Benha University

Shoubra Faculty of Engineering

Surveying Engineering
Lecture 2: linear measuring techniques-Scale

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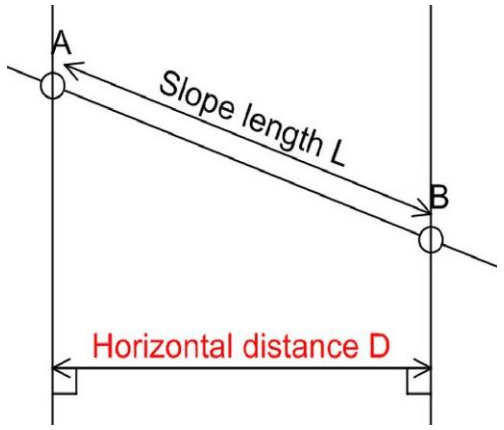
Types of distance measurements

• **Linear distance measurements** in plane surveying are made in such a way that they are horizontal.
Where a distance is measured along a slope it will have to be projected.



<u>Methods of Measurement:</u>

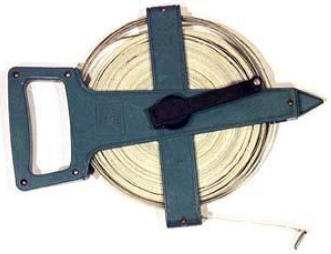
1. Pacing — Accuracy 1 : 100
2. Taping — Accuracy 1 : 10,000
3. Electronic Distance Measurement (EDM) — Accuracy 1 : 10,000 to 1:100,000

Taping

1.Direct distance measurement

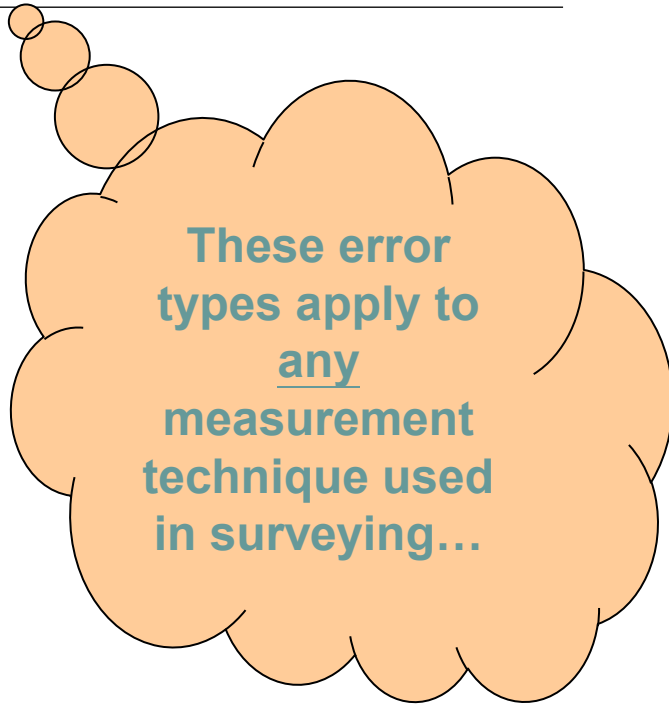
2.Equipment for measurement of lines

Equipment	Material
Chain	Tempered steel
Steel band	steel
tapes	Varies (synthetic material, glass fibre, coated steel



Types of errors

- **Blunders**
  - mistakes and gross errors
- **Systematic errors**
  - repeated size and sign
  - affect accuracy
- **Random errors**
  - small and usually undetectable (noise)
  - affect precision



Errors and corrections

Systematic errors:

1. Standardization
2. Slope
3. Tension
4. Temperature
5. Sag

Errors and corrections

1- Standardization:

1. Occurs when the length of the tape is not equal to the standard one
2. Due to wear and tear, tape tends to stretch
3. The error per tape length can be measured by checking the tape against a standard.

$$standardisation\ corr = L\frac{(l_s - l)}{l}$$

L = measured length (m)
l_s = standard length of tape (m)
l = nominal length of tape (m)

$$correct\ length = measured\ length \times \frac{length\ of\ band}{length\ of\ standard}$$

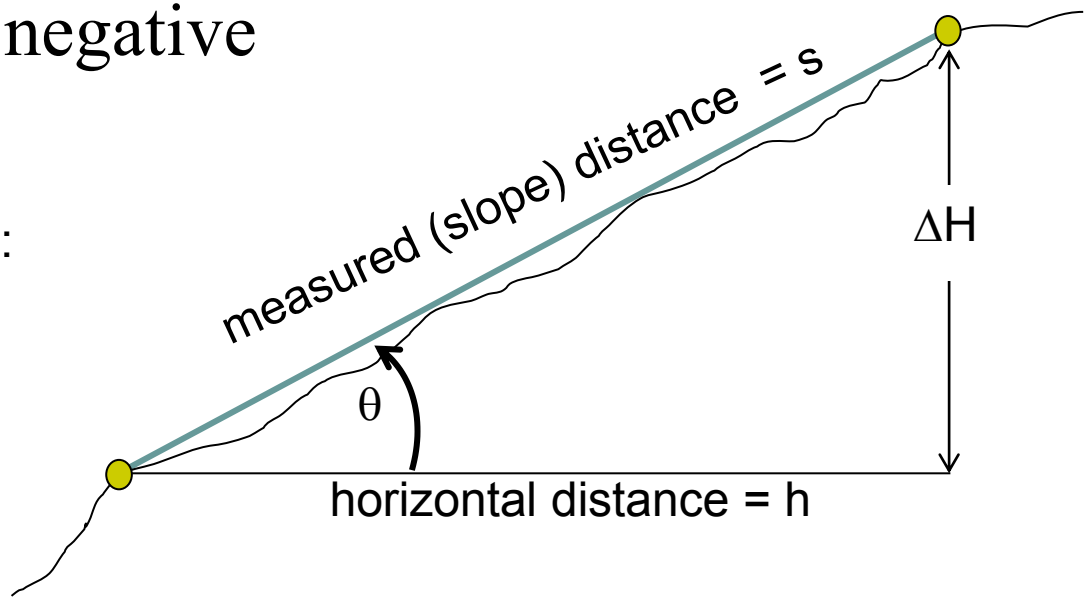
Errors and corrections

2- Slope:

1. Measurement should be on the horizontal plane
2. Slope lines must be reduced to horizontal
3. Correction is always negative

To calculate the *horizontal* distance :

$$h = s\cos\theta \quad \text{or} \quad h = (s^2 - \Delta H^2)^{1/2}$$



Representation of a Scale :

3-Tension:

– Caters for elasticity of tape material

- Occurs when the tape is tensioned to a value at which it was not standardized at.

$$correction = \frac{(P - P_s)}{A \times E} \times L$$

P, Ps = field and standard tension respectively (N)

A = cross sectional area of band (mm2)

E = Young's modulus of elasticity (N mm-2)

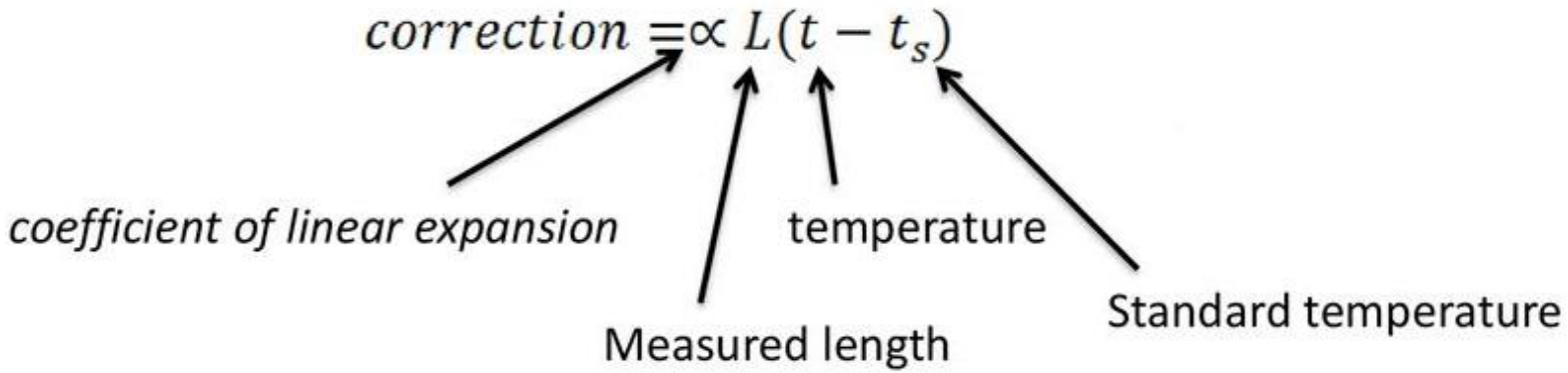
L = length measured (m)

Errors and corrections

4-Temperature:

– Due to thermal characteristics

- Required if the temperature is not the same as when the tape was standardized



For Steel tapes ά is 0.0000112 per °C

Errors and corrections

5- Sag:

If a tape was standardized on flat level, using catenary will introduce a sag error due to its weight.

W = weight of tape per meter (N/m)

l = measured length of span (m)

ά= angle of slope between supports

P = tension applied

Correction always -ve

$$sagcorr = -\frac{w^2 l^3}{24P^2}\cos^2\alpha$$

Errors and corrections

A steel tape of nominal length 30 m was used to measure a line AB by suspending it between supports. The following measurements were recorded

Line	Length Measured	Slope Angle	Mean Temp.	Tension
AB	29.872 m	3° 40’	5°C	120 N

The standardization length of the tape against a reference tape was known to be 30.014 m at 20°C and 50 N.
If the tape weighs 0.17 N/m and has a cross sectional area of 2 mm?, calculate the horizontal length of AB.

Scale

Map Scale - What is it?

1. shows the relationship between the distance on a map and the actual distance on the Earth's surface
2. a small distance on a map represents a much larger distance on the Earth

Types of Scale

There are 2 types of scale:

1- Nominal Scale:

1 . DIRECT STATEMENT

uses words to describe the relationship between a distance on a map and a specific distance on the Earth's surface

1 cm to 10 km or 1 cm = 10 km

Types of Scale

2. REPRESENTATIVE FRACTION

a ratio where one unit on the map equals a specific number of the same unit on the Earth's surface

always done as a ratio or fraction of 1

1:50,000

lcm on the map equals 50,000cm on the Earth

SCALE CONVERSIONS

R.F to Direct Statement

divide the second term by 100,000 to change cm to km

Example: 1:50,000 (R.F.)

lcm = 50,000cm/100,000 (CONVERSION)

1cm = 0.5km (DIRECT STATEMENT)

Direct Statement to R.F.

Multiply the second term by 100,000 to change km to cm

Example: 1 cm:2.5km (DIRECT STATEMENT)

lcm = (2.5km)(1 00,000) (CONVERSION)

1cm = 250,000cm (R.F.)

Types of Scale

2- Graphical Scale:

A graphical scale is a line drawn on the map so that its map distance corresponds to a convenient units of length on the ground.

Types of Graphical Scales in Surveying
1-Plane Scale :

It is possible to measure two successive dimensions only.

• A plain scale consists of a line (special RULER) divided into suitable number of equal units.

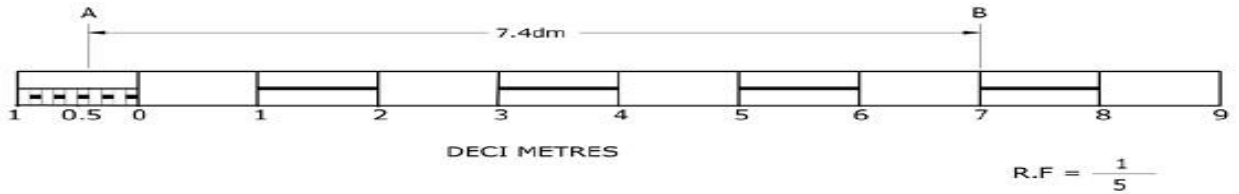
The first unit is subdivided into smaller parts.

• The zero should be placed at the end of the 1st main unit

• From the zero mark, the units should be numbered to the right and the sub-divisions to the left.

• The units and the subdivisions should be labeled clearly.

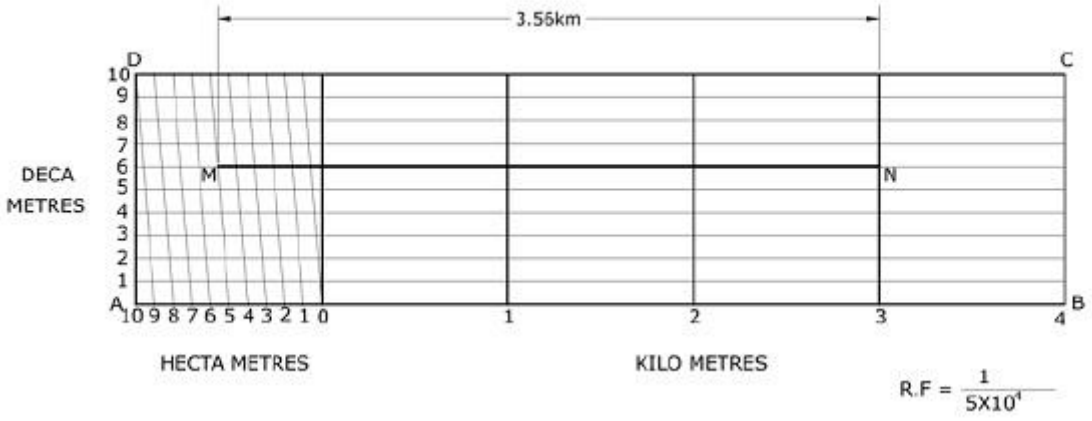
• The R. F. should be mentioned below the scale.

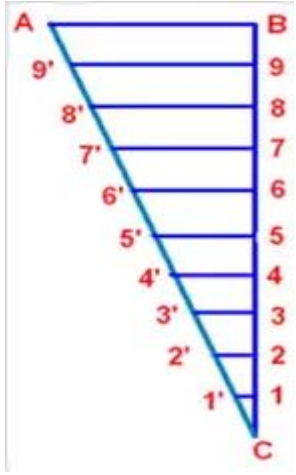


Types of Graphical Scales in Surveying
2-Diagonal Scale :

It is possible to measure three successive dimensions.

- Through Diagonal scale, measurements can be up to second decimal (e.g. 4.35) unit
- Diagonal scales are used to measure distances in a unit its immediate two subdivisions subdivisions cm & mm, or yard, foot & inch. ;
- Diagonal scale can measure more accurately than the plain scale.





Types of Maps Scale

Purpose of Survey	Scale	R.F
Building Site	1 cm = 10 m	1:1000
Town Planning, Reservoir planning, etc	1 cm = 50 cm to 100 m	1:5000 to 10000
Route Surveys	1 cm = 10 m to 60 m	1:1000 to 1:6000
Longitudional Sections.	1 cm = 10 m 1 cm = 1 m	1:1000 1:100
Cross- Sections	1 cm = 1 m	1:100
Land Surveys/ Cadastral Surveys	1 cm = 10 m to 50 m	1:1000 to 1:5000
Topographical Maps	1 cm = 0.25 km to 2.5 km	1:25000 to 1:250000
Geographical Maps	1 cm = 5 km to 150 km	1:500000 to 1:15000000
Mine Surveys	1 cm = 10 m to 25 m	1:1000 to 1:2500
Forest Maps	1 cm = 250 m	1:25000

Supplementary files:

- https://www.youtube.com/watch?v=YUzjrMTSMT4
- https://www.youtube.com/watch?v=KTNBT7sOe9E
- https://www.youtube.com/watch?v=Wv1T_pxvmMo
- https://www.youtube.com/watch?v=CHiErhohSrA

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Thanks

Dr.Eng. Hassan Mohamed