Surveying Engineering
Theodolite

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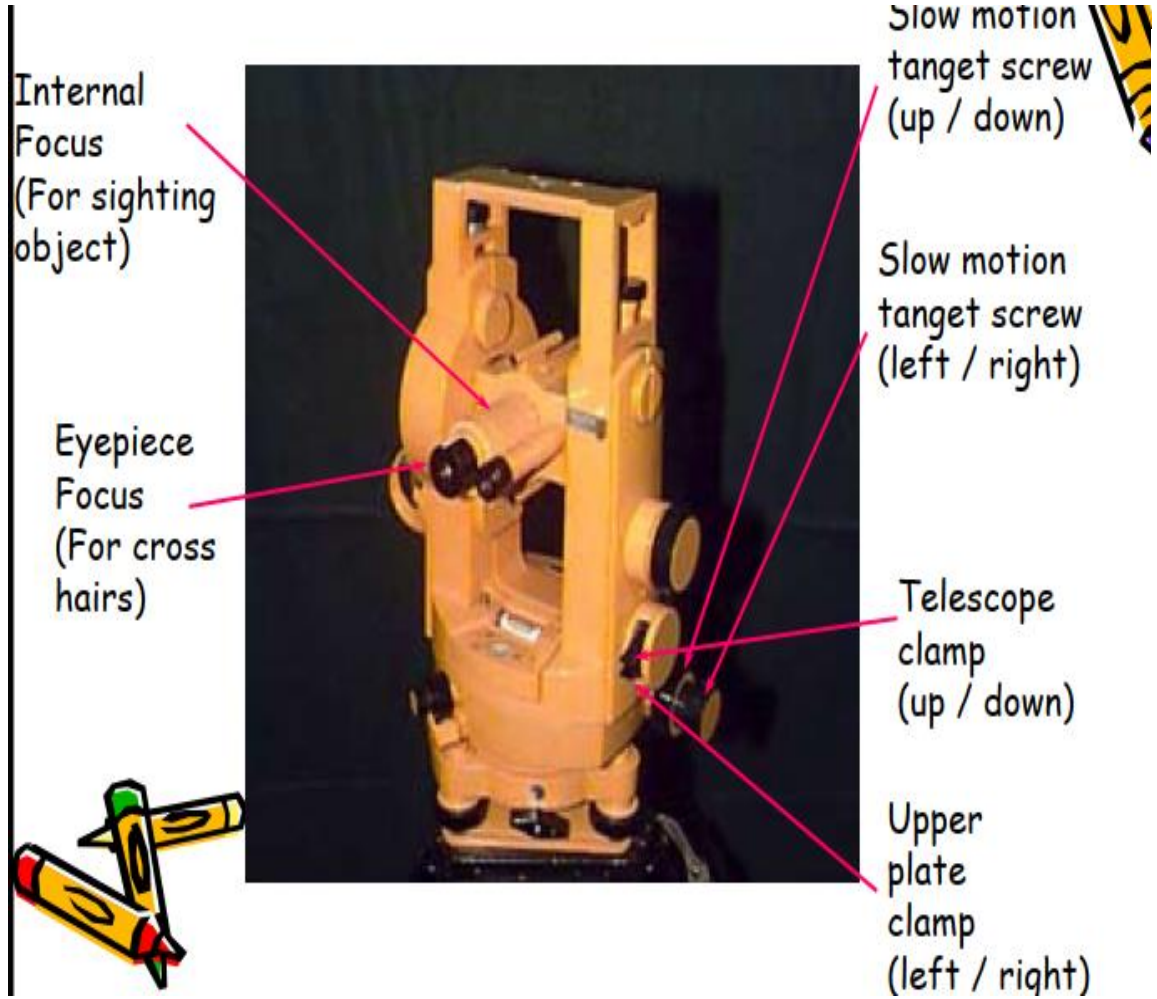
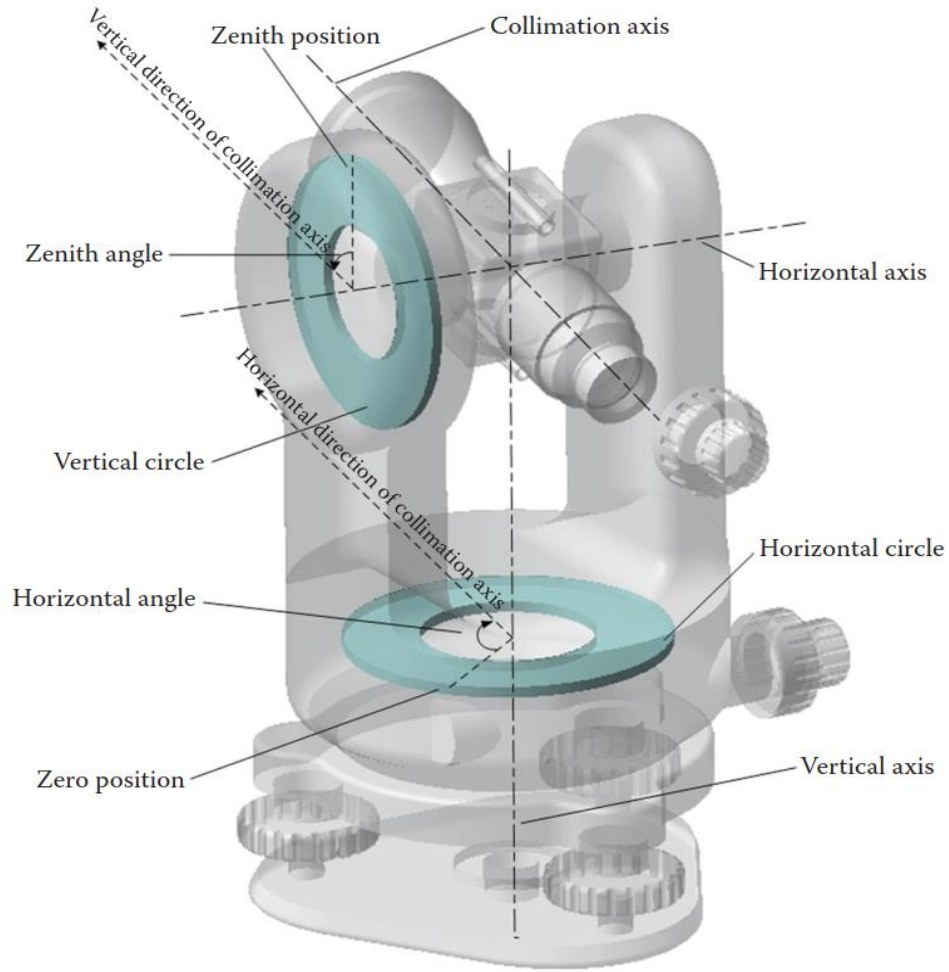
Theodolite Parts

- Telescope- It is used to see the object. It rotates about a horizontal axis in the vertical plane.
- Horizontal Circle It is used for measuring the horizontal angle.
- Vertical Circle- It is used for measuring the vertical angle.

- The lower plate The lower plate is that the base of the entire instrument. It homes the foot screws and the carrying for the vertical axis. Horizontal angles are measured with this plate.

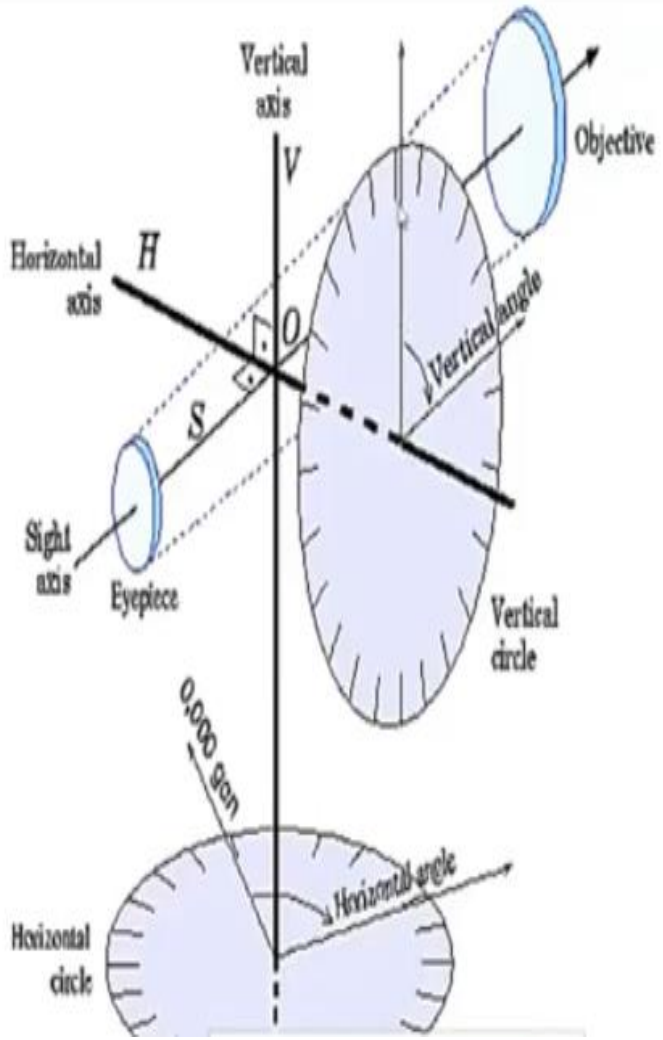

Internal Focus (For sighting object)
Eyepiece Focus (For cross hairs)
Slow motion tanget screw (up / down)
Slow motion tanget screw (left / right)
Telescope clamp (up / down)
Upper plate clamp (left / right)


Vertical direction of collimation axis
Zenith position
Collimation axis
Zenith angle
Horizontal axis
Horizontal direction of collimation axis
Vertical circle
Horizontal circle
Horizontal angle
Zero position
Vertical axis

Basic Axes of theodolite

- Optical and electronic theodolites have an identical geometric and kinematical scheme . This consists of vertical and horizontal rotation axes and the collimation axis.
- The vertical axis is the instrument rotation axis. The horizontal axis is the telescope rotation axis. The vertical rotation axis is provided with the horizontal measuring circle.
- The horizontal rotation axis is provided with the vertical measuring circle.
- The collimation axis is the line that connects the center of the telescope objective with the reticle’s crosshairs.

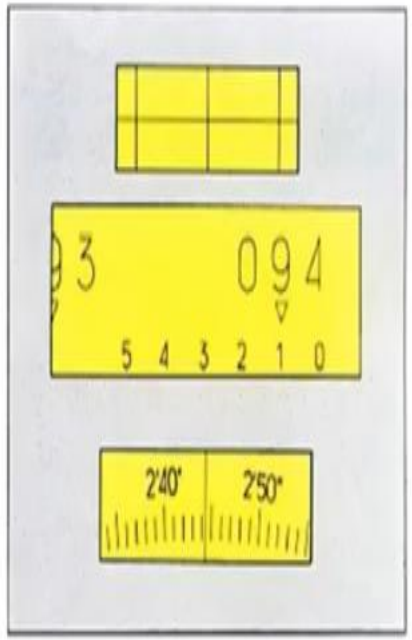

المحور الراسي
الدائرة الراسية VCR
توضيح صورة الهدف
توضيح حامل الشعرات
براغي الحركة العمودية
سريع
وبطئ
التسامت الضوئي
فقاعة التسوية الافقية
براغي الحركة الافقية سريع
وبطئ
فقاعة التسوية الدائرية
الدائرة الافقية
HCR
براغي التسوية


Vertical axis
V
Objective
Horizontal axis
H
O
Vertical angle
S
Sight axis
Eyepiece
Vertical circle
0,000 gon
Horizontal angle
Horizontal circle

التيودوليت ذو الميكرومتر

Universal-Theodolit

WILD T2



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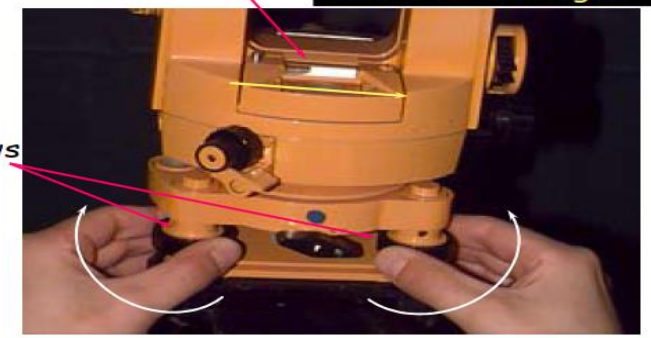
Theodolite adjustment

- The vertical axis must be set into the plumb position at the beginning of a measurement. This is carried out by the means of the foot screws on the tribrach and using a tubular level as an indicator .
- Next we rotate the instrument and place the tubular level parallel to the line connecting foot screw 1 with foot screw 2. Then we set the bubble into the center of the tubular level turning foot screws 1 and 2. Next we turn the instrument at 90° around its vertical axis and again center the bubble by the means of foot screw 3. Then we turn the instrument 180° to check adjustment of the tubular level.
- If the bubble on the tubular level moves from the center, set it halfway back to the center by the means of leveling screw 3. Now we correct the other halfway by the means of the adjusting screw. We need to be sure that the bubble is in the center by rotating the instrument at 180°. If not, repeat the adjustment. We need to repeat checking and adjusting until the bubble is in the center at any instrument position.

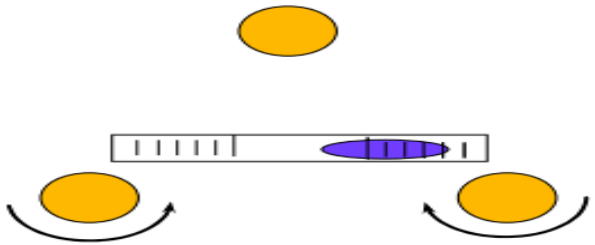
Plate Level Bubble Tube

Required to move the bubble to the right

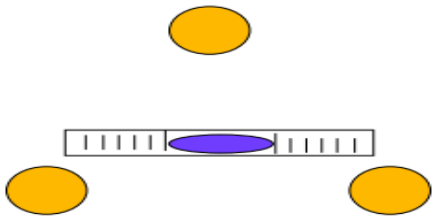
Foot Screws



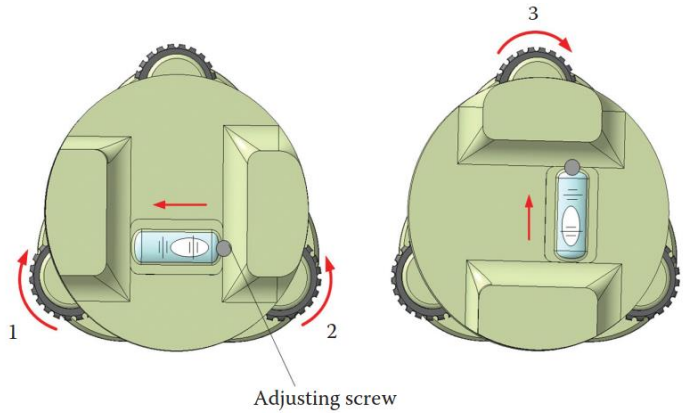
Bubble follows LEFT THUMB



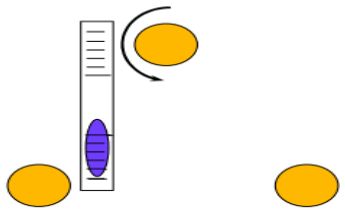
Position a



Position a

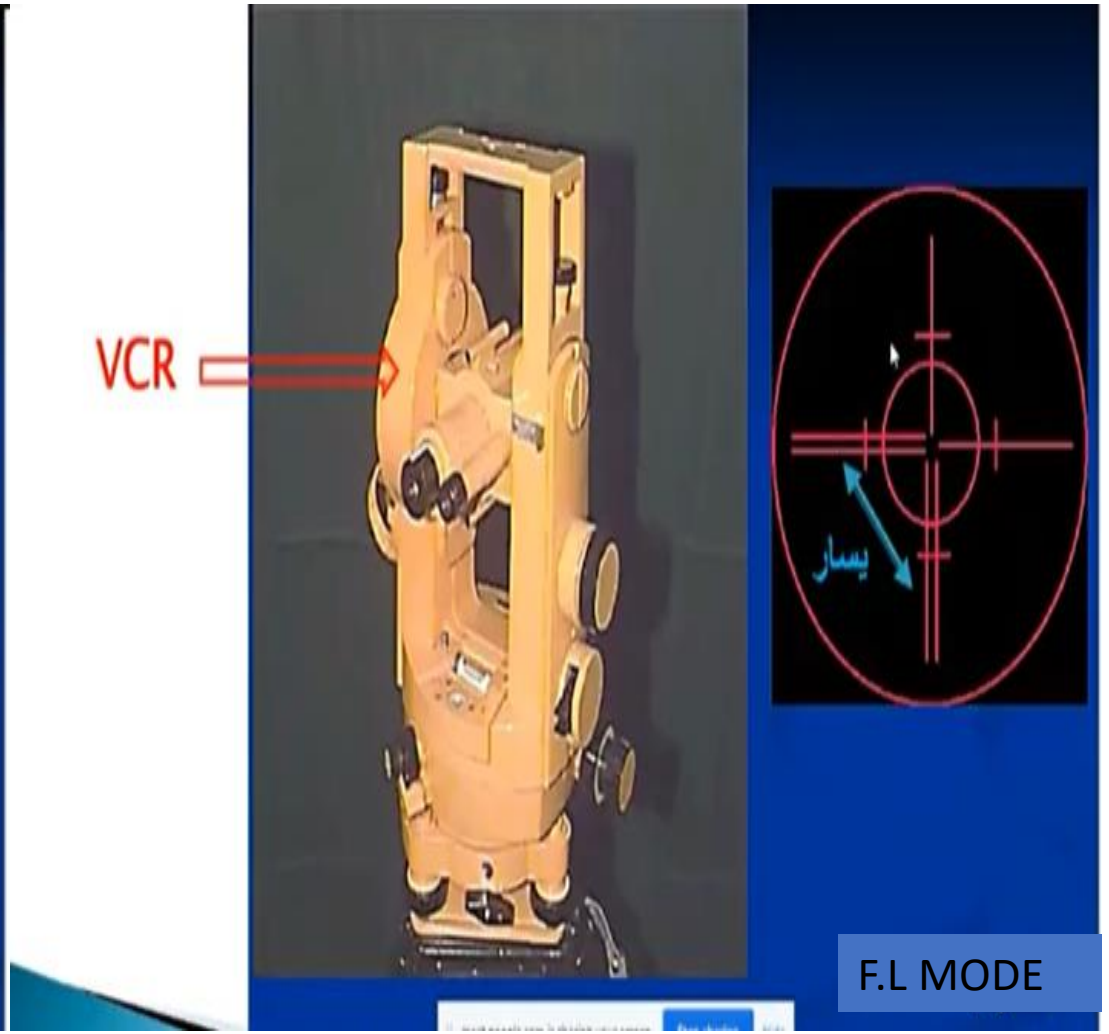


Bubble still follows LEFT THUMB



Position b
90º to position a

Theodolite measuring mode



Summary of Errors in Angle Measurements

Instrumental Errors

1. Plate bubble’s out of adjustment
2. Horizontal Axis not perpendicular to vertical axis
3. Axis of Sight not perpendicular to vertical axis (Collimation error)
4. Vertical Circle Index Error

- **Natural Errors**

1. Wind causes vibrations (difficult sightings)
2. Temperature variations cause bubbles to run
3. Refraction
4. Tripod settlement

- **Personal Errors**

1. Centering incorrectly
2. Bubbles not centered
3. Poor focusing
4. Leaning targets

- **Common Mistakes**

1. Point or Target misidentifications
2. Incorrect recordings
3. Improper focusing

Horizontal Angle Measurements

• Mean face mode Its represented the average value for the F.L & F.R mode readings for both vertical or horizontal angle . The mean face angle is represent the angle which are used later in traversing process

Calculating the F.L & F.R mean and the horizontal angle :

For this type of angle the readings values for F.L and F.R mode are given and the horizontal angle for each value as follow :

1- From the point on which the device is setting, the (F.L) value is fixed in the direction of the observed point.

2- After fixing the value of (F.L) from step (1), we change the value of (F.R) as follows:

If the given FR value is less than 180 F.R + 180

If the given FR value is greater than 180 F.R – 180

$F.R_{NEW} = F.R_{given} \pm 180°$

3-We add the value of (the variable F.R) with the value of the constant (F.L) from step No. (1) and the result of the addition is divided by (2), so the quotient represents the modified direction of the first line (mean)

4- The same steps above are applied for each direction from the device station to the observed point..

5- The horizontal angle between two directions is :

Horizontal angle = Mean later – Mean previous

Note : if the result value of the subtraction process was negative we should add 360° to get the horizontal angle value .

Example1: In the traversing works, the theodolite was used to measure horizontal angles, and the measurements were as follows:

Theodolite station	**Observed point**	**Horizontal circle reading**	
		F.L	F.R
B	A	15° 19' 40"	195° 19' 20"
	C	120° 27' 55"	300° 28' 5"

Find horizontal angle ABC value .

Solution

BA		BC	
15° 19' 40"	F.L	120° 27' 55"	F.L
195° 19' 20"	F.R	300° 28' 5"	F.R
-180°		-180°	
15° 19' 20"		120° 28' 5"	
+15° 19' 40"		+120° 27' 55"	
(30° 39' 00")/2		(240° 56' 00")/2	
BA_{mean} = 15° 19' 30"		BC_{mean} = 120° 28' 00"	

$\sphericalangle ABC = 120° 28' 00" - 15° 19' 30" = 105° 8' 30"$

Theodolite station	Observed point	Horizontal angle value		Mean	angle
		F.L	F.R		
B	A	15° 19' 40"	195° 19' 20"	15° 19' 30"	105° 08' 30"
	C	120° 27' 55"	300° 28' 5"	120° 28' 00"	

- Example2 : from the result of the observation in the below table find the value of acute angle ABC

Theodolite station	Observed point	Horizontal circle reading	
		F.L	F.R
B	A	345°20' 10"	165° 20' 40"
	C	30° 42' 20"	210° 42' 50"

- Solution: .

BA		BC	
345° 20' 10"	١. نثبت F.L	30° 42' 20"	١. نثبت F.L
165° 20' 40"	٢. نغير F.R	210° 42' 50"	٢. نغير F.R
+180°		-180°	
345° 20' 40"		30° 42' 50"	
+345° 20' 10"		+30° 42' 20"	
(690° 40' 50")/2		(61° 25' 10")/2	
BA_{mean} = 345° 20' 25"		BC_{mean} = 30° 42' 35"	

$\sphericalangle ABC = 30° 42' 35" - 345° 20' 25" = - 314° 37' 50" + 360°$

➔ $\sphericalangle ABC = 45° 22' 10"$

Theodolite station	Observed point	Horizontal angle value		Mean	angle
		F.L	F.R		
B	A	345°20' 10"	165° 20' 40"	345° 20' 25"	- 314° 37' 50"
	C	30° 42' 20"	210° 42' 50"	30°42' 35"	= 45° 22' 10"

Theodolite station	Observed point	Horizontal angle value		Mean	angle
		F.L	F.R		
B	A	345°20' 10"	165° 20' 40"	345° 20' 25"	- 314° 37' 50"
	C	30° 42' 20"	210° 42' 50"	30°42' 35"	= 45° 22' 10"

Example 3: In traversing works a theodolite device were used for measuring the horizontal angles and the values was as follow :

Theodolite station	Observed point	Horizontal circle reading	
		F.L	F.R
B	A	00° 03' 20"	180° 03' 10"
	C	31° 25' 20"	211° 25' 40"
C	B	275° 10' 20"	95°10' 12"
	D	45° 46' 10"	225° 46' 18"

Find the values of angles ABC & BCD.

Solution:

Theodolite station	Observed point	Horizontal angle value		Mean	angle
		F.L	F.R		
B	A	00° 03' 20"	180° 03' 10"	00° 03' 15"	31° 22' 15"
	C	31° 25' 20"	211° 25' 40"	31° 25' 30"	
C	B	275° 10' 20"	95°10' 12"	275° 10' 16"	130° 35' 58"
	D	45° 46' 10"	225° 46' 18"	45° 46' 14"	

Angle ABC = 31° 22' 15"

Angle BCD = 130°35' 58"

End of lecture…
Questions and Answers?