Digital Land Surveying and Mapping (DLS&M)

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Lecture – 25
Error in Total Station

Welcome students. This is the 25th lecture on Digital Land Surveying and Mapping. In today's lecture, I am going to discuss on different Errors in Total Station.

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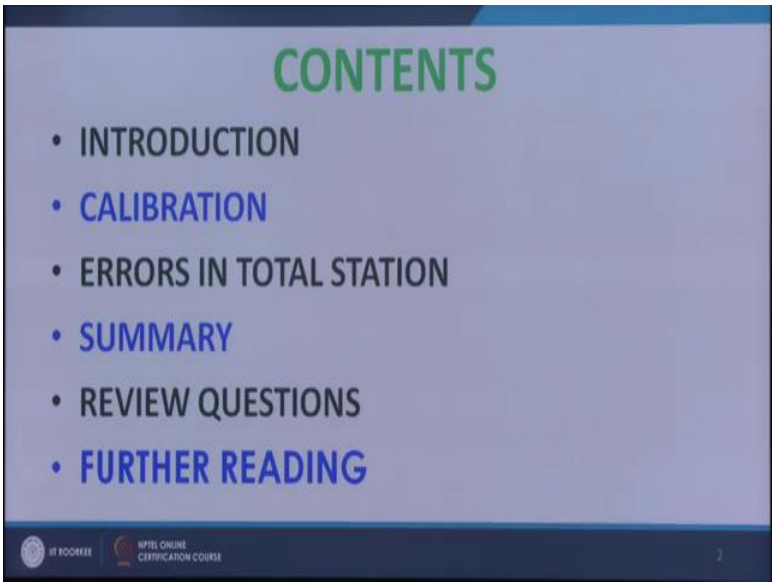

Now, this lecture, we will be discussed under following heads: introduction followed by the calibration, and then the different errors in total station followed by summary for the reading and review questions. Now, you know that there are three axis that is available in total station one is that horizontal axis, then vertical axis.

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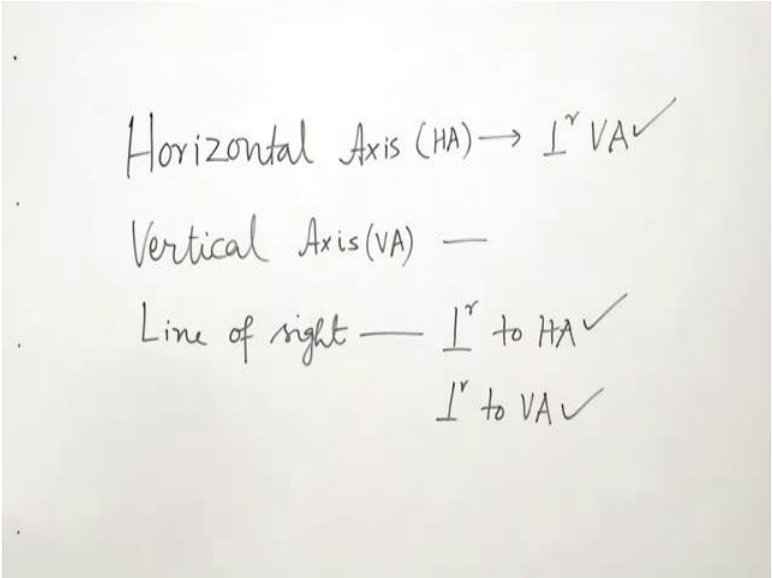

Horizontal axis, vertical axis, and line of collimation or axis of sight line of sight or sight axis; so these are the three axis already I had discovered that the line about which our telescope rotates that is the horizontal axis. And the line about which our whole total station rotates in the horizontal plan that is the vertical axis when perfectly centered level. And the line of along which we do see the object that is the line of sight. Now, this line of sight should be perpendicular to horizontal axis, then our horizontal axis should be perpendicular to vertical axis as well as our line of sight also should be perpendicular to the vertical axis.

So, these are the three the conditions, which any total station should satisfy, and then we call that the instrument is permanently adjusted. And these three conditions had to be satisfied by the total station before we start taking the observation. So, this is the prerequisite condition to make use of total station that our horizontal axis should be perpendicular to the vertical axis, our line of sight should be perpendicular to the horizontal axis and also line of sight should depend on the vertical axis.

And this is the ideal condition, but practically hardly we find that our instruments are exactly permanently adjusted. So, we need to take care if there is any lock in permanent adjustment or not. If there is any lock in just permanent adjustment that leads to some errors, so that is what we will be discussing today. And it has been found that if we go for both face observation; that means our direct mode and reverse mode. So, like direct

mode is this one and if we see this one is the reverse mode, so we will have if we take the average of these two reading then most of the errors can be avoided.

But unfortunately in the field hardly we go for both mode of observation because of limited. Now, you can see in this instrument also if I want to take measurement from this side I will not be able to take because I do not have the data collector this side. So, due to limitation of the instruments also due to various others reason, generally we do not go for both face observation in total station or we can say in the industry single face observation are most rampant. So, we need to know very well what are the different types of errors arise out of the lock in permanent adjustment of the instruments. The errors that arise due to lack in permanent adjustment of the instrument can be measured and then taken care of through a process called calibration.

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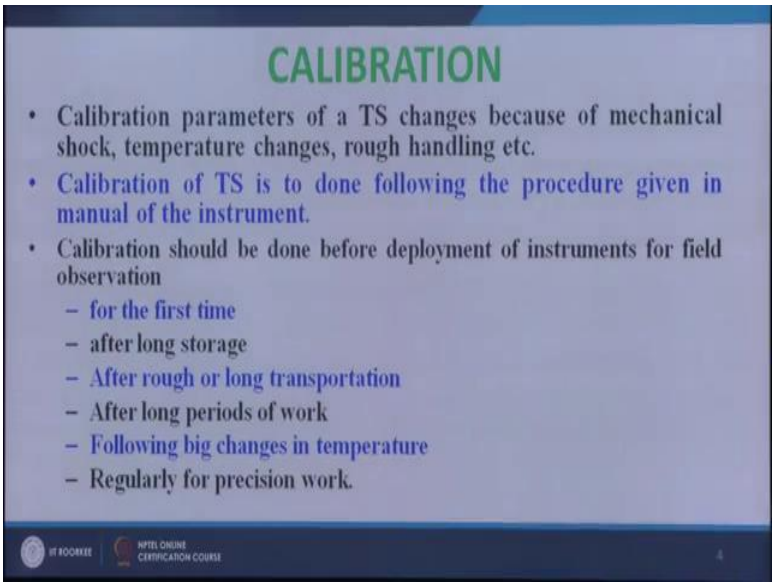

So, first we need to say what about calibration actually, whenever we use our instrument or whenever there is a difference in temperature that means, there is a fluctuation of temperatures or whenever we transport the instrument from long distance, and the permanent adjustments of the instrument gets changes also the calibration parameter that means, the calibration parameter of the instruments gets changes due to mechanical shock, temperature change, rough handling etcetera. And that those parameters have to be recalibrated and have to be fed to the instrument so that during our observation, it

takes care of those parameters automatically. So, and that can be done some by making use of some standard calibration process that is available.

And we should go for calibration of the instrument before we start the instrument in the beginning that means, when we have purchased a new instrument to start observation with instrument we should go for calibration. Now, if we want to use the instrument after long stage that means, for a long time if we have not used the instrument, then we should go for calibration before we start to use, if we transport the instrument for a long distance there may be some jerk or of transportation. So, we should go for calibration, and then if we in the field also if we see that there is a large fluctuation of temperature, then also we should go for calibration. And more specifically when we want to go for very precision work, we should go for calibration.

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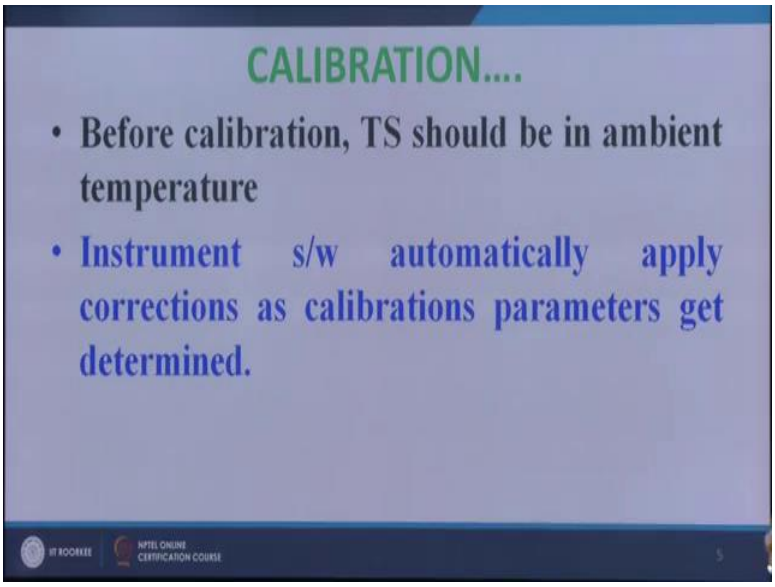

Now, one thing has to be remembered that before we calibrate the instrument that temperature of the instruments should be maintained, it is combined temperature that mean temperature at which it functions properly. Now, once calibration has been done those parameter will be uploaded inside this software automatically and the software will take care of these parameters of its own; so calibration process also done; once it is done, it will be automatically taken care of by the instrument. Now, due to the lack in permanent adjustment of the instrument that is if the horizontal axis is not perpendicular to vertical axis, if the line of sight is not perpendicular to horizontal axis or vertical axis.

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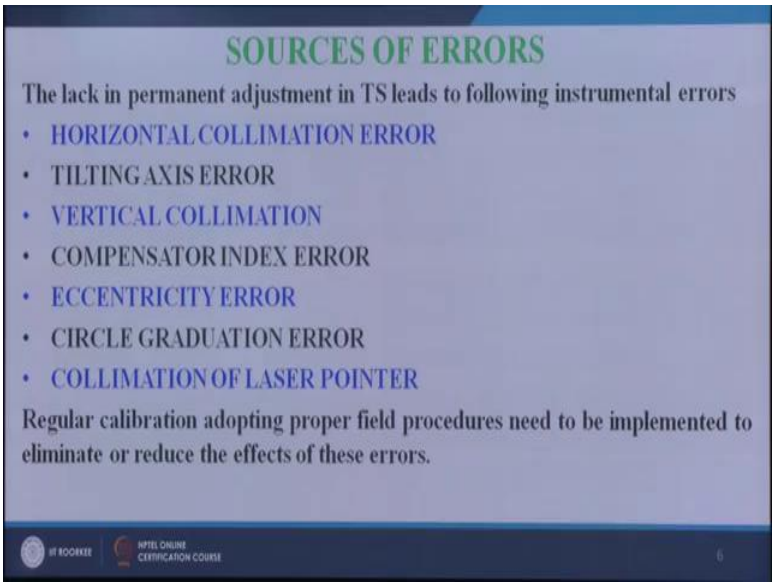

Then there are different types of error that will come across and also some other error that will come in total station like horizontal collimation error, tilting axis error, vertical collimation error, compensator index error, eccentricity error, circle graduation error collimation laser of laser pointer error. These are the main errors, which generally we find with the total station. And we are too taken care of these errors primarily. Now, you take care of these errors actually we should regularly calibrate our instrument preferably in the field before we go for any measurement and that will reduce or eliminate most of these errors in our measurement.

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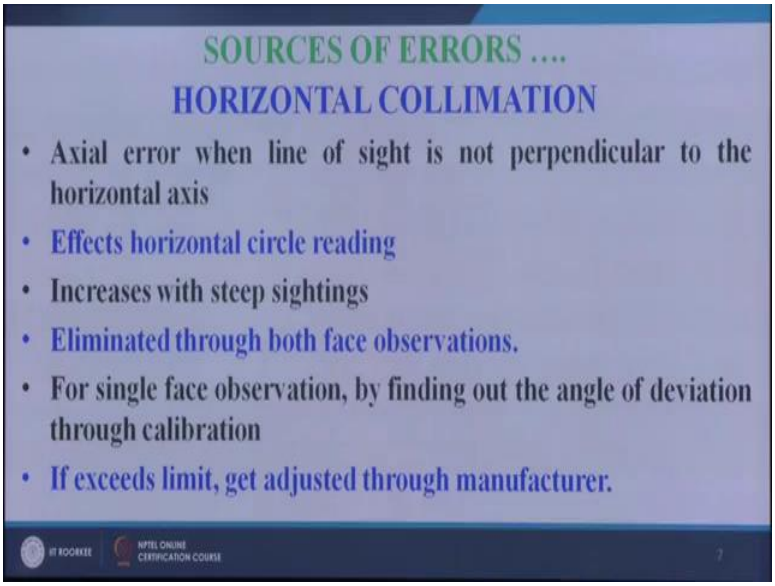

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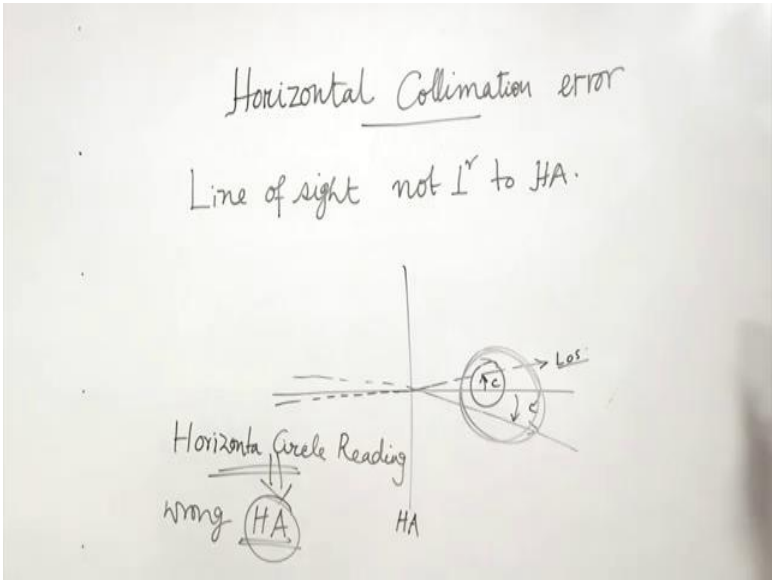

Now, the horizontal collimation error, horizontal collimation error, it is when the line of collimation or line of sight is not perpendicular to horizontal axis. That means, if this is the telescope, this is the line of sight will be passing through this. And if this line is not perpendicular to the horizontal axis, then horizontal axis will be like this, and our collimation axis should be perpendicular; if it is not done, suppose it is inclined. So, if it is inclined then there will be some axial rotation. So, this is our horizontal axis about which our telescope is rotating, and this is our line of sight. So, line of sight is not perpendicular then we have the error like this, this is called axial error; and due to this axial error, the reading in horizontal circle reading will be affected. So, horizontal circle reading means we will get wrong horizontal angle.

So, if we get the mistakes or wrong of these, there is error in horizontal angle then that will lead to error in position as well as other parameters. Now, these error will be severe if the line of sight is stiff that means, if I say like this or like that, so that will be our still severe. Now, as I told you that if we take both phase measurements, so like this is the face like measurement or yours sight reveres mode.

And if we take the left or you can in case of total station, we will say that the original mode or then if we take this mode as well as this mode measurement, and if we take the average of that that means, both face left and face right condition then that average will provide us with eliminate these errors. So, if we if the face that conditions our line of

sight is like this, and in phase right condition the line of sight will be like this. So, this will cancel each other in the horizontal angle measurement where we will take the average. So, this is the idea behind the line of collimation, horizontal collimation error, but as I told you in the industry or in the in use of total station the use of single phase measurement is rampant. So, we need to take care of it through calibration; through calibration we do find out the value of c, the angular error in axial angler error axial angular error.

And that can be that will be made available in the total station, and the software will take care of it should be within certain limit.

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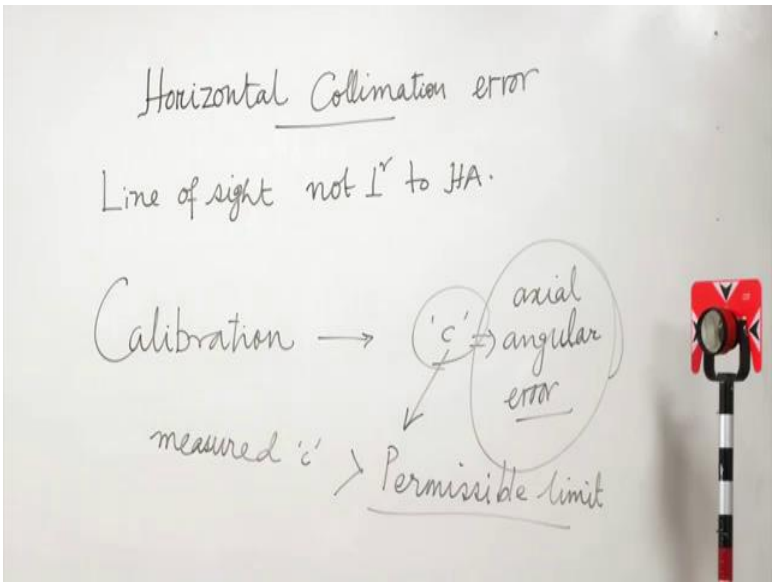

So, in the manual it will be written what is the limit which is permissible now if this limit if the calibrated measured value if the measured value of c is greater than permissible limit permissible limit of the instrument. Then we should send our instrument to the manufacturers to make this correction in the laboratory or in their factory, so that is all about horizontal collimation error.

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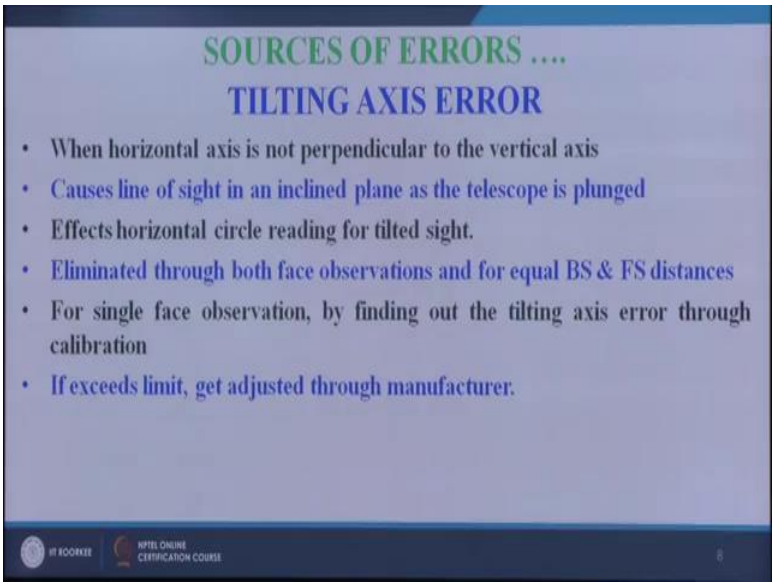

Next, tilting axis error.

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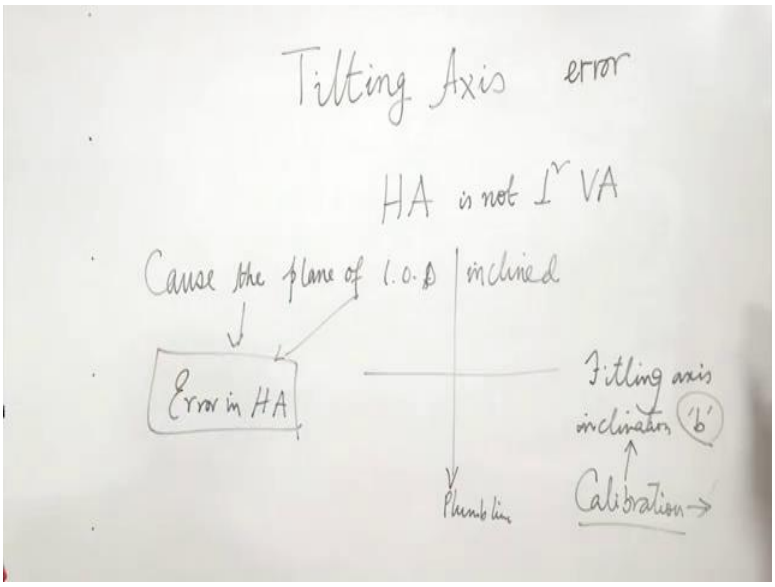

Tilting axis error, now this is these happens when the horizontal axis is not perpendicular to vertical axis; that means, this axis is not perpendicular to this. So, the vertical axis, plumb line and the horizontal axis is this one. So, if it is not, if the horizontal axis is not perpendicular to vertical axis, then it will cause the plane of the line of sight inclined as we plan. That means, if we make keep this telescope horizontal then there is no problem, but if we want to see this above or below then this 20 axis error will cause a reading loss

or error in horizontal angle. Cause the plane of line of sight inclined that will lead you to error in horizontal angel, horizontal circle reading.

Now, they say these are also can be eliminated by taking the both phase measurement and taking the average. However, of this again as the single-phase measurement is rampant we need to measure the tilting axis, tilting axis inclination say b this value again has to be computed using calibrated through a calibration we have to measure. And once it is measured then we can get this to the computer software which will automatically taken care of. Again similarly if this value is axis, if the measure value of the tilting axis interaction is more than the permissible value then we have to send again this instrument to the manufacturer.

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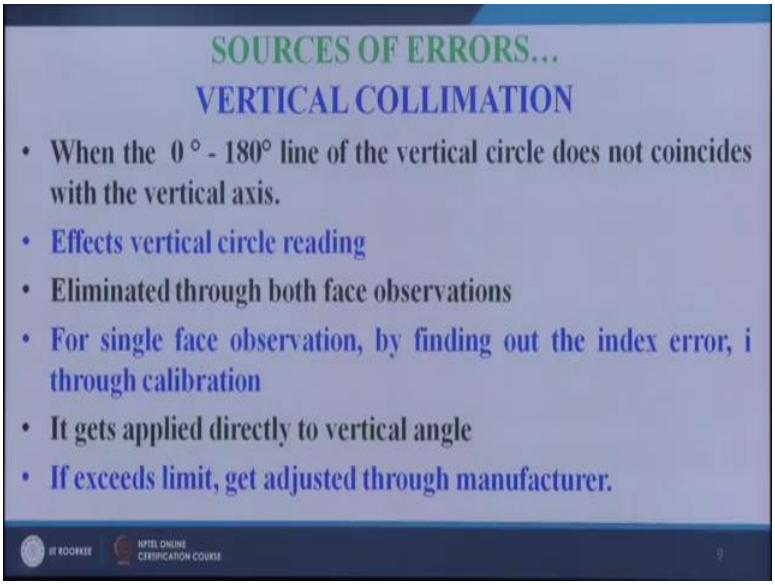

Now, third error is vertical collimation error.

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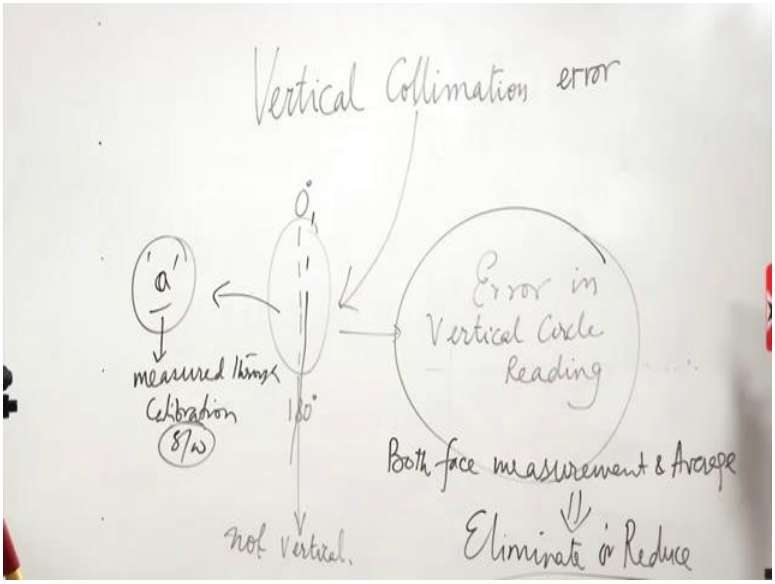

Vertical collimation error: now as we know that when the instrument is properly leveled then our vertical circle remains in a vertical plane. So, that 0 degree and 180 degree line of the vertical circle should be in a vertical line. Now, if it fails, if the 0 degree, 180 degree is not vertical then vertical collimation error comes. So, as a result of this, the vertical circle reading error in vertical circle reading it leads to error in vertical circle reading. So, again same thing, again this can be reduced or eliminated by making use of both face measurement and taking its average and average provides the we can eliminate or reduce. But as the single face measurement is rampant, also we need to find out this collimation error angle; what is the angle of inclination of this with vertical.

So, see suppose it is a, so this angle of inclination has to be measured using calibration measured by through a calibration and made available to the software. To do this very correction whenever we go for our vertical angle measurement and again if it exceeds the permissible limit we should send this instrument to the manufacturer for necessary corrective measures.

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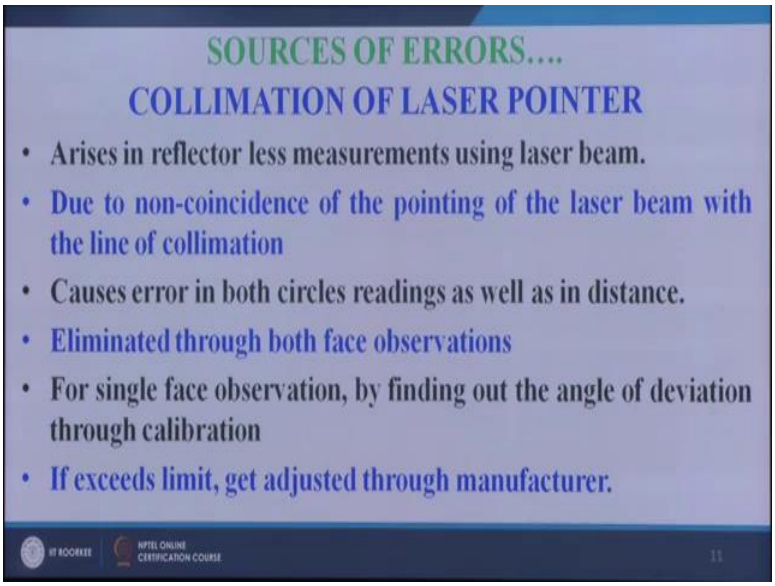

Next, the compensator index error.

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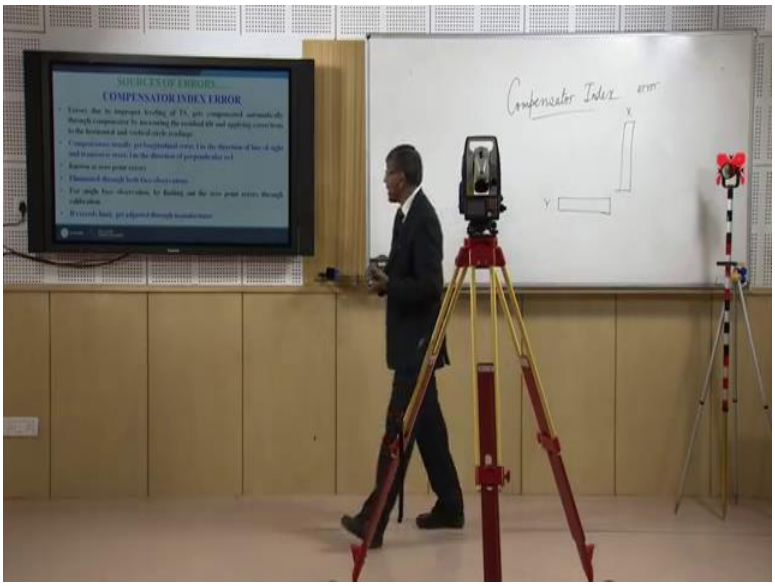

Now as we know that each of these instruments is provided with some compensators. So, that compensator compensates the leveling that was whenever we do carry out the leveling and centering operation, there is always some residual leveling error which we do finally, carry out the leveling using the electronic compensator instrument. Like, so here you can see that there are two one longitudinal and another; one compensator will indicates in this direction another in this direction. So, we call it y and x.

So, there are two compensator generally we had which we do make adjusted at by doing this thing to get provide has the exact leveling of the instrument. There is always some error associated with the compensator one in the longitudinal level, another in the transverse direction. So, suppose l is the error in the longitudinal direction, and t is the error in the transverse direction. And these two longitudinal and transverse errors of the compensator index is also known as zero point errors. Now, these errors also can be eliminated by taking the both face measurement.

However, this because for single face measurement also we need to know these errors, and these errors can be also be find out by through calibration or and if the limit exceeds then we should go for sending the instrument to the factory.

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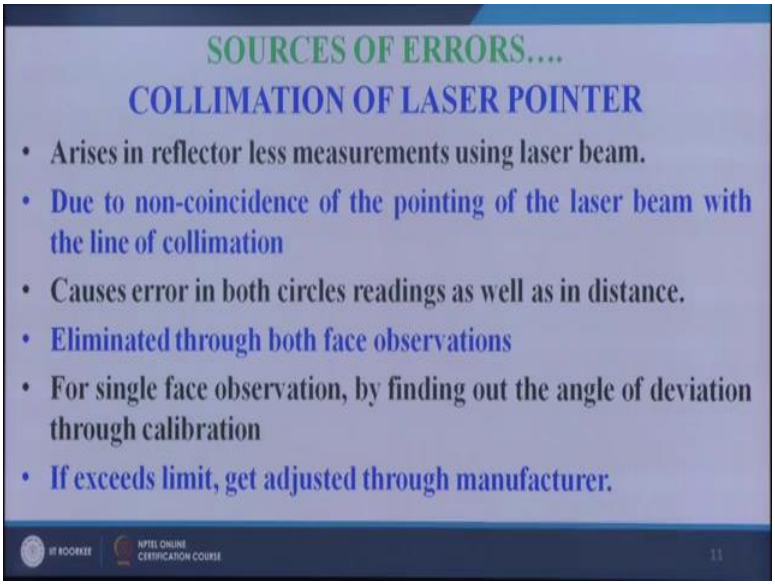

Next, collimation of laser pointer. So, whenever we use laser pointer in a reflector less measurement.

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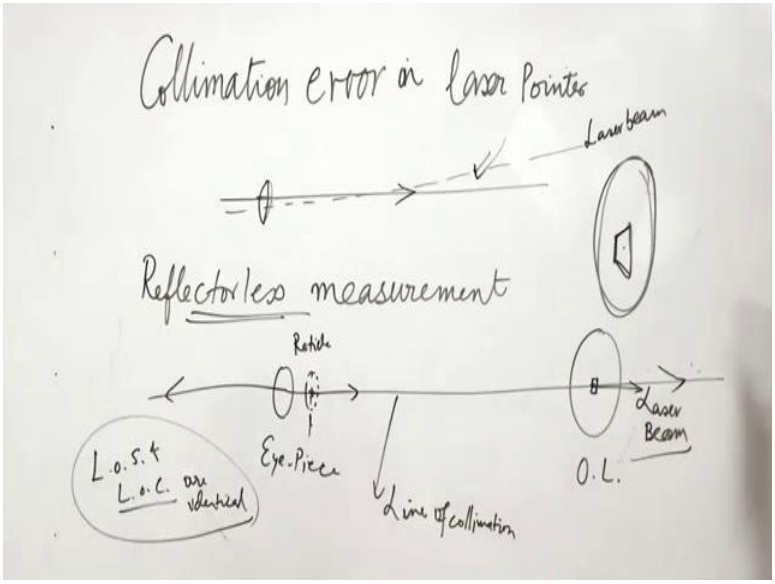

Collimation error in laser pointer: now we know that in case of a reflector less measurement, what we do, in inside the telescope, this is the eye piece and this is the objective lens. And the line joining the center of this and the center of this that is called line of collimation or line of collimation. And also there is a reticule, and the center of this is if it passes through this, this is called from here it is called line of sight.

So, in ideal case line of collimation line of sight and line of collimation are identical that is the condition we require for our observation using telescope. Now, apart from the now whenever there is a reflector unless measurement, actually you will see that there is a guided path through which the laser beams we send the laser beam to strike the target. Now, if you say this total station, we will find that here there is a mark like this, which is the location for this is the location for laser guidance. Now, the center of that laser guidance should be the center of this laser guidance and the center of the optical lines should be identical that is the requirement.

Now, in ideal case, they are coinciding, but sometimes the center of the laser guide or in the center of the objective lens, do not coincides. Due to this, there is a error of collimation of laser pointer. Now, because our instrument takes gets the measurement by the laser beam. So, say here we assume that the direction of the laser beam is the in direction of the line of sight, direction of the line of collimation. Now, if there is any discrepancy between this is the line of collimation on if it is this is the laser beam, this is

the laser beam and all the measurement, which is done with respect to this, but it is coming to reticule here. So, there will be some error and that error causes errors in both circles of measurement.

In order to avoid these errors, we need to we can also do the both face measurement and taking the average. However, for a single face measurement, again this derivation can be found out through a calibration and that has to be stored in the instrument. So, these are the fundamental errors that are associated with the total station instrument. Apart from that there are two errors, like already we have discus that there are two pairs of circles one is the horizontal circle in this and there is a pair of vertical circle here. And the whether it is horizontal circle or is a vertical circles, the center of this the geometric center of this circle may not coincide with the center of the rotation.

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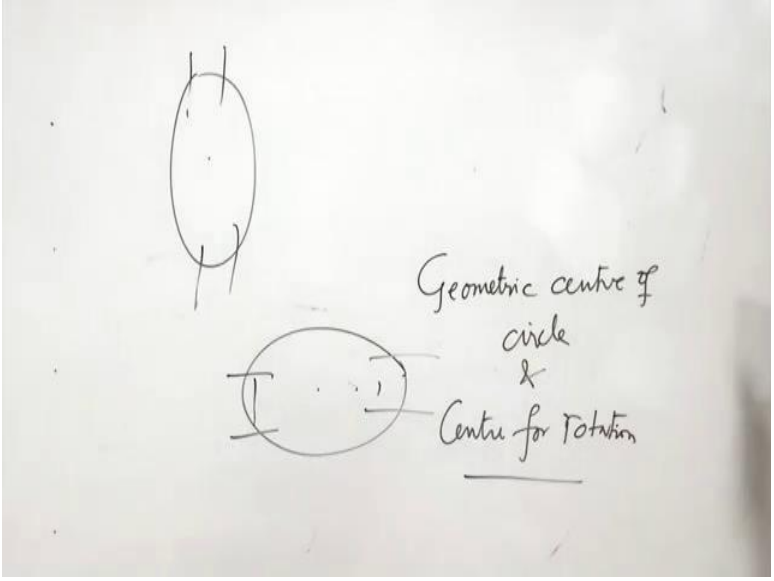

So, if there is a discrepancy between the geometric center of the circle and center for rotation, they should coincide, but if there is a discrepancy between these two then that eccentricity error comes. Of course, this eccentricity error is also not much because it is within the instrument, but this can be avoided by again by taking the average of measurements on opposite sides of the circle. So, we should try to take the measurement, some measurements in this side and some measurement in this side. So, if we take the measurement in both sides or some measurement this side, some measurement this side. So, then we can help we can taking the average we can eliminate or minimize this error.

Another error is that that is a circle graduation error. So, this type of error generally arise a low cause of total stations where these graduations may not be very fine or precise. So, there may be very minor deviation in the measurements at some location, so that will arise the circle graduation error. And these error may be horizontal circle as well as in the vertical circle. And generally we should take measurement at defined location of the circles like. So, and then we can minimize or eliminate.

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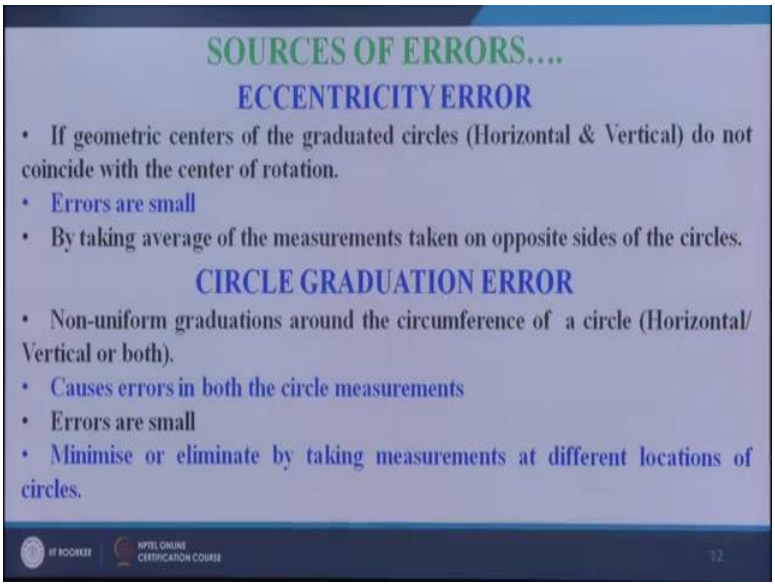

So, with this, I like to conclude this class because there are of course, there are many other errors which I will be taking up in my next class. So, primarily, I have discussed in this class about the errors associated with the total station, when there is a lock in permanent adjustment of the total station. However, most of the errors that arises out of the lock in permanent adjustment can be avoided by taking the both face measurement and the average of them.

However, in the industry, the single face measurements are rampant. So, we need to go for finding out the measure, we have need to measure as well as to remove those errors and that can be done through calibration process. And before doing any significant work or any precise work we should go for calibration of the instrument. With this, I like to conclude this class. Next class, we will be on other errors in total station.

Thank you.