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MSc in Structural Engineering

Engineering Surveying
Theory 1: Introduction & Definitions

Introduction

Surveying is the art of measuring distances, angles, and positions above, on or below the earth's surface. The relative positions of points are located by means of measuring distances, directions and angles accurately with the help of various surveying instruments. Surveying also includes the art of locating or setting out points on the ground from a plan or a map.

Main Purposes involved in surveying:

- To determine the relative positions of points on the earth's surface.
- To set out the lines and grades needed for the construction of buildings, roads, dams, and other structures,
- To calculate areas, volumes and other related quantities,
- As well as to prepare necessary maps and diagrams of an area.

Introduction

Engineering Surveying is an important disciplinary field that serves construction projects. The knowledge and skills that you will learn in this field will enable you to be able to work as an engineering surveyor, providing geospatial information for construction projects.

Engineering Surveying involves

- Project planning and design;
- Quality control of construction projects to ensure the projects progress according to their designs and given tolerances; and
- Monitoring the performance and health conditions of completed structures and facilities

History of Surveying

It is impossible to determine when exactly surveying was first used. But there are many examples of early survey works that have done by the Babylonians and Egyptians.

Some examples of early surveying works:

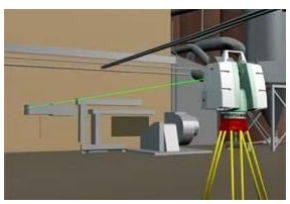
- Babylonian maps on tablets (2500 B.C)
- Irrigation ditches constructed in Babylon (1800 B. C)
- Division of land in Egypt by surveyors known by harpedonapata (rope stretchers) using ropes with knots to re-establish boundary marks removed by flooding of Nile river and for the purpose of taxation (1400 B.C).
- The construction of the great Egyptian pyramids using the 3:4:5 method of right angle setting and a level made of isosceles triangle and plum bob.

History of Surveying

- **Greek and Roman** had tried to use science in surveying at 150 B.C.
- **During the Middle Ages**, the **Arabs** kept Greek and Roman science alive. Little progress was made in the art of surveying, and the only writings pertaining it were called **"practical geometry."**
- **In the 18th and 19th centuries**, the art of surveying advanced more rapidly. The need for maps and locations of national boundaries caused **England and France** to make extensive surveys requiring accurate **triangulation**; thus, **geodetic** surveying began. **The U.S. Coast Survey** (now the National Geodetic Survey of the U.S. Department of Commerce) was established by an act of Congress **in 1807**. Initially its charge was to perform **hydrographic surveys** and prepare nautical charts. Later its activities were expanded to include establishment of **reference monuments** of precisely known positions throughout the country.

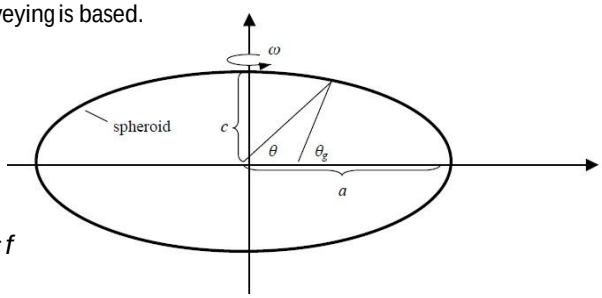
History of Surveying

- Developments in surveying and mapping equipment have now evolved to the point where the **traditional instruments** that were used until about the **1960s or 1970s** the transit theodolite, dumpy level, and steel tape have now been almost completely replaced by an array of new **"high-tech" instruments**. These include electronic total station instruments, which can be used to automatically measure and record horizontal and vertical distances, and horizontal and vertical angles; and global navigation satellite systems (GNSS) such as the global positioning system (GPS) that can provide precise location information for virtually any type of survey. Laser-scanning instruments combine automatic distance and angle measurements to compute dense grids of coordinated points. Also new aerial cameras and remote sensing instruments have been developed, which provide images in digital form, and these images can be processed to obtain spatial information and maps using new digital photogrammetric restitution instruments (also called softcopy plotters).


Earth Shape

The surface of the earth is an approximate oblate ellipsoid of it is revolution. The length **polar** and **equatorial** axes are **12713.168 km** and **12756.413 km** respectively. The difference is only about **43 km** as computed by Clark in 1866. The polar axis is shorter than the equator axis. When the distance of measurement is small, practically there is no difference between the curved distance and corresponding straight line distances, and curvature of the earth is neglected. But in case of bigger area long distance cannot be neglected and earth curvature is considered. Hence, the surface of the earth has curvature and this is the main factor on which the two divisions of surveying is based.



The earth flattening parameter *f* according to WGS84 is

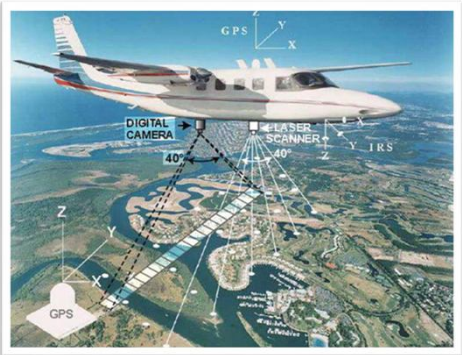
$f = (a - c)/a \quad = \quad 1/298.257$

Types of Surveying

In general, there are many different classifications of surveying based on the area of study, nature of field, object of survey and used instruments.

Here we divide surveying into two main types:

1. **Aerial Surveying (Photogrammetric):** It is a method of surveying that uses either photograph taken from ground or air or from space.



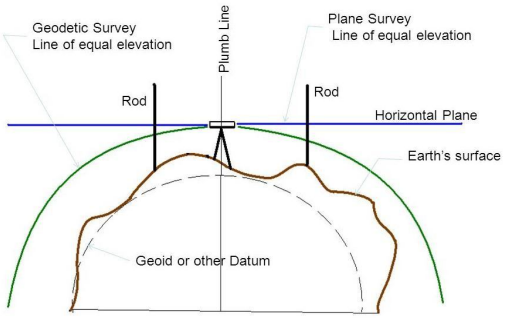
Types of Surveying

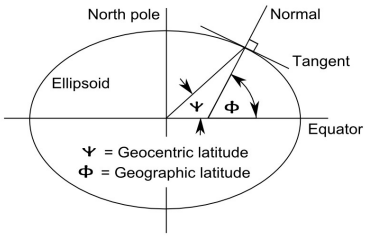
2. Ground surveying: It is a surveying made by ground method and instruments .

Types of Surveying

Types of Ground surveying:

1. **Geodetic surveying:** Is the type of surveying that takes into account the true shape and size of the earth, which the surface of the earth is considered to be a spherical for X and Y dimensions. These surveys are of high precision and extend over large areas.
2. **Plane surveying:** Is The type of surveying in which the mean surface of the earth is considered as a plane, or in which its spheroidal shape is neglected, with regard to horizontal distances and directions.





Types of Surveying

Types of Ground surveying: Comparison between Plain and Geodetic Surveying

No.	Plain Surveying	Geodetic Surveying
1	The earth surface is considered as plain Surface.	The earth surface is considered as Curved Surface.
2.	The Curvature of the earth is ignored	The curvature of earth is taken into account.
3	Line joining any two stations is considered to be straight	The line joining any two stations is considered as spherical.
4.	The triangle formed by any three points is considered as plain	The Triangle formed by any three points is considered as spherical.
5.	The angles of triangle are considered as plain angles.	The angles of the triangle are considered as spherical angles.
6.	Carried out for a small area < 250 km^2	Carried out for a small area > 250 km^2

Types of Surveying

Types of Plane surveying:

1. **Topographic surveying:** Preliminary surveys used to tie in the natural and constructed surface features of an area. The features are located relative to one another by tying them all into the same control lines or control grids.
2. **Hydrographic surveying:** Preliminary surveys used to tie in under water features to a surface control line. Usually shore-lines, marine features, and water depths are shown on hydrographic maps.
3. **Route surveying:** It deals with route, highways, railroads, electricity transmission lines, and channels.
4. **Mining surveying:** It deals with locating mines on or under earth surface.
5. **Construction surveying:** Layout surveys for engineering works.

Types of Surveying

6. **Control Survey:** Made to establish the horizontal and vertical positions of arbitrary points.
7. **Property Survey (land survey or cadastral survey):** It is involved in determining boundary locations or in laying out new property boundaries, calculation of land area, or the transfer of land property from one owner to another.
8. **City Surveying:** They made in connection with the construction of streets, water supply systems, sewers and other works.

Astronomical Survey: The astronomical survey offers the surveyor means of determining the absolute location of any point or the absolute location and direction of any line on the surface of the earth. This consists in observations of bodies such as the sun or any fixed star.

Types of Surveying

Classification based on the object of survey

1. **Engineering Surveying:** Used by the engineers during the design, construction, and maintenances stage. Such as, buildings, roads, reservoirs, and water supply systems.
2. **Mine Survey:** Underground surveying in mines, tunnels and for exploring minerals in earth such as gold, coal, etc.
3. **Geological Survey:** Prepare geological maps which shows the different strata of earth surface, kinds of minerals and faults.
4. **Military Survey:** This is used for determining points of strategic importance within military projects.

Classification based on the instrument used

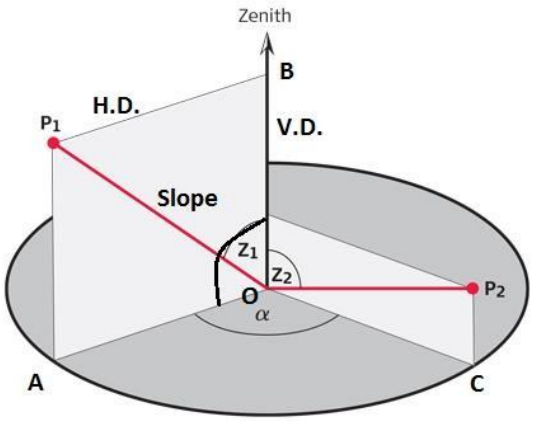
1. Chain survey
2. Traverse survey
3. Photographic survey
4. Theodolite survey
5. Plane table survey
6. Aerial survey

Terminology

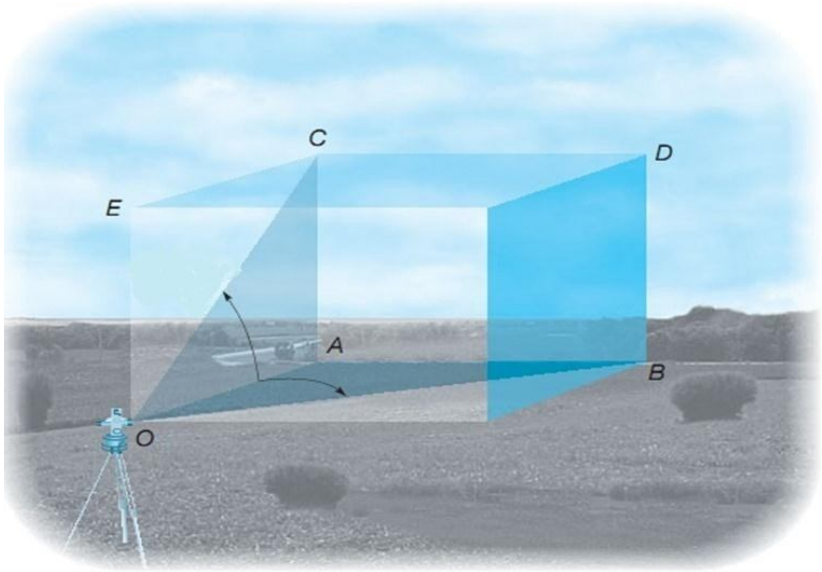
1. **Horizontal distance:** a distance measured in a horizontal plane. If a distance is measured along a slope, it is reduced to its horizontal equivalent.
2. **Vertical distance:** a distance measured along the direction of gravity at that point. The vertical distances are measured to determine the difference in elevations (height) of the various points.
3. **Horizontal Angle:** an angle measured between two lines in a plane that is horizontal at that point.
4. **Vertical Angle:** an angle measured between two lines in a plane that is vertical at a point.

Terminology

5. **Slope:** Slope refers to the angle, or grade, of an incline. Slope can be upward or downward. Slope is typically expressed as a percent, and corresponds to the amount of rise, or vertical distance, divided by the run, or horizontal distance.
6. **Slope distance:** is the length of slope line which is connected to two ground points



Terminology



Terminology

7. **Mean Sea Level (MSL):**
   The average level of the ocean's surface, calculated as the arithmetical mean of hourly tide levels taken over an extended period and used as the standard for determining geodetic vertical control points.

8. **Benchmark:** Is the natural and artificial point established at known plan elevation that is used as the basis for measuring the elevation of other topographical points.

9. **Elevation:** The elevation of a geographic location is its height above or below a fixed reference point.