Northern Technical University (NTU)
Technical college of Kirkuk (TCK)
Surveying Engineering Department

1st class

SURVEYING I

Lecture One:
Introduction to Surveying

lecturer: Sumaya Falih Hasan
Sumaya.h.falh @ntu.edu.iq

Outline

1.1 Definitions

1.2 Types of surveying

1.3 Classification of surveying

1.4 Measurements in surveying •

1.1 Definitions

1-Surveying. is the science of measuring distance, angles, and positions, on or near the surface of the earth.it is an art in that only a surveyor who possesses a thorough understanding of surveying techniques will be able to determine the most efficient methods ,required to obtain optimal results over a wide variety of surveying problems.

1.2 Types of surveying

Plane surveying	Geodetic surveying
Effect of the curvature of the earth surface is ignored.	Effect of the curvature of the earth surface is included.
The earth surface is assumed to be plane, i.e. two dimensional.	The earth surface is assumed to be spherical, i.e. three dimensional.
Involves smaller areas less than about 260 km2.	Involves larger areas more than about 260 km2.
Lower degree of accuracy.	Higher degree of accuracy.

1.3 Classification of surveying

1- Classification based up on the nature of the field:

- **Land surveys**

a. Topographical surveys.

b. Cadastral surveys.

c. City surveys.

- Hydrographic surveys.
- Astronomical surveys.

2- Classification based on the purpose of the surveys:

a) Engineering surveys.

b) Mine surveys.

c) Geological surveys.

d) Industrial surveys.

3. Classification based on instrument used:

a) Chain surveying.

b) Theodolite surveying.

c) Compass surveying.

d) Plane table surveying.

e) Tachometric surveying.

f) Triangulation surveying.

g) Photogrammetric surveying.

1.4 Measurements in surveying

There are two kinds of measurements used in plane surveying:-

1) Linear measure [Horizontal or vertical distance].

Linear measurements may be taken in the horizontal plane such as horizontal distance or in the vertical plane such as heights or depths. The instruments which are used in linear measurements are chain, tape…etc.

system	Metric system	English system
Units of length measurement	1 centimeter=10 millimeters 1 decimeter=10 centimeters 1 meter=10 decimeter 1 meter=100 centimeter 1 km =1000 m	1 foot=12 inches 1yard=3feet 1 mile=5280feet 1 mile=1760 yards 1 meter=3.2808 ft I foot=0.3048m 1 inch=25.4mm 1km=0.62137miles 1 chain=66 feet 1 mile=80 chains
Units of area measurement	1 hectare= 10000 m^2 100 acre =1 hectors. 1 km^2=1000000m^2 1 km^2.=100 hectometer 10 ULK = 100 m^2 1 donam = 2500 m^2 1 km = 400 don am.	1 acre= 100 m^2 1 acre= 43560 ft^2 1 hectors= 100 acre 1 km^2=247.1acres 1sq yard=9 ft^2
Units of volume measurement	Cubic centimeters, cubic meters……etc.	Cubic inches, cubic feet, cubic yards

2) Angular measure   [Horizontal or vertical angles].

Angular measurements may be taken in the horizontal and vertical plane such as horizontal angles and vertical angles. The instruments which are used in angular measurements are compass, total station theodolite…etc.

A- Sixagesmial system of angular measurements:(degree system)

In this system, the circumference of a circle is divided in to 360 equal parts each part is known as one degree.

1 circumference = 360 of arc

1 degree = 60 minutes of arc

1 mint = 60 seconds of arc.

B- Centesimal system of angular measurements: (grad system)

In this system the circumference of a circle is divided in to 400 equal. Each part is known as one grad.

1 circumference = 400 grads

1 grads = 100 centigrade

1 centigrade = 100 cencentigrads

C- Radian system:

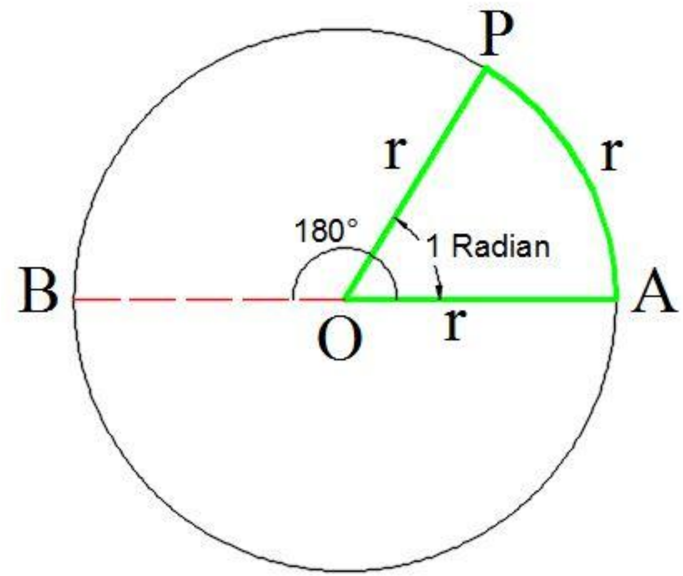
The difference in direction of two intersecting lines, or it is the inclination of two straight lines. The radian is defined as the measure of the angle between two radian of circle which contains an arc equal to the radius on the circumference of the circle.

Angle AOP/ Angle AOB= Arc AP /Arc APB

1 Radian /180°= r/π r

1 Radian = 180°/π , π=3.14259

1 Radian = 57.29577951 °



Example :convert the following:

1- 45°17´22" to radian units
2- 0.65447 to grad units

<u>Solution :</u>

<u>HOMEWORK(H.W1)</u>
Convert the angle θ=82°33´50.5" to
1-radian system
2-grad system

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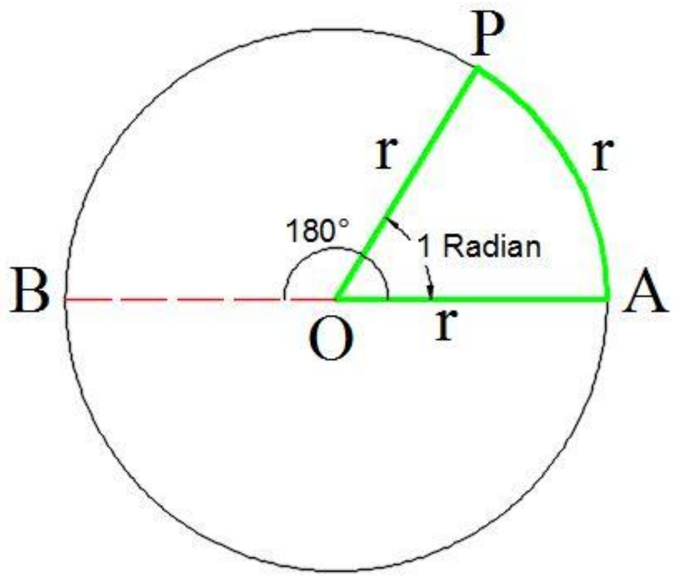

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SURVEYING I

Lecture two:

-Scales

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Outline

Scales

Types of scales

1) Numerical scales

1.1 A word scales (Engineers scales)

1.2 Fraction scales (R.F)

2) Graphical scale

2.1 Linear or plain scale

2.2. Diagonal scales

Scales:

Is the fixed relation that every distance on the map bears to the corresponding distance on the ground.

The scale can be defined as the ratio of the plotted distance on the map to the ground distance.

$$\text{Scale (s)} = \frac{\text{distance on the map}}{\text{distance on the ground}}$$

1-topographic maps = $\frac{1}{250000}$ to $\frac{1}{25000}$

2-large scale maps = $\frac{1}{10000}$ to $\frac{1}{20000}$

3-location maps = $\frac{1}{2500}$ to $\frac{1}{500}$

4-cadastral maps = $\frac{1}{1000}$ to $\frac{1}{500}$

Types of scales:

There are two types of scales:

1) Numerical scales.

1.1 A word scales (Engineers scales).

(1 cm = 5 m)

1.2 Fraction scales (R.F)

One unites of length on the plan represents same number of same units of length on the ground for example 1: 500, 1: 1000.

To convert an engineer's scale in to fraction scale multiply the whole number of meters by 100 similarly a fraction scale may be converted in to engineer's scale by dividing the denominator on by 100

$$\frac{1}{10 \times 100} = \frac{1}{1000}$$

Or 1 / 1000

Or 1: 1000

The distance (250 m) on the ground: -

$$250 \times \frac{1}{1000} = 0.25 \text{ m} = 25 \text{ cm on the map .}$$

Area $250 \times \frac{1}{1000} \times \frac{1}{1000} = 0.0025 \text{ m}^2 = 2.5 \text{ m}^2 \text{on the map .}$

Volume (250m ^{2}) on the ground: -

$$250 \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} = 0.00000025 \text{m}^3$$

$$= 0.25 \text{ cm}^3 \text{on the map .}$$

The selection of a proper scale depends on the following factors.

Extent of survey.

- Purpose of the survey.
- Accuracy required
- The size of the sheet to contain that surveying. The following are the same of the scales recommend for survey map

:

Type or purpose of survey	*Scale*	*R.F.*
(a) Topographic Survey		
1. Building sites	1 cm = 10 m or less	$\frac{1}{1000}$ or less
2. Town planning schemes, reservoirs etc.	1 cm = 50 m to 100 m	$\frac{1}{5000}$ to $\frac{1}{10000}$
3. Location surveys	1 cm = 50 m to 200 m	$\frac{1}{5000}$ to $\frac{1}{20000}$
4. Small scale topographic maps	1 cm = 0.25 km to 2.5 km	$\frac{1}{25000}$ to $\frac{1}{250000}$
(b) Cadastral maps	1 cm = 5 m to 0.5 km	$\frac{1}{500}$ to $\frac{1}{5000}$
(c) Geographical maps	1 cm = 5 km to 160 km	$\frac{1}{500000}$ to $\frac{1}{16000000}$
(d) Longitudinal sections		
1. Horizontal scale	1 cm = 10 m to 200 m	$\frac{1}{1000}$ to $\frac{1}{20000}$
2. Vertical scale	1 cm = 1 m to 2 m	$\frac{1}{100}$ to $\frac{1}{200}$
(e) Cross-sections		
(Both horizontal and vertical scales equal)	1 cm = 1 m to 2 m	$\frac{1}{100}$ to $\frac{1}{200}$

2) Graphical scale:

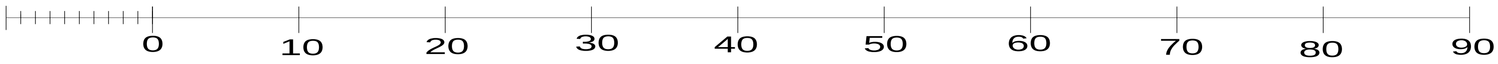
A graphical scale is a line sub-divided in to plan distance corresponding to same units of length on the surface of the earth.

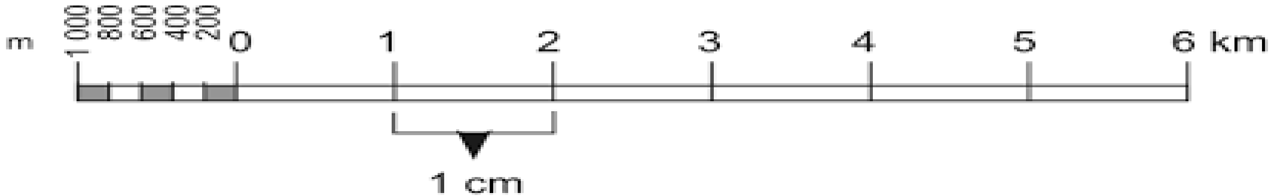
The classifications of scales:

The scales drawn on maps or plans may be classified as follows:-

1-Plain scale.
2-Diagonal scale.

2.1 Linear or plain scale: is one on which it is parallel to measure only two dimensions, such as meters and decimeters, the first part is sub-divided in to equal parts.

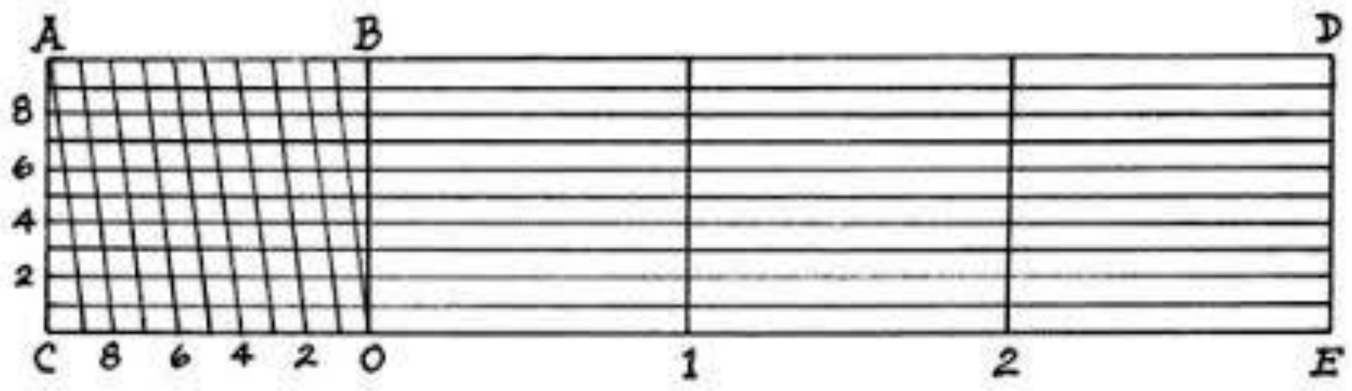




2.2. Diagonal scales:

This scale is used for the purpose of specifying short lengths that cannot be determined by the linear scale, when it is possible to obtain an accuracy greater that can be obtained by the linear scale.

It is possible to read in units and the one-tenth and one-hundred parts i.e.,meters, decimeter and centimeters.



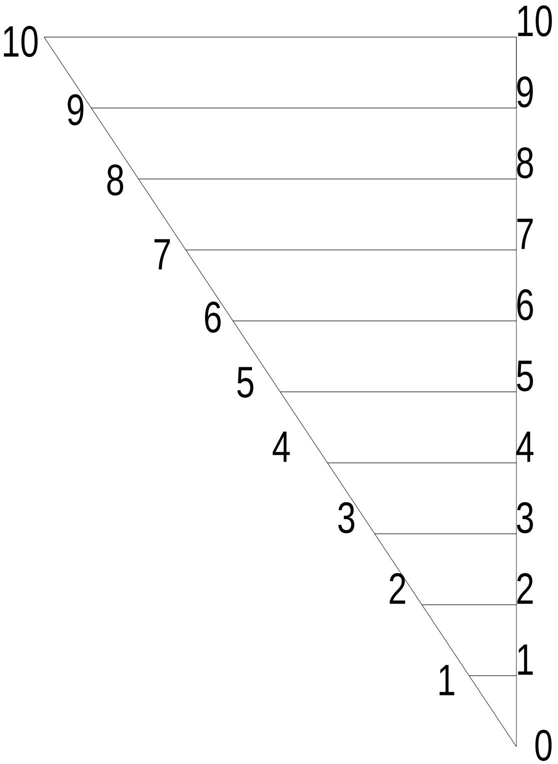
2.2.1 Principle of diagonal scale:

The construction of a diagonal scale is based on the principle of similar triangles in which like sides are proportional

1-1' = $\frac{1}{10}$ of AB

2-2' = $\frac{2}{10}$ of AB

9 -9' = $\frac{1}{10}$ of AB



Ex:1

What is the R.F of the following scales:

1- 1cm= 8m

2- 1cm= 100m

3-1cm= 4Km

Solution:

Ex:2

Construct a plain scale (linear scale)if the R.F equal to(1/1000)and read to (2m) and show a distance of (22m) and (46m)on it?

Solution:

Ex:3

Construct a diagonal scale if (R.F.=1/1000) and read to (0.5m)and show a distance of (22.5m,47.5m)on it?

Solution:

Ex:4

An area of (36 cm^2)of a map represents on area of (2304 m^2).what is the R.F.?

Solution:

<u>Homework 2:</u>

1:construct a linear scale for (R.F.=1/500) read to (1m) and show the following reading (26m,39m, an 41m)on it.

2: draw a diagonal scale for (R.F.=1/2500)read to (0.5m)and show (36.5m,57.5 and 82.5m) on it.

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SURVEYING I

Lecture three :

Obstacles

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Obstacles in chaining:

Various obstacles by any one of these methods:

1)Those which obstruct ranging but not chaining.(e.x. high level ground).

2) Those which obstruct chaining but not ranging.(e.x. river, pond)

3) Those which both ranging and chaining.(e.x. building)

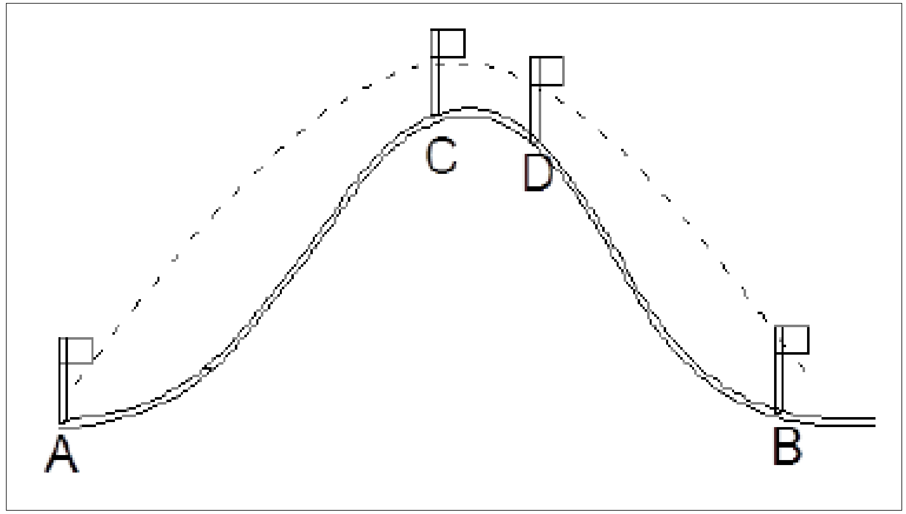
1) Obstacles which obstruct ranging but not chaining:

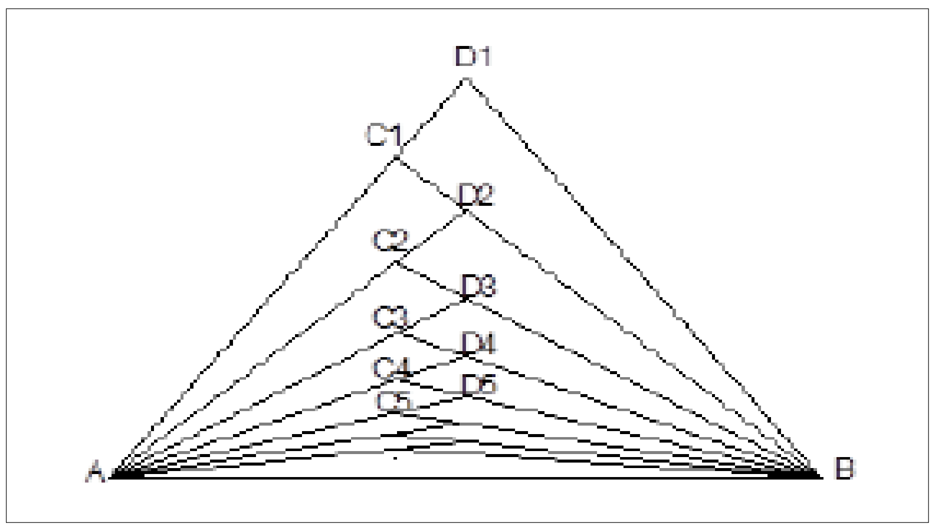
Two cases may occur:

a) Both ends are visible from intermediate points on the line.

b) Both ends may not be visible from intermediate point on the line.

Difficulties faced in both cases may be overcome by reciprocal ranging and random line methods.


C
D
A
B


D1
C1
D2
C2
D3
C3
D4
C4
D5
C5
A
B

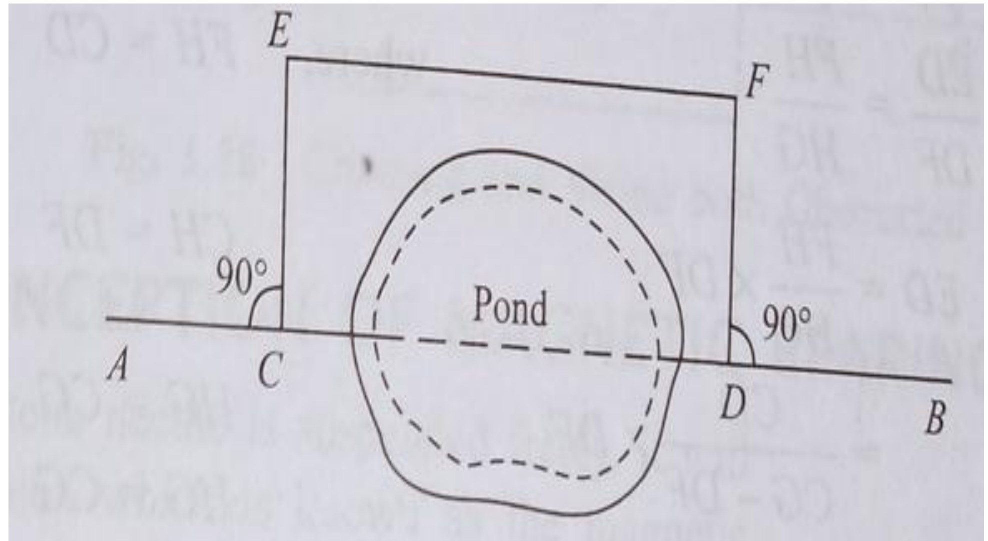
2) Obstacles to chaining but not ranging

The typical types of obstruction under this category are such as water bodies i.e. , lakes , ponds , rivers , hills , etc. , where the distance between two convenient points on the survey line on either side of the obstacle is required to be determined : - There may be two cases : -

Case (I) when it is possible to chain round the obstacle, **e.x. pond**.

Case (II) when it is not possible to chain round the obstacle **e.x. river**.

Case (I) when it is possible to chain round the obstacle

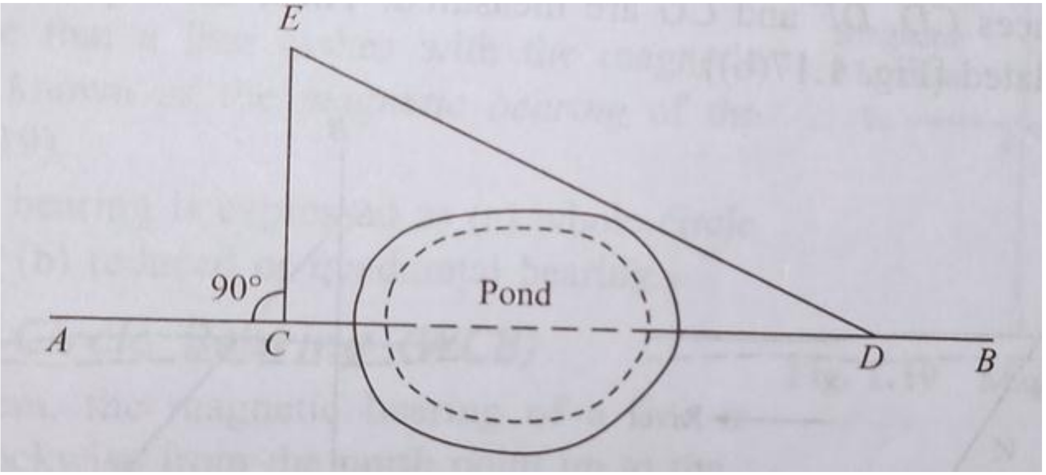


Method (a):

- Select two points **A** and **B** on either side.
- Set out equal perpendiculars AC and BD.
- Measure CD;
- then CD = AB
- Length of line AB= AC+CD+DB

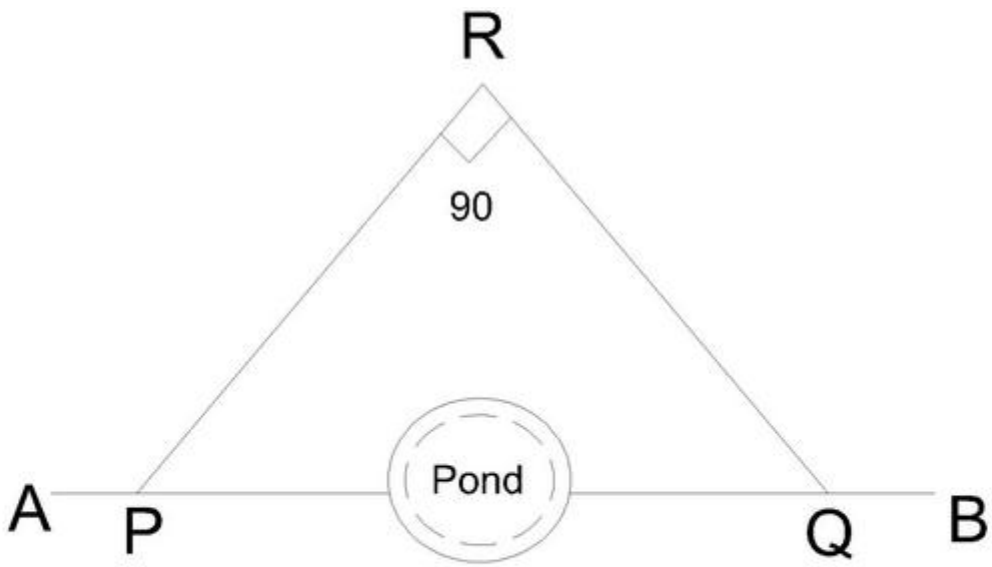
Method (b):

- Set out **CE** perpendicular to the chain line.
- Measure **CE** and **ED**.
- The length **AB** is calculated from the relation
- CD $= \sqrt{ED^2 - EC^2}$
- **AB =AC+CD+DB**



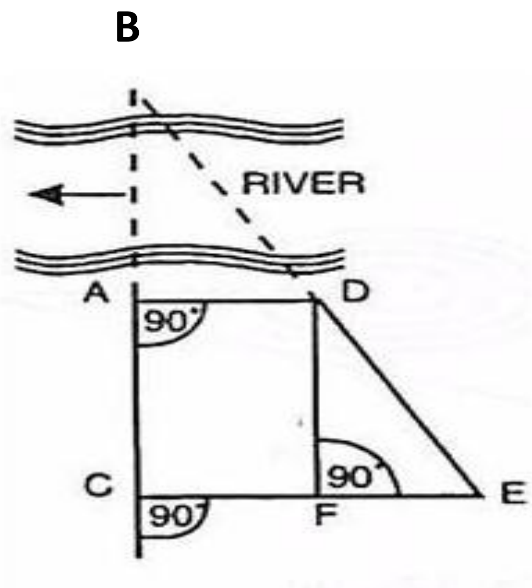
Method (c):

- By optical square or cross staff, find a point **R** which subtends **90°** with **P** and **Q AS shown in figure** .
- Measure **PR** and **QR.**
- The length **PQ** is calculated from the relation: **PQ=** $\sqrt{PR^2 + QR^2}$
- **AB=AP+PQ+QB**



Case (II): when it is not possible to chain round the obstacle

Method (a):



- Select point **B** on one side and **A** and **C** on the other side.
- locate **AD** and **CE** as perpendiculars to **AB** and range **B**, **D** and **E** in one line.
- Measure **AC**, **AD** and **CE**. If a line **DF** is drawn parallel to **AB**, cutting **CE** in **F** perpendicularly, then triangles **ABD** and **FDE** will be similar.

- $\frac{AB}{AD} = \frac{DF}{FE}$ But FE = CE - CF = CE - AD, and DF = AC.

$\frac{AB}{AD} = \frac{AC}{CE-AD}$ From which $\mathbf{AB} = \frac{AC \times AD}{CE-AD}$

3) OBSTACLES TO BOTH CHAINING AND RANGING

A building is the typical example of this type of obstacle. The problem lies in prolonging the line beyond the obstacle and determining the distance across it. The following are some of the methods

Choose two points **A** and **B** to one side and

Locate perpendiculars **AC** and **BD** of equal length.

Join **CD** and prolong it past the obstacle.

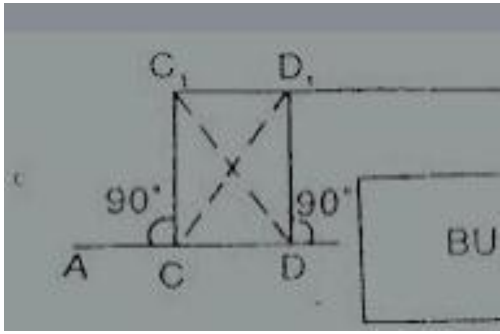
Choose two points **E** and **F** on **CD** and

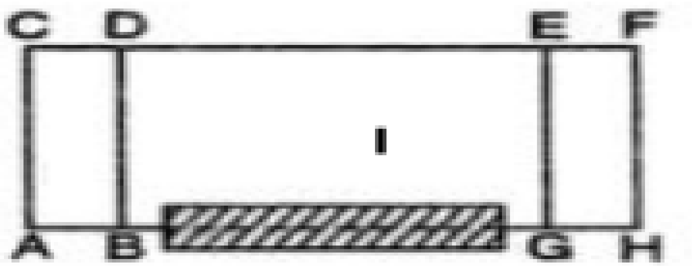
locate perpendiculars **EG** and **FH** equal to that of **AC** (or **BD**).

Join **GH** and prolong it.

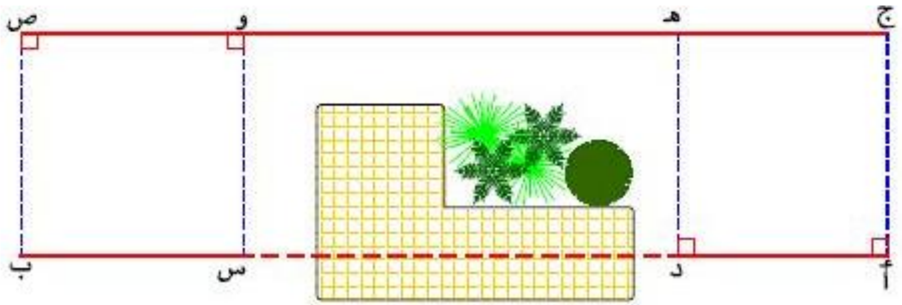
Measure **DE**. Evidently, **BG = DE**

AH=AB+DE+GH





(a)



Example(1):Calculate the obstruct distance (AB)using the figure below, if AC =20m, CE=35m, ED=25m?

Example(2):find the length DE and DF so as points E and F lie on the extension of line BC?

H.W3: find the width of river (GD)using the figure below, if DE=24m, EC=55m, CB=30m?

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Lecture four :

Tape corrections

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Tape correction

We have seen the different sources of errors in linear measurements. In most of the errors, proper corrections can be applied. However, corrections are not necessary but in important and precise work, correction must be applied. Since in most of the cases a (tape)is used for precise work, the corrections are sometimes called as(tape corrections),though they can also apply to the measurements taken with a chain.

Common Mistakes in chaining: An in – experienced chain man generally makes the following mistakes, while chaining a line

1- Displacement of arrows.

2- Failure to observe the zero point of the tape.

3- Adding or deleting a full chain length.

4- Reading from the wrong end of the chain.

5- Reading number wrongly.

6- Calling numbers wrongly.

7- Reading wrong meter marks.

8- Wrong recording in the field.

A correction is **positive** when the uncorrected length is to be in creased and **negative** when it is to be decreased to get the true length.

The corrected length of the base is calculated by applying the following corrections:-

1- correction for absolute length.

2- correction for temperature.

3- correction for pull or tension.

4- correction for sag.

5- correction for slope.

1- correction for absolute length

If the absolute length (actual length) of the tape is not equal to its nominal (designated length),a correction will have to be applied to the measured length of the line.

C_A= correction for absolute length(m)

L = measured length of line.

lf = actual tape length.

ls= nominal or designated length of a tape.

$$C_A = [\frac{lf - ls}{ls}] * L$$

2- correction for Temperature:

The length of the tape increases as its Temperature is raised and decreases as its temperature is lowered , if the Temperature of a tape is above the normal , the correction is positive if it is below the normal ,the correction is negative

$$C_T = \propto L(T_f - T_s)$$

Where :

CT : **correction for Temperature(m)**

$\propto$: Coefficient of thermal expansion $(1/c°)$

L: -measured length of line.

Tf :field temperature of the tape$(c°)$

Ts : standardized temperature at which the tape was standardized.(20°C)

$the\ cofficient\ of\ thermal\ expansion\ of\ steel\ used\ in\ ordinary\ tape = 0.0000645/F$

=0..0000116/C

For invar $\propto$ = 0.0000010

And for steel $\propto$ = 0.000012

Then the temperature correction

3- correction for pull or Tension:

If the pull applied during measurements is more than the pull at which the tape was standardized, the length of the tape increases and hence the measured distance becomes less than actual, the correction is therefore ‹positive. On the other hand if the pull is less the length of the tape decrease and consequently the measured distance becomes more which makes the correction negative.

$$C_P = \frac{(Pf - ps)}{A\,E}\,.L$$

Let:

C_P = correction for pull (m).

A = Area of the tape: - cross –sectional(cm^2) or (in^2)

L: - measured length of the line in (m) or(ft).

pf: pull applied during measurement(field pull)in (Kg)or(ib).

Ps: pull under which the tape is standardized (standard pull)in (Kg)or(ib). = 5 kg

E: The Young's modulus for the tape materials(modulus of elasticity(force/area)in (Kg/cm^2)

E for steel = $21\times 10^6 \frac{kg}{cm^2}$ **E for invar = $15.4\times 10^5 \frac{kg}{cm^2}$**

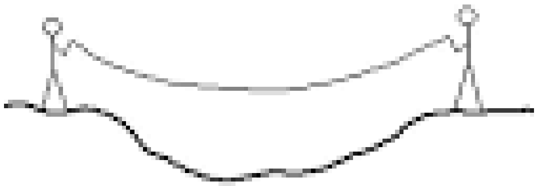
4- correction of Sag :

The horizontal distance will be less than the distance along the curve. The sag correction is given by

The Sag correction:

$$C\ sag = \frac{L^3 W^2}{24 P f^2}\ \textbf{approximately}\ (-ve)$$

$$w = W/L$$



Where:

L: - distance between supports in (m) or (ft).

Pf: applied tension in the field (field pull)in (kg)or(ib).

W:Weight of tape suspended between supports in (kg/m)or (ib/ft)

w: Weight of tape per unit length in (kg/m)or (ib/ft)

5- Correction for slope :

The distance measured along the slope between two points is always greater than the horizontal distance between them- :

$$Ch=\frac{h^2}{2l}$$

a)Correction for difference in elevation= $\frac{(difference\ in\ elevation)^2}{2*sloped\ distance}$

Horizontal distance (L)=sloped distance(l)-correction for different in elev.(h).

b)

Horizantal distance (L)=sloped distance(l)*cos for (slope angle).

Difference in elevation (h)=sloped distance(l)*sin for (slope angle).

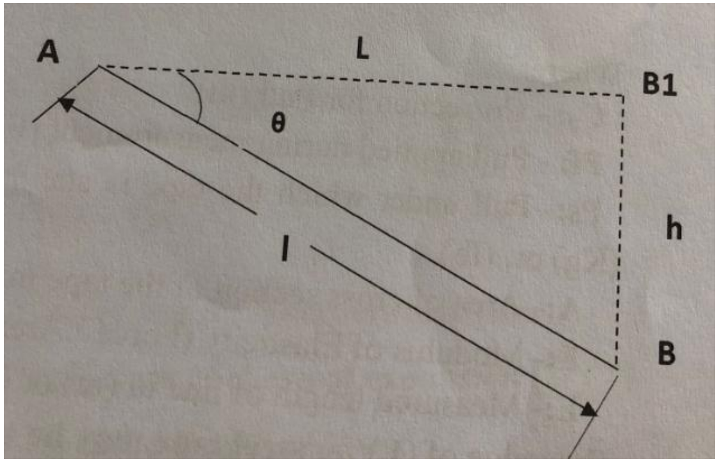
Ch=l-L

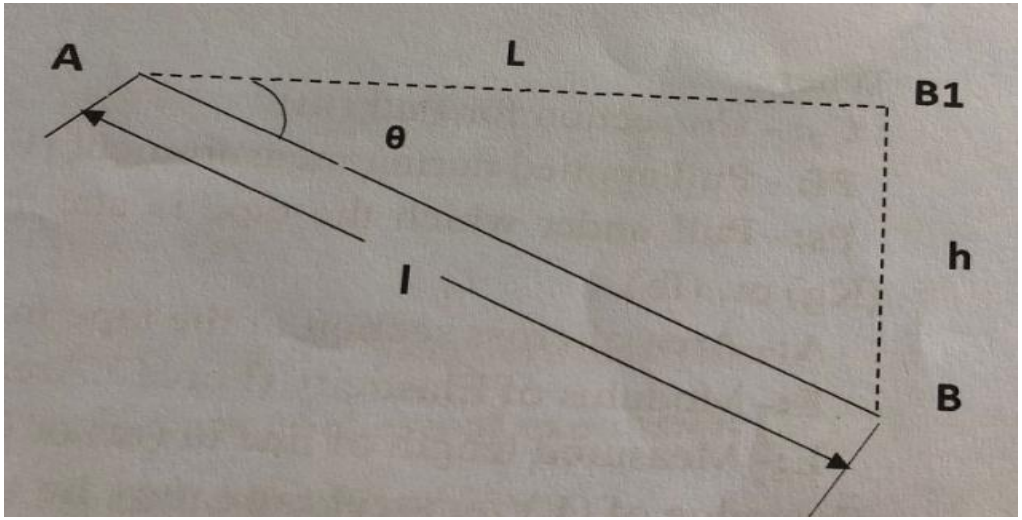
=l-l cosθ

Ch=l(1-cosθ)

which L=lcosθ

Percent slope%=$\frac{difference\ in\ elevation*100}{horizantal\ distance}$





$$Ch = \frac{h^2}{2l}$$

l:-the inclined distance.

h: - the difference in elevation of A and B

$$Cs = L\,(1 - \cos\theta)$$

Correction for errors in taping		
Correction	sign	Formula
Absolute length	±	$C_A = [\frac{lf - ls}{ls}]*L$
temperature	±	$CT = \propto L(Tf - Ts)$
pull	±	$C_P = \frac{(Pf - ps)}{A\,E}.L$
sag	-	$Cs = \frac{L^3 W^2}{24 Pf^2}$
slope	-	$Ch = h^2/2l$ $Ch = l(1-\cos\theta)$
$L_{corrected} = L_{measured} \pm C_A \pm CT \pm C_P - Cs - Ch$		

Q1/to measure a base line, a steel tape with (30m) long standardized at (15c°) under pull of (10kg) was used. Find the correction per tape length if the field temperature was (20c°) and the pull exerted was (16kg). If the tape section area was ($0.03419 cm^2$), weight of the tape was (0.8kg), E ($2.1*10^6$ kg/cm^2) and the coefficient of thermal expansion was ($7.1*10^{-6}$ /c°)?

Q2/a line of (625 m) was measured along a slopping ground. The difference in height between the end points was found to be (2.5m). Find the horizontal distance?

H.W1/

A measurement of 171.278 m was recorded with a 30-m tape that was only 29.996 m long under standard conditions. What is the corrected measurement?

H.W2/

A 30-m tape is used with a 100N force instead of the standard tension of 50N. If the x-section area of the tape is 1.8 mm2, what is the tension error per tape length?

Note: The Young's modulus for the tape materials= $200 * 10^9\ N/m^2$

H.W3/

A steel tape in (100 ft) long at a temperature of 60 °F when being horizontally on the ground. It's cross sectional area in 0.01259 .in, its weight in 2 Ib the coefficient for expansion 65 * 10^{-7}*pe*r ,°F the tape is strict ahead over three support which are of the same level and at equal intervals. Calculate the actual length between the end graduations under the following conditions T = 80°F, pull = 30 Ib E (for steel) = $3*10^6$ per sq.m.

Northern Technical University (NTU)
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Surveying Engineering Department

1st class

SURVEYING I

Lecture five :

levelling

lecturer: Sumaya Falih Hasan
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DEFINITIONS

Leveling: is a branch of surveying is to find the elevations of given points with respect to a given or assumed datum.

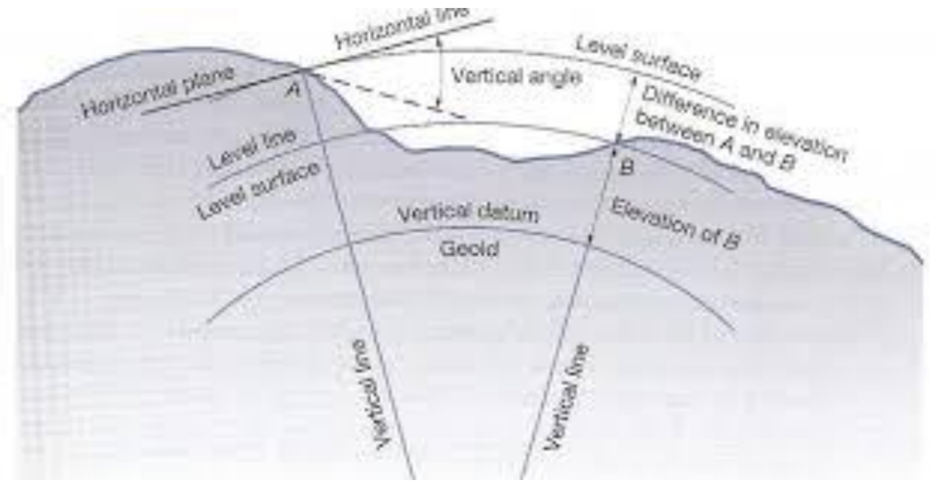
Horizontal Line: It is straight line tangential to the level line at a point. It is also perpendicular to the plumb line.

Vertical Line: It is a line normal to the level line at a point. It is commonly considered to be the line defined by a plumb line.

Level Line: A level line is a line lying in a level surface. It is, therefore, normal to the plumb line at all points.

Level Surface: A level surface is defined as a curved surface which at each point is perpendicular to the direction of gravity at the point.

Datum: Datum is any surface to which elevations are referred. The mean sea level affords a convenient datum world over, and elevations are commonly given as so much above or below sea level.



Elevation(reduced level) : The elevation of a point is a vertical distance above (+) or below (-)an assumed level surface or datum.

Mean Sea Level: Mean sea level is the average height of the sea for all stages of the tides.

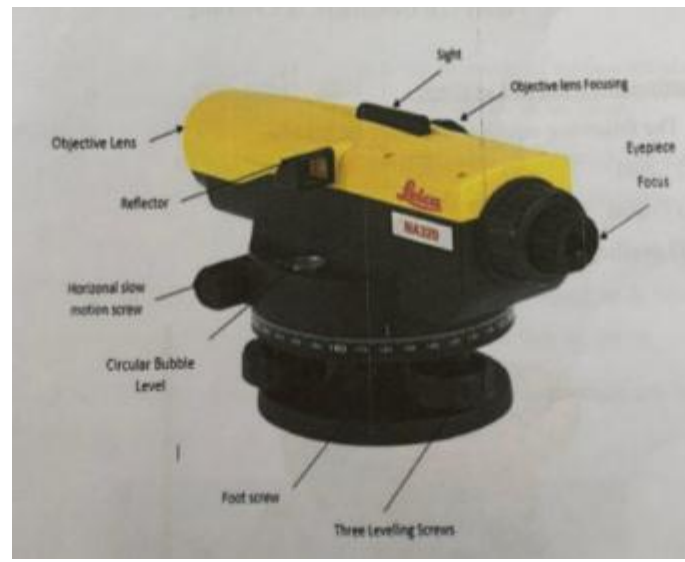
Equipment used in leveling:

1-level
2-tripod
3-leveling staff

Levels

The purpose of level is to provide a horizontal line of sight. A level consists of the following:

1- a telescope to provide line of sight
2- a level tube to mark the line of sight horizontal
3- a levelling head to bring the bubble in its center of run
4- a tripod to support the instrument



There are the following types of levels:

a-)dumpy levels
b-)tilting levels
c-)automatic levels

Components of Dumpy Level

<u>Levelling staff</u>:

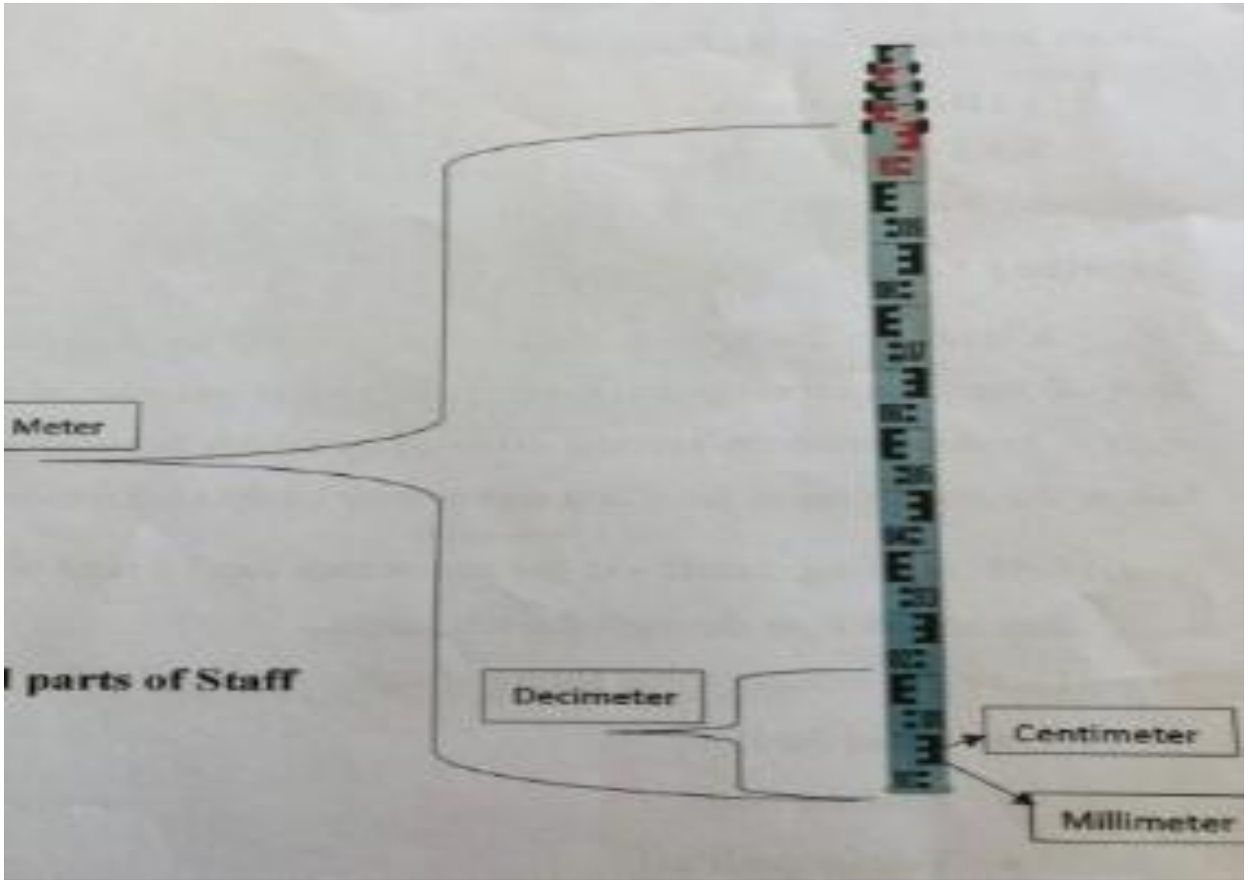
Is a straight rectangular rod having graduations the foot of the staff representing zero reading.

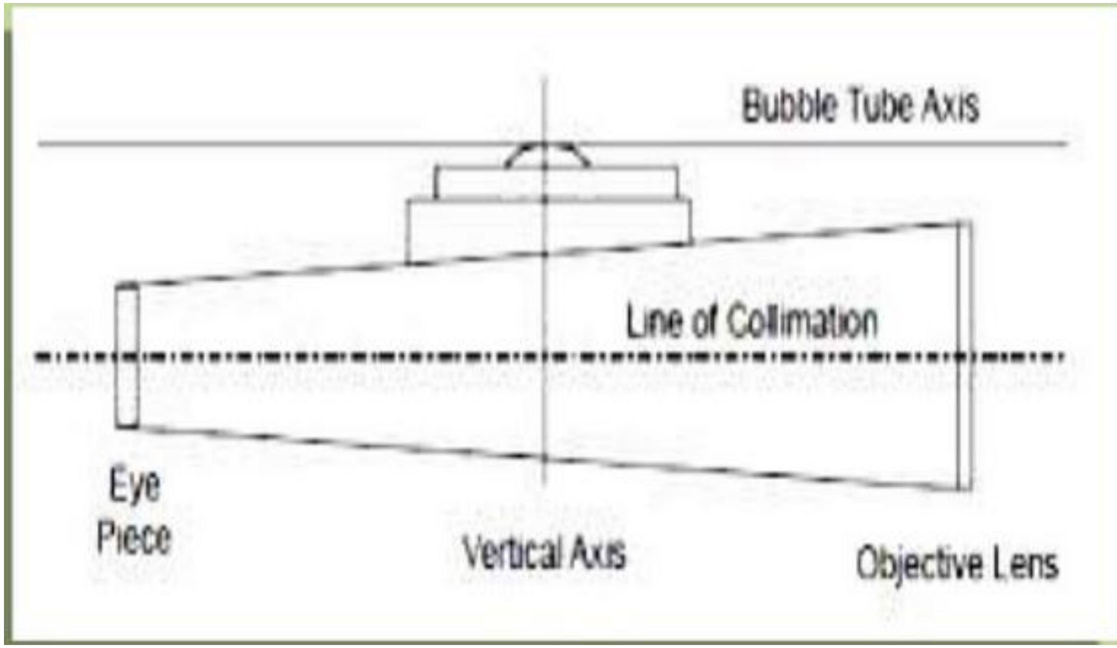
A-self- reading staff

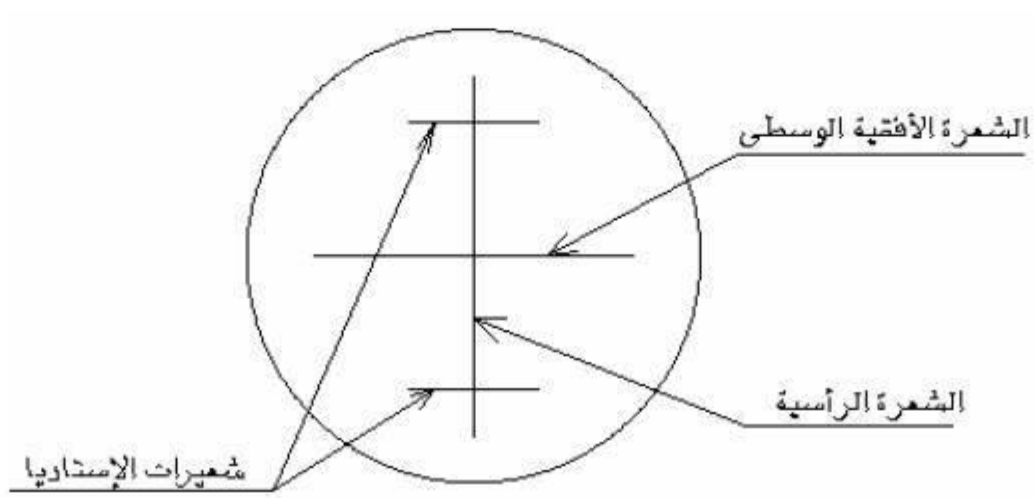
Is the one which can be read directly by the instrument man through the telescope.

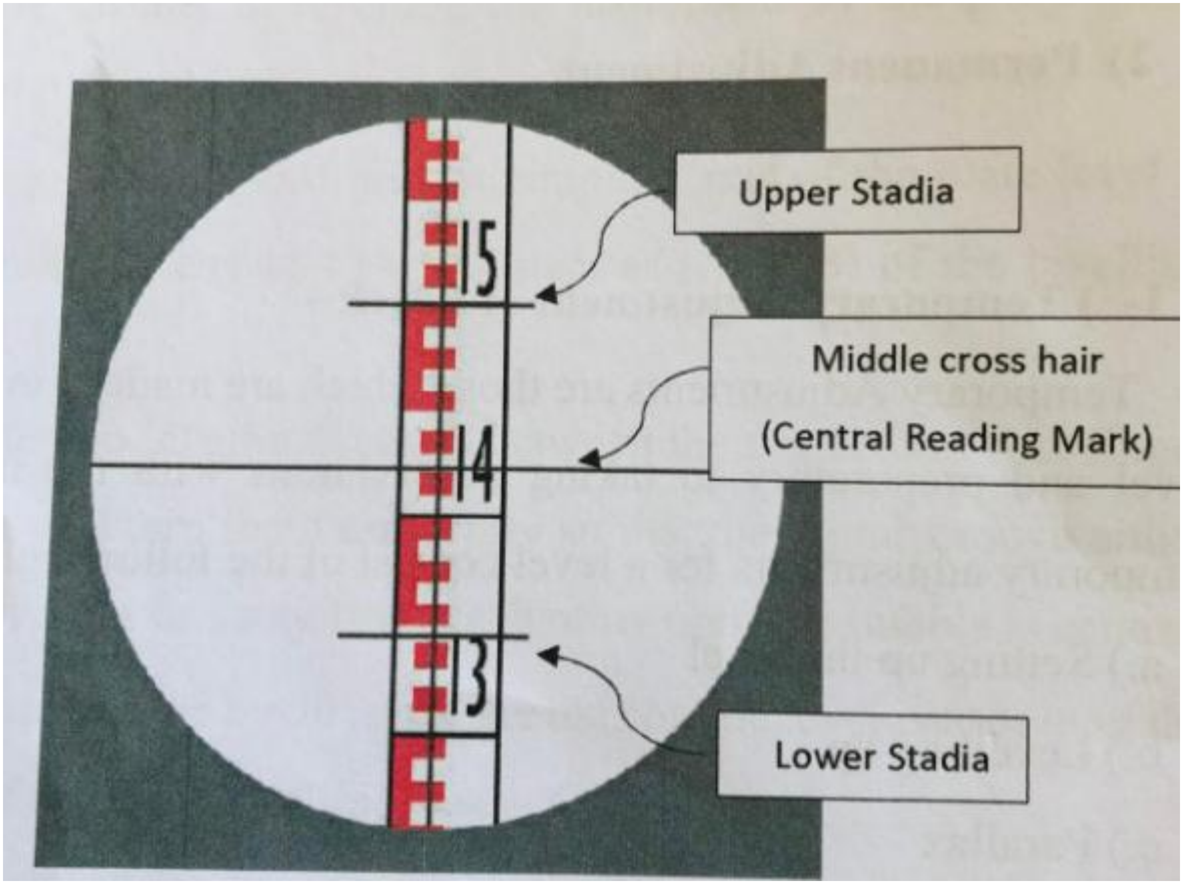
B- target staff

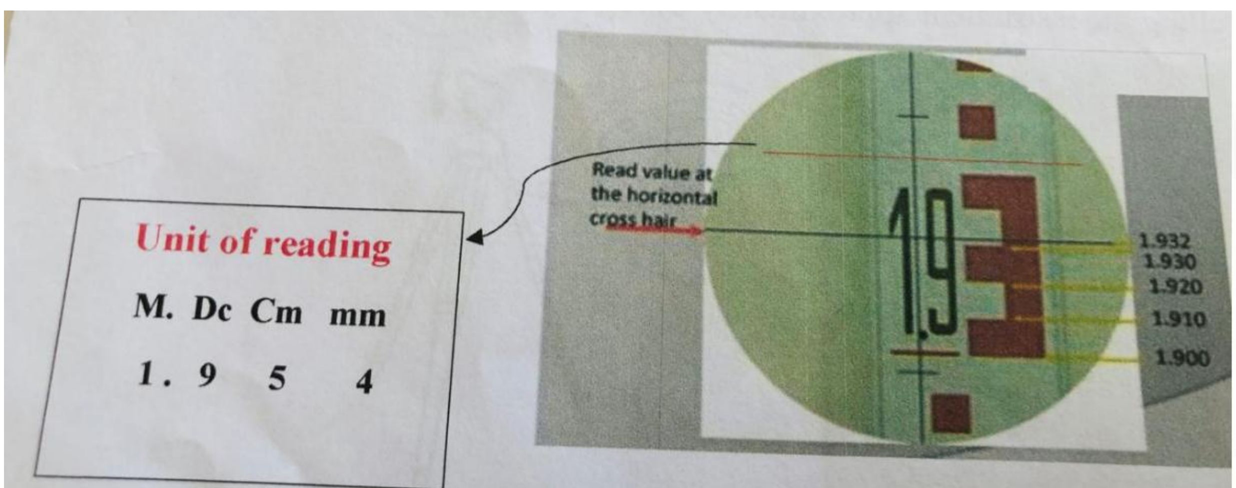
Is a staff which contain a moving target against which the reading is taken by staff man.

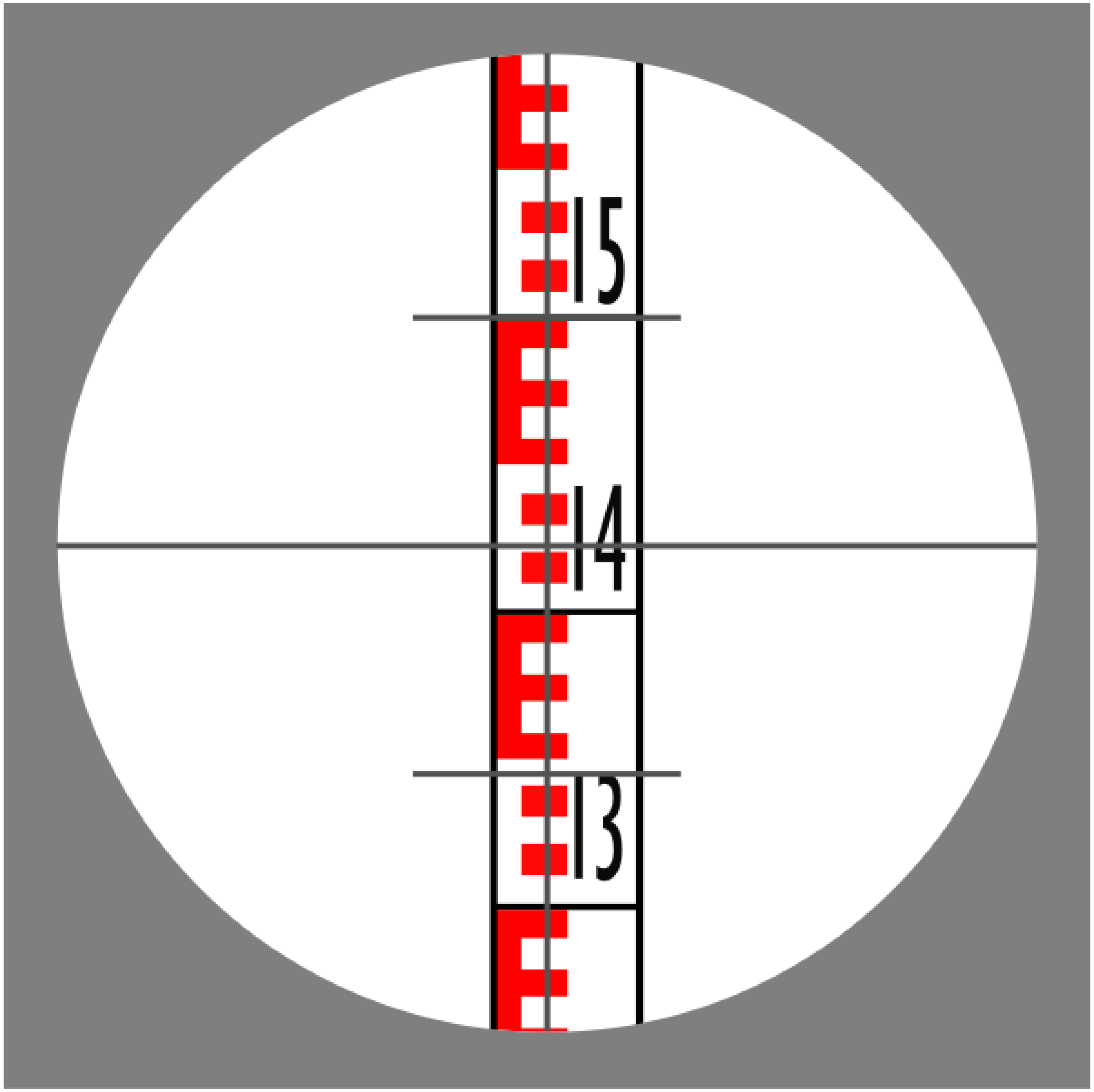

Meter
l parts of Staff
Decimeter
Centimeter
Millimeter


Bubble Tube Axis
Line of Collimation
Eye
Piece
Vertical Axis
Objective Lens


الشعرة الأفقية الوسطى
الشعرة الرأسية
شعيرات الإستاديا


15
14
13
Upper Stadia
Middle cross hair
(Central Reading Mark)
Lower Stadia


Unit of reading
M. Dc Cm mm
1 . 9 5 4
Read value at the horizontal cross hair
1.9
1.932
1.930
1.920
1.910
1.900


15
14
13

<u>Terms in levelling</u>

Station: in levelling ,a station is that point where the level rod is held and not where level set up.it is the point that is to be established at a given elevation.

Bench Mark and Reference Datum
In order to calculate the heights of points a datum is required, i.e. a reference level. This is usually the mean sea level. For this purpose, the use of Bench Marks is necessary, and these are classified as follows:
Backsight (BS) - First staff reading taken immediately after setting up the instrument.

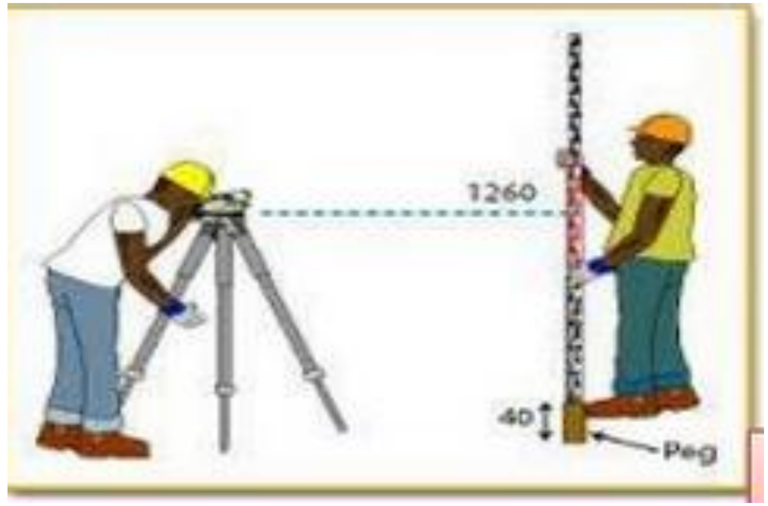
Foresight (FS) - last staff reading taken before moving the instrument to another location.

Intermediate sight (IS) all readings taken between a BS and a FS.

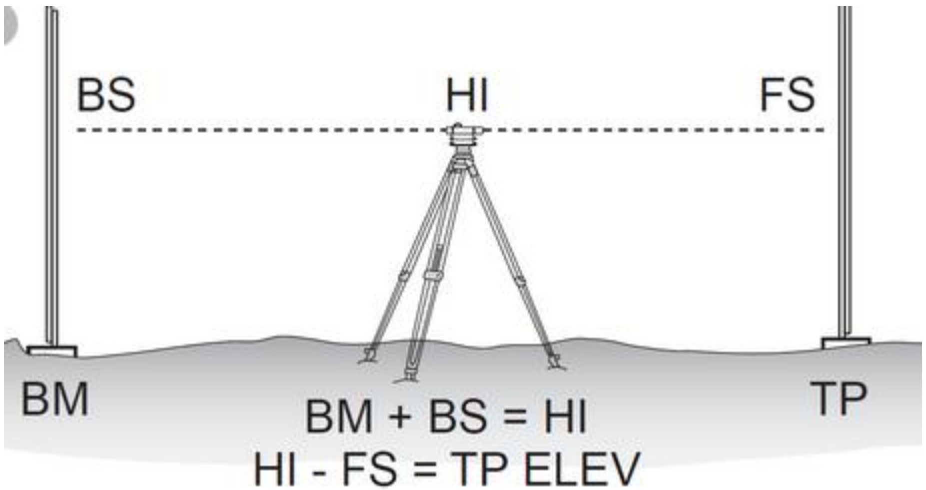
Height of instrument(H.I):for any set up of the level ,the elevation of the line of sight with respect to assumed datum.

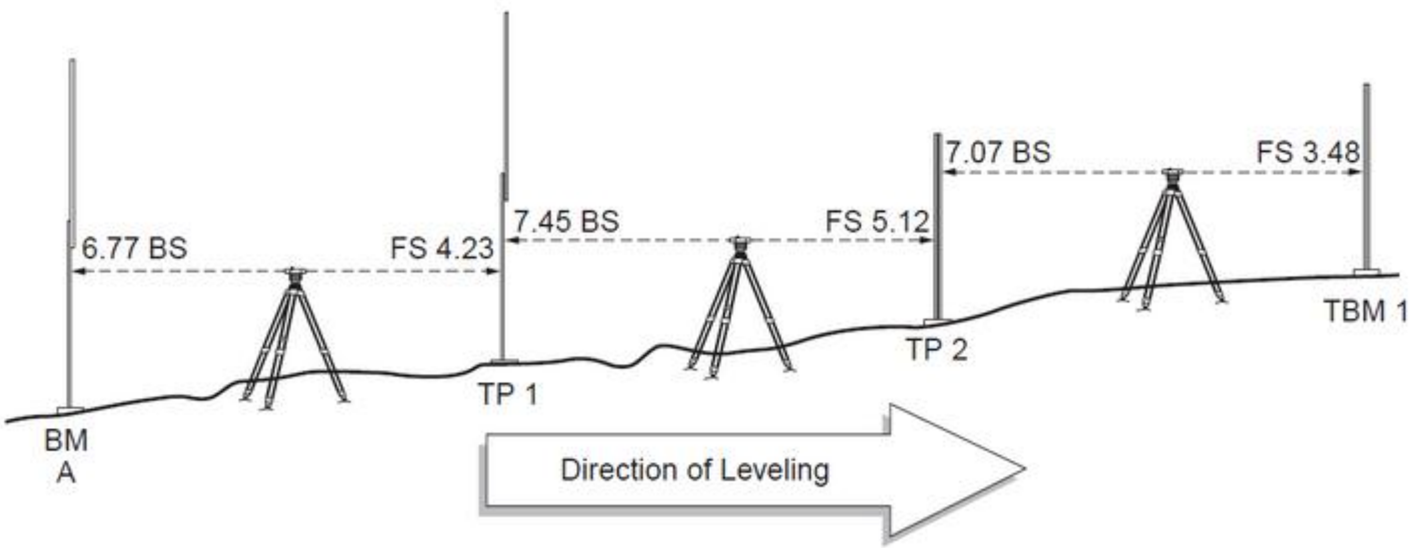
Turning point(T.P): the point on which both the foresight and back sight are taken during the operation of levelling.

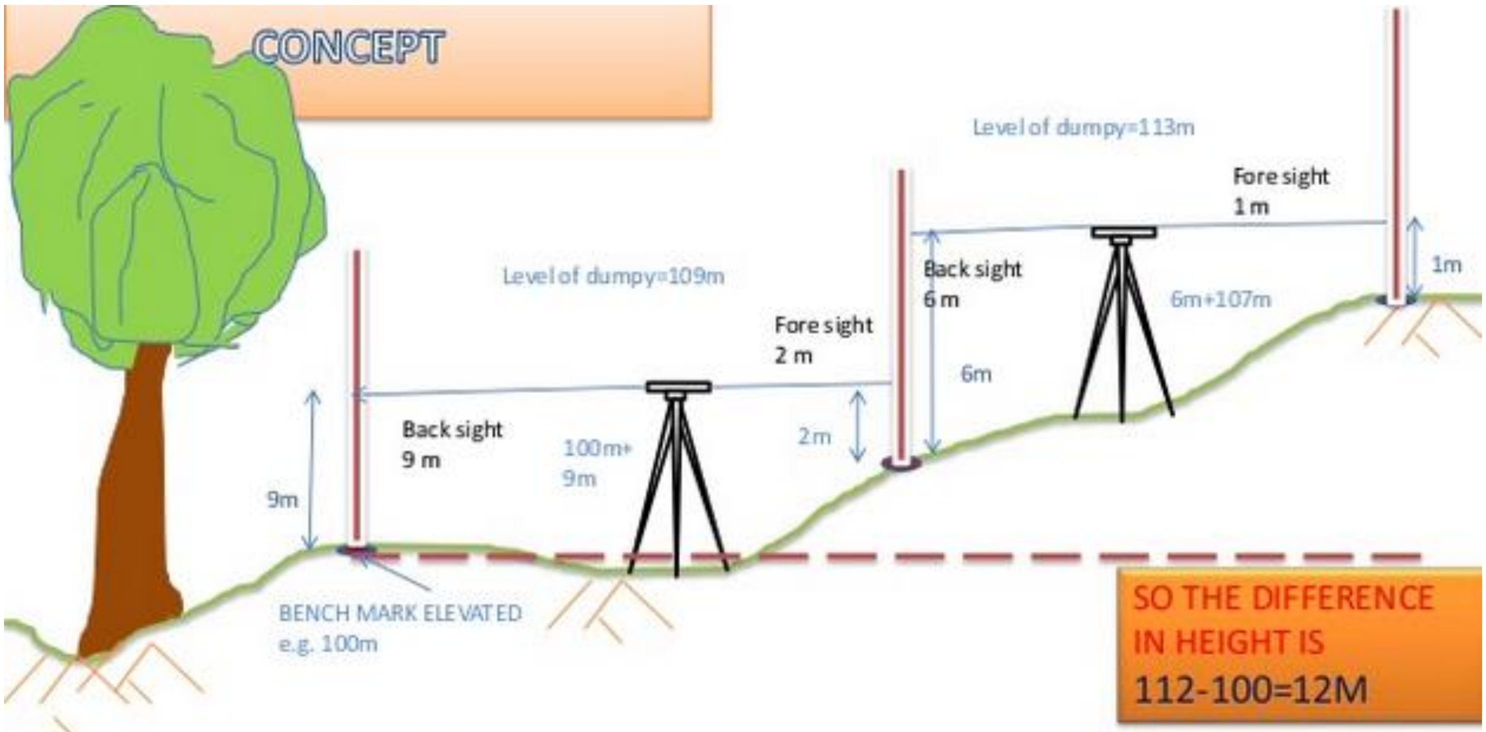
Bench Mark (BM) – a point with known height above mean sea level (or other reference datum).

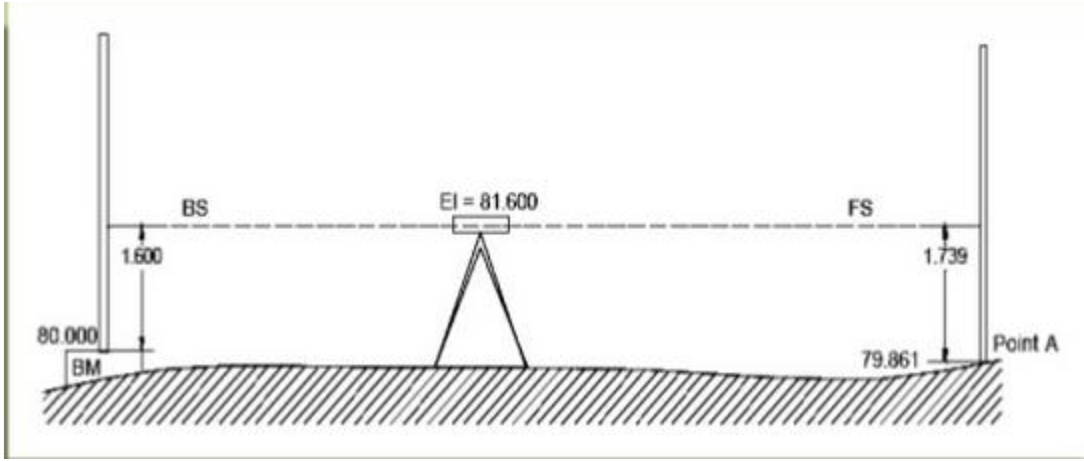

1260
40
Peg

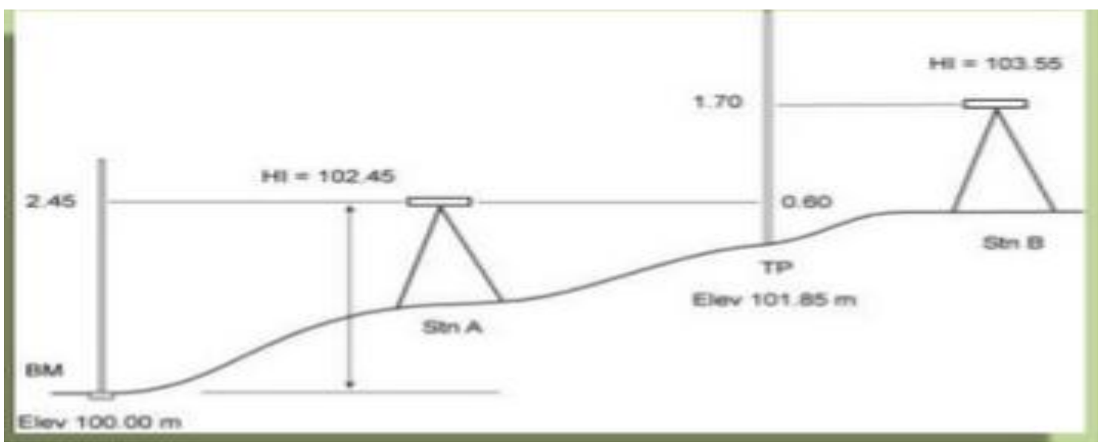

Rotate dumpy round
Rotate dumpy round
Back sight
6 m
Fore sight
1 m
Back sight
9 m
Fore sight
2 m
TOP OF SLOPE
?
BENCH MARK ELEVATED
e.g. 100m
Divide hill into 3 spots to make easier
Otherwise too far to see or level staff not long enough
Move level staff to new spot

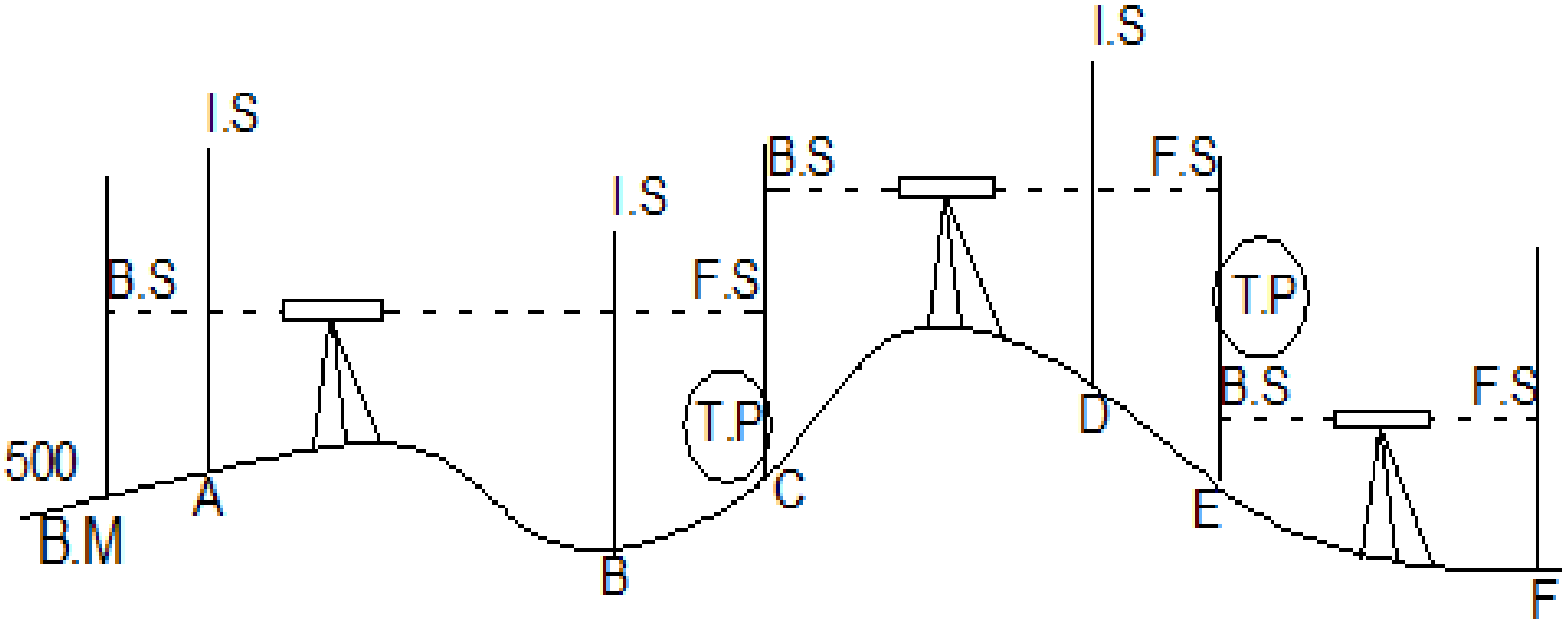

BS
HI
FS
BM
TP
BM + BS = HI
HI - FS = TP ELEV


6.77 BS
FS 4.23
7.45 BS
FS 5.12
7.07 BS
FS 3.48
BM
A
TP 1
TP 2
TBM 1
Direction of Leveling


CONCEPT
Level of dumpy=113m
Fore sight
1 m
1m
Back sight
6 m
6m+107m
6m
Level of dumpy=109m
Fore sight
2 m
2m
Back sight
9 m
100m+
9m
9m
BENCH MARK ELEVATED
e.g. 100m
SO THE DIFFERENCE
IN HEIGHT IS
112-100=12M


BS
EI = 81.600
FS
1.600
1.739
80.000
BM
79.861
Point A


HI = 103.55
1.70
HI = 102.45
2.45
0.60
Stn B
TP
Elev 101.85 m
Stn A
BM
Elev 100.00 m



I.S
I.S
B.S
I.S
B.S
F.S
F.S
T.P
T.P
B.S
F.S
500
A
B.M
B
C
D
E
F

Methods of leveling Computation:

1. Height of Collimation Method (Height of Instrument) (H.I.)
2. Rise and Fall Method

1. Height of Collimation Method (Height of Instrument) (H.I.)

It consist of finding the elevation of the plane of collimation (H.I.) for every set up of the instrument, and then obtaining the reduced level of point with reference to the respective plane of collimation.

1. Elevation of plane of collimation for the first set of the level determined by adding back side to R.L. of B.M.

2. The R.L. of intermediate point and first change point are then obtained by starching the staff reading taken on respective point (IS & FS) from the elation of the plane collimation. [H.I.]

3. When the instrument is shifted to the second position a new plane collimation is set up. The elevation of this plane is obtained by adding B.S. taken on the C.P. from the second position of the level to the R.L. C.P. The R.L. of successive point and second C.P. are found by subtract these staff reading from the elevation of second plane of collimation Arithmetical check

Sum of B.S. – sum of F.S. = last R.L. – First R.L.

This method is simple and easy.
Reduction of levels is easy.
Visualization is not necessary regarding the nature of the ground.
There is no check for intermediate sight readings
this method is generally used where more number of readings can be taken with less number of change points for constructional work and profile leveling.

2. Rise and Fall Method:

It consists of determining the difference of elevation between consecutive points by comparing each point after the first that immediately preceding it. The difference between there staff reading indicates a rise fall according to the staff reading at the point. The R.L is then found adding the rise to, or subtracting the fall from the reduced level of preceding point.

Arithmetic check

Sum of B.S. – sum of F. S. = sum of rise – sum of fall = last R. L. – first R.L.

This method is complicated and is not easy to carry out.

Reduction of levels takes more time.

Visualization is necessary regarding the nature of the ground.

Complete check is there for all readings.

This method is preferable for check leveling where numbers of change points are more.

Example levelling (height of instrument method)

Example 1: - The following readings were taken with a level and 4 m staff. Draw up a level book page and reduce the levels by the height of instrument method. 0.578 B.M. (= 58.250 m), 0.933, 1.768, 2.450, (2.005 and 0.567) T.P., 1.888, 1.181, (3.679 and 0.612) T.P., 0.705, 1.810.

Solution:

Section-1:
H.I.1 = *R. L1* + B.S.1 = 58.250 + 0.578 = 58.828 m
R. L2 = H.I.1 – I.S.2 = 58.828 – 0.933 = 57.895 m
R. L3 = H.I.1 – I.S.3 = 58.828 – 1.768 = 57.060 m
R. L4 = H.I.1 – I.S.4 = 58.828 – 2.450 = 56.378 m
R. L5 = H.I.1 – F.S.5 = 58.828 – 2.005 = 56.823 m

Section-2:
H.I.5 = *R.* l 5 + B.S.5 = 56.823 + 0.567 = 57.390 m
R. L6 = H.I.2 – I.S.6 = 57.390 – 1.888 = 55.502 m
R. L7 = H.I.2 – I.S.7 = 57.390 – 1.181 = 56.209 m

R. L8 = H.I.2 – F.S.8 = 57.390 – 3.679 = 53.711 m

Section-3:
H.I.8 = *R. L8* + B.S.8 = 53.711 + 0.612 = 54.323 m
R. L9 = H.I.8 – I.S.9 = 54.323 – 0.705 = 53.618 m
R. L10 = H.I.8 – F.S.10 = 54.323 – 1.810 = 52.513 m

Station	B.S.	I.S.	F.S.	H.I.	R.L.	Remarks
1	0.578			58.828	58.25	B.M = 58.828 m
2		0.933			57.895	
3		1.768			57.06	
4		2.45			56.378	
5	0.567		2.005	57.39	56.823	T.P.1
6		1.888			55.502	
7		1.181			56.209	
8	0.612		3.679	54.323	53.711	T.P.2
9		0.705			53.618	
10			1.81		52.513	
Sum	1.757		7.494			

For checking (1.757 – 7.494 = - 5.737) and (52.513 – 58.25 = - 5.737)

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SURVEYING I

Lecture seven:

RECIPROCAL LEVELLING

lecturer: Sumaya Falih Hasan
Sumaya.h.falih@ntu.edu.iq

RECIPROCAL LEVELLING

When it is necessary to carry leveling across a river, ravine or any obstacle requiring a long sight between two points so situated that no place for the level can be found from which the lengths of foresight and backsight will be even approximately equal, special method i.e.. Reciprocal leveling must be used to obtain accuracy and to eliminate the following:

(1) Error in instrument adjustment;

(2) Combined effect of earth's curvature and the refraction of the atmosphere, and

(3) Variations in the average refraction.

Let A and B be two points on opposite banks of river the different of level of A and B may be determine as follows:

1-set up the level near to point A, take the reading (a1 & b1)on the staff held at A&B.

2-transfer instrument to another side to B and set it very near to B observe the readings at A&B as a2 and b2

Where:

Instrument at (A):- staff reading at A =a1, staff reading at B =b1

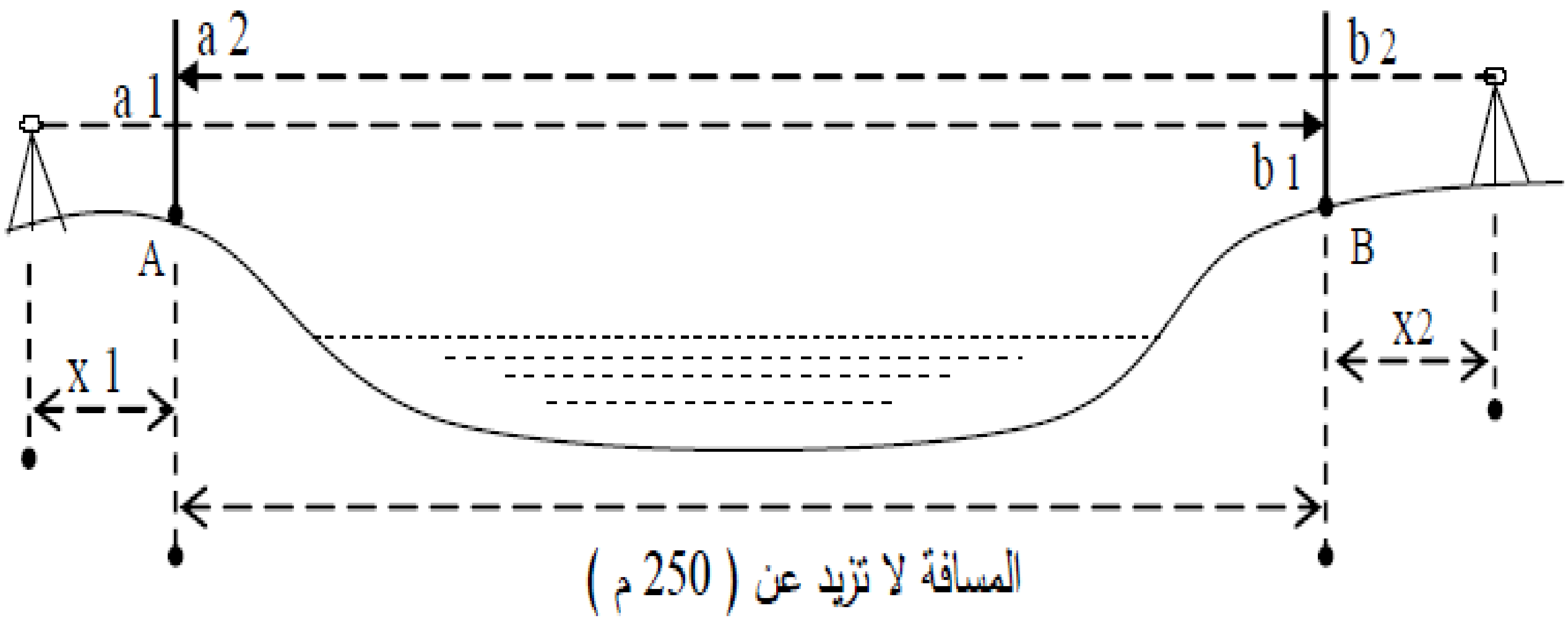
Instrument at (B):- staff reading at B =a2, staff reading at B =b2

3-A true difference in elevation between A and B is equal to the mean of two apparent difference of levels.

Difference in elevation between A and B is:

Real difference between (H)elevation of point A & B= (a1-b1)+(a2-b2)/2

R.LB = R.LA $\pm$ difference elevation



a 2
b 2
a 1
b 1
A
B
x 1
X2
المسافة لا تزيد عن (250 م)

EX: - A dumpy level was set up with its eye piece over peg A. The height of the center of the instrument above peg was 1.31 m. the reading over another peg was 0.90 m .the level was then removed and set up near peg B the height of the instrument at B was 1.43 m the reading on the staff at A was 1.84. Determine the actual R.L. on peg B, if R.L. of peg A was 100.00.

Sol: -

a 1 = 1.31 , a2 = 1.840

b 1 = 0.90 , b2 = 1.430

a 1 – b 1 = 1.31 – 0.90 = 0.41 m

a 2 – b 2 = 1.430 – 1.840 = 0.41 m

The true difference in elevation = $\frac{(a\,1 - b\,1) + (a\,2 - b\,2)}{2} = \frac{(1.31 - 0.90) + (1.840 - 1.430)}{2}$

. $\frac{0.41 + 0.41}{2}$ = 0.41

R.LB = R.LA $\pm$ difference elevation

100.00 + 0.41 = 100.41m

H.W: In levelling between two points (A) , (B) on opposite banks of a river the level was setup near (A) and the staff reading on (A) and (B) were (2.243 , 3.391) respectively . the level was then moved and setup near (B) and respectively staff reading on (A) and (B) were (1.889 , 3.041). Find the true difference of level (A) ,(B) and R.L of point (B) if R.L point (A) is (100) ?

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Surveying Engineering Department

1st class

SURVEYING I

Lecture ONE: *(*Second Semester)

Longitudinal (Profile)

lecturer: Sumaya Falih Hasan
Sumaya.h.falih@ntu.edu.iq

Longitudinal (Profile)

The process of determining the elevations of a series of points at measured intervals along a line such as the centerline of a projected highway or railway.

Some important notes about the profile:

The x – axis represent the distance

The y – axis represent the elevation

There are two elevations

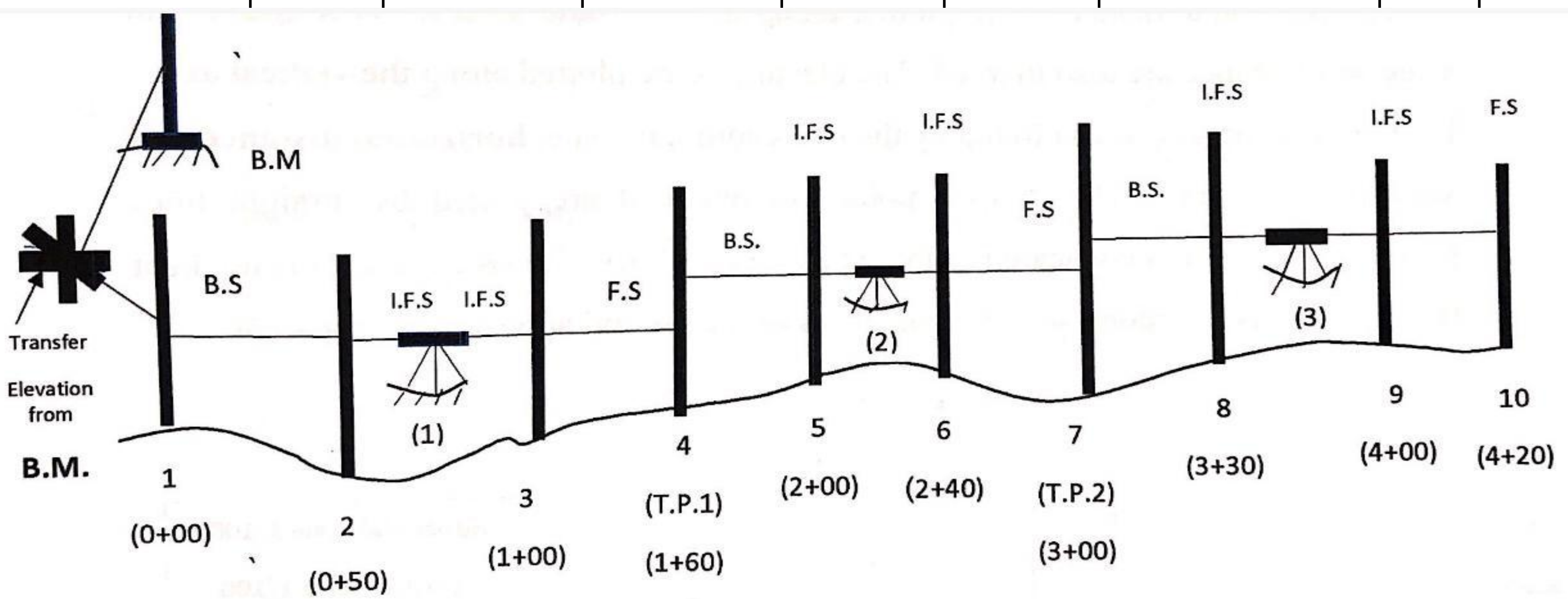
Grade (Design, Project, formation) elevation

Ground surface elevation

Ground elev. – grade elev. = either + cut   or – fill

Vertical scale (V.S.) is greater than horizontal scale (H.S)

Station (point)	.B.S	I.S.	F.S.	H.I.	R.L.	Grade elevation	Depth cut	fill
0+00(or1)								
0+50(or2)								
01+00(or3)								



Example: A levelling net where be done for longitudinal section to construct a road with a length of (500 m)and the distances were an equal amount between stations which equal to (50 m)and the reading were written as listed in the following table. The elevation of first station (0+00)is (25.000m)and the following are required as follows:-

1-compute the R.L.of all points on the ground surface.(ground elevation).

2-draw the longitudinal section on a scale of(1/5000)for distance and (1/100)for the elevation.

3-assigning and drawing the grade elevation for a road that start from a station of (0+00)with slope of (0.5%)to the down upon reach the stations(5+00).

4-compute the depth of cut and fill for each station.

Sol:

station	Dis. (m)	B.S.	I.S.	F.S.	H.I	R.L.	Grade line (m)	Cut +	Fill -	REMA RKS
A	0+00	1.52			26.52	25	25	0.00	0.00	B.M
B	0+50		1.91			24.61	24.75		0.14	
C	1+00	2.59		2.41	26.7	24.11	24.5		0.39	T.P.1
D	1+50		1.92			24.78	24.25	0.53		
E	2+00	1.2		1.48	26.34	25.22	24	1.22		T.P.2
F	2+50		1.44			24.9	23.75	1.15		
G	3+00	1.16		1.5	26	24.84	23.5	1.34		T.P.3
H	3+50		1.82			24.18	23.25	0.93		
I	4+00	1.22		1.91	25.31	24.09	23	1.09		T.P.4
J	4+50		2.3			23.01	22.75	0.26		
K	5+00			3.85		21.46	22		1.04	
∑		7.61		11.15						

Next grade (any station) = last grade – slope ± *distance

Next grade (0+50)=25-0.5/100*50=24.75

Next grade (1+00)=24.75-0.5/100*50=24.5

Next grade (1+50)=24.5-0.5/100*50=24.25

Next grade (2+00)=24.25-0.5/100*50=24

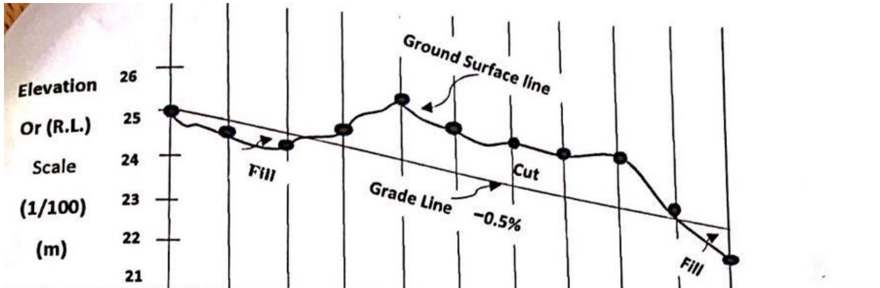
.

Depth at (any station) = ground(Elev.) – grade (Elev.)

Depth (0+00) =25-25=0.00

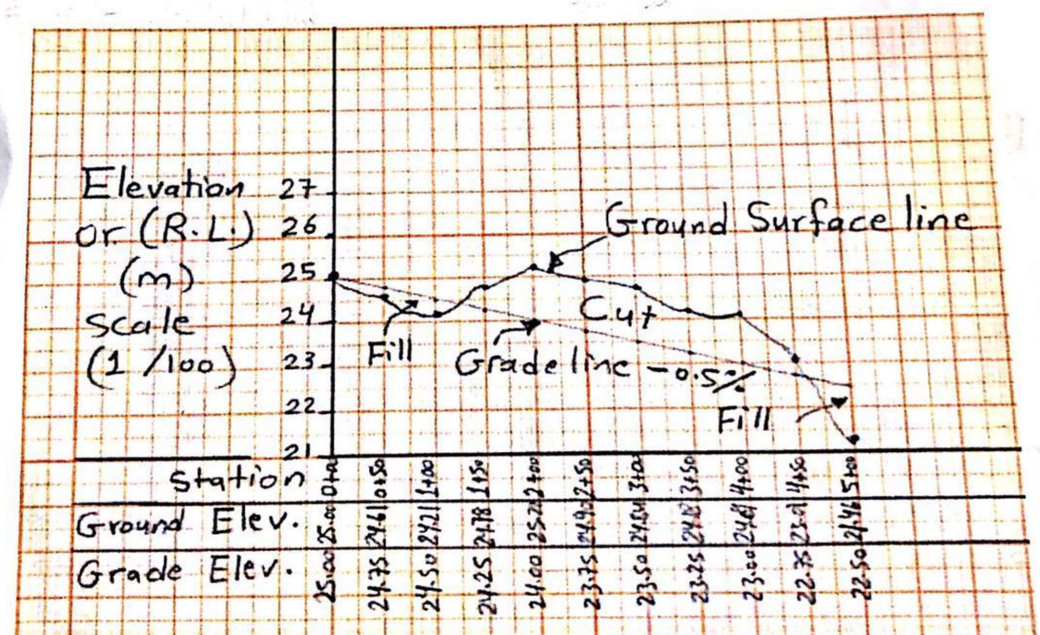
Depth (0+50) = 24.61 -24.75= -0.14m (fill)

Depth (1+00) = 24.11-24.5= -0.39 (fill)



Station	0+00	0+50	1+00	1+50	2+00	2+50	3+00	3+50	4+00	4+50	5+00
Ground Elev.	25.000	24.610	24.210	24.78	25.220	24.900	24.840	24.18	24.090	23.010	21.460
Grade Elev.	25.000	24.750	24.500	24.250	24.000	23.750	23.500	23.250	23.000	22.750	22.500

Figure (3): - Profile Section for Ground and Grade Line



Example: A service of R.L readings are taken along a street where the distance between stations is 50m and the grade line starts from station (0+00) with R.L =25m with a slop (0%) to the end of the project. Determine the height of cut and fill use H.S. =1:5000 and V.S=1:50?

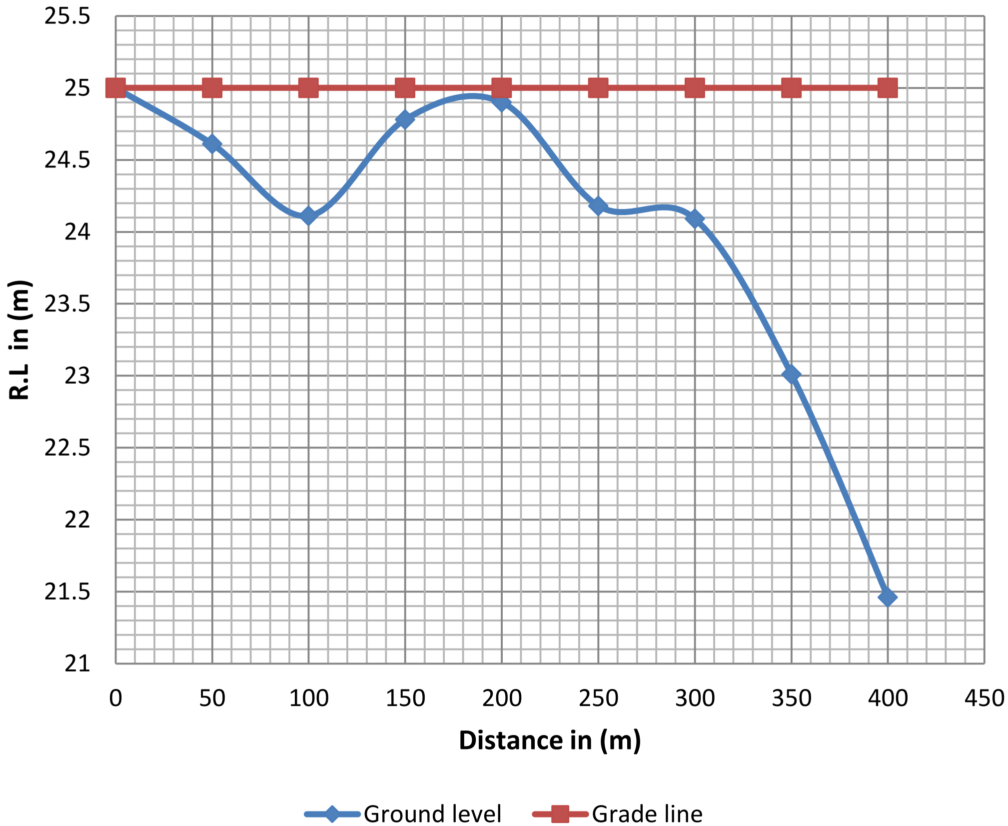
Sol:

Example: A service of R.L readings are taken along a street where the distance between stations is 50m and the grade line starts from station (0+00) with R.L =25m with a slop (0%) to the end of the project. Determine the height of cut and fill use H.S. =1:5000 and V.S=1:50?

Sol:

station	Dis. (m)	R.L (m)	Grade line (m)	Cut +	Fill -
A	0+00	25	25	0	0
B	0+50	24.61	25		0.39
C	1+00	24.11	25		0.89
D	1+50	24.78	25		0.22
E	2+00	24.9	25		0.1
F	2+50	24.18	25		0.82
G	3+00	24.09	25		0.91
H	3+50	23.01	25		1.99
M	4+00	21.46	25		3.54

station	Dis. (m)	R.L (m)	Grade line (m)	Cut +	Fill -
A	0+00	25	25	0	0
B	0+50	24.61	25		0.39
C	1+00	24.11	25		0.89
D	1+50	24.78	25		0.22
E	2+00	24.9	25		0.1
F	2+50	24.18	25		0.82
G	3+00	24.09	25		0.91
H	3+50	23.01	25		1.99
M	4+00	21.46	25		3.54



Example: A service of R.L readings are taken along a street where the distance between stations is 50m and the grade line starts from station (0+00) with R.L =25m with a slop (0%) to the end of the project. Determine the height of cut and fill use H.S. =1:5000 and V.S=1:50?

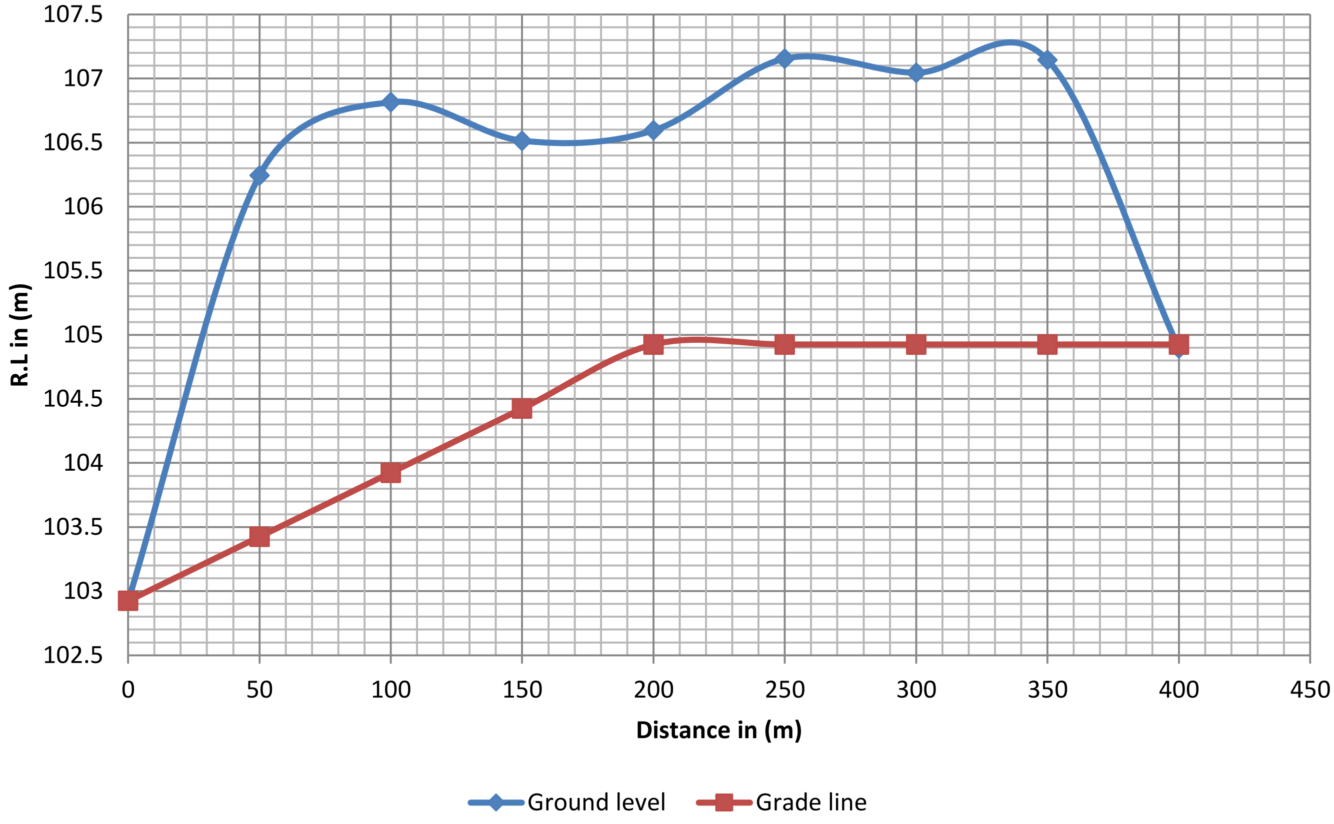
Sol:

station	Dis. (m)	R.L (m)	Grade line (m)	Cut +	Fill -
A	0+00	25	25	0	0
B	0+50	24.61	25		0.39
C	1+00	24.11	25		0.89
D	1+50	24.78	25		0.22
E	2+00	24.9	25		0.1
F	2+50	24.18	25		0.82
G	3+00	24.09	25		0.91
H	3+50	23.01	25		1.99
M	4+00	21.46	25		3.54

Example: **A leveling is done along center line of a street as shown below, if the R.L of the street first station is 102.925 m and the grade line starts from A with slope +1% up to point E then 0% up to end . Determine the height of the cut and fill, if we have the readings ⇒ 4.365, 1.045, (2.15), 1.58, 1.88, (2.03), 1.95, 1.39, 1.5, (1.7), 1.6, 3.85 and the H.S=1:5000 ,** V.S=1:50

Sol:

Sta.	B.S	I.S	F.S	H.I	Dist.	R.L	Grade line	Cut +	Fill -
A	4.365			107.29	0	102.925	102.925	0	0
B	2.15		1.045	108.395	50	106.245	103.425	2.82	
C		1.58			100	106.815	103.925	2.89	
D	2.03		1.88	108.545	150	106.515	104.425	2.09	
E		1.95			200	106.595	104.925	1.67	
F		1.39			250	107.155	104.925	2.23	
G	1.7		1.5	108.745	300	107.045	104.925	2.12	
H		1.6			350	107.145	104.925	2.22	
M			3.85		400	104.895	104.925		0.03
Σ	10.245		8.275						


107.5
107
106.5
106
105.5
105
104.5
104
103.5
103
102.5
R.L in (m)
0
50
100
150
200
250
300
350
400
450
Distance in (m)
Ground level
Grade line

Northern Technical University (NTU)
Technical college of Kirkuk (TCK)
Surveying Engineering Department

1st class

SURVEYING I

Lecture two : **(Second Semester)**

Cross-section levelling

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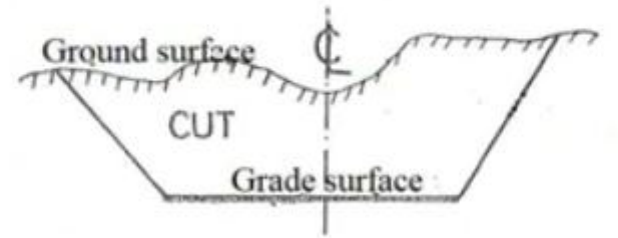
cross section levelling

Cross sectioning of ground surface is perpendicular to profile-section which mentioned in the profile levelling. It is obtained using the process of cross section levelling .in this process, the elevations of both right and left of the line are computed using short distances, and then the cross-section is determined.

Shapes of cross-sections

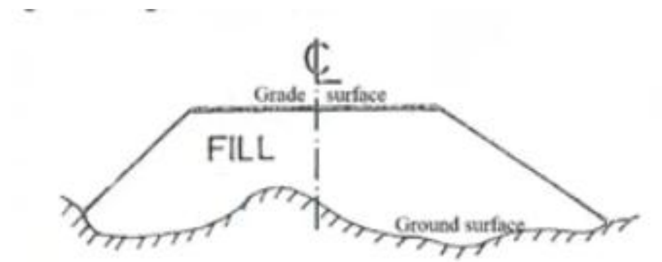
1-cut section:

Ground elevation is higher than grade elevation



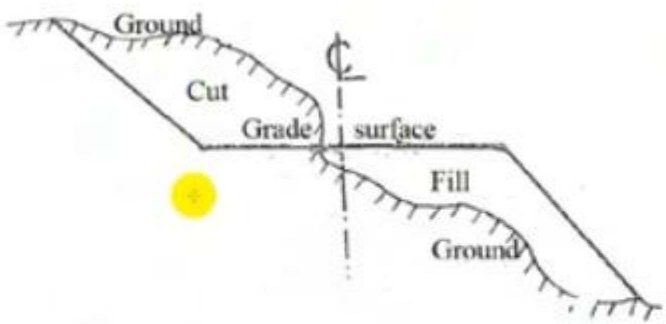
2-cut section:

grade elevation is higher than ground elevation



3-cut section:

In one side, ground elevation is higher than grade elevation and in another side the grade elevation is the higher



Shapes and calculations of cross-sections

-for a level-section

d= ground elevation – grade elevation

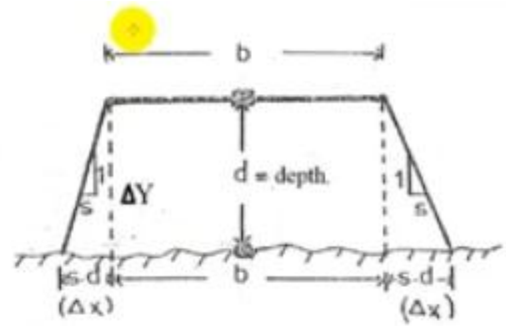
$\Delta X = S*d$

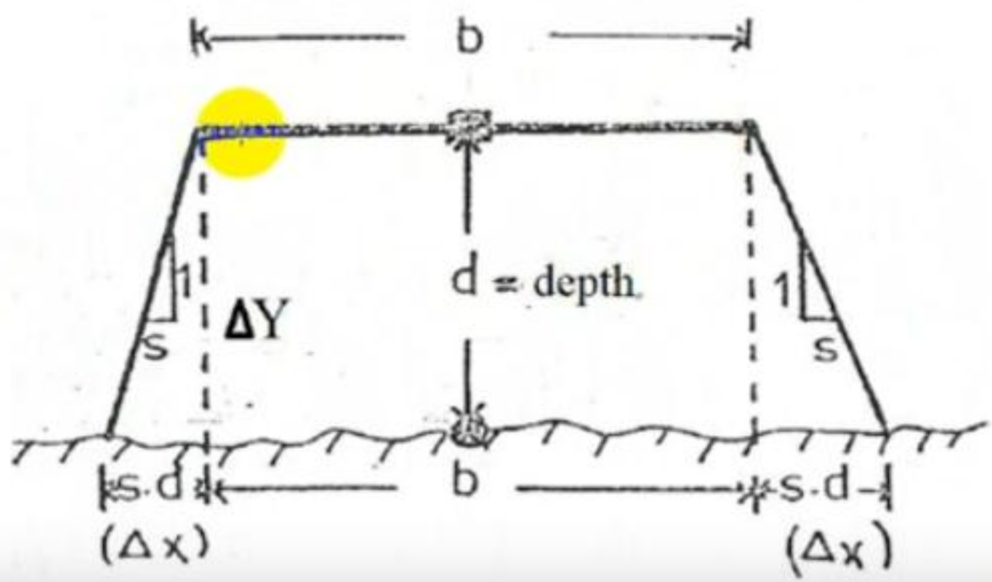
If d = + depth of cut

If d = - depth of fill

$1/S = \Delta Y/\Delta X$

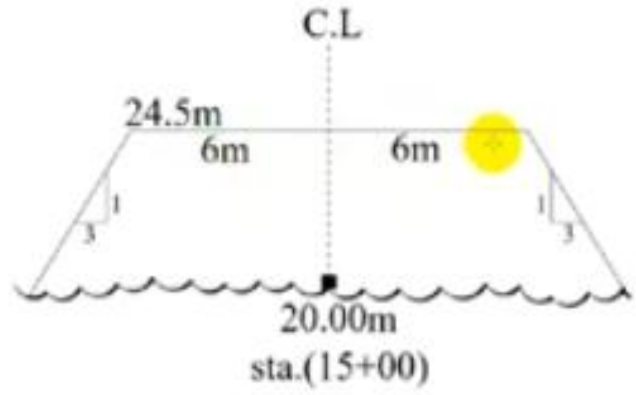
$A = d\,(b + s*d)$





Ex

Compute the area of cross section by using proper formula?



-For a three level section:

$$A = \frac{1}{2}\left[\frac{b}{2}(dR + dL) + d(XR + XL)\right]$$

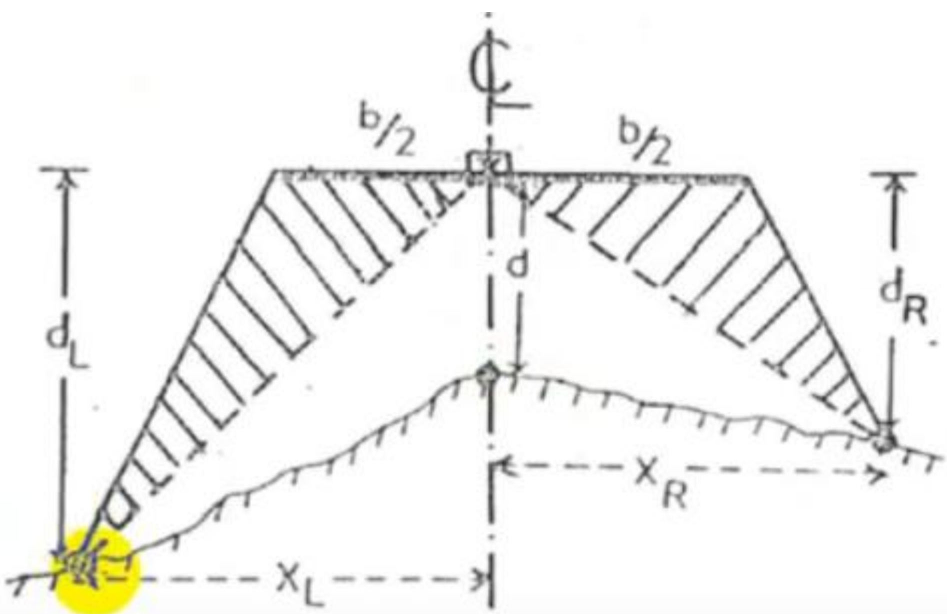
b= width of street

dR= depth of right

dL= depth of left

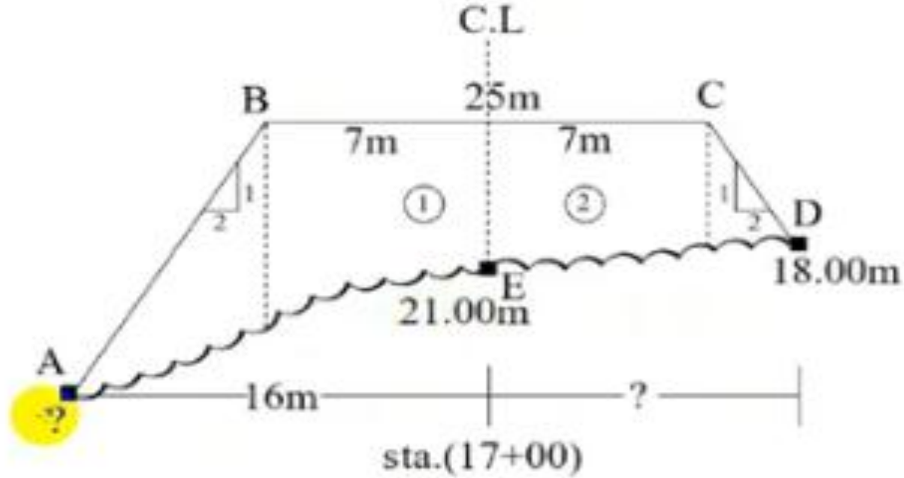
XR= distance of right

XL= distance of left



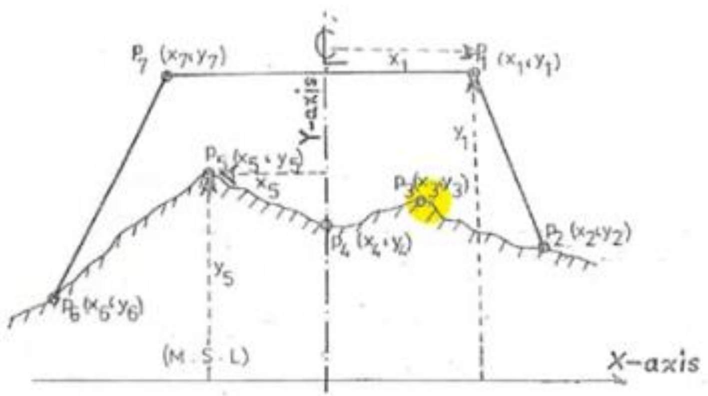
Ex

Compute the area of cross section by using proper formula?



-for a multi-level section:

In this case, the coordinate formula is used to calculate the area



Ex

Compute the area of cross section by using proper formula?