MEASUREMENT OF HORIZONTAL ANGLE

Horizontal angles are measured on the horizontal circle of a theodolite by operating the upper clamp, the lower clamp, and the upper and lower tangent screws. It should be remembered that with both the clamps set, the upper plate, the lower plate, and the telescope are immobile with respect to the levelling head and tripod. With the upper clamp tight and the lower clamp loose, the two plates cannot move in relation to each other, but the telescope can sweep through 360° in the horizontal plane. With the lower clamp set and the upper one loose, the same 360° sweep is allowed, but this time the upper plate moves relative to the lower plate. This simplifies the measurement of horizontal angle between any given pointing's of the telescope.

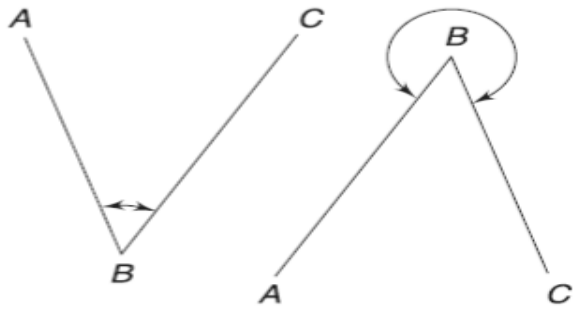
To measure a horizontal angle, say ABC, the following procedure is followed:

1. Set up the instrument over B and level it.

2. Loosen the upper clamp and turn the upper plate until the index (the arrow) of the vernier A, nearly coincides with the horizontal circle. Clamp both the plates with the upper clamp.

3. Turn the upper slow motion (tangent) screw so as to make the two zeros exactly coincident.

4. Loosen the lower clamp and direct the telescope to sight station A (Fig.).



The approximate bisection of the station is done by sighting from over the telescope through a pin-and-hole arrangement provided over its top. Clamp the plates by the lower clamp.

5. Bisect station A exactly by using the lower slow motion (tangent) screw. Exact bisection is done by bringing the station mark exactly at the intersection of horizontal and vertical hairs. The vertical circle clamp and slow-motion screws are used to achieve this.

6. Check the vernier A. It should be 0-0. Note the reading of the vernier B. It should be 180°.

7. Unclamp the upper plate, swing the telescope clockwise and bring the station C in the field of view. Tighten the upper clamp and bisect C accurately using the upper slow motion (tangent) screw.

8. Read both the verniers. The reading on vernier A directly gives the value of angle ABC. From the reading on vernier B, subtract 180° to get the value of angle ABC. Take the mean of the two values to get the value of angle ABC.

9. Change the face of the instrument and repeat the procedure. Thus, a second value of the angle ABC is obtained. The average of the two values is the required horizontal angle. A horizontal angle is measured either by the method of repetition or by reiteration.

Method Of Repetition **Measurement of Horizontal and Vertical Angle**

To measure an angle by repetition, between two stations, means to measure it two or more times allowing the vernier to remain clamped each time at the end of each measurement instead of setting it back to 0° every time when sighting at the previous station. Thus, an angle reading is mechanically multiplied by the number of repetitions. The value of the angle observed is obtained by dividing the accumulated reading by the number of repetitions. Generally, six repetitions are done, three with the telescope normal and three with the telescope inverted.

1. To measure an angle, say ABC, by the method of repetition, set up the instrument at B and level it. The telescope should be in normal position.

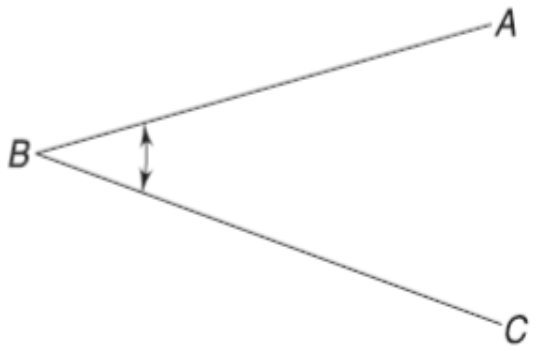
2. Loosen the upper clamp and turn the upper plate until the index (the arrow) of the vernier A coincides with the zero (or 360°) of the horizontal circle. Clamp both the plates with the upper clamp.

3. Turn the upper slow motion (tangent) screw so as to make the two zeros exactly coincident.

4. Sight station A (Fig. 4.10). Tighten the lower clamp and bisect station A exactly by the lower tangent screw. Read both the verniers.

5. Unclamp the upper plate and swing the telescope clockwise. Bisect station C by the upper clamp and tangent screw.

1. Read both the verniers. Take the average to get angle ABC. 7. Unclamp the lower plate and swing the



Horizontal angle by repetition

2. Telescope clockwise and bisect station A accurately by using the lower clamp and lower tangent screw.

3. Read both the verniers. Check the vernier reading. It should be the same (unchanged) as that obtained in step 6.
4. Release the upper plate by using the upper clamp and tangent screw and bisect station C accurately (the telescope is turned clockwise). The vernier will read twice the angle ABC.
5. Repeat the process for required number of times, say three times, and find out the value of angle ABC.

11. Repeat the above procedure with the face changed and calculate the angle ABC.

12. The average of the two values of angle ABC thus obtained with face left and face right gives a precise value of the horizontal angle.

Advantage:

1.The errors of graduations are minimised by reading the angle on different parts of the graduated circle.

2. Personal errors of bisection are eliminated.

3. The errors due to eccentricity of the centres and that of the verniers are eliminated, by reading both the verniers.

4. Error due to the line of collimation not being perpendicular to the transverse axis of the telescope is eliminated as both the face left and face right readings are taken.

Method Of Reiteration

This method of measuring a horizontal angle is preferred when several angular measurements are to be made at a station. All the angles are measured successively and finally the horizon is closed. The final reading on vernier A should be same as the initial zero. If not, the discrepancy is equally distributed among all the angles.

1. To measure angles AOB, BOC, COD and DOA (Fig.), set up the instrument at O and level it.

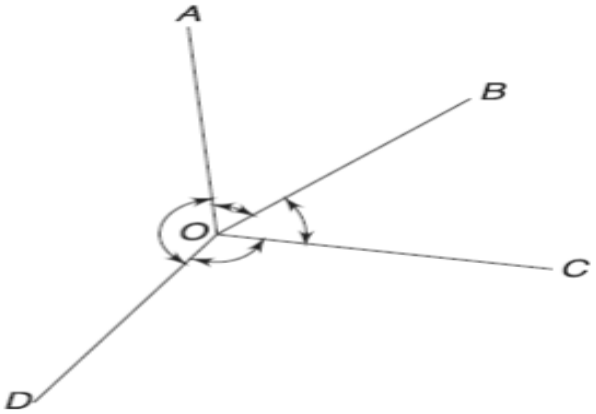
2. Set the vernier A to read zero using the upper clamp and tangent screw.

3. Direct the telescope towards A and bisect it exactly using the lower clamp and lower tangent screw. Read the two verniers A and B.

4. Unclamp the upper plate, swing the telescope clockwise and bisect B accurately, using the upper clamp and upper tangent screw. Read both the verniers.

5. Similarly, bisect stations C, D and finally A, and read both the verniers in all the cases. The last reading on vernier A should be 360°. If not, the discrepancy is noted and distributed.

6. Transit the telescope, swing the instrument in anticlockwise direction with face right and repeat the whole procedure.



Horizontal angle by reiteration

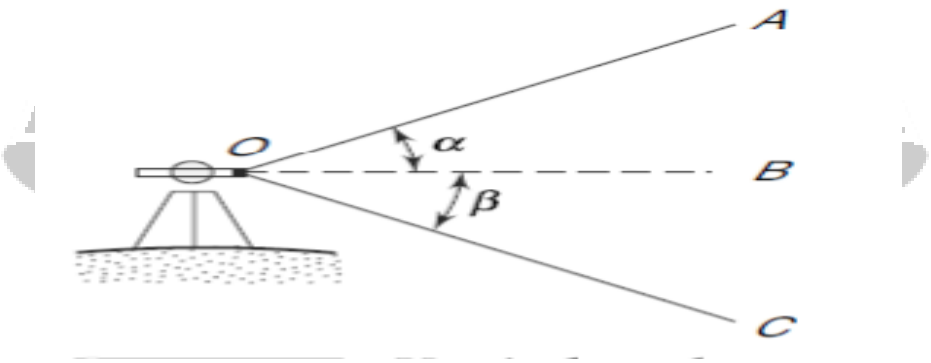
Comparison of Method of Repetition and Reiteration

The method of repetition is preferred for the measurement of a single angle and when accuracy is desired beyond the least count of the instrument with a coarsely graduated circle. On the other hand, the method of reiteration is preferred in triangulation, where a number of angles may be required at one point by the instrument with a finely graduated circle. By exercising appropriate precautions, instrumental errors can be eliminated theoretically, for either of the methods. Though the method of repetition appears to be better, it is more time consuming and chances of personal errors are more and even many repetitions may yield ordinary results.

MEASUREMENT OF VERTICAL ANGLE

A vertical angle may be defined as the angle subtended by the line of sight and a horizontal line at a station in the vertical plane.

If the point to be sighted is above the horizontal plane, the angle is called the angle of elevation (+) and if the point is below it, the angle is called the angle of depression (–).



Vertical angle Measurement

1. Suppose AOB (α), the vertical angle, is to be measured (Fig.). Set up the instrument at O and level it.

2. Using the upper clamp and upper tangent screw, set the zero of the vertical vernier to the zero of the vertical circle. Check the bubble of the altitude level which should be central. It not, bring it to the centre with the help of the clip screw. This will ensure that the instrument is in adjustment.

3. Loosen the vertical circle clamp and rotate the telescope in a vertical plane and bring

station A in the field of view. Bisect it accurately with the vertical clamping and tangent screws. Read both the verniers C and D on the vertical circle.

4. Change the face and repeat the procedure.

5. The average of the two observations gives the value of the required angle.

Errors

The sources of error in angular measurement may arise from imperfections in the adjustments and construction of the theodolite. The errors arising from imperfect adjustment of a theodolite are as follows:

Vertical Axis error (α): Axis not vertical in an observation, either from imperfect plate level adjustment, or settlement of the instrument.

Lateral collimation error (β): Line of collimation not perpendicular to the horizontal axis.

Horizontal axis error (γ): Horizontal axis not perpendicular to the vertical axis.

Vertical collimation error (δ): Line of altitude bubble not parallel to the line of collimation when the verniers of vertical circle read zero.

The above errors are often co-existent, wholly or in part in any given case. The defects in construction are usually those of eccentricity and graduations. The former can be eliminated by taking the mean of the two vernier readings, whereas the latter can be minimised by taking observations over different portions by the horizontal scale.