Ergonomics for Beginners Industrial Design Perspective

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Module No. # 03

Human Physical Dimension Concern

Lecture No. # 13

Measuring Techniques

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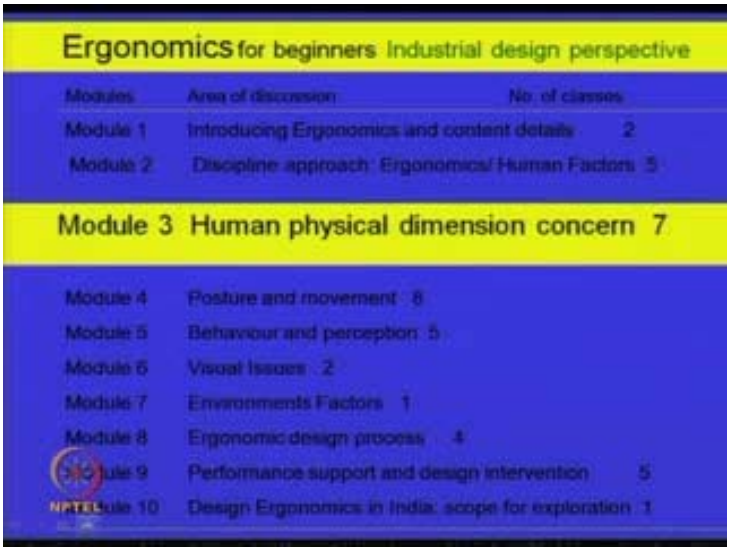

Welcome to this 13 session of ergonomics for beginners industrial design perspective. Now, we are continuing with module 3 - human physical dimension concern - out of the total 7 lectures in this. So today's class is the measuring techniques of anthropometry.

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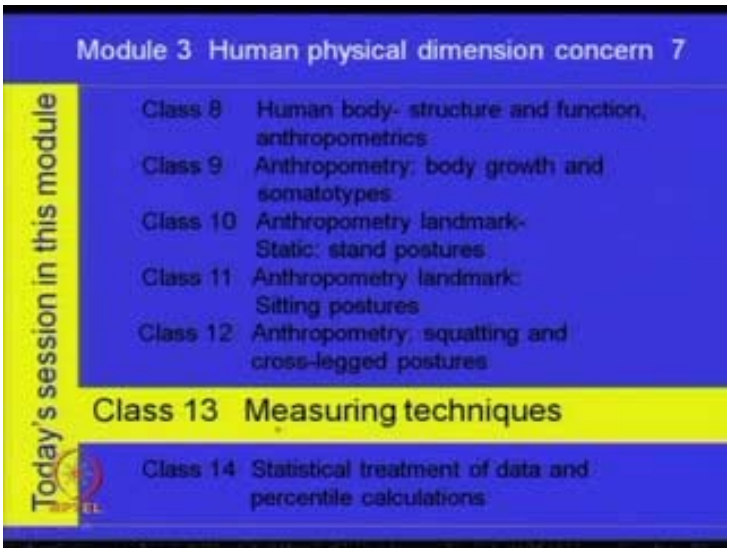

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Now, last sessions whatever we have discussed about anthropometry, that we have stressed upon landmarks for areas anthropometric measurements and relevant application aspects of standing and sitting - that is, seat-desk posture; and sitting on floor postures - that is, specifically the cross-legged and squatting, and that posture considering static as well as various dynamic reach values.

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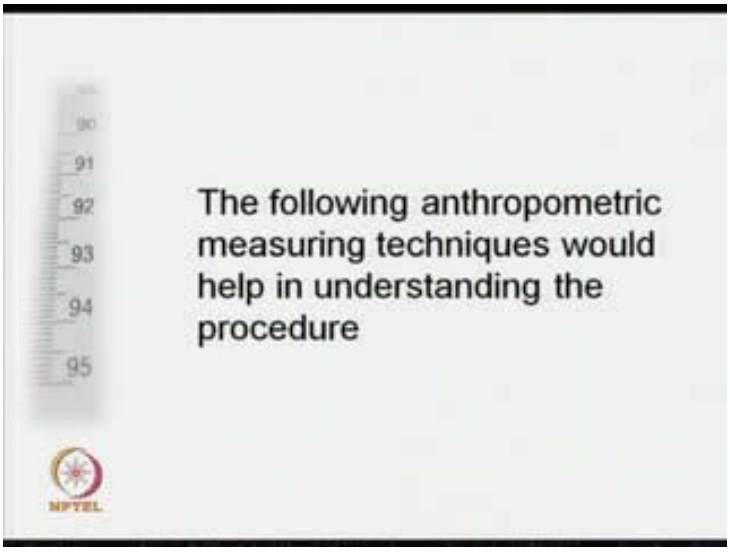

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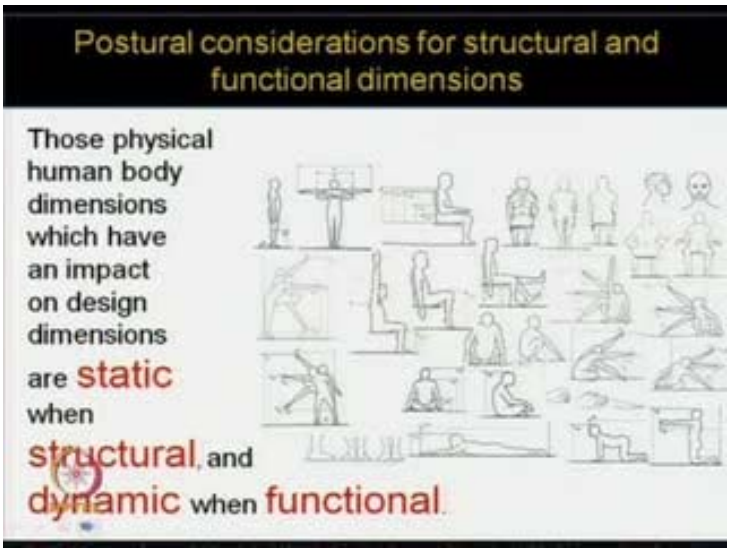

Now, today's topic is anthropometric measuring techniques. Now, the following anthropometric measuring techniques would help in understanding the procedure. Now, this measuring procedure has some postural considerations for structural and functional dimensions. Those physical human body dimensions which have an impact on design dimensions are basically the static. When it is If we consider it as structural and dynamic with the functional aspects in consideration like in these figures, there are many static figures as well as dynamic considerations that have been shown here.

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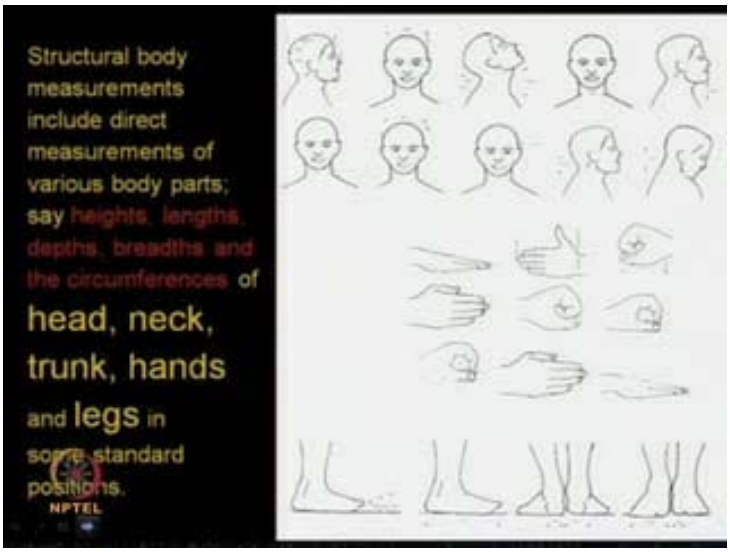

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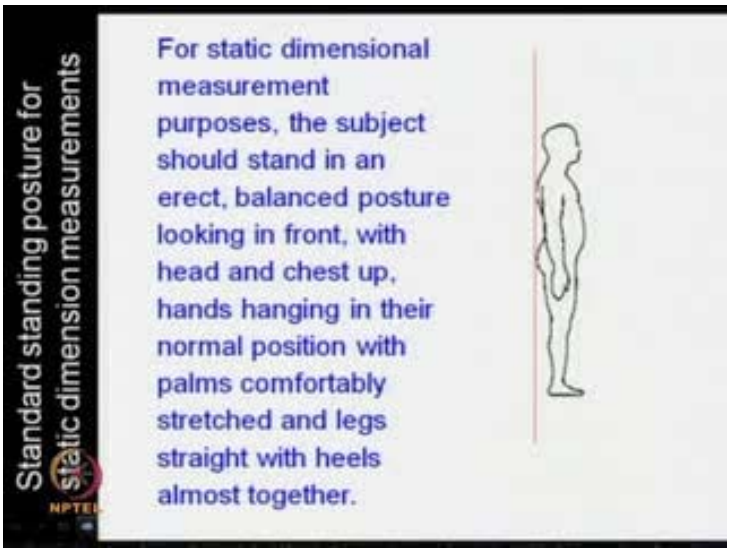

Now, how to measure all the things? Structural body measurements include direct measurements of various body parts - say heights, lengths, depths, breadths, and the circumferences; and the circumferences of head, neck, hands, that the hands and legs have in some standard postures or standard positions. Now, standard standing posture of static dimension measurements - it means that for static dimensional measurement purposes, the subject should stand in an erect, balanced posture looking in front, with head and chest up, hands hanging in their normal position with palms comfortably stretched and legs are at straight with heels almost together position. So, this is considered as standard standing posture for static body measurements.

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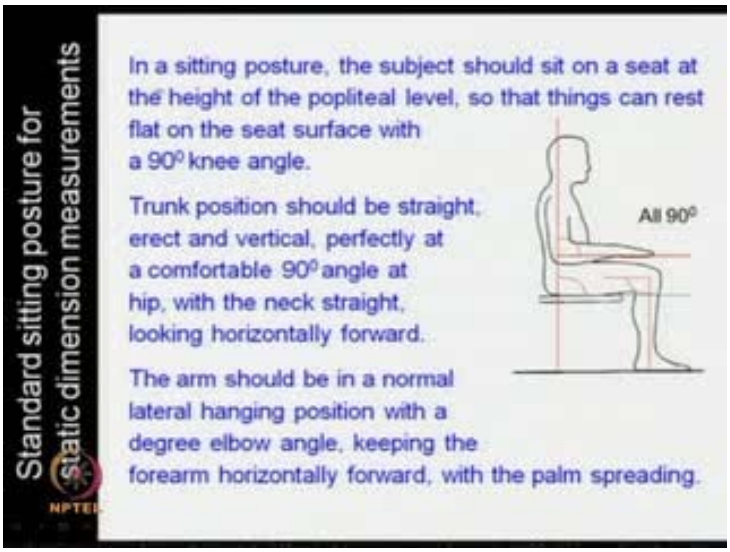

Now, in a sitting posture - it would be in a sitting posture - the subject should sit on a seat at the height of popliteal level. This is the popliteal level, so that the thighs can rest on a flat surface, on the seat surface with a 90 degree angle.

So, all this elbow angle, hip angle and the popliteal - that is below the knee angle, all are at 90 degree positions and the heel in front of that heel this is also 90 degree.

Trunk position should be straight, erect and vertical, perfectly at a comfortable 90 degree angle at hip, with the neck straight, looking horizontally forward. The arm should be in a normal lateral hanging position with a 90 degree elbow angle, keeping the forearm horizontally forward, with the palm spreading.

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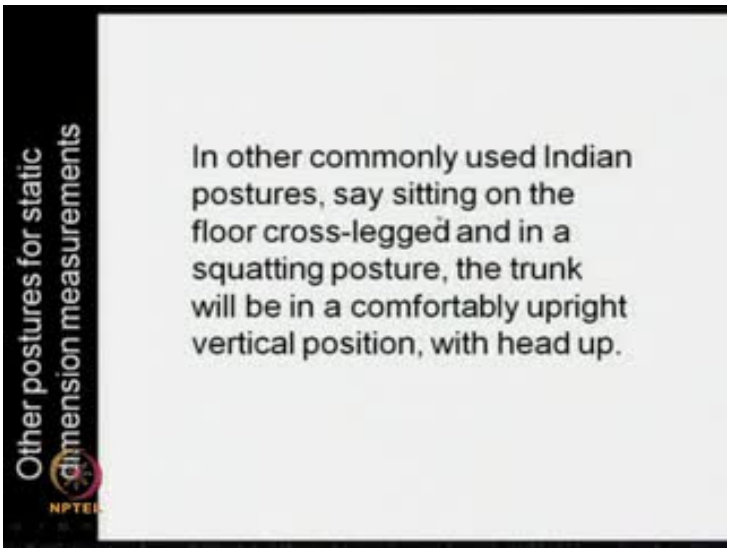

This is the standard posture for static sitting measurements in a seat-desk posture. Now, other postures for static dimension measurements are in other commonly used Indian postures, say sitting on the floor cross legged and in a squatting posture, the trunk will be in a comfortably upright vertical position, with head up for static measurements.

Now, while adopting any specific posture to do certain activity, at that time whatever the body takes the shape, in that particular position the specific body measurements will be at the dynamic considerations.

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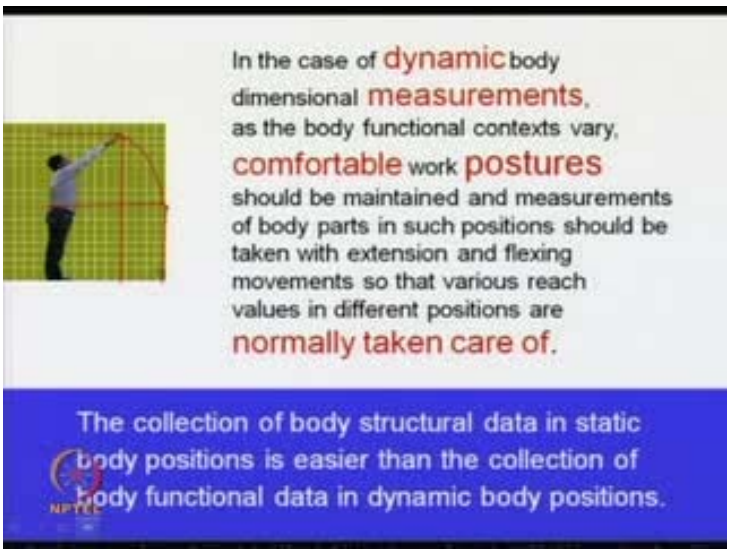

Now, in the case of dynamic body dimensional measurements, as the body functional contexts vary, the comfortable work postures should be maintained and measurements of the body parts in such positions should be taken with extension and flexing movements. So, that various reach values in different positions are normally taken care of. In this case, where in this figure, when we are measuring the upper comfortable reach limit and the middle comfortable reach limit, the person has to feel comfort while reaching to those points, because this dimension will be required to decide some design dimensions where to up to reach that point he should have a comfort feeling.

The collection of body structural data in static body positions is easier to measure than the collection of body functional data in dynamic body positions; so what type of dynamic dimension we require, it depends on specific context.

Now, we are coming to the measuring methods: in certain requirement when the body dimensions of a particular target users group is not available, we may need to generate some data of our own, and for that we require to measure some dimensions taking consideration of a relatively, likely the target users group. Now, what would be the measuring methods that we are going to discuss?

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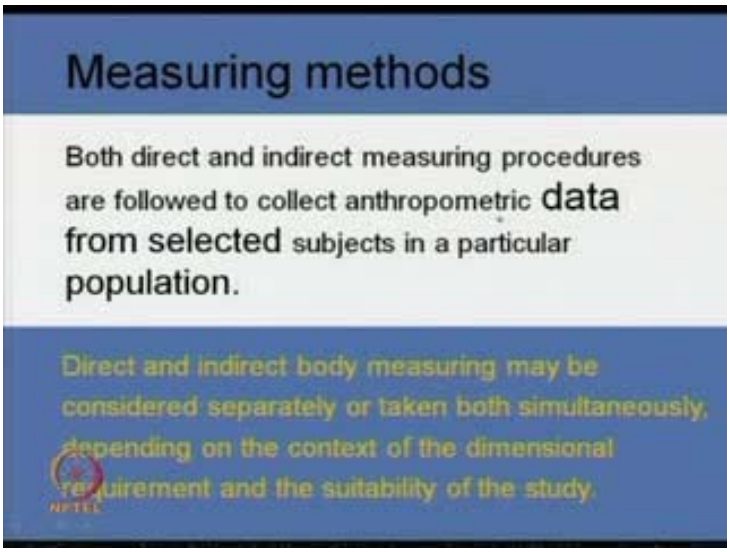

Both direct and indirect measuring procedures are followed to collect anthropometric data from selected subjects in a particular population group. Direct and indirect body

measuring maybe considered separately or taken both simultaneously, depending on the context of the dimensional requirement and the suitability of the study.

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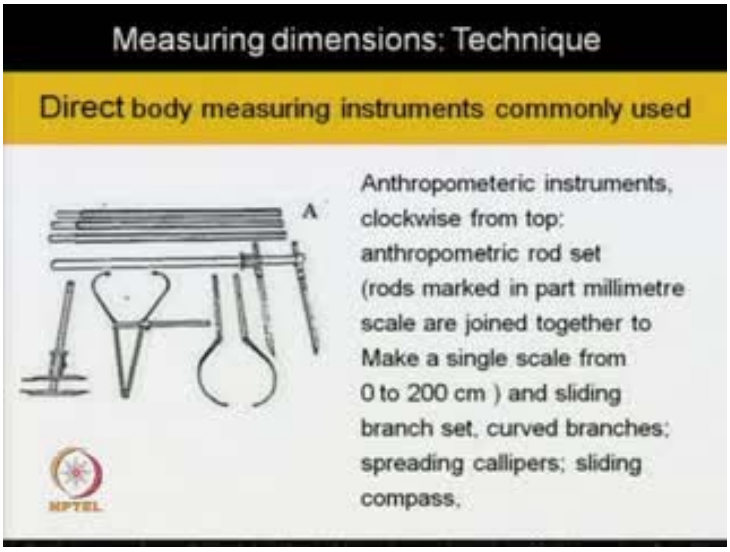

Now, we will see some of the measuring techniques. The direct body measuring requirements - that is instruments - that are commonly used are a set of anthropometric instruments. That is, if we see from the clockwise movement, we will see that first from the top: this is that anthropometric rods; anthropometric rod set - these rods marked in part millimeter scale are joined together to make a single scale from 0 to 200 centimeter - like if we see these things. so what is. These are the anthropometric rod sets that are there; total 4 sets are there.

The first rod has from 1 to 51 marks; means all the things, all the pieces have 50 marks - 50 centimeter marks. Now, one after another, if we join to make a scale to a full rod, it will be useful to measure a total height dimension in all others that I am going to demonstrate now.

Suppose, for a standing purpose, now with the base either we may hold the rod directly placed on a floor or we may have a base, so that it can stand on it and then go on putting the rods one after another on the top, so that it can form a total height of 200 centimeters.

Each rod which has a two branches sliding. So, if we keep it like this way, then suppose this is the total height and if a person stands here, then we can fix it to the simple height

and then after reading the total dimension, we can get it. Now, in this figure we will show now in and in sliding branch sets, these are the two sliding branch sets and curved branches. Curved branches are like this; suppose this is required here in a circular way, the centimeter and the millimeter marks are here. So, in certain cases we need to measure the group distances, where this measurement is not possible with this type of attachment; means if we have normally what is happen keeping fixed one side and another side if we slide like this way and the body will be in between, then with this we can have the total measurements dimension from here.

But in certain cases where we require to measure groups, these groups are not possible to measure with this anthropometric rods, there this would be better; suppose we want to measure these two points, so like this way if we fix it here and then we can measure the reading from this scale; so it would be good.

Another thing is that is spreading caliper; spreading caliper is this (Refer Slide Time: 10:31), if I want to measure this arm length, the small distances like this or maybe this distances thickness etcetera, it will be easier to measure with this.

In certain cases also we may require to measure this, where the distance of this is put here in a half marked scale. Now this is also fully measured for these different lengths, breadths and depths, etcetera; so the measurement we can read from this point.

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So, these are all some standard equipment that is normally used. The rod set whatever we demonstrated right now looks like this (Refer Slide Time: 16:27), and when we joined one after another, it becomes a total rod set; means anthropometric rods, when all the pieces are joined, it may match total 200 centimeter rod.

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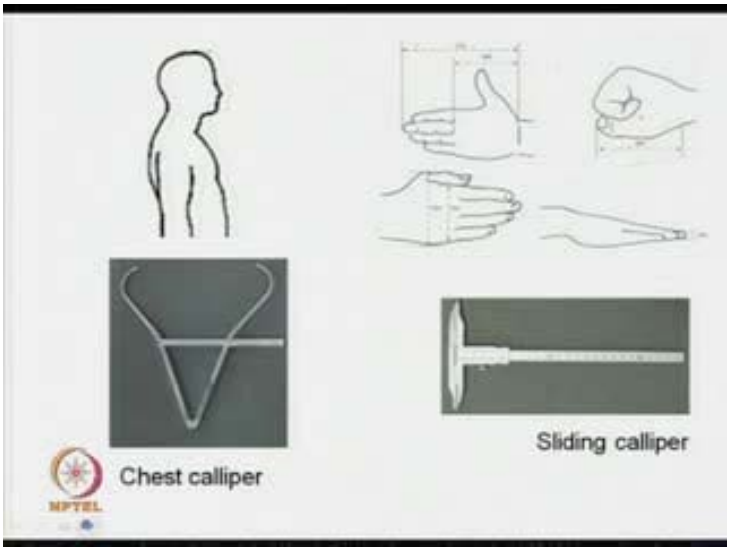

Now, for these calipers, whatever we discuss right now is the chest caliper and etcetera; for those we have to measure these distance, sliding caliper you can slide it sliding caliper for this type of measurements.

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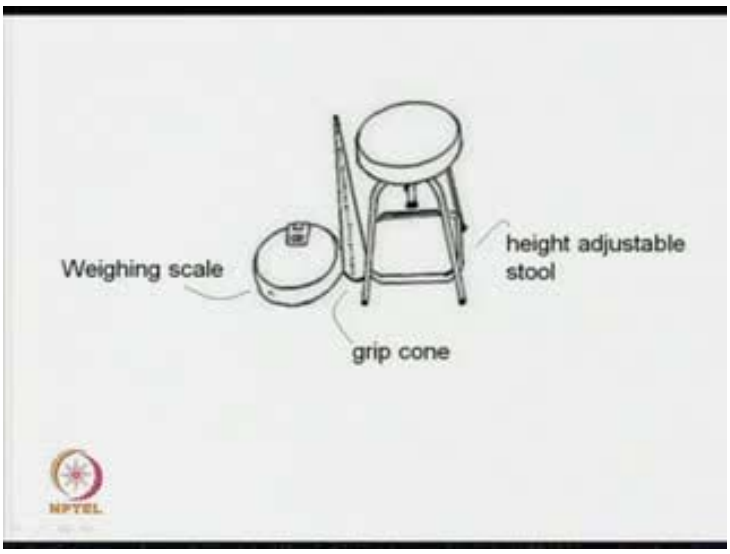

Now, for sitting and other requirements: for the sitting requirement or body measurement, this is the weighing scale; there are varieties of weighing scales, it depends on the accuracy you require, accordingly the weight machines can be selected. Now, here we are showing one normal bathroom scale, that can also be used to measure the body weight, and then a height adjustable stool; this height adjustable stool is necessary, so that short height, medium height, or tall height people when they sit on it, this height can be adjusted according to their popliteal height. So the standard sitting posture for static body measurement that just we have shown right now. just below This type of posture can be maintained.

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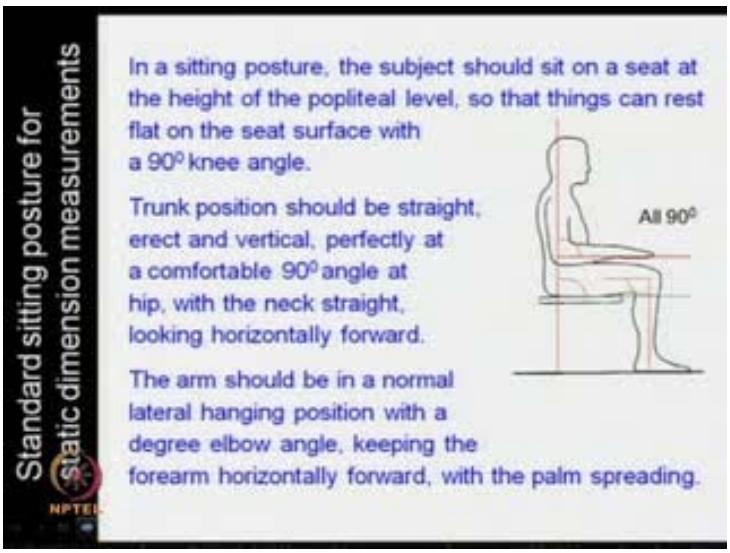

Now, for measuring the different grips, the grip dimension inner side, grip dimension for anything to design some handle type of thing where we need to hold. So, what would be the dimension for this? What would be the dimension for that purpose?

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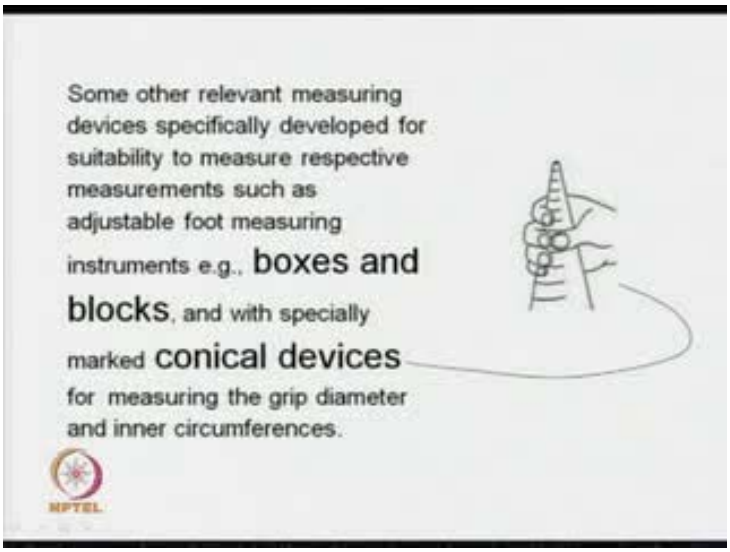

Now, for that a grip cone marks with diameter is there like this (Refer Slide Time: 19:52). Some other relevant measuring devices specifically developed for suitability to measure respective measurements such as adjustable foot measuring instruments - if we want to measure the different foot sizes, then some adjustable length from boxes, one can make it and then just keep your foot within that box and accordingly you slide the another measuring piece, so that you can get the total foot length, etcetera or foot depth. Sometime, like that means boxes and blocks can also be used and with specifically marked a conical device for measuring the grip diameter and inner circumferences of a grip can be used.

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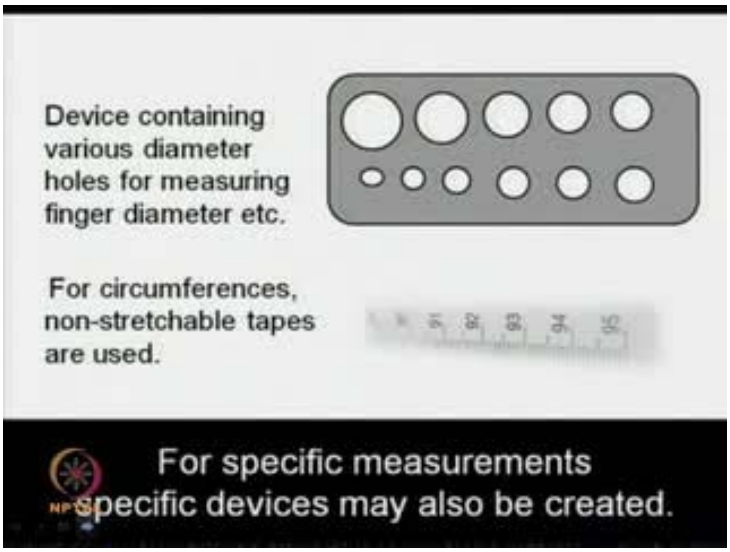

Now, for some other purposes, like if I want to know the different sizes, then the measurements of circumferences, then depths and then breadths of fingers. For that a device containing various diameter holes for measuring finger diameter, etcetera, are also used; means, what happens? You need to put your finger in all these things, where it fits that would be your measurement.

Now, for the body circumference, head like that have different circumferences; circumferences of these non-stretchable tapes are used; why it has to be non-stretchable? Because it stretches, if it has little more pressure, if it becomes elastic and stretches, then measurement will be wrong. So for this purpose non-stretchable tapes are used.

So, for specific measurements, specific devices may also be created; whatever equipment or measuring devices we discussed now are normally used, but for specific purpose some data we require maybe in dynamic position or in static position. So, we can develop our own measuring devices, but one thing is that when you develop such devices, it has to be justified for what measurement it would be used, and what type of calibration refinement we are considering for that.

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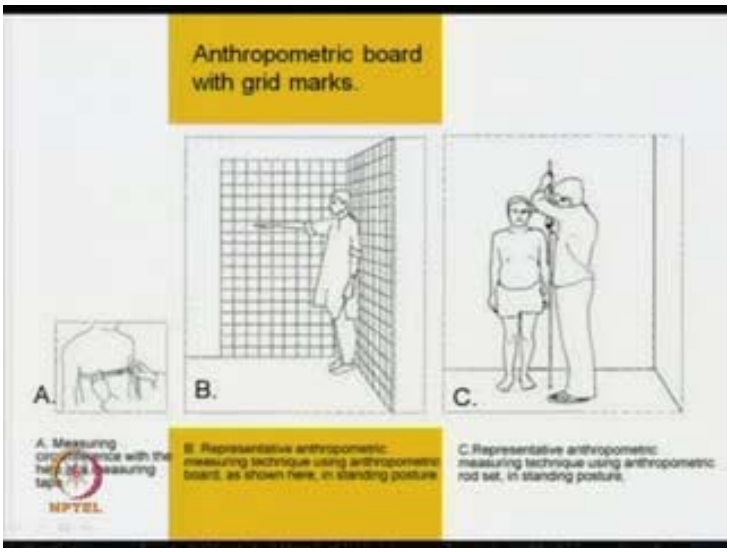

Now, here we can say that with the non-stretchable tape, the circumferences are being measured; anthropometric rod set in this right hand figure is being used to measure the different heights.

Now, another measuring device or system, that is the anthropometric board with grid marks; so anthropometric boards of both sides are the this is the anthropometric board, and with this anthropometric board if a person stands and extends his arm or whatever there the height, length, breadth, thickness, etcetera, can directly be measured reading the grids. So, representative - this figure B here - it is a representative anthropometric measuring technique using anthropometric board as shown here in standing posture. So here different bending also reach values and etcetera can be measured using this anthropometric board and there maybe varieties of anthropometric board we can use. We may have three or four sides closed this grids, even the floor then we can have videography from different angles to get a specific measurement values.

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Now, in this figure, we are showing that the figure is showing measuring body height; now sliding this bar on the anthropometric rod body heights. In this case, the shoulder height is under being measured, but using a various heights can be measured with this.

Now, in this small videotape, it may say that the techniques of this. Now, here we are showing only head, eye, sternum, shoulder, etcetera, but when you put it below then respective heights also can be measured. But in this video, it is shown that if we do not use a standard base like this (Refer Slide Time: 24:06) then what happens to this rod? It may bend; so for body measurements, bending of rod should not be allowed.

Now, the breadth and depth measurement using anthropometric rod set - just now we mentioned that with like this way, with like this way (Refer Slide Time: 24:06) spreading this one where it is the body fits you can increase or decrease the size and specific measurements can be done.

So, this small video here - this clipping - it shows that how these measurements are used. Now, in a sitting posture that is for the seat-desk posture, now here the adjustable stool is used, so that the 90 degree positions at elbow, thigh and foot can be maintained, and the hip also can be maintained; and then the same anthropometric rod can be used for this. In these also - as it is a demonstration video - here it is being demonstrated that without using or if we do not use the base plate here, then there could be a chance of bending of this rod and with this the measurement may not be correct.

So, in these cases, specifically, for the measuring heights, etcetera, the base should be used to maintain the rod that is in a upright position.

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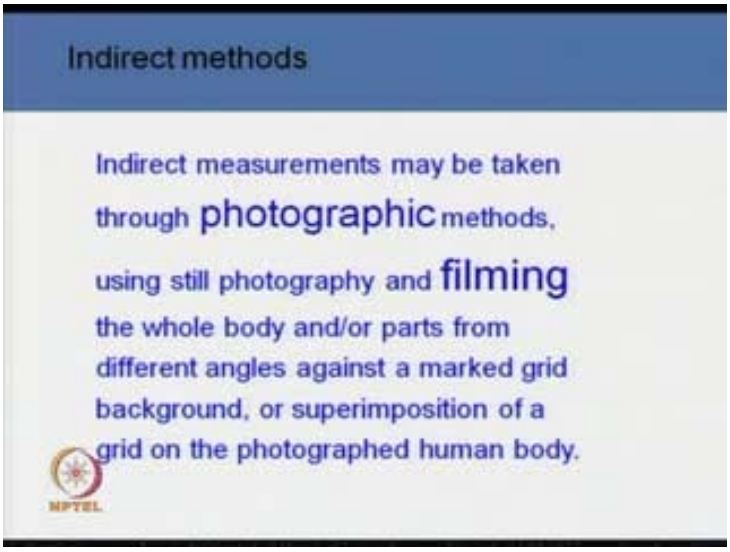

Till now, we have discussed the direct measurement systems; it means, you have the person and then measure directly with the landmarks in that subject's body. Now, there are some indirect methods where this direct measurement is not possible or in a small time, we may require to measure many subjects. So, indirect measurements maybe taken through photographic methods; it means, taking photographs using still photography and filming the whole body and or parts from different angles against a marked grid background or superimposition of a grid on the photograph human body. But, in this case we must consider the problem of parallax error.

With this photograph, from this filming of the human body when he is in an action, we can have dynamic dimensions. Now, all those photography and films etcetera, are having some software available; through those softwares, direct measuring measurement values can be collected.

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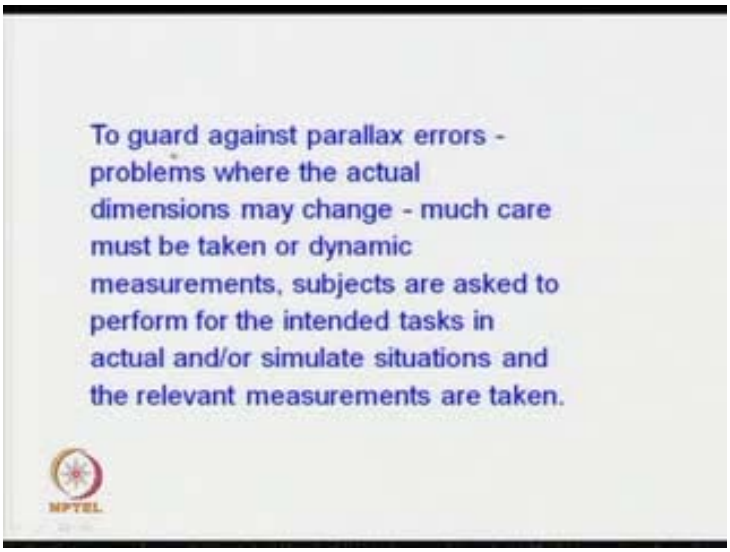

Now, some caution on this - caution is that to guard against parallax error; that is the problems where the actual dimensions may change, much care must be taken or dynamic measurements, the subjects are asked to perform for the intended tasks in actual and or simulated situations and the relevant measurements are taken, so the parallax error has to be considered.

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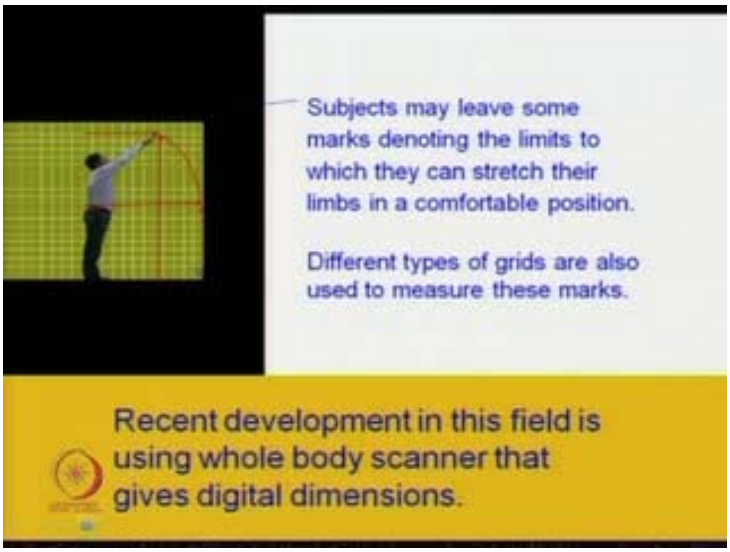

Now, another thing is that when we measure a dynamic reach values. So, in this case, the left hand figure it says that the same that upper comfortable reach and middle

comfortable reach, when you are measuring the subject may leave some marks denoting the limits to which they can stretch their limbs in a comfortable position; like while putting, if he has a chalk on his hand or a marking device on his hand. So, while doing this activity, he can put marks on this grid, so that the total arm movement pattern one can measure directly on this.

Different types of grids are also used to measure these marks in it is with this height, length from the axis the body axis, etcetera, can measure.

Now, what we are discussed is photography or using direct measuring equipment. these are all direct or indirect Recent development in this field is using whole body scanner system, that gives digital dimensions. In this class, we are discussing the direct method system; so this digital dimension measuring through whole body scanner, we are not discussing but this facilities are there and with this digital human body scanner, in a very small time, many people with many body dimensions can measure this for mass measurement purpose.

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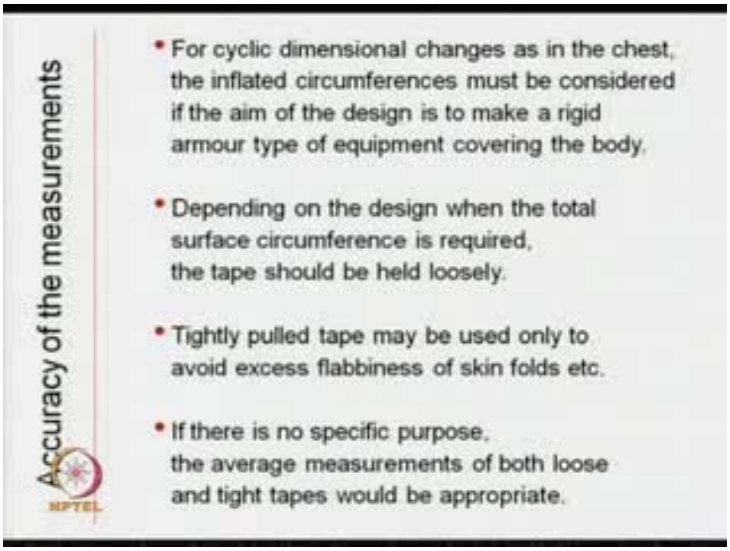

Now, the thing comes, accuracy of the measurements. A few points we must understand for cycle dimension: for cyclic dimensional changes as in the chest, the inflated circumferences must be considered, if the aim of the design is to make a rigid armor type of equipment covering the body; it means, when we are measuring some circumference - now, while breathing out it collapses and while breathing in it expands; if we want to

make a rigid armor, if we use the collapsed chest breadth, chest circumference, then in an actual situation it may not be suitable when we need to take breath in.

In that case, the maximum dimension here we consider and for that with the chest expanded position, we need to measure this and then some other allowances, that is, extra value should be considered for design specifications.

Depending on the design, when the total surface circumference is required, the tape should be held loosely. Tightly pulled tape maybe used only to avoid excess flabbiness of skin poles, etcetera. Suppose, if we have a very flabby arm, then if we want to measure that circumference for a certain design, there this flabbiness of this through or this fat it may not necessary. So, there may be a little tightly held tape should be used. Now, it depends for what purpose we are going to use this measurement and accordingly see whether it will be tightly held or loosely.

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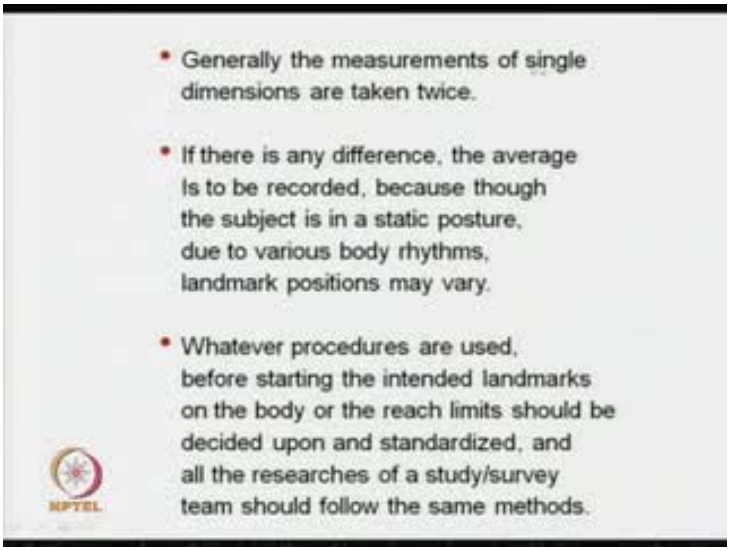

If there is no specific purpose, the average measurements of both the loose and tight tapes would be appropriate for circumferences. Generally, the measurements of single dimensions are taken twice, because there may be some kind of human error to avoid this and another issue is that, if I want to measure, suppose I want to make a working surface, platform height, normally it is said that it should be above your normal elbow height at the normal hanging arm hanging position.

Now, whether depth would be that height, for what height we should have a right hand right elbow height or left elbow height. In that case, right elbow height and left elbow height both to be measured and average can be used; these are the some general and this is for to fix the basic design dimension, but to work on it then some dynamic requirement is necessary, because at this erect position we cannot extract any good work activity. So, there are some other different body postures likely little bending, and etcetera, are there; so, for that a specific dynamic time consideration is necessary; so this for this design requirement cases we will discuss in next classes.

If there is any difference, the average is to be recorded, because though the subject is in a static posture due to various body rhythms, landmark positions may vary. Whatever procedures are used, before starting the intended landmarks on the body or the reach limits should be decided upon and standardized; it means, while measuring some dimensions, first the body landmarks should be noted and then go for measurement. So, with the subject and the equipment, we do not need to look for the landmarks and all the researchers of a study or survey team should follow the same methods. because Suppose we are measuring hundred people in a certain time period, we may appoint five or six people or maybe more. For everybody we should follow the same measuring techniques, same measuring landmarks, and then only the collective data will be fault free.

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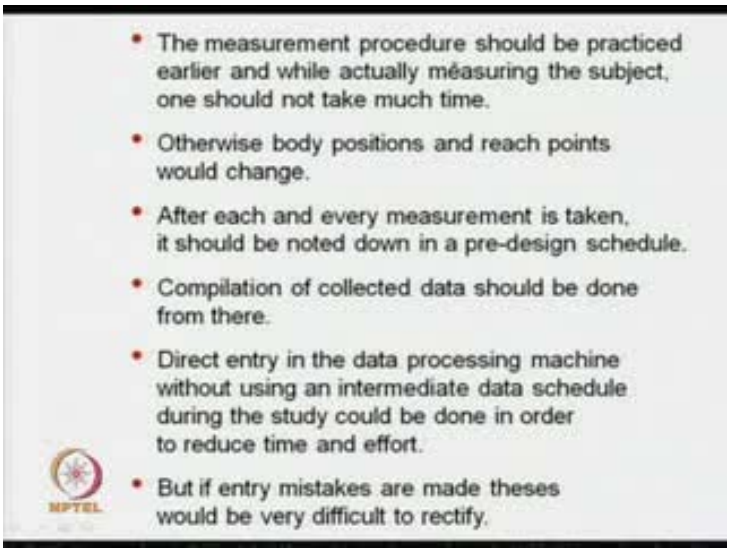

The measurement procedure should be practiced earlier, and while actually measuring the subject, one should not take much time to maintain that so-called standard anthropometric posture - is little difficult; for longer time we cannot maintain that, so there will be some deviation. Now, if the deviation is there when we are measuring certain dimensions, body was in a posture and when we are measuring some other dimensions then the body may change its.

First the practice has to be done, so that we know which subject we should not spend much time. Otherwise, body positions and reach points would change. After each and every measurement is taken, it should be noted down in a pre-design schedule. Completion of collected data should be done from there, compilation has to be made and then statistical treatment will be there.

Direct entry in that data processing machine - a direct entry of data directly into the data processing machine - without using an intermediate data schedule during the study could be done in order to reduce time and effort, but in this case a proper check has to be maintained whether the data entry is done properly. But if entry mistakes are made, these would be very difficult to rectify, because once it is entered directly into the machine, it will be little difficult to rectify it.

Now, the subjects we have discussed are the measuring techniques, but on whom are we measuring the subjects and what would be the sample size selection procedure? Should we measure only 5 persons to have a dimension or 100 persons or 2000 persons - how many? What will be the sampling procedure?

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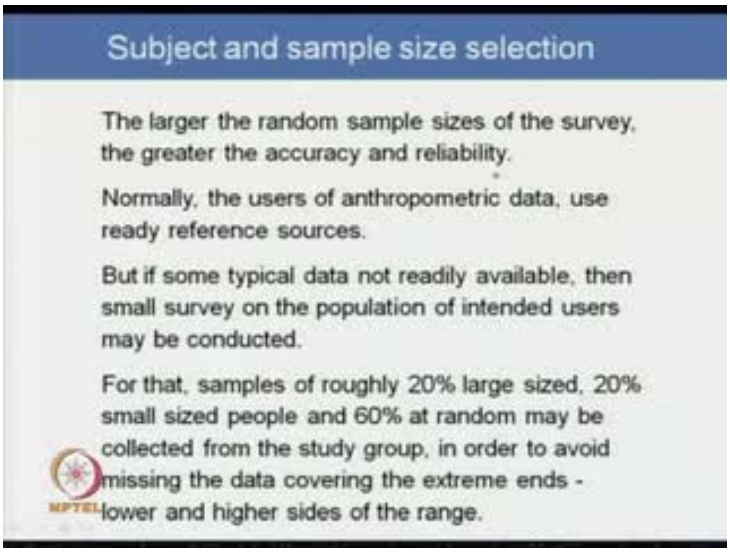

The larger the random sample sizes of the survey, the greater the accuracy and reliability will be there. Normally, the users of anthropometric data, use ready reference sources - normally. But if some typical data is not readily available, then small survey on the population of intended users may be conducted. and for that purpose For that, samples of roughly 20 percent larger size, 20 percent small size and 60 percent random may be collected from the study group, in order to avoid missing the data covering the extreme ends - lower and higher sides of the range. It means, in a population, if we measure some 100 people, so these 100 people may represent smaller sizes or maybe taller sizes; to get a normal bell shaped curve of sample representation, it would be easier better if some calculated sample size sampling is done. Normally, it said by visual judgment, select 20 percent of the samples group large sizes, 20 percent small sizes, and with rest 60 percent randomly select, so what happens? Both the ends containing smaller size and stall the tallest size all will be there. So, these are the minimum requirements, one can say.

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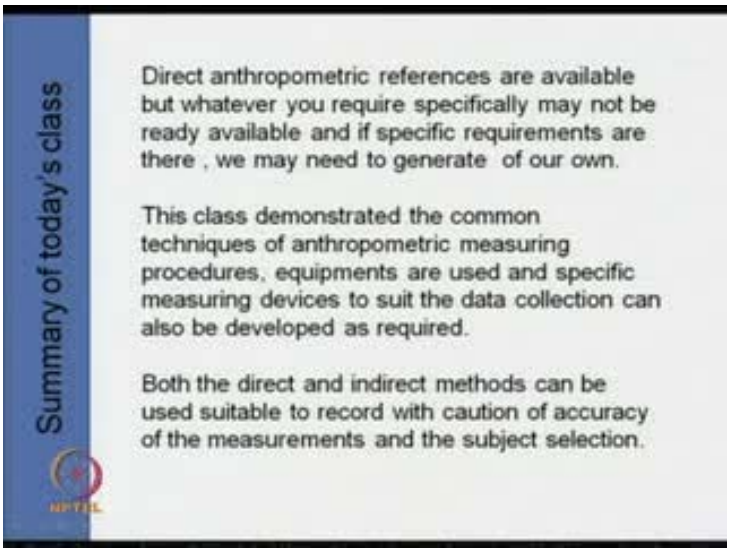

Now, summary of the today's class. Today, whatever we discussed this if summarically, if we say the direct anthropometric references are available from many sources various sources are there but whatever you require specifically may not be ready available for some dimensions and if specific requirements are there, we may need to generate of our own.

This class demonstrated the common techniques of anthropometric measuring procedures, equipments are used and specific measuring devices to suit the data collection can also be developed as required.

Both the direct and indirect methods can be used suitable to record with caution of accuracy of the measurements and the subject selection procedure.

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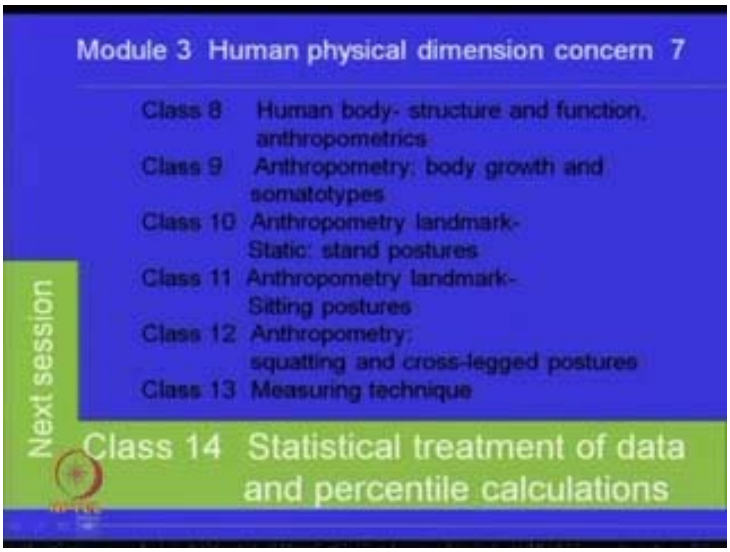

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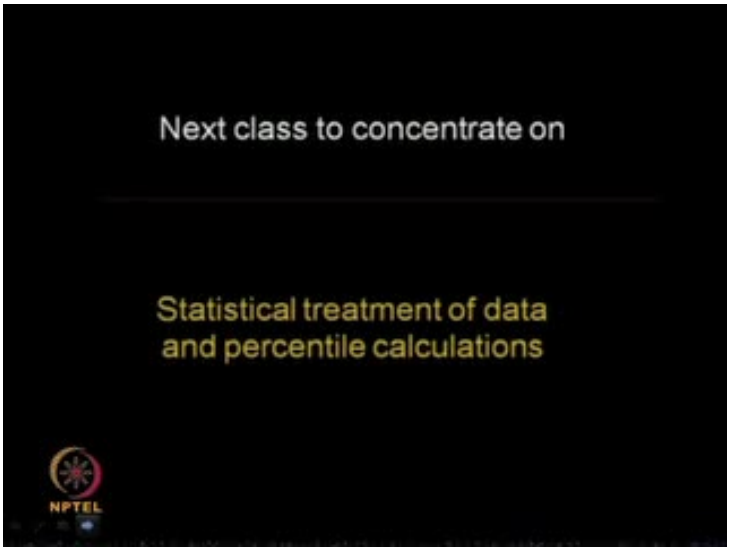

With this, we can say that in this module number 3, that human physical dimension concern, we are concluding the class 13 measuring techniques; next class - 14 - we will see the statistical treatment of data and percentile calculations. So, with this we are concluding today's session. We will see you in next class. Thank you.