Program : **B.Tech**

Subject Name: **Surveying**

Subject Code: **CE-303**

Semester: **3rd**

UNIT 5

Hydrographic Survey: Soundings, methods of observations, computations and plotting. Principles of photographic surveying: aerial photography, tilt and height distortions, Setting out works.

Definition:

It is the branch of surveying which deals with anybody of still or running water such as a lake, harbor, stream or river. Hydrographic surveys are used to define shore line and under water features. Hydrographic surveying or bathymetric surveying is the survey of physical features present underwater. It is the science of measuring all factors beneath water that affect all the marine activities like dredging, marine constructions, offshore drilling etc.

Hydrographic surveying is mainly conducted under authority concerns. It is mainly carried out by means of sensors, sounding or electronic sensor system for shallow water.

The information obtained from hydrographic surveying is required to bring up nautical charts which involves,

- Available depths
- Improved Channels
- Breakwaters
- Piers
- The aids to navigation harbor facility

These surveys also take part in necessary data collection relating to construction and developments of port facilities, such as pier construction. This help in finding the loss in capacity due to silt and many uncertainties.

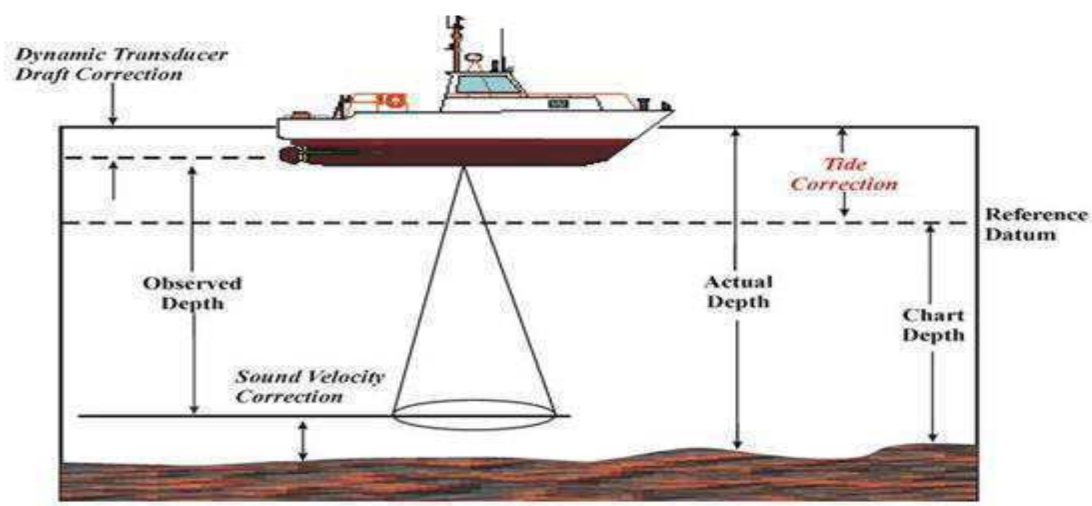

Fig: Hydrographic Surveying

Applications of Hydrographic Surveying

Following are the applications of hydrographic surveying:

- Dock and Harbor Engineering
- Irrigation
- River Works
- Land reclamation
- Water Power
- Flood Control
- Sewage Disposal

Uses of Hydrographic Surveying

Uses of hydrographic surveying are given below:

1. Depth of the bed can be determined
2. Shore lines can be determined
3. Navigation Chart Preparation
4. Locate sewer fall by measuring direct currents
5. Locating mean sea level
6. Scouring, silting and irregularities of the bed can be identified
7. Tide measurement
8. River and stream discharge measurement
9. Massive structures like bridges, dams harbors are planned

Preliminary Steps in Hydrographic Surveying

The method starts by locating special control points along the shore line. The sounding method is employed to determine the depth at various points by means of stationary boats. Sounding locations can be either made from boat to the control points or by fixing a point in the boat and taking sounding from the control point. Before this procedure certain preliminary steps have to be made:

1. Reconnaissance
2. Locate Horizontal Control
3. Locate vertical Control

Reconnaissance

As every project require a start-up plan to complete it effectively and economically, reconnaissance has to be undergone. A complete reconnaissance of whole survey area to choose the best way of performing the survey.

This would facilitate satisfactory completion of the survey in accordance with the requirements and specifications governing such work. Aerial photographs would help this study.

Locating Horizontal Control

The horizontal control is necessary to locate all features of the land and marine in true relative positions. Hence a series of lines whose lengths and azimuths are determined by means of either triangulation or any other methods. Tachometric and plane table survey can be conducted in order to undergo rough works. No rules are kept for establishing horizontal control as topography, vegetation, type, size of topography affect the rules.

But in general a rules can be kept for type of control say:

- It is advisable to run traverses along each shore, connecting each other by frequent tie lines –If water body > 1km wide.
- It is advisable to run transverse line only along one of the banks -If water body is narrow
- Triangulation system -If shorelines filled by vegetation
- Large network of triangulation system for large lakes and ocean shore lines.

Locating Vertical Control

Before sounding establishment of vertical control is essential to determined. Numerous benchmarks are placed in order to serve as vertical control. Setting and checking the levels of the gauges are uses of benchmarks.

Sounding in Hydrographic Survey

The process of determining depth below water surface is called as sounding. The step before undergoing sounding is determining the mean sea level. If the reduced level of any point of a water body is determined by subtracting the sounding from mean sea level, hence it is analogous to leveling. The specific need for sounding are

1. Preparation of navigation charts that is an all-time information for future purpose also
2. Material that to be dredged has to be determined early to facilitate easy movement in project without any confusion
3. Material dredging should also accompany where filling has to be done. Material dumping is also measured
4. Design of backwaters, sea wells require detailed information that is obtained from sounding

Equipment for Sounding

The essential equipment used for undergoing sounding are

1. Shore signals and buoys
2. Sounding Equipment
3. Instruments for measuring angles

1. Shore signal and buoys

These are required to mark the range lines. A line perpendicular to shore line obtained by line joining 2 or 3 signals in a straight line constitute the range line along which sounding has to be performed. Angular observations can also be made from sounding boats by this method. To make it visible from considerable distance in the sea it is made highly conspicuous.

A float made of light wood or air tight vessel which is weighted at bottom kept vertical by anchoring with guy wires are called buoys. In order to accommodate a flag a hole is drilled. Under water deep, the range lines are marked by shore signals & the buoys.

2. Sounding Equipment

The individual units involved are explained one by one:

a. Sounding boat

A flat bottom of low draft is used to carry out sounding operation. Large size boats with motor are used for sounding in sea. The soundings are taken through wells provided in the boat. A figure depicting sounding boat.

b. Sounding pole or rod

Rod made of seasoned timber 5 to 10cm diameter and 5 to 8m length. A lead shoe of sufficient weight is connected at bottom to keep it vertical. Graduations are marked from bottom upwards. Hence readings on the rod corresponding to water surface are water depth.

c. Lead line

A graduated rope made of chain connected to the lead or sinker of 5 to 10kg, depending on current strength and water depth. Due to deep and swift flowing water variation will be there from true depth hence a correction is required.

Other sounding equipment used is Waddell's sounding machine. These are employed when large sounding work has to be undergone. A standard machine to measure maximum of 30 to 40m is designed that are bolted over the well of the sounding boat.

Another equipment used is fathometer which is an echo-sounding instrument used to determine ocean depth directly. Recording time of travel by sound waves is the principle employed. Here the time of travel from a point on the surface of the water to the bottom of the ocean and back is recorded. Knowing the velocity of sound waves the depth can be calculated.

d. Fathometer : Eco-sounding

It is used for ocean sounding where the depth of water is too much, and to make a continuous and accurate record of the depth of water below the boat or ship at which it is installed. It is an echo-sounding instrument in which water depth are obtained by determining the time required for the sound waves to travel from a point near the surface of the water to the bottom and back.

It is adjusted to read depth in accordance with the velocity of sound in the type of water in which it is being used.

Arial Photogrammetry

Introduction

- The Photogrammetry has been derived from three Greek words:
    - Photos: means light
    - Grammar: means something drawn or written
    - Matron: means to measure
- This definition, over the years, has been enhanced to include interpretation as well as measurement with photographs.

The art, science, and technology of obtaining reliable information about physical objects and the environment through process of recording, measuring, and interpreting photographic images and patterns of recorded radiant electromagnetic energy and phenomenon (American Society of Photogrammetry, Slam).

- Originally Photogrammetry was considered as the science of analyzing only photographs.
- But now it also includes analysis of other records as well, such as radiated acoustical energy patterns and magnetic phenomenon.

Definition of Photogrammetry includes two areas:
(1) Metric: It involves making precise measurements from photos and other information source to determine, in general, relative location of points. Most common application: preparation of plannimetric and topographic maps.

(2) Interpretative: It involves recognition and identification of objects and judging their significance through careful and systematic analysis. It includes photographic interpretation which is the study of photographic images. It also includes interpretation of images acquired in Remote Sensing using photographic images, MSS, Infrared, TIR, SLAR etc.

Aerial Photogrammetry

Photographs of terrain in an area are taken by a precision photogrammetric camera mounted in an aircraft flying over an area.

Terrestrial Photogrammetry

Photographs of terrain in an area are taken from fixed and usually known position or near the ground and with the camera axis horizontal or nearly so.

Photo-interpretation

Aerial/terrestrial photographs are used to evaluate, analyze, and classify and interpret images of objects which can be seen on the photographs.

Applications of Photogrammetry

Photogrammetry has been used in several areas. The following description give an overview of various applications areas of Photogrammetry :

(1) Geology:

Structural geology, investigation of water resources, analysis of thermal patterns on earth's surface, geomorphologic studies including investigations of shore features.

- engineering geology
- stratigraphics studies
- general geologic applications
- study of luminescence phenomenon
- recording and analysis of catastrophic events
- Earthquakes, floods, and eruption.

(2) Forestry:

Timber inventories, cover maps, acreage studies

(3) Agriculture:

Soil type, soil conservation, crop planting, crop disease, crop-acreage.

(4) Design and construction

Data needed for site and route studies specifically for alternate schemes for Photogrammetry. Used in design and construction of dams, bridges, transmission lines.

(5) Planning of cities and highways

New highway locations, detailed design of construction contracts, planning of civic improvements.

(6) Cadastral

Cadastral problems such as determination of land lines for assessment of taxes. Large scale cadastral maps are prepared for reapportionment of land.

(7) Environmental Studies

Land-use studies.

(8) Exploration

To identify and zero down to areas for various exploratory jobs such as oil or mineral exploration.

(9) Military intelligence

Reconnaissance for deployment of forces, planning man oeuvres, assessing effects of operation, initiating problems related to topography, terrain conditions or works.

(10) Medicine and surgery

Stereoscopic measurements on human body, X-ray Photogrammetry in location of foreign material in body and location and examinations of fractures and grooves, biostereometrics.

(11) Miscellaneous

Crime detection, traffic studies, oceanography, meteorological observation, Architectural and archaeological surveys, contouring beef cattle for animal husbandry etc.

categories of Photogrammetry

- Photogrammetry is divided into different categories according to the types of photographs or sensing system used or the manner of their use as given below:

(1) On the basis of orientation of camera axis:

(i) Terrestrial or ground Photogrammetry

When the photographs are obtained from the ground station with camera axis horizontal or nearly horizontal

(ii) Aerial Photogrammetry

If the photographs are obtained from an airborne vehicle. The photographs are called vertical if the camera axis is truly vertical or if the tilt of the camera axis is less than 3o. If tilt is more than (often given intentionally), the photographs are called oblique photographs.

(2) On the basis of sensor system used:

Following names are popularly used to indicate type of sensor system used in recording imagery.

- Radargrammetry: Radar sensor
- X-ray Photogrammetry: X-ray sensor
- Hologrammetry: Holographs
- Cine Photogrammetry: motion pictures
- Infrared or color Photogrammetry: infrared or color photographs

(3) On the basis of principle of recreating geometry

When single photographs are used with the stereoscopic effect, if any, it is called monoscopic Photogrammetry. If two overlapping photographs are used to generate three dimensional view to create relief model, it is called stereo Photogrammetry. It is the most popular and widely used form of Photogrammetry.

(4) On the basis of procedure involved for reducing the data from photographs

Three types of Photogrammetry are possible under this classification:

(a) Instrumental or analogue Photogrammetry

It involves photogrammetric instruments to carry out tasks.

(b) Semi-analytical or analytical

Analytical Photogrammetry solves problems by establishing mathematical relationship between coordinates on photographic image and real world objects. Semi-analytical approach is hybrid approach using instrumental as well analytical principles.

(c) Digital Photogrammetry or softcopy Photogrammetry

It uses digital image processing principle and analytical Photogrammetry tools to carry out photogrammetric operation on digital imagery.

(5) On the basis of platforms on which the sensor is mounted:

If the sensing system is space borne, it is called space Photogrammetry, satellite Photogrammetry or extra-terrestrial Photogrammetry.

Out of various types of the Photogrammetry, the most commonly used forms are stereo Photogrammetry utilizing a pair of vertical aerial photographs (stereo pair) or terrestrial Photogrammetry using a terrestrial stereo pair.

Classification of Photographs

The following paragraphs give details of classification of photographs used in different applications

(1) On the basis of the alignment of optical axis

(a) Vertical: If optical axis of the camera is held in a vertical or nearly vertical position.

(b) Tilted: An unintentional and unavoidable inclination of the optical axis from vertical produces a tilted photograph.

(c) Oblique: Photograph taken with the optical axis intentionally inclined to the vertical. Following are different types of oblique photographs:

(i) High oblique: Oblique which contain the apparent horizon of the earth.

(ii) Low oblique: Apparent horizon does not appear.
(iii) Trim trogon: Combination of a vertical and two oblique photographs in which the central photo is vertical and side ones are oblique. Mainly used for reconnaissance.
(iv) Convergent: A pair of low oblique's taken in sequence along a flight line in such a manner that both the photographs cover essentially the same area with their axes tilted at a fixed inclination from the vertical in opposite directions in the direction of flight line so that the forward exposure of the first station forms a stereo-pair with the backward exposure of the next station.
Comparison of photographs

Type of photo	Vertical	Low oblique	High oblique
Characteristics	Tilt < 3°	Horizon does not appear	Horizon appears
Coverage	Least	Less	Greatest
Area	Rectangular	Trapezoidal	Trapezoidal
Scale	Uniform if flat	Decreases from foreground to background	Decreases from foreground to background
Difference with map	Least	Less	Greatest
Advantage	Easiest to map	-	Economical and illustrative

(2). On the basis of the scale
(a) Small scale - 1: 30000 to 1: 250000, used for rigorous mapping of undeveloped terrain and reconnaissance of vast areas.
(b) Medium scale - 1: 5000 to 1: 30000, used for reconnaissance, preliminary survey and intelligence purpose.
(c) Large scale - 1: 1000 to 1: 5000, used for engineering survey, exploring mines.
(3). On the basis of angle of coverage
The angle of coverage is defined as the angle, the diagonal of the negative format subtends at the real node of the lens of the apex angle of the cone of rays passing through the front nodal point of the lens.

Name	Coverage angle	Format size (cm)	Focal length (cm)
Standard or normal angle	60°	(i) 18 (ii) 23	(i) 21 (ii) 30
Wide angle	90°	(i) 18 (ii) 23	(i) 11.5 (ii) 15
Super wide or ultra wide angle	120°	(i) 18 (ii) 23	(i) 7 (ii) 8.8
Narrow angle	< 60°		

formation recorded on photographs
The following information is recorded on a typical aerial photograph :
1. Fiducially marks for determination of principal points.

2. Altimeter recording to find flying height at the moment of exposure.
3. Watch recording giving the time of exposure.
4. Level bubble recording indicating tilt of camera axis.
5. Principal distance for determining the scale of photograph.
6. Number of photograph, the strip and specification no. for easy handling and indexing.
7. Number of camera to obtain camera calibration report.
8. Date of photograph

Types of projections

1. Parallel: The projecting rays are parallel.
2. Orthogonal: Projecting rays are perpendicular to plane of projection. This is a special case of parallel projection. Maps are orthogonal projection. The advantage of this projection is that the distances, angles, and areas in plane are independent of elevation differences of objects.
3. Central: Central projection is the starting point for all Photogrammetry. In this projection rays pass through a point called the projection center or perspective center. The image projected by a lens system is treated as central projection although in strictest senses it is not so.

Vertical photograph

A photograph taken with the optical axis coinciding with direction of gravity.

Tilted or near vertical

Photograph taken with optical axis unintentionally tilted from vertical by a small amount (usually < 3°).

Focal length (f)

Distance from front nodal point to the plane of the photograph (from near nodal point to image plane).

Exposure station (point L)

Position of frontal nodal point at the instant of exposure (L).

Flying height (H)

Elevation of exposure station above sea level or above selected datum.

X-axis of photo

Line on photo between opposite collimation marks, which most nearly parallels the flight direction.

Y-axis

Line normal to x-axis and join opposite collimation marks.

Principal point (o)

The point where the perpendicular dropped from the front nodal point strikes the photograph or the point in which camera axis pierces the image plane.

Camera axis

It is a ray of light incident at front nodal point in the object space and at right angles to the image plane.

Fiducially marks or collimation marks

Index marks usually four in number, rigidly connected with the camera lens through the camera body and forming images on the photographs to which the position on the photograph can be referred.

Photographs center

The geometrical center of the photograph as defined by the intersection of the lines joining the fiducially marks.

Format

It is the planar dimension of photograph (9" x 9", 7" x 7", 23 cm x 23 cm, 18 cm x 18 cm, 15 cm x 15 cm).

Photogram

Photograph taken with a photogrammetric camera having fixed distance between negative plane and lens and equipped with fiducially or collimating marks. For photogram the bundle of rays on the object side at the moment of exposure can be reproduced. To achieve this the following data known as the elements of interior orientation must be known:

- Calibrated focal length
- Lens distortion data
- Location of the principal point with reference to the photograph center (normally these two coincide)

Hence, a photogram is a photograph with known interior orientation

Difference between near vertical photographs and map

1. Production: Quickest possible and most economical method of obtaining information about areas of interest. Boon for difficult areas. Enlarging and reducing easier in case of photographs than maps.
2. Content: Map gives an abstract representation of surface with a selection from nearly infinite number of features on ground. Photograph shows images of surface itself. Maps often represent non-visible phenomenon (like text) this may make interpretation difficult for photograph. Special films like color and infrared films can bring about special features of terrain.
3. Metric accuracy: Map is geometrically correct representation, photos are generally not. Maps are orthogonal projections, photo is central projection. Map has same scale throughout photo has variable scale. Bearing on photographs may not be true.
4. Training requirement: A little training and familiarity with the particular legend used in the map enables proper use of map. Photo-interpretation requires special training although initially it may appear quite simple as it gives a faithful representation of ground.

