Computation of Reduce Level Using Modern Survey Equipment at Sub-level from Vembakottai to P.S.R.Engineering College Sivakasi.

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Abstract– **Although surveying techniques have always played a primary role in collecting data for mapping, recently new instruments and methods for data capture and processing have introduced the chance to increase the mass and the variety of achievable information.**

Nowadays real-time monitoring system based on robotic total station imagery, statellite, airborme, and terrestrial laser scanner devices are able to give a set of powerful tools for the geometric surveying and modeling.

The paper focuses on the new trends in surveying gadgets and their application in mine surveying which has been pushed up in the latest year by the diffusion of information technology.

Keywords: *Tapping, Electronic Distance Measurement, Tapes, Fiber Glass Tapes, Pegs.*

I. Introduction:

Surveying is defined as taking a general view of, by observation and measurement determining the boundaries, size, position, quantity, condition, value etc. of land, estates, building, farms mines etc. and finally presenting the survey data in a suitable form. This covers the work of the valuation surveyor, the quantity surveyor, the building surveyor, the mining surveyor and so forth, as well as the land surveyor.

Another school of thought define surveying as the act of making measurement of the relative position of natural and manmade features on earth's surface and the presentation of this information either graphically or numerically.

VEMBAKOTTAI TO P.S.R.ENGINEERING COLLEGE

(BENCHMARK:+89.500 m)

Name of Dam	**Vembakottai Dam**
Location:	
a) Name of Taluk	Vembakottai
b) Name of Village	Vembakottai
c) Longitude	77°45'17''E
d) Longitude	09°20'00''N
Catchment area	615.27 sq miles
Dependable yield adopted	
a) Hilly	30 Mcft/sq. Miles
b) Plain	15 Mcft/sq. Miles
Total length of the dam	3400 m (11154.72 ft.)
F.R.L. and M.W.L.	+87.500 m (287.07 ft.)
M.W.L after flood routing	+87.924 m (288.46 ft.)
Minimum drawdown level	+88.50 m (264.10 ft.)
Deepest foundation level	+77.50 m (254.26 ft.)
Water spread area	5.47 sq.km
Capacity at F.R.L	11.29 Mcum (398.70 Mcft)
No. of filling	2
Annual storage	22.58 Mcum (797.50 Mcft)
Average annual yield	22.58 Mcum (797.50Mcft)
Ayacut:	
a) direct-single crop	8100 acre (3279.35 ha)
Earth dam	
a) Top bund level	+89.500m (293.64ft)
b)Length of bund	3338m (10951.31ft)
c) Max.height of bund	9.00m (29.53ft)
d) Top width of bund	3.65m (12ft)
e) Type	Homogeneous embankment
f) Ht dam above bed level	9.00m(29.53) ft.
Spill way	
a) Crest of spillway	+80.50 m
b) Nos and size of spillway	5 Nos-10mx7m
c) Max flood discharge	1656.25 cusec
d) Type of shutter and hoist	Radial gates operated by rope drum type hoist
e) Length of spill way	62 m (206.62 ft)
f) Location @ L.S of bund	1460 to 1522 m
River bed level	+80.50 m (264.ft)
Scour sluice	Nil
Maximum height of water	7.00 m (22.967 ft)
Right main sluice	
a) Sill level	+80.50 m (264.10.ft)
b) Nos.and vent size	1 No.3'x5'(0.9 m x1.5 m)
c)Maximum discharge	1.258 cumec (45 cusec)

capacity	
Lactation @L.S of bund	1650 m (5413.32 ft)
Channel	
a) Length	2995 m
a) No.of direct sluices	2 Nos
Storage required for fish	27.51 Mcft
Left main canal	Right main canal
Rainfall station	At dam site

Fig-1

1.1 The process of surveying is therefore in three stages namely:

(i) Taking a general view:

This part of the definition is important as it indicates the need to obtain an overall picture of what is required before any type of survey work is undertaken. In land surveying, this is achieved during the reconnaissance study.

(ii) Observation and Measurement:

This part of the definition denotes the next stage of any survey, which in land surveying constitutes the measurement to determine the relative position and sizes of natural and artificial features on the land.

(iii) Presentation of Data:

The data collected in any survey must be presented in a form which allows the information to be clearly interpreted and understood by others. This presentation may take the form of written report, bills of quantities, datasheets, drawings and in land surveying maps and plan showing the features on the land.

Fig-3

1.2 Types of Surveying:

On the basis of whether the curvature of the earth is taken into account or not, surveying can be divided into two main categories.

Fig-2

1.2.1 Plane surveying:

The type of surveying where the mean surface of the earth is considered as a plane. All angles are considered to be plane angles. For small areas less than 250 km2 plane surveying can safely be used. For most engineering projects such as canal, railway, highway, building, pipeline, etc constructions, this type of surveying is used. It is worth noting that the difference between an arc distance of 18.5 km and the subtended chord lying in the earth…s surface is 7mm. Also the sum of the angles of a plane triangle and the sum of the angles in a spherical triangle differ by 1 second for a triangle on the earth…s surface having an area of 196 km2.

1.2.2 Geodetic surveying:

That branch of surveying, which takes into account the true shape of the earth (spheroid).

Fig-4

1.3 CLASSIFICATION OF SURVEYING:

1.3.1 Introduction

For easy understanding of surveying and the various components of the subject, we need a deep understanding of the various ways of classifying it.

1.3.2 Objective:

To enable the students have understanding of the various ways of classifying surveying Classification Of Surveying Surveying is classified based on various criteria including the instruments used, purpose, the area surveyed and the method used.

Fig-5

1.4 CLASSIFICATION ON THE BASIS OF INSTRUMENTS USED:

Based on the instrument used; surveys can be classified into;

i) Chain tape surveys

ii) Compass surveys

iii) Plane table surve

iv) Theodolite surveys

Classification based on the surface and the area surveyed

1.4.1 Land survey:

Land surveys are done for objects on the surface of the earth. It can be subdivided into:

1.4.2 Topographic survey:

This is for depicting the (hills, valleys, mountains, rivers, etc) and manmade features (roads, houses, settlements…) on the surface of the earth. Cadastral survey is used to determining property boundaries including those of fields, houses, plots of land, etc. Engineering survey is used to acquire the required data for the planning, design and Execution of engineering projects like roads, bridges, canals, dams, railways, buildings, etc.

1.4.3 City surveys:

The surveys involving the construction and development of towns including roads, drainage, water supply, sewage street network, etc, are generally referred to as city survey.

1.4.4 Marine or Hydrographic Survey:

Those are surveys of large water bodies for navigation, tidal monitoring, the construction of harbours etc.

1.4.5 Astronomical Survey:

Astronomical survey uses the observations of the heavenly bodies (sun, moon, stars etc) to fix the absolute locations of places on the surface of the earth.

1.5 CLASSIFICATION ON THE BASIS OF PURPOSE:

1.5.1 Engineering survey:

Engineering surveying is the broad term used to describe the work of surveyors on civil engineering jobs. The role of an engineering surveyors is a lot larger than simply set out for construction of a lot larger than simply set out for construction of a structure and survey pick ups.

1.5.2 Control Survey:

Control survey uses geodetic methods to establish widely spaced vertical and horizontal control points.

1.5.3 Geological Survey:

Geological survey is used to determine the structure and arrangement of rock strata. Generally, it enables to know the composition of the earth.

1.5.4 Military or Defence Survey:

It is carried out to map places of military and strategic importance

1.5.5 Archeological survey:

It is carried out to discover and map ancient/relies of antiquity.

1.6 CLASSIFICATION BASED ON INSTRUMENT USED:

1.6.1 Chain/Tape Survey:

This is the simple method of taking the linear measurement using a chain or tape with no angular measurements made.

1.6.2 Compass Survey:

Here horizontal angular measurements are made using magnetic compass with the linear measurements made using the chain or tape.

1.6.3 Plane table survey:

This is a quick survey carried out in the field with the measurements and drawings made at the same time using a plane table.

1.6.4 Leveling:

This is the measurement and mapping of the relative heights of points on the earths surface showing them in maps, plane and charts as vertical sections or with conventional symbols. Theodolite survey takes vertical and horizontal angles in order to establish controls.

Fig-6

1.7 CLASSIFICATION BASED ON THE METHOD USED:

1.7.1 Triangulation Survey:

In order to make the survey, manageable, the area to be surveyed is first covered with series of triangles. Lines are first run round the perimeter of the plot, then the details fixed in relation to the established lines. This process is called triangulation. The triangle is preferred as it is the only shape that can completely over an irregularly shaped area with minimum space left.

1.7.2 Traverse survey:

If the bearing and distance of a place of a known point is known: it is possible to establish the position of that point on the ground. From this point, the bearing and distances of other surrounding points may be established. In the process, positions of points linked with lines linking them emerge. The traversing is the process of establishing these lines, is called traversing, while the connecting lines joining two points on the ground. Joining two while bearing and distance is known as traverse. A traverse station is each of the points of the traverse, while the traverse leg is the straight line between consecutive stations. Traverses may either be open or closed.

1.7.3 Closed Traverse:

When a series of connected lines forms a closed circuit, i.e. when the finishing point coincides with the starting point of a survey, it is called as a closed travers here ABCDEA represents a closed traverse. Closed traverse is suitable for the survey of boundaries of ponds, forests etc.

1.7.4 Open Traverse :

When a sequence of connected lines extends along a general direction and does not return to the starting point, it is known as open travers or (unclosed traverse). Here ABCDE represents an open traverse. Open traverse is suitable for the survey of roads, rivers etc.

1.8 CLASSIFICATION OF SURVEYORS:

Surveying is made up of various specializations known as sectors or classes as shown below:

1.8.1 General Practice Surveyors:

Surveyors under this class are mostly concerned with valuation and investment. Valuation surveyors deal with property markets, land and property values, valuation procedures and property law. Investment surveyors help investors to get the best possible return form property.

They handle a selection of properties for purchase or sale by pension funds, insurance companies, charities and other major investors. They also specialize in housing policy advice, housing development and management.

1.8.2 Planning and Development Surveyors

They are concerned with preparing planning applications and negotiating with local authorities planners to obtain planning permission.

1.8.3 Building Surveyors

Their work involves advising on the construction, maintenance, repair of all types of residential and commercial property.

The analysis of building defects is an important part of a building surveyors discipline.

1.8.4 The Quantity Surveyors

They evaluate project cost and advice on alternative proposals. They also ensure that each element of a project agrees with the cost plan allowance and that the overall project remains within budget.

1.8.5 Rural Practice Surveyors:

Surveyors in rural practice advice land owners, farmers and others with interests in the country side. They are responsible for the management of country estates and farms, the planning and execution of development schemes for agriculture, forestation, recreation, sales of properties and live stock.

1.8.6 Mineral Surveyors

They plan the development and future of mineral workings. They work with local authorities and the land owners on planning applications and appeals, mining laws and working rights, mining subsidence and damage, the environmental effects of land and deep underground mines.

1.8.7 Land surveyors:

They measure land and its physical features accurately and record them in the form of a map or plan for the purpose of planning new building and by local authorities in managing roads, housing estates, and other facilities. They also undertake the positioning and monitoring for construction works.

1.9 BRANCHES OF SURVEYING

1.9.1 Aerial Surveying:

Aerial surveys are undertaken by using photographs taken with special cameras mounted in an aircraft viewed in pairs. The photographs produce three-dimensional images of ground features from which maps or numerical data can be produced usually with the aid of stereo plotting machines and computers.

1.9.2 Hydrographic Surveying (Hydro-Survey):

Hydro survey is undertaken to gather information in the marine environment such as mapping out the coast lines and sea bed in order to produce navigational charts. It is also used for off shore oil exploration and production, design, construction and maintenance of harbours, inland water routes, river and sea defence, pollution control and ocean studies.

1.9.3Geodetic Survey:

In geodetic survey, large areas of the earth surface are involved usually on national basis where survey stations are precisely located large distances apart. Account is taken of the curvature of the earth, hence it involves advanced mathematical theory and precise measurements are required to be made. Geodetic survey stations can be used to map out entire continent, measure the size and shape of the earth or in carrying out scientific studies such as determination of the Earths magnetic field and direction of continental drifts.

1.9.4 Plane Surveying:

In plane surveying relatively small areas are involved and the area under consideration is taken to be a horizontal plane. It is divided into three branches.

- Cadastral surveying
- Topographical surveying
- Engineering surveying

1.9.5 Cadastral surveying:

These are surveys undertaken to define and record the boundary of properties, legislative area and even countries. It may be almost entirely topographical where features define boundaries with the topographical details appearing on ordinance survey maps. In the other hand, markers define boundaries, corner or line points and little account may be taken of the topographical features.

1.9.6 Topographical Survey

These are surveys where the physical features on the earth are measured and maps/plans prepared to show their relative positions both horizontally and vertically. The relative positions and shape of natural and man –made features over an area are established usually for the purpose of producing a map of the area of for establishing geographical infrmation system.

1.9.7 Engineering Survey:

These are surveys undertaken to provide special information for construction of Civil Engineering and building projects.The survey supply details for a particular engineering schemes and could include setting out of the work on the ground and dimensional control on such schemes.

2.0 BASIC PRINCIPLES IN SURVEYING:

2.1 PRINCIPLE OF WORKING FROM WHOLE TO PART:

It is a fundamental rule to always work from the whole to the part. This implies a precise control surveying as the first consideration followed by subsidiary detail surveying

This surveying principle involves laying down an overall system of stations whose positions are fixed to a fairly high degree of accuracy as control, and then the survey of details between the control points may be added on the frame by less elaborate methods.

Once the overall size has been determined, the smaller areas can be surveyed in the knowledge that they must (and will if care is taken) put into the confines of the main overall frame.

Errors which may inevitably arise are then contained within the framework of the control points and can be adjusted to it.

Surveying is based on simple fundamental principles which should be taken into consideration to enable one get good results.

Working from the whole to the part is achieved by covering the area to be surveyed with a number of spaced out control point called primarycontrol points called primary control points whose pointing have been determined with a high level of precision using sophisticated equipments. Based on these points as theoretic, a number of large triangles are drawn. Secondary control points are then established to fill the gaps with lesser precision than the primary control points. At a more detailed and less precise level, tertiary control points at closer intervals are finally established to fill in the smaller gaps. The main purpose of surveying from the whole to the part is to localize the errors as working the other way round would magnify the errors and introduce distortions in the survey. In partial terms, this principle involve covering the area to be surveyed with large triangles. These are further divided into smaller triangles and the process continues until the area has been sufficiently covered with small triangles to a level that allows detailed surveys to be made in a local level. Error is in the whole operation as the vertices of the large triangles are fixed using higher precision instruments.

Using measurements from two control parts to fix other points. Given two points whose length and bearings have been accurately determined, a line can be drawn to join them hence surveying has control reference points. The locations of various other points and the lines joining them can be fixed by measurements made from these two points and the lines joining them. For an example, if A and B are the control points, the following operations can be performed to fix other points.

i) Using points A and B as the centers, ascribe arcs and fix (where they intersect).

ii) Draw a perpendicular from D along AB to a point C.

iii) To locate C, measure distance AB and use your protractor to equally measure angle ABC.

iv) To locate C the interior angles of triangle ABC can be measured. The lengths of the sides AC and BC can be calculated by solving the triangle.

2.2 THE PROCESS OF SURVEYING:

The survey process passes through 3 main phases – the reconnaissance, field work and measurements, and, the office work.

2.2.1 Reconnaissance survey:

This is a pre-field work and measurement phase. It requires taking an overall inspection of the area to be surveyed to obtain a general picture before commencement of any serious survey. Walking through the site enables one to understand the terrain and helps in determining the survey method to be adopted, and the scale to be used. The initial information obtained in this stage helps in the successful planning and execution of the survey.

2.2.2 Field work and measurement:

This is the actual measurements in the field and the recordings in the field notebook. To get the best results in the field, the surveyor must be acquainted with the functions of the equipment's and take good care of them.

2.3 Office work:

This is the post field work stage in which data collected and recordings in the field notebooks are decoded and used to prepare the charts, planes and maps for presentation to the clients and the target audience.

2.4 IMPORTANCE OF SCIENTIFIC HONESTY

Honesty is essential in booking notes in the field and when plotting and computations in the office. There is nothing to be gained from cooking the survey or altering dimensions so that points will tie-in on the drawing. It is utterly Unprofessional to betray such trust at each stage of the survey.

This applies to the assistants equally as it does to the surveyor in charge. Assistants must also listen carefully to all instructions and carry them out to the later without questions.

2.5 CHECK ON MEASUREMENTS

The second principle is that; all survey work must be checked in such a way that an error will be apparent before the survey is completed.

Concentration and care are necessary in order to ensure that all necessary measures are taken to the required standard of accuracy and that nothing is omitted. Hence they must be maintained in the field at all times.

Surveyor on site should be checking the correctness of his own work and that of others which is based on his information.

Check should be constantly arranged on all measurements wherever possible. Check measurements should be conducted to supplement errors on field. Pegs can be moved, sight rails altered etc.

Survey records and computations such as field notes, level books, field books, setting out record books etc must be kept clean and complete with clear notes and diagrams so that the survey data can be clearly understood by others. Untidy and anonymous figures in the field books should be avoided.

Like field work, computations should be carefully planned and carried out in a systemic manner and all field data should be properly prepared before calculations start. Where possible, standardized tables and forms should be used to simplify calculations. If the result of a computation has not been checked, it is considered unreliable and for this reason, frequent checks should be applied to every calculation procedure.

As a check, the distances between stations are measured as they are plotted, to see that there is correspondence with the measured horizontal distance. Failure to match indicates an error in plotting or during the survey.

If checks are not done on observations, expensive mistake may occur. It is always preferable to take a few more dimensions on site to ensure that the survey will resolve itself at the plotting stage.

2.6 ACCURACY AND PRECISION

These terms are used frequently in engineering surveying both by manufacturers when quoting specifications for their equipments and on site by surveyors to describe results obtained from field work.

Accuracy allows a certain amount of tolerance (either plus or minus) in a measurement.

Precision demands exact measurement. Since there is no such things as an absolutely exact measurement, a set of observations that are closely grouped together having small deviations from the sample mean will have a small standard error and are said to be precise.

2.7 ECONOMY OF ACCURACY AND ITS INFLUENCE ON CHOICE OF EQUIPMENTS

Survey work is usually described as being to a certain standard of accuracy which in turn is suited to the work in hand. Bearing in mind the purpose for which the survey is being made, it is better to achieve a high degree of accuracy than to aim for precision (exactness) which if it were to be altered would depend not only on the instrument used but also on the care taken by the operator to ensure that his work was free from mistake.

Always remember that, the greater the effort and time needed both in the field and in the office, the more expensive survey will be for the client. The standard accuracy attained in the field must be in keeping with the size of the ultimate drawings.

The equipment selected should be appropriate to the test in hand. An important factor when selecting equipment is that the various instruments should produce roughly the same order of precision. A steel chain best at an accuracy of 1/500 to 1/1000 would be of little use for work requiring an accuracy of 1/1000. Similarly, the theodolite reading to one second would be pointless where a reading to one minute is sufficient.

Having selected the equipment necessary, the work should be thoroughly checked and if found wanting should be adjusted, repaired or replaced or have allowance calculated for its deficiencies. This task will be less tedious if field equipment is regularly maintained.

2.7.1 Horizontal Distance Measurement

One of the basic measurements in surveying is the determination of the distance between two points on the earth…s surface for use in fixing position, set out and in scaling.

Usually spatial distance is measured. In plane surveying, the distances measured are reduced to their equivalent horizontal distance either by the procedures used to make themeasurement or by applying numerical corrections for the slope distance (spatial distance). The method to be employed in measuring distance depends on the required accuracy of the measurement, and this in turn depends on purpose for which the measurement is intended.

2.7.2 Pacing:

where approximate results are satisfactory, distance can be obtained by pacing (the number of paces can be counted by tally or pedometer registry attached to one leg). Average pace length has to be known by pacing a known distance several times and taking the average. It is used in reconnaissance surveys& in small scale mapping.

2.7.3 Odometer of a vehicle:

Based on diameter of tires (no of revolutions X wheel diameter); this method gives a fairly reliable result provided a check is done periodically on a known length. During each measurement a constant tyre pressure has to be maintained.

2.7.4 Tachometry:

Distance can be can be measured indirectly by optical surveying instruments like theodolite. The method is quite rapid and sufficiently accurate for many times.

2.8 TYPES OF SURVEYING OPERATIONS.

2.8.1 Taping (chaining):

This method involves direct measurement of distances with a tape or chain. Steel tapes are most commonly used .It is available in lengths varying from 15m to 100m. Formerly on surveys of ordinary precision, lengths of lines were measured with chains.

2.8.2 Electronic Distance Measurement (EDM):

Is indirect distance measuring instruments that work using the invariant velocity of light or electromagnetic waves in vacuum.

They have high degree of accuracy and are effectively used for long distances for modern surveying operations.

2.8.3 Tapes:

Tapes are used where greater accuracy of measurements are required, such as the setting out of buildings and roads. They are 15m or 30m long marked in metres, centimeter and millimeters. Tapes are classified into three types;

2.8.4 Fibre Glass Tapes:

These are much stronger than lines and will not stretch in use

Fig-7

2.8.5 Pegs:

Pegs are made of wood 50mm x 50mm and some convenient length. They are used for points which are required to be permanently marked, such as intersection points of survey lines. Pegs are driven with a mallet and nails are set in the tops.

2.8.6 Levelling Staff:

This consists of two pairs of vanes set at right angle to each other with a wide and narrow slit in each vane. The instrument is mounted upon a pole, so that when it is set up it is at normal eye level. It is also used for setting out lines at right angle to the main chain line.

Fig-8

2.9 CRITERIA FOR SELECTING A SURVEY LINES/OFFSETS

During reconnaissance, the following points must be borne in mind as the criteria to provide the best arrangement of survey lines,

2.9.1 Few survey lines:

The number of survey lines should be kept to a minimum but must be sufficient for the survey to be plotted and checked.

2.9.2 Long base line:

A long line should be positioned right across the site to form a base on which to build the triangles.

Well conditioned triangle with angles greater than 300 and not exceeding 1500 It is preferable that the arcs used for plotting should intersect as close as 900 in order to provide sharp definition of the stations point.

2.9.3 Check lines:

Every part of the survey should be provided with check lines that are positioned in such a way that they can be used for off- setting too, in order to save any unnecessary duplication of lines.

Obstacles such as steep slopes and rough ground should be avoided as far as possible.

Short offsets to survey lines (close feature preferably 2m) should be selected: So that measuring operated by one person can be used instead of tape which needs two people.

Stations should be positioned on the extension of a check line or triangle. Such points can be plotted without the need for intersecting arcs.

2.9.4 Ranging:

Ranging involves placing ranging poles along the route to be measures so as to get a straight line. The poles are used to mark the stations and in between the stations.

3.ERRORS IN SURVEYING

Surveying is a process that involves observations and measurements with a wide range of electronic, optical and mechanical equipment some of which are very sophisticated.

Despite the best equipments and methods used, it is still impossible to take observations that are completely free of small variations caused by errors which must be guided against or their effects corrected.

3.1.TYPES OF ERRORS

3.1.1 Gross Errors

These are referred to mistakes or blunders by either the surveyor or his assistants due to carelessness or incompetence.

On construction sites, mistakes are frequently made by in – experienced Engineers or surveyors who are unfamiliar with the equipment and method they are using.

These types of errors include miscounting the number of tapes length, wrong booking, sighting wrong target, measuring anticlockwise reading, turning instruments incorrectly, displacement of arrows or station marks etc.

Gross errors can occur at any stage of survey when observing, booking, computing or plotting and they would have a damaging effect on the results if left uncorrected.

Gross errors can be eliminated only by careful methods of observing booking and constantly checking both operations.

3.1.2 Systematic or Cumulative Errors

These errors are cumulative in effect and are caused by badly adjusted instrument and the physical condition at the time of measurement must be considered in this respect. Expansion of steel, frequently changes in electromagnetic distance (EDM) measuring instrument, etc are just some of these errors.

Systematic errors have the same magnitude and sign in a series of measurements that are repeated under the same condition, thus contributing negatively or positively to the reading hence, makes the readings shorter or longer.

This type of error can be eliminated from a measurement using corrections (e.g. effect of tension and temperature on steel tape).

Another method of removing systematic errors is to calibrate the observing equipment and quantify the error allowing corrections to be made to further observations.

Observational procedures by re-measuring the quantity with an entirely different method using different instrument can also be used to eliminate the effect of systematic errors.

3.1.3 Random or Compensating Errors

Although every precaution may be taken certain unavoidable errors always exist in any measurement caused usually by human limitation in reading/handling of instruments.

Random errors cannot be removed from observation but methods can be adopted to ensure that they are kept within acceptable limits.

In order to analyze random errors or variable, statistical principles must be used and in surveying their effects may be reduced by increasing the number of observations and finding their mean. It is therefore important to assume those random variables are normally distributed.

3.2 CORRECTIONS TO LINEAR MEASUREMENT AND THEIR APPLICATION: -

The following corrections are to be applied to the linear measurements with a chain or a tape where such accuracy is required.

1. Pull correction,
2. Temperature correction
3. Standard length correction

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4. Sag correction

5. Slope correction

6. Mean sea level correction.

3.2.1 Pull Correction: -

`A chain or tape of nominal length having cross sectional area of the link or that of a tape, as the case may be, equal to A and standardized under a pull Ps is employed to measure a length at a pull PF. If Young…s modulus of elasticity of the material is E the extension of its length is = *(PF* □ *PS) L AE* The recorded length is less than the actual by this extension. The error is here, -ve, the actual length is obtained by adding the extension to L. the correction is +ve. If PF is less than PS the error will be +ve and correction –ve.

3.2.2 Temperature Correction: -

A chain or a tape of nominal length …L… standardized at temperature TS and having cross sectional area, A is employed to measured length at temperature TF being the coefficient of linear expansion of the material of the chain or tape per unit rise of temperature, F – TS)L. If TF is more than TS, recorded length is less than the actual by the amount of extension. The error is –ve and the correction to the length L is +ve by the amount of extension. If the field temperature TF is less than TS the error is =+ve and the corrections is –ve.

3.2.3 Sag Correction :-

In case of suspended measurement across a span L the chain or tape sag to take the form of curve known as catenary. *C Sa* □ (*wl*1)2 *l*1□ *W* 2*l*1 24*P*2 24*P*2

Where,

w= weight of the tape per metre length

W= Total weight of the tape

P=pull applied (in N)

*l*1 = The length of tape suspended between two support

l = length of the tape = n *l*1 (in m)

Sag correction is always negative.

3.3 BACK AND FORE BEARING:

3.3.1 Introduction:

In this section, we will examine the back and fore bearing; and the steps to be taken when traversing with compass survey. Back and fore bearing Fore bearing is the compass bearing of a place taken from a status to the other in the direction that the survey is being carried out. The back bearing in the other hand is the bearing in the opposite direction i.e. the bearing taken backwards from the next station to its preceding station that the fore bearing was taken. The difference between BB and FB is always 1800. Back and fore bearing If B is sighted from an observer at A, and the NS and N1S1 are the magnetic NS lines, then Forward bearing (FB) = < N A S + < S A B

Back bearing BA = < N1 B A

Back Bearing BA = Forward Bearing AB - 1800

If the observer relocates to B and observers B, then forward bearing (FB) BA = < N1 BA and back bearing (AB) = < NAS + SAB. Hence, we can conclude that Forward Bearing = < N1 B A + 1800. As a general rule, if the Fore Bearing is less than 1800, add 1800 to get the Back. Bearing, and if the Fore Bearing is greater than 1800, then subtract 1800 to get the Back Bearing.

3.4 REDUCED BEARING

Thus, the reduced bearing is similar to the Quadrant bearing.

Its values lies between 0^{O} to 90^{O}, but the quadrant should be mentioned for proper designation.

The following table should be remembered for conversion of WCB to RB.

0TO90 I RB=WCB N-E

90 TO 180 II RB=180-WCB S-E

180 TO 270 III RB =WCB-180^{O} S-W

270 TO 360 IV RB=360^{O} - WCB N-W

3.5 LEVELLING

Leveling is the art of determining the elevation of given points above or below a datum line or establishing in given points of required height above or below the datum line. It evolves measurement in vertical plane. Definition of basic term‘s used in levelling:

3.5.1 Level surface:

Any surface parallel to the mean spheroid of the earth is called level surface and the line drawn on level surface is known as level line.

3.5.2 Horizontal surface:

Any surface tangential to level surface at a given point is called – Horizontal surface at point. Hence horizontal line is at right angles to plumb line.

3.5.3 Vertical surface:

It is the line connecting the point & centre of earth. Vertical & horizontal line is normal to each other.

3.5.4 Datum:

The point or the surface with respect to which levels of other points or planes are calculated is called ‘ Datum or surface.

3.5.5 Mean sea level (MSL):

Mean sea level is the average height of sea of all stages of tides. Any particular place is derived by averaging over a long period of 19 years. In India the mean‘s sea level used is that at Karachi (Pakistan). In all important survey this is taken as datum.

3.5.6 Reduced level:

Levels of various points are taken as heights above the datum surface are known as Reduced level.

3.5.7 Bench mark:

Bench mark is a relatively permanent point of reference whose Elevation w.r.t some assumed datum is known. There are four types of bench mark

1. G.T.S (Great trigonometry survey)
2. Permanent bench mark
3. Arbitrary bench mark.
4. Temporary bench mark.

3.6. LEVELLING INSTRUMENTS:

A level is an instrument giving horizontal line of sight & magnifying the reading far away from it.

It consists of following 4 parts.

1. Telescope to provide line of sight.
2. Level tube to make the line of sight horizontal.
3. The levelling head to bring the bubble in its centre of run.
4. A tripod to support instrument

3.7 TYPES OF LEVELS:

1. Dumpy level
2. wye level
3. Cooke's ‘ Reversible level
4. Tilting level
5. Auto level
6. Cushing's level

3.8 WORKING PRINCIPLE OF AUTO & DUMPY LEVEL:

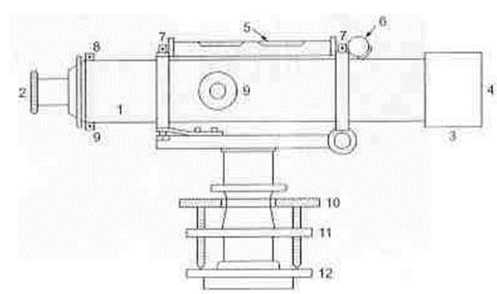

Fig-9

3.9 PARTS OF FIGURE

1. Telescope
2. Eye piece
3. Shade
4. Objective end
5. Longitudinal bubble
6. Focusing screw
7. Foot screws
8. Upper parallel plate
9. Diaphragm adjusting screws
10. Bubble tube adjusting screw
11. Transverse bubble tube
12. Foot plate.

The dumpy level originally designed by 'Gravatt consists of a telescope tube firmly secured in two collars fixed by adjusting screws to the stage carried by the vertical spindle.

The modern form of dumpy level has the telescope tube & the vertical spindle cast as one piece & a long bubble tube is attached to the top of the telescope. This form is known as 'solid dumpy.

Leveling head generally consists of two parallel plates with either three- foot screws or four foot screws. The upper plate is known as 'tribrach. Lower part is known as 'trivet which can be screwed on to a tripod.

3.9.1 The advantages of the dumpy level over the wye level:

1. Simple construction with fewer movable parts
2. Fewer adjustments to be made
3. Longer life.

3.9.2 Levelling staff:

A levelling staff is a straight rectangular rod having graduations. The foot of the staff representing 0 reading. During levelling staff is held vertical at the point and from level horizontal sight is taken.

Levelling staff may be divided into 2 groups

1. Self ' reading
2. Target staff.

3.9.3 Parts of telescope:

1. Objectives
2. Eye piece
3. Diaphragm
4. Focusing device

4. FUNDAMENTAL AXIS OF A LEVEL:

4.0.1 Vertical axis:

It is the centre line of axis of notation of the level.

4.0.2 Axis of level tube:

It is an imaginary line tangential to the longitudinal curve of the tube at its middle point. It is horizontal when the bubble is central.

4.0.3 Axis of telescope:

It is the line joining the optical centre of the object glass & the centre of eye piece.

4.0.4 Line of collimation or line of sight:

It is the line joining the intersection of cross hairs & optical centre of the object glass.

4.1 Temporary staff adjustment of a level:

1. Setting up
2. Levelling up
3. Focusing

4.1.1 Setting up:

It is to set the tripod stand to a convenient height by bringing bubble to the centre of run through the movement of tripod legs radially.

4.1.2 Levelling up:

To make the vertical axis truly vertical the levelling is made with the help of foot screws.

Loosen the clamp and turn the instrument until bubble axis is parallel to line joining any two screws.

Turn the two screws inward or outward equally till bubble is centered.

Turn the telescope through 90 degrees so that it lies over the third screw.

4.1.3 Focusing:

For quantitative measurements it is essential that the image should always be formed in the fixed plane in the telescope where the cross ' hairs are situated The operation of forming or bringing the clear image of the object in the pane of cross hairs is known ' as ' focusing

Complete focusing involves two steps

1. Focusing the eye ' piece
2. Focusing the objective

Telescope in which the focusing is done by the external movement of either objective or eye 'piece is known as ' External focusing telescope.Telescope in which the focusing is done by the internally with a negative less is known as ' internal focusing telescope Sensitiveness of a bubble tube: When the difference in elevation between any two points is determined from a single set up by back sighting on one point and fore sighting on the other.

The error is due to non-parallelism. When the bubble is not in the centre of run and sensitivity is lost, due to the error of curvature and refraction which is eliminated if lengths of 2 sides are made equal.

4.1.4 Error due to Curvature:

The horizontal line of sight does not remain straight but it slightly bends towards having concavity towards earth surface due to refraction.

CC = d2/2R

4.1.5 Error due to Refraction:

As the line of sight is curved downwards towards the earth surface reading gets decreased. To make the objects appear higher than they really are, this correction is applied to staff readings,

CR = 0.01121d2

where d is in km.

4.2 TERMS USED IN LEVELLING:

4.2.1 Station:

Station is the point where levelling staff is held & not the point where level is kept.

4.2.2 Height of instrument:

For any set up of the level the height of instrument is the elevation of the plane of sight respect to assumed datum. This also known as ' plane of collimation.

4.2.3 Back sight:

It is sight taken on a level staff held at a point of known elevation with an intension of determining plane of collimation or sight.

4.2.4 Intermediate sight (I.S):

Sight taken on after taking back sights before taking last sight from an instrument station is known as ' intermediate sight. The sight is also known as +ve sight (add)

4.2.5 Fore sight (F.S):

This is the last reading ' taken from instrument just before shifting the instrument. This is also ve sight.

4.2.6 Change point (C.P):

This is a point on which both fore sight & back sight are taken.

4.2.7 Reduced level:

Reduced level of a point is the level of the point with respect to assumed datum.

4.3 TYPES OF LEVELLING

1. Simple levelling
2. Differential levelling
3. Fly levelling
4. Profile levelling
5. Cross-sectioning
6. Reciprocal leveling

4.3.1 Simple levelling:

It is the difference in levels of two near by points. It is obtained by simple levelling

4.3.2 Differential levelling:

When the distance between two points is very large it may not be possible to take the readings from single setting of instruments. Each shifting facilitated by taking CP.

4.3.3 Fly levelling:

It is to carry out levelling with respect to temporary bench mark in convenient direction taking number of CP

4.3.4 Crossectioning:

In many engineering projects to calculate earth work involved not only LS is involved but CS of ground is taken in regular intervals.

4.3.5 Reciprocal levelling:

When it is not possible to balance FS and BS due to non-parallelism of line of collimation and axis of bubble tube and also due curvature and refraction this is used.

H= [(ha- hb) + (h'a- h'b)]/2

4.3.6 Profile levelling:

This type of levelling is known as ‘ longitudinal section.

The reduced levels of various points at regular intervals are found along a line or a set of lines.

Then the engineers draw the sectional view of the ground to get the profile. This type oflevelling is commonly employed in deciding railways, highways, canal, sewage line routes.

After getting reduced level of various points along the line, profile of the ground is plotted on a drawing sheet. Normally vertical scale is much larger than the horizontal scale to clearly view the profile. Then when the engineers decide the formation level of the proposed project The decision is mainly based on balancing, cutting & filling so that the transport of earth is minimum. However, the proposed gradient of formation level should not be more than as permitted. After deciding the formation level & the gradient the difference between two consecutive points is known. If RL of first point is known RL of other points are calculated.

4.4. STEPS TO TAKE OBSERVATION:

Differential levelling is the method of direct levelling the object of which is. To determine Difference in elevations of two points regardless of horizontal position of point with respect to each Other, when points are apart it may be necessary to setup the instrument several times. This type of Levelling is also known as ‘FLY LEVELLING‘.

Instrument level is setup at convenient positions near first point (say A).Temporary adjustments should be

Station	Point	Back sight	Intermediate sight	Foresight height of	instrument	Reduced level	Remark

Table 1

SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
1	0.8					89.5	Dam turning point
2		1			0.2	89.3	
3	1.49		1.58		0.58	88.72	Dam temple
4		1.32		0.17		88.89	
5		1.35			0.03	88.86	
6	1.44		1.38		0.03	88.83	Dam rest room
7		0.77		0.67		89.5	
8		1.96			1.19	88.31	
9		0.93		1.03		89.34	
10		1.12			0.19	89.15	
11	1.95		1.2		0.08	89.07	Kandiyapuram
12		2.44			0.49	88.58	
13		2.62			0.18	88.4	
14		2.9			0.28	88.12	
15		3.2			0.3	87.82	
16		3.62			0.42	87.4	
17		4.82			1.2	86.2	
18	1.82		2.94	1.88		88.08	North street
19		1.2		0.62		88.7	
20		0.92		0.28		88.98	
21		0.1		0.82		89.8	
22		1.5			1.42	88.38	
23		1.42		0.1		88.48	
24	1.34		1	0.42		88.9	Entrance
25		1.86			0.52	88.38	
26		1.92			0.06	88.32	
27		4			2.08	86.24	
28		4.12			0.12	86.12	
29	1.46		0.85	3.27		89.39	c Shapped curve
30		1.77			0.31	89.08	
31		1.61		0.16		89.24	
32		1.52		0.09		89.33	
33		1.55			0.03	89.3	
34		1.67			0.12	89.18	
35		1.99			0.32	88.86	
36	1.24		2		0.01	88.85	Water treatment plant
37		1.29			0.05	88.8	
38		1.47			0.18	88.62	
39		1.42		0.05		88.67	
40		1.51			0.09	88.58	
41		1.76			0.25	88.33	
42	2.26		0.72	1.04		89.37	Union office
43		1.33		0.93		90.3	
44		1.37			0.04	90.26	
45		1.25		0.12		90.38	
46		1.17		0.08		90.46	
47		1.73			0.56	89.9	
48		1.69		0.04		89.94	
49	1.45		1.3		0.39	89.55	Small pond
SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
50		1.59			0.14	89.41	
51		1.58		0.01		89.42	
52		1.7			0.12	89.3	
53		1.72			0.02	89.28	
54		1.72				89.28	
55		1.69		0.08		89.31	
56	2.9		0.83	0.86		90.17	S Shaped curve
57		1.72		1.18		91.35	
58		1.78			0.06	91.29	
59		1.62		0.16		91.45	
60		2.2			0.58	90.87	
61	1.12		0.72	1.48		92.35	Union office
62		1.33			0.21	92.14	
63		1.25		0.08		92.22	
64		1.73			0.48	91.74	
65	1.45		1.3	0.43		92.17	Ramco cement
66		2.54			1.09	91.08	
67		3.34			0.8	90.28	
68	1.54		0.82	2.52		92.8	Turning
69		1.59			0.05	92.75	
70		1.58		0.01		92.76	
71		1.7			0.12	92.64	
72		1.72			0.02	92.62	
73		1.72				92.62	
74	2.9		0.83	0.89		93.51	Bridge
75		1.99		0.91		94.42	
76		1.46		0.53		94.95	
77		1.42		0.04		94.99	
78		1		0.42		95.41	
79	2.15		0.23	0.77		96.18	Kottaipatti turning
80		1.58		0.57		96.75	
81		1.42		0.16		96.91	
82		1.28		0.14		97.05	
83		1.1		0.18		97.23	
84		0.92		0.18		97.41	
85		0.73		0.19		97.6	
86	2		0.5	0.23		97.83	Coranation firework
87		1.75		0.25		98.08	
88		1.48		0.27		98.35	
89		1.28		0.2		98.55	
90		1.21		0.7		98.62	
91		0.87		0.34		98.96	
92		0.67		0.2		99.16	
93		0.54		0.13		99.29	
94	1.71		0.33	0.21		99.5	Standard firework
95		1.62		0.09		99.59	
96		1.31		0.31		99.9	
97		1.07		0.24		100.14	
98		0.72		0.35		100.49	

done, (setting up, leveling up, elimination of a parallot) are Performed.

First sight of B.M (point of known elevation) is taken and reading is entered in back Sight sscolumn.

If distance is large instrument is shifted, the

instrument becomes turning point (or) changing point.

After setting up instrument at new position, performing temporary adjustment and Take back sight as turning point.

Thus, turning point will have both back sight and fore sight readings.

Link wise the process is repeated till last point (say B) is reached.

Readings are entered in a tabular form is given Below and Reduced levels are calculated either by height of instrument method (or) rise and fall method.

ARITHMETIC CHECK:

- Σ B.S - ΣF. S= ΣRISE - ΣFALL= LAST RL - FIRST R.L

4.5. IMPORTANT TERMS:

4.5.1 Centering:

The setting of theodolite exactly over a station marked by means of plumb bob is known as cantering**.**

4.5.2 Transiting:

The method of turning the telescope about its horizontal axis in a vertical plane through 180' is termed as transiting. In other words, transiting results in a change of face.

4.5.3 Face left:

It means that the vertical circle of theodolite is on the left of the observer at the time of taking reading.

4.5.4 Face right:

Table 2

SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
99	1.61		0.39	0.33		100.82	Azhagusamy traders
100		1.3		0.31		101.13	
101		1.05		0.25		101.38	
102		0.9		0.15		101.53	
103	1.95		0.75	0.15		101.68	Shri vetri vinayaga
104		1.72		0.23		101.91	
105		1.58		0.14		102.05	
106		1.42		0.16		102.21	
107		1.31		0.11		102.32	
108		1.24		0.07		102.39	
109		1.18		0.06		102.45	
110		1.05		0.13		102.28	
111		1.1			0.05	102.53	
112	1.75		1.25		0.15	102.38	Uthaya store crackers
113		1.52		0.23		102.61	
114		1.51		0.01		102.62	
115		1.54			0.03	102.59	
116		1.5		0.04		102.63	
117	1.14		1.75		0.25	102.38	Essar petrol bulk
118		1.38			0.24	102.14	
119		1.31		0.07		102.21	
120		1.43			0.12	102.09	
121		1.6			0.17	101.92	
122		1.95			0.35	101.57	
123		2.02			0.07	101.5	
124		1.84		0.18		101.68	
125	1.6		1.7	0.14		101.82	Ponirulappa samy kovil
126		1.74			0.14	101.68	
127		1.55		0.19		101.87	
128		1.47		0.05		101.95	
129		1.55			0.08	101.87	
130		1.47		0.08		101.95	
131		1.74			0.27	101.68	
132		1.65		0.09		101.77	
133		1.54		0.11		101.88	
134		1.62			0.08	101.8	
135	1.56		1.67		0.05	101.75	Thulukkan kurichi stop
136		1.57			0.01	101.74	
137		1.76			0.19	101.55	
138		1.61		0.15		101.7	
139	2.29		1.31	0.3		102	Cement store
140		2.31			0.02	101.98	
141		1.26			1.05	103.03	
142		1.49		0.23		102.8	
143		1.38			0.11	102.91	
144		1.15			0.23	103.14	
145	1.98		1.29	0.14		103	Thulukkan kurichi
146		1.95			0.03	103.03	
147		1.76			0.19	103.22	
SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
148		1.57			0.19	103.41	
149		1.37		0.2		103.61	
150		1.14		0.23		103.84	
151		1.03		0.11		103.95	
152	1.05		1.12		0.09	103.86	lamelumangai puram pond
153		1.3			0.25	103.61	
154		1.43			0.13	103.48	
155		1.5			0.07	103.41	
156		1.62			0.12	103.29	
157		1.54		0.08		103.37	
158		1.25		0.29		103.66	
159	1.81		1.31		0.06	103.6	Bus stop
160		1.68		0.13		103.73	
161		1.55		0.13		103.86	
162		1.58			0.03	103.83	
163		1.37		0.21		104.04	
164		1.3		0.07		104.11	
165		1.1		0.2		104.31	
166	2.2		1.02	0.08		104.39	End
167		1.91		0.29		104.68	
168		1.62		0.29		104.97	
169		1.43		0.19		105.16	
170		1.34		0.09		105.25	
171		0.1		1.24		106.49	
172		0.91			0.81	105.68	
173	1.9		0.8	0.11		105.79	Culvert
174		2.12			0.22	105.57	
175		2.15			0.03	105.54	
176		1.68		0.47		106.01	
177		1.44		0.24		106.25	
178		1.53			0.09	106.16	
179	2		1.5	0.03		106.19	Sevelpatti outer
180		1.85		0.15		106.34	
181		1.74		0.11		106.45	
182		1.7		0.04		106.49	
183		1.5		0.2		106.69	
184		1.45		0.05		106.74	
185	1.87		1.5		0.05	106.69	Sevelpatti entrance
186		1.48		0.39		107.08	
187		1.65			0.17	106.91	
188		1.85			0.2	106.71	
189	1.68		2.1		0.25	106.46	MSP store
190		1.57		0.11		106.57	
191		1.26		0.31		106.88	
192		1.4			0.14	106.74	
193		1.83			0.43	107.17	
194	0.6		2.5		0.67	107.84	Water tank
195		0.98			0.38	108.22	
196		1.56			0.58	107.64	

Table 3

SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
197		2.1			0.54	107.1	
198	2.3		2.2		0.1	107	Sevalpatti end
199		2.55			0.25	106.75	
200		2.31		0.24		106.99	
201		2.03		0.28		107.27	
202		1		1.03		108.3	
203	3.5		0.4	0.3		108.9	Government school
204		2.9		0.6		109.5	
205		2.39		0.51		110.01	
206		2.2		0.19		110.2	
207		1.45		0.75		110.95	
208		1.1		0.35		111.3	
209		1.1				111.3	
210	3.1		1.11		0.01	111.29	RR Nagar
211		2.75		0.35		111.64	
212		2.38		0.37		112.01	
213		1.87		0.51		112.52	
214		1.4		0.47		112.99	
215		1.55			0.15	112.84	
216		1.45		0.1		112.94	
217		1.65			0.2	112.74	
218		1.85			0.2	112.54	
219	1.54		1.54	0.31		112.85	Small bridge
220		1.1		0.44		113.29	
221		0.92		0.18		113.47	
222		0.84		0.08		113.55	
223		1.1			0.26	113.29	
224		1.49			0.39	112.9	
225		1.85			0.36	112.59	
226		1.76		0.09		112.63	
227	3.4		1.9		0.14	112.16	Water tank
228		2.25		1.15		113.76	
229		1.95		0.3		114.06	
230		1.7		0.25		114.31	
231		1.5		0.2		114.51	
232		1.45		0.05		114.56	
233		1.15		0.3		114.86	
234	0.98		0.9	0.25		115.11	Ammaiyarpattai
235		1.15			0.17	114.94	
236		1.35			0.2	114.74	
237		1.65			0.3	114.44	
238		1.55		0.1		114.54	
239		1.5		0.05		114.59	
240		1.48		0.02		114.61	
241		1.25		0.23		114.84	
242		0.95		0.3		115.14	
243	1.96		0.8	0.15		115.29	mmaiyarpattai bus stop
244		1.74		0.22		115.51	
245		1.32		0.42		115.93	
SI.NO	B.S(m)	I.S(m)	F.S(m)	RISE(m)	FALL(m)	R.L(m)	REMARKS
246		0.83		0.49		116.42	
247		0.59		0.24		116.66	
248	1.4		0.25	0.34		117	Fire work
249		2.1			0.7	116.3	
250		1.5		0.6		116.9	
251		1.44		0.06		116.96	
252		1.33		0.11		117.07	
253		1		0.33		117.4	
254		0.85		0.15		117.55	
255		0.9			0.05	117.5	
256	1.6		0.9			117.5	PSREC gate
257		1.42		0.18		117.68	
258		1.44			0.02	117.66	
259		1.32		0.12		117.54	
260		1.27		0.05		117.59	
261		1.1		0.17		117.76	
262		1		0.1		117.86	
263	1.9		0.9	0.1		117.96	Bus stand
264		1.85			0.95	117.01	
265		1.75		0.1		117.11	
266	1.4		1.41	0.34		117.45	PSR main gate
267		1.74			0.33	117.12	
268		1.5			0.16	116.96	
269	1.1		1.15	0.75		117.71	ECE block
270		1.28			0.07	117.64	
271	1.25		1.28		0	117.64	ECE end
272		1.57			0.29	117.35	
273			1.87		0.3	117.05	

TO CHECK :

Σ RISE =52.67
Σ FALL=28.76
Σ BS=83.44
Σ FS=57.04
LAST RL-FIRST RL=Σ BS-Σ FS=Σ RISE-Σ FALL
27.55=26.4=23.91

This refers to the situation when the vertical circle of the instrument is on the right of the observer when the reading is taken.

4.5.5 Changing face:

The operation of bringing the vertical circle from one side of the observer to the other is known as changing face.

4.5.6 Swinging the telescope:

This indicates turning the telescope in a horizontal plane. It is called 'right swing' when the

telescope is turned clockwise and 'left swing' when the telescope is turned anticlockwise.

4.5.7 Line of collimation:

It is an imaginary line passing through the optical centre of the objective glass and its continuation**.**

4.5.8 Axis of telescope:

The axis is an imaginary line passing through the optical centre of the object glass and optical centre of eyepiece.

4.5.9 Axis of the bubble tube:

It is an imaginary line tangential to longitudinal curve of bubble tube at its middle point.

4.6.0 Vertical axis:

It is the axis of rotation of the telescope in the horizontal plane.

4.6.1 Horizontal axis:

It is the axis of rotation of the telescope in the vertical plane.

4.6.2 Temporary adjustment:

The setting of the theodolite over a station at the time of taking any observation is called temporary adjustment.

4.6.3 Permanent adjustment:

When the desired relationship between fundamental lines is disturbed, then some procedures are adopted to establish this relationship. This adjustment is known as permanent adjustment

4.7 MEASUREMENT OF HORIZONTAL ANGLE

The procedure is explained for measuring horizontal angle θ = PQR at station Q

1.Set the theodolite at Q with vertical circle to the left of the line of sight and complete all temporary adjustments.

2.Release both upper and lower clamps and turn upper plate to get 0° on the main scale. Then clamp main screw and using tangent screw get exactly zero reading. At this stage Vernier reads 0° and Vernier B reads 180°.

3.Through telescope take line of sight to signal at P and lock the lower clamp. Use tangent Screw for exact bisection.

4. Release the upper clamp and swing telescope to bisect signal at R. Lock upper clamp and use tangent screen to get exact bisection of R.

5.Read Vernier‘s A and B. The reading of Vernier A gives desired angle PQR directly, while 180° is to be subtracted from the reading of Vernier B to get the angle PQR.

6.Transit (move by 180° in vertical plane) the telescope to make vertical circle to the right of telescope. Repeat steps 2 to 5 to get two more values for the angle.

7. The average of 4 values found for θ, give the horizontal angle. Two values obtained with face left and two obtained with face right position of vertical circle are called one set of readings.

8. If more precision is required the angle may be measured repeatedly. i.e., after step 5, release lower clamp, sight signal at P, then lock lower clamp, release upper clamp and swing the telescope to signal at Q. The reading of Vernier A doubles. The angle measured by Vernier B is also doubled. Any number of repetitions may be made and average taken. Similar readings are then taken with face right also. Finally, average angle is found and is taken as desired angle ‘Q‘. This is called method of repetition.

9. There is another method of getting precise horizontal angles. It is called method of reiteration. If a

number of angles are to be measured from a station this technique is used. With zero reading of Vernier A signal at P is sighted exactly and lower clamp and its tangent screw are locked. Then θ1 is measured by sighting Q and noted. Then θ2, θ3 and θ4 are measured by unlocking upper clamp and bisecting signals at R, S and P. The angles are calculated and checked to see that sum is 360º. In each case both veneers are read and similar process is carried out by changing the face (face left and face right)

4.8. MEASUREMENT OF VERTICAL ANGLE

Horizontal sight is taken as zero vertical angle. Angle of elevations are noted as +ve angles and angle of depression as ‘ve angles.

To measure vertical angle the following procedure may be followed:

1.Complete all temporary adjustment at the required station.

2.Take up levelling of the instrument with respect to altitude level provided on the A ‘ frame.This levelling process is similar to that used for levelling dumpy level i.e., first altitude level is kept parallel to any two levelling screws and operating those two screws bubble is brought to centre. Then by rotating telescope, level tube is brought at right angles to the original position and is levelled with the third screw. The procedure is repeated till bubble is centred in both positions.

3.Then loosen the vertical circle clamp, bisect P and lock the clamp. Read veneers C and D to get vertical angle. The observation recorded by the above process is then entered to the table in a specific format given below.

4.9 Conclusion

This paper described the survey process, consisting of three phases:

1. survey design,
2. survey instrument development, and
3. survey execution.

Data analysis and reporting of results was identified as an important fourth phase of the survey process. This paper provided specific guidance for the design and implementation of survey research. Additional guidance is provided in the Appendix—A Checklist for Survey Assessment.

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5.1.Appendix

5.1.1 A Checklist for Survey Assessment

5.1.2 Survey Design

1) Indicate why a survey is the preferred data collection method for this study. Consider its propensity to error and bias, resource requirements, and comparison to ther data collection methods.

2) Indicate whether the survey will be cross-sectional (information collected at one time) or longitudinal (information collected over time).

3) Specify the survey media, the rationale for that choice, arguments for cost, availability, convenience, and accuracy of results.

5.1.3 Population and Sample

4) Describe the population, its size if known, and how it will be identified. Address questions of access and use of sampling frames if intended.

5) Determine whether the sampling design will be single stage (researcher contacts subjects directly) or multi-stage (researcher must first contact organizations, gather lists within organizational units, then sample within each cluster).

6) Identify how the sample will be selected. Aim for random sampling, using theoretical samples only if subject availability is problematic.

7) Discuss whether the population will be stratified to ensure that specific characteristics are represented in the sample. The sample must reflect the characteristics of the population in general.

8) Identify the strata that will be used (gender, age, education level, rank). For each stratum, state whether the sample will be chosen so that the characteristic of interest is proportionate or disproportionate to the size of the stratum.

9) Indicate the procedure for selecting the random sample from the population lists or the sampling frame. Random number selection is most rigorous

10) Describe the sample size required and explain the sample size formula used.

5.1.4 Survey Instrument

11) Identify the survey instrument that will be used, whether it was designed for this study, modified from previous instruments, or developed by another researcher.

A-1

For modified and legacy instruments, indicate that permission has been granted to use the instruments (or parts thereof) for this study.

12) For legacy instruments, discuss the findings of previous researchers regarding the validity and reliability of the instrument.

13) Attach a copy of the survey instrument as an appendix to the test plan.

14) Describe the major sections of the instrument, including the cover letter, the question categories (demographics, belief questions, attitude questions, behavior questions, attribute questions), and the closing instructions. Describe the types of scales that are to be used (Likert ratings, binary choice, multiple choice, preference rankings).

15) Describe how the instrument will be pilot tested. Provide a rationale for this procedure, including the number of testers and how their comments will be incorporated into the final survey version.

16) Establish the follow-up actions for written surveys, such as postcard reminders, follow-up letters with replacement questionnaire forms, and telephone calls.

5.1.5 Study Variables

17) Develop a table that lists each variable (independent, dependent, and mediating) in the study, the research question or hypothesis that it responds to, and the survey questions that will elicit that information.

5.1.6 Data Analysis Plan

18) Discuss the method for determining nonresponse bias. Wave analysis is one method that examines the responses received from those who submitted their surveys late in the response period. This group almost did not respond and, therefore, approximates the no respondents. If responses from this late group are not substantially different from responses received earlier in the response period, "a strong case for absence of response bias can be established" (Creswell, 1994, pp. 123-124). Another method for determining nonresponse bias is to telephone a few no respondents to determine whether their responses to selected survey questions differ significantly from the responses that were received.

19) A descriptive analysis of all independent and dependent variables will be conducted. Summary statistics, such as means, variances, and standard deviations, will be reported for each variable.

20) If building one's own scales in an instrument, discuss how survey items will be combined into scales on the independent and dependent dimensions by using factor analysis. Report how the reliability of these scales will be checked statistically for

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21) Identify the statistics that will be used to compare groups or relate variables and provide evidence either in support of in refutation of the hypothesis. Provide a rationale for the choice of statistics and base that rationale on the unit of measurement of scales in the study, the intent of the research to either relate variables or compare groups, and whether the data meet the assumptions of the statistic

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