Hydrographic Surveying

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What This Text Covers . . .

Hydrographic Surveying

Preparatory Surveys

Control Surveys

Definitions

1. Hydrographic surveying is the process used in surveying any body of water and its adjacent land areas in order to obtain information needed for locating and plotting on a chart such features as shore lines, underwater contours, and navigable channels and shoals, rocks, sunken wrecks, and other obstructions to navigation.

The process of measuring the depth of a body of water at a particular point is known as taking a sounding, and an individual measurement of depth is called a sounding.

Operations

2. The fundamental operations in a hydrographic survey are to take soundings and to locate these soundings on a chart with respect to control stations whose positions have been established. Curves showing the variations in the depth of the body of water can then be drawn on the chart. Such features as rocks, shoals, wrecks, reefs, and prominent landmarks are also located on the chart.

Purposes of Hydrographic Surveys

3. The data obtained in a hydrographic survey may be used for one or more of the following purposes:

1) To determine what changes it is desirable or necessary to make in the dimensions of the channel or basin under consideration.

2) To indicate where material should be removed by dredging or blasting and where it may be deposited for filling, and to measure the quantity of material removed or the extent of the filling.

3) To obtain the information necessary for planning the construction of sea walls, jetties, lighthouses, docks, bridge piers, and other structures.

4) To construct a map or chart of a channel for navigation purposes.

5) To determine the volume of the body of water, or the capacity of the containing basin.

Divisions of a Survey

4. A hydrographic survey is normally divided into several parts. The most important are the following: geodetic control and triangulation; locating topography, shore stations, and buoys; taking soundings; locating the soundings with respect to the control points; and plotting depth curves, or contours.

Scales of Charts

5. The scale of a chart is the ratio of a unit distance on the chart to the corresponding actual distance on the surface of the earth. Thus, the scale 1:10,000, or $\frac{1}{10{,}000}$, means that one unit of distance on the chart represents 10,000 similar units on the surface of the earth. The basic scale used by the United States Coast and Geodetic Survey for hydrographic surveys is 1:20,000. Other scales used are generally convenient multiples of this basic scale. Some larger scales are 2, 4, and 8 times the basic scale, or 1:10,000; 1:5,000; and 1:2,500. For a smaller scale, the second term of the ratio, or the denominator of the fraction, should be a multiple of 20,000. Examples are 1:40,000; 1:60,000; 1:80,000; and 1:100,000. Usually a survey is plotted to a scale that is twice that of the final printed chart. This procedure serves t reduce small errors and thus increases the accuracy of th printed chart.

Units of Measurement

6. In hydrographic surveying, specific units of measure ment are generally used for certain kinds of distances, an parts of units are expressed in decimal form rather than i fractional form. For example, the units used for expressin depths of water are the foot and the fathom. The fathom i equivalent to 6 ft. Short horizontal distances are usuall expressed in feet, but the United States Coast and Geodeti Survey measures horizontal distances in meters, nautica miles, and statute miles. Elevations above the topographi datum plane are expressed in feet. Bearings are expressed i degrees and minutes.

Some general rules for recording soundings on hydro graphic sheets are as follows:

1) Either fathoms or feet may be used, but both unit should not be used on the same hydrographic sheet. Th choice will depend on the location of the survey, the depth c the water, and the unit used on existing charts.

2) Where the foot is the unit used, each depth shoul usually be a whole number. However, depths should b shown to the nearest half-foot at important points on navigabl bars; at critical points in channels having an average depth nc greater than 42 ft; at the high points on important shoal where the least depth is less than 42 ft; in shallow enclose waters and shallow inland routes, and near the low-wate line.

3) Where the fathom is the unit used, the normal prac tice is to show depths less than 11 fathoms in fathoms an tenths, depths between 11 and 31 fathoms to the nearest hal fathom, and depths greater than 31 fathoms to the neares whole number.

Purpose of Control

7. Control is the method of coordinating a hydrographic survey so that the land and water features are kept in proper relation to each other. Control points are so located by latitude and longitude that any area surveyed may be reproduced in its correct geographic position on any suitable map or chart.

Location of Control Points

8. The control for a survey is a number of accurately located points, known as stations, which are properly situated for use as reference points in the survey. These points are located geographically by a survey of a suitable order of precision. Triangulation is generally used to establish the principal control stations for a survey, but traverses may be preferable in some cases. Necessary intermediate stations are then established from the principal control stations. Control stations must be close enough to one another to permit the accurate location of all topographic and hydrographic features in the survey area. The physical nature of the area and the scale of the survey will determine the spacing of the control points.

Datums

9. All triangulation work in the United States is referred to a datum, which is known as the North American datum of 1927. The vertical datum for control elevations is mean high water. However, the sounding datum is mean low water for the Atlantic Ocean and the Gulf of Mexico, mean lower low water for the Pacific Ocean in general, and mean low water springs for the part of the Pacific Ocean near the Panama Canal Zone.

Triangulation and Topography

System of Triangulation

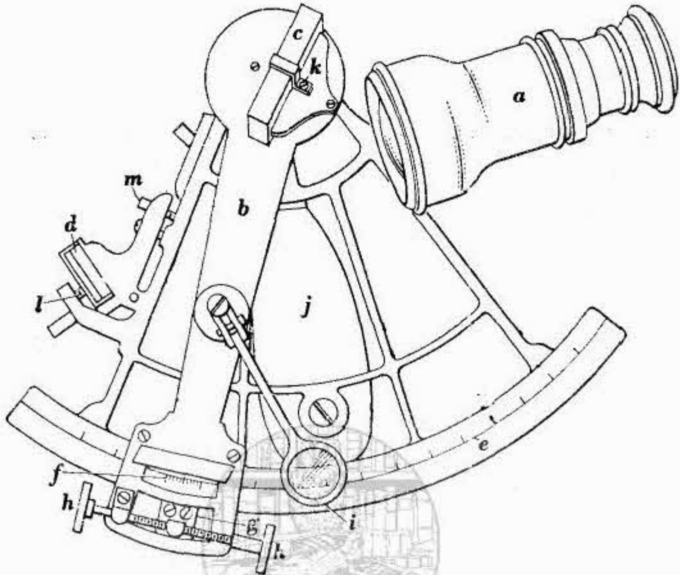
10. A triangulation system usually furnishes the control for both topographic and hydrographic surveying. Such a system is a framework composed of a connected chain or network of triangles, the vertexes of which are the triangulation stations. One line in the system, known as the base line, is measured very carefully, and the latitudes and longitudes of the stations at its ends are determined. All angles between stations are accurately measured, and all distances between stations are calculated by applying the principles of trigonometry.

Location of Triangulation Stations

11. Triangulation stations should be located on elevations of ground which command a strategic view, and these locations should be convenient for use in both the topographic and hydrographic parts of the survey. When new triangulation stations are connected with stations established by an older triangulation survey, the older stations must be checked and verified before they are used as part of the control system for the proposed survey. In many cases it is necessary to establish additional stations for use in the hydrographic survey and to tie them in with the triangulation stations.

Topography

12. Topographic surveys are made mainly for the purpose of locating points on the ground so that they may be plotted on a map or chart. It is also necessary to determine some elevations. The topographic features to be located may include hills, valleys, trees, streams, lakes, buildings, highways, railroads, and canals. It is usually important that a nautical chart show topographic features, as well as the locations and depths of soundings, because the prominent features on shore



a. telescope
b. index arm
c. index mirror
d. horizon mirror
e. graduated scale
f. vernier
g. clamp screw
h. tangent screw
i. reading glass
j. wooden handle
k, l, m. adjusting screws

FIG. 1. SEXTANT

serve as landmarks for ships sailing within sight of land. Topographic features are generally located with respect to control points by means of the plane table or by air photographs.

Shore Stations

Use of the Sextant

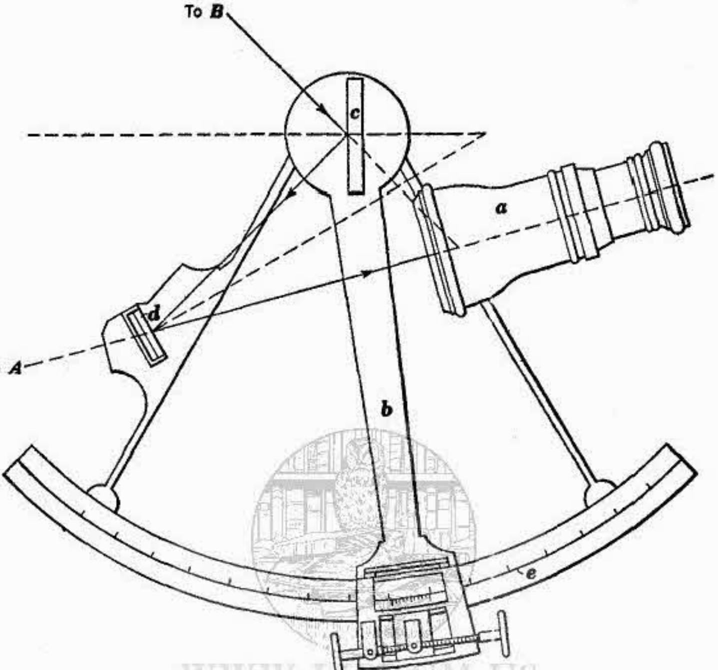
13. If the party which made the topographic survey did not locate a sufficient number of stations for use by the hydrographic party, it is necessary for the hydrographic party to establish additional natural or artificial control stations. The position of a new station is generally established by the measurement of angles at the new station between lines to control stations whose positions are known. The instrument generally used by a hydrographic party for measuring angles is the sextant.

By the use of a sextant the angle between two lines of sight can be measured by a single observation. Also, the sextant is held in the hand, and successive angular measurements may be made with great rapidity. It is, therefore, especially adapted for use in a boat on the water, where the motion renders the use of fixed instruments impracticable. The sextant is used to establish the locations of shore stations, buoys, and soundings.

A typical sextant is shown diagrammatically in Fig. 1. To a metal frame are attached a telescope *a*, an arm *b*, called the index arm, an index mirror *c*, which is fastened to the index arm, and a horizon mirror *d*. The mirrors may be of glass with a silver backing or of a metal called stellite, which takes a high polish and does not tarnish.

The frame of the sextant has a limb with a scale *e*, which is graduated in angular measure and is read with the aid of a vernier *f* at the lower end of the index arm. This arm can be held in a desired position by a clamp screw g, which is not visible in the illustration. After the clamp screw has been tightened, the index arm can be moved slowly by means of the tangent screw *h*. Two other parts of the sextant are a reading glass *i* and a wooden handle *j*.

If the sextant is in adjustment, the vernier reading on the scale is zero when the index mirror is parallel to the horizon mirror. Any reading other than zero when the two mirrors are parallel is the index error. If the zero mark of the vernier is off the main part of the graduated scale when the mirrors are parallel, the index error is added to the vernier reading obtained by measuring an angle. If the zero mark of the



a. telescope *c.* index mirror
b. index arm *d.* horizon mirror
e. graduated scale

FIG. 2. PRINCIPLE OF SEXTANT

vernier is on the main part of the scale when the mirrors are parallel, the index error is subtracted from the vernier reading for a measured angle. The methods of adjusting a sextant are described in the appendix at the end of this text.

The principle of operation of the sextant is indicated in Fig. 2. One object *A* is viewed directly through the telescope *a*, the rays of light from the object passing just over the edge of the reflecting part of the horizon mirror *d*. Also, rays from a second object *B* will enter the telescope at the same time if the index mirror *c* is so tilted by moving the index arm *b* that the rays reflected first from the index mirror and then from