CHAPTER 1
BASICS OF SURVEYING

1.1 SURVEYING DEFINED

- **What is surveying?**

Surveying is the art of measuring distances, angles and positions on or near the surface of the earth.

- **It is an art?**

Because only a surveyor who has full 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.

- **It is scientific?**

Because the use of mathematical techniques to analyze field data. Accuracy and reliability depends on understanding scientific principles underlying and affecting survey measurement.

1.2 TYPES OF SURVEYING

There are two types of surveying:

Plane surveying: Earth surface is considered a plane of x-y dimensions.

- Z-dimension (height) referenced to the mass spherical surface of the earth (Mean Sea Level).
- Most engineering and property survey are plane survey correction to curvature is made for long strips (e.g. Highway).

Geodetic surveying:

Earth surface is considered spherical in revolution (actually ellipsoid)

- Z is referenced to MSL (surface of earth)
- Very precise surveys (boundaries and coastal networks).

1.3 CLASSES OF SURVEYS

1. **Preliminary survey** (data gathering) **:**

   is the gathering of data (distances, position and angles) to locate physical features (rivers, roads, structures) so that data can be plotted to scale (map or plan), also include difference in elevation so that contour could be plotted.

2. Layout survey:

Marking on the ground (using sticks, iron bar or concrete monuments) the features shown on a design plan features:

- Property lines (subdivision survey).
- Engineering work (construction survey).
- Z-dimensions are given for x-y directions.

3. Control survey:

used to reference preliminary and layout surveys.

Horizontal control:

arbitrary line tied to property line or HWY center or coordinated control stations.

Vertical control:

Benchmarks: points whose elevation. above sea level is carefully determined.

- In Control survey more care to accuracy.
- Control lines should be easy to re-establish.

1.4 DEFINITIONS

1- Topographic survey: preliminary surveys used to tie earth surface features.

2- Hydrographic survey: preliminary surveys tie underwater feature to surface control line

3- Route surveys: preliminary, layout and control surveys that range over a narrow but long strip of land (highways, railroads, electricity transmission lines and channels).

4- Property surveys: preliminary, layout and control surveys determine boundary locations .

5- Aerial survey: preliminary and final surveys to convert aerial photograph into scale map using photogrametric techniques.

6- Construction survey: layout of engineering work.

7- Final (as built) survey: preliminary surveys tie in features that just have been constructed

1.5 SURVEYING INSTRUMENT

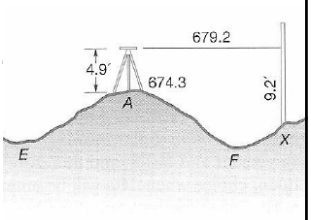
1- Transit and theodolite: Establish straight or curved lines, horizontal and vertical angles.

2- The level and rod: measure difference in elevations.

3- Steel tape: measure horizontal and slope distances.

4- Total station.

5- GPS (global positioning system) receivers



Steel tape

Level (stadia principle)

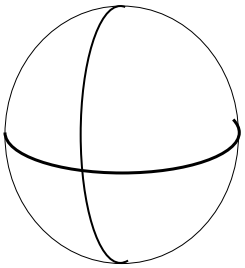
Total station

Thedilite

GPS

1.6 SURVEY GEOGRAPHIC REFERENCE

Define reference as the surface of earth.



Latitude: East & West //equator.
- Max angle 90^{o} north or south.

Longitude (Meridians): North/South converge at poles & max angle = 180 degree east or west from the plane of 0^{o} longitude Greenwich.

- used in geodetic not plane survey.
- Plane survey use coordinates grid system.

1.7 SURVEY GRID REFERENCE

States and provinces have adopted a grid system best suited to their needs.

- Limited in size: no serious error due to curvatures.

- Easy to use (plane geometry & trigonometry).

- Common datum for x & y dimensions.

- Easy to translate to geodetic survey.

1.9 SURVEY VERTICAL REFERENCE

Vertical dimension can be referenced to any datum.

- Mostly used datum is mean sea level MSL = 0.000 ft.
- Benchmarks → permanent points whose elevation has been precisely determined.

1.10 DISTANCE MEASUREMENTS

Distance between two points can be horizontal, slope or vertical and are recorded in feet (foot units) of meters (SI units).

-Horizontal and slope distances can be measured by using fiberglass, steel tape or EDM (electronic distance measuring) + difference in elevation and slope distance.

- Vertical distance can be measured by using tape as in construction work or level and leveling rod

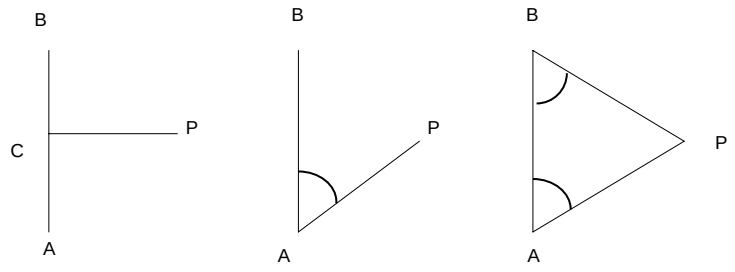
1.11 UNIT OF MEASUREMENT

There are two main measuring systems:

English system and Metric system (SI units).

- All countries will change to Metric system.
- Angles are measured by: Degrees, minutes and seconds.
- 1 revolution = 360 degrees, 1 degree = 60 minutes and 1 minutes = 60 seconds.

1.12 LOCATION METHODS

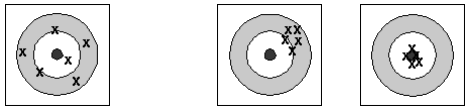


- (a): right angle offset tie.
- (b): the angle distance tie (polar tie).
- (c): angle at A and B of distance BP of AP (intersection technique).

1.13 ACCURACY AND PRECISION

Accuracy: relationship between measure & true value of measurement.

Precision: Degree of refinement with which the measurement is made.



Accurate, not precise
(the average is accurate)

precise
not accurate

accurate
and
precise

Example:

	True Distance	Measured Distance	Error
Cloth tape	157.22	157.3	0.08
Steel tape	157.22	157.23	0.01

- More precise method resulted in more accurate.
- More precise method may result in less accurate measurement.

Example: Repaired tape.

1.14 ACCURACY RATIO

Error of closure: The difference between the measured location and the theoretical correct location (repeated measurement, mathematical analysis).

Exp. measured distance 250.56 errors 0.06

Known distance 250.50

Accuracy ratio 0.06/250.50 = 1/4175 = 1/4200

- Fraction whose numerator is unity and denominator closest 100 unit.

1.15 ERRORS

- No measurement (except count) can be free of error.
-True value is determined statistically (mean) to calculate error.

Systematic error: error whose magnitude and algebraic sign can be determined and eliminated (temp. error).

Random Error:
- Error due to surveyor skill.
- Tend to cancel each other.
- Little significance except for high precision survey.
- Unskilled or careless surveyor can make problem.
- Large random error doesn't result in accurate work even if they cancel.

1.16 MISTAKES

There are many mistakes that cold be happened to surveyors.
- Blunders made by survey personnel
e.g. 68 instead of 86.
- Miscounting tape length, measuring from wrong point.
- Mistakes will occur and must be discovered and eliminated by verifying the measurement (Repeat Geometry analysis, etc.).
- Every measurement should be repeated to eliminate mistakes and improved precision.

1.17 STATIONING

Along Baseline: stations or champagne **At night angle:**
offset dist.
Beg. 0+00 ft (m).