SURVEYING-I

Traversing

Introduction

- Prior to any field measurements, control framework must first be established.
- Subsequent field measurements can then be taken in relation to this framework.
- **Working from the whole to the part.**

What is a traverse?

- a kind of horizontal control framework.
- a method of determining the positions of a series of points by measuring the angles and distances between them.

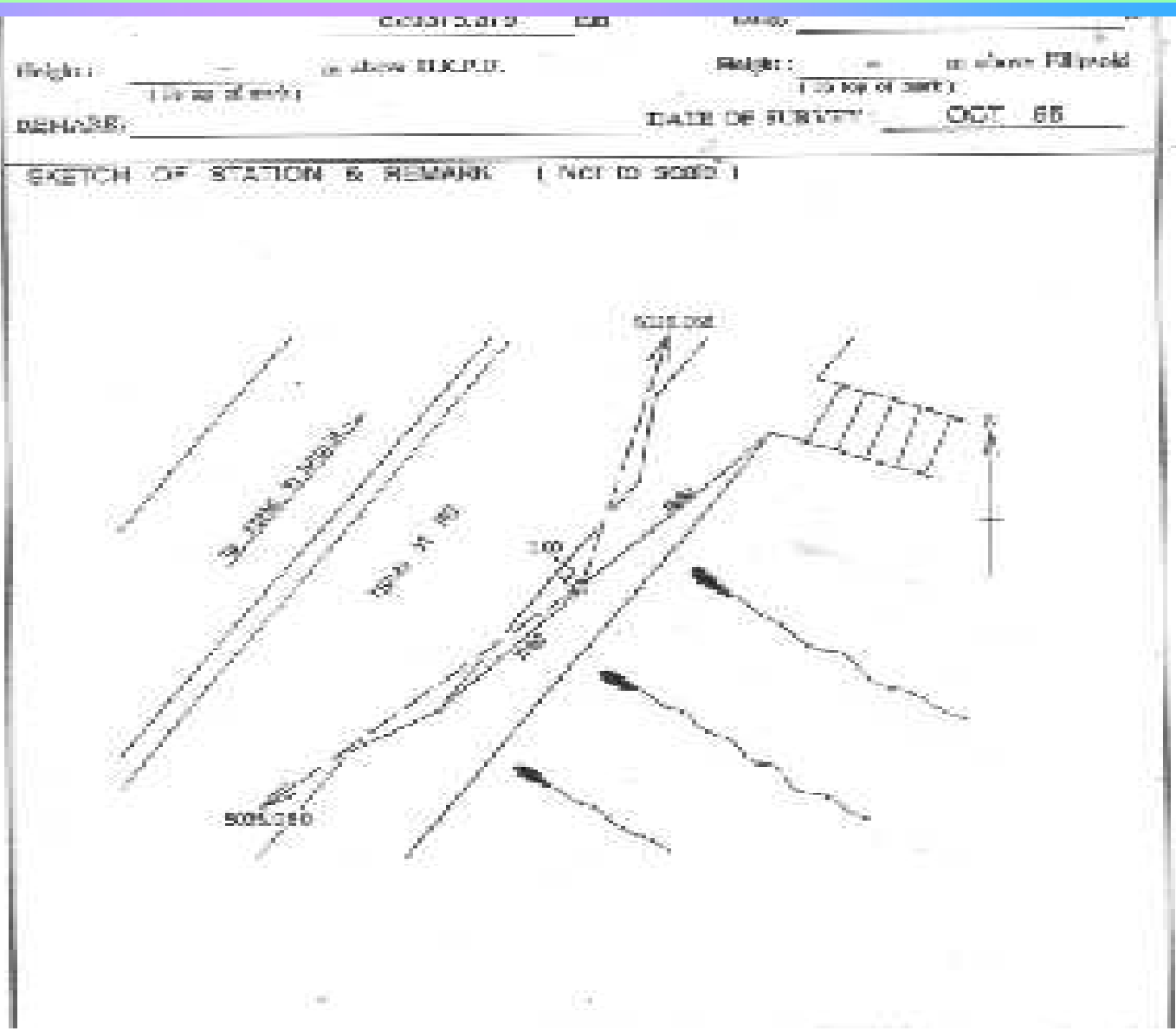
Types of Control Station

Trig. Station

Picket Box

Traverse Control Sheet

Urban Survey Mark

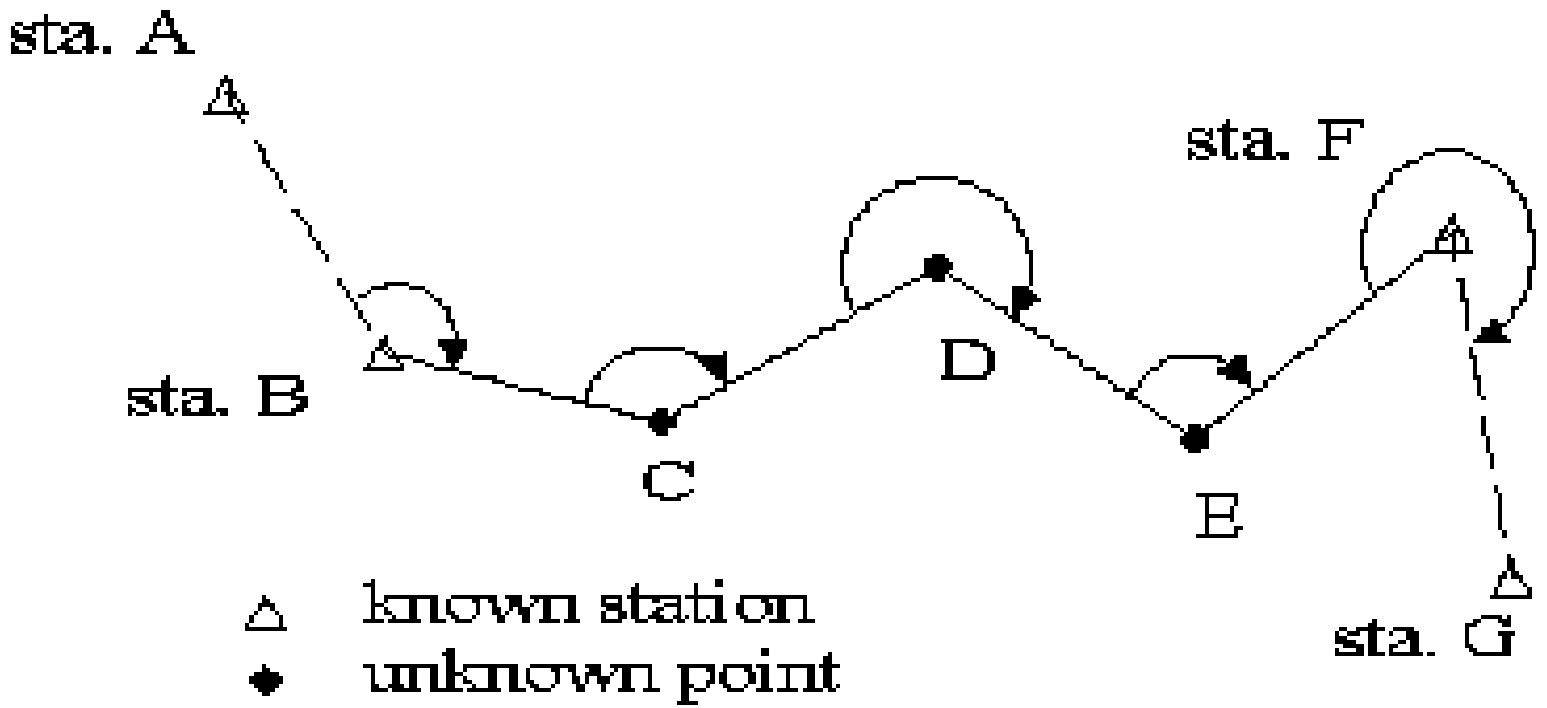


Types of Traverses

Closed Traverse - ***link traverse***

- originates from one known survey station and terminates on another known station.

Link Traverse

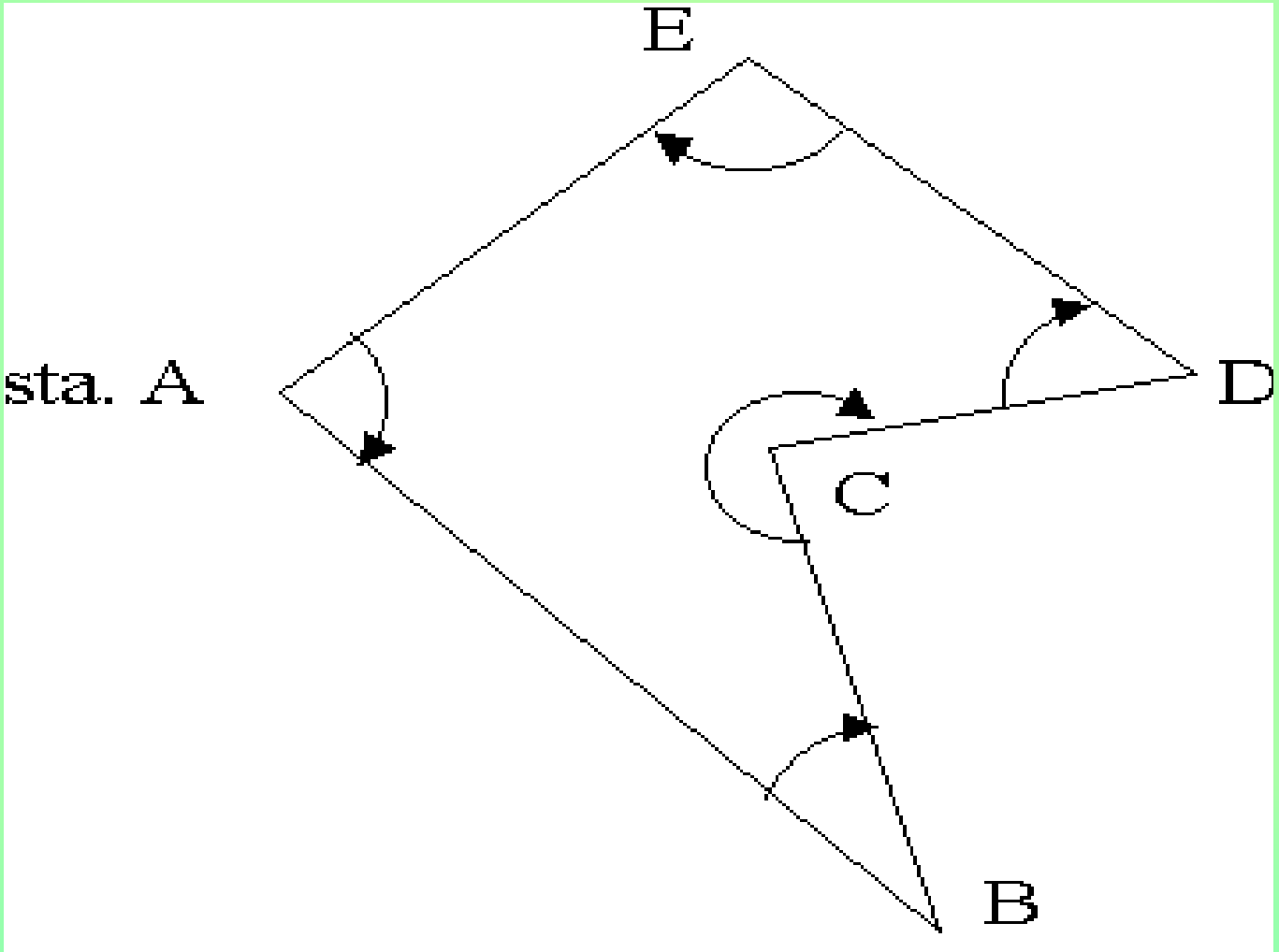


Types of Traverses

Closed Traverse - ***closed-loop traverse***

- A traverse closing back onto its starting station.

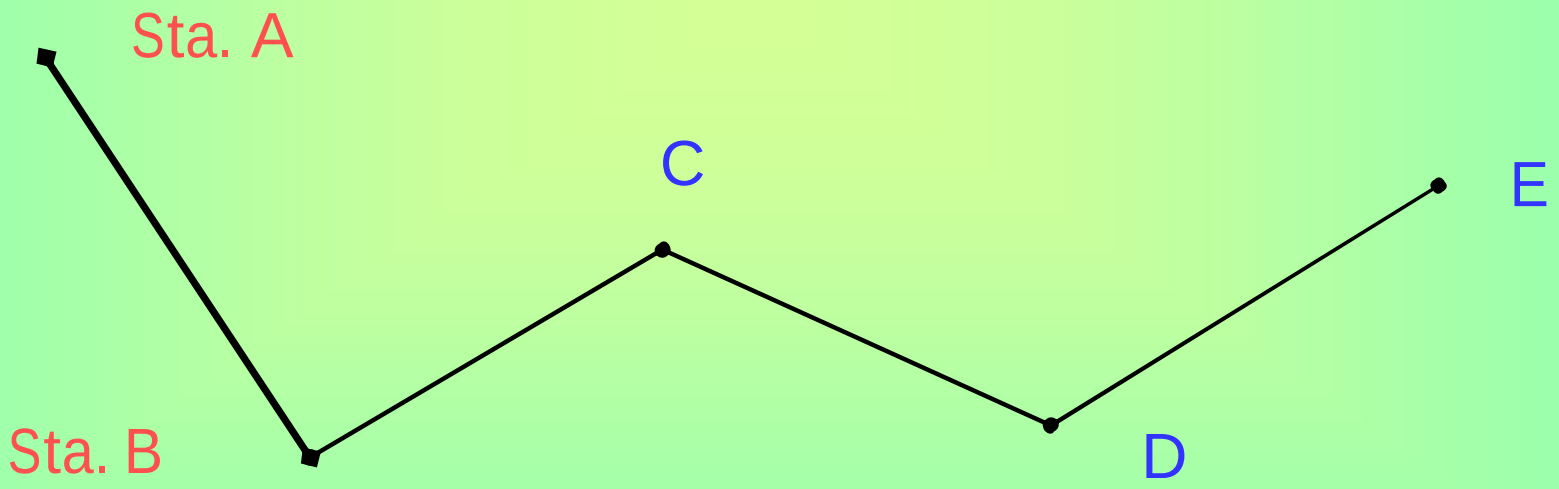
Closed-loop Traverse



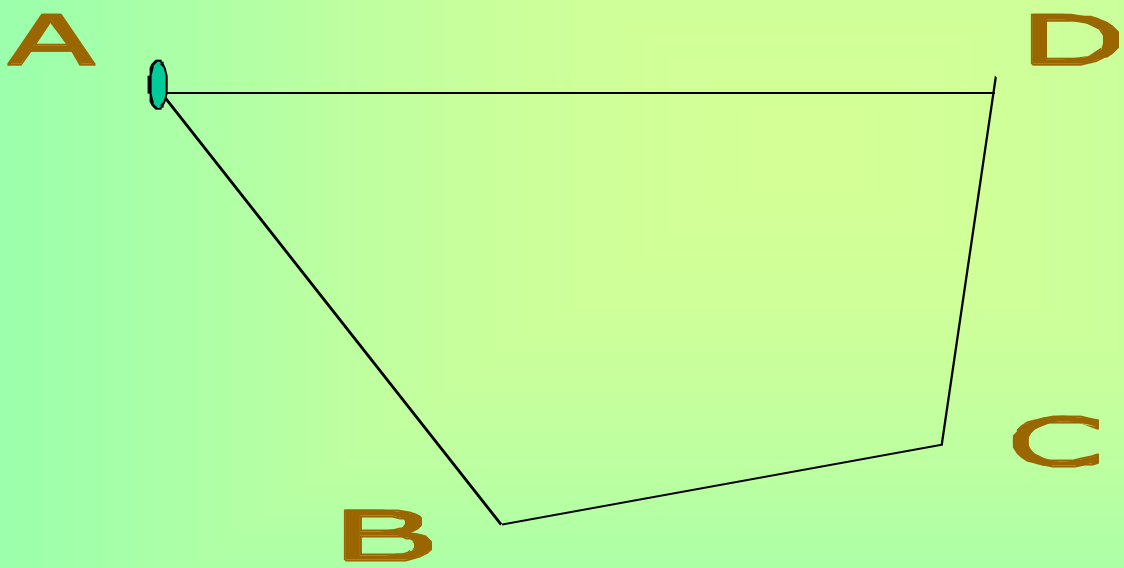
Types of Traverses

Open Traverse

- do not close onto a known station



Closed-loop Traverse



Comparison

Closed traverse:

- capable of being checked and adjusted to fit accurately between known points.

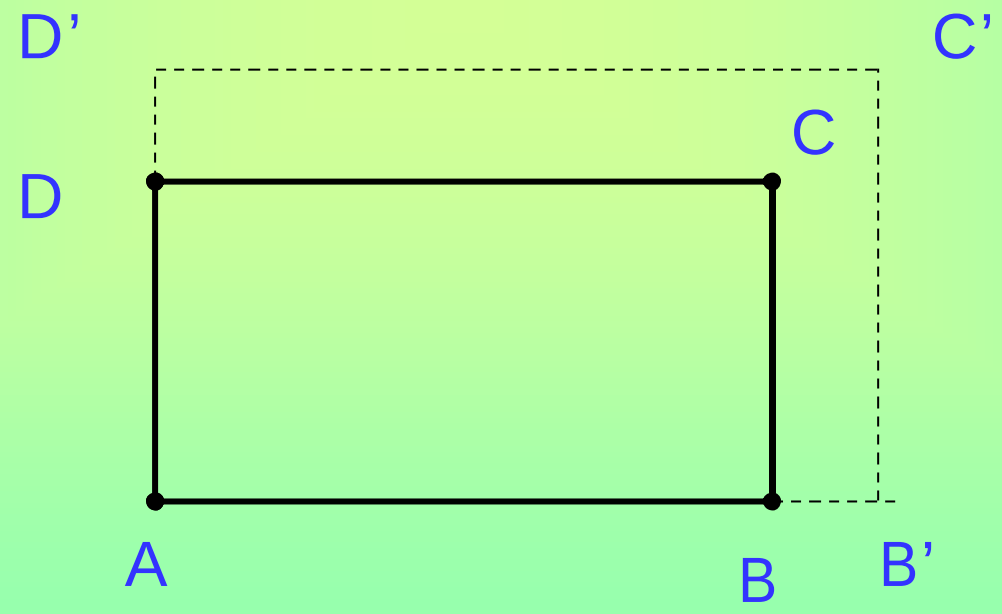
Open traverse:

- cannot be easily checked nor can it be properly adjusted.
- should only be used in exceptional circumstances.

Closed-loop or Link??

- ***Closed-loop traverse***

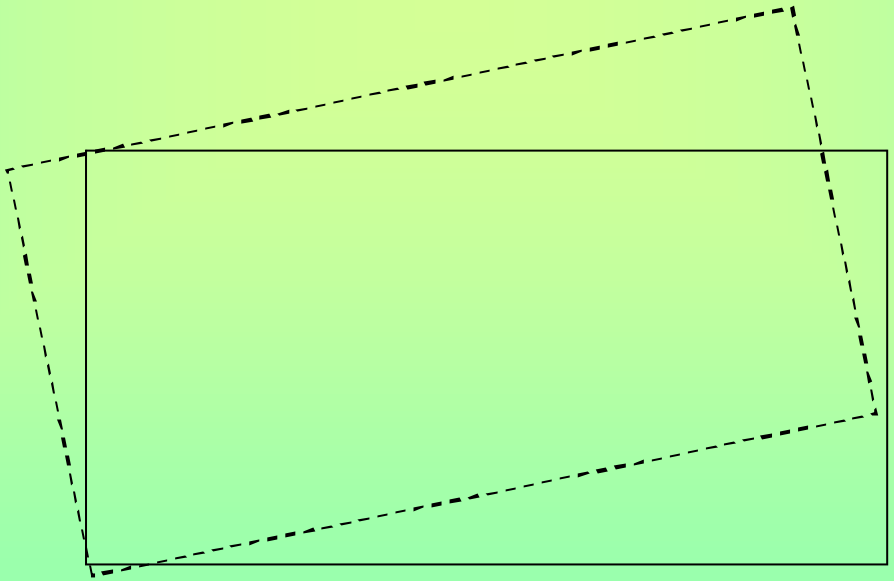
➔ Systematic error of distance measurement are not eliminated



Closed-loop or Link??

Closed traverse:

- orientation error would not be revealed in angular misclosure.



Closed-loop or Link??

Link traverse:

- systematic error and orientation error are clearly revealed by the error vector.

Purpose of Traversing

(a) Surveying Detail

- Traverse network can be accurately plotted on a map or plan.
- Positions of natural and artificial features are located relative to the network.
- These details can then be plotted in their proper position by reference to the plotted traverse network.

Purpose of Traversing

(b) Setting Out

- Positions of new constructions , usually defined by wooden pegs, can be established by the surveyor based on traverse control stations from information supplied by the designer, architect or engineer.

Purpose of Traversing

(c) Monitoring

- Existing structures, that are within the vicinity of ongoing construction projects, may sometimes be affected.
- To avoid the possibility of deformation, periodical monitoring, i.e. daily, weekly or monthly, must be performed

Purpose of Traversing

What are the three main purposes of traversing ??

(1) Surveying detail;

(2) Setting out ; and

(3) Monitoring survey

Measurements required

- length and bearing of each line of the traverse must be measured.

(a) Length Measurement

- a variety of methods can be used depending on the accuracy required and the purpose of the survey.

Measurements required

- ***Methods of Length Measurement***
  - Direct linear measurement
  - Catenary measurement
  - Electro-magnetic distance measurement
  - Tacheometric measurement

Measurements required

(b) Bearing Measurement

- Compass observations
- Obtained from the angles measured using an optical theodolite, a digital theodolite or a total station instrument

Measurements required

Two field procedures are adopted to:

- facilitate the calculation of required bearings,
- reduce the possibility of observational and calculation errors.

Measurements of Angles

These two procedures are the following:

(1) 1st theodolite observation is always made to the ***back station*** and the next observation to the ***fore station***.

- helps to prevent errors arising when deciding which angle has actually been measured.

angle to the right method

Measurements of Angles

(2) Angles are measured on ***both faces*** of the theodolite and the results are meaned.

- eliminates instrumental errors and provides ***two*** measures of the angle, thus checking against gross error in either measurement.

Booking and reducing angular observations

- two common methods of booking and reducing of angular observations are illustrated below.
- they tend to bring out instrumental errors and prevent observational errors.

Booking and reducing angular observations

Method 1

At Station A *Nail in wooden peg*				
F.L	B	0° 00 ' 00 "		
F.L.	C	76° 28 ' 20 "	76° 28 ' 20 "	
F.R.	C	256° 28 ' 20 "	76° 28 ' 00 "	76° 28 ' 10 "
F.R.	B	180° 00 ' 20 "		

Booking and reducing angular observations

Method 2

Inst.	To	F.L.	F.R.		Mean	Angle
A	R.O.	0° 00’ 00”	180° 00’ 20”		10”	
	B	76° 28’ 20”	256° 28’ 20”		20”	76° 28’ 10”
	R.O.	0° 00’ 00”	180° 00’ 00”		00”	

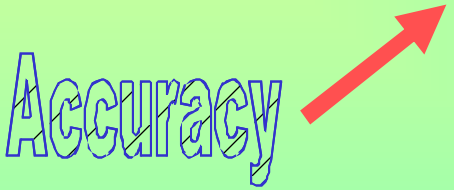
Classes of Traverse

- graded into different classes or orders, depending on their accuracy
  - *Precise traverse (accuracy >* $\frac{1}{10{,}000}$ *)*
  - *Ordinary traverse (accuracy ≤* $\frac{1}{10{,}000}$*)*

Observing and Measuring Specifications for Traverse

Type of Traverse	Number of Arcs	Spread	Type of Theodolite	Max. angular Misclosure (“)	Linear Misclosure (in mm)	
					EDM	Steel Tape
Main	4	6”	1” direct	$5\sqrt{n}$	$20 + \frac{s}{30}$	$10 + \frac{s}{20}$
Minor	2	10”	1” direct	$10\sqrt{n}$	$10 + \frac{s}{12}$	
Title	1 or 2	20”	20” direct	$20\sqrt{n}$	$10 + \frac{2s}{15}$	
Detail	1	-	1” direct	$40\sqrt{n}$	$10 + \frac{s}{4}$	

n = Number of station occupied
s = Total distance of traverse (m)



Precise Traverses

- angular and linear measurements are made with greater refinement.

(a) ***Distance***

- EDM, with direct correction to horizontal, are normally used.
- tapes and bands are standardised; temperature and corrections, such as tension, sag, are applied.

Precise Traverses

(b) **Angle**

- 1” or 0.1” theodolite and the mean of several ***arcs*** or ***rounds*** of observations is taken.
- Accuracies ranges from 1/10 000 to over 1/100 000

Usage of Precise Traverses

- To supply ***precise control points*** for mapping in flat country where triangulation is unsuitable.
- To provide ***accurately positioned reference points*** for cadastral and engineering surveys.
- To provide ***data for engineering works*** where high precision is a must, e.g. in tunnelling.

Ordinary Traverses

- accuracy is less than 1/10 000
- taping corrections are not normally required.
- ***Distance*** : linen tapes, or stadia methods are used depending on the purpose of the survey and the accuracy required.
- ***Angle*** : 20” to 1’ theodolite are used.

Usage of Ordinary Traverses

- ***Site surveys*** for architectural and engineering development. Accuracy is between 1/5000 and 1/10 000
- ***Topographical surveys*** for mapping or cadastral purposes. Accuracy is between 1/100 and 1/5 000

Usage of Ordinary Traverses

- ***Exploratory*** or ***preliminary surveys*** in unmapped country.
  - they are less frequently used today, but are sometimes necessary for calculating quotations for large engineering works in poorly mapped regions.
  - Accuracy is between 1/50 and 1/500.

Equipment

For accuracy from 1/5 000 to 1/10 000:

- Optical or digital theodolite, or total station instrument.
- Target/reflector and tripod.
- Steel band 30m, 50m or 100m long for taping.
- Hammer, wooden pegs, nails, drill and paint for marking stations.

Equipment

- Data logger or RAM card for digital theodolite or total station instrument.
- Field book and pencil for optical theodolite.

Reconnaissance

- vitally important part of any survey project.
- ***Purpose:*** decide the best location for the traverse stations.
- Stations should be intervisible for ease of traverse observations.

Reconnaissance (con't)

- For topographic detail location, stations should be positioned:
  - to afford best view of the terrain and
  - to ensure maximum amount of detail can be surveyed from each station.

Reconnaissance (con't)

- For setting out engineering structures, station should be sited:
  - to afford best positions for setting out and
  - to provide accurate location.
- Distance between stations should be kept as long as possible to minimize the effect of centring errors.

Reconnaissance (con't)

- As cost is always important, ideally the scheme should be completed in the minimum of time, with the minimum of personnel.
- Type of survey station is governed by the purpose of the traverse.

Reconnaissance (con't)

- For quick, one-off survey of a small area, then wooden pegs about 0.25 m long and driven down to ground level may suffice. A fine point on the top of the peg defines the control point.
- For others, long-life stations are required to be constructed.
- On paved or black-topped surfaces, masonry nails may be used.

Thanks