Mustansiriyah University
College of Engineering
Highway and Transportation Engineering Department

Engineering Surveying Laboratory

Second Year - First Semester

Experiment 3

Level Setup and Staff Reading



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General Objective

To develop students skills in setting up a level, reading a leveling staff, and determining horizontal distances.

Learning Objectives

By the end of this experiment, students will be able to:

1. Identify the main components of the level and their functions.
2. Set up and level the instrument on a tripod.
3. Focus the telescope and eliminate parallax.
4. Read and record the upper, middle, and lower staff readings.
5. Calculate the horizontal distance and check the consistency of the staff readings.

Introduction

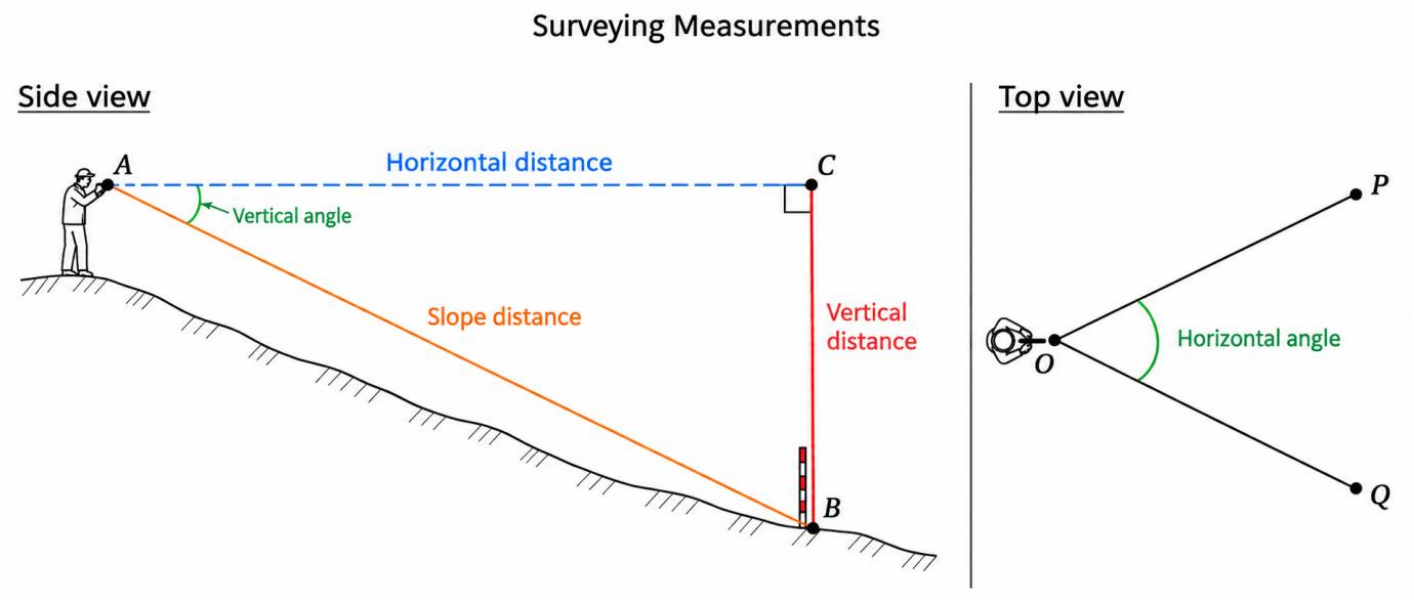
Leveling is a basic surveying operation used to determine elevations and differences in elevation for engineering projects. In this experiment, students set up a level, adjust its circular bubble, and focus the telescope to read a leveling staff. The readings are recorded and used to calculate the horizontal distance and check their consistency, emphasizing the importance of correct setup and reading procedures.

Experiment 3: Level Setup and Staff Reading

Surveying Measurements

There are five basic kinds of measurements in plane surveying:

1. Horizontal angles
2. Horizontal distance
3. Vertical angles
4. Vertical distance
5. Slope distance



By using combinations of these basic measurements, it is possible to compute relation positions between any points. Measurement of distances and angles it is the essence surveying.

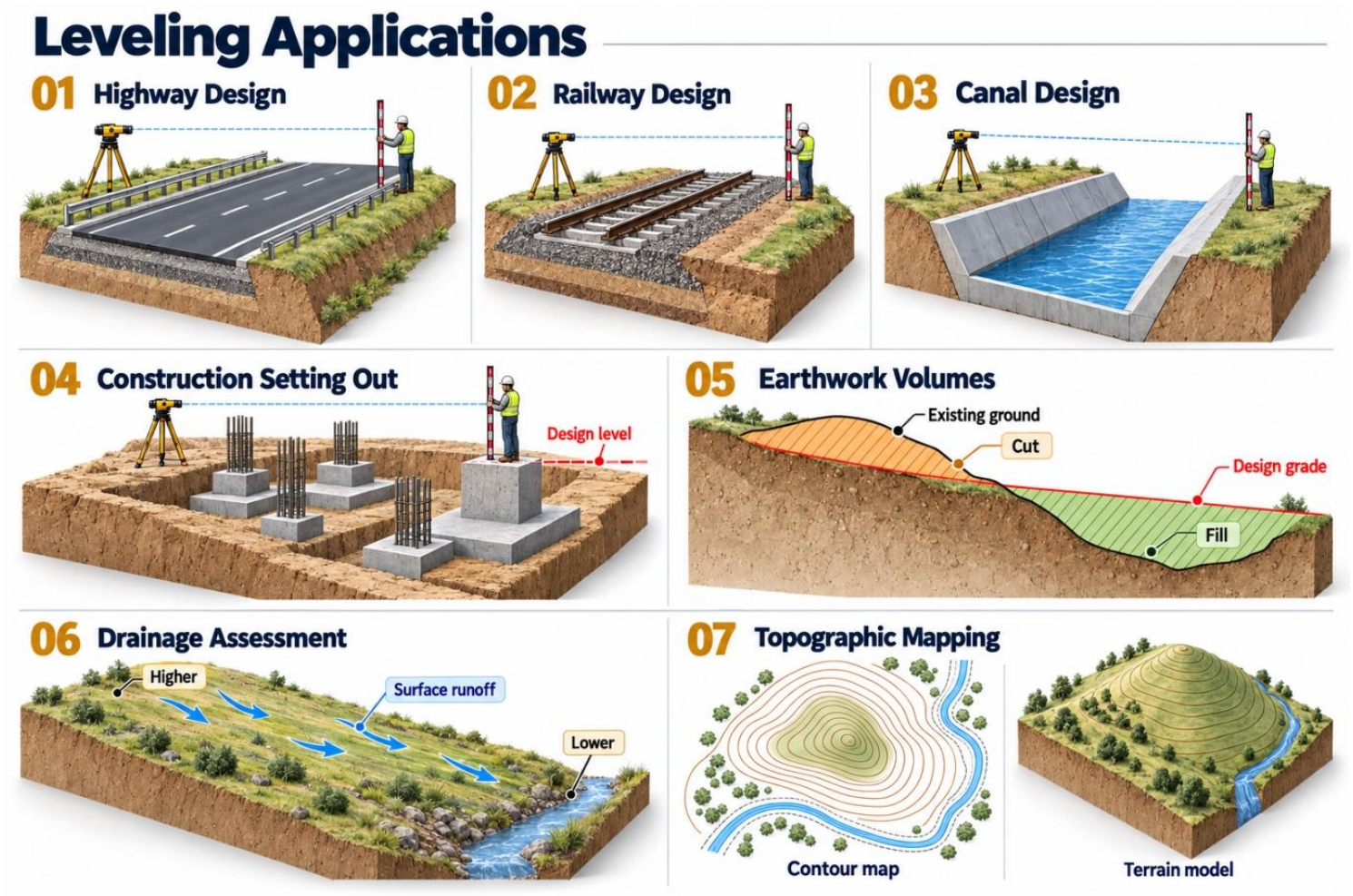
Asst. Lect. Hussein Mohammed Noor / Asst. Prof. Teba Tariq /Asst.Prof: Areej Muhy

Leveling and Applications

Leveling is the general term applied to any of the various processes by which elevations of points or differences in elevation are determined. It is a vital operation in producing necessary data for mapping, engineering design, and construction.

Leveling results are used to:

- Design highways, railroads, canals, sewers etc.
- Layout construction projects according to planned elevations.
- Calculate volume of earthwork and other materials.
- Investigate drainage characteristics of the area.
- Develop maps showing ground configuration.



Purpose

To identify the main components of the level instrument, set up the level, and take readings on a leveling staff.

Equipment:

1. Level instrument (جهاز التسوية)



2. Tripod (الحامل الثلاثي)



3. Staff (المسطرة)




EXPLODED VIEW
TOPCON
Conceptual illustration

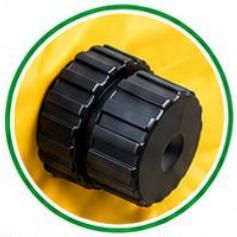
AUTOMATIC LEVEL

Main Components and Functions



1. Objective Lens

Forms the image of the staff.



2. Focusing Screw

Used to obtain a sharp and clear image.



3. Sighting Guide

Helps aim the telescope at the staff.



4. Eyepiece

Focuses the crosshairs for the observer.





5. Circular Bubble

Indicates approximate leveling of the instrument.



6. Horizontal Tangent Screw

Provides fine horizontal aiming.



7. Horizontal Circle

Provides horizontal angle readings.



8. Leveling Screws

Center the bubble by adjusting the instrument.

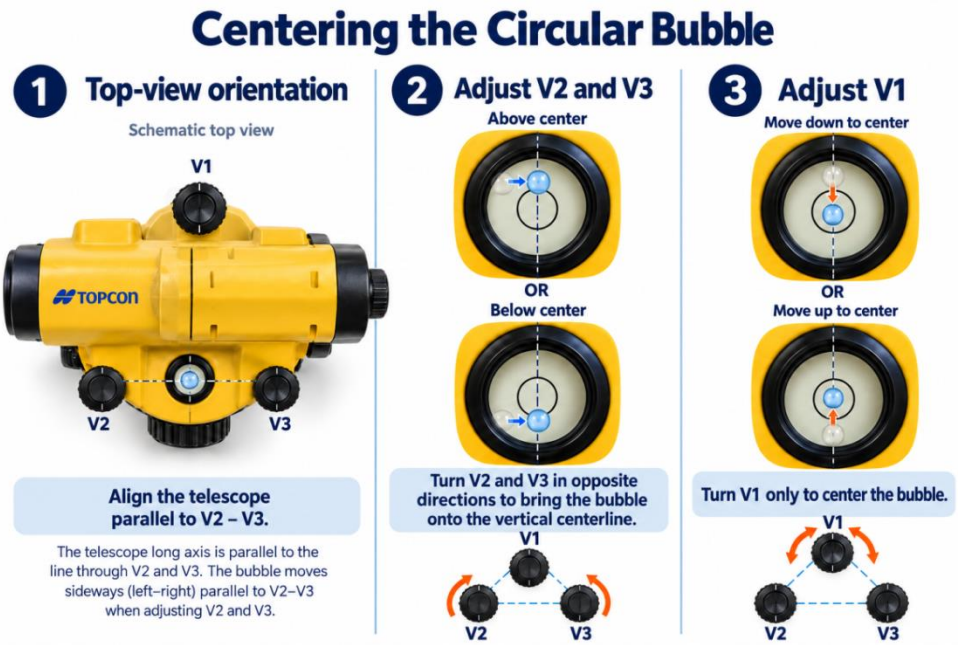
Procedure of setting up level (ضبط افقية جهاز التسوية)

1. Screw the lower plate of the instrument on the head of the tripod.

تثبيت قاعدة جهاز التسوية على سطح الحامل الثلاثي للجهاز بواسطة البرغي الموجود

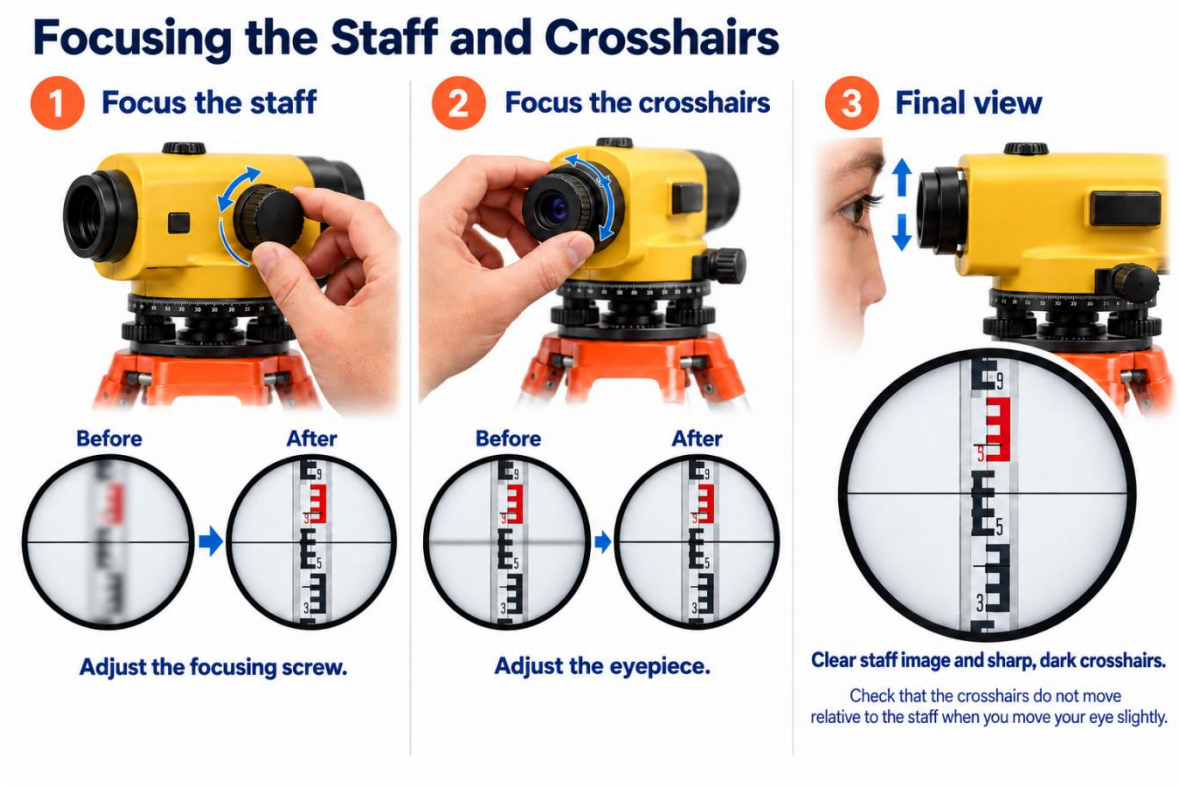


2. The circular bubble should be brought to its central position using the foot screws. if using an instrument fitted; with foot screws the best procedure is as follows. By rotating foot screws (V2) and (V3) in opposite directions at the same time the bubble can be set on the line V1V́1.
Now, by rotating foot screw (V1) only, the bubble can be centered in the target ring.
تضبط استوائية الجهاز وافقيته بواسطة ثلاث براغي (V1,V2,V3) كما موضح في الشكل ادناه.بعد وضع تلسكوب الجهاز بشكل يوازي اثنين من البراغي (V2,V3) عندها يتم تدوير البرغيين معا بشكل معاكس اما للداخل او للخارج بحيث تكون موقع الفقاعة اما فوق اوتحت وباتجاه محور البرغي الثالث (V1) بعد ذلك يتم تدوير البرغي الثالث بمفرده اما للداخل او الخارج لحين دخول الفقاعة في منتصف الدائرة وبهذا يكون الجهاز قد اكمل ضبط استوائيته.



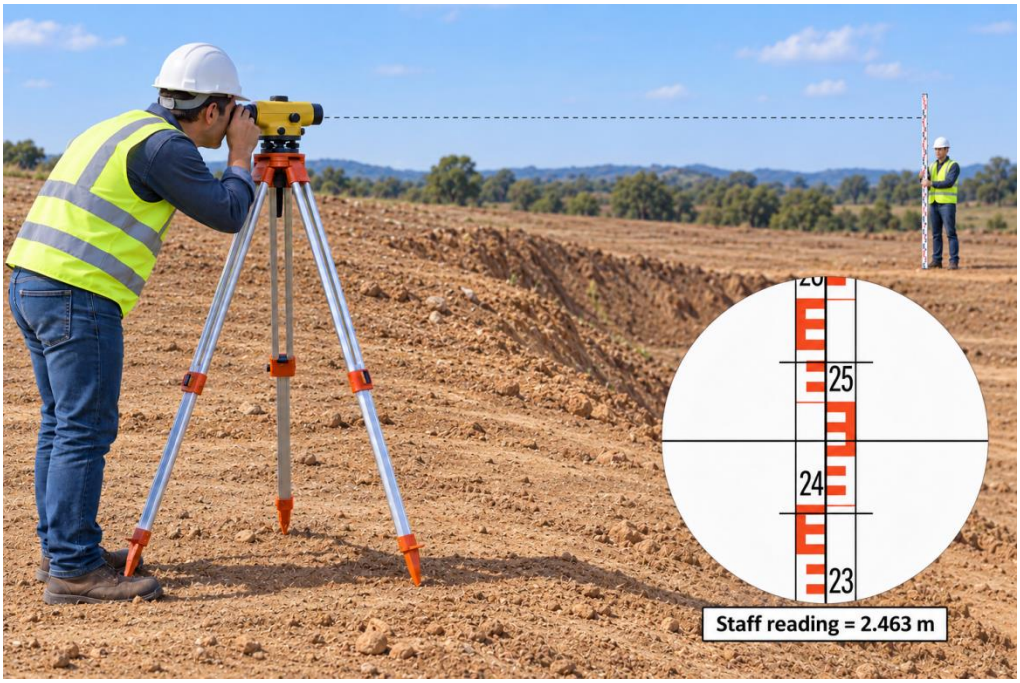
3. It is essential that parallax between the cross hairs and the image of the leveling staff be eliminated stadia surveying by level.

من الضروري توضيح رؤية المسطرة من خلال برغي **توضيح الصورة** وبرغي **توضيح الشعيرة**



4. Sight on the staff and record readings (upper, middle, and lower)

بعد ضبط الجهاز يمكن البدء بقراءة المسطرة



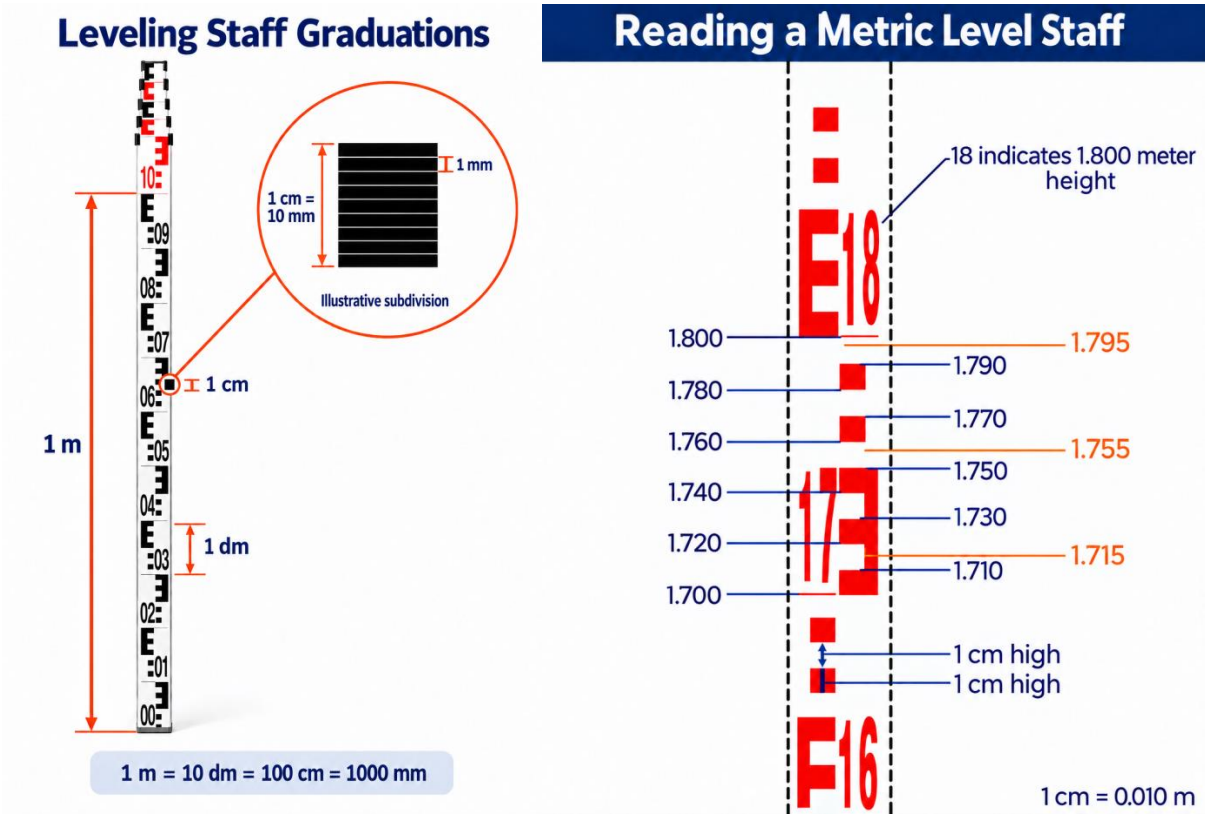
For more information, watch this **YouTube** video.

https://youtu.be/A_dQj9jDXJ4?si=FE5q0hIcQea221Rf

Staff Reading

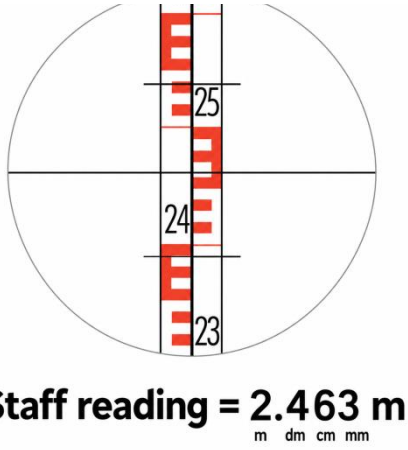
The leveling staff has a total length of 5 m and is divided into five one-meter sections, with graduations alternating between **red** and **black** for successive meters. Each meter (m) is divided into 10 decimeters (dm), and each decimeter (dm) into 10 centimeters (cm). Each centimeter (cm) equals 10 millimeters (mm), which are estimated visually between the centimeter graduations. The first figure illustrates the graduations of the leveling staff, while the second figure presents examples of staff readings.

يبلغ الطول الكلي لمسطرة التسوية 5 أمتار، وهي مقسّمة إلى خمسة أقسام، طول كل منها متر واحد، وتُميَّز تدريجاتها باللونين **الأحمر** و**الأسود** بالتناوب لكل متر. ويُقسَّم كل متر إلى 10 ديسيمترات، وكل ديسيمتر إلى 10 سنتيمترات. ويعادل كل سنتيمتر 10 مليمترات، تُقدَّر بصريًا بين التدريجات. يوضّح الشكل الأول تدريجات مسطرة التسوية، بينما يعرض الشكل الثاني أمثلة على قراءتها.



For more information, watch this **YouTube** video.

https://youtu.be/2MNEBrntFf8?si=cj8G1hX5M4Wdcabx



Horizontal Distance Measurement Using a Level and Staff

To determine the horizontal distance between the level and the staff position, record the upper and lower stadia hair readings and use the following equation:

لتحديد المسافة الأفقية بين جهاز الليفل وموقع المسطرة، تُسجَّل قراءتا الشعيرتين العليا والسفلى، وتُستخدم المعادلة الآتية:

H = (U − L) × 100
Where:
H: Horizontal distance in meters.(المسافة الأفقية بالمتر)
U: Upper stadia hair reading in meters. (قراءة الشعيرة العليا بالمتر)
L: Lower stadia hair reading in meters.(قراءة الشعيرة السفلى بالمتر)

This equation assumes a multiplying constant of 100 and an additive constant of zero.

تفترض هذه المعادلة أن ثابت الضرب يساوي 100 وثابت الجمع يساوي صفرًا.

Checking the Consistency of Staff Readings

للتاكد من المسطرة بشكل عمودي وغير مائل باي اتجاة والجهاز بوضع مستوي والقراءة صحيحة نتحقق من مايلي:

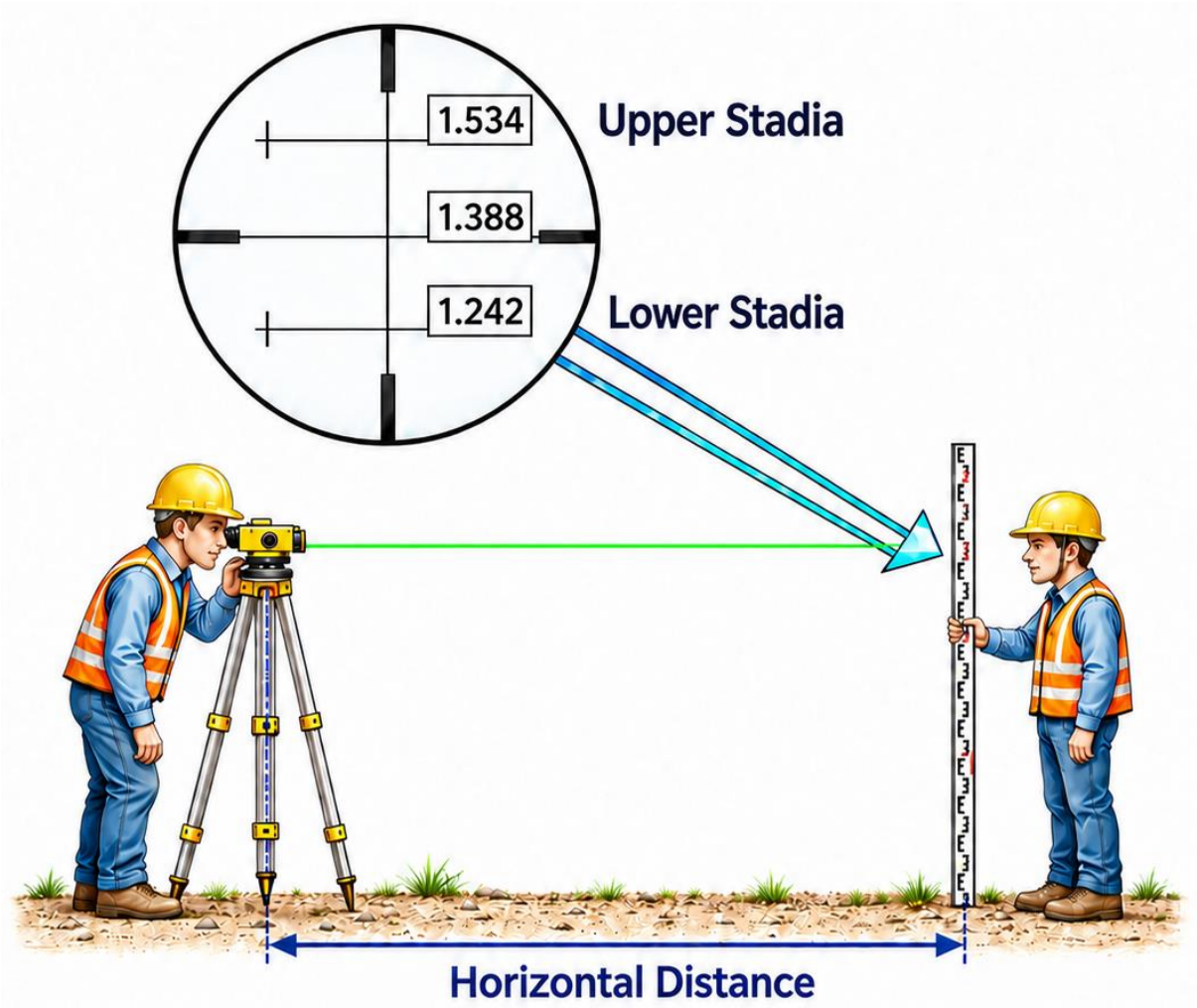
The middle crosshair reading should approximately equal the average of the upper and lower stadia hair readings:

يجب أن تساوي قراءة الشعيرة الوسطى تقريبًا متوسط قراءتي الشعيرتين العليا والسفلى:

M ≈ (U + L) / 2
M: Middle crosshair reading in meters.(قراءة الشعيرة الوسطى بالمتر)
This check alone does not confirm that the staff is vertical or the instrument is level; both must be checked separately.

لا يكفي هذا التحقق وحده للتأكد من عمودية المسطرة أو أفقية الجهاز؛ إذ يجب التحقق من كلٍّ منهما بصورة مستقلة.

Example



Upper Stadia Reading = 1.534 m
Middle Crosshair Reading = 1.388 m
Lower Stadia Reading = 1.242 m
Difference in Stadia Readings = 1.534 – 1.242
= 0.292 m

Horizontal Distance = Difference × Multiplying Factor
= 0.292 × 100
= 29.2m

Middle Reading Check = (1.534 + 1.242) / 2
= 1.388 m ✓

Distance to the Staff = 29.2m

Data Sheet

Experiment 3: Level Setup and Staff Reading

Student Name: Date: / /

	Readings				
Upper Stadia Hair					
Middle Stadia Hair					
Lower Stadia Hair					

Group Names

No.	Student Name
1	
2	
3	
4	
5	
6	
7	
8	

Supervisor signature