to the humidity and the temperature, humidity and the temperature conditions are favorable for efficient working of the workers in a factory environment. If the, the ambient conditions or the climate conditions within the building are not favorable, they are skewed. Means, either too hot or cold conditions exist, then these can make the worker uncomfortable and which in turn will cause very, very increase the fatigue to the workers and the reduced efficiency.

So, it is important that suitable, favorable climatic conditions within the plant are maintained to avoid the skewed hot or climate, cold climatic conditions which will make the workers uncomfortable and reduce the efficiency of the workers. And therefore, it is important that you know, the human body walks automatically to adjust the temperature of the body and if it is disturbed, then, then the body does not work properly and one, and there will be very feeling of the fatigue.

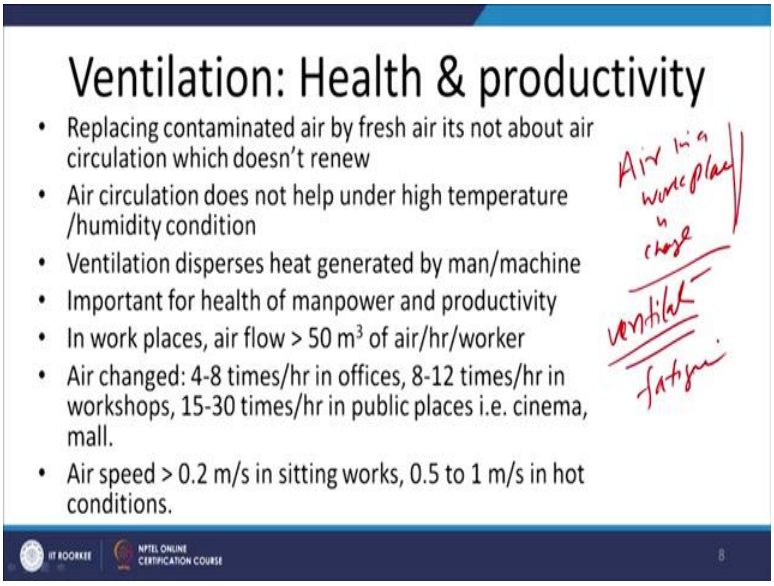
So, maintenance of the thermal balance of the human body is very important for healthy and efficient working of the workers. So, for that what is important, regulate the room working temperatures. So, for this we can use the air conditioning or suitable ventilation so that the working environment, working temperature of the plant building is within the healthy conditions, maybe like say, 20 to 30 degrees centigrade. So, worker is able to work efficiently under those conditions. So, use of the suitable air conditioning can be done to avoid the skewed, the climatic conditions within the plant, which will otherwise make the workers uncomfortable.

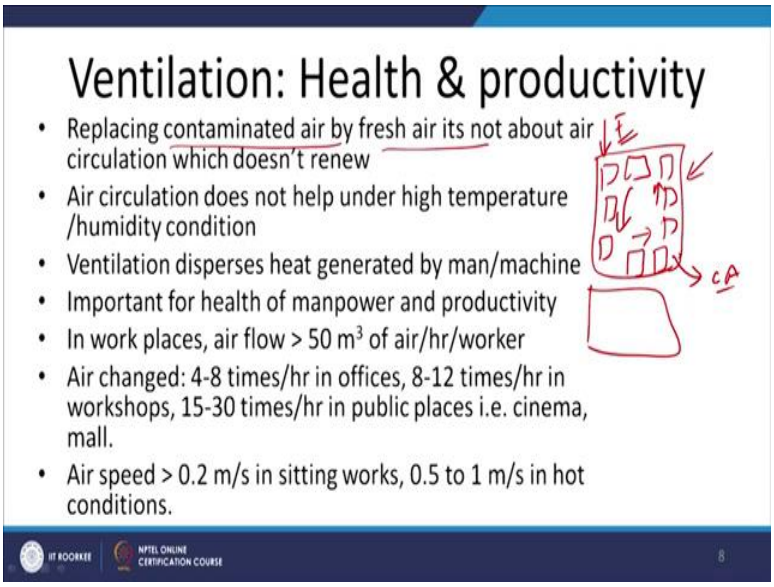
Ventilation in case of the hot workplaces, helps to reduce the effect of the high temperature and make the workers feel better. We can, the heat source can be isolated from the workers directly by putting the suitable thermal insulations. Like there is a heat source and here workers are working, then in between the suitable suppression can be installed, so that the workers are not directly affected by the heat source directly. The humidity within the plants should be controlled, so that it is not unnecessarily too high, the lower humilities will be able to, will allow the workers to work efficiently without much fatigue.

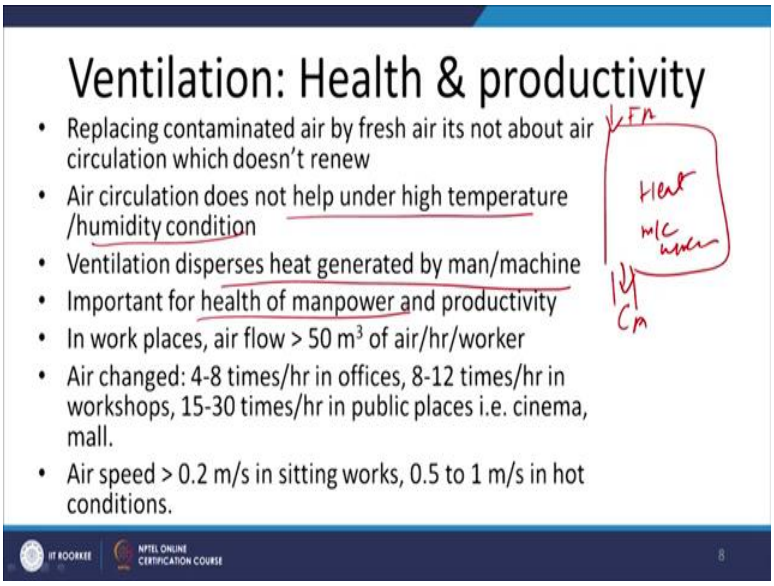
And, if the hostile climatic conditions cannot be avoided, then the, the work and the rest schedules should be designed in such a way; that after exposure to the hostile working conditions worker is given the rest for sufficient time, so that he can recover from those conditions effectively to do the job again. Depending upon the kind of the hostile working conditions, the temperature conditions, the work and rest schedules are designed accordingly. And here, like the workers may be given a rest of 30 minutes after one hour or workers may be given rest of 30 minutes after the exposure of the thirty minutes.

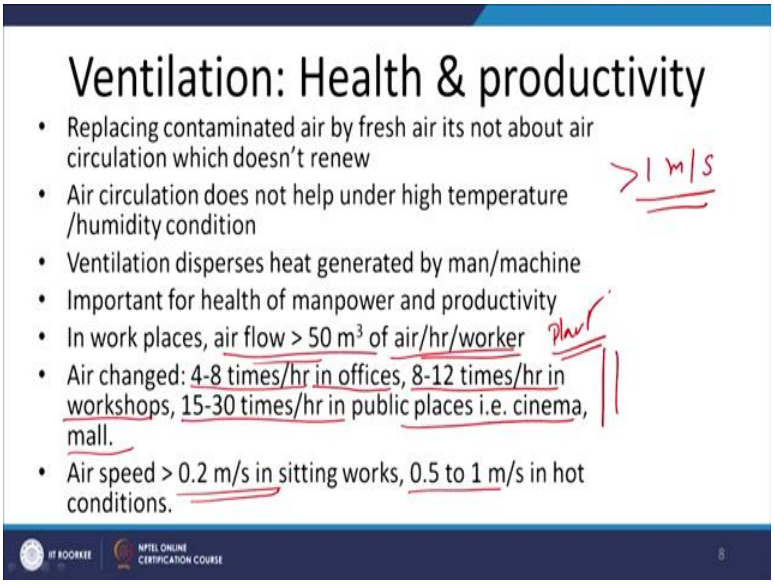
So, depending upon the kind of the working conditions, suitable work and rest schedules, that is called work organization can be designed. So, that the worker can work efficiently without much fatigue and he should be given enough for clothing, for protection to the radiations and other hostile working conditions. Like there maybe, a lot of dust, or there may be huge sound, or there may be heat radiations. So, suitable protection clothing should be given to the workers, so that thermal balance of the human body is not disturbed, and a worker can continue to work there, without much fatigue.

(Refer Slide Time: 24:11)









Now, ventilation is a kind of, like how fast the air in a workplace is changed. To replace the old air or used air with the fresh air, requires the proper ventilation. And absence of the ventilation can lead to the very fatigue and uncomfortable environmental to the workers. So, it is important that the used air is taken away and used air is replaced by the fresh air. So, if you see replacing this used or contaminated air by the fresh air is called ventilation. It is not circulation. Like say in this space, the work space, this is the work space and the, like say there are about 8 workers are there, are 9 workers are there in this space.

So, very congested a space and many workers. In this case, the ventilation should be very efficient so, that whatever the air is there that is being used by these workers. So, the

contaminated air from this space has to be cleared by the fresh air. So, the fresh air should replace the contaminated air. So, even in the congested space we can provide, continue to provide the fresh air if the ventilation is good. So, here the fresh air will be fed in and the contaminated air will be removed.

On the other hand, this air, if here there is no entry and there is no exit and just the air is circulated with the help of fans. So, this, in case of the air circulation, there is no renewal, the air is not renewed, but the same air is circulated within the closed space. And this, this does not this is not basically ventilation, this is just the circulation. So, air circulation does not help but the ventilation is actually needed for the, for creating the healthy and the productive environment in a plant.

So, air circulation as I said it does not help under the high temperature conditions and the humidity conditions, we need the proper ventilation to create the healthy and efficient working environment. Whenever there is the fresh air gets in and the contaminated air is taken out. In this case, whatever heat is generated by the machines and the workers, that is displaced, that is removed. So, this is one of the advantage of the, one of the advantages of the ventilation like the heat is displaced or disposed, ventilation disperses the heat generated by the man and machine.

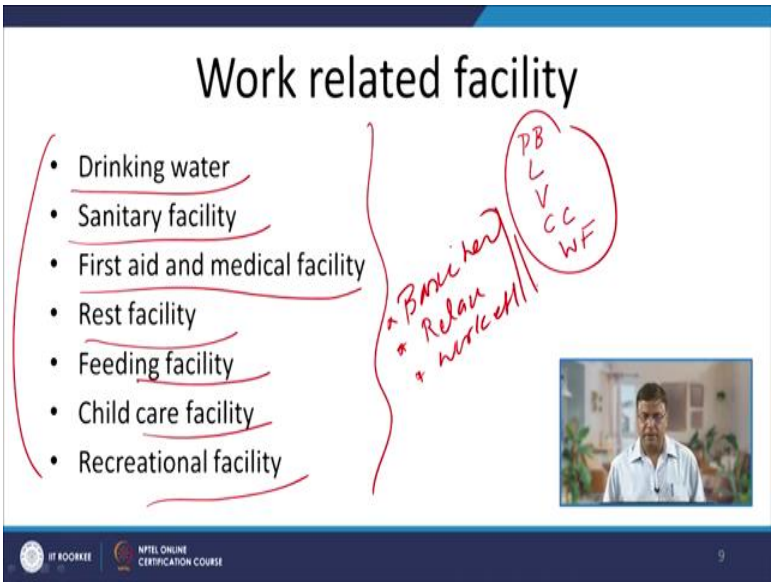
And, so this is very important for the healthy, for health of the manpower and improved productivity. There are some of the conditions related with the ventilation and that will be in facilitated and realized through the suitable ventilation system. In workplace, the air flow should be greater than the 50 cubic meter of the air per hour per worker, this is in case of the typical plants in workplaces like this. So, air has to be changed 4 to 8 times per hour in offices. The air should be changed 8 to 12 times per hour in the workshops, and in closed public spaces like the 15 to 30 times in public places like, cinemas and the shopping malls.

So, so in, so, what is needed what are contaminated air that should be displaced, replaced by the fresh air and this frequency is different for the different kind of the working conditions. And the air speed for effective ventilation when workers are doing the work in sitting conditions, the air speed should be greater than the point 2 meters per second. And when the workers are working under the high temperature conditions, under the hot conditions, then the speed, wind or the air

speed, by the design ventilation should be in the range of point 5 to 1 and if the further hostile conditions exist, then the air speed should be greater than the 1 meter per second.

So, depending upon the working conditions over the high temperature conditions the different air speeds, different air speeds should be realized to the proper ventilation.

(Refer Slide Time: 30:11)



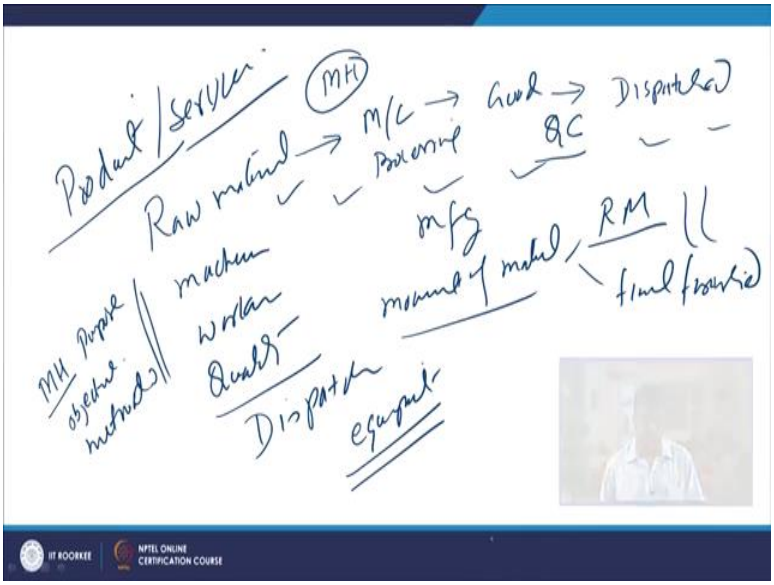
Apart from the ventilation so, as I said in organization of the facilities, we have seen the organization of the facilities affected by the plant building, the kind of the lighting needed, kind of the ventilation needed, the kind of the climatic conditions need to be maintained, and also the kind of the work facility, work facilities for the workers to be accommodated in a plant, so that the workers can continue to work efficiently for increased productivity.

So, the facilities like the drinking water, sanitary facilities, the first aid, and the medical facilities, rest facilities, the feeding facilities, child care facilities, and the recreational facilities should be provided. So, we need to accommodate these facilities in the plants, so that workers can satisfy their basic needs and they can relax and they can work efficiently. So, that the, so that the plant gains in terms of the productivity and the reduced costs of the product and services; which are being provided by the organization or the plant.

(Refer Slide Time: 31:41)

Now, we will see that once the facilities, one, once the facilities have been placed in the plant building, then the production has to be started.

(Refer Slide Time: 32:00)



So for, the production purpose, whether it is production of the goods, or the products, or the services. For producing the goods, what we need the raw material, and we need the machines, and we need workers to work on these machines, and to check the quality of the products being manufactured we need the quality checks. And thereafter, the dispatching of the goods to the

customers or to the dealers. In this process, starting from the raw material, raw material will be fed to the different machines. Then there will be processing of the raw material through these machines, and then we will be getting the good.

To check the quality of this good what we need, the quality control, once the quality is found, okay it is dispatched. So, what we see in this process of the manufacturing from the raw material to the supply of the finished goods to the customers or to the dealers, the, the things are being moved. So, this movement of the material from; the raw material stage to the final finished product stage there is a continuous movement of the material and the kind of efforts that we need to move this material from the stage 1, 2, 3, 4, 5, 6, n number of stages some kind of the equipment's are used.

So, this function where in the material is moved from one stage to the another, in course of the manufacturing and then sending it finally to the dealers and customers. We use a function called material handling, material handling basically, this is the prerequisite. This is the necessary condition in course of the manufacturing. However, it does not contribute positively. This is the kind of the activity that we do not want or we want to minimize. But the things cannot be done without this.

Because it does not aid, it does not help in giving the final shape to the raw material, to the giving material handling does not help in giving the final shape, to the raw material from its raw material is to the finished product stage, that is why we want to reduce the material handling. So, what are the, what is the scope of the material handling, and what we want to realize in the material handling these objectives, the purpose, the methods about all these things related with the material handling; we will be talking in the next presentation.

So, in this presentation basically I have talked about the different types of the building designs. And I have also talked about, the importance of the ventilation, lighting, climate conditions. And apart from that, I have talked about the need of the material handling, in course of the manufacturing. Thank you for your attention.