Ergonomics for beginners Industrial design Perspective

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Module No. # 03

Human physical dimension concern

Lecture No. #11

Anthropometry Landmark: Sitting postures

Welcome to today's session. This is module 3, session number 11, ergonomics for beginners Industrial design perspective.

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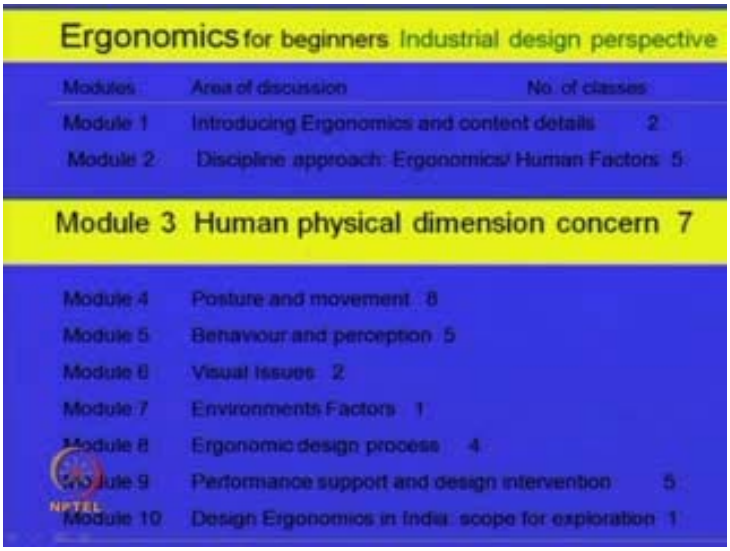

Now, today, the third module is the Human physical dimension concern.

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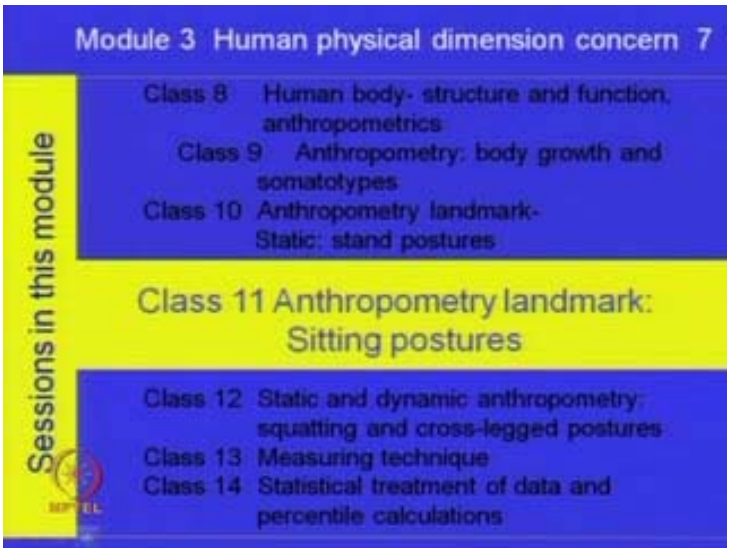

Today's class is Anthropometry landmark: Sitting postures.

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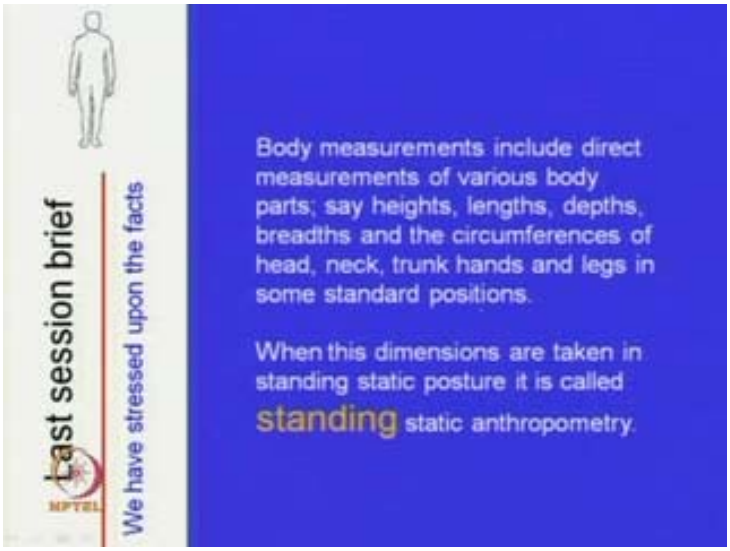

Now, last session brief is that, we have stressed upon the facts that body measurements include direct measurements of various body parts; say heights, lengths, depths, breadths and the circumferences of head, neck, trunk, hands and legs in some standard positions; that is the anthropometry dimensions. When these dimensions are taken in standing static posture, it is called standing static anthropometry - we have discussed that in last class.

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Now, today, we will be discussing about the sitting ergonomics which is sitting anthropometry. Now, with this sitting anthropometry, we are going to discuss how body behaves in different context, in leisure as well as in working condition, in various adopted body postures for different tasks to perform; specifically, the seat desk type of sitting posture. What are the basic anthropometric dimensions that are considered? What are their measurement landmarks? We are going to discuss that today.

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Now, with this, if we see this figure here, it says that the seat structure, this structure or this arrangement fits to our body. Now, how can we recognize that a structure or a specific arrangement can be used as a seat? When we test its dimension and our body's geometric dimension, the movement you can take and how we can make use of those arrangements to fit our body. So, these things we need to consider and always these type of judgment are going on in our mind when we see some object in our surroundings. So, whether to use these types of seating, this arrangement as a seat needs to be judged with our body structure understanding and the angles and movements for that.

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Now, this type of sitting may be extended sitting that is relaxing. Now, further, this posture, we can say that it is a seat or a bed. So, it can be used as a seat as well as bed. This person can sit like this and then it can be a seat. So, what are the differences? What are the modifications in the furniture structure? - That tells us how to use it and for that there is always an underlying judgment of our body structure and body dimension are going on in this judgment.

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Now, again in the sitting is that, the context specific seat: That means here what has happened to those some spaces left in this side? It means 3 persons can be accommodated in this design, in this seat, but the context and the surroundings suggest that if a couple sits here, then third person obviously would not choose this for sitting.

So, then, what are the psychological allowances we require that adds to our physical body dimensions? We also need to consider these allowances; not only the sitting, the person's body, breadth, etcetera.

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Now, sitting variations and body behavior: This type of sitting arrangement whatever we are seeing here in this left hand figure, the person sits here and now you can see that if this is the sit plate and his thigh bone is like this; so, here, special place cart is there and pressure on the thigh is there. So, sitting in this posture for longer time would not be possible; it will be tiring. Also, the height of this seat and the work table does not match together. So, what has happened? The person is bending there. While bending and working, that back pain etcetera will be there. So, what would be the appropriate dimension for sitting? That, we need to consider; so, for that, some specific landmarks and some dimensions we need to know.

So, in the right hand corner also, the same thing. Here, what has happened? The normal chairs are used; this type of plastic made chairs are available and it is used, but when we are using here, the desk is a certain type, but if desk varies then whether this match is proper or not. Now, though this chair can be adjusted with this desk, but the preferred posture because there is no control over our behavior; we do not know how and when we should behave what type of things.

So, here, though he can use the seat properly and bring it closer to the desk or still he sits like this. So, that gives a problem in this region. Then, not only the furniture dimension, but the furniture design should be in such a way that it should tell its users how to use it properly; otherwise, if we cannot use a good design properly, it will give some bad effect - bad result.

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The seat desk type of sitting: Seat desk type of sitting. Now, the same again the problem is that like this these are the problems. So, it can be said that his leg cannot get proper rest here, as the total leg length and this chair, this dimension does not match here. So, this person requires a higher chair height to keeping the foot on a firm ground here. So, for that, there are varieties of chairs available. Now, in this right hand corner, if we see that, in this case that chair depth depends on the angle. Now, if she does not use this backrest, if she goes little forward, then what happens? Then there is a problem in this and then a bend has to be there (Refer Slide time: 09:50). So, how to use it properly - that we need to consider while considering any design idea; that is, it should match with our body dimension; specifically, in the sitting posture.

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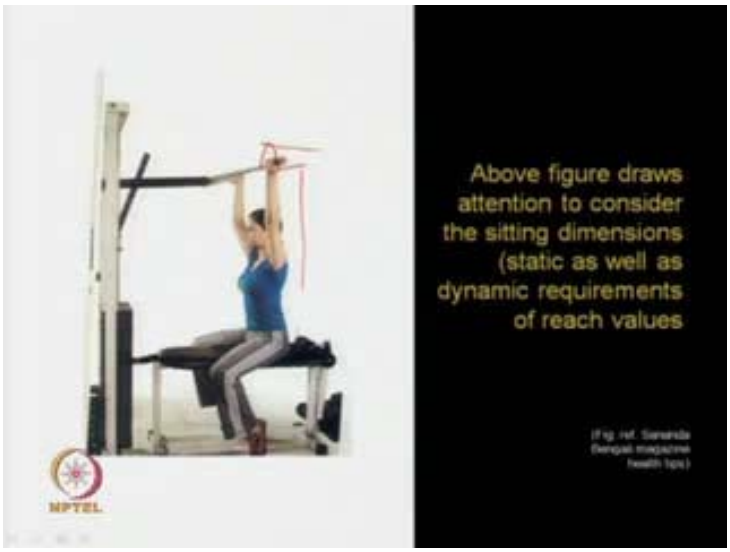

Another thing, we can say that, now not only the static dimensions or anything, but in this figure, this figure is taken from a Bengali magazine. As a health tip, here she says that while using this equipment for exercise purpose, she has to lift her arm maximum to hold this handle. Now, here it comes that what will be the total distance from floor to this handle would be given so that this girl can operate it easily. So, not only the physical body, only that length, breadths and etcetera, the main body and trunk, leg, but the upper maximum arm reach also needs to be considered.

Now, in this case, one thing we will need to keep in our mind that here, the holding point is here. Now, if she has to hold but still arm can go till this level (Refer Slide Time: 11:22). So, the arm, this total maximum upward vertical reach and the upward maximum vertical grasp is little different. So, it is in that around 7 to 10 centimeters is a lower, just lower. So, this type of dimensional considerations we need to keep in our mind while designing such things.

Now, this, our figure draws attention to consider the sitting dimensions static. Why we need a static because the seating arrangements, understand what would be the height of the seats and like that, seat and then the breadth of the seat as well as dynamic requirements of reach value also requires to be considered.

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Now, here, we will see a series of figures where it says that dynamic body dimension requirement to accommodate activities while remain seated in a position; like in this case, now this person is sitting here and he is doing something; so, it seems that he is sitting in a specific posture he has adopted here, but the same position while he is attending this dog. Now, see different types of things. So, what has happened is the total space whatever he is occupying here is different than this. Another thing that when he is doing like this way, he has come forward; so, the total movement - the leg, the thigh, this length and a leg length, the static considers and whatever it been seen here as perfect, may not be suitable here.

So, here, for this activity, he has to change his position; some of the body parts. Then what behavior these body parts do and what type of dimensional modifications are necessary? That has to be added when we design a furniture; means, what will be the angle here this furniture and etcetera? To decide this, this type of dynamic movement we need to consider.

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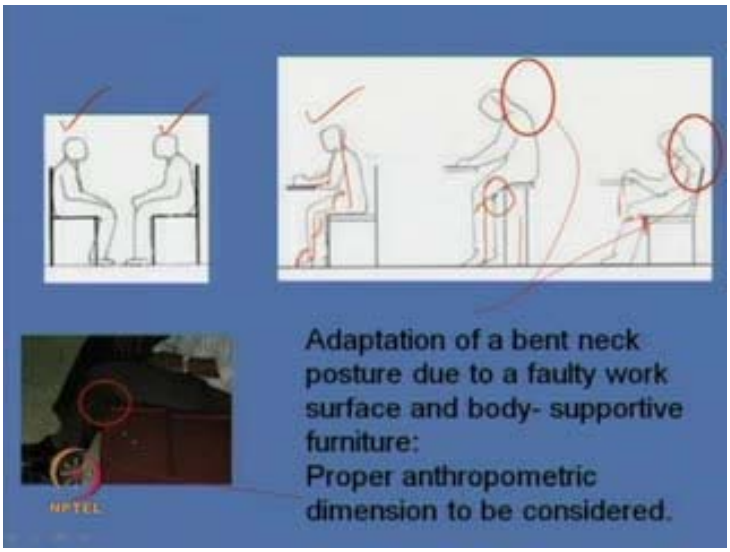

Now, normal sitting: If we sit in desk position in a chair or a tool, normally it is preferable to sit like this way, but for working, this type of sitting is preferably 90 degree. All these are ideal, but to do certain activities, these all 90 degree is not possible to have it. With all these 90 degree angles at elbow, then waist, leg and knee and this foot angle here, these are some standard postures; it is used for measuring some body dimensions, but when he does some activity at that time, when he moves, that movement should be considered as dynamic dimensions.

Like here, we can say that, if the leg length is lower than the seat length, then the posture is coming like this; so, there is a muscle cut here. Also to see this, to do the activity here and to have a good vision, he has to take a bent neck. In this case, also the chair height is short and a short chair height when he is taking this backrest and the distance between this front (()) of the chair to this front (()) of table is more, and here he needs to take a backrest. Then, there is again the bend is there. So, for this bend, there is a problem. So, that has to be considered. When the leg height does not match with the furniture leg height, then the muscle problem is here. So, now, we can say that adaptation of a bent neck posture due to faulty work surface and body supportive furniture, all these things are happening. Now, in this case, proper anthropometric dimension has to be considered.

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Now, the problem comes that, when we are using a specific seat, it may not match with many people equally and also those fixed dimension furniture may not be adjustable to accommodate the dynamic movement supposed to perform using that design. So, for that, some adjustable seating has come to market.

Now, here, what has happened? The height adjustment is possible; seat height, seat plate, this angle movement is also possible. Now, this arm rest height and then arm rest front back position is possible; backrest angle is possible; to maintain different angle can be done; in this backrest itself, the height and angle can be modified. To do certain activities, when we need to move little bit; for that, legs have some swirling wheels.

Now, in this case, it is said that what type of swirling seats we need to consider. In this case, when we use a trolley and we need a direction to movement, at that time, either front wheels or rear wheels should move and have the swirling quality so that it will have a direction. But, if all the 4 wheels are in a swirling kind of thing, then it will move freely. But, to have a direction, it will have some problem. But for this seat, specifically where I need to sit and I need to move like this to do certain activities, for that purpose, 5 legs are provided with a swirling wheels so that there will be free and smooth movement. So, these are the added configuration along with human body dimensions.

To accommodate user's body dimensions including movement in sitting position, the adjustable seat is necessary, and the adjustability range and etcetera will depend on the task, the user expected to perform.

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So, today's class concerns those physical human body dimensions which have an impact on design dimensions in static sitting posture, and second the structural body measurements include direct measurements of various body parts; say heights, lengths, depths, breadths and the circumferences of head, neck, trunk, hands and legs in some standard positions. In this case, the standard position is sitting on chair or it is on a stool position.

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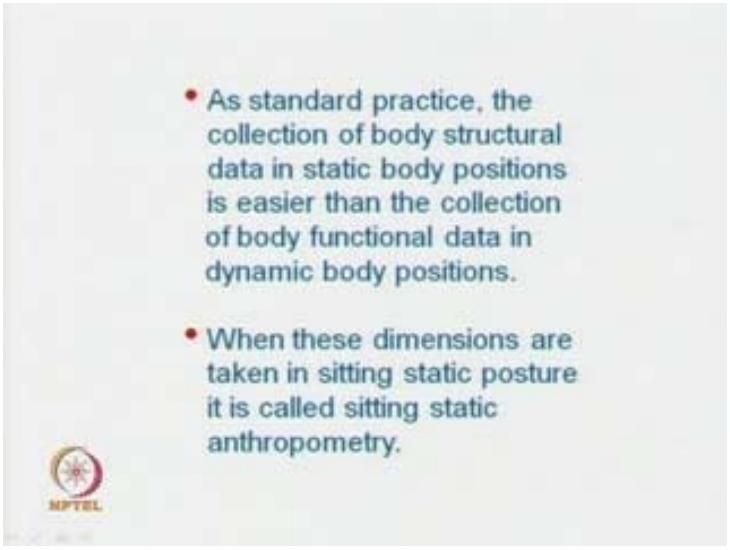

As standard practice, the collection of body structural data, the dimensions in static body positions is easier than the collection of body functional data in dynamic body positions; because when a person is static, then if you want you can measure it, but when the person is in movement, it will be difficult to measure with specific measuring devices. In that case, some indirect measurement system using videography, photography and some others are necessary. When these dimensions are taken in sitting static posture, it is called sitting static anthropometry. Now, we will look into some sitting landmarks, basically with a static and in some dynamic additions to that.

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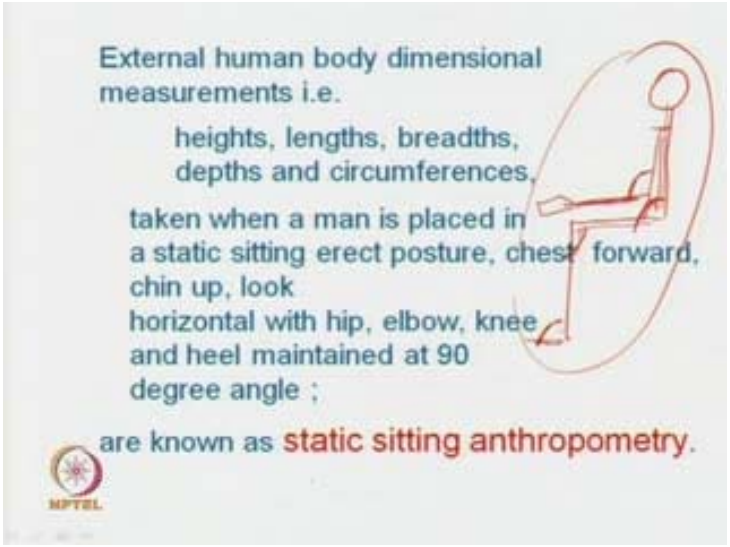

Human body dimensional measurements that is height, length, breadths, depths and circumferences taken when a man is placed in a static sitting erect posture, chest forward, chin up, look horizontal at with hip, elbow, knee and heel maintained at 90 degree angle; means a person will sit like this with the elbow hanged downward with a 90 degree angle.

So, here, what has happened? Trunk will be almost vertical with the head elbow angle 90 degree, waist angle 90 degree, hip angle 90 degree, knee angle 90 degree, and the leg and foot angle 90 degrees. Here, then this thigh and this arm will be in a parallel position. So, this trunk and leg will be in parallel position; trunk will be in parallel position; thigh and forearm will be in a parallel position. Now, the static standard postures for anthropometric measurements in these things are known as static sitting anthropometry. Now, we will see the landmarks.

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Now, whatever landmarks we are showing here, the source reference is Chakrabarti, D., 1997, a book was published. The name of that book we will see - Indian Anthropometric Dimensions for Ergonomic design Practice from Nationalist of Design, Ahmedabad India, total pages 161. and the present and this present author plus in this a person. So, this D support is myself is here and when we have done this work. So, there 23 different locations in India were covered. The total persons we covered 961 were 710 men and 251 women we have measured; with total dimensions, we measured 290 dimensions.

Some of these dimensions, landmarks we are providing here and then data concern from this book can be directly referred and this book looks like this. It is available at National Institute of Design, Ahmedabad.

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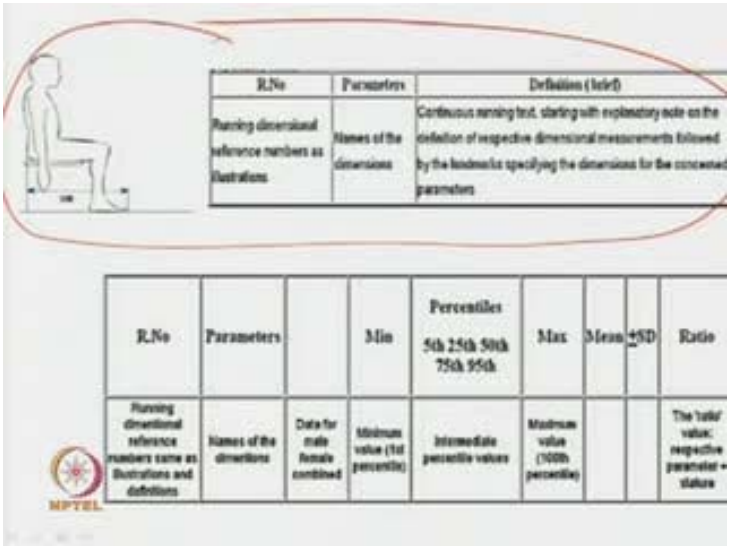

Now, the data normally are presented in this format that some figure with some reference number, this reference number that is running reference number, and parameters name and some definitions are provided there. Then, data is presented following the same reference number, then parameter name, data for male female, and combined use minimum value and percentile values of 5th 25th 50th 75th and 95th percentile values provided; maximum minimum standard deviation and ratio; means that parameter concerned and the height, body height is pressure ratio is provided. Now, here, we are describing this portion; that is, the figure concerned and the landmarks.

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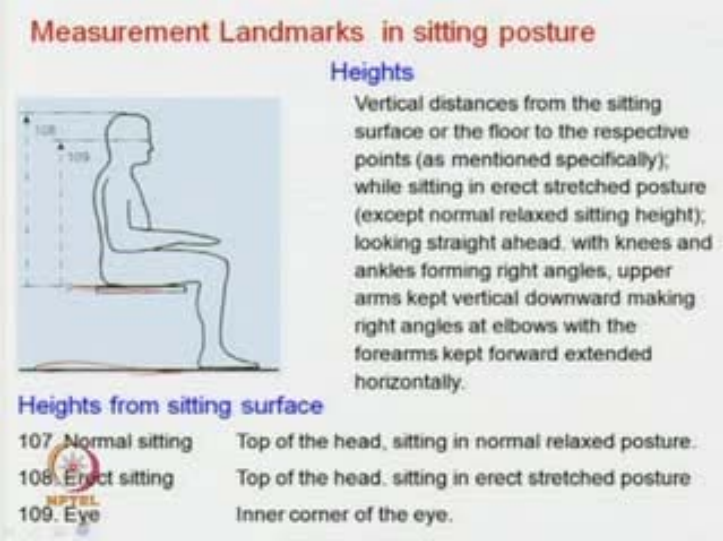

Now, the measurement landmarks in sitting posture: The heights: What are the definitions of heights? Vertical distance from sitting surface or the floor to the respective points; if it is a height then to the maximum point of head; if it is eye, then inner point of eye, like that; While sitting in erect stretched posture except normal relaxing sitting height because if we stay erect, the height and if we sit in a normal posture, it reduces; looking straight ahead with knees and ankles forming 90 degrees, upper arm kept vertical downward making right angles at elbows with the forearms forward extended horizontally.

So, this is the position where the heights are normally measured. Now, heights from the sitting are that, we can take the normal sitting height when a person is not stretched, but in a normal sitting posture that is the normal height. So, normal height is that top of the head sitting in normal relaxed posture from the seat surface. Now, these numericals are the reference numbers we said. Now, 108 here, it says that erect sitting posture - the erect height is that top of the head sitting in erect stretched posture; top of the head on this thing. Then, eye height is that inner corner of the eye height from the sitting surface.

Now, why this dimension? Where do we require in designing? Suppose, we are making a sitting posture, we need to make a partition carton where many people are working, but this separator partition should not meet the ceiling. So, there would be an open space over, but while sitting, no one should see each other for the privacy. In that case, we can

take this eye height and then that barrier would cross this eye height, but when we stand, we should see others.

In that case, what has happened? The standing eye height, the barrier height - it should be within the sitting eye height; the standing eye height - in between somewhere it will be there so that while sitting, privacy will be maintained, but while standing, you can see others. In such cases, these types of dimensions are necessary. So, the design applications of all these dimensions, we will discuss it later with some examples. At present, we are discussing the landmarks for specific measurements and it will be easier to select data from different sources. The specific source, I just mentioned right now; that we have already done earlier. That book, we showed that my book resource is till today; It is being used as a major Indian alternative data source.

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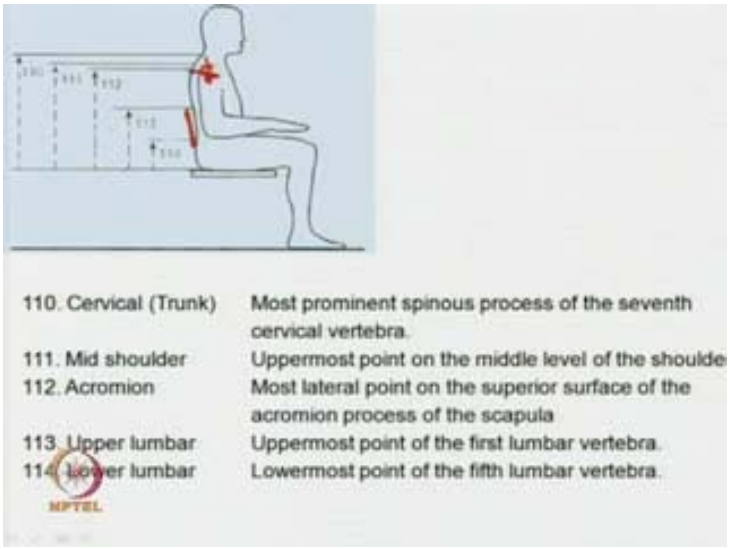

Now, the Cervical: The maximum bony point on the neck. The cervical trunk height, the trunk is the most prominent spinous process of the seven cervical vertebras. So, this is the 110. This is the height for cervical with trunk height. Now, mid-shoulder height is that. With this, the shoulder point, the middle point is the mid-shoulder point - uppermost point on the middle level of the shoulder. Now, acromion is that where this scapula bones meets; in this position, most lateral point on the superior surface of the acromion process of the scapula - that is 112; this point is the scapula point.

Then, upper lumbar and lower lumbar: Now, this upper lumbar and lower lumbar: This region has a major role in seat design; specifically, for the back resting design. Now, upper most point of the first lumbar vertebra and the lower lumbar position is that lower most point of the fifth lumbar vertebra. Now, how quickly one can recognize what are these two points? Now, simply if we see this rib cage where it matches with this vertebral column, that point is that upper lumbar point; at this waist bone, if we go on to pushing, tracking this waist bone where it matches with the vertebral column, that point is at the lower lumbar point. So, that portion is very important for backrest design and that carries most of our body load and it assists in bending, etcetera.

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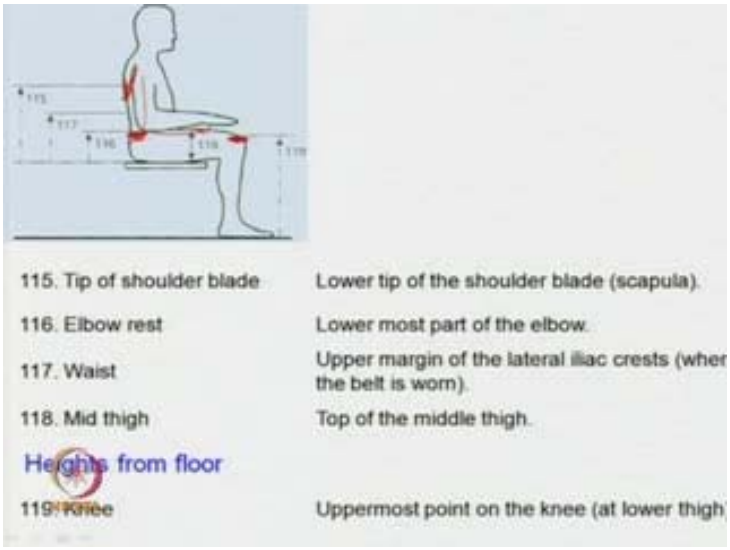

The Tip of the shoulder blade: Why need to know this shoulder blade is that, now in this case, here in this, this is a point in this point, somewhere here this point this is a triangle bone. This point is that shoulder blade - lower tip of the shoulder blade (Refer Slide Time: 33:10). Why we need to know this matter, this point because if there is a backrest and we are supposed to move over that, if the task demands that movement, then this backrest should be below that so that it will assist in that type of movement. If it crosses that, then it restricts that movement.

Now, Elbow rest: Lower part of the elbow; when we are sitting in this standard position, the lower most point of the elbow, that height on the seat is the elbow rest. This will be useful for fixing armrest height.

Waist: Top of waist is that upper margin of the lateral iliac rest where the belt is worn; somewhere here, in this position; this is that waist.

Mid-thigh: While sitting in a thigh in a horizontal position, the middle, that maximum point, that height this is the mid-thigh height. This is required to maintain the space between the table top and the seat surface top. Now, all these heights we discussed right now are above or from the seat surface. Now, some of the time heights would be from floor, like knee height. Knee height is the upper most point on the knee at lower thigh level; this point is that knee point; knee point is 119 - knee height.

Now, from floor again that thigh clearance height: So, this knee height will give an idea of what would be the minimum requirement, a clearance requirement for that table top so that thigh can go in, when you are pushing your thigh inside the table top.

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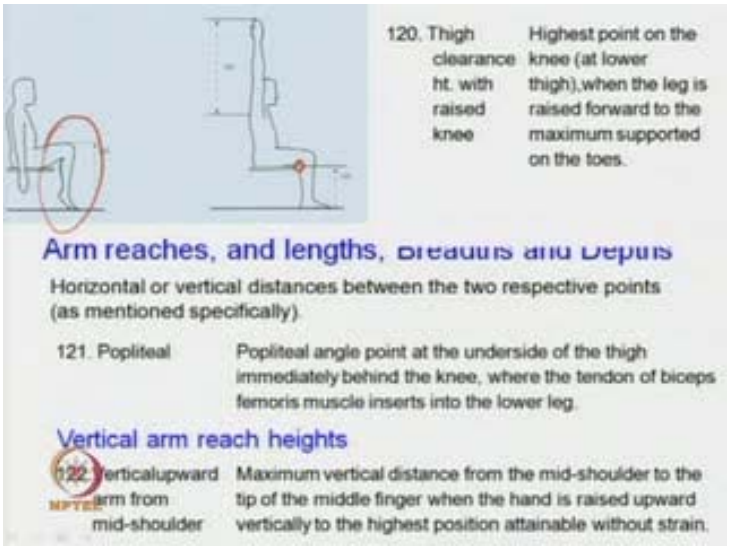

I thought, by behavior sometimes we practice this type of posture. We raise our leg and it is required to avoid fatigue and etcetera. So, in that case, to provide this facility, this table top should have that gap. So, in that case, this will be considered as dynamic clearances. If we consider this thigh clearance height with raised knee; Thigh clearance height definition - we can say that highest point on the knee at lower thigh when the leg is raised forward to the maximum support on the toes.

Now, Arm reaches, and Lengths, and Breadths and Depths: Horizontal or vertical distances between the two respective points as mentioned specifically, like popliteal; popliteal point means for a knee, knee is that frontal, and just at the rear side where, thigh and this lower leg side meets this corner point is the popliteal point. So, that point took from the floor, this height is popliteal height. Popliteal angle point at the underside of the thigh immediately behind the knee where, the tendon of bicep femoris muscle inserted into the lower leg; this biceps femoris muscle tendon - this muscle is coming this side (Refer Slide Time: 37:53). Then this corner point is the popliteal point; this is necessary to fix the seat height.

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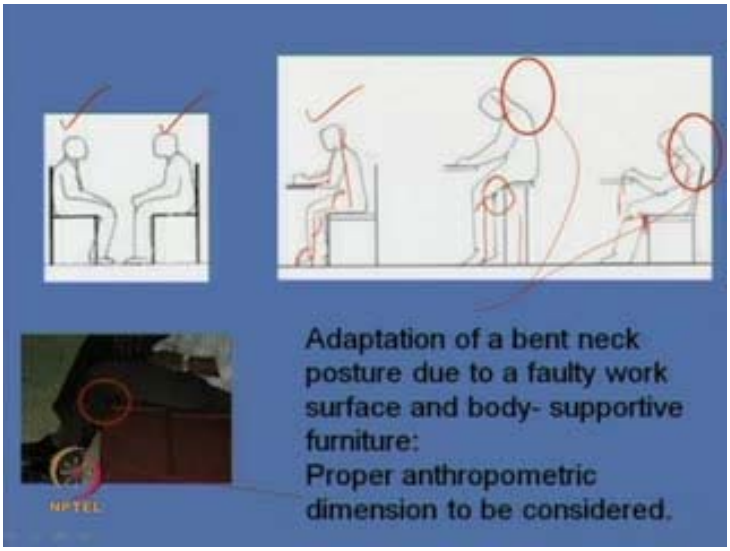

if the seat height is more than this, then the leg will hang; if it is more than this height, then this posture enables, it less than this type of posture will be there (Refer Slide Time: 38:32). So, this is very important consideration for seat height.

Now, the Vertical arm reach height: Vertical upward arm reach from mid-shoulder, maximum arm reach from mid-shoulder: Maximum vertical distance from the mid-shoulder to the tip of the middle finger when the hand is raised upward vertically to the highest position attainable without strain.

So, these dimensions, when we add it with the mid-shoulder height, then we are getting the total distance. That is, if we have to keep any object overhead that needs to be operated quite often, it should be within that limit. So, for that, it is necessary. If it is

necessary to avoid its presence for safety reason, then that location should be well beyond this height.

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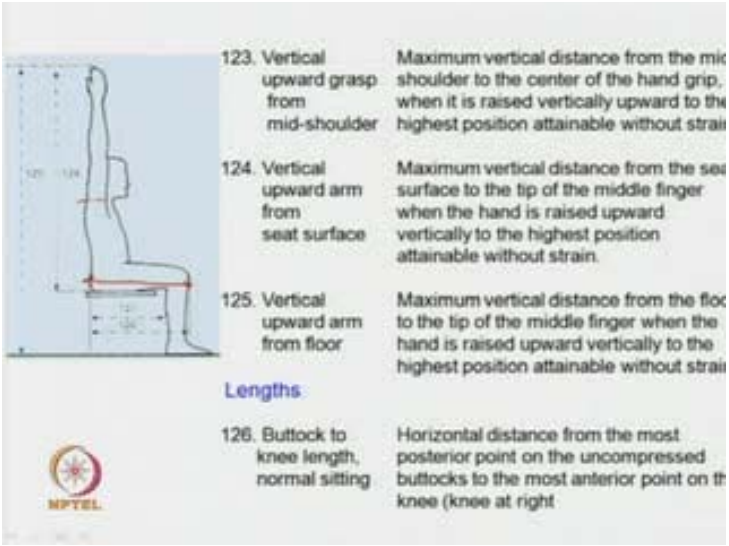

Now, vertical upward grasp is from mid-shoulder: Now, we said that total reach value considering this maximum tip. Now, when you hold something which is around 7 to 10 centimeter lower than this, it should be considered. So, 123 is that vertical upward grasp reach from mid-shoulder; maximum vertical distance from the mid-shoulder to the center of the hand grip, when it is raised vertically upward to the highest position attainable without strain.

Vertical upward arm from seat surface: Now, we said that from mid-shoulder. Now, from the seat surface, the same point, and from the floor is the distance from floor.

Now, Lengths: Lengths from buttock while sitting: What will be the seat length or clearances? Now, 126th point is a buttock to knee length normal sitting, horizontal distance from most posterior point. Posterior means backward posterior point on the uncompressed buttock; uncompressed buttock means if there is a wall, we should not press our buttock and then take measurement; so, it will be free. So, uncompressed buttock point, maximum point to the knee point; this distance, this length is the buttock knee length; normal sitting to the most anterior point of the knee; that is the right knee or left knee; you can consider it.

This is required to have a clearance value. Suppose when we are sitting, then what will be the frontage of a table? So, that clearance we need to consider, but while making a seat length, it would be within the buttock popliteal length. Then, if we bend our leg backward or forward, then it will be upward. This height will vary and the length also will vary.

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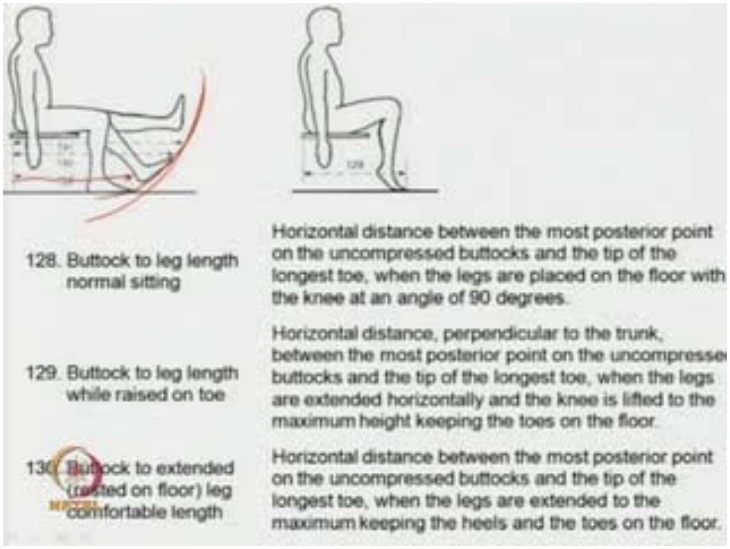

Now, buttock to leg length normal sitting: Now, while sitting, our behavior is that to move our leg like this. So, our leg movement takes this type of card movement. Now, here the normal sitting with all the 90 degree position, foot placed firm on the floor. This is horizontal distance between the most posterior point of the uncompressed buttock and the tip of the longest toe. So, this distance this distance when the legs are placed on the floor with the knee at an angle at 90 degree. So, this is the buttock to leg length. Now, while leg is raised normally, then from this buttock point to this tip of the toe, this distance is that buttock to leg length while raised on toe.

Why these things are necessary? Now, while you are making a table type of structure and a modesty panel in between below the table top, and if someone sits on the other side, if the person concerned here wishes to extend his leg, his leg should not touch others. So, if we know what the angle is and what is the distance length here, then accordingly, from a seat we can fix this modesty panel. For that, these types of things are necessary. Another thing is that, if we need to fix a pedal where foot needs to be operated upon, then what is

the distance or length we can keep there. For that, all these are necessary. Then, buttock extended leg raised on the floor. Now, when we raise it on the floor, then how much it is coming?

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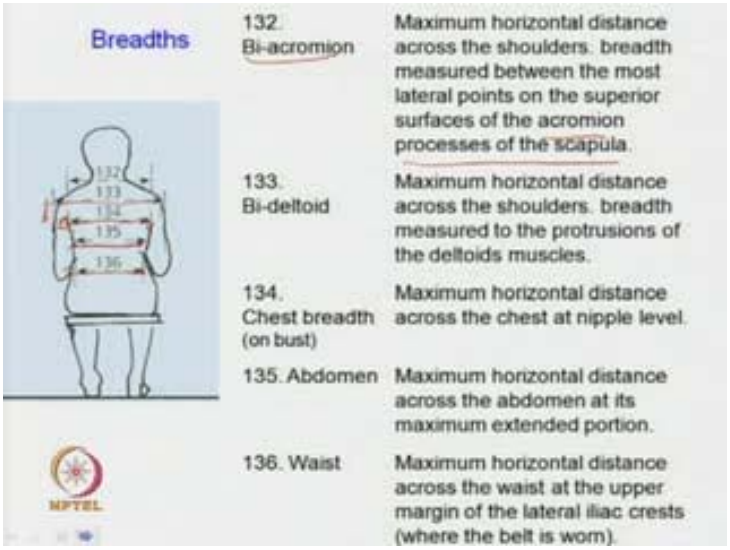

Now, Breadths: Body breadths are necessary for backrest or anything where the trunk needs to be rested; for that purpose or maybe some clearance for movement. The Bi-acromion breadth is that, acromion point is that 2 bony prominences and where it emits this distance. Maximum horizontal distance across the shoulders, breadth measured between the most lateral points on the superior surfaces of the acromion process of the scapula; this is the bi-acromion breadths, this one (Refer Slide Time: 46:05).

Now, Bi-deltoid: These are the deltoid muscles - these thick muscles. So, maximum carp point to maximum carp point; this distance, this breadth is the bi-deltoid breadth from here to here (Refer Slide Time: 40:17 to 40:26). This is the bi-deltoid breadth. Maximum horizontal distance across the shoulders, breadth measured to the protrusions of the deltoid muscles. These muscles are the deltoid muscles.

Now, Chest breadth on bust: This is that with the maximum, like here (Refer Slide Time: 46:52), maximum horizontal distance across the chest at nipple level.

Then, Abdomen: This one is the abdomen level - maximum horizontal distance across the abdomen at its maximum extended point.

Then, Waist: Waist means maximum horizontal distance across the waist at the upper margin of the lateral iliac rest where the belt is worn; this point is that maximum waist dimension.

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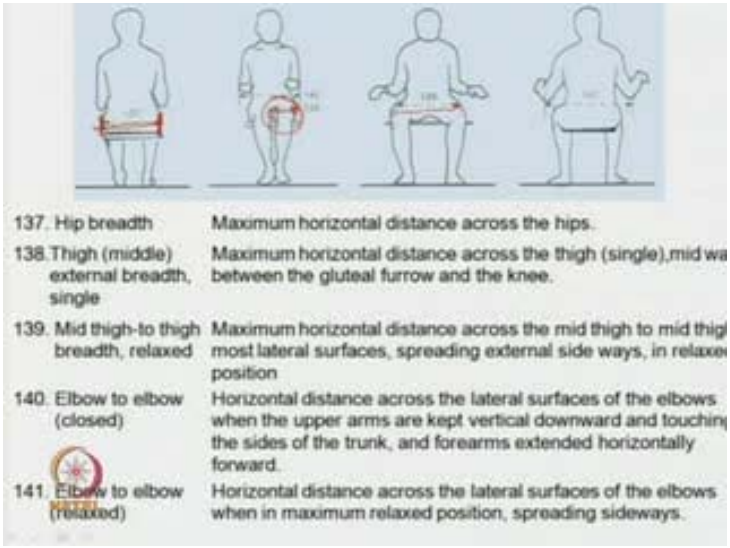

Now, Hip breadth: Hip breadth is maximum distance between hip points. Then, Thigh - middle external body single: thigh distance or maximum thigh distance or middle, that this thigh distance this is the thigh middle external breadth single.

Mid-thigh to mid-thigh breadth relaxed: like when we sit normally, we do not sit knees closed position, we normally sit knees little apart. At that point, what would be the maximum? This thigh to thigh distance; so, maximum thigh to thigh distance is like this.

Then, Elbow to elbow distance: This is elbow to elbow closed and elbow to elbow relaxed distance.

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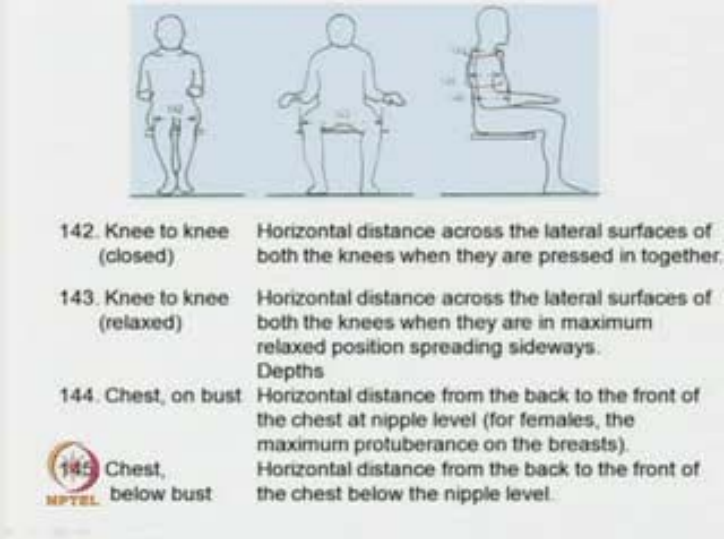

142. Knee to knee (closed)	Horizontal distance across the lateral surfaces of both the knees when they are pressed in together.
143. Knee to knee (relaxed)	Horizontal distance across the lateral surfaces of both the knees when they are in maximum relaxed position spreading sideways.
	Depths
144. Chest, on bust	Horizontal distance from the back to the front of the chest at nipple level (for females, the maximum protuberance on the breasts).
145. Chest, below bust	Horizontal distance from the back to the front of the chest below the nipple level.

Now, knee to knee distance, the knee to knee relaxed distance, chest on bust depth and chest below bust, that depth.

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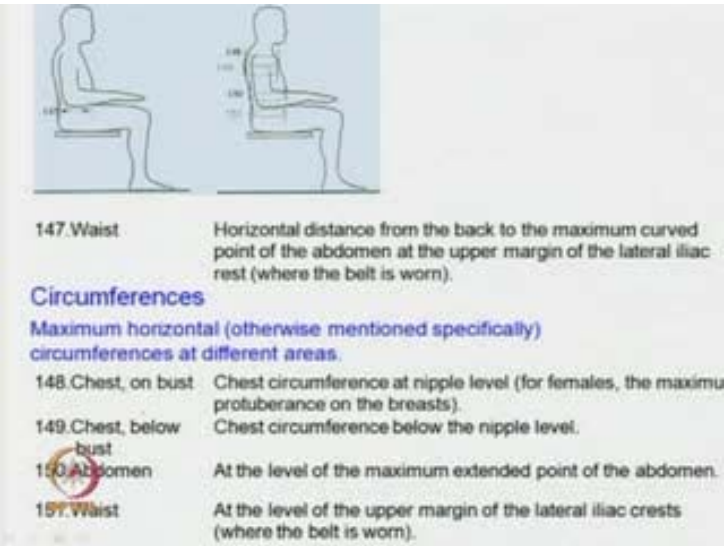

147.Waist	Horizontal distance from the back to the maximum curved point of the abdomen at the upper margin of the lateral iliac rest (where the belt is worn).

Circumferences

Maximum horizontal (otherwise mentioned specifically) circumferences at different areas.

148.Chest, on bust	Chest circumference at nipple level (for females, the maximu protuberance on the breasts).
149.Chest, below bust	Chest circumference below the nipple level.
150.Abdomen	At the level of the maximum extended point of the abdomen.
151.Waist	At the level of the upper margin of the lateral iliac crests (where the belt is worn).

Then waist depth, then circumferences are at different points; all the different circumferences are taken.

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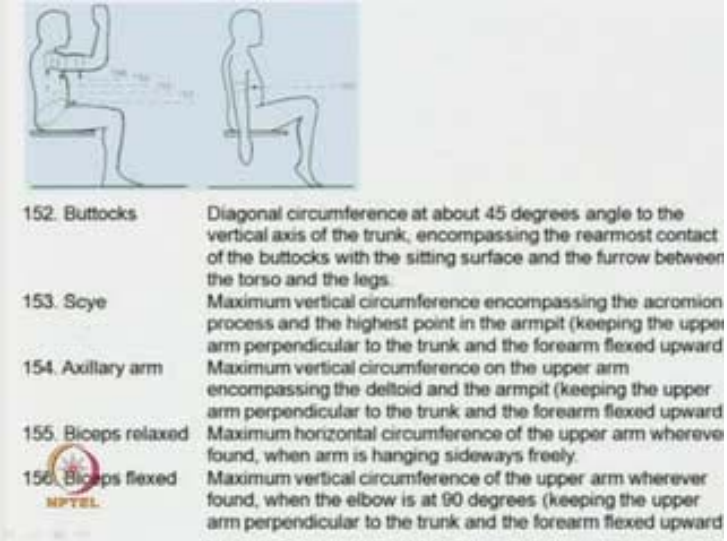

Then, buttock, sinus like this side, and biceps and biceps relaxed.

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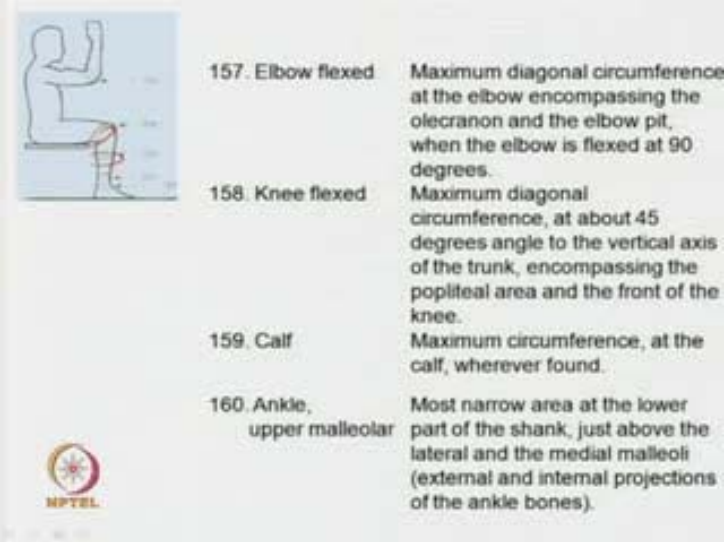

Then elbow relaxed, then knee relaxed, then calf circumferences and then ankle circumference etcetera are all considered.

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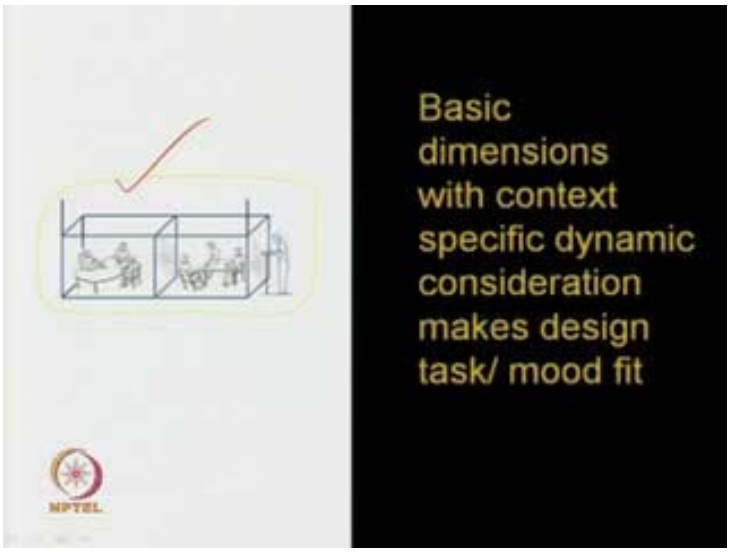

Now, with all these things, to have a situation like this, different body behavior, accordingly, the dimensional modifications along with the basic dimensions are required to be considered. So, basic dimensions with context specific dynamic consideration makes design or task mood fit.

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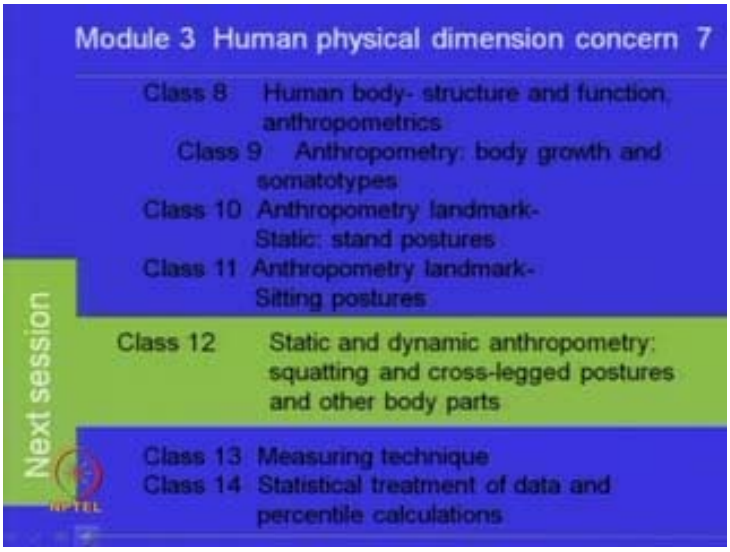

So, with this, we are concluding. Next session will be that static and dynamic anthropometry: squatting and cross-legged postures and other body parts. So, next class, with this figure, you can say that we will be discussing some different type of sitting on

floor position and the landmarks of that, and some other considerations. With this, we are concluding today’s session. So, next day, we will meet you with a floor sitting and the dimensions, and some other requirements for that purpose.

Thank you.