IS 5497 (2008): Guide for topographical surveys for river valley projects [WRD 5: Gelogical Investigation and Subsurface Exploration]

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भारतीय मानक

नदी घाटी परियोजनाओं के लिए स्थलाकृतिक सर्वेक्षणों की मार्गदर्शिका

(दूसरा पुनरीक्षण)

Indian Standard

GUIDE TO TOPOGRAPHICAL SURVEYS FOR RIVER VALLEY PROJECTS

(Second Revision)

ICS 07.060

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Geological Investigations and Subsurface Exploration Sectional Committee, WRD 05

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geological Investigations and Subsurface Exploration Sectional Committee, had been approved by the Water Resources Division Council.

This standard was first published in 1969 and revised in 1983. In the first revision, specifications regarding scale of maps for different surveys had been modified to reflect current practice. Provisions regarding river survey, flood survey and command area development survey had been added. In this revision contour intervals for different types of surveys have been incorporated and modified where needed. Subjective details about the individual surveying methods have been deleted as they are readily available in all standard text-books on surveying, Geodesy, Photogrammetry and Cartography or departmental handbooks of the Survey of India.

Topographical survey forms a very important and vital activity for river valley projects. Any river valley project to be planned and constructed is to be based on certain basic facts and figures. The process of collection of these facts and figures is termed as investigation in general. The first requisite of investigation is to carry out topographical survey and prepare maps which are graphical representation of land. Topographical survey enables presentation of a picture of the terrain in the form of maps, which provide important and accurate data about topography and other characteristics of the area. These accurate data assist in formulation of correct plans for development of river valley projects for harnessing and utilizing the country's water resources. The cost of surveying and mapping is only a minor fraction of the total cost of the project and when undertaken at initial stage will save a lot of infructuous expenditure arising out of incomplete or faulty data.

It has been assumed in the formulation of this Indian Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been formulated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GUIDE TO TOPOGRAPHICAL SURVEYS FOR RIVER VALLEY PROJECTS

(Second Revision)

1 SCOPE

This standard lays down the general principles and guidelines for topographical surveys connected with a river valley project.

2 REFERENCES

The standards listed below contain provisions which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
5510 : 1969	Guide for soil survey for river valley projects
15686 : 2006	Recommendations for preparation of geological and geotechnical maps for river valley projects

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Absolute Orientation — The process by which an adjoining pair of relatively oriented aerial photographs are brought to correct horizontal scale and vertical datum.

3.2 Azimuth — The azimuth of a body is the angle between the observer's meridian and the great circle (vertical circle) through the body and the zenith of the observer.

NOTE — The meridian of an observer is the great circle passing through the poles, the zenith and the nadir.

3.3 Diapositive — A positive print of a photograph prepared on film or glass transparency.

3.4 Electromagnetic Distance Measuring (E.D.M.) Instruments — These are the instruments based on electro-magnetic waves for precise measurement of distance. These are further divided into two groups, namely M.D.M. (Microwave distance measuring instruments) and E.O.D.M. (Electro-optical distance measuring instruments). M.D.M. instruments use micro waves as carrier while E.O.D.M. instruments use light or infra-red rays.

3.5 Height — The height of a point above mean sea-level is the length of the vertical between the mean sea-level surface and the point.

3.6 Latitude — The latitude of a place is the angle between the direction of a plumb line at the place and the plane of the equator. It is marked N or S according to the place being north or south of the equator.

NOTE — If earth is assumed a perfect sphere of homogenous density the plumb line shall pass through the centre of sphere.

3.7 Longitude — The longitude of a place is the angle between a fixed reference meridian called the prime or first meridian and the meridian of the place. Longitude is measured from 0° to 180° eastward or westward and is marked °E or °W .

3.8 Mean Sea-Level — Mean sea-level is the average elevation of the sea water level which is determined by continuous observation of the varying level of the sea for as long a time as possible.

3.9 Photogrammetry —The science and art of obtaining reliable measurements by means of photography.

3.10 Photographic Interpretation — The art of examining photographic images for the purpose of identifying objects and judging their significance.

3.11 Relative Orientation — The process by which two successive aerial photographs having common overlap is brought to mutual geometrical relationship between themselves, which existed at the time of their exposure.

3.12 Stereopair — Two photographs with sufficient overlap and consequent duplication of detail to make possible stereoscopic examination of an object or an area common to both.

4 CLASSIFICATION

4.1 Types of Survey

Topographical surveys required for river valley projects may be broadly classified under seven important types, namely, river survey, reservoir survey, site survey, command area survey, communication survey, flood control and command area development survey. These surveys are required in different stages of investigation of a river valley project. Methods of topographical survey vary depending on the degree of accuracy to be attained, extent of the project and topography of the project area (*see* IS 15686 and IS 5510).

4.1.1 *River Surveys*

River surveys cover longitudinal section (L-Section) and cross-section (X-Section) of the river upstream and downstream of the proposed structure.

4.1.2 The L-Section on the upstream side shall extend from the axis of the structure to the point up to which the back water effect is likely to extend or up to the maximum water level (MWL) + 5 m whichever is more. If any headworks is situated within the reach, the L-Section shall be taken up to the headworks. On the downstream side, the L-Section shall extend for 10 km from the axis of the structure or up to the nearest headworks, whichever is less. The levelling of the L-Section shall be done at 50 m or less intervals along the fair weather deep channel. The following items shall also be indicated in the L-Section:

a) Date of survey of the particular reach and average water level on that day;

b) Deep pools and rapids, rock outcrops, etc; and

c) Maximum historical observed highest flood level (H.F.L.).

4.1.3 The X-Section on the upstream side shall be taken at 200 m intervals up to MWL + 5 m or 1 km on either side of the firm bank, whichever is less, for a distance of 2 km from the axis of structure and thereafter at 1 km intervals corresponding to the length of the L-Section. On the downstream side, X-Section shall be at 200 m intervals and taken up to historical highest flood level + 5 m on either side of firmbank for a distance of 2 km to 5 km from the axis of the structure depending upon the meandering nature of the river. A X-Section shall also be taken along the axis of the structure. The levelling shall be done at 50 m or less intervals. The following items shall also be indicated in the X-Section:

a) Date of survey and the water level on that day;

b) Maximum and minimum historical/observed water level; and

c) Rapids and rock outcrops, etc.

4.1.4 The longitudinal section shall be plotted to a scale of 1: 10 000 horizontal and 1: 100 vertical. Cross-sections shall be plotted to a scale of 1: 2 000 horizontal and 1: 100 vertical.

4.2 Reservoir Survey

A reservoir survey is necessary to provide the basic data for calculation of water storage capacity of a reservoir, for indicating the limit of submergence areas and for locating the topographic depressions or saddles in the reservoir rim which may cause spilling or leakage of the reservoir. The scale and contour interval for topographical survey for reservoir survey depend on the extent of the area and the topography of the site. The reservoir survey is made with a view to examining all possible alternatives for its locations and to eliminate such of the proposals which become unsuitable from considerations of technical feasibility, economy and practicability. The reservoir survey enables preparation of a fairly dependable project report supported by cost estimates and economic studies. Reservoir survey maps shall be made on scales ranging from 1:2 000 to 1:10 000 with contour interval of 1 or 2 or 5 m corresponding to natural ground slopes less than 10°, 10°-30° and more than 30° respectively.

4.3 Site Survey

A site survey is carried out to investigate the suitability of a site for a particular structure, such as dam site, power house or tunnel site. A dam site survey should cover a sufficiently large area to include all possible locations of the main dam, coffer dams, spillways, separate outlet structures, and other appurtenances. The scale of dam site survey maps may range from 1 : 500 to 1 : 1 000, with contour interval of 1m to 2m. Power house site survey should include an area for possible construction of plant sites, stockpile areas, warehouse, switchyard areas and camp sites. The scale of maps may normally be from 1 : 250 to 1 : 1 000. Tunnel site survey maps should be made along possible tunnel alignments on scale 1 : 1 000 to 1 : 10 000, with contour interval of 2 m to 5 m and contour plan of area shall cover the length of the tunnel and minimum 300 m on either side of the centre of the tunnel. The levelling should be done at regular intervals into a regular mesh of 50 m or even closer depending upon the terrain and the contour interval should be 1 or 2 or 5 m corresponding to natural ground slopes less than 10°, 10°-30° and more than 30° respectively.

4.4 Command Area Survey

The command area is the area, which is likely to be benefited from the river valley project. The command area survey is very important in order to know beforehand the capability of the command area to make maximum use of the benefits of the river valley project. Sometimes the command area survey is also necessary to assist in designing the layout of main canals and distributaries for irrigation purposes. The scale of command area survey maps should range from 1 : 10 000 to 1 : 15 000 and contour interval of 0.5 m or 1 m depending upon the steepness of the country. Block levelling on 50 m or less grid basis shall be done.

4.5 Communication Survey

The movement of construction equipment and material to a project construction site will normally require the construction of access roads, as most project sites are not accessible from existing highways. Sometimes branch lines from the existing railway routes will be required. Existing railways and highways running through the reservoir area may have to be relocated where these are liable to be inundated or submerged by a reservoir. The surveys are required for this purpose and for deciding the alignment and grades of railways and highways. The surveys for the location or relocation of railways and highways are normally performed in consultation with the field survey parties of the railway or highways authorities who should be entrusted with the determination of specification and survey instructions.

4.6 Flood Control Survey

These surveys are required in some project areas for flood control work, that is, for the planning and execution of flood protection works. These maps are prepared on 1 : 10 000 or 1 : 15 000 scale with contour interval of 1 or 2 or 5 m corresponding to natural ground slopes less than 10°, 10°-30° and more than 30° respectively.

4.7 Command Area Development Survey

These are carried out for shaping topography to conserve water resources and for an integrated development to optimise productivity of the area. Scale for such survey maps varies between 1 : 1 000 to 1 : 5 000 with contour interval of 0.5 m or 1 m.

5 PROVISION OF CONTROL

5.1 Control Survey

First of all, the whole area should be covered with a number of carefully determined ground control points which will form a network on which the ensuing detail survey of the area can be based upon. The accuracy of a detail survey depends on the accuracy of its network of ground control points and hence the desired accuracy of control survey has to be decided in advance keeping in view the scale, purpose and topography of area. It is also essential to ensure that the control in adjoining river valley projects is consistent. For this purpose, the control surveys are invariably linked to the national control network provided by the Survey of India.

5.1.1 Two types of ground control points are required for survey, namely, horizontal and vertical control points. The horizontal control provides the planimetric position of a control point. The vertical control provides the altitude or height of a control point above the mean sea-level.

5.2 Horizontal Control

The co-ordinates of horizontal control points should be fixed either in terms of latitude and longitude expressed in degrees, minutes and seconds or in rectangular terms in grid metres in northings and eastings relating to predetermined origin and type of projection.

5.2.1 Horizontal control points may be fixed by one or a combination of the following method:

a) Doppler satellite control,
b) Triangulation/E.D.M. trilateration,
c) Theodolite/E.D.M. traverse, and
d) Resection.

Of these, the best method for topographical operations is a system of accurate triangulation, whereby undue accumulation of error is precluded in the extension of the network, and at the same time limits are set to the intrusion of error, in the internal details to be surveyed.

5.2.2 *Triangulation/E.D.M. Trilateration or Traverse*

The electronic distance measuring (E.D.M.) instruments in control surveys operations are useful. In view of the accuracy and speed of operations of these instruments, their use is recommended to avoid the laborious and time consuming methods of linear measurements by chains. Since these instruments measure distances, they may be used for measuring three sides of a triangle which is known as trilateration. They may also be used for traversing to measure traverse legs in conjunction with theodolite for measuring angles. E.D.M. trilateration of traverse is carried out by the Survey of India.

5.2.2.1 According to the procedure of observations, instruments used and quality of triangulation results, a triangulation is classified as primary, secondary and tertiary. There are a variety of electronic distance measuring instruments available today which are very useful in control survey operations. This classification may also be called as first-order, second-order and third-order triangulation. The primary and secondary triangulations are termed as geodetic. The tertiary triangulation is called topographic. All geodetic data which form the basis of topographical survey are published in triangulation and levelling pamphlets. These pamphlets may be obtained from the Survey of India.

5.2.2.2 Primary triangulation is the highest grade of triangulation and is employed for the determination of the shape and figure of the earth and other geodetic investigations. It also constitutes the basic precise framework for mapping and for power order of triangulation. As it is independent of external checks, all possible precautions and refinements should be taken in the observations and their reduction. The length of a base-line in primary triangulation may be about 8 km to 12 km on the average and the sides of the triangles may range from 16 km to 50 km. The average triangulation error (or the discrepancy between the sum of the measured angles in a triangle and 180° plus the spherical excess of the triangle) should not be in excess of 1s. The probable error of computed distance should lie between 1 in 50 000 to 1 in 250 000.

5.2.2.3 Secondary triangulation is designed to connect two primary series and thus furnish points closer together than those of primary triangulation. The average triangular error in secondary triangulation should not exceed 3 s. The probable error of computed sides should lie between 1 in 20 000 to 1 in 50 000.

5.2.2.4 Tertiary triangulation is run between the stations of the primary and secondary series and forms the immediate control for topographical surveys. The average triangular error may range from 3 s to 15 s and the probable error of computed sides may lie between 1 in 5 000 to 1 in 20 000.

5.2.2.5 The initial data required for commencing topographical triangulation in an area of which a detail survey is contemplated, is a base of known length, an azimuth, latitude, longitude and height above mean sealevel of one station. The triangulation chain starts from this known base and closes on another known base.

5.2.3 *Theodolite Traverse*

In some stretches of flat country, primary triangulation series may lie over 150 km apart, and even where a secondary series might have been run to connect them, many of the secondary control points might have been destroyed. Owing to the flatness of the country the expense of triangulating the intermediate area may be greater and triangulation may take several seasons to carry out. In such cases theodolite traversing is a more expedient and economical method of control survey. Traversing is a more laborious and at the same time a less accurate method of fixing control points than triangulation and, therefore, may only be resorted to in flat ground where buildings, trees, high grass or haze prevent distant vision.

5.2.3.1 The length of traverse legs are measured by chains (Crinoline chains, *see* Note 1) or steel bands [Hunter short base (*see* Note 2)] or subtense bars or invar wires or E.D.M. instruments according to the accuracy aimed at.

NOTES

1 Crinoline chain is a riband of steel about 3 to 5 mm wide and about 1/2 mm thick, obtainable in lengths of 100 m to 110 m. It is calibrated for its length under standard conditions of temperature and pressure. It is used for direct measurement of distances where the accuracy desired is of higher standard. The tension applied during field measurements should normally be the same as that applied during calibration.

2 Hunter short base is a short measured base, invented by Hunter, consisting of calibrated steel tapes hung in catenary, for commencement or carrying forward of control work by triangulation or traverse. Normally it consists of four tapes calibrated under standard conditions of temperature and pressure. The tapes together with other accessories are easily portable and form a convenient base to commence and carry forward control operations in any type of terrain, particularly bushy and undulating, with meagre existing control points.

5.2.3.2 The angles between consecutive traverse legs should be measured by a theodolite set up at each station in turn. Vertical angles should be observed by theodolite from one station to another when heights are required. If the position of one station and the bearing of a traverse line connected to it are known, then the position of the next and all succeeding stations may be computed.

5.2.3.3 The rate of accumulation of errors in traverse affects the accuracy and shall be kept under control by closing traverses on well fixed points at both ends and also by introducing bases and azimuths. Topographical or tertiary traverse may have an accuracy of 1 in 5 000 provided more precise angular and linear measurement devices are used.

5.2.3.4 The observation of azimuths, either from sun or stars, at frequent intervals, provides a direct check against accumulation of errors of angular measurements. These azimuths, as well as the bearings from one station to another, should be computed in the field. If comparison reveals an error larger than $1\frac{1}{2}$ minutes in 12 stations in main traverse lines the line shall be reobserved.

5.2.3.5 The most important field check in linear measurements is the established custom of measuring each line twice and comparing the values. Each line should be measured once with a long chain 30 m in length and a second time with a short chain 20 m in length. These two measurements should agree within 1 in 500 for chains and 1 in 1 000 for steel bands. The measurements of the length obtained by the longer chain shall be accepted. In E.D.M. instruments field check is obtained by repeat observations. However, the time taken is much less than surface taping and accuracy achieved is of high order.

5.2.3.6 Traverse should be computed in rectangular co-ordinates and referred to an origin.

5.2.4 *Resection*

This method may be adopted to determine the geographical position of a point on the ground occupied by surveyor, by making observations to other stations or points of known co-ordinates without visiting them. This method obviates the necessity of visiting or making observations from other existing control points and stations. When the observations are made with theodolite, it is termed as 'trigonometrical resection' or 'theodolite resection'. In topographical triangulation, stations may occasionally be fixed by this method when it is not convenient to visit other stations for making observations. A judicious selection of the control points is essential while adopting this method. It also involves complicated computations. However, occasionally, it may be necessary to resort to this method in exploratory or active service work.

5.3 Vertical Control

5.3.1 Vertical control points are essential to know the altitude of the area. The heights of vertical control points above mean sea-level may be determined by one or combination of the following methods of levelling:

a) Trigonometric levelling, and
b) Levelling (spirit levelling).

5.3.2 *Trigonometric Levelling*

The elevations of triangulation stations may be established by observing the vertical angles between stations and computing the differences in elevation trigonometrically. The angles are taken at the time the station is occupied for the purpose of measuring the horizontal angles. The trigonometrical levelling should start from and close on certain point of known elevation. From the known elevation of these points the elevations of the triangulation stations and intersected points may be computed by means of the differences in height derived from the vertical angles and the lengths of the triangle sides. In measuring the vertical angles the theodolite should be placed over the centre mark of the station and its height above the station should be measured. The triangulation stations should have definite signals which should be observed for sighting the cross-hair when measuring the vertical angle. From the known height of the distant signal above the ground, the height of the triangulation station sighted may be computed.

5.3.2.1 The main difficulty in obtaining accurate results in this kind of work arises from the uncertainty of the atmospheric refraction. It may be nearly eliminated by taking reciprocal observations between two stations when the refraction is steady. The best time to observe vertical angles is during the middle of the day, from 1300 h to 1600 h as the refraction is then much less variable than in the morning or late afternoon.

5.3.2.2 Trignometric levelling may be used for fixing vertical control points where the terrain is steep and undulating and the contour interval aimed at is 5 m or more.

5.3.3 *Levelling*

Levelling or the determination of the relative altitude of points on the earth's surface, is an important operation; both in acquiring data for the design of all classes of works and during construction. Like triangulation, depending on its quality, levelling is classified as high precision, secondary, double tertiary or tertiary.

5.3.3.1 High precison levelling is carried out to provide the main vertical framework of the country and for the detemination of the shape and figure of the earth and other geodetic investigations. It also constitutes the basic precise framework for less precise levelling. Secondary and double tertiary levelling may be used for estabilishing the elevations of the controlling bench marks in the project area for all subsequent levelling. Tertiary levelling may be used for providing a dense network of vertical control points in the project area.

5.3.3.2 The simplest operation for levelling consists in determination of the difference of level between two points so situated that, from one position of the instrument, readings may be obtained on a staff held successively on the two points. The precise location of the instrument is immaterial, but to eliminate the effects of possible instrumental error, refraction and curvature effects the two sights should be nearly equal in length as may be judged. Precision levelling also requires observations for the values of gravity along the path of levelling, for accurate computations.

5.3.3.3 The closing error for the different classes of levelling shall not exceed those given below:

Sl No.	*Classes of Levelling*	*Error of Closure* mm
(1)	(2)	(3)
i)	High precision	$\pm 4\sqrt{K}$
ii)	Secondary	$\pm 6\sqrt{K}$
iii)	Double tertiary	$\pm 12\sqrt{K}$
iv)	Tertiary	$\pm 24\sqrt{K}$

where K is the distance, in km.

5.4 Field Observations

For achieving good results, the records should be maintained in a systematic way in order to facilitate computations and reduction of results. All field observations should be recorded neatly in ink in the observation forms provided for the purpose. The required number of measures laid down for the order of accuracy to be aimed at should be observed. On completion of observations at a station the mean should be calculated and compared for agreement. On completing this, the observer should scrutinize the results, and when large differences appear, a repeat set of observations of the stations, which gave doubtful results, should be taken before doing other works. If this important precaution is omitted, errors will accumulate subsequently and there will be no means of rectifying them. Measures which do not comply with the prescribed criterion should be repeated before leaving the station of observation.

5.4.1 For triangulation stations, all three angles of each triangle must be observed and the observer should keep up a record of completely observed triangles, to enable him to note his triangular error, that is, the difference of the sum of the three observed angles of a triangle from 180°, spherical excess being considered as necessary, and to see that it is within the specified limits. Any repeat observations of triangles, if necessary, should be completed before leaving the area of work.

5.5 Field Control Charts

Field control charts should be maintained both for horizontal and vertical control points for showing their location and also for assisting in computations. For triangulation, a field triangulation chart should be prepared either on a smaller scale existing map or even on blank paper with the existing triangulation stations shown on it. A scale of $\frac{1}{4}$ to $\frac{1}{2}$ of that of the detailed survey will generally be found suitable. For levelling, a field levelling chart should be maintained on an existing large scale map of the area.

5.5.1 All great trignometrical (G.T.) stations or other stations or well defined intersected points of old topographical triangulation falling in the area of work should be plotted and inked on the field triangulation chart in a distinctive colour. When one series of triangulation is joined to another, two adjacent stations common to both the series should be observed and clearly indicated in the triangulation chart for facilitating computations All new stations and their connecting rays should be inked clearly on the chart.

5.5.1.1 All high precision and secondary level lines and bench-marks should be clearly marked on the field) levelling chart in a distinctive colour. All new level lines and their alignments along with the position of benchmarks should be inked clearly on the chart.

5.6 Survey Marks and Stations

Whenever possible, stations should be placed on rock *in-situ* with a mark which should consist of a hole of about 5 mm diameter drilled into the rock about 20 mm deep with a circle engraved around it. For more precise work with E.D.M. instruments the hole drilled in the centre may be of 1 mm to 2 mm diameter, 3 cm to 4 cm deep with a copper or brass wire of the same diameter plugged into it and made flush with the top surface.

5.6.1 When rock is not available, a large stone should be embedded about 1 m underground, with a circle and dot cut on it, with a second mark-stone similarly treated, and having its dot vertically above the dot of the lower mark, placed flush with the top surface of the platform, or, if the triangulator may obtain some old 2.5 cm piping, about 1 m length, it may be driven vertically into the ground, the centre of this being taken as the actual mark.

5.6.2 Surrounding the mark, a platform should be built of earth and stones, at least 0.5 m high and about 3 m square. The sides of the platform should be revetted with big stones or gently sloped.

5.6.3 For traversing wooden pegs 8 cm × 8 cm square in section and 30 cm long may be used. A circle and dot shall be engraved on top of each peg which are driven vertically into the ground with the top flush with the ground. Traverse stations may also be made by a circle and dot on parapets of culverts, wells or verandahs of public buildings, like inspection bungalows, dak bungalows, etc.

5.6.4 In levelling, the levelling staves are generally placed on iron crow-foots firmly placed on the ground so that there is no sinking of the levelling staff during observations. In precise levelling, wooden pegs are driven in ground in place of iron crow-foots for stability of staves during the levelling operation. However, for a bench-mark a circle with B and M written on either side may be used for semi-permanent and permanent bench-marks engraved on parapets or culverts, well or verandahs or steps of public buildings like inspection bungalows, dak bungalows, etc.

5.6.5 The descriptions of G.T. stations and high precision bench marks are given in the G.T. pamphlets and levelling pamphlets (published by Survey of India). These pamphlets covering the area of project should be obtained from the Survey of India during investigations.

5.6.6 All the permanent stations and bench-marks established by the Survey of India are required to be protected, maintained and periodically inspected by the local authorities in collaboration with the Survey of India. Any of these marks disturbed, damaged or missing must be reported to the Survey of India immediately.

5.6.7 For river valley surveys, certain reference control points may be required to be established for controlling subsequent surveys and construction programmes. The actual specifications of these control points will depend on their importance and type of soil on which to be constructed. These should be finalized in consultation with the Survey of India and constructed at least one season in advance to make allowances for settling down.

5.7 Survey Computations

Apart from carrying out good field work and computing them correctly, it is also important to maintain the records in the most systematic manner. All computations should be carried out in duplicate and independently. The duplicate computations should be compared to check any gross disagreement. Both sets of computations should be signed and dated. The completed computations should be scrutinized by a responsible officer. Use of electronic scientific pocket calculator in the field helps to expedite survey computations. Computations can also be carried out with the help of micro and large computers. To guard against computer failure, computer programmes should be used with check data and results.

5.7.1 On completion of computations the following records of control survey should be prepared:

a) History sheet of control surveys,
b) Description of stations/bench-marks,
c) List of co-ordinates/heights, and
d) Traces of triangulation/traverse levelling charts.

5.7.1.1 A short narrative account of the control survey, mentioning the object of the control survey, the instruments and signals used and other facts of interest should be included in the history sheet.

5.7.1.2 All basic data collected during the survey and all computations made as a part thereof should be preserved and filled in such a manner as to be readily available and easily understood. The records should be classified job-wise and kept safe. All original records and computations should be preserved carefully.

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Review of Indian Standards

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