Project Report on

" Ground Survey Using Dumpy Level "

Submitted to,

Department of Biotechnology,

Government of India.

under

DBT Star College Scheme

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CERTIFICATE

This is to certify that the work incorporated in the dissertation entitled"Ground Survey Using Dumpy Level "

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Declaration

We hereby declare that the work done in this thesis entitled "Slope Profile of KaradGhat with the help of Dumpy level "*is submitted to Department of Geography, MES, Arts, Commerce and Science College Sonai. This project is completed under the DBT Star College Scheme and the supervision of Dr. R.V. Wagh The works is original and not submitted in part or full by me or any other to this or any other University.*

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" GROUND SURVEY USING DUMPY LEVEL "

INTRODUCTION: The continuous land body is known as the ground. Earth surface is not continius. It has up and down condition. It's a ground physically (and electrically) connected to earth via a conductive material such as copper, aluminum, or an aluminum alloy. A true earth ground, as defined by the National Electrical Code (NEC), consists of a conductive pipe, or rod, physically driven into the earth to a minimum depth of 8 feet. *It is the mark of an instructed mind to rest satisfied with the degree of precision which the nature of the subject permits, and not to seek an exactness where only an approximation of the truth is possible.*

—Aristotle

Ground water is an important natural resource throughout the world. In the United States, approximately 50 percent of the population and more than 90 percent of rural residents use ground water as their source of domestic drinking water (USGS 1990). Ground water is the source of about 34 percent of the irrigation waters in the United States. Other uses of ground water have grown dramatically; total use of ground water for 1985 was an estimated 73 billion gallons a day (USGS 1990), more than double the usage in 1950. In addition, ground water is the principal source of surface water during low flow periods. About 30 percent of river and stream flow comes from ground water, where it contributes to important ecological habitat as well as surface drinking water supplies (USEPA 1991a).

The importance of ground water has long been recognized, but the potential for ground water to become contaminated as a result of human activities at or near the land surface has only been recognized in recent years. Before about 1980 it was thought that soils served as filters, preventing harmful substances deposited at the

surface from migrating downward into ground water. Today it is known that soils and other intervening layers have a finite capacity to filter and retard, and so protect ground water.

Over the past two decades, a large number of chemicals and wastes from human activities have been found in ground water throughout the United States. Ground water can be contaminated by localized releases from sources such as hazardous waste disposal sites, municipal landfills, surface impoundments, underground storage tanks, gas and oil pipelines,

back-siphoning of agricultural chemicals into wells, and injection wells. Ground water can also become contaminated by substances released at or near the soil surface in a more dispersed manner including pesticides, fertilizers, septic tank leachate, and contamination from other nonpoint sources.

Nitrates from fertilizers and animal wastes are the most pervasive type of ground water contamination. An estimated 20.5 million tons of fertilizers were applied to crops during 1988-1989 (USDA 1989). Between 1960 and 1985, agricultural use of nitrogen quadrupled, to 12 million tons (USDA 1987). Nitrate levels in ground water have increased concurrently with these rises in fertilizer application.

Pesticides also contribute significantly to ground water pollution. Each year about 661 million pounds of active pesticide ingredients are used in agriculture (OTA 1990, USEPA 1987). The first reported instances of ground water contamination by pesticides occurred in 1979 when dibromochloropropane (DBCP) was detected in California and aldicarb in New York. Subsequently, DBCP was detected in ground water in four additional states. By 1983, ethylene dibromide (EDB) had been found in wells in 16 counties of California, Florida, Georgia, and Hawaii (USEPA 1987). These findings prompted the suspension of EDB use in the United

States. By 1988, pesticides had been detected in the ground water of more than 26 states (USEPA 1988). The largest monitoring study conducted in the United States, EPA's National Pesticide Survey (USEPA 1990), concluded that about 10.4 percent of wells in community water systems and 4.2 percent of rural domestic well water had detectable residues of one or more pesticides; fewer than 1 percent of all wells, however, were estimated to contain at least one pesticide in excess of established levels of health concern.

Once contaminated, ground water is very expensive to clean up; in many cases, cleanup may not be possible within a reasonable time (Mackay and Cherry 1989, Haley et al. 1991). In addition, ground water is the only source of drinking water for many rural areas (USGS 1990). The cost of replacing contaminated sources with bottled water or other alternatives is high relative to that of existing ground water resources (Abdalla 1990).

Situations are relatively obvious. For example, ground water contamination is likely to occur in areas having shallow water tables and sandy soils with high recharge rates. Such relatively obvious situations, however, are found on land that comprises only a small fraction of the area of the United States. Efforts to protect against future contamination must focus on the much larger areas where relative vulnerability to contamination is more difficult to distinguish. Given this understanding, resource managers have sought to identify areas where contamination is more likely to occur than in other areas. Thus the concept of ground water vulnerability to contamination was developed.

SURVEY : A survey is a research method used for collecting data from a predefined group of respondents to gain information and insights into various topics of interest. They can have multiple purposes, and researchers can conduct it in many ways depending on the methodology chosen and the study's goal. In the

year 2020, research is of extreme importance, and hence it's essential for us to understand the benefits of social research for a target population using the right survey tool.

The data is usually obtained through the use of standardized procedures to ensure that each respondent can answer the questions at a level playing field to avoid biased opinions that could influence the outcome of the research or study. The process involves asking people for information through a questionnaire, which can be either online or offline. However, with the arrival of new technologies, it is common to distribute them using digital media such as social networks, email, QR codes, or URLs.

It's a simple question: What is a survey? It seems like a simple question, but as with many things, the answer is more complex than many people appreciate. Surveys can take multiple forms but are most common in the form of a questionnaire, either written or online. It's easy to create a survey with digital software and Qualtrics offers free survey templates. Plus, digital software can save your company time and money because they have lower setup and administrative costs. It's more convenient for the customer or respondent because they can take the survey on whichever digital device is most convenient for them (tablet, computer, phone, etc). It's also more convenient for you because you just need to send the survey link via email and you'll have the data in your survey management software as soon as responses come in. Survey of India, The National Mapping Agency of the country under the Department of Science & Technology, is the oldest scientific department of the govt. of india.

Survey of India as the National Mapping Agency of India is into survey and map preparation for more than two and the half centuries and has gone through various phases from paper maps to digital maps and now advancing to enterprise GIS systems.

National Map Policy – 2005 has given Survey of India a revised mandate of producing, maintaining and disseminating the National Topographic Data Base (NTDB) of the whole country, which is the foundation of all spatial data consisting of National Spatial Reference Frame, National Digital Elevation Model, National Topographic Template, Administrative Boundaries and Toponomy (place names).

National Spatial Reference Frame includes the framework of precise coordinates and heights, tidal observations and prediction of tides, gravity surveys and geo-magnetic observations. National Topographic Template includes topographic maps on all scales, aeronautical charts, special purpose maps for Airports/Airfields and other maps for special purposes. Administrative Boundaries include International and Inter-State boundaries. Besides mapping, the mandate also includes capacity building within and outside the Department.

At present SoI is undergoing a transformation phase for providing products and services in tune with the advancements in technology, mapping techniques and Standards according to user requirements.

As part of the modernization effort the National Spatial Reference Frame (NSRF) is being modernised by establishing Continuously Operating Reference Stations (CORS) Network across the country and by developing the Geoid Model for the entire country to enable accurate and speedy positioning services.

With the idea of providing digital data as per user requirement, SOI is using the latest technology for generation of high resolution National Topographic Data Base (HR-NTDB). Currently the source data for generation of HR-NTDB is being acquired through High Resolution Satellite Imagery (HRSI), UAV/Drones, LiDAR etc. Apart from mapping on standard scales i.e. 1:50,000, 1:250.000 etc., SoI is also generating geo-spatial data on scales varying from 1:500 to 1:10000 based on the user requirements.

SoI is also implementing various National and State Level Projects to meet the requirements of various Central and State Govt agencies – SVAMITVA Scheme for MoPR, National Hydrology Project and National Mission for Clean Ganga for MoJS, Drone based large scale mapping for various States.

With the mammoth Surveying and mapping task with latest technology in hand, SoI is geared up for fulfilling the mandate and requirements of projects to meet the objectives of National development with best of the efforts. A single survey is made of at least a sample (or full population in the case of a census), a method of data collection (e.g., a questionnaire) and individual questions or items that become data that can be analyzed statistically. A single survey may focus on different types of topics such as preferences (e.g., for a presidential candidate), opinions (e.g., should abortion be legal?), behavior (smoking and alcohol use), or factual information (e.g., income), depending on its purpose. Since survey research is almost always based on a sample of the population, the success of the research is dependent on the representativeness of the sample with respect to a target population of interest to the researcher. That target population can range from the general population of a given country to specific groups of people within that country, to a membership list of a professional organization, or list of students enrolled in a school system (see also sampling (statistics) and survey sampling).

The persons replying to a survey are called respondents, and depending on the questions asked their answers may represent themselves as individuals, their households, employers, or other organization they represent.

Survey methodology as a scientific field seeks to identify principles about the sample design, data collection instruments, statistical adjustment of data, and data processing, and final data analysis that can create systematic and random survey errors. Survey errors are sometimes analyzed in connection with survey cost. Cost constraints are sometimes framed as improving quality within cost constraints, or alternatively, reducing costs for a fixed level of quality. Survey methodology is both a scientific field and a profession, meaning that some professionals in the field focus on survey errors empirically and others design surveys to reduce them. For survey designers, the task involves making a large set of decisions about thousands of individual features of a survey in order to improve it.

The most important methodological challenges of a survey methodologist include making decisions on how to:

- Identify and select potential sample members.
- Contact sampled individuals and collect data from those who are hard
- to reach (or reluctant to respond)
- Evaluate and test questions.
- Select the mode for posing questions and collecting responses.
- Train and supervise interviewers (if they are involved).
- Check data files for accuracy and internal consistency.
- Adjust survey estimates to correct for identified errors.

Survey Instrument: for the purpose of systematic survey, there are the following survey instrument as the listed below-

Instruments used in surveying include:

- Alidade.
- Alidade table.
- Cosmolabe.
- Dioptra.
- Dumpy level.
- Engineer's chain.
- Geodimeter.
- Graphometer.

There are other types of surveyors, but these are the most common. Surveyors must stand by their work, and they're required to make accurate calculations. That's why Engineering Supply offers the best surveying instruments on the market. Some of the products that we sell include but may not be limited to:

- Surveying tripods
- Surveying bipods
- Fiberglass grade rods
- Aluminum grade rods
- Builder's grade rods
- Story poles
- Laser levels
- Auto-levels
- Transit levels
- Hand levels
- Abney levels
- Surveyor's brush axes

- Land surveying markers
- Land surveying rods
- Marking paint
    - At the end of the course the students will posses knowledge about survey field techniques
    - 1) **CHAIN SURVEYING**
    - 1. Study of Chains and its accessories
    - 2. Aligning, Ranging and Chaining
    - 3. Chain Traversing
    - 2) **COMPASS SURVEYING**
    - 1. Compass Traversing
    - 3) PLANE TABLE SURVEYING
    - 1. Plane table Surveying: Radiation
    - 2. Plane table Surveying: Intersection
    - 3. Plane table Surveying: Traversing
    - 4. Plane table Surveying: Resection – Two point problem
    - 4) **LEVELLING**
    - 1. Study of levels and levelling staff
    - 2. Fly leveling using Dumpy level
    - 3. Fly leveling using Tilting level
    - 4. Check leveling
    - 5) **LONGITUDINAL & CROSS SECTIONING**
    - 1. LS and CS
    - 6) CONTOURING
    - 1. Contouring
    - THEODOLITES
    - 7) Study of Theodolites

The dumpy level is an optical instrument used for surveying and levelling operations. It comprises of a telescope tube, firmly held between two collars and adjusting screws. The complete instrument is staged by the vertical spindle. The telescope placed on the dumpy level can be rotated amongst the horizontal plane

The dumpy level is an optical instrument used for surveying and levelling operations. It comprises of a telescope tube, firmly held between two collars and adjusting screws. The complete instrument is staged by the vertical spindle.

The telescope placed on the dumpy level can be rotated amongst the horizontal plane. Relative elevation of survey points on the land can be determined through the dumpy level.

The dumpy level was invented by Willian Gravatt, in 1832. Being a civil engineer, he invented the dumpy level while using Y (Wye) level instrument. *The dumpy level* is an optical surveying leveling instrument consisting a telescope tube firmly secured in two collars fixed by adjusting screws to the stage by the vertical spindle.

The telescope of dumpy level can rotate only in a horizontal plane. Relative elevation of different points of a surveying land is determined with dumpy level.

English civil engineer William Gravatt is considered as the inventor of the dumpy level. He invented dumpy level in 1832 while using the conventional Y level.

A dumpy level is also called a builder's level, an automatic level. A level is an optical instrument used to establish or verify points in the same horizontal plane in a process known as levelling, and is used in conjunction with a levelling staff to establish the relative heights levels of objects or marks. It is widely used in surveying and construction to measure height differences and to transfer, measure, and set heights of known objects or marks.

It is also known as a Surveyor's level, Builder's level, Dumpy level or the historic "Y" level. It operates on the principle of establishing a visual level relationship between two or more points, for which an inbuilt telescope and a highly accurate bubble level are used to achieve the necessary accuracy. Traditionally the instrument was completely adjusted manually to ensure a level line of sight, but modern automatic versions self-compensate for slight errors in the coarse levelling of the instrument, and are thereby quicker to use.

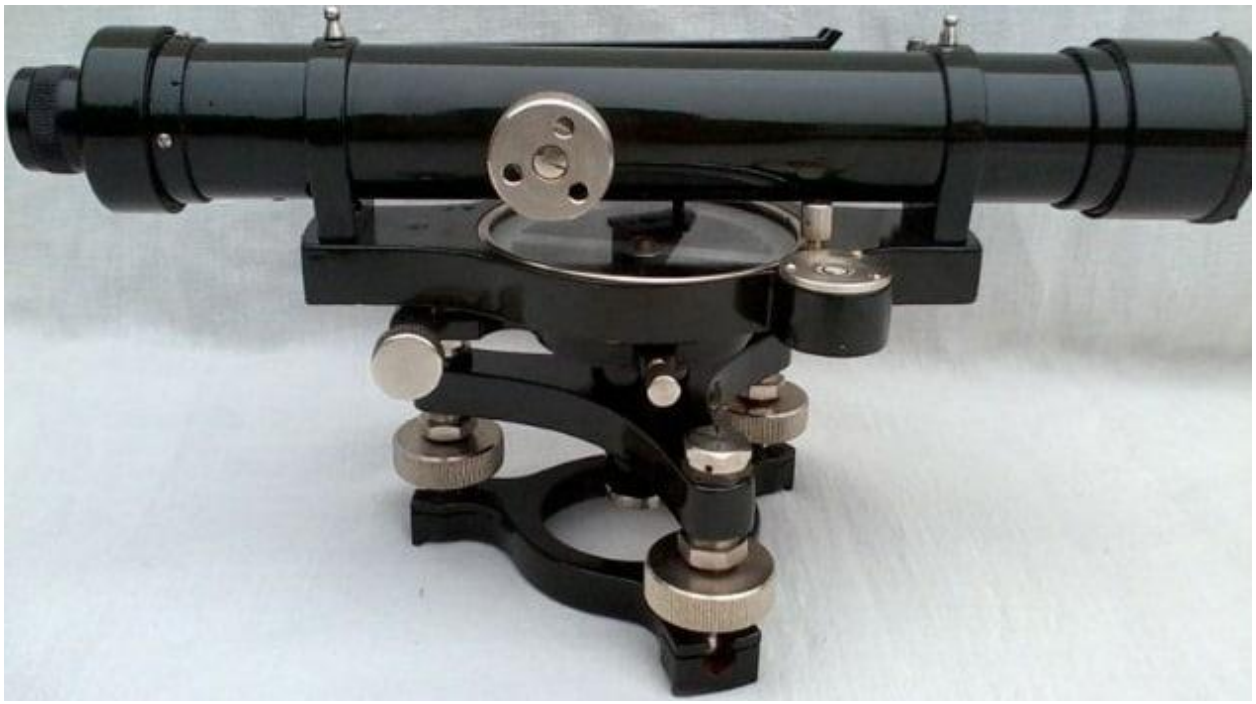
The optical level should not be confused with a theodolite, which can also measure angles in the vertical plane.

Instruments used in surveying include:

- Alidade
- Alidade table
- Cosmolabe
- Dioptra
- Dumpy level
- Engineer's chain
- Geodimeter
- Graphometer
- Groma (surveying)
- Laser scanning
- Level
- Level staff
- Measuring tape
- Plane table
- Pole (surveying)
- Prism (surveying) (corner cube retroreflector)

- Prismatic compass (angle measurement)
- Ramsden surveying instruments
- Ranging rod
- Surveyor's chain
- Surveyor's compass
- Tachymeter (surveying)
- Tape (surveying)
- Tellurometer
- Theodolite
  - Half theodolite
  - Plain theodolite
  - Simple theodolite
  - Great theodolite
  - Non-transit theodolite
  - Transit theodolite
  - Seconds theodolite
  - Electronic theodolite
  - Mining theodolite
  - Suspension theodolite
  - Traveling theodolite
  - Pibal theodolite
  - Registering theodolite
  - Gyro-theodolite
  - Construction theodolite
  - Photo-theodolite
  - Robotic theodolite

- Vernier theodolite
- Total station
- Transit (surveying)
- Tripod (surveying)
- Universal instrument (surveying)



English civil engineer William Gravatt is considered as the inventor of the dumpy level. He invented dumpy level in 1832 while using the conventional Y level. A dumpy level is also called a builder's level, an automatic level.

The dumpy level is a widely used surveying instrument in surveying. The advantages which have made the dumpy level so popular is given below.

- Simple construction with fewer movable parts.
- Fewer adjustments to be made.
- Due to the rigidity of dumpy levels, it retains its two adjustment for a long time.

- High optical power.
- E. G. Fischer and his colleagues in the Instrument Division of the U. S. Coast and Geodetic Survey designed this precise level in 1900. C. L. Berger & Sons began making levels of this sort around 1912, noting that they "follow absolutely" the Survey's specifications, "using 'invar' where specified, thus insuring a rigid maintenance of the adjustment of instrument under marked changes of temperature." This example is marked "C. L. Berger & Sons. Boston USA 17475." It dates from 1930, and belonged to the Coast and Geodetic Survey.
- Ref: E. G. Fischer, "Description of Precise Levels Nos. 7 and 8," *Report of the Director of the United States Coast and Geodetic Survey* (1900), Appendix 6.
- C. L. Berger & Sons, Inc., *Catalog of Engineering, Surveying & Mining Instruments* (Boston, 1927), pp. 43-44.

A dumpy level (also known as a Builder's Level) is an optical instrument used to establish or check points in the same horizontal plane. It is used in archaeological surveying to measure horizontal levels, for example to demonstrate the difference in height at the top and base of a slope such as an excavated pit or a surviving earthwork. Equipment The level 'kit' consists of a level head (in box), staff and tripod. The level head comprises an eyepiece, bullseye spirit level, three levelling screws and a focus for the telescope lens; the base also incorporates a 360 degree compass. The 5m staff is in sections. Each ‘block’ represents one centimetre, and each 'E' represents 5 centimetres. The 10 cm sections alternate back and forth and between black and white, and the colour alternates between black and red for each metre. The tripod is composed of aluminum and plastic, with three extendable/lockable legs and a base plate with screw fitting with which to attach the level head. There is a canvas carrying strap and a belt to secure the legs

together. Benchmarks and Temporary Bench Marks (BM/TBM) Find the nearest OS Bench Mark (BM), which is part of the national height system for mainland Great Britain and forms the reference frame for heights above mean sea level. Bench Marks are no longer maintained by the Ordnance Survey (although Fundamental (F)BMs are), but they should be marked on most maps. If the height value is not shown on the map, Ordnance Datums can be obtained from Bench Mark databases: http://www.ordnancesurvey.co.uk/benchmarks/; or http://www.bench-marks.org.uk/search Bench Marks can usually be found on churches, but also on other notable buildings, houses, bridges etc. The database describes where it is and what type of benchmark symbol is used (usually carved into stone, the centre of the horizontal groove is the height reference). It is worth finding the nearest BM to your survey site as soon as possible so that you can establish the best way to transfer the height from the BM to your site. In Swavesey we were able to use a BM on the north side of the church. The value of this was found in the database: 8.5222m OD – we used 8.52m, to two decimal points.

• The staff can be difficult to steady in high winds; you do need to keep it vertical and still. Do not use fully-extended near overhead power cables. • Always pull out (and return) the sections one at a time, and put the staff back in its sleeve after use. Keep mud and grit off it as much as possible, as this will scratch the painted markings. After a survey, dampen the microfibre cloth supplied and wipe off each section of the staff as you close it up. • The level head is a precision instrument, and should be handled carefully. When not in use it should always be kept in its box. If it is raining please make sure that you cover it with a bag or rain hood, or preferably unscrew the head and place it in its box. If the level head does become wet, make sure that it dries out somewhere inside/out of the rain before being returned to its box. If you don't dry it out properly, moisture may seep inside which will result in the telescope 'fogging up' and possible damage to the internal parts. •

When your survey is complete, carefully unscrew the level head and place it in its correct position within the box, close the lid and make sure the catch is secure. • PLEASE TAKE CARE NOT TO DROP THE BOX: If the level head or box containing the level head is kicked or dropped you must report this to the Jigsaw team as soon as possible as it may require calibration or repair. • Undo the catches on the tripod legs and carefully move the retract the legs and clamp the catches back and fasten the belt. Please ensure that the tripod does not get dented or damaged, as this may make it unusable.

The dumpy level is an optical instrument used for surveying and levelling operations. It comprises of a telescope tube, firmly held between two collars and adjusting screws. The complete instrument is staged by the vertical spindle.

The telescope placed on the dumpy level can be rotated amongst the horizontal plane. Relative elevation of survey points on the land can be determined through the dumpy level.

The dumpy level was invented by Willian Gravatt, in 1832. Being a civil engineer, he invented the dumpy level while using Y (Wye) level instrument.

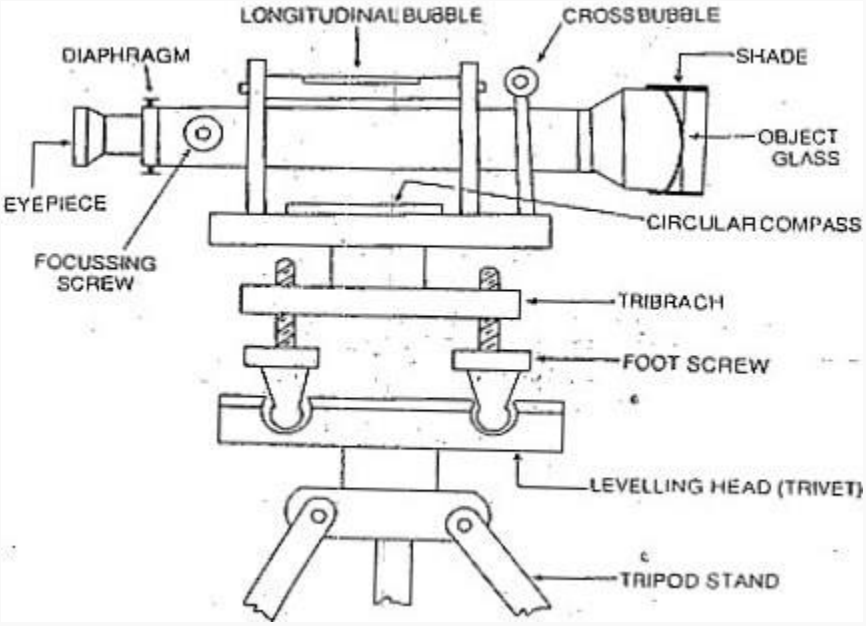
Dumpy level holds significant importance in the surveying of a construction site. The level of accuracy and handiness of dumpy level has made it a prominent choice amongst surveyors.

- The prime reason for performing levelling on a construction site is to make the field level and even.
- To determine the differences in height between two points.
- To measure the height and distance of different locations of surveying land through the principle of relativity.
- To measure following distance amongst various point on the surveying land.
- Setting out levels and inclined surfaces for construction.

- To draw contours on land.

We have gained expertise in providing our customers with Land Surveying Instruments that are sourced from the reliable manufacturers of the market. These products are widely acknowledged by the clients due to their longer functional life, corrosion resistance, dimensional accuracy and wear & tear resistance. In addition to this, all our products are available in various sizes, dimensions, designs and shapes at most competitive prices to fulfill their exact requirements in a better way. STUDY AND USE OF SURVEYING AND LEVELING INSTRUMENTS Surveying is defines as the art of determining the relative positions of various points above, on or below the surface of the earth. The ultimate object of survey is to prepare a map or plant using the data obtained through the survey. The collection of data by linear and angular measurements and elevation difference is called the field work. The processing of data plotting and computation of area and volume are called office work. Use of agricultural survey Surveying is primarily divided into two types. (1) Plane surveying (2) Geodetic surveying Agricultural surveying is the simplest form of plane surveying. With the use of survey, the boundaries of fields can be correctly located and area can be accurately computed. Land leveling and grading may be perfectly done if the differences in elevations are known. Alignments of canals for irrigation and drainage can be effectively done by proper surveying. Surveying plays a vital role in soil conservation measures like contour bunding, graded bunding, bench terracing construction of farm ponds and percolation ponds etc. In addition to this, surveying plays a key role in laying underground pipe line system, alignment of irrigation channels, drainage systems, farm roads and farm stead construction etc. For linear and angular measurements in the plains, chain, compass and plane table surveys are used with necessary instruments. To determine the difference in elevation a dumpy level is used. The details of instruments used in each survey are given below: 1.

Chain survey 1. Chain and Tape 2. Cross Staff 3. Ranging rods 4. Offset Rods 5. Arrows 2. Compass Survey 1. Prismatic Compass 2. Chain 3. Ranging Rods 4. Offset Rods 3. Plane Table Survey 1. Plane Table with Tripod Stand 2. Alidade 3. Trough Compass 4. 'U' frame with plumb bob 5. Spirit Level 6. Chain 7. Ranging Rods 4. Leveling 1. Dumpy Level 2. Tripod Stand 3. Telescopic Metric Staf

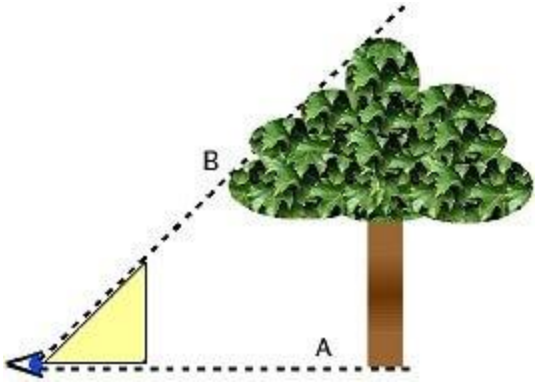


Hand Levels can be a great tool for use by professionals and consumers. They are a very practical and low cost tool with a wide variety of uses. They were first created when someone thought of attaching a spirit level to a telescope. Once the instrument is level, the user looks through the telescope to compare different points against the same reference point. It is used for rough leveling and not designed for precision work. Sometimes Professional Land Surveyors or Grading Contractors will use a Hand Level to get an idea or estimation of level instead of taking the time to set up a tripod with a leveling instrument. EngineerSupply sells Hand Levels. Internal stadia markings assist the user in determining the distances. Land Surveyors and Land Development Professionals use Hand Levels and Sight Levels as they are ideal for preliminary survey and simple distance estimation. Hand

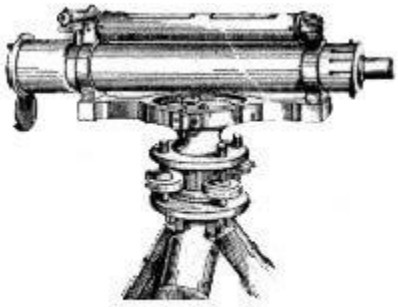
levels are ideal for laying lawns, paving, brick-laying, creating retaining walls, grading and excavation work, shed and pergola construction, fencing and numerous other home DIY projects.

Abney Levels

An Abney Level is similar to a Hand Level in that it is a telescope with a spirit level attached. The main distinction is that the spirit level on an Abney level is not set in a static horizontal position. An Abney Level features a graduated arc. EngineerSupply sells Abney Levels. Once the arc is set at a specific degree it will cause the spirit level to show level at that specific angle. Many Abney levels will feature items such as stadia and will have a feature to focus items at different distances. Some even have a magnification feature. Abney levels are easier to use and inexpensive. They are used to measure degrees, percent of grade and topographic elevation. The user can then determine height, volume and grade through manipulating the readings with trigonometry.



Land Surveyors, Builders, Contractors, Agriculture Professionals, Foresters, and many other Professionals use Abney levels. One unique use of an Abney level is to indirectly measure the height of a tree.



Dumpy Levels

Dumpy Levels are more like a Builders' Level than a Hand Level. It is not a hand-held tool, but instead needs to be mounted on a tripod. It has largely been replaced by Auto Levels and a Builders' Level. It needs to be perfectly level on all 4 leveling screws because it has no self leveling features like most Auto Levels today. Any slight variation will cause measurements to be inaccurate. Auto Levels allow the user to set the instrument close to level and the instrument will adjust the fine level using its internal compensator. This decreases setup time and improves accuracy of measurements. Although dumpy levels are not typically used anymore

many people will refer to Auto Levels and Builders' Levels as “dumpy levels” despite the vast differences in the instruments.

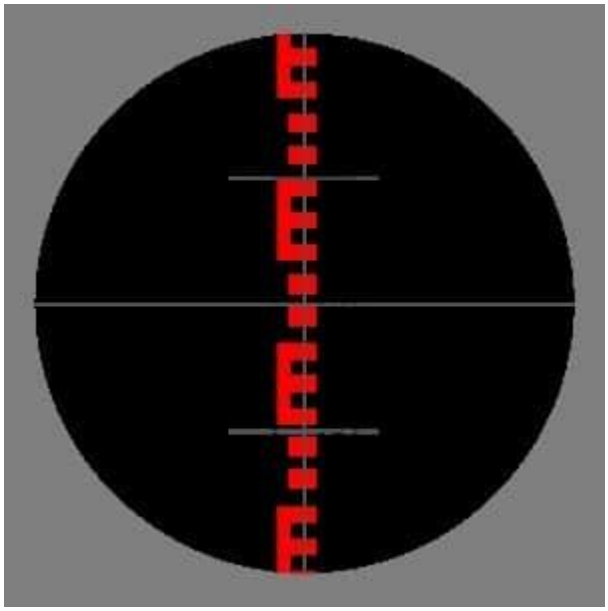
Uses of the dumpy level Instrument: Dumpy level is commonly used leveling instrument to locate the points in same horizontal plane. It is also called as automatic level or builder's level. Elevations of different points and distance between the points of same elevation can be determined by dumpy level

A dumpy level, also known as an automatic level or builder’s level, is a tool designed to find the height of land masses. Though these devices may look intimidating or confusing, dumpy levels are fairly easy to use once you know how to set them up and what kinds of measurements they provide.

The important parts of telescope are as follows

- Eye piece
- Objective lens
- Diaphragm
- Focusing screw
- Ray shade

Eye piece Eye piece is used by the observer’s eye to view the distant object. It contains magnifying glass which magnify the observing image and also the cross hairs of diaphragm. So, accurate reading can be obtained. Erecting eyepiece is used to view the normal image which is generally inverted by objective lens. Objective lens Objective lens are provided at the other end of the telescope. The objective lens consists of two parts, the front part consists convex type lens and the back part consists concave lens. So, the image obtained from the objective lens is always inverted. Diaphragm Diaphragm is provided in front of the eye piece. It contains cross hairs made of dark metal which are arranged in perfect perpendicular

positions. These cross hairs are used by the eye piece to bisect the objective through objective lens. 

Focusing screw Focusing screw is used to adjust the focus if cross hairs and the image clarity. The magnification of eye piece is managed by this focusing screw. Ray shade Ray shade is used to prevent the objective lens from sunlight or any other light rays which may cause disturbance to the line of sight.

Bubble tubes

Bubble tubes are provided to check the level of the instrument. Two bubble tubes are provided in a dumpy level which are arranged perpendicular to each other on the top of the telescope. One tube is called as longitudinal bubble tube and another is called as cross bubble tube. The instrument is said to be in perfect position when both the bubbles of the tubes are at center or middle of the tube.

Compass

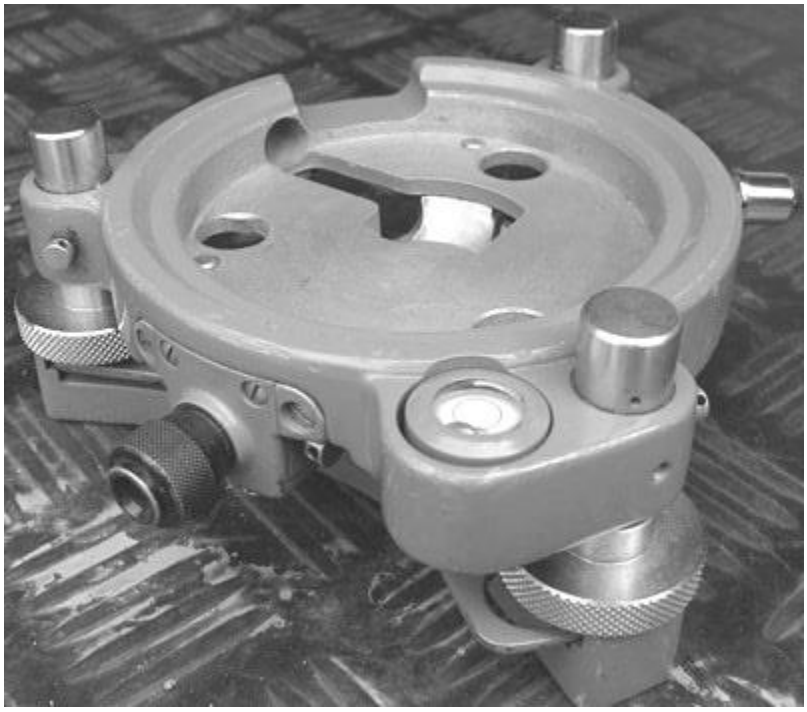
Compass is used to determine the magnetic bearing of line. In case of dumpy level, circular compass is provided just under the telescope. The compass contains a pointer in it and readings are marked inside it. The pointer is set to zero when it faces the north line from which the magnetic bearings are measured.

Vertical spindle

Vertical spindle is located at the center of the whole instrument. The telescope can be rotated in horizontal direction with respect to vertical spindle. The instrument is connected to the tripod stand using vertical spindle.

Tribrach

Tribrach plate is parallel to the leveling head or trivet. It is connected to trivet by leveling screws or foot screws which can adjust the tribrach plate. The horizontal level of the instrument can be achieved by adjusting this tribrach plate.



Foot screws

Foot screws are provided to regulate the tribrach position and hence the instrument can be leveled which is known by observing the bubble tube. The tribrach plates can be lowered or raised using foot screws. The position of tribrach is said to be correct when the bubble in bubble tube is at center.

Leveling head

Leveling head is also called as trivet. It contains two triangular shaped plates which are arranged parallel to each other. Three groves are provided at the three corners of the plates in which foot screws are supported.

Tripod

Tripod is used to support the whole leveling instrument on its top. It consists three legs which can be adjustable to required position. The legs are of same height and they may be solid or hollow. Steel shoes are provided at the bottom of each leg to

hold the ground in a fixed position.

Procedure of Dumpy Level Surveying

The procedure of dumpy level surveying starts with some temporary adjustments which are:

- Setting up of instrument
- Leveling up
- Focusing

Setting up of Dumpy Level

The instrument is fixed to the tripod stand using clamp screws. Spread the tripod legs and position the instrument at convenient height. Firstly fix the two legs in the ground at a point and centering of bubble in the bubble tubes is done by adjusting third leg.

Leveling up

The leveling up of an instrument is done using foot screws or leveling screws. In this case, the telescope is arranged parallel to the any two leveling screws and the bubble in the tube is centered by turning both the screws either inwards or outwards. When it is centered, then the telescope is turned 90^{o} and the third screw is turned until the bubble come to center. Repeat the process until the bubble in the tube always stays at the middle in any position of telescope.

Focusing

Focusing is done by adjusting eye piece and focusing screw. Eye piece is adjusted until the cross hairs of diaphragm are clearly visible. To eliminate the parallax error, a white paper is used to obtain sharp vision of cross hairs. Focusing screw is adjusted to view the clear image of the objective or staff. Focusing is said to be done when the cross hairs bisect the objective or staff with clear vision. After completion the above temporary adjustments, now it's time to take levels of required positions or points. The telescope is rotated towards the line of objective or staff and bisect it. The levels are noted at different points which values are decided from a known bench mark point in that area. The details are tabulated as below.

Position observed	Level reading	HCR (higher cross hair reading)	LCR (lower cross hair reading)	(HCR-LCR) x 100	Distance of point from instrument	Remarks / Error
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-

Benefits of Dumpy Level Surveying

- Dumpy level is easy to use.
- Adjustments can be made as per the requirement on any type of ground.
- Level readings are very accurate in case of dumpy level.
- Optical power is high for dumpy level.
- Price of dumpy level is cheap when compared to other instruments.

Drawbacks of Dumpy Level Surveying

- It is limited to only horizontal angle measurement.
- The angles obtained by dumpy are not that accurate.

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