Ergonomics for beginners Industrial design Perspective

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Module No. #04

Posture and movement

Lecture No. # 19

Vertical work surface

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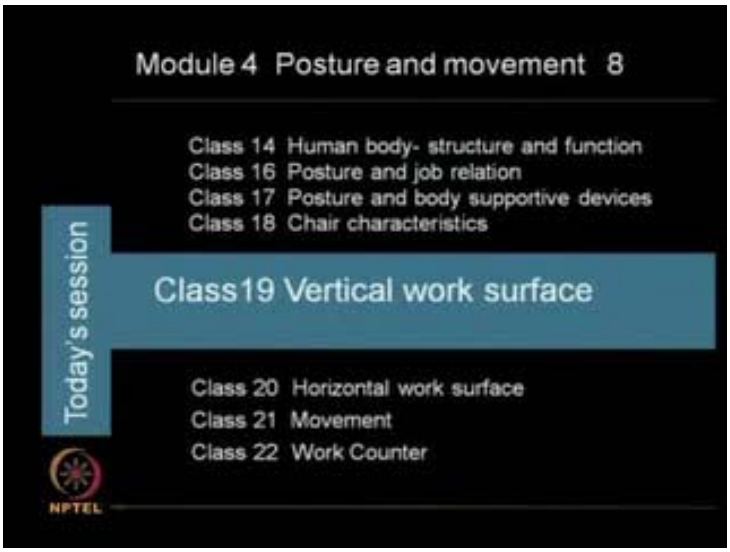

So, today is the nineteenth session of ergonomics for beginners with industrial design perspective. Now, the current module is that module number 4. We are continuing with posture and movement among 8 sessions within this module. So, today's module is class number 19 that is vertical work surface.

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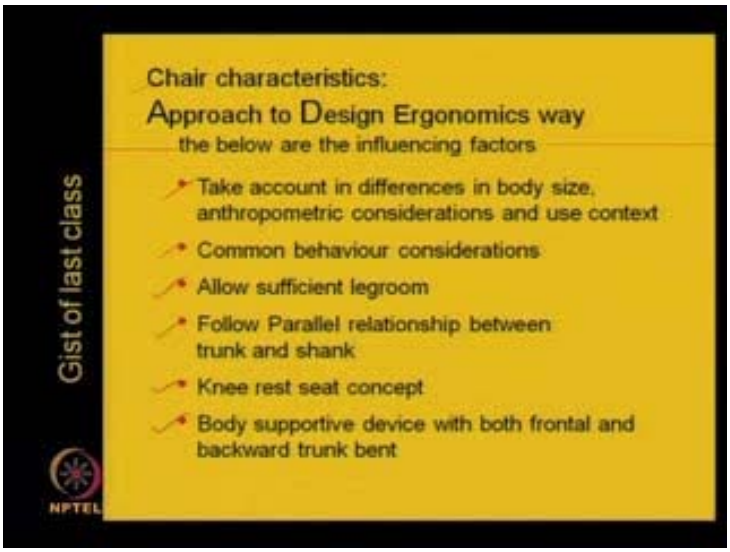

Now gist of last classes was the chair characteristics. Now, the approach to design ergonomics way, the below are the influencing factors that we have discussed in last class. To summarize, whatever we have discussed - the first point is that take account in differences in body sizes, anthropometric considerations with that and the use context, and accordingly, make some design dimensions and other considerations for seat designs. For that, common behavior considerations are also necessary. Specifically, we know that back the chair means a fitting platform with a specific height arm rest for arm to rest on that and specifically the backrest. With that, another thing is that, below any work surface, allow sufficient legroom. So that leg pre-movement is possible, follow parallel relationship between trunk and lower leg that is a shank. So, in different postures, may be, when the body trunk and thigh at different angle.

So, the trunk and the lower leg follows parallel relation and we need to honor that while making any body supportive device, that is seat or bed kind of thing. Normal chair means we feel that there will be a backward inclined or horizontal seatback form with backrest, but in certain cases, where we require to concentrate or to look at that front, and so, a bending forward movement is necessary at that condition. The knee rest support seat concept, is also there, that is balance chair type of concept where you do not require the backrest.

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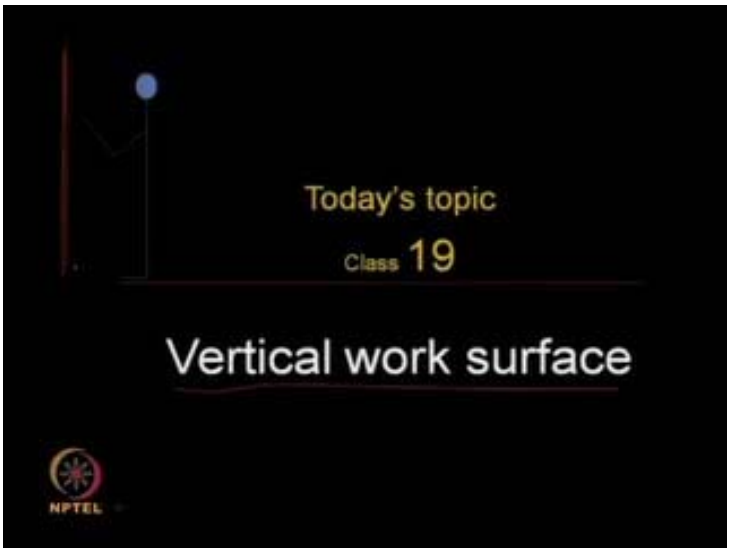

Specifically, the body supportive device with both the frontal and backward trunk bent condition should be honored and that type of maybe work station one can develop. So, with this, we have concluded last session for that normal chair characteristic. and Today's topic, the class number 19, today that is, that vertical work surface means a person may need to work in a vertical oriented surface and then what would be the different considerations for that.

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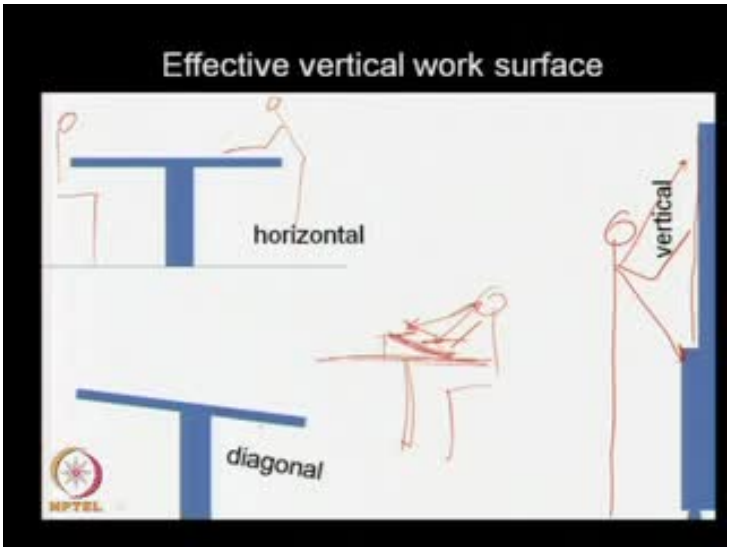

Now, the effective vertical work surface, when we talk about it, we must consider the other work surfaces that is mostly the horizontal, where a person can stand, lean forward and work or a person can sit and work like that, and also, there are some kind of diagonal work surfaces with varied angle, so that a person can stand and can work on that or maybe in a sitting position. Sometimes, what happens is, when a work surface is horizontal, still when a person sits; sometimes, they may require an additional support system.

So that angular or slant work surface can be added on this normal horizontal surface. So that without changing the whole surface, here, a specialized area can be raised; so that for reading any book or something or keeping on that is possible, working is possible; so that it helps maintaining the eye distance at the both ends and it is easier to work also. Now, there are certain work surfaces where the vertical work surfaces are there, like these type of things vertical work surface, where man needs other seat or in a standing posture, they can work and the different reach values and etcetera; it needs to be considered.

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Now, so, with that, we can say that some of the working context like in this figure, it is said that - this person climbing on a ladder, he is fixing some work here, in this position; so, it is a vertical work surface. Now the context is that, if the work surface is already

created and then we ask a person to work with, then we may need to consider the working tools he is using.

How best we can design that. So that, with that handle device or an additional design support, he can performs the task on the vertical surface. and Another thing is that, if we require to make a specific surface where the vertical arrangement of certain things is necessary, then we can have a special consideration for vertical work surface. That is going to be today's discussion topic and we are coming to that.

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Another object is that, in a vertical work surface, there may be a slant also. In this figure, it is seen that a person is working in a slant vertical context much above the floor level. So what is happened, to hold himself in that position, a special safety belt or safety tie-up is required here, and then, he is working on that. So, where the work surface is already created, there we have to take some different approach, and in other ways, we may require to develop a special curvature on the vertical work surface to assist our arm reach and eye reach also.

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In this case, another work surface is that horizontal, but above head. In that context also we may, we can do something that either a curved upper surface, or if the surface has to be maintained in this position, then do certain design. So that the task can be easily performed; that we have discussed in earlier classes. Now, this context is well-known context surface and the person's anthropometry. In this case, the vertical work surface and the different reach values with this.

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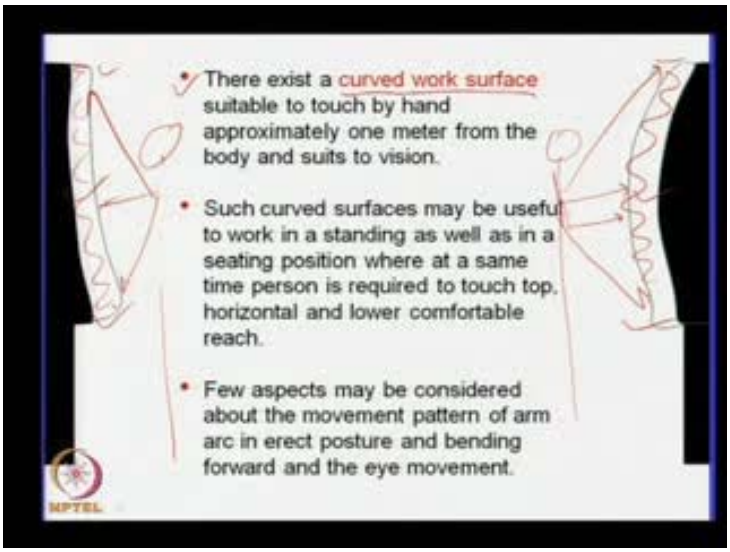

Now, we can say that with all those, there exist a curved work surface context, like, in this case, we may have a curved surface like this, either concave or a curved work surface, that is a convex type of work surface. Now, if a person stands somewhere, then he has to touch here; he has to touch here; he has to touch here, (Refer Slide Time: 10:48) but in this case what has happened, his arm has to be bent, and here, he has to extend his arm. In this case, it can be said that the similar problem may be there. Then what would be the considerations? We can say that there exists a curved work surface suitable to touch by hand approximately one meter from the body and it suits to vision. Such curved surfaces may be useful to work in a standing as well as in a sitting position. Where, at the same time person is required to touch top, horizontal and lower comfortable reaches.

Few aspects maybe considered about the movement pattern of arm arc that is arm movement, arm arc in erect posture and bending forward posture with the natural eye movement. How eye behaves?

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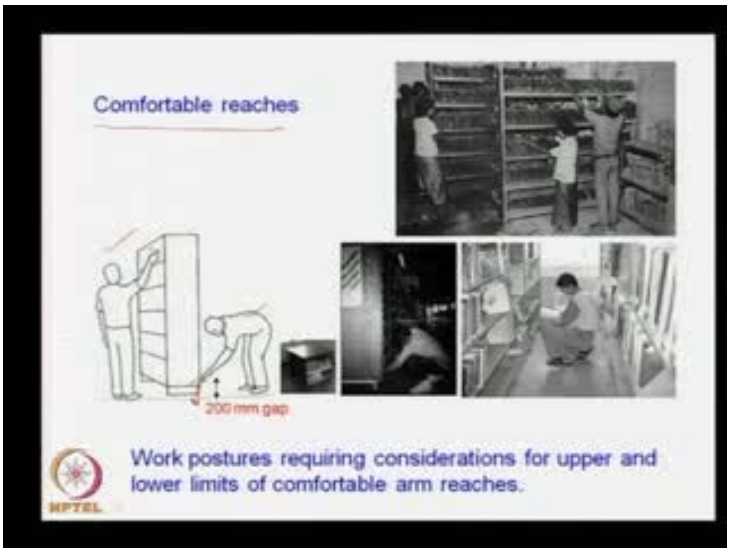

Now, if we see this figure here, when you are talking about comfortable reaches, if a person has to work in a almirah type of furniture, then it should be of comfortable arm reach, and below from the floor around 20 millimeter gap has to be maintained; so that he does not need to bend much. It is seen that if we keep the lower arm reach at around 20 millimeter above the floor level, then it does not give much pressure on the back, but if he has to go below this, then it creates that problem.

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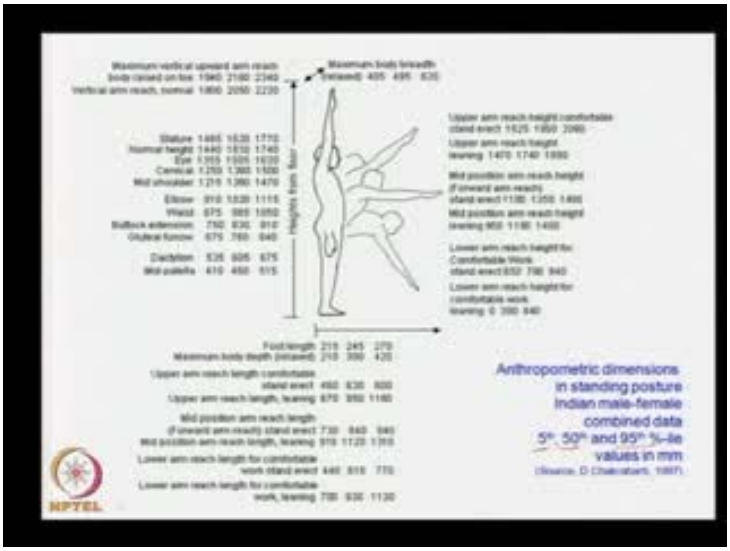

In this case also you can see in the library and etcetera; these are the similar type of problems. Now, the work posture requiring considerations for upper and lower limits of comfortable arm reaches are necessary for this type of activities, and accordingly, the design should be considered. This is a general dimensions of a man, male and female combined data. So, different arm reach values are given here in 3 different percentile forms are fifth percentile, fiftieth percentile, and ninetieth percentile values in millimeter. All the points are given here. This data has been taken from anthropometric dimension in standing posture Indian male female combined data. and The source is that from D Chakrabarti's book of Indian anthropometric dimensions for ergonomic design practice published by National Institute of Design in 1997, from that is the reference of this data.

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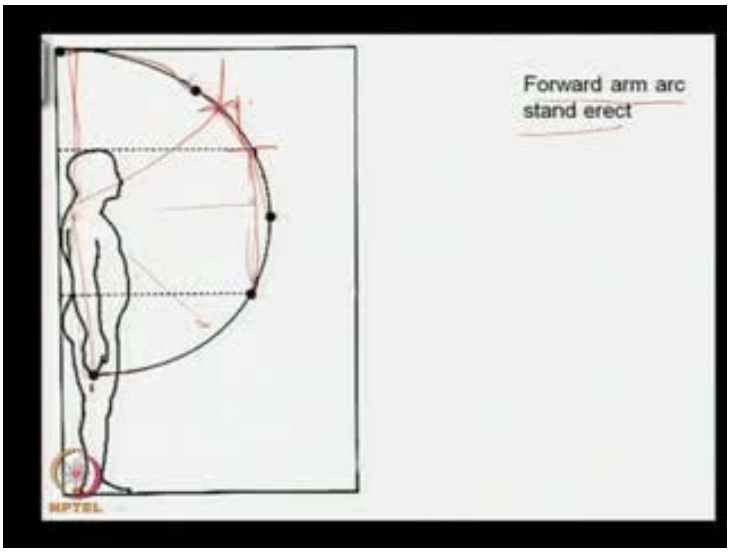

So, with this, some concepts, we would like to discuss now. Now, when a person stands or sits from the heel point, if we draw a line, then, we can say this is that body axis; from this body axis or for our normal or for our convenience of discussion, if we see that, if a person stands keeping back and heel on the wall; from this wall, if we measure the arm reach value in a standing posture, so, the maximum reach will be here and then arm reaches are like this; these are the arm reaches. So, this arc is forward arm arc in a stand erect posture. Here we can say that our arm. So, this curvature is a mechanical curvature, but our arm has some facility that we can extend at our shoulder level. So, considering this we can say that from this head height and straight to this anphelion height, we may have a straight vertical surface, and then, for every 20 centimeter, it has an angle of 15 to

20 degree. and Like this way, it matches the top end, and accordingly, below the anphelion, it also behaves like this.

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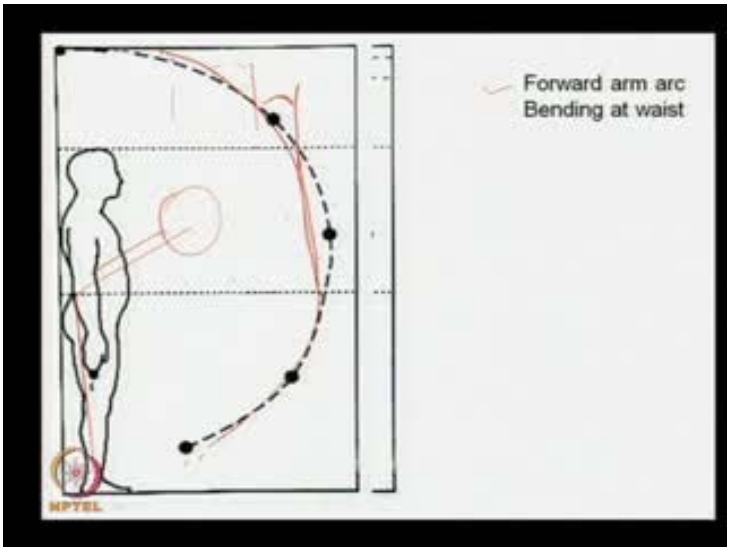

The similar case, when a person bends from here, bends and then touches. So, this is the arm arc that is the forward arm arc bending at waist. This also more or less, it also follows the same principle that every 20 centimeter, an angle of 15 to 20 degree above the head height and below the anphelion height also the similar nature arm arc movement. and This verticals from head height to anphelion height, it may be vertical straight. So, if this type of a work surface is given, then this person can get good reach and this distance is mostly, we can say that, with the arm reach or with a bending initiative, it may be around 1 within 1.5 meter distance from the back.

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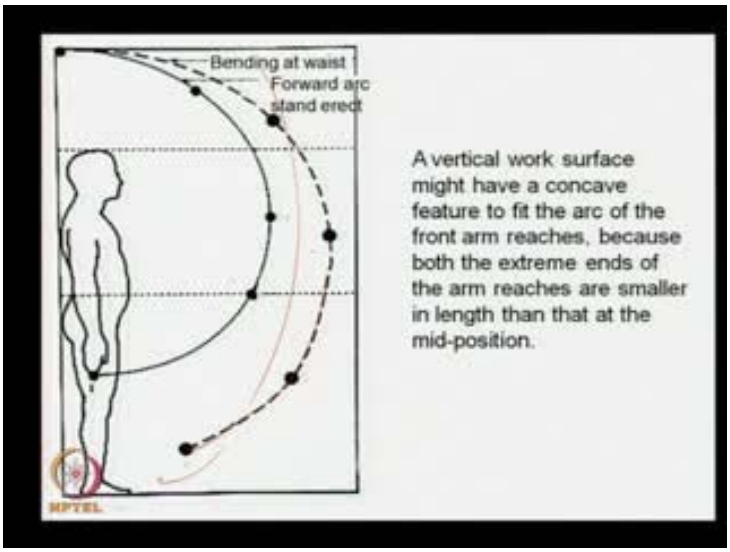

Now question comes; if we consider both the arm reaches, then this is the behavior of the arm arc. So, this arm arc, the forward arm arc at the stand erect position and this one is a forward arm arc with a bent at waist, that type of posture. So, here we can say that a vertical work surface might have a concave feature. Then, if we want to make a work surface where easy reach is necessary, then the vertical work surface should have a bent like this way for the front arm reaches because both the extreme ends of the arm reaches are smaller in length than that of the mid position.

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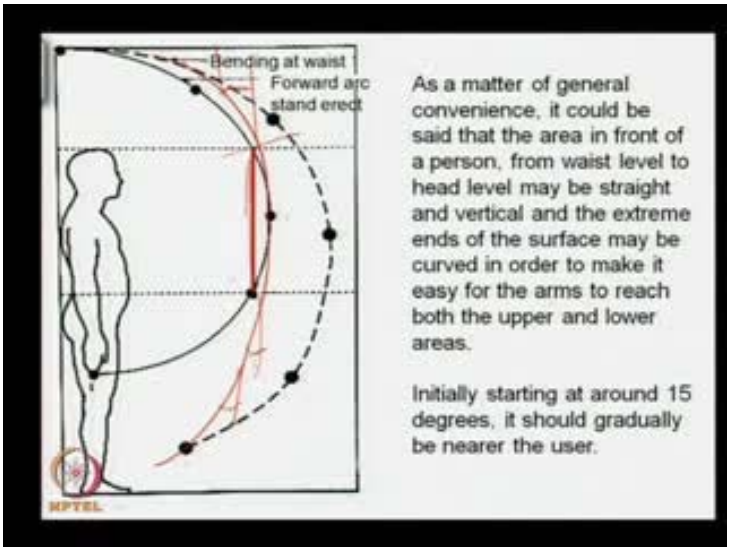

So, here it comes closer; it also comes closer; then this is the largest area. (Refer Slide Time: 18:45) So, as a matter of general convenience, it could be said that the area in front of a person from waist level that is the anphelion level to head level may be straight and vertical. and The extreme ends of the surface may be curved, in order to make it easy for the arms to reach both the upper and lower areas. So, initially starting at around 15 degree from here, if we try to make a surface like this way, then, we can say that initially at every 20 centimeter around 15 degree, we can have a bent inward and below also like this 15 degree inward inclination, it should gradually be nearer the user.

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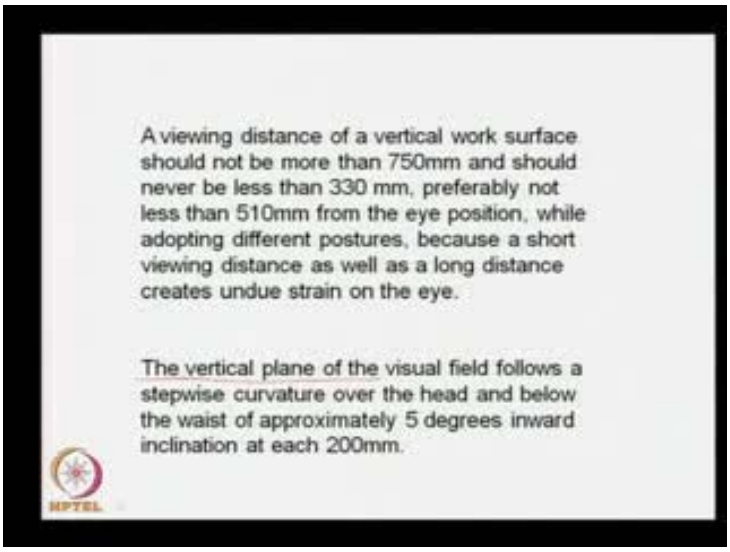

Now question comes the viewing distance. Now, when we say that from head height to anphelion height, that is waist height, it may be vertical and then above this and below the anphelion, that is waist, it will be every 20 centimeter around 15 degree inward angle, but eye moves in different way. It is seen that from head height to anphelion height, if it is a straight vertical, then above this, at roughly around at around 20 centimeter eye moves in a 5 degree inward inclination and below the anphelion, it also behaves in a similar way.

So that it gives an easy vision in this surface. So, a viewing distance of a vertical work surface should not be more than 750 millimeter than this distance and should never be less than 330 millimeter. If the viewing distance is below this, then there is some problem comes, preferably not lesser than 510 millimeter from the eye position, while

adopting different postures because a short viewing distance as well as a long distance creates undue strain on the eyes, like, if it is a very close vision, then, if we want to focus on this finger and then bring it closer, so it is around 13 to 15 centimeter distance from the eye, the focus becomes blur. So, what happened is to make it focused either head has to go back or it becomes blur.

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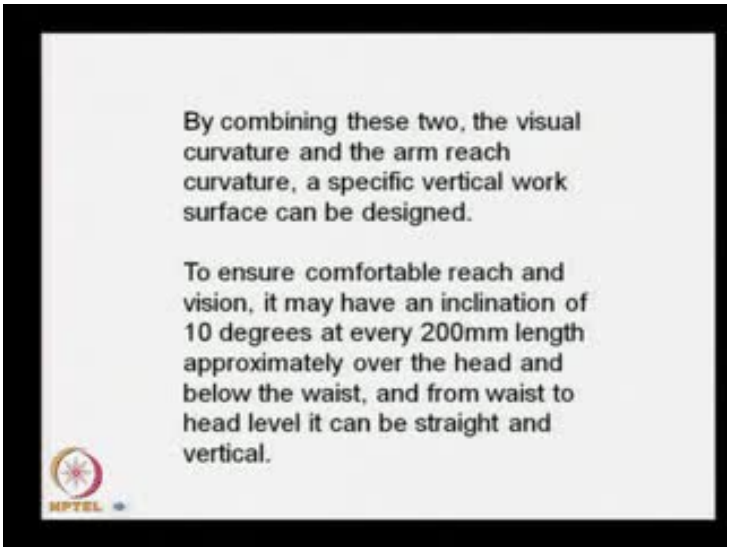

So, depending on this context and everything we can say that, the vertical plane of the visual field follows a stepwise curvature over the head, and below the waist at approximately 5 degrees inward inclination at each 200 millimeter. So, with this, by combining these two is the arm reach values and eye movement. The visual curvature and the arm reach curvature; a specific vertical work surface can be designed. To ensure comfortable reach and vision, it may have an inclination of 10 degrees at every 200 millimeter length approximately over the head and below the waist, and from waist to head level, it can be straight and vertical.

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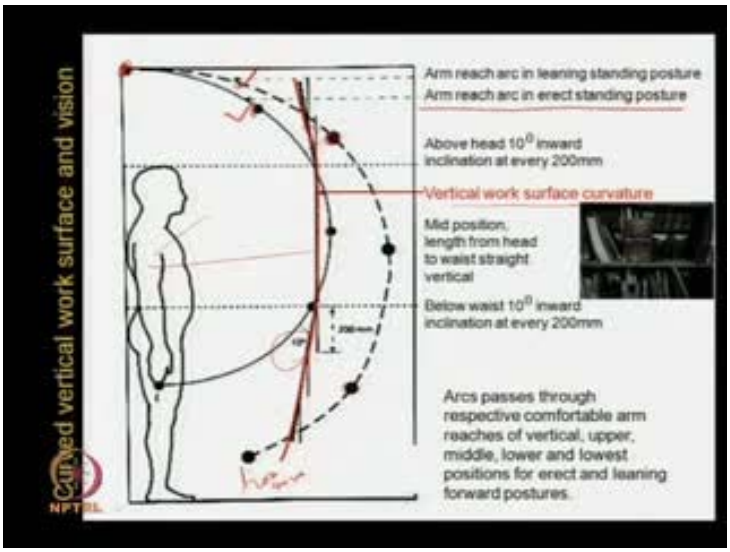

Now, this we would like to see in a schematic diagram here; so, this schematic diagram mentions about the curved vertical work surface and vision; it is easy to touch. The person is standing here; this curvature, inner curvature is this, this one is the arm reach arc in erect standing posture, this is the upper arm reach, this is the upper comfortable arm reach, middle comfortable arm reach, lower middle comfortable arm reach, and the hanging arm depth arm reach. (Refer Slide Time: 23:36) The second outer one is that arm reach arc in leaning standing posture, where, this is the top reach; this is the upper comfortable arm reach; this is the middle comfortable with bending forward maximum; this is the lower middle arm reach; and this is the lower most arm reach value, like this way and here this one is the 200 millimeter, we need to leave this space.

Now considering all these, the arm moves around a bit for each 20 centimeter, 15 degree to 20 degree angle above head and below waist and eye moves maybe 5 degree inward angle above head and below waist, and in between, this will be straight. So, combining these two both above head a 10 degree inward inclination is given here, 10 degree inward inclination and below also; so it gives a special curvature here. So that arm reach as well as vision both will be easier. Arcs passes through respective comfortable arm reach of vertical, upper, middle, lower and lowest positions of our erect and leaning forward postures, it also would be easier to touch as well as it will follow the vision easiness also. So this red line which is the vertical work surface curvature is preferable.

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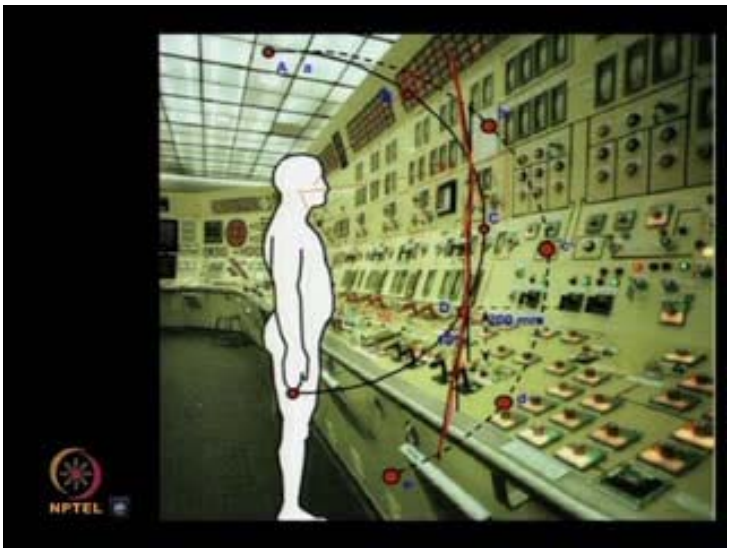

Now this is the front; so, at both sides right and left both sides also it may have a similar type of curvature. So, if we can create a work area like that, so, it will be bit easier to touch each and every point of that work surface and it can be easy to see all the things on the surface. So, accordingly notice can be placed on that notices or may be control switches and etcetera, may be kept on those areas, it will be easier for that. Now, some example, we are trying to show with this; suppose, this is a work surface where this needs to be touched and vision to be controlled. So, in this case, if we can follow the same angle whatever in earlier slide we have seen, so, it will be easier like that way. So, the person can see this vision angle also will be like this way and the touch wise also, arm reach will also follow the same thing.

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So, it will be obviously easier. Now, another example we can give in our normal day to day life is that of some shops. Suppose this is a shop; in this shop, if a person stands somewhere here, then for him this visual distance is more, this visual distance is also more, and touch also. If he needs to touch this lower button and etcetera, lower switches here. Then he needs to sit with a squatting posture or if he stands and wants to touch it here, then he has to stretch his body. So, in that case, if we can create a work surface like this, then it would have been better for him to touch now. How we can create this type of curvature work surface? That we can discuss now in next slides.

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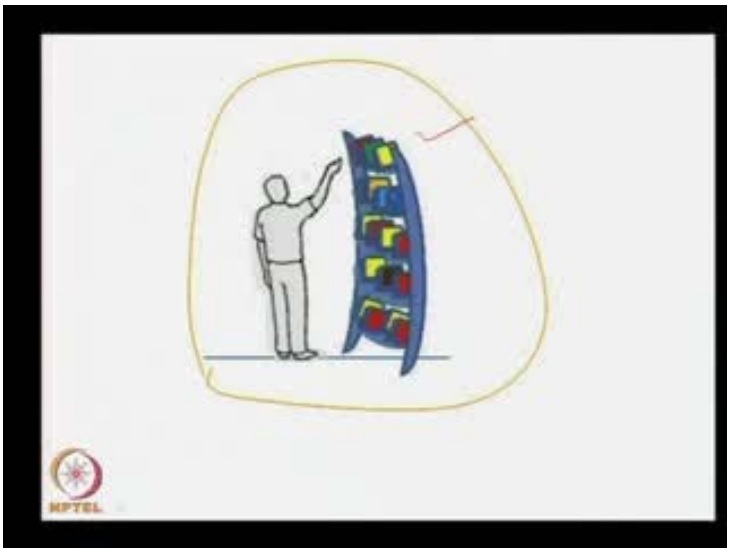

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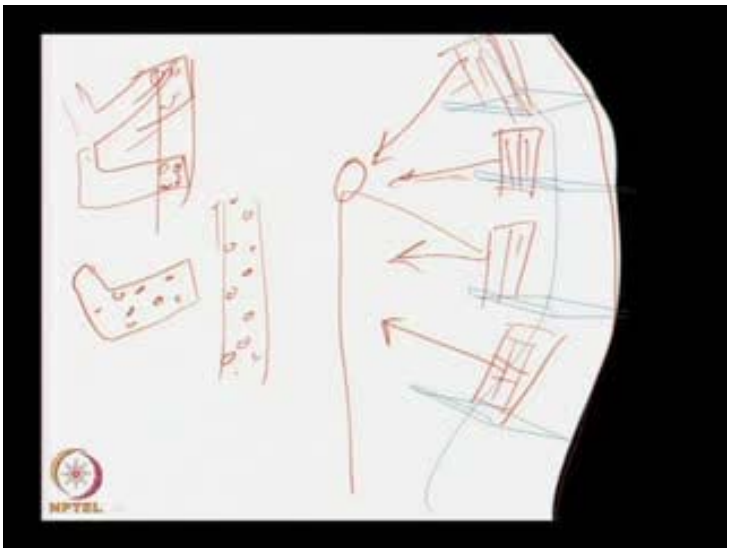

Suppose, in this case, now, if we can make a book rack or maybe display rack like this, it will be easier to touch and easier to vision. Now, if we want to create this thing in a wall mounted rack, then what would be the concept? Wall mounted rack, suppose, this is a wall, and in this is wall, this is the surface; (Refer Slide Time: 29:19) so, here what has happened, if the similar type of plates, if we place in little upward angle, and then, if we can keep some material or maybe book or something like this way, then it gives you this type of angle. Similar thing, if we keep somewhere here, like this way, then it may give this angle, and here, if we keep in a vertical way, so it comes like this way; the vertical way, it comes like this way. So, if a person stands here and for him, the vision as well as reach will be within control. Now small design solution for this. Now, how to create these racks here? Now, suppose, if we can make some slotted angle holes kind of thing, just this is a scheme I am presenting here. Suppose, this is varieties of holes containing 1 plate here, and then, these type of plates with many holes are here.

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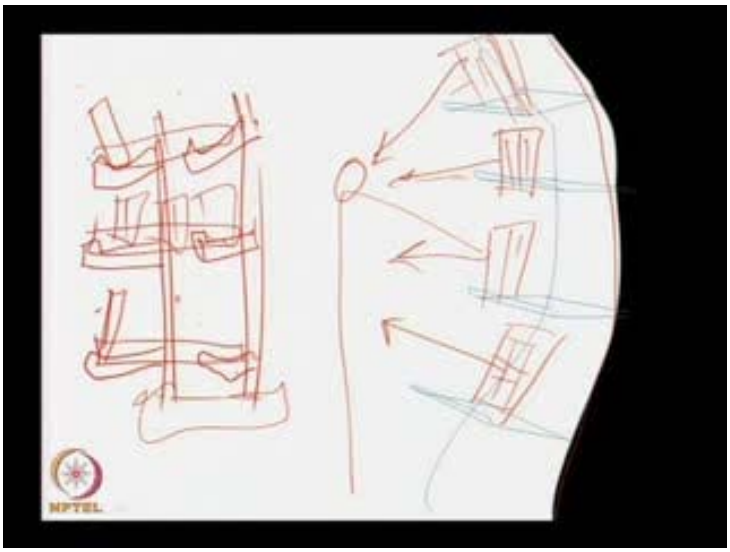

So, if we can fit within this, so, if I put this like here, if I match these holes, then it may be horizontal. If I place something like this way, then it will be angular to below, and like this, if we keep other way, if we join here, then it may create like this way. So, if we make an arrangement like this, and then, if we join it to like that, suppose here like this way, and then, in this case, and then, if we put a platform here, then what has happened? This angle, it comes like this. So, we can keep some item here; we can keep some item here; and we can keep some item here, like this way. So, by this way, we can create a design. If the scope for wall mounting is not there, then we can make a self-standing rack like this way. This will be there; so, by this we can make a specific arrangement.

Now another thing which can say that - now this is whatever we mentioned here, it is all in for a standing person or for a sitting on a chairperson; a person is sitting on a chair, that type of activities. Now there are certain contexts where people work in a cross-legged position or in a squatting posture and work. So, in that case also the same, but the arm reach value and eye movement, it will remain same. So, in that context also, if we can make a surface like this way, work surface, then it will be easier.

Now, some specific application area like - suppose in a nursery school where normally children they sit in long seats. Nowadays, we also prefer that children should use individual small seat that is stool kind of thing that stool and etcetera. It may have different feature, varieties like mushroom type of feature and etcetera. So, children may

like that. They may carry here and there their own seats; they may make their own groups; their groups bringing all the seats together like that they can meet.

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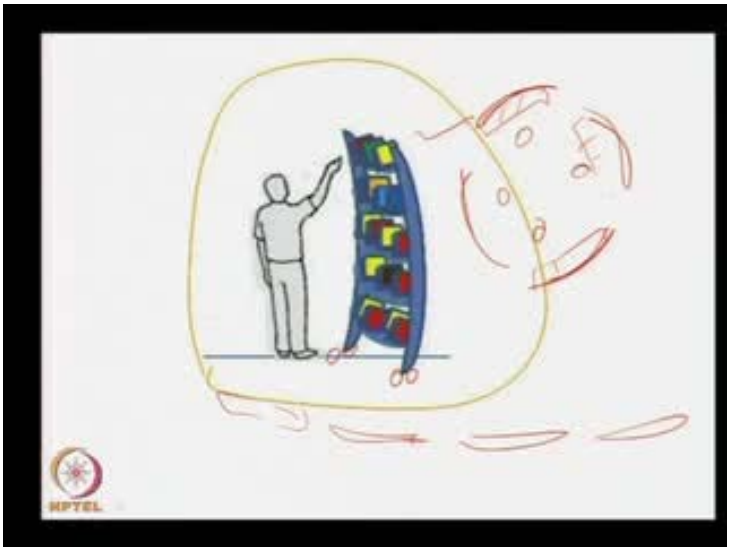

And also we can say that, when we are allowing this 2 or 3 or 4 children, we make a group and can do certain activity like games and etcetera or maybe study, whatever. So, there, if we can have this type of small racks with swiveling wheels, etcetera, and then, if we can make in different arrangement like this, and then it may create an enclosed activity area. So, within that they can sit and they can play within among themselves; they can collect whatever material they require stacked on this type of racks, it can be dismantled. If we want to make larger group, then break these types of things and then have a larger group like this way; you can arrange like this way; so there is flexibility is there. In that case, what we are considering that, children's arm reach values, arm arcs and then vision is almost the same thing. So, like this way new and varieties of new experiences, we can create with the existing framework.

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Now, with this, another example is that, now this is the work surface; now, when we are making any machines, so, for the making machines, the work height and distance must follow comfortable arm reaches. Now, in this case, suppose the machine functioning purpose, the mechanical purpose, it may have some structure, but the controls and displays, it may be placed in such a way that, it should be within the arm reach and the display material. It should be presented in such a way that, it can follow that same arc type of thing; so that it will be easier to touch, to control the machine and for vision easy to read the instructions or the feedback, the machine is giving to the man like this way. So here what has happened? Minimum 20 centimeter gap is necessary and now here, if we need this surface would have been like curvatures, like this way that we have discussed earlier like this.

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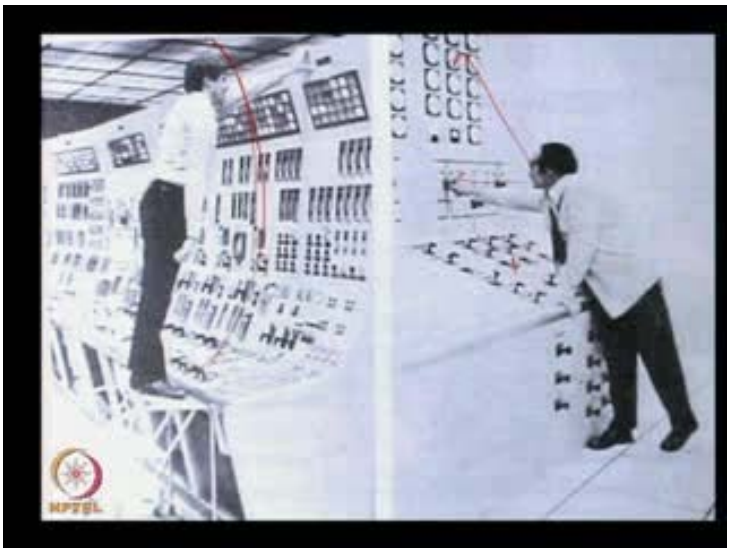

So, not only in a furniture purpose but in this machine context also this arm reach arc as well as the vision movement, the arc follows; it should be considered. Just one example, it is taken from a very well-known reference of a book. Here, it is shown that some concepts in this right hand part, the person has to touch all the things, and the vision, the problem, it is creating and now he has to see this, if this person has to concentrate at the same time or to look at this point, this point, and this point it is, but impossible for him to attend, but this case, if we can make like this way, it will be easier like this way. So, we can say that, for horizontal work surface one consideration we made, then slanting's and etcetera, it may have different context and upper work surface to work with, it may have different context or if we need to work on that, then that curvature has to be considered. Below, if I need to work with, then that curvature also has to consider. Suppose, in the both sides some controls and etcetera are there, that we need to operate upon. So, that also should follow the same type of considerations like that.

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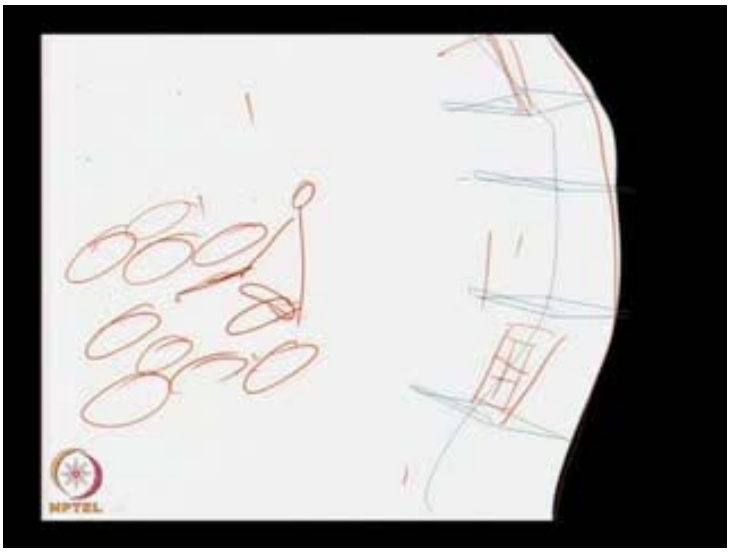

Now, suppose in certain cases, just another example we can say. Suppose in a fish market, some people are selling fish or some fruits and etcetera; suppose a person is sitting here in a cross-legged position and he is selling something and there are many baskets around him. So, what is happened, there are many baskets in this context; it is full with material; so it is difficult for him to reach all the baskets.

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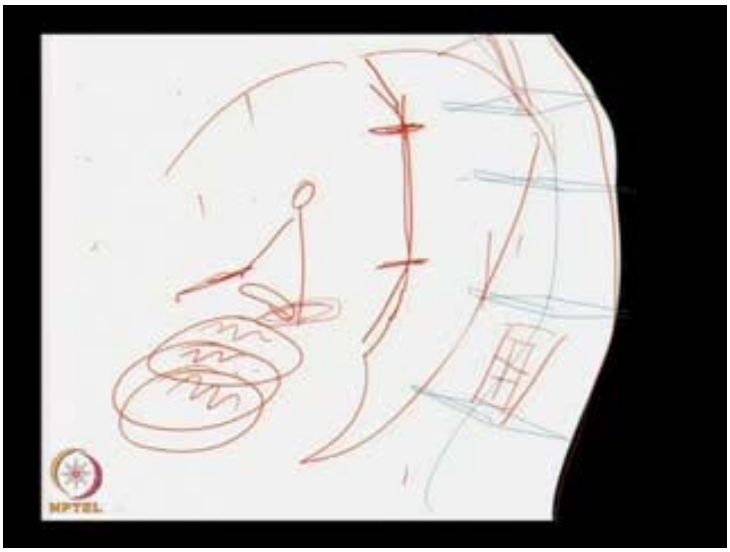

So, with that, may be another concept we may have like this, that, if we have a circle like this and then another circle over this, another circle over this, like that. So, what is

happened? The reach wise it will be easier for him like this way. Suppose this is a top layer, one layer, then another layer, then another layer, it will be on different heights. So, what is happened? The material here, he can touch it and he can rotate it also as per his requirement. So, this type of designs can be developed with this concept.

So, the concept here is that, arm reach, the arc, it takes from head height to waist height that is anphelion height is a vertical straight. Then, above head height, every 20 centimeter a 5 degree inward inclination and below that also every 20 centimeter, 5 degree inward inclination and it may have in different places like this. So, if we can make a working area like this way and then, if we have a revolving seat here for this person to sit, then he can touch in all the sides with equal comfort. That is the main requirement we would like to achieve here. Now depending on specific context, this information we have to apply; for that we need to keep our eyes open to find out the need; and where we can apply these information's precisely; and for the benefit of the activity concerns, task concerns.

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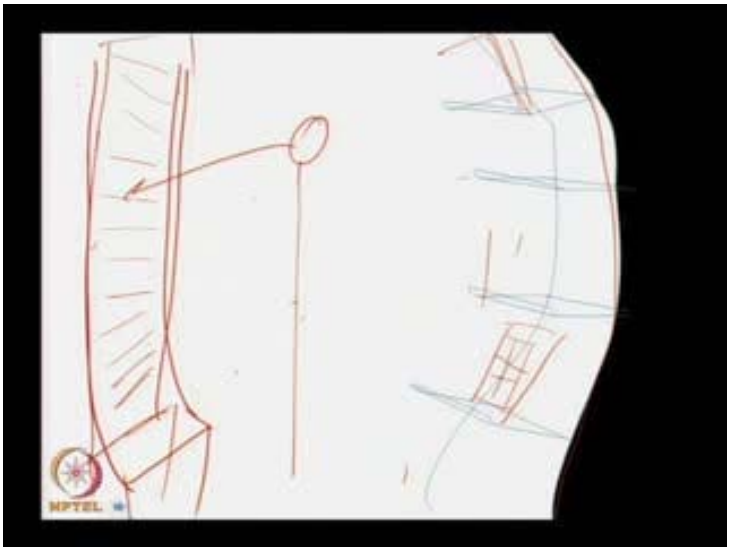

So, with this, we are concluding today's session - that is a vertical work surface, that is curved work surface. Now, if slant is required, then how much we can extend our arm? That needs to be considered. Just another example we can say here that, suppose this is a blackboard; in this blackboard, normally, what is there? This is the blackboard. Blackboards are like this way; so, the person writes here; so, when he is writing

somewhere here, then at the shoulder level there is no problem; he is writing it and top also, but when he's writing towards the floor level, then he has to bend himself and then writing is not perfect and writing starts bending. When he starts writing from the top, it takes a bend like this way and then it becomes horizontal and then the writing starts moving upward like that way; so, it is a problem. So, in that case, if we can make our this blackboard concept or the whiteboard, wherever we are writing, then, if we can have a concept like this, then what is happened? It will be easier to touch as well as work like this; it will be easier to work with; so the reach and vision would be easier.

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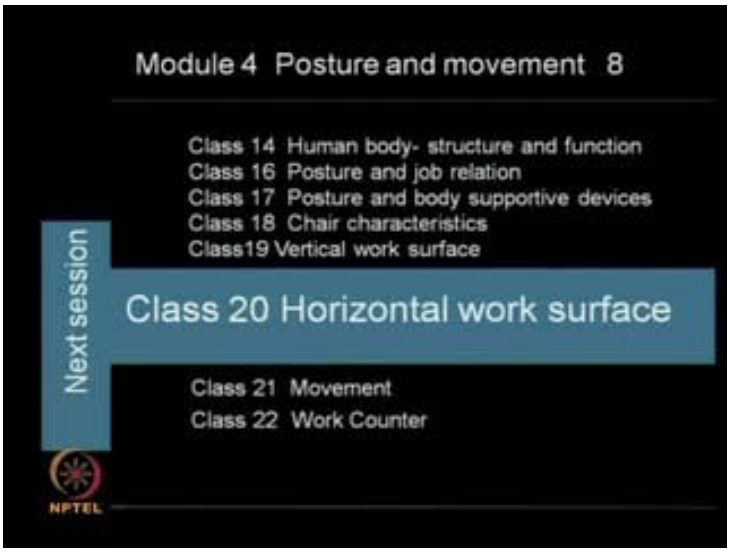

So, with this, we are concluding today's session - vertical work surface with the curved arc. Next session will be class number 20, where we would like to discuss the horizontal work surfaces and the specific design application concern with that. So, with that, we are concluding the today's session. So, thank you very much; next day we will meet. Thank you.