

Theoretical Concepts of Surveying

Prepared by:

Dr. Maher A. El-Hallaq

Associate Professor of Surveying – IUG

Chapter One: Introduction



Dr. Maher A. El-Hallaq

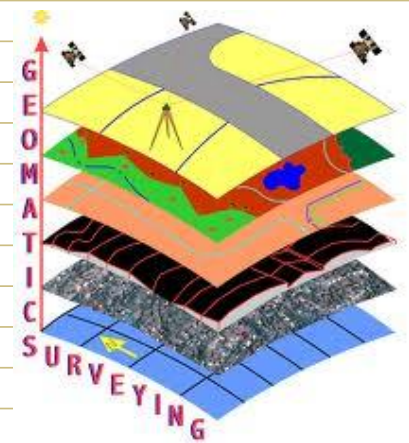
*Lecturer of Surveying
The Islamic University of Gaza*

Contents

- Survey definition.
- Earth surfaces.
- Survey types.
- Survey measurements.
- Survey Equipment.
- Survey scale
- Mapping outputs.

Surveying ?

Art and science of **making** and **analyzing** earth measurements and the **processing** of those measurements into positional information such as **maps** and **coordinates** and **etc.**



Surveying ?

علم و فن تمثيل سطح الأرض و ما عليها
من معالم طبيعية و صناعية على
الخرائط أو العكس.

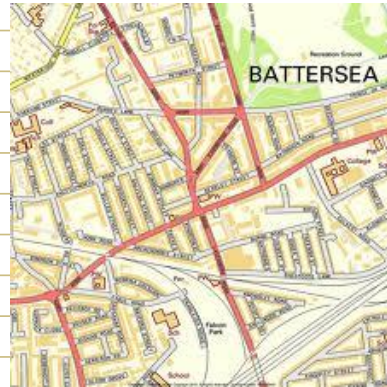


Surveying ?

The determination of relative spatial location of points on or near the earth surface.

It includes:

✓ Mapping tasks

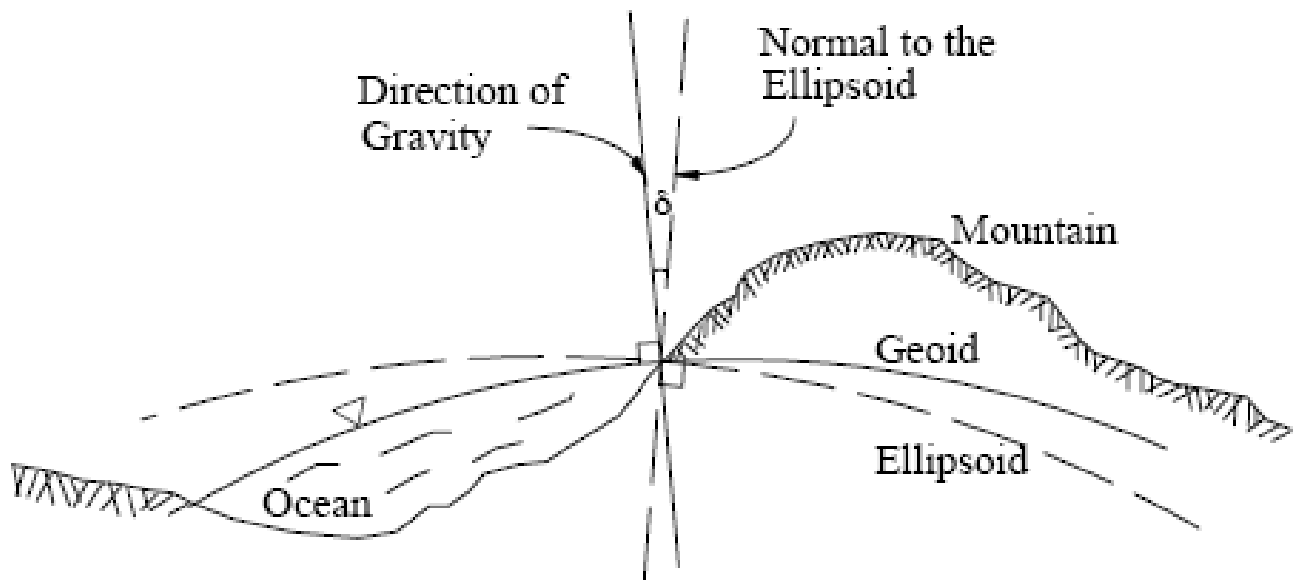


✓ Setting out tasks

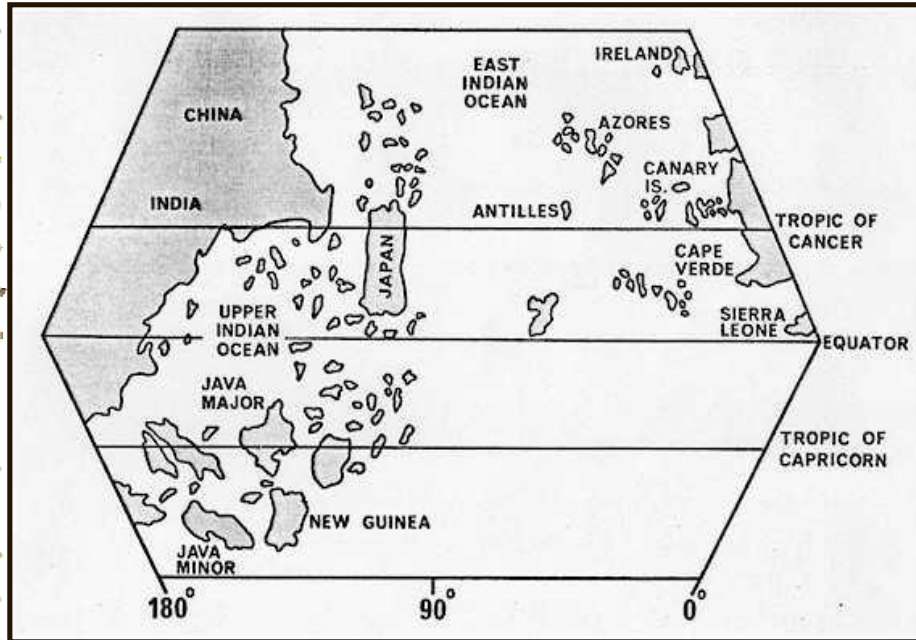


Earth Surfaces

- ✓ Natural surface.
- ✓ Geoid surface.
- ✓ Ellipsoid surface.



History of Surveying



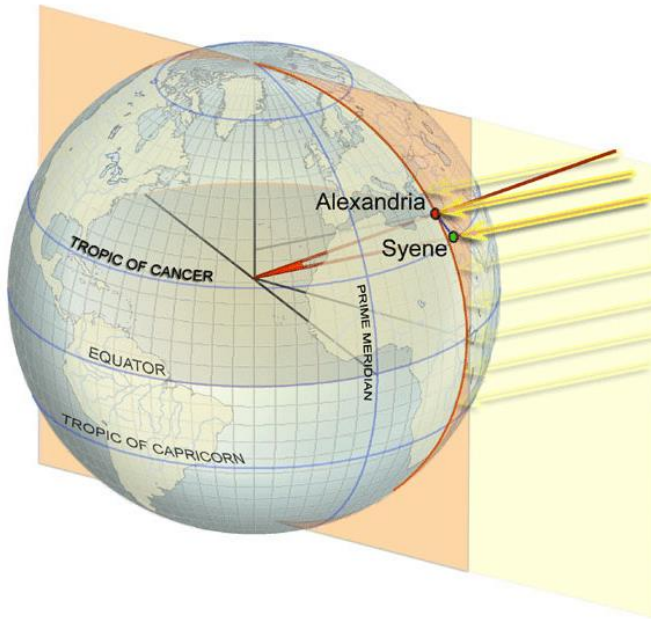
- Toscanelli (1397-1482) famous incorrect vision of the world

History of Surveying

Eratosthenes (215 BC)

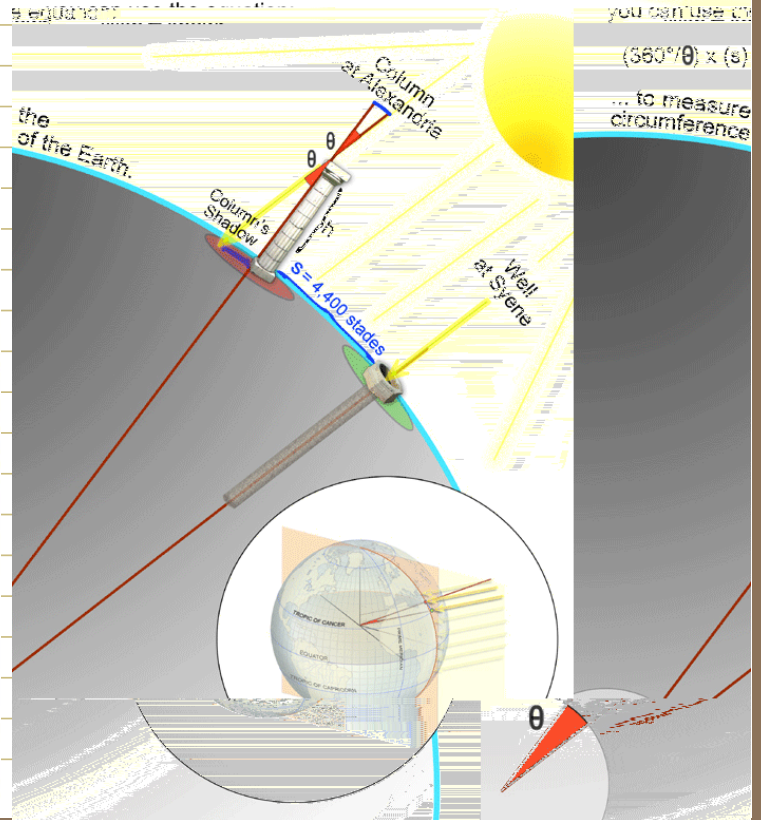
$S = 4400$ stadia ~ 787 km

$\theta = 7.2^\circ$ $C = 39376$ km



With h and s known,
you can solve for θ .

With θ known,



History of Surveying

The Earth is “almost” a sphere with a circumference
~**40000 km** long

Better approximate by an oblate ellipsoid

Today accepted Value

Equatorial Radius 6378 km

Polar Radius 6357 km

Sphere of Equal Volume Radius **6371 km**

Flattening 1/298.257223563

Survey Measurements

- Distances. أطوال
- Angles and directions. زوايا و اتجاهات
- Elevations. مناسيب

Recently:

Coordinates (x, y, z)

Survey Types

According to the size of survey

- **Plane surveying.** مساحة مستوية

area of survey $< 50 \text{ km}^2$

- **Geodetic surveying.** مساحة جيوديسية

area of survey $> 50 \text{ km}^2$

Survey Types

According to the purpose of survey

- Cadastral or Land surveying. مساحة تفصيلية
- Topographic surveying. مساحة طبوغرافية
- Route surveying. مساحة الطرق
- Hydrographic surveying. مساحة مائية
- Construction surveying. مساحة إنشائية
- Mine surveying. مساحة مناجم

Survey Types

According to the method of survey

- **Ground or Field surveying.** مساحة أرضية

Ex: Leveling, total station surveys

- **Remote surveying.** مساحة تصويرية

Arial photographs and satellite images

Chapter One: Introduction



Dr. Maher A. El-Hallaq

*Lecturer of Surveying
The Islamic University of Gaza*

Survey Scale

Architectural works, building works, location drawings: $1/50$, $1/100$ and $1/200$.

Site plans, civil engineering works: $1/500$, $1/1,000$, $1/1250$, $1/2,000$ and $1/2,500$.

Town surveys, highway surveys: $1/1250$, $1/2,000$, $1/2,500$, $1/5,000$, $1/10,000$, $1/20,000$ and $1/50,000$.

Mapping: $1/25,000$, $1/50,000$, $1/100,000$, $1/200,000$, $1/500,000$ and $1/1,000,000$.

Survey units

Length Measurement Unit

$$1 \text{ meter} = 100 \text{ cm}$$

$$1 \text{ kilometer} = 1000 \text{ m}$$

$$1 \text{ foot} = 12 \text{ inches}$$

$$1 \text{ yard} = 3 \text{ ft}$$

$$1 \text{ mile} = 5280 \text{ ft}$$

Area Measurement

$$1 \text{ donum} = 1,000 \text{ m}^2$$

$$1 \text{ hectare} = 10,000 \text{ m}^2$$

$$1 \text{ km}^2 = 1,000,000 \text{ m}^2 = 100 \text{ ha}$$

$$1 \text{ acre} = 43560 \text{ ft}^2$$

Angle Measurement

$$1^\circ = 60' = 3600''$$

$$1^g = 100^c = 10,000^s$$

$$\text{Example: } 213^\circ 24' 47''$$

$$\text{Example: } 128^g 60^c 81^s$$

360

400

Survey Equipment

- Distances.

{tapes, EDM, theodolite, total station, etc}

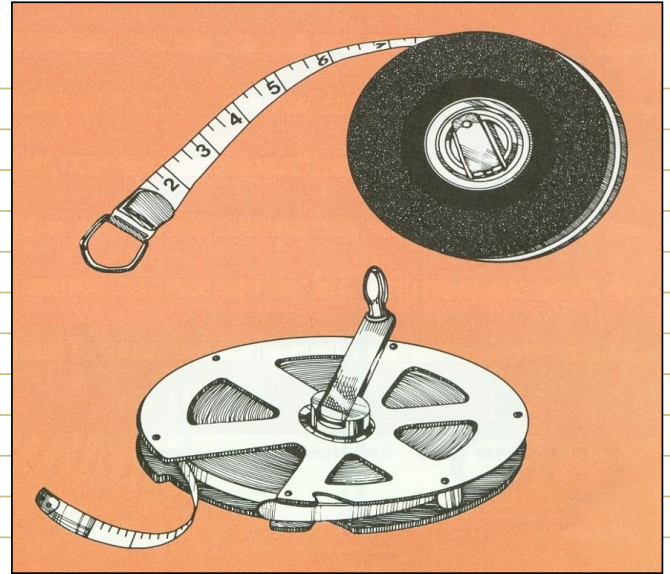
- Angles and directions.

{theodolite, compass, total station, etc}

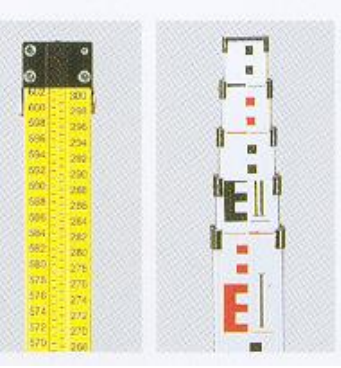
- Elevations.

{level, theodolite, total station, GPS, etc}

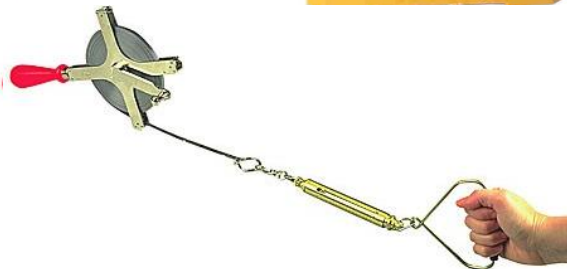
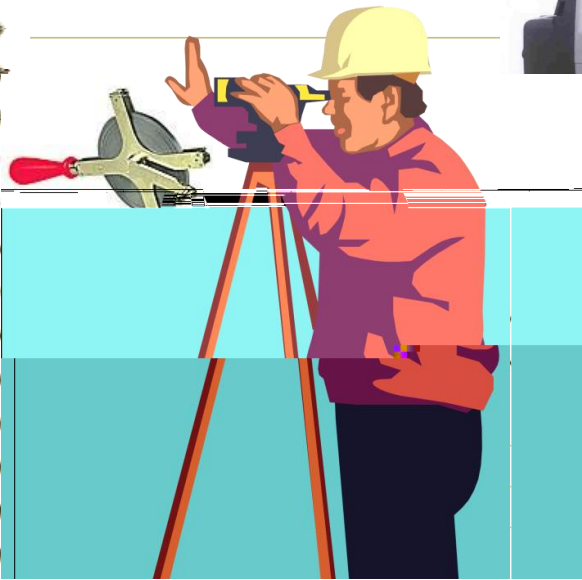
Survey Equipment



Survey Equipment



0.5 m



Survey Equipment



Total Station



Survey Equipment



GPS

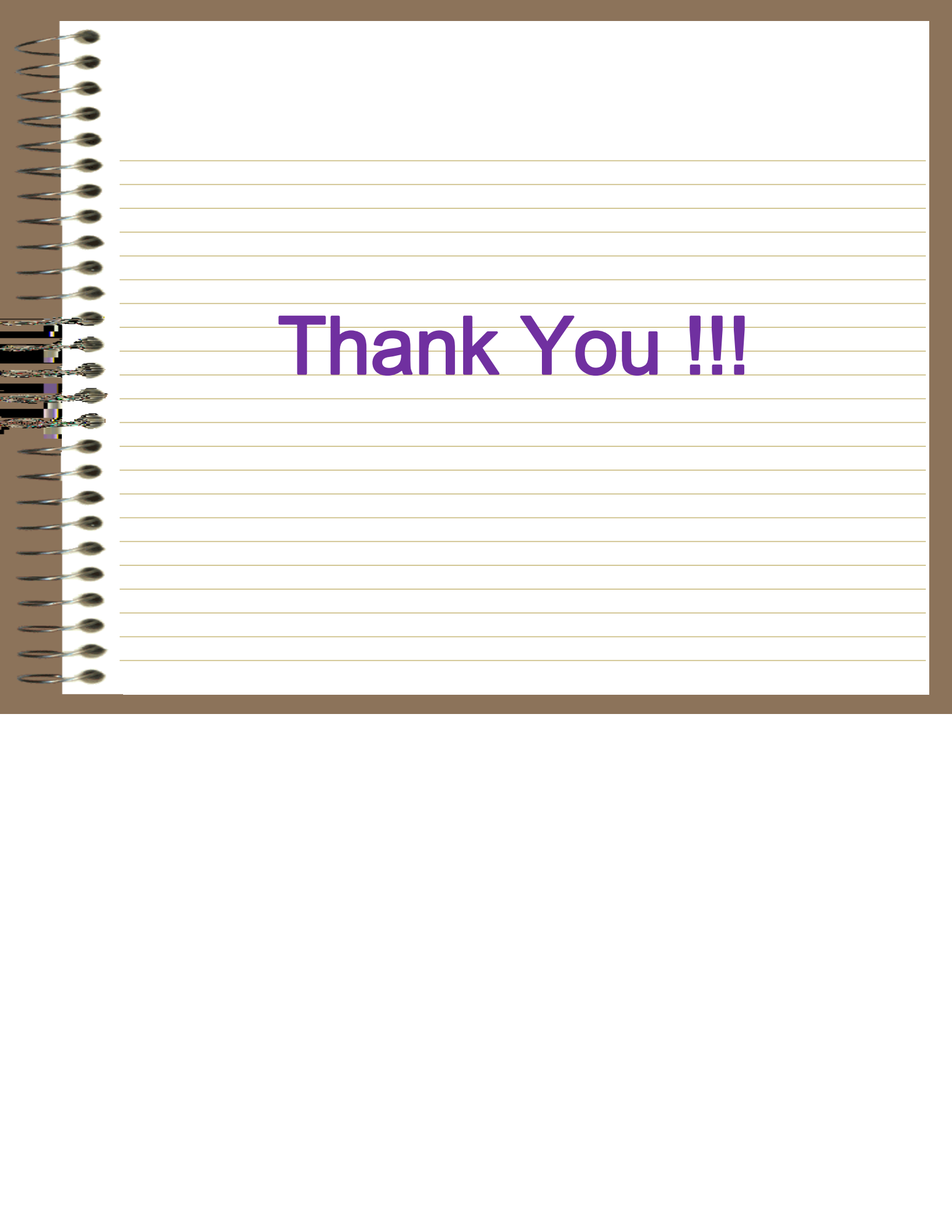


Field and office work

- Planning and design of the survey.
- Care, handling and adjustment of the instrument.
- Fixing horizontal locations of objects.
- Determining the elevations of objects.
- Recording field measurements.
- Field computations for purpose of verifying the data.
- Office computations.

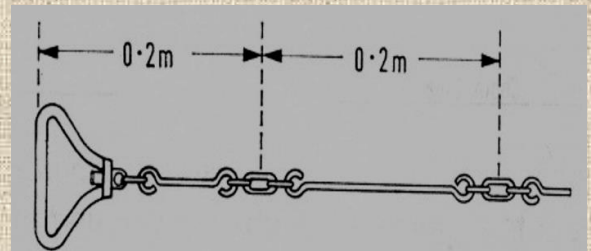
Methods of presenting data

- Maps. (planimetric and topographic)
 - geographic maps: large areas.
 - hydrographic maps: shorelines, bottom conditions, depths.
 - thematic maps: concentration of a specified subject.
 - photogrammetric maps and orthophotos
- Profiles.
- Cross sections.
- Geographic calculations.
- others.

A spiral-bound notebook with a brown cover and a white page. The page has horizontal yellow lines. The text "Thank You !!!" is written in the center in a bold, purple, sans-serif font. The spiral binding is on the left side.

Thank You !!!

Chapter 3: Chain Surveying



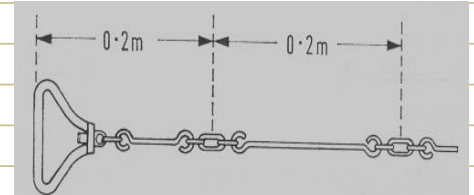
Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

Contents

- Taping Methods.
- Taping Equipment.
- Tape Surveying Process.
- Lines Measurement.
- Setting out right angles.
- Mapping Details.
- Taping Obstacles.
- Taping Errors.

Taping Methods

- Pacing
- Car Speed
- Chain
- Tape
- EDM
- GPS



Dr. Maher A. El-Hallaq

Taping Equipment

1. Tapes

Length: (10 m, 20 m, 30 m, 50 m)

Material: Steel or fiber glass

Purpose: measuring distances



Dr. Maher A. El-Hallaq

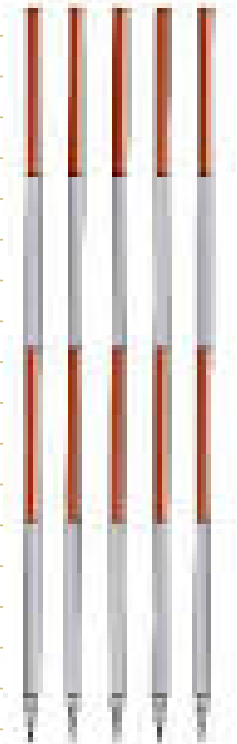
Taping Equipment

2. Ranging Rods

Length: (2 m, 2.5 m, 3 m)

Material: Steel or wood

Purpose: showing stations



Dr. Maher A. El-Hallaq

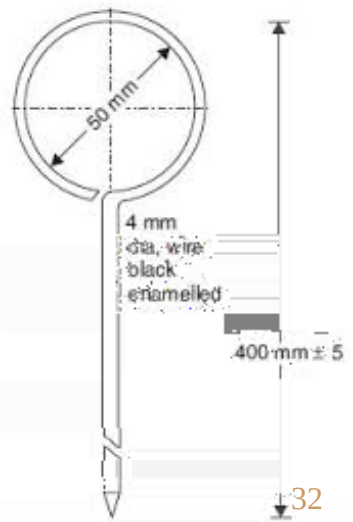
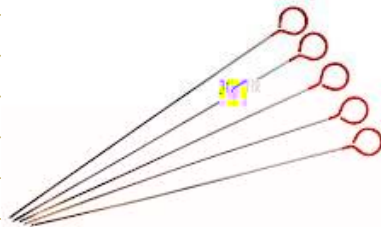
Taping Equipment

3. Arrows

Length: (40 cm long, 4 mm in diameter)

Material: Steel

Purpose: mark and fix stations



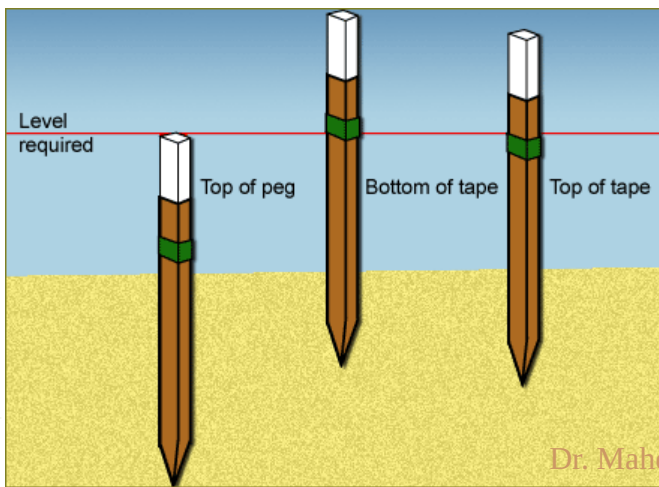
Taping Equipment

4. Pegs

Length: (4×4 cm, 3-5 cm di, 40 cm long)

Material: Steel or wood

Purpose: marking and fixing stations



Dr. Maher A. El-Hallaq

Taping Equipment

5. Markings



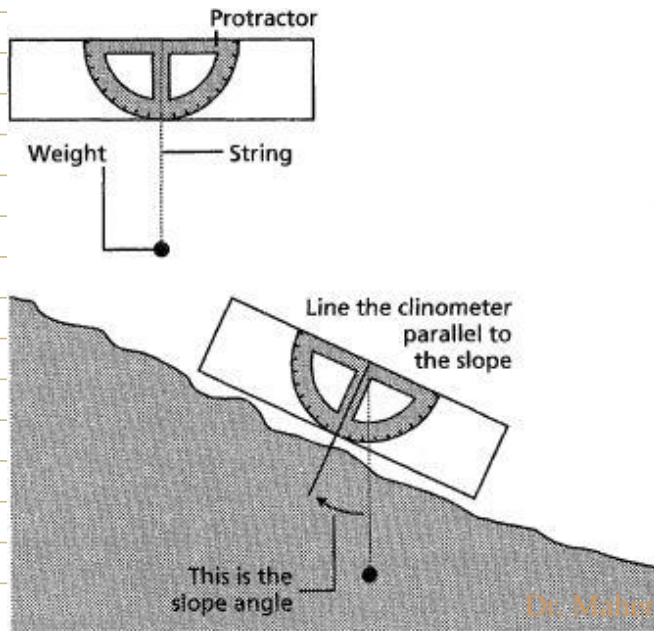
Purpose: marking and fixing stations



Taping Equipment

7. Clinometer (Abney level)

Purpose: measuring the inclination angle of sloping lines



Taping Equipment

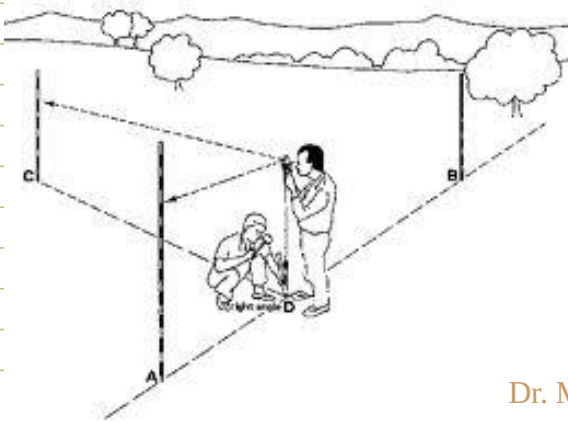
8. Compass

Purpose: **measuring directions**



Taping Equipment

9. Others

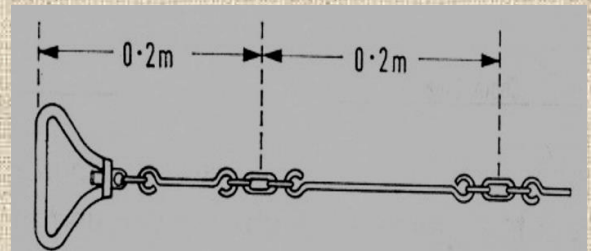


Dr. Maher A. El-Hallaq

Thank you

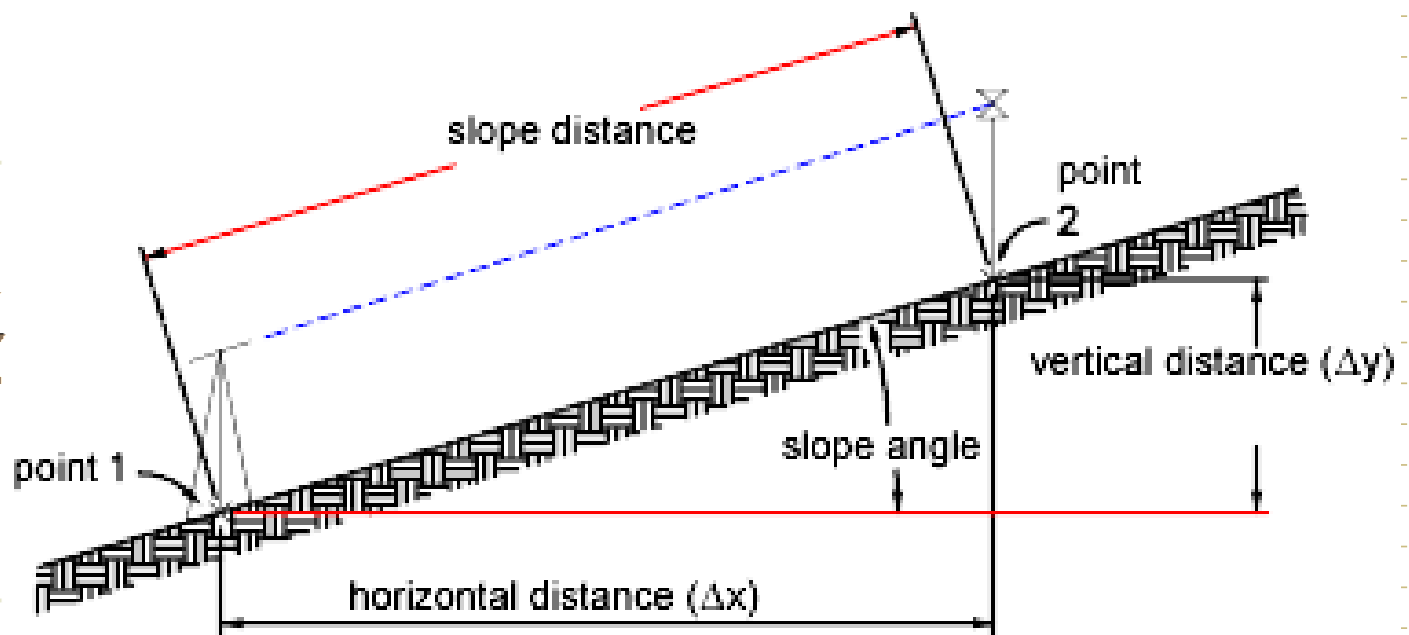


Chapter 3: Chain Surveying



Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

Tape Surveying Process



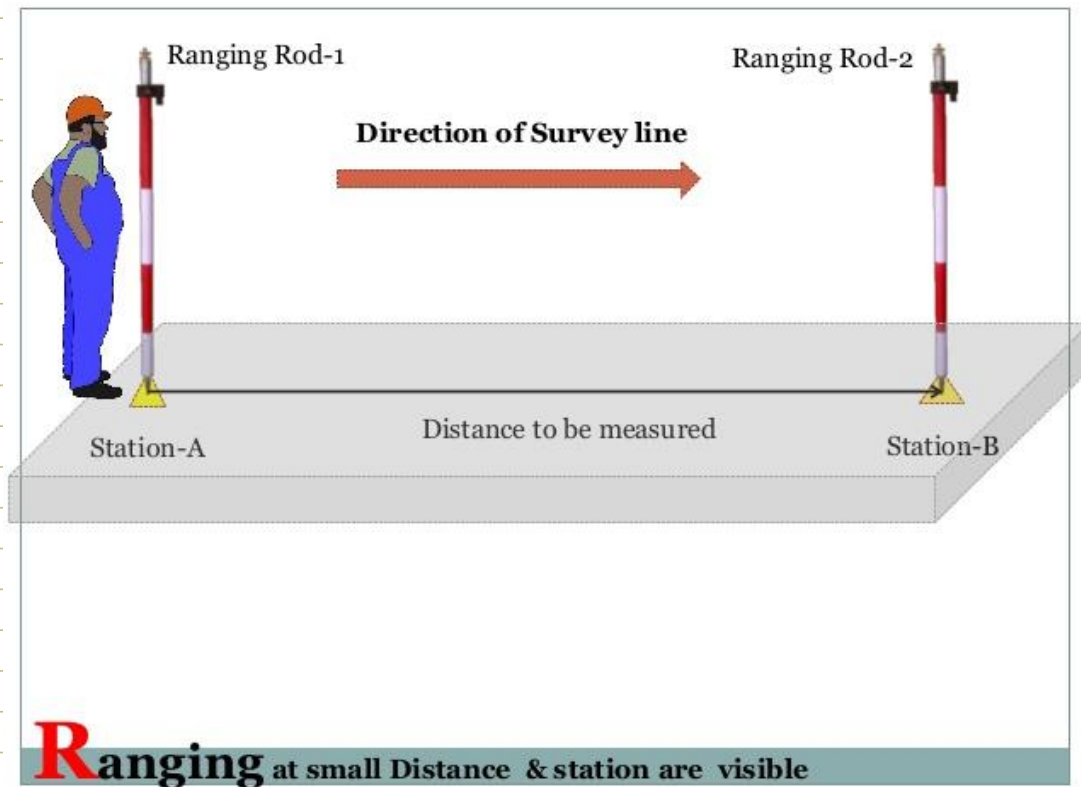
Tape Surveying Process

Line measuring cases:

1. Level ground
2. Uniformly sloping ground
3. Uneven ground

Tape Surveying Process

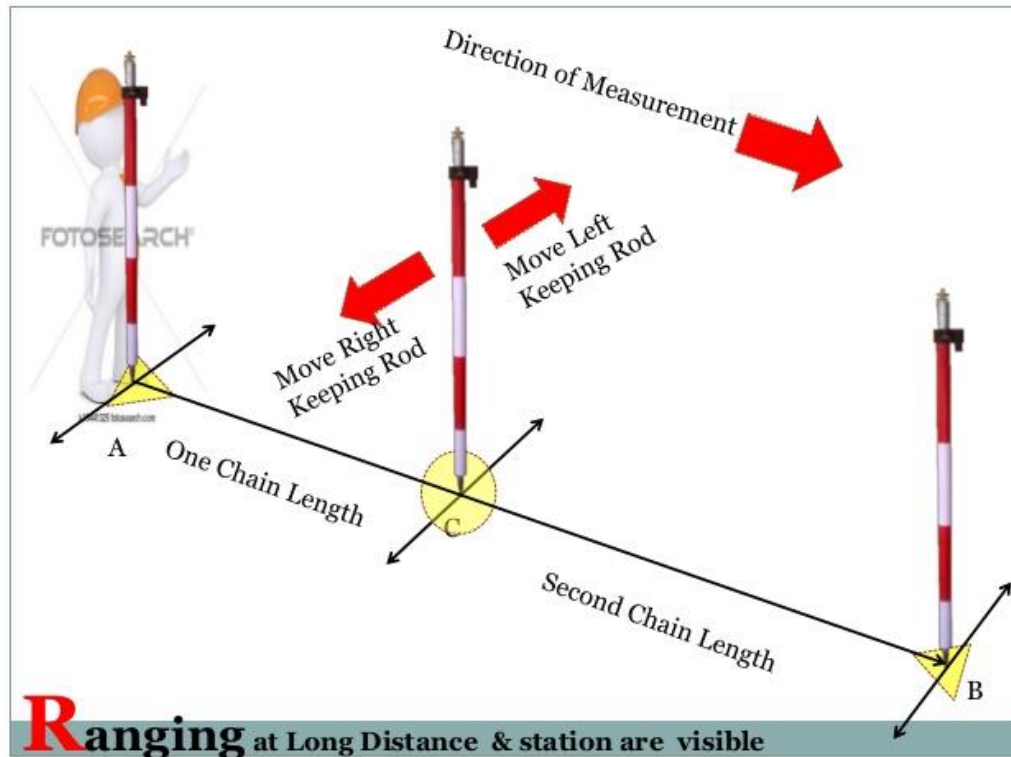
1. Level ground ($D < \text{Tape length}$)



Dr. Maher A. El-Hallaq

Tape Surveying Process

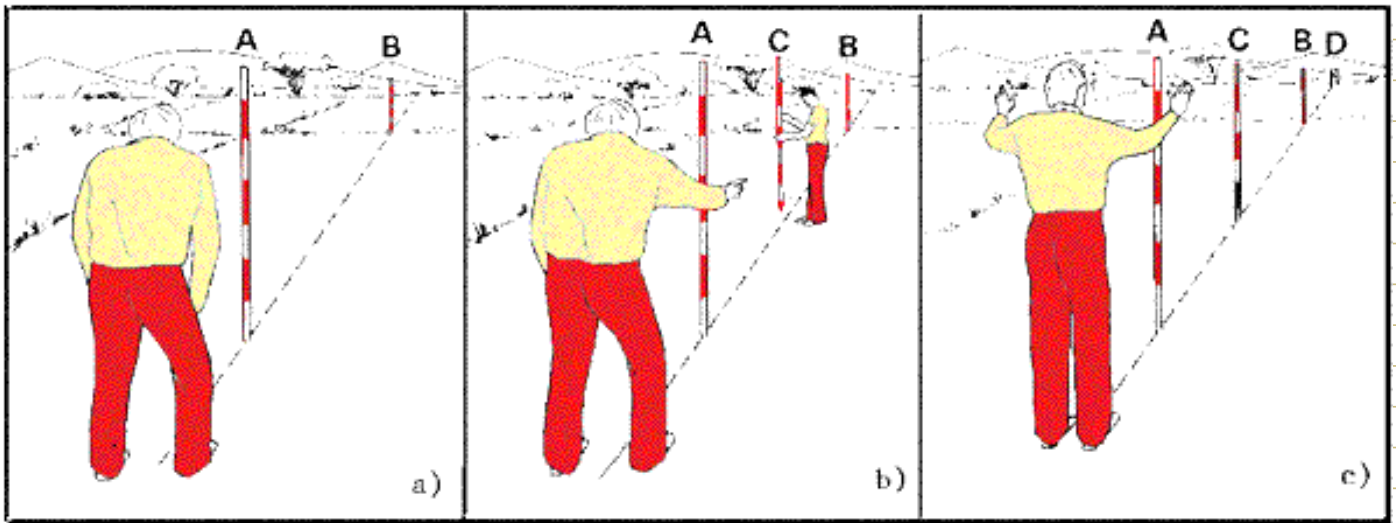
1. Level ground ($D > \text{Tape length}$)





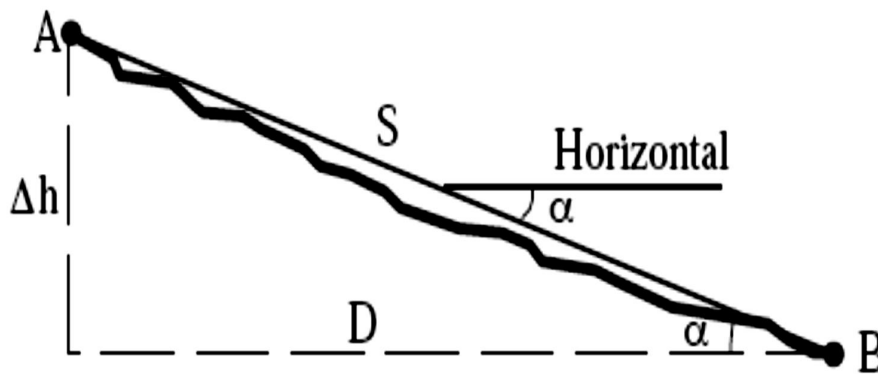
Tape Surveying Process

1. Level ground

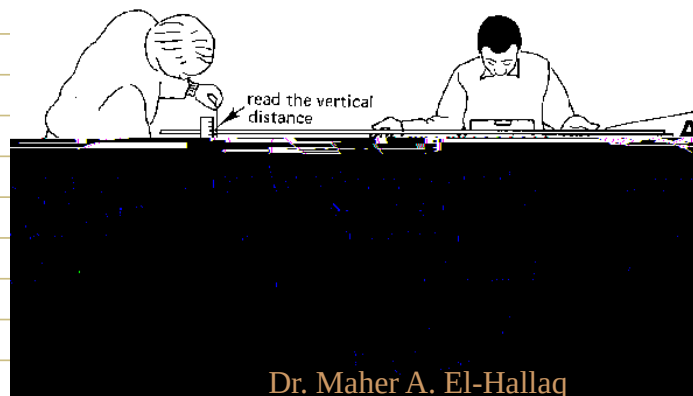


Tape Surveying Process

2. Uniformly sloping ground Short Distance



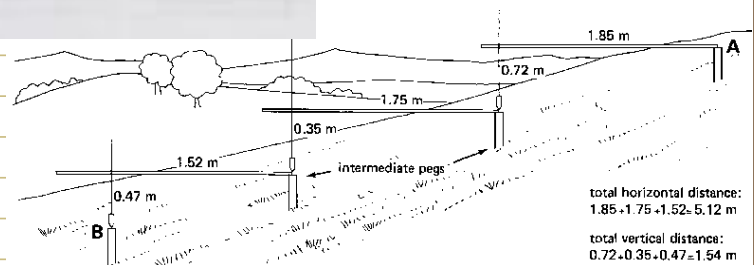
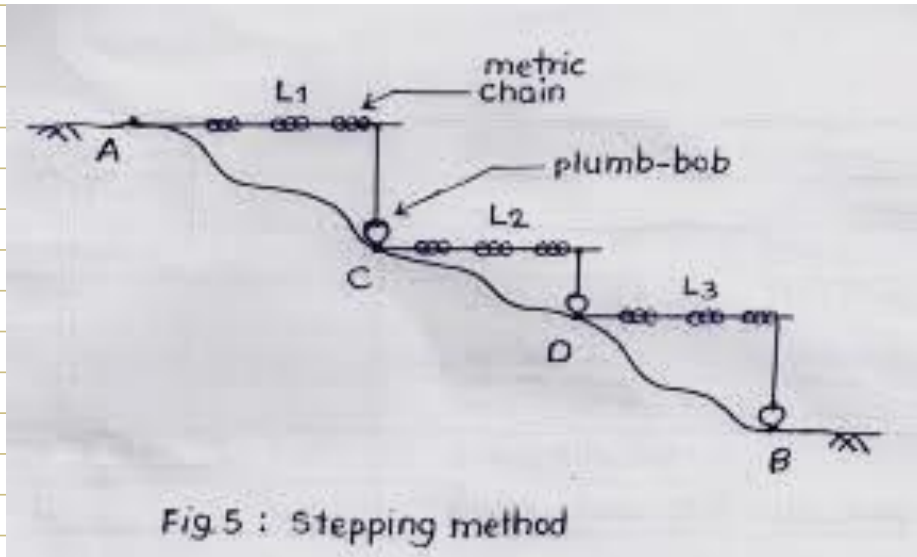
$$D = S \cdot \cos \alpha$$
$$\Delta h = S \cdot \sin \alpha$$



Dr. Maher A. El-Hallaq

Tape Surveying Process

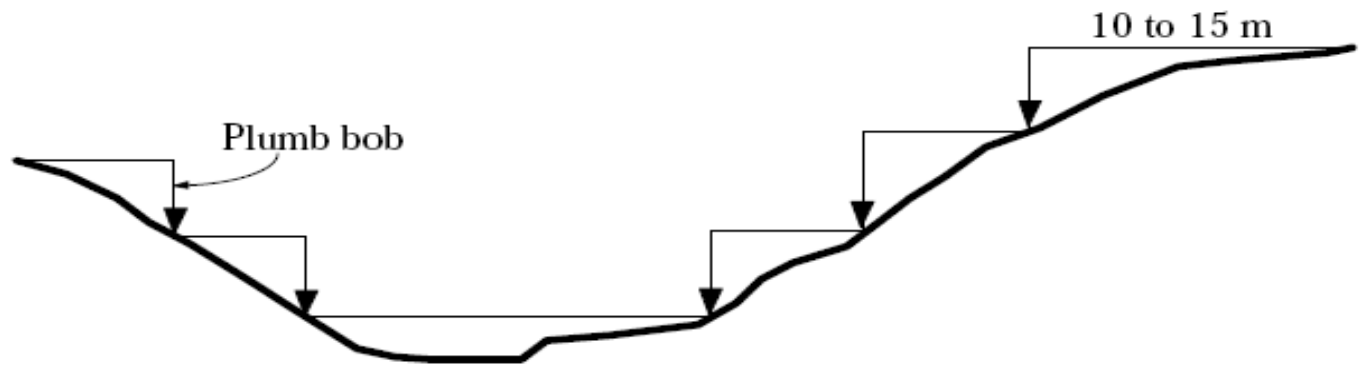
2. Uniformly sloping ground Long Distance



Dr. Maher A. El-Hallaq

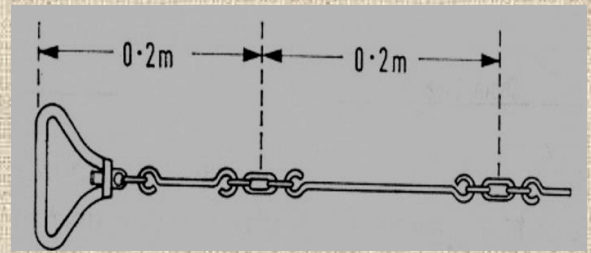
Tape Surveying Process

3. Uneven ground





Chapter 3: Chain Surveying



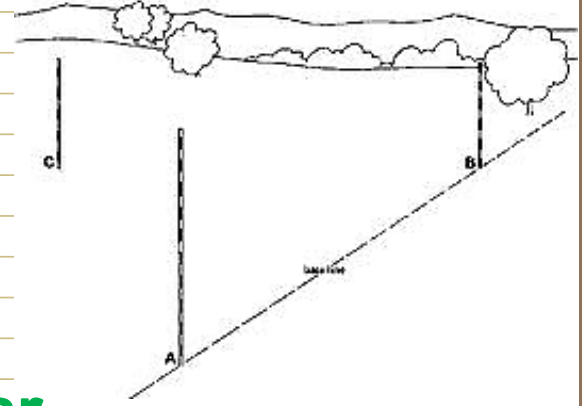
Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

Setting out right angles

Setting out includes: توقيـع الأعمدة

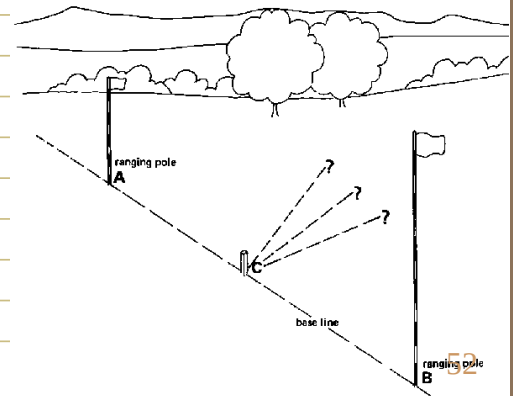
✓ Dropping a perpendicular

- Shortest distance method
- The equilateral triangle
- Prisma method



✓ Erecting a perpendicular

- The equilateral triangle
- Pythagoras method
- Prisma method

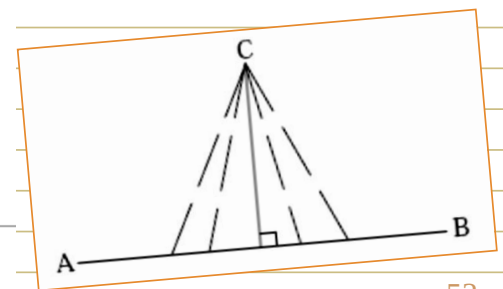
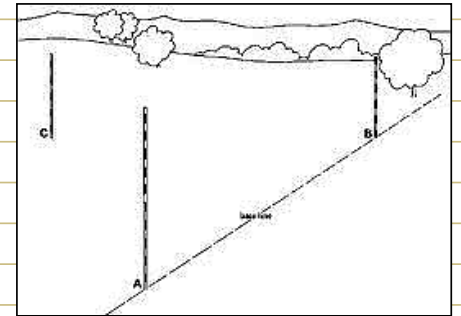
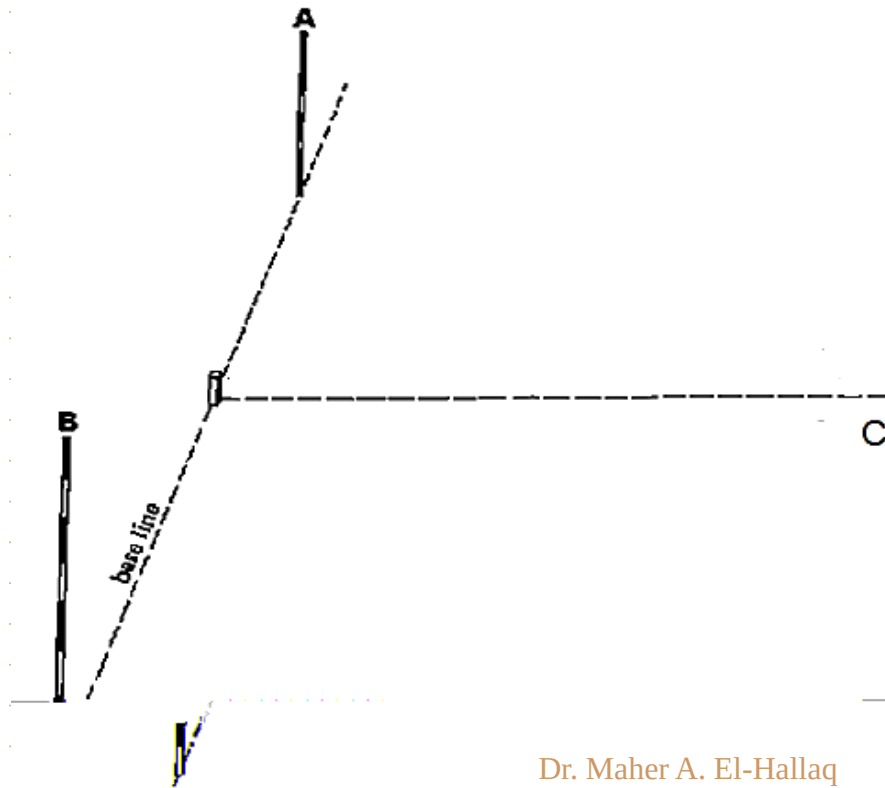


Dr. Maher A. El-Hallaq

Setting out right angles

✓ Dropping a perpendicular

The Shortest distance method

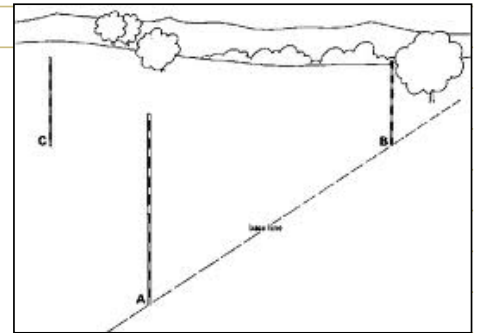
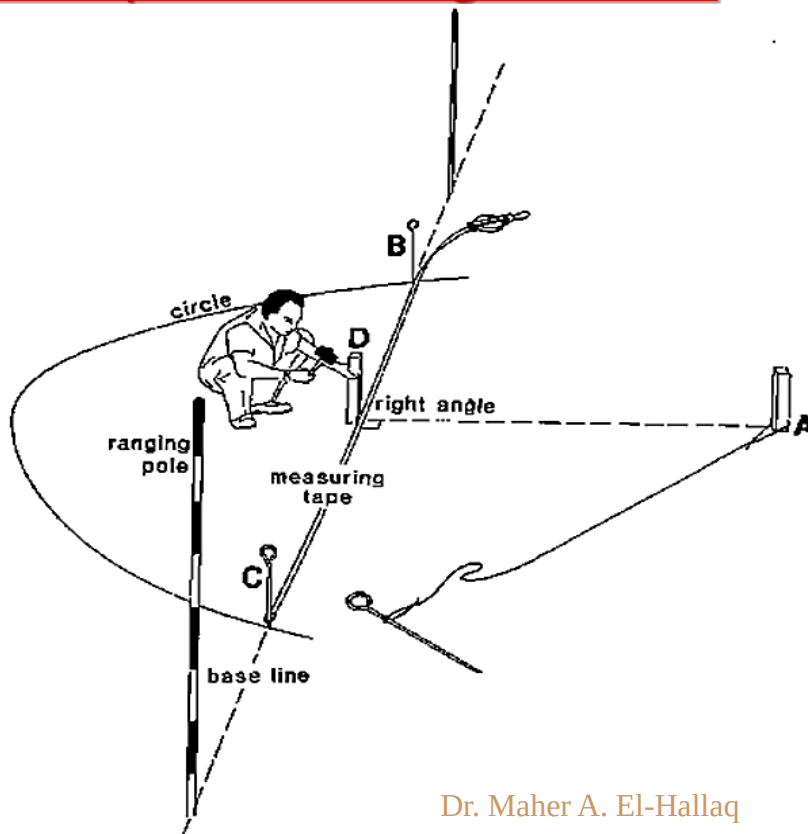


Dr. Maher A. El-Hallaq

Setting out right angles

✓ Dropping a perpendicular

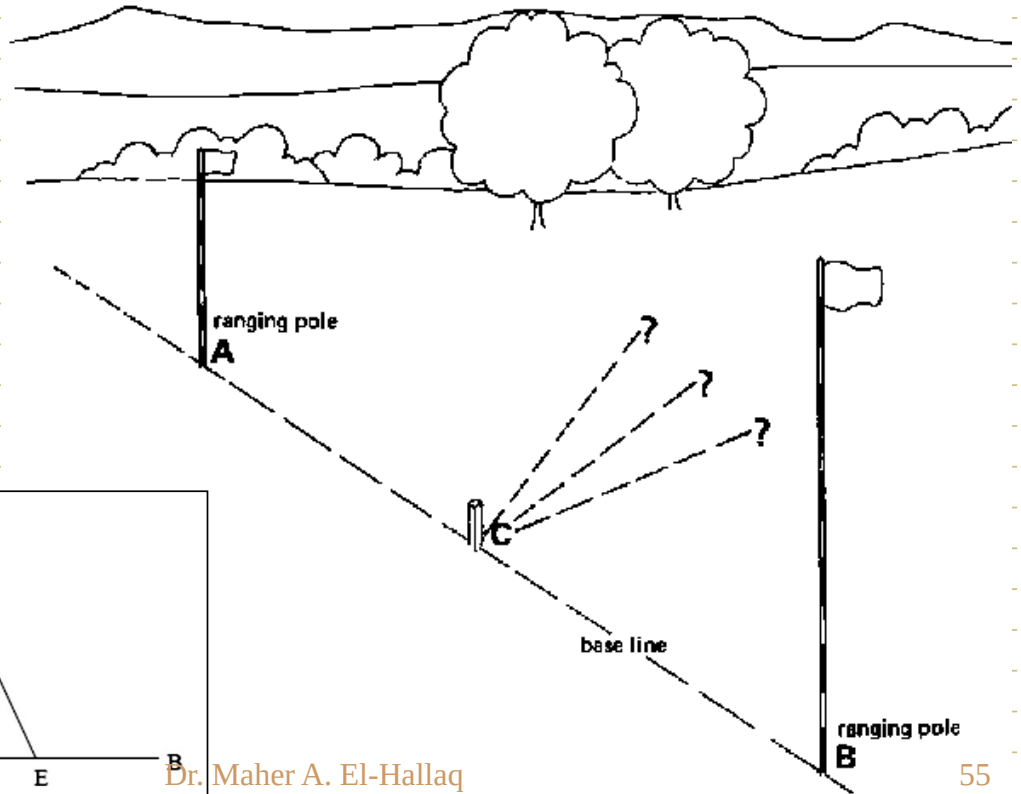
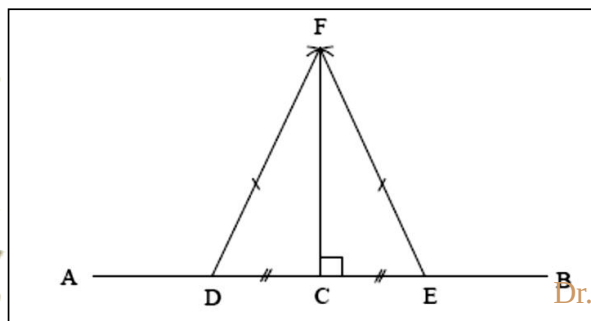
The equilateral triangle method



Setting out right angles

✓ Erecting a perpendicular

- The equilateral triangle

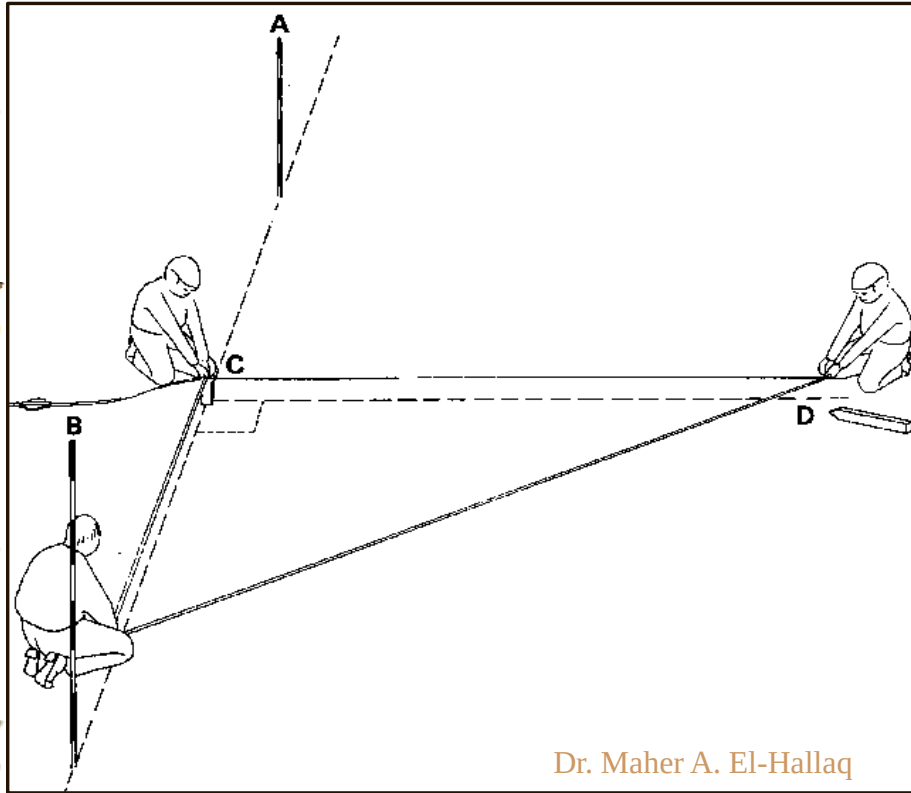


Dr. Maher A. El-Hallaq

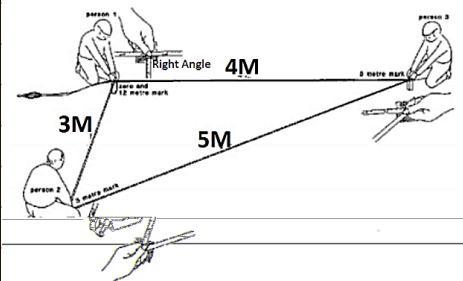
Setting out right angles

✓ Erecting a perpendicular

- Pythagoras Method



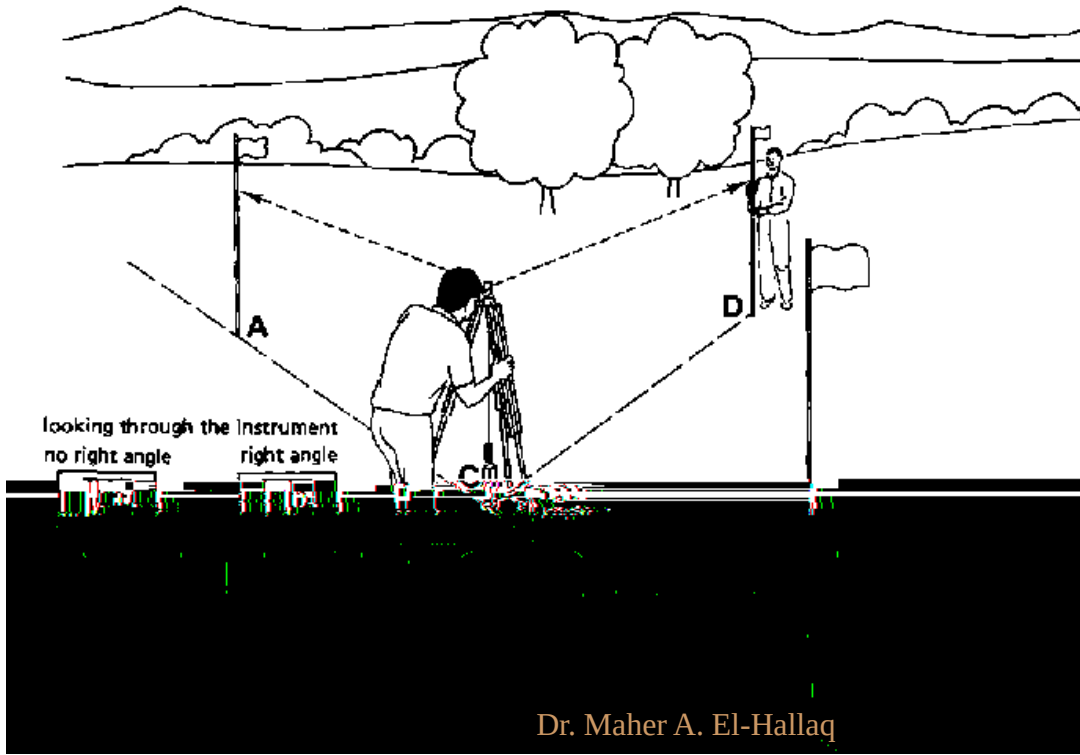
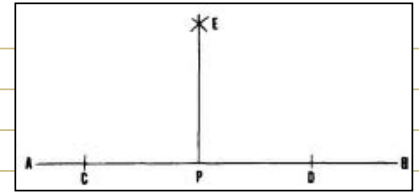
Dr. Maher A. El-Hallaq



Setting out right angles

✓ Erecting a perpendicular

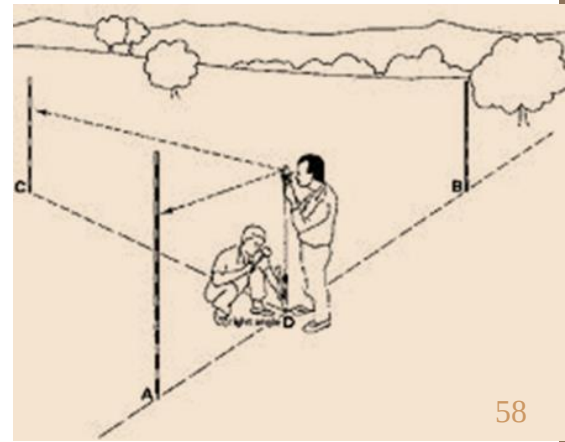
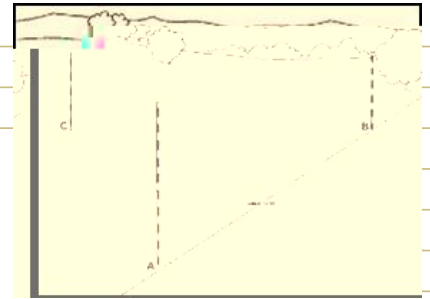
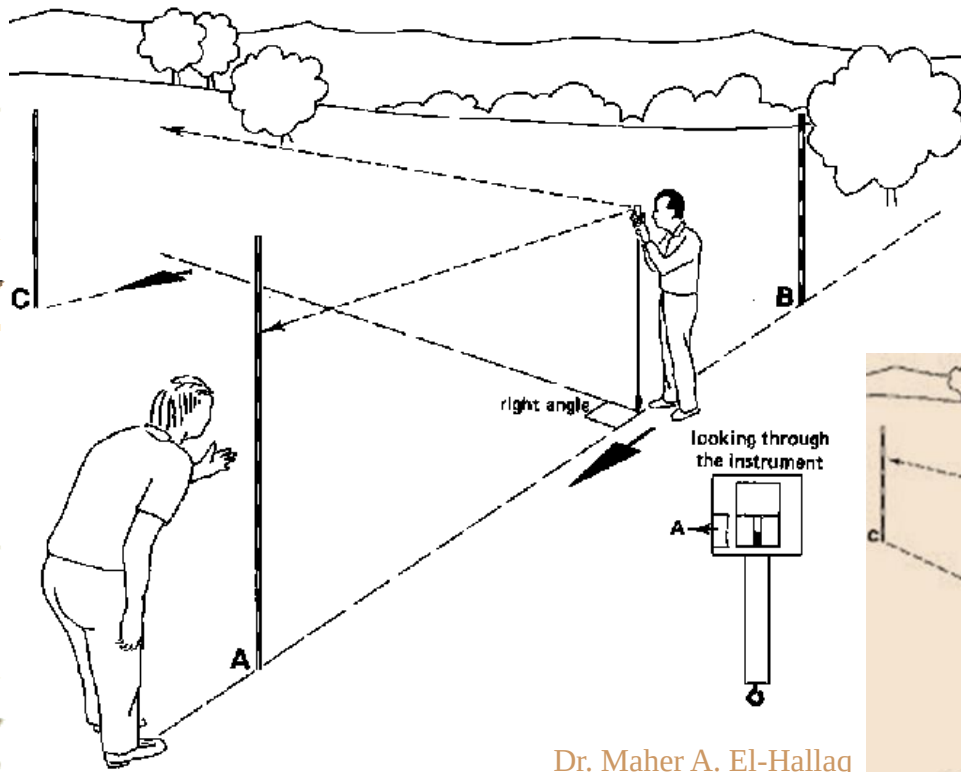
- Prisma Method



Setting out right angles

✓ Dropping a perpendicular

- Prisma Method

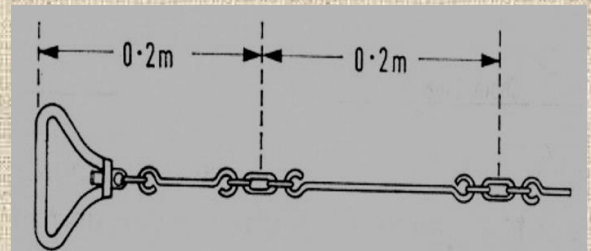


Dr. Maher A. El-Hallaq

Thank you



Chapter 3: Chain Surveying



Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

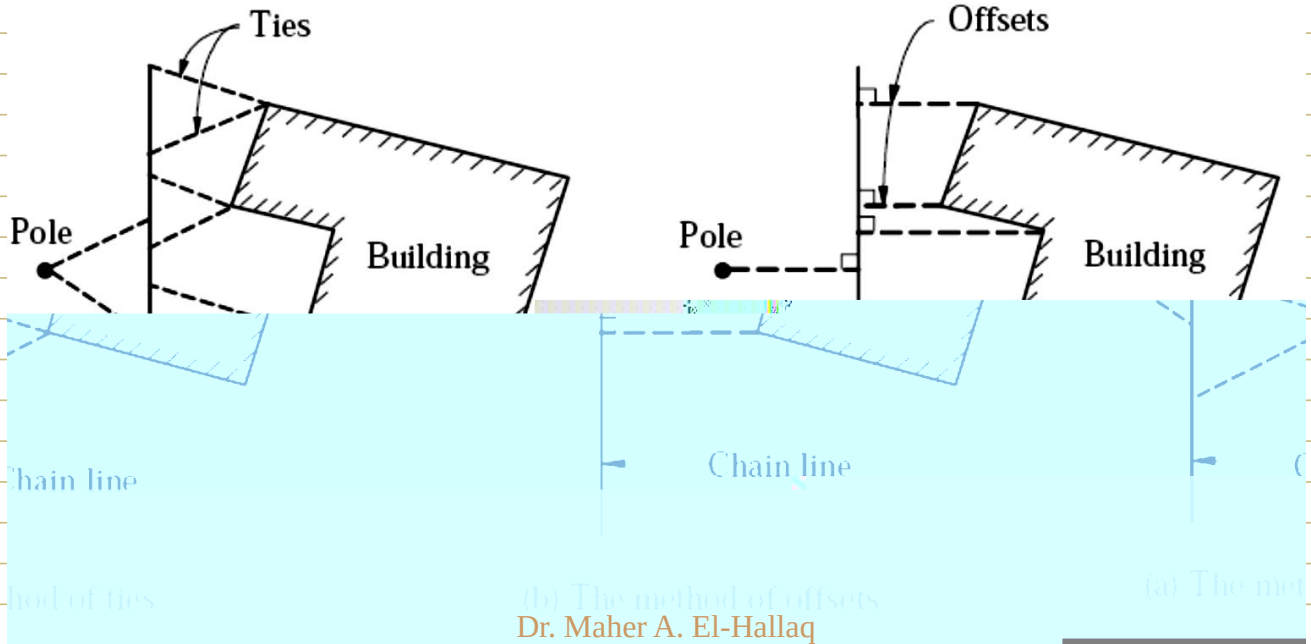
Mapping Details using chain surveying

Mapping Methods:

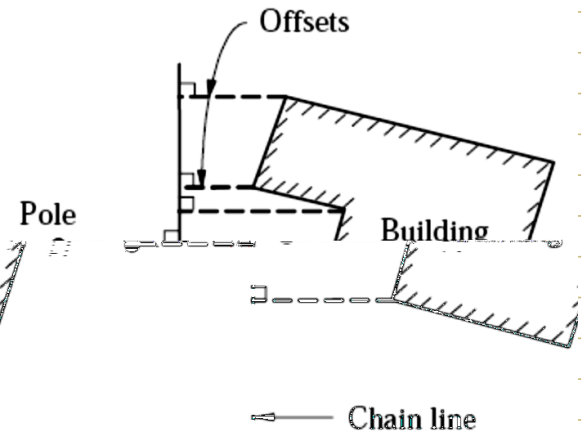
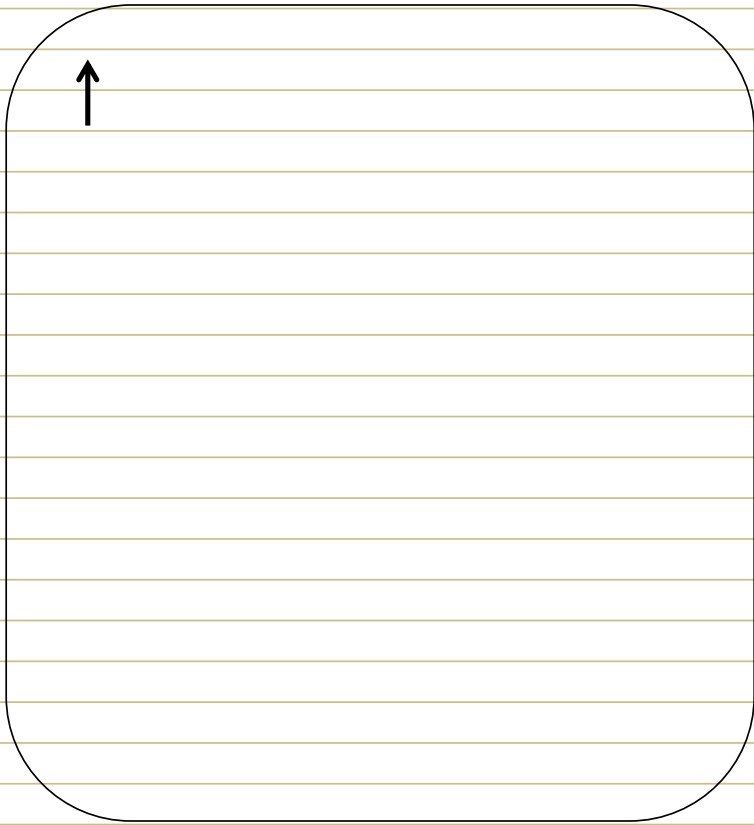
1. Method of offsets

2. Method of ties

Chain line = known survey line
= known (length + direction)

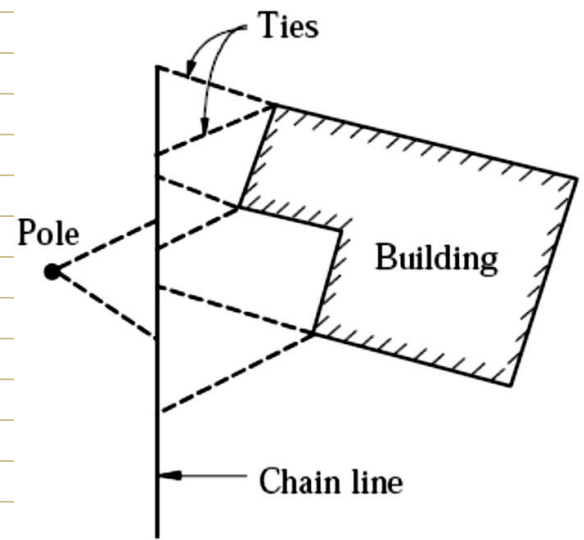
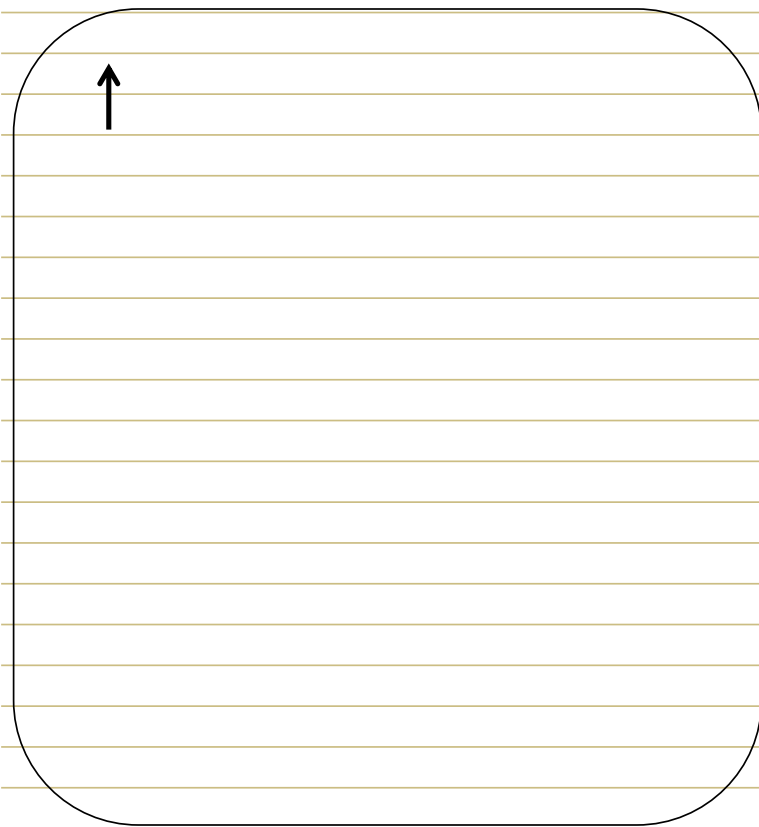


Mapping Details using chain surveying



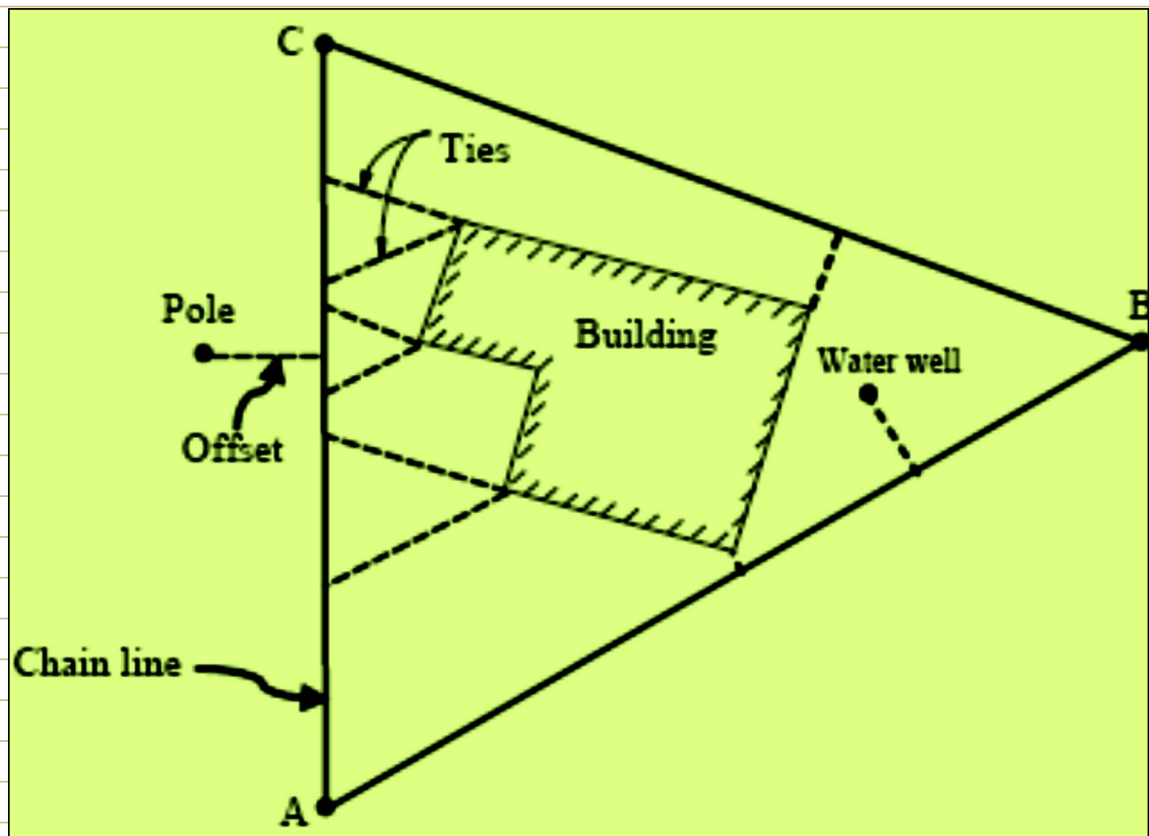
(b) The method of offsets

Mapping Details using chain surveying

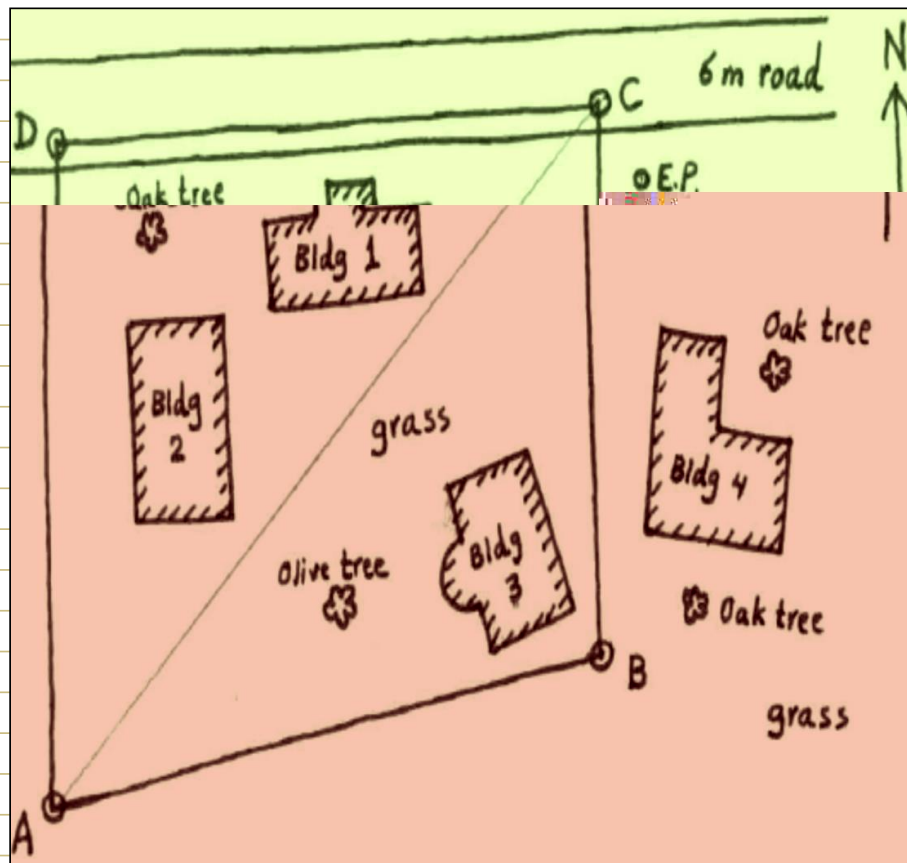


(a) The method of ties

Mapping Details using chain surveying

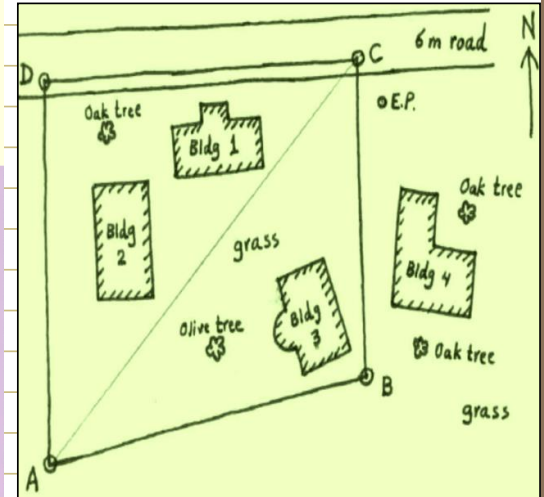
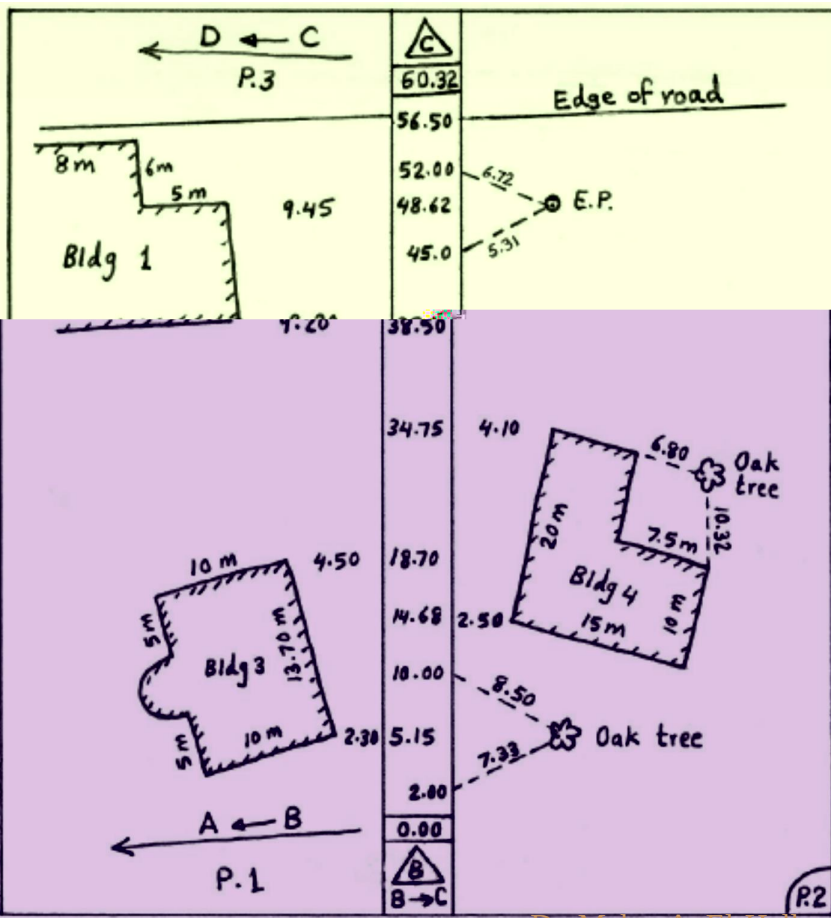


Mapping Details using chain surveying



1. Chain stations should be chosen on firm, easy to reach grounds and close to stationary objects
2. Chain lines should be as close as possible to details
3. No. of chain lines should be kept to a minimum
4. Chain lines should not pass through obstacles
5. It should be possible to see at least two other stations from each station
6. Angles between chain

Mapping Details using chain surveying

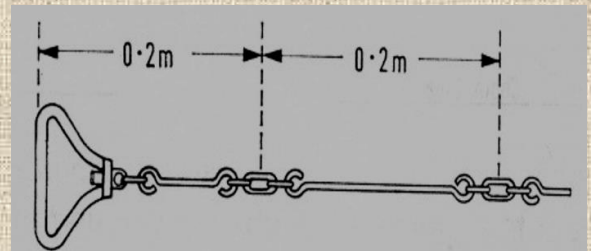


Dr. Maher A. El-Hallaq

Thank you



Chapter 3: Chain Surveying



Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

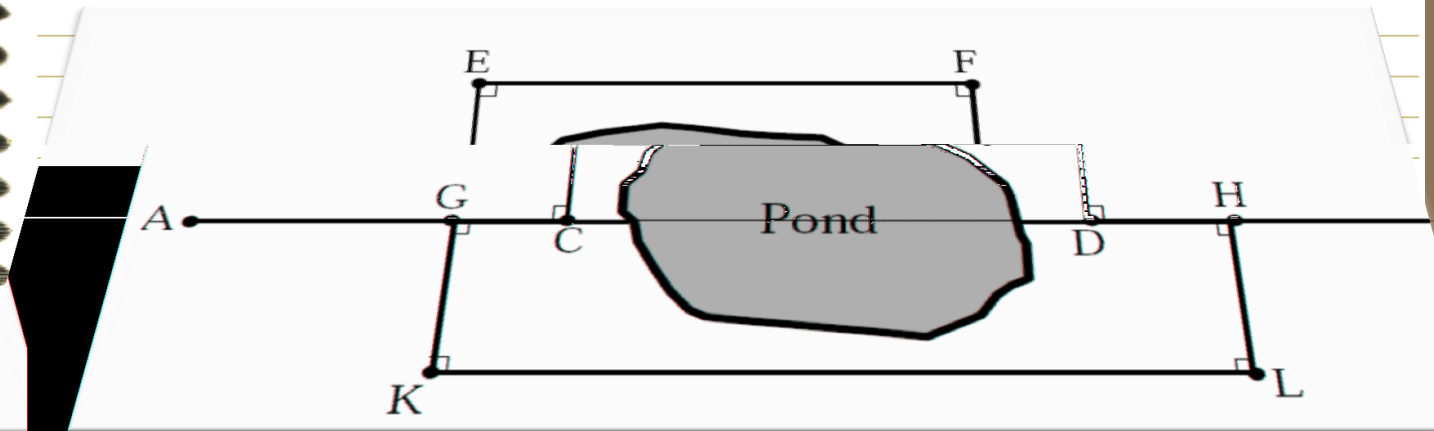
Chaining Obstacles

Three cases:

1. Vision is clear but chaining is prevented
2. Chaining is possible but vision is prevented
3. Both vision and chaining are prevented

Chaining Obstacles

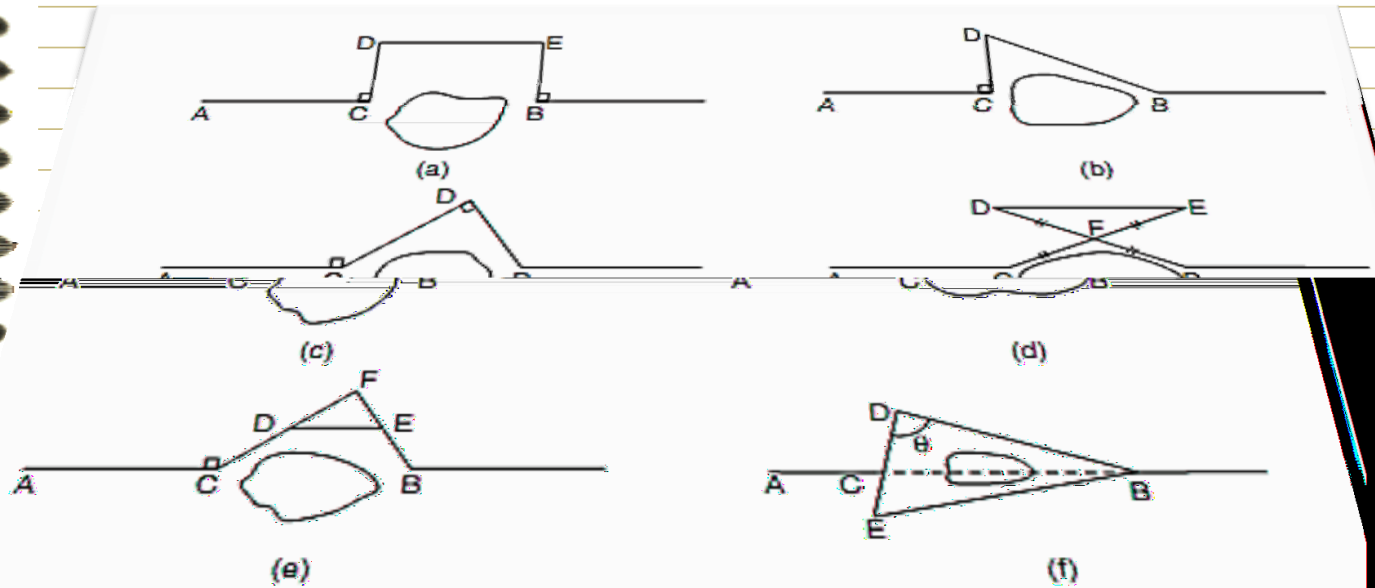
1. Vision is clear but chaining is prevented



$$\begin{aligned} AB &= AC + EF + DB \\ &= AG + KL + HB \end{aligned}$$

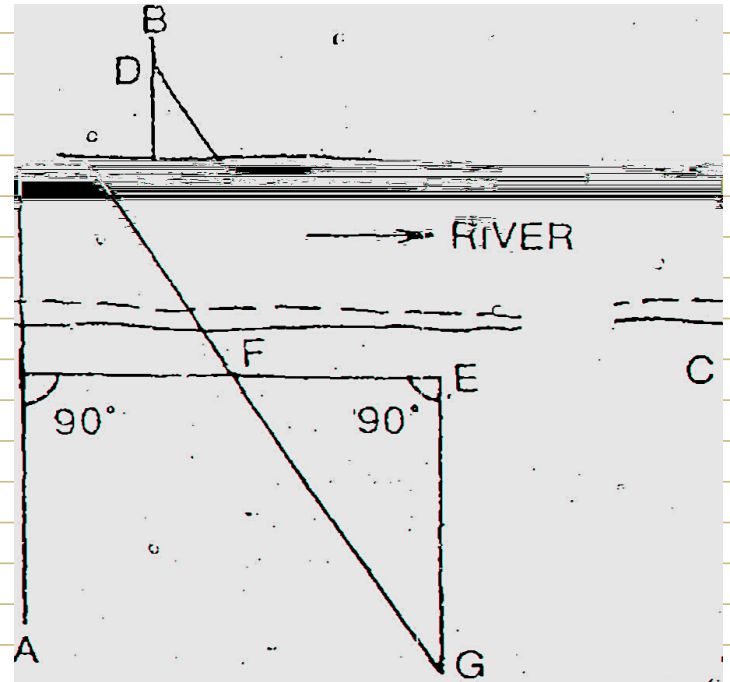
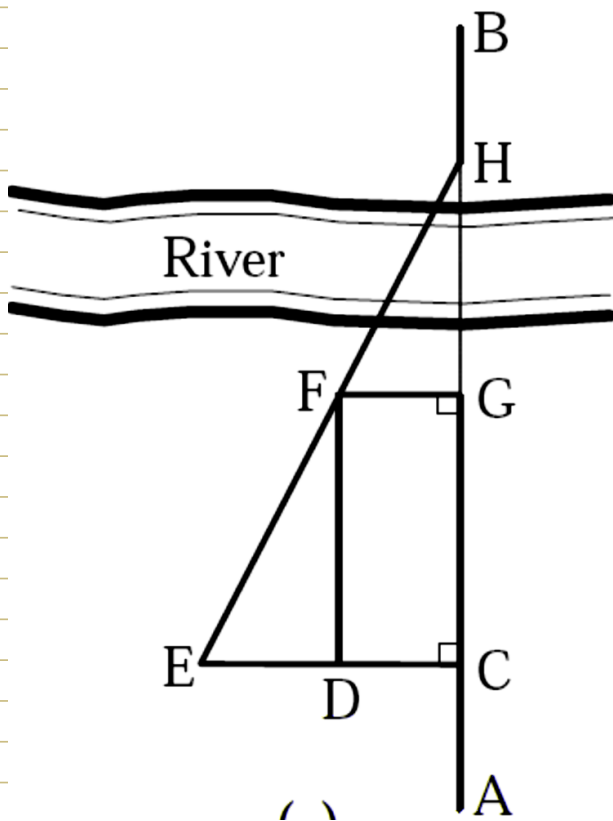
Chaining Obstacles

1. Vision is clear but chaining is prevented



Chaining Obstacles

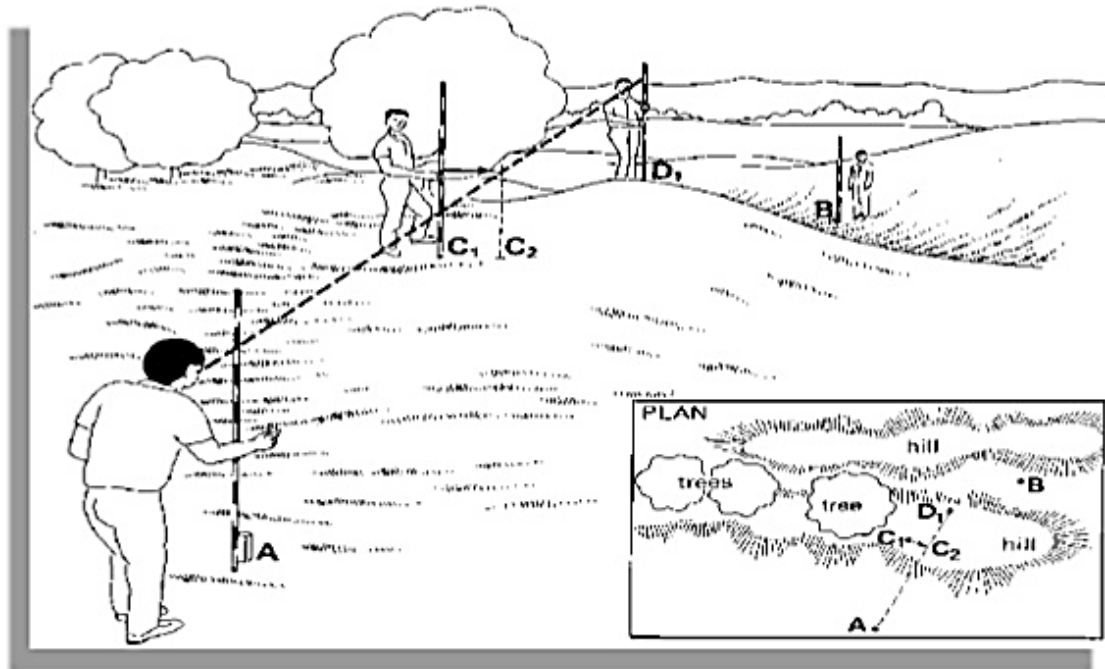
1. Vision is clear but chaining is prevented



Chaining Obstacles

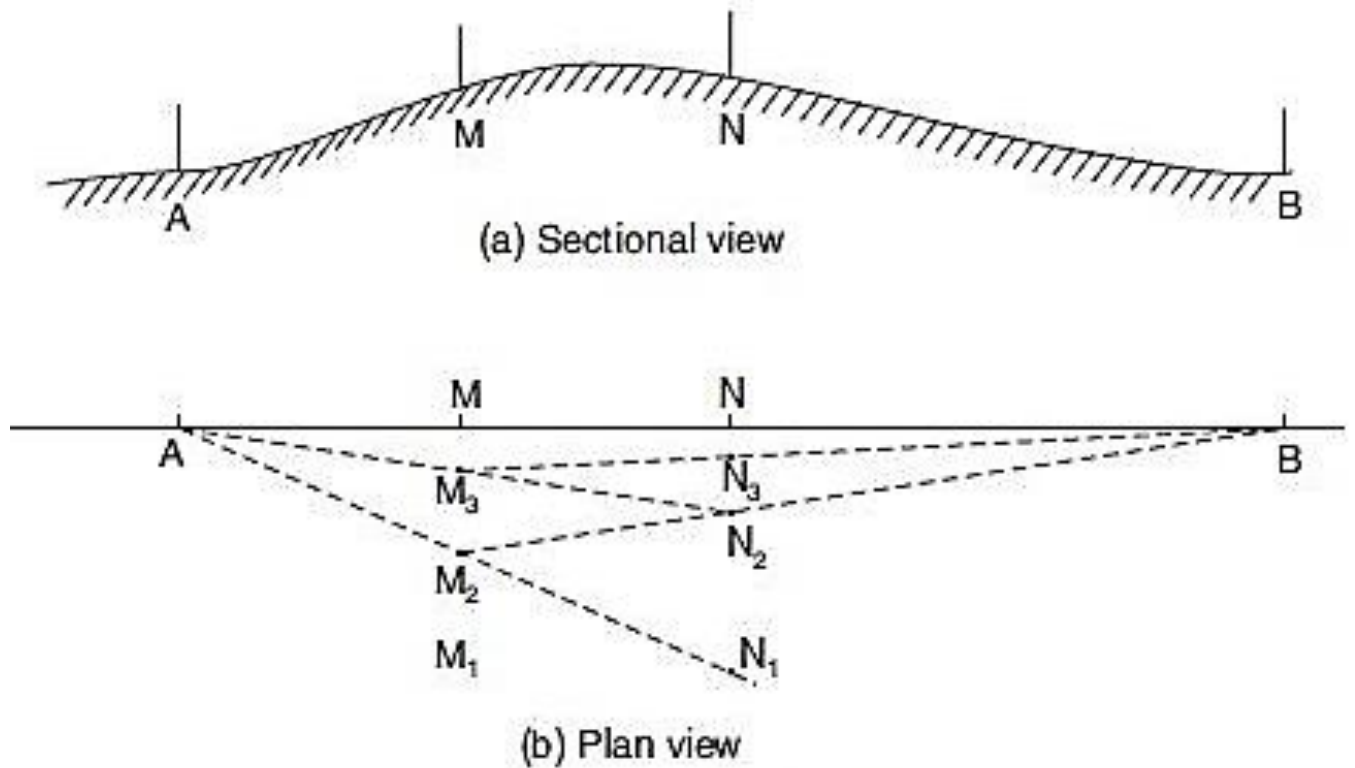
2. Chaining is possible but vision is prevented

Indirect or Reciprocal Ranging



Chaining Obstacles

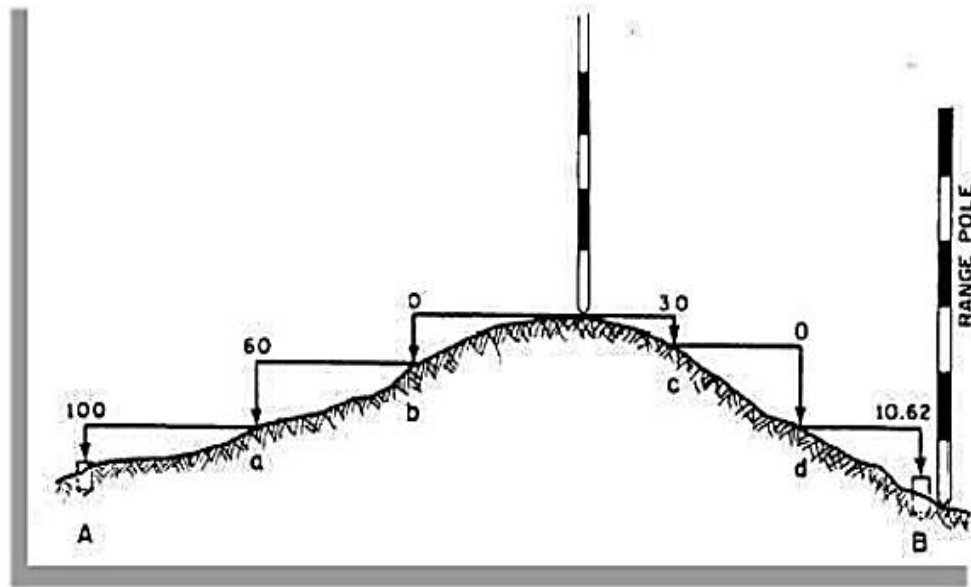
2. Chaining is possible but vision is prevented



Chaining Obstacles

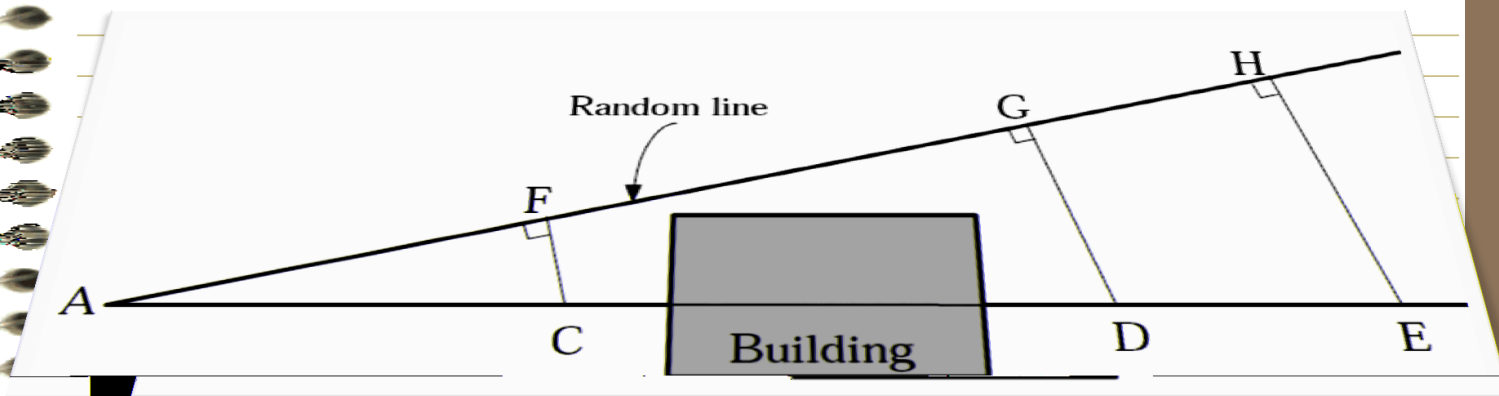
2. Chaining is possible but vision is prevented

Indirect /Reciprocal Ranging



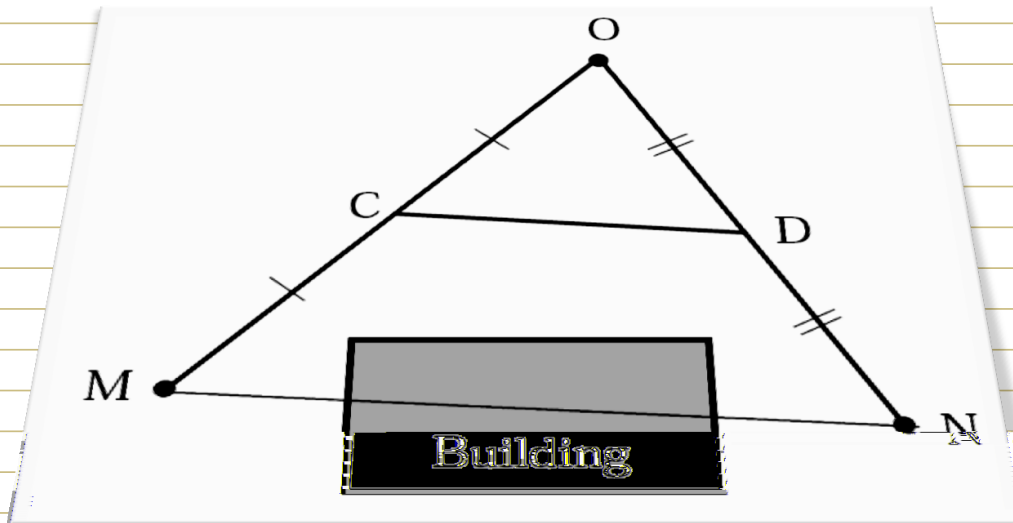
Chaining Obstacles

3. Both vision and chaining are prevented



Chaining Obstacles

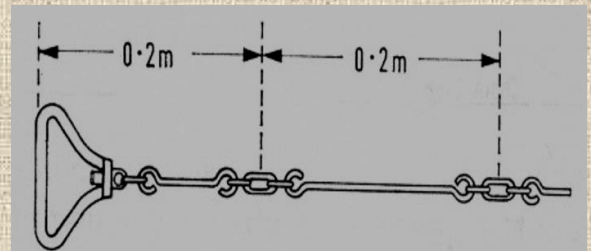
3. Both vision and chaining are prevented



Thank you



Chapter 3: Chain Surveying



Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

Chaining Errors

Sources of errors:

1. Human Operator الشخص الذي يقوم بالقياس

2. Equipment Used أداة القياس

3. Environmental ظروف القياس

Chaining Errors

Types of errors:

1. Blunders (Mistakes)

2. Random Errors

3. Systematic Errors

- Temperature
- Pulling
- Sag
- Length

Chaining Errors

1. Blunders (Mistakes)

These are simply mistakes caused by human carelessness, fatigue and haste. They are random in both sign and magnitude. Typical mistakes in chaining a line are:

Omitting an entire chain length in booking.

Misreading the chainage by confusing the tallies - say the 14 m and 16 m tallies on a 30 m tape.

Erroneous booking such as writing 32.14 m instead of 23.14 m.

It is a lower to pass undetected mistakes could lead to an unprecise field erroneous result. They can be eliminated by careful work and by using procedures that provide checks for blunders.

Chaining Errors

2. Random Errors

These errors arise from a lack of precision of the human eye

chance of these errors being negative as being positive
they tend to cancel out

no attempt is made to correct for them in chaining

Repeating the measurement several times and taking the average value will reduce these errors to a minimum

Chaining Errors

3. Systematic Errors

These arise from sources that are known, and their effects, therefore, can be eliminated.

Examples:

A. Temperature

B. Pulling

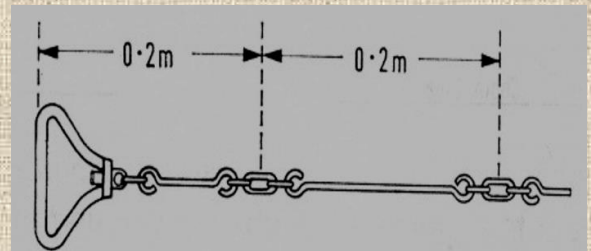
C. Sag

D. Length

Thank you



Chapter 3: Chain Surveying



Dr. Maher A. El-Hallaq
Associate Professor of Surveying
The Islamic University of Gaza

Chaining Errors

3. Systematic Errors

These arise from sources that are known, and their effects, therefore, can be eliminated.

Examples:

A. Temperature

B. Pulling

C. Sag

D. Length

Chaining Errors

3. Systematic Errors

A. Temperature Correction

$$C_t = 0.0000116(T - T_0)L_m$$

0.0000116 is the coefficient of thermal expansion of steel per °C

T is the field temperature

T_0 is the temperature under which the tape is calibrated

L_m is the measured length of the line

Chaining Errors

3. Systematic Errors

B. Pulling Correction

$$C_p = \frac{(P - P_0)L_m}{AE}$$

C_p = the tension correction in ft or m

P = the applied tension

P_0 = the calibration tension

A = the cross-sectional area of the tape in in^2 or cm^2

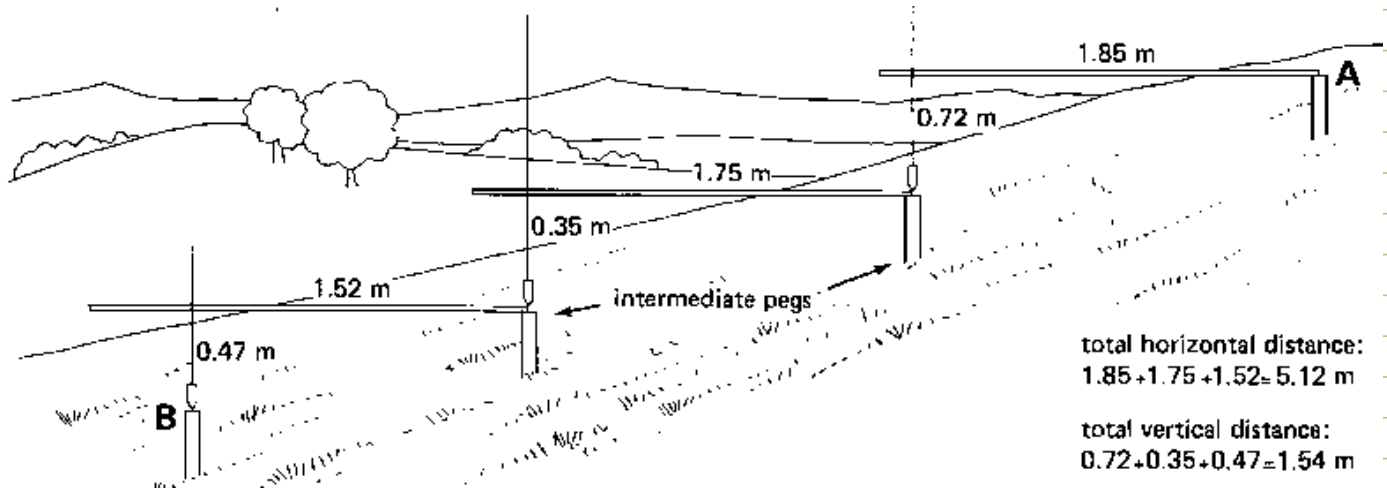
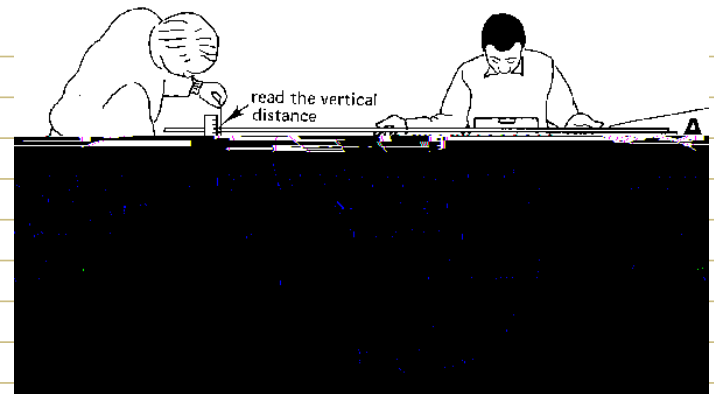
E = the modulus of elasticity of the tape material (fo

L_m = the measured length of the line

Chaining Errors

3. Systematic Errors

C. Sag Correction



Chaining Errors

3. Systematic Errors

C. Sag Correction

$$C_s = -\frac{W^2 L}{24P^2} - \frac{w^2 L^3}{24P^2}$$

W = the total weight of the section of tape

w = unit weight per meter of tape (or ft)

L = the interval (open length) between supports (in m or ft)

P = the tension on the tape (pull)

Chaining Errors

3. Systematic Errors

C. Sag Correction

Example:

A 30 m steel tape weighing 0.0112 kg/m and supported at 0, 15 and 30 m points under a tension of 5 kg.

$$C_s = -2 \left(\frac{w^2 L^3}{24 P^2} \right) = -2 \left(\frac{0.0112^2 \times 15^3}{24 \times 5^2} \right) = -0.001 \text{ m.}$$

Chaining Errors

3. Systematic Errors C. Sag Correction

Example: $L_m = 225 \text{ m}$, $P = 5 \text{ kg}$

A 30 m steel tape weighing 0.0112 kg/m

Chaining Errors

3. Systematic Errors

D. Length Correction

$$C_l = (\ell_a - \ell_o) \frac{L_m}{\ell_o}$$

C_l = length correction in the line of length L

ℓ_a = actual length of the tape

ℓ_o = nominal length of the tape

L_m = measured length of the line L_o = the nominal length of the tape

Chaining Errors

3. Systematic Errors Correction

Correct line length = measured length $\cdot \frac{\text{actual length of the tape}}{\text{nominal length of the tape}}$

Similarly,

$\left(\frac{\text{measured area}}{\text{actual area}} \right)^2 \dots \text{Correct area} = \text{measured area} \cdot \left(\frac{\text{actual length of the tape}}{\text{nominal length of the tape}} \right)^2$

Total Systematic Correction:

$$L_c = L_m + C_t + C_s + C_p + C_\ell$$

Thank you

