AGE 303 – SURVEYING FOR AGRICULTURAL ENGINEERS

COURSE OUTLINE

- **Types of surveys, classes of surveys**
- **Instruments and care,**
- **measurement of distances – pacing, stadia, taping, electronic and photographic methods.**
- **Leveling – elevations. The engineer's telescope, bubble tube, dumpy level, level rods, automatic level. Errors and corrections.**
- **Angles and directions – bearings and azimuths, magnetic compass and earth's magnetic field.**
- **Aerial surveying, topograpahic maps, introduction to photogrammetry.**
- **Remote sensing and GIS.**

INTRODUCTION:

Land Surveying: It has to do with the determination of relative spatial location of points on or near the surface of the earth. It is the art of measuring horizontal and vertical distances between objects, of measuring angles between lines, of determining the direction of lines, and of establishing points by predetermined angular and linear measurements.

Land surveying is divided into:

(a) **Geodetic surveying** – Curvature of earth into consideration – Large Areas

(b) **Plane surveying** – Actual field measurement, horizontal plane – Small areas, short distance

CLASSES OF LAND SURVEY:

- **Control survey** consists of establishing the horizontal and vertical positions of arbitrary point.
- **Land or property survey** is performed to determine the length and direction of land lines and to establish the position of these lines on the ground.
- **Topographic survey** is made to secure data from which may be made a topographic map indicating the configuration of the terrain and the location of natural and human-made objects.
- **Hydrographic survey** refers to surveying bodies at water for the purposes of navigation, water supply or subaqueous construction.
- **Mine survey** utilizes the principles for control, land, geologic, and topographic surveying to control, locate, and map underground and surface works related to mining operations.
- **Engineering surveys** are performed to lay out, locate, and monitor public and private engineering works.
- **Route survey** refers to those control, topographic, and construction. Surveys necessary for the location and construction of lines of transportation or communication, such as highways, railways, canals, transmission lines and pipelines.
- **Photogrammetric surveys** utilizes the principles of aerial and terrestrial photogrammetry, in which measurements made on photographs are used to determine the positions of photographed objects.

INSTRUMENTS / EQUIPMENTS:

•Survey equipment includes:

-Dumpy level	-Prismatic compass
-Measuring tools	-Poles and pegs
-Survey staff	-Others

EQUIPMENT CARE

(A) DUMPY LEVEL

- Protect the equipment from impact and vibration

•While an observation is being made, do not touch the instrument except as necessary to make a setting; and do not move about.

•Always use the sunshade. Attach or remove it by a clockwise motion, in order to unscrew the objective.

•Avoid carrying the instrument on the shoulder while passing through doorways or beneath low-hanging benches; carry it under the arm, with the head of the instrument in front.

•Return the instrument regularly to a manufacturer's representative or qualified instrument repair shop for cleaning, maintenance and repair.

(B) TAPING EQUIPMENT

Keep the tape straight when in use, any tape will break when kindled or subject to a strong pull. Steel tapes rust readily and for this reason should be wiped-dry after being used. Use special care when working near electric power line. Fatal accidents have resulted from throwing a metallic tape over a power line.

Do not use the flag pole as a bar to loosen stakes or stones, such use bends the steel point and soon renders the point unfit for lining purposes.

SURVEYING INSTRUMENTS

This can be divided into two

(A) Linear measurement

(B) Angular measurement – level readings

A. **Linear Measurement**: (Chain Surveying)

The following equipment is available for linear measurements.

a.**Chain** – (20m, 25m, 30m, or 50m long). It can be read direct to the nearest link (200mm in length), every tenth link being marked by a tally.

b.**Linen Tapes** - May or may not be plastic coated, sometime reinforced by a metallic thread, available in (10m, 15m, 20m, or 30m). They are usually graduated at intervals of either 5mm or 10mm dependent upon the inherent accuracy of tape.

c.**Steel Tapes & Bands** – available in various lengths up to 100m and can be read direct to the nearest mm.

- **OTHER EQUIPMENT**
- **Ranging Rods** – Poles of circular section 2m, 2.5m or 3m long, painted with character red and white bands which are usually 0.5m long, and tipped with a pointed steel shoe to enable them penetrate the ground.
- **Use –** Used in the measurement of lines with the chain and for marking any points which required to be seen.

- **Arrows**: they are steel skewers and about 40mm long and 3 to 4mm diameter .A piece of red ribbon at the top enable them to be seen more clearly. An arrow with a lump of lead at its bottom end is occasionally used as a term of plumb- bob.
- **Use** – When chaining a long line, the chain has to be laid down a number of times and the positions of the ends are marked with arrows.

- **Pegs** – They are wooden of typical size of 40mm x 40mm x 0.4m long.
- **Use –** Points which required to be more permanently marked, such a the intersection point of chain line are marked by nails set in the top of oak pays divine into the ground by a mallet.

ANGLE MEASUREMENTS AND LEVEL READINGS

- The instruments used for these observations are, theodolites and level respectively which a common feature in the telescope.
- The telescope:-
- In its simplest from, the telescope comprises on objective, an eye-piece and a diaphragm. The objective produce an inverted image at the diaphragm and this is magnified by the eyepiece
- Use function
- It fixes accurately the line of sight (collimation) from a point over the instrument state to some distant point.

Chain surveying: - Measuring with chain lengths of a series of straight lines, and locating points and ground relative to these lines by measuring two other lines – ties or by measuring offsets at right angles to the chain line

- Procedure in chain length surveying consists of measurement with the chain the lengths of a series of straight lines,
- Two basic procedures here are:-
- The chaining or 'ranging' of lines, and
- The setting out of the right angles in connection with offsets

FIELD WORK

- - Length of the three sides of ABC being known, the can be plotted. Any area of land can be divided into a series of which form a framework, which may be plotted, and which cover the greater part of the area to be surveyed. To locate topographical and man-made features relative to details frame work, measurement are made with tape from the lines during the course of chaining.

OBSTACLES

- The max length of line we can be range is normally governed by visibility
- Types of obstacles
- Those which obscure vision but do not prevent chaining
- Those which prevent chaining but not vision
- Those which prevent chaining and vision
-
- Small hill dealt with by the method of repeated alignment
- First problem can be solved by measurements made round the obstacle which may be a pond or standing crops with the 2nd, of which a river or stream of greater width than a chain length geometrical construction is necessary

- **ERRORS IN CHAINING AND THEIR CORRECTION**
- Types of error
- Mistakes
- Systemic or cumulative errors
- Accidental or compensating errors
-
- Mistakes / Blunders: - These are due to in experience or to carelessness on the part of the surveyor or the chairmen. It is random in both occurrence and magnitude
- Examples are: -
- Omitting an entire chain length in booking. This is prevented by noting down each chain length, ad by the leader keeping careful count of the arrows
- Mis-reading the chain age by confusing the tallies say the 14m and 16m tallies on 30m chain. Also the units four and six are capable of being mis-read. Only careful reading can prevent these mistakes
- Erroneous booking:-Prevented by the chainman carefully calling out the result and the surveyor repeating it, paying attention when calling 5 or 9 7 or 11

- **B Systematic or cumulative Errors: -** In surveying, systematic errors occur due to natural causes instrumental factors, and the observer's human limitation, temperature, humidity, and barometric pressure – natural sources that affect angle measurements and distance measurements either by tapes or electronic distance measuring equipment
- (2) Instrumental factors are caused by either imperfections in construction or lack of adequate adjustment of equipment before their use in data acquisition. e.g.
- (a) graduations on linear and circular scales,
- (b) lack of centering of different components of instrument
- (c) Compromise in optical design, which leaves certain amounts of distortions and aberration
- (3) Human observer limitations – man relies mostly on the natural senses of vision and hearing, both of which $^1/_2$ limitations and vary due to circumstances and from one individual to another. The set of error committed by an observer depend on the precise physical, psychological, and environmental conditions that exist during the particular observational experiment. There are two such errors in chaining to which corrections are applied. Correction of chain for standardization and correction for sloping ground

- (1) Correction of chain for standardization – checking the chain frequently, at the beginning of each day's chaining is a good rule, and necessary for effective correction because chain changes is length due to wear and tear correct length of line – measured length of line x length of chain use / length of standard
- Correct area = measured area x (length of chain used / length of standard)^2
  - Correction for sloping ground. Lines chained sloping land must be longer than lines chained on the flat, if the slope is excessive, then your correction must be applied. There are two methods
- Stepping: - best for ground of variable slope .it involves chaining in short length of 30 – 50 links, the leader holding the length horizontal
- Measuring along the slope – ground runs in long regular slopes. The slope is measured either by an instrument known as a clinometers or by leveling, a procedure which gives the surface height at points along the slope. In either case the angle of slope can be found, and hence the corrected length from
- Correct length = measured length x cos x – (3) x = angle of slope

- **(C) ACCIDENTAL OR COMPENSATING ERRORS.**
- This third gap of error arises from lack of protection in the human eye and in the method of using equipment. They are not mistakes and as there is as munch chance of their being +ve as being -ve, the errors from these sources tend to cancel out, i.e tend to be compensatory.
-
- **The basic equipment required in leveling is**
- (a) a device which gives a truly horizontal line(the level)
- (b) a suitably graduated staff for ready vertical heights (the level staff)
- **Definitions**
- **A level line:-** is one which is at constant height relative to mean cell level, and since it follows the mean surface of the earth, it must be a curved line.
- **A horizontal line:-** however is tangential to the level line at any particular pt, since it is perpendicular to the direction of gravity at that pt . Over short distance the lines two lines are taken to coincide; but over long distances a correction for their divergence becomes necessary.
- **Curvature and Refracted:-** In leveling It is necessary to consider the effect of (1) The curvature of the earth and (2) Atmospheric retraction, which affects the line of sight. Usually, these 2 effect are considered together

- **Methods of Leveling**
- Difference in elevation may be measured by the following method
  - Direct or spirit leveling – Measuring vertical distances directly. This is the most precise method and the one commonly used in determination of elevation.
  - Indirect or trigonometric leveling, - measuring vertical angles and horizontal or slope distances. Direct or spirit leveling – Measuring vertical distance directly

Use of leveling staffs and level

- The level is set up at position 1(as in practical). The relative levels of A,B,C and D can be determined by holding the staff at each in turn and ready the height at which the line of sight intercepts it. For example, if the staff ready at A is 3m and at B is 1.8m, then B is 1.2m higher than A.

- The pt A is a bench mark (B.M.). Ordnance surveyors ½ established bench marks at frequent intervals over the whole country, the reduced levels of these mark reckoned from Ordnance Datum, are known and can be found on ordnance survey maps. By starting the level run at a bench mark, the reduced levels of all subsequent pts can be determined e.g. if the staff readings taken from position1, at A,B,C and d, are 3m, 1.8m, 3.5m and 1m respectively, and if the reduced level (R.L) of A is 32m AOD, than the reduced levels of B,C, and D are respectively 33.2m, 315m and 34m A.O.D.
- When an instrument is set up in a position for leveling the first staff ready is called a back sight. The last staff ready before moving the instrument is a foresight, and all other staff readings are called intermediate sights. Thus, from position 1, the ready at A is a back sight, the ready at D is a foresight and those at B and C are “inter sights” (a common abbreviation for “intermediate sights”) then the instrument is moved to position 2 the new ready, 2m say, at E, 1.8m say, is a foresight. The point D is called a change point (C.P.), the staff being kept there while the position of the instrument is changed.

- **BOOKING**
- The terms defined above are used when booking the field observations by either of the two available methods (Height of collimation method and rise and fall method).
- The staffs ready quoted in the previous section are booked in the same way for both methods, but the reduced levels are calculated differently in each method.

1. **Height of collimation method**

- Notes
- "Height of collimation" (which is sometimes also called "height of instrument") means the height of the line of sight, which is the same for all telescope pointing from one instrument station
- The reduced level of A is known and is before written in the "R.L." column before any readings are taken
- The back sight, 3m, at A is observed and entered in the appropriate column
- The height of collimate is calculated thus. 32+3 = 35m
- The staff readings at B is observed and entered as an inter sight
- The reduced level of B is calculated thus: 35.0 – 1.8 = 33.2m
- The reduced level of C and D are similarly obtained.
- D is a change pt. While the staff is held at D the instrument is moved to position 2, where the new line of sight is at a different level from that of position 1. it is calculated as before, namely 34+2 = 36m, the new height of collimation
- The reduced level of E is calculated thus 36.0 – 1.8 = 34.2m
- The arithmetic is checked by apply the following formula:
- Sum of sum of
- Back sights Foresights= Last R..L –first R .L.
- 50- 2.8=34.2- 32.0
- The 'Distance' column is sometimes used to describe the staff position

- 2. <u>Rise and fall method</u>
- <u>Notes</u>
- (a) The staff readings & R.L.S are booked in the same order as in the previous method.
- (b) The staff ready at A is 1.2m greater than at B; evidently the foot of the staff has risen 1.2m in the move from A to B There is thus a rise of 1.2m and, consequently
- R. L. of B = 32.0 + 1. 2 =33. 2
- (c) Similarly, there is a fall from B to C of 3.5 – 1.8= 1.7m
- Hence R.L of C = 33.2 – 1.7 =31 .5M
- The reduced level of any staff station is obtained by adding the "rise" to or subtracting the "fall" from, the reduced level of the previous staff station.
- By this method there is an additional arithmetic check thus
- Sum of sum of Sum of Sum of
- Back sights Foresights = rises falls = Last R. L. –first R .L.
- i.e. 5.0 – 2.8 = 3.9 – 1.7 = 34.2 – 32.0
- Rule: In both methods the check on arithmetic works only if the first staff ready booked is a back sight and the last staff ready booked is a foresight. This check should be carried out at the bottom of every page of levels

COMPARISON OF METHODS

- In the rise and fall method each level is calculated from the previous reduced level, and before a satisfactory arithmetic check ensures that all the reduced levels are correctly calculated.
- In the height of collimation method mistakes in isolated reduced level can occur without upsetting the check.
- On the other hand, this method involves less arithmetic than the rise and fall method, and is before quicker

ANGLES AND DIRECTIONS

- Surveying is the science and art of measuring distances and **angles on or** near the surface of the earth.
- It is an orderly process of acquiring data relating to the physical characteristics of the earth and in particular the relative position of points and the magnitude of areas.
- Evidence of surveying and recorded information exists from as long ago as five thousand years in places such as China, India, Babylon and Egypt.
- The word angle comes from the Latin word angulus, meaning "a corner".
- In surveying, the direction of a line is described by the horizontal angle that it makes with a reference line. This reference line is called a **meridian**
- The term "meridian" comes from the Latin meridies, meaning "midday". The same Latin stem gives rise to the terms A.M. (Ante Meridian) and P.M. (Post Meridian).

- A **meridian (or line of longitude) is an** imaginary arc on the Earth's surface from the North Pole to the South Pole that connects all locations running
- along it with a given longitude.
- The position of a point on the meridian is given by the latitude. The meridian that passes through Greenwich, England, establishes the meaning of

  zero degrees of longitude, or the Prime Meridian
- There are three types of meridians:
- **Astronomic** - direction determined from the shape of the earth and gravity; also called geodetic north
- **Magnetic** - direction taken by a magnetic needle at observer's position
- **Assumed** - arbitrary direction taken for convenience

- Methods for expressing the magnitude of plane angles are: sexagesimal, centesimal, radians, and mils
- **Sexagesimal System** - The circumference of circles is divided into 360 parts (degrees); each degree is
- further divided into minutes and seconds. Sexagesimal (base-sixty) is a numeral system with sixty as the base. It originated with the ancient Sumerians in the 2000s BC, was transmitted to the Babylonians, and is still used in modified form nowadays for measuring time, angles, and geographic coordinates. Babylonian mathematics as used in ancient Mesopotamia was not a pure base 60 system, in the sense that it didn't use 60 distinct symbols for its digits.

Approximations

- 1° is approximately the width of a little finger at arm's length.
- 10° is approximately the width of a closed fist at arm's length.
- 20° is approximately the width of a handspan at arm's length.
- These measurements clearly depend on the individual subject, and the above should be treated as rough approximations only.

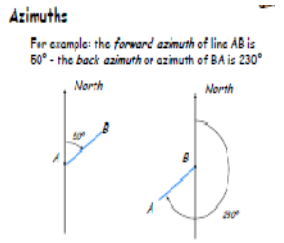
- **Centesimal System** - The circumference of circles is divided into 400 parts called gon (previously called grads)
- **Radian** - There are 2π radians in a circle. (1 radian = 57.2958° or 57°17'45")
- **Mil** - The circumference of a circle is divided into 6400 parts (used in military science)

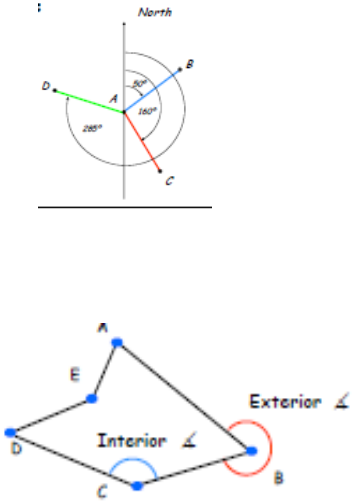
Azimuths

- A common terms used for designating the direction of a line is the azimuth from Arabic al-sumut, from al (the) + sumut (way). The azimuth of a line is defined as the clockwise angle from the north end or south end of the reference meridian.
- Azimuths are usually measured from the north end of the meridian North B.Every line has two azimuths (forward and back) and their values differ by 180°
- Azimuth are referred to astronomic, magnetic, or assumed meridian For example: the forward azimuth of line AB is 50° - the back azimuth or azimuth of BA is 230°

- **Bearings**
- The bearing of a line is defined as the smallest angle which that line makes with the reference meridian
- A bearing cannot be greater than 90° (bearings are measured in relation to the north or south end of
- the meridian - NE, NW, SE, or SW)
- It is convent to say: N90°E is due East
- S90°W is due West
- Until the last few decades American surveyors favoured the use of bearings over azimuth.
- A **traverse** is a series of successive straight lines that are connected together.
- A traverse is **closed** such as in a boundary survey or **open** as for a highway
- An **exterior angle** is one that is not enclosed by the sides of a closed traverse

- An **interior angle** is one enclosed by sides of a closed traverse.
- An **angle to the right** is the clockwise angle between the preceding line and the next line of the a traverse
- A **deflection angle** is the angle between the preceding line and the present one





Aerial survey

Aerial survey is a geomatics method of collecting information by utilising aerial photography or from remote sensing imagery using other bands of the electromagnetic spectrum, such as infrared, gamma, or ultraviolet. It can also refer to the chart or map made by analysing a region from the air.

This is typically done using aeroplanes, helicopters, and in history with balloons. Aerial survey should be distinguished by satellite imagery technologies because of its better resolution, quality and atmospheric conditions. Today, aerial survey is often recognized as a synonym for aerophotogrammetry, part of photogrammetry where the camera is placed in the air. Measurements on aerial images are provided by photogrammetric technologies and methods.

Topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines in modern mapping, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features.

The Canadian Centre for Topographic Information provides this definition of a topographic map:

"A topographic map is a detailed and accurate graphic representation of cultural and natural features on the ground."

- However, in the vernacular and day to day world, the representation of relief (contours) is popularly held to define the genre, such that even small-scale maps showing relief are commonly (and erroneously, in the technical sense) called "topographic".
- The study or discipline of topography, while interested in relief, is actually a much broader field of study which takes into account all natural and man made features of terrain. Topographic maps show natural and man made features.

REMOTE SENSING

- Remote sensing is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that is not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, buoy, or ship).
- In practice, remote sensing is the stand-off collection through the use of a variety of devices for gathering information on a given object or area. Thus, Earth observation or weather satellite collection platforms, ocean and atmospheric observing weather buoy platforms, monitoring of a pregnancy via ultrasound, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and space probes are all examples of remote sensing.
- In modern usage, the term generally refers to the use of imaging sensor technologies including but not limited to the use of instruments aboard aircraft and spacecraft, and is distinct from other imaging-related fields such as medical imaging.

- There are two kinds of remote sensing.
- Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding area being observed. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography, infra-red, charge-coupled devices, and radiometers.
- Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a passive sensor then detects and measures the radiation that is reflected or backscattered from the target.
- RADAR is an example of active remote sensing where the time delay between emission and return is measured, establishing the location, height, speed and direction of an object.