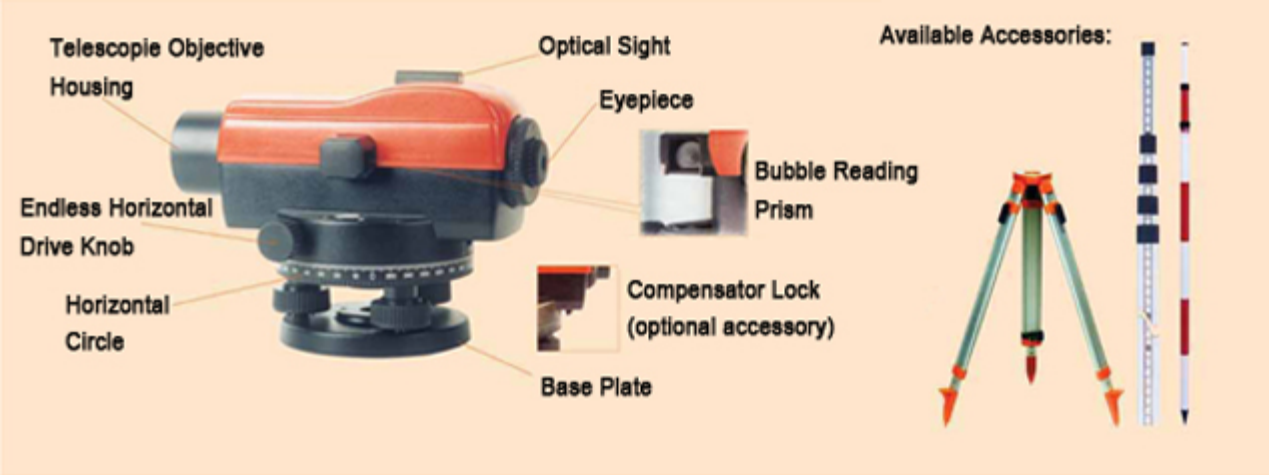
STRUCTURAL CONSTRUCTION WORKS

LEVEL – II

Based on March 2022, Curriculum Version 1



Module Title: - Apply basic leveling procedures

Module code: EIS SCW2 03 0322

Nominal duration: 110Hour

Prepared by: Ministry of Labor and Skill

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Addis Ababa, Ethiopia

Table of Content

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

- (BS)- Back sight
- (FS)- Fore sight
- (IS)- Intermediate sight
- (ELEV)- Elevation
- (HI) Height of Instrument -
- (TBM) - Temporary Benchmark
- (BM)- Benchmark
- (STA)- Station

Introduction to the Module

In Structural construction works the Performing leveling for structural work of Structural construction works helps to know single plane for the purpose of establishing correct and accurate set out of buildings components. It includes the setup, testing and use of leveling devices, and establishing and transferring heights using a range of leveling equipment.

This module is designed to meet the industry requirement under the Structural construction works occupational standard, particularly for the unit of competency: Setting out Profile Set-up for Building Works

This module covers the units:

- Plan and prepare.
- Set up Levelling device.
- Levelling operation
- Clean up.

Learning Objective of the Module

- Plan and prepare.
- Setup levelling device.
- Perform Levelling operation
- Clean up.

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Plan and prepare.

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Work instructions for basic leveling information.
- Safety (OHS) requirements.
- Signage and barricade
- Tools and equipment.
- Environmental requirements.
- Statutory and regulatory authority.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply Work instructions for basic levelling information.
- Follow Safety (OHS) requirements.
- Identify and implement signage and barricade
- Select tools and equipment.
- Apply environmental requirements.
- Apply Statutory and regulatory authority.

1.1. Work instructions for basic leveling information.

1.1.1. Introduction

There are a few rules that apply to all categories and whenever field work is being carried out & should be adhered to at all times.

- **Working from the whole to the part**

One of the underlying principles of surveying (i.e. working within a framework of established points to "fix" points that are unknown)

- **Accuracy**

Use of instruments to measure angles, distances and level (requires techniques & procedures to be mastered). Important to realize that Absolute precision can never be obtained, despite ideal conditions and the use of the best equipment & techniques

- **Errors**

Much of what is done in surveying is prone to errors Gross (mistakes), systematic & random (unavoidable) Mistakes arise from inattention, inexperience and carelessness. Important to adopt procedures or independent checks that eliminate or isolate such errors

- Survey methods

Surveys can usually be executed in several ways by a combination of instruments and methods. Main factors to consider when deciding upon technique to be used: Purpose & extent of the survey Degree of accuracy required Control of errors Nature of the country (i.e. topography, vegetation, visibility & access issues, etc) Commercial issues (i.e. budget & programme considerations)

- **Good survey practice (As a general guide)**

Use equipment which is well maintained, regularly checked and "calibrated" Analyze acceptable error limits for each component of the survey (i.e. set the target accuracy specification). Be aware of likely error sources; resolve existing & underlying errors (don't introduce new ones) Conform to defendable marking, measuring, recording and processing methods.

1.1.2. Leveling

Levelling is defined as "an art of determining the relative height of different points on, above or below the surface". Levelling is the process of measuring, by direct or indirect methods, vertical distances in order to determine elevations.

The purpose of levelling is to make vertical axis truly vertical. It is done with the help of foot screws

1.1.3. Basic Rules for Leveling

- Always start and finish a leveling run on a Benchmark (BM or TGBM) and close the loops
- Keep fore sight and back sight distances as equal as possible
- Keep *lines of sight* short (normally < 50m)
- Never read below 0.5m on a staff (refraction)
- Use stable, well defined change points
- Beware of shadowing effects and crossing waters

1.2. Safety (OHS) requirements

1.2.1. Definition

Occupational health and safety is the discipline concerned with preserving and protecting human resources in the workplace.

Occupational health is the adaptation of work to man and of each man to his job. It has the following components

- Promotion and maintenance of the highest
  degree of physical, mental and social wellbeing of workers in all occupations;
- Prevention among workers of departures from health caused by their working
  conditions;
- Protection of workers in their employment from risks resulting from factors adverse to health
- Placing and maintenance of a worker in an occupational environment adapted to his physiological and psychological equipment

Occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. The health of the workers have several determinants, including risk factors at the workplace leading to cancers, accidents, musculoskeletal diseases, respiratory diseases, hearing loss, circulatory diseases, stress related disorders and communicable diseases and others.

1.3. Signage and barricade

1.3.1. Barricade

Definition

Means a physical barrier, usually temporary, erected or placed to restrict the entry of persons to an area and/or prevent personnel being exposed to a hazard.

Barricades can be classed as either a soft barricade or a hard (solid) barricade.

Soft barricades are those that use an approved tape to prevent or restrict access to an area. They are suitable in situations where physical protection by use of a safety barrier system is not warranted. A hard barricade is a self-supporting fence, or a self-supporting series of continuous plastic, concrete or other solid barriers, erected or placed to restrict the entry of persons to an area. Examples include scaffold

tubes, concertina/expandable barriers, and water filled plastic or

concrete modular devices (Jersey type barriers)

- **Barricading Requirements**

Barricading is one of the risk control measures used to protect personnel from hazard such as:

- ✓ being struck by falling objects, material movements or plant;
- ✓ Fall from height, including falling into open excavations or penetrations;
- ✓ Fall from unprotected edges (e.g. removed flooring, walkways, stairs and handrails);
- ✓ Exposure to hazardous substances, process or activities;
- ✓ UN authorized entry into a confined space or other restricted work areas; and
- ✓ Any potentially hazardous work processes, such as hot works, demolition work, scaffolding, radiation work and work involving asbestos.

Barricading may also be used as part of incident management and emergency response procedures.

- **Selection of Barricade**

The following factors are to be considered as part of a risk assessment when selecting the type of

barricade (soft or hard):

- ✓ risk associated with the hazard;
- ✓ required strength of the barrier (e.g. impact potential); and
- ✓ the amount of clearance provided from the hazard by the barricade.

- Erection and Use of Barricade

The barricade shall be placed so that the whole area affected by the hazard is appropriately identified,

- ✓ taking the following factors into account:
- ✓ distance to/from the hazard;
- ✓ possible movement of an object inside the barricade if it falls;
- ✓ access and egress; and
- ✓ sparks or slag generated from hot work activities

1.3.2. **Signage**

Definition

An inscribed board, plaque or other delineated space on which a combination of legend or symbolic shape is used to convey a message.

- Safety Signage Requirements

Safety signs are erected to warn workers or the public of specific hazards and to communicate necessary precautionary measures and emergency actions. Safety signage, in accordance with Queensland Work Health and Safety Regulation 2011, is required for:

- ✓ construction sites;
- ✓ confined spaces;
- ✓ asbestos;
- ✓ hazardous areas;
- ✓ hazardous chemicals;
- ✓ site specific Personal Protective Equipment (PPE) requirements;
- ✓ fire protection equipment;
- ✓ emergency and first aid information;
- ✓ emergency eyewash shower; and
- ✓ traffic management and pedestrian control.

- **Signage display tips for best effect.**
  - ✓ Keep signs clean and clear of objects or trees.
  - ✓ Should not have sharp or rough edges
  - ✓ Make signs highly visible – clear , large enough lettering with contrasting background,
  - ✓ Ensure clearly illuminated – during day or night [extra lighting may be needed]
  - ✓ Place at reader eye level – no more than 2 m from ground level;
  - ✓ For visually impaired persons, position to enable persons to get close enough to read the sign, without endangering themselves.

- ✓ Securely attach to fencing or barricades to prevent removal or becoming a flying object in severe weather.

1.4. Tools and equipment.

1.4.1 .Tool

A. Hand Level:

The hand level is a handheld instrument used on low precision work, or to obtain quick checks on more precise work. It consists of a brass tube approximately 6 inches long, having a plain glass objective and peep-sight eyepiece.

Fig.1. Hand level

The instrument is held in one hand and leveled by raising or lowering the objective end until the cross line bisects the bubble. Resting the level against a rod or staff provides stability and increases accuracy. This instrument is especially valuable in quickly checking proposed locations for instrument setups in differential leveling.

B. Measuring Tape

A measuring tape is used when a ruler is too short to measure the distance or length. We use the measuring tape to measure short distances in meters. Measuring tapes are usually gradated in millimeters, centimeters and meters

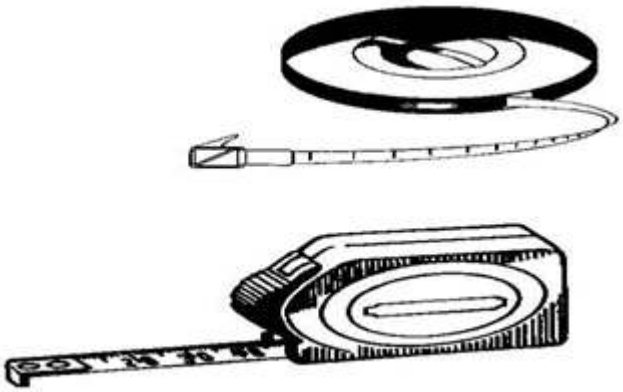


Fig.2.The different types of tapes

C. Leveling staff

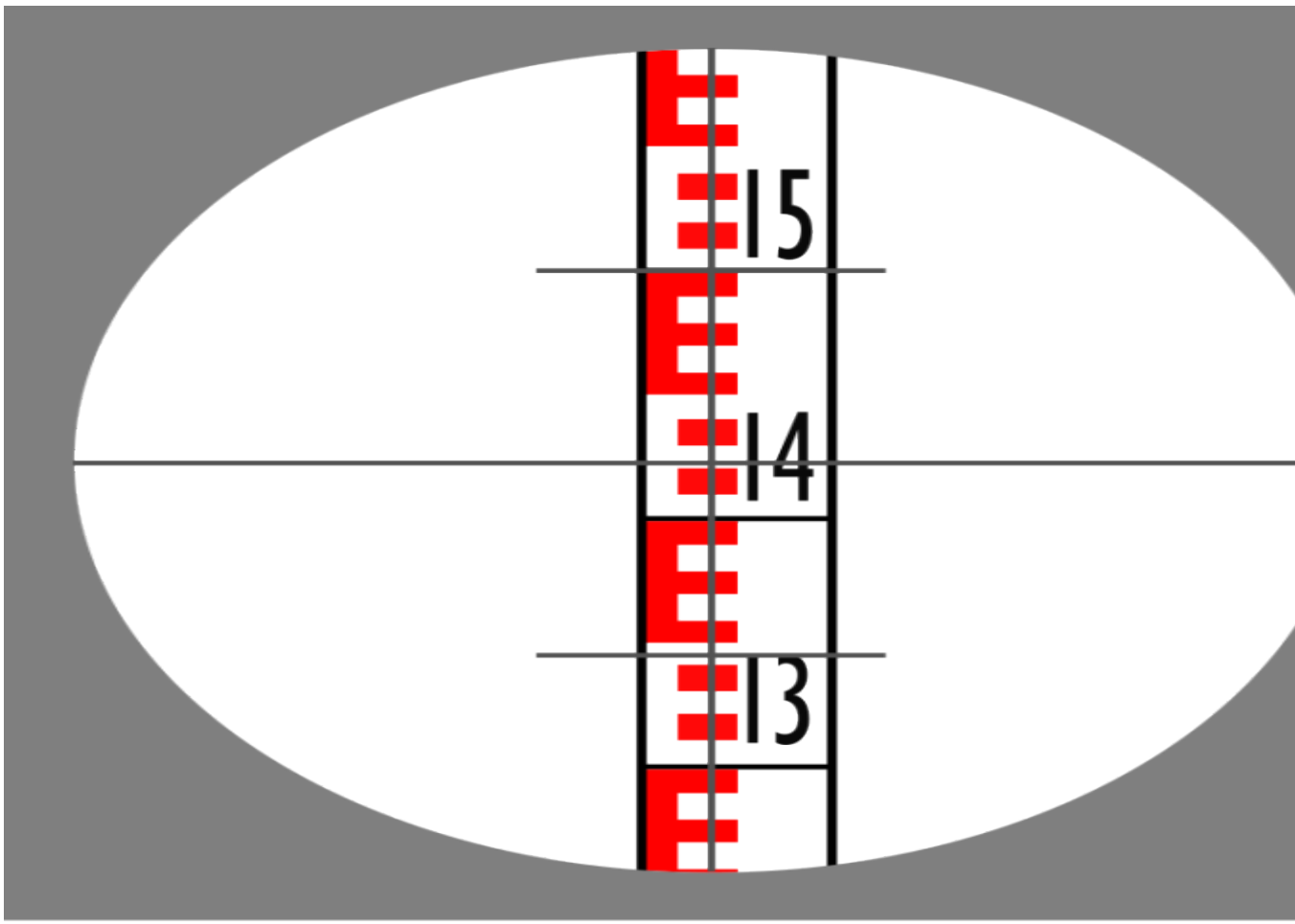


Fig.3.levelling staff

1.4.1 .Equipment

D. Auto Level:

The Auto level is a naturally leveling elite optical instrument valuable amid site overviews and building development to assemble exchange or set horizontal levels and grade applications.

An optical level consists of a precision telescope with **crosshairs** and **Stadia marks.** The cross hairs are used to establish the level point on the target, and the stadia allow range-finding; stadia are usually at ratios of 100:1, in which case one meter between the stadia marks on the levelling staff represents 100 meters from the target.

Stadia marks on a crosshair while viewing a metric levelling rod. The top mark is at 1.5 m and the lower is at 1.345 m. The distance between the marks is 0.155 m, yielding a distance to the rod of 15.5 m.

Auto Level Labeled Diagram:

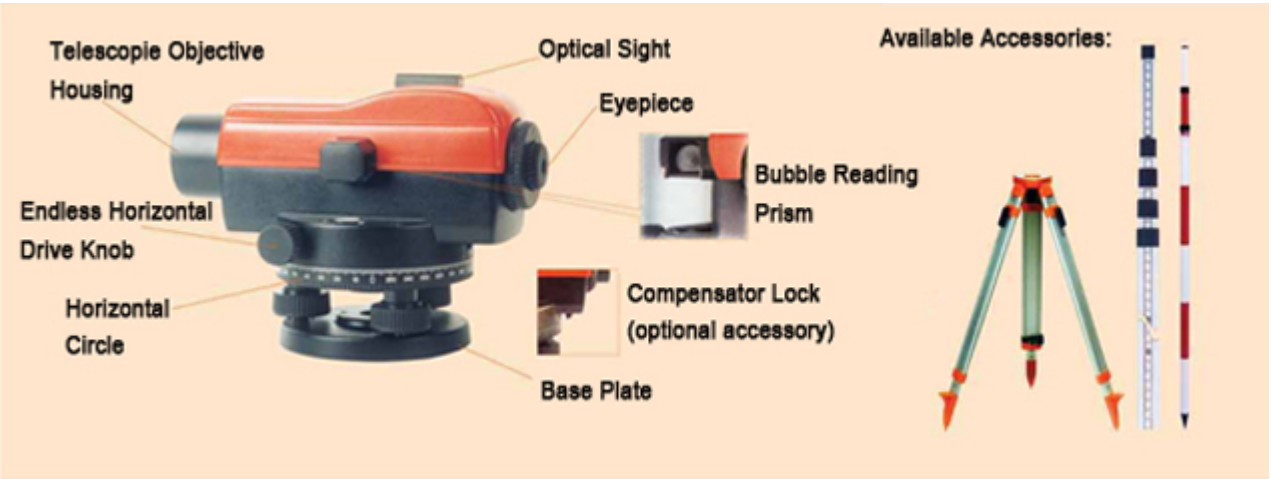


Fig.4.Auto level diagram

E. Digital Level:

Digital automatic **levels** are a precise instruments used for precise **leveling**. Operation of **digital levels** is based on the **digital** processing of video indications of

a coded staff. At the beginning of measurement a visual pointing of the instrument into the surface of **leveling** meter is performed.

With all the advances in electronics in distance measurement, angle measurement, and positioning, it is not too surprising that dramatic advances also have been made in leveling.

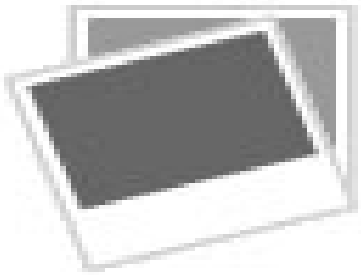


Fig.5.NA2000

Above picture is of **NA 2000** by **Wild Heerbrug.** The NA 2000 features digital, electronic image-processing for determining heights and distances with automatic recording of data for future transfer to computer.

Fig.6.Digital level

F. Tilting Level:

It consists of a telescope attached with a level tube which can be tilted within few degrees in vertical plane by a tilting screw.

Advertisements

The main peculiarity of this level is that the vertical axis need not to be truly vertical, since the line of collimation is not perpendicular to it. The line of collimation, is, however, made horizontal for each pointing of telescope by means of tilting screw. It is mainly designed for precise leveling work.

Fig.7.Tilting level

G. Telescopes:

The telescopes of leveling instruments define the line of sight and magnify the view of a graduated rod. The components of a telescope are mounted in a cylindrical tube. Its four main components are objective lens, negative lens, reticle and eyepiece. Two of these parts the

objective lens and eyepiece are external to the instrument, and are shown in the auto level below.

Fig.8.Part Automatic level

Objective Lens: Its main function is to gather incoming light rays and direct them toward the negative focusing lens.

Negative Lens: It is located between objective lens and reticle. Its function is to focus rays of light that pass through the objective lens on to the reticle plane.

Reticle: The reticle consists in a pair of perpendicular reference lines(usually called crosshairs) mounted at the principal focus of the objective optical system. The point of intersection of the crosshairs together with the optical centre of the objective system, forms the so called *line of sight* sometimes called *line of collimation.*

Eyepiece: The eyepiece is a microscope (usually with the magnification from about 25 to 45 power) for viewing the image.

1.5. Environmental requirements.

1.5.1. Introduction

Every chartered surveyor must consider the environmental factors within the parameters of their profession. Environmental surveyors are specialists in all aspects of the management, monitoring and assessment of the environment in the context of real estate, land and construction. As experts, they are likely to be working in many areas, including environmental management, land use and contaminated land, environmental auditing and assessment.

Environmental surveyors are also involved in planning processes. Many planning/building permit applications require some form of environmental input either related to Environmental Impact Assessment (EIA) or similar due diligence work.

Many other types of market exist in the day to day management of land and property. Environmental surveyors also need an in-depth knowledge of legislation, professional due diligence, insurance, investment and all sectors of risk management from groundwater pollution risk to pollution control within the air that we breathe.

There is huge demand and major opportunities for qualified environmental professionals due to a high media profile, coupled with demands on natural resources worldwide.

The Environmental Surveying pathway is ideal for anyone pursuing a career in property who has a particular interest in specializing in environmental management, land use and contaminated land, environment auditing and assessment. Although environmental management is a skill applied by chartered surveyors across a wide variety of assets, this pathway is aimed at individuals who work in development, regeneration, town planning and, residential and/or commercial work. Other areas, such as machinery and business assets, arts and antiques or minerals have their own dedicated RICS pathway.

The Environmental Surveying pathway places emphasis on competency in environmental Practice. However, as with the other property pathways, a broad base of experience in general property practice is also required. Candidates undertaking the pathway may gain their experience in either a residential commercial or rural property context – or a mixture of these.

1.6. Statutory and regulatory authority.

The term 'statutory and regulatory requirements' can be expressed legal requirements; as clarified in Note 2 under the clause 1.1 (General) of ISO/FDIS 9001:2015 - QMS Standard.

This term expresses two types of requirements:

i. Statutory requirements
ii. Regulatory requirements

Both statutory requirements and regulatory requirements are those requirements that are required by law. These requirements are non-negotiable and must be complied with. Failure to comply a legal requirement may result in a fine or penalty and possibly a custodial sentence for the person or persons responsible or organization for such failure.

"Statutory refers to laws passed by a state and/or central government, while regulatory refers to a rule issued by a regulatory body appointed by a state and/or central government."

Statutory requirements are those requirements which are applicable by virtue of law enacted by the government. These are enacted by passing the law in the legislative assembly or parliament

A regulatory requirement can be termed as administrative legislation that constitutes or constraints rights and allocates responsibilities. It is somewhat different from the statutory legislation and there can be following types of regulations applicable on an organization:

- Legal restrictions or responsibilities declared by a government authority
- Self-regulation by an industry through trade association

ISO/FDIS 9001:2015 QMS Standard requires an organization to determine and control the statutory and regulatory requirements applicable to the organization's products and services.

It is the responsibility of the organization to demonstrate compliance within its quality management system. On perusal this ISO/FDIS 9001: 2015 QMS Standard, we find, in the introduction part of the standard indicates that this standard, can be used by internal and external parties. So it is imperative for the organization to be aware of the general and specific statutory and regulatory requirements applicable to the product and services within the scope of the quality management system.

The term 'statutory and regulatory requirements' has been used in **0.1 General** of this standard, which states, 'The potential benefits to an organization of implementing the quality management system based on this international standard are i) the ability to consistently provide products and services that meet the customer and applicable statutory and regulatory requirements.

Accordingly, the organization should have a methodology in place

A. For determining, maintaining and updating all applicable statutory and regulatory requirements,
B. For communicating all applicable statutory and regulatory requirements within the organization.
C. The organization should ensure that determined statutory and regulatory requirements are utilized as 'process inputs'.
D. The organization should monitor 'process outputs' for compliance with statutory and regulatory requirements.

Self-check-1

Test-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

A	B
---------1. Leveling	A. Low precision work
---------2. Eye pieces	B. Gathering light
---------3. Objective lens	C. Microscope
---------4. Leveling rod	D. Measuring height
---------5. Hand level	E. View metric
	F. Automatic leveling

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. What is the purpose of environmental surveying?
2. Write down at least OHS requirement?
3. What is the purpose of leveling?

Part III: Definition

Direction: Give short answer to the following questions. Time allotted for each item is 2mniut and each question carry 4 point.

1. Telescope
2. Tilting level
3. Digital level
4. Auto level
5. Regulatory

Note: Satisfactory rating – above 60% Unsatisfactory – below 60%

Unit Two: Setup leveling device.

This unit to provide you the necessary information regarding the following content coverage and topics:

- Heights or levels to be transferred
- Level procedures.
- Set up levelling devices
- Adjust Levelling staffs.
- Move devices with care.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify heights or levels to be transferred
- Apply levelling procedures.
- Set up and testing levelling devices
- Adjust levelling staffs.
- Move devices with care.

2.1 Heights or levels to be transferred

2.1.1. Introduction

Heights

Heights are defined using horizontal and vertical lines. The figure below shows a plumb-bob suspended at point P, the direction of gravity along the plumb-line defines the vertical at point P. A horizontal or level line is any line at right angles to this

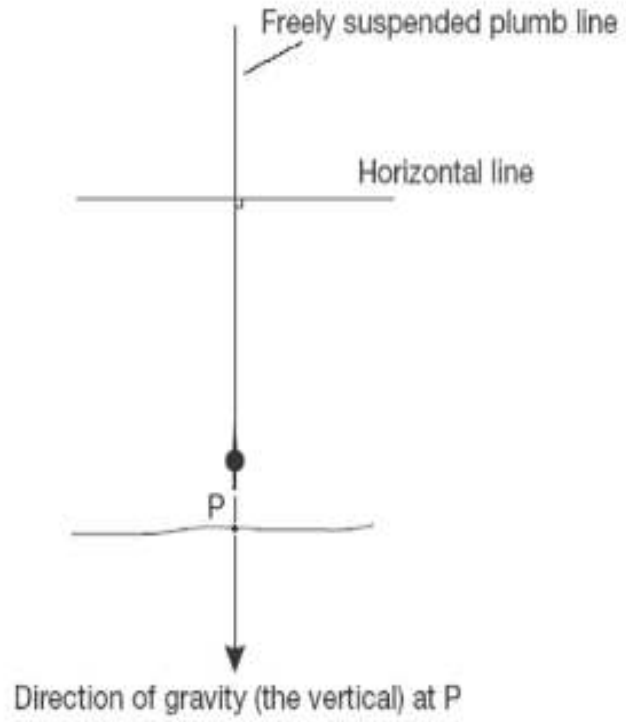


Fig.8.Horzontal and Vertical line

For site work, any horizontal line can be chosen as a datum for heights and for levelling. The height of a point is measured along the vertical above or below the chosen datum. The height of a point relative to a datum is known as its reduced level (RL).

On most construction sites there is a permanent datum. The horizontal line or surface passing through this, with its height, becomes the leveling datum..

Any reference point on site which has had a height assigned to it is known as a bench mark. For most surveys and construction work, several bench marks would normally be established by levelling from the datum. If heights are based on an arbitrary datum these are known as Temporary Bench Marks or TBMs.

2.2 Level procedures.

2.2.1. First Leveling procedure

A. The instrument must be check before use! (see lecture)
B. The instrument and level must be stable settled-up
C. The bubble tube must be leveled before the reading
D. Beware of sun exposure (will wander)
E. Ensure the instruments pendulum is in-limit
F. The instrument must be set up in the middle between two staffs
G. Prevents curvature effects

If impossible, use the same distances, but opposite for the next readings

H. You must not use the parallax screw between the back sight and foresight readings
I. Readings must be taken 30-50 cm above the ground
J. Surface refractions
K. Beware also of temperature gradients (inside/outside buildings) !!!!
L. Staff should be set up vertically
M. A change plate should be used
N. Leveling must be done in two opposite directions but the same line (beware of gravity gradients)
O. Staff should be calibrated, especially if INVAR
P. Be careful when crossing rivers (large water surfaces)
Q. Use “same-time” (mutual) observations
R. Repeat it during different times of the day

2.2.2. Second Leveling procedures

A. Setting up

i. Back sight and foresight distances should be approximately equal to avoid any errors due to collimation, refraction or earth curvature.
ii. Distances must not be so great as to not be able to read the graduations accurately.

iii. The points to be observed must be below the level of the instrument, but not lower than the height of the staff.

B. Elimination of parallax

i. Parallax is the apparent movement of the image produced by movement of the observer's eye at the eyepiece.
ii. It is eliminated by focusing the telescope on infinity and then adjusting the eyepiece until the cross-hairs appear in sharp focus. The setting will remain constant for a particular observer's eye.

C. Booking

i. Level books or loose-leaf levelling sheets shall be numbered and indexed in a register.
ii. Details of the site, work, date, observer, chainman, booker, weather, wind, instrument and any other relevant items shall be entered.
iii. Enter the first observation (which is on a known point) in the Back sight column, and sufficient detail in the Remarks column to identify it. Enter the point's R.L. zero from the site register or plate on the BM, etc.
iv. Enter all other points on subsequent lines as intermediates except the point chosen as the foresight. Identify them in the Remarks column as above. Enter the foresight on a further line in the Foresight column.
v. Change the instrument to the next setup. Enter the following back sight on the same line as the previous foresight but in the Back sight column.
vi. Repeat the above procedure at each setup on the outward run then reverse it to work back to the starting point on the return run. The furthest point out is treated as for all other change points.

2.3 Set up levelling devices

2.3.1. Procedures

The following steps are taken when using to set up leveling instrument

1. Set up the tripod

2. Ensure the top is level

3. Push legs firmly into the ground

4. Attach level

5. Use foot screws to centralize the circular bubble

6. Test to see if the compensator is working

7. Remove parallax

Once the level is set up its important that the line of sight is horizontal. When the foot screws have been used to centralize the circular bubble, it is assumed that the compensator has set the line of sight to be horizontal.

However, most levels are not in perfect adjustment and when leveled their line of sight is never exactly horizontal.

If the line of sight is not horizontal when the instrument has been leveled, the level has a collimation error.

As most levels will have some level of collimation error, a method is required to check if the error is within acceptable limits. This is known as a two-peg test. This needs to be conducted when using a new or different level for the first time and at regular intervals thereafter.

2.3.2. Temporary Adjustments of a level

These adjustments are performed at every setup of instrument

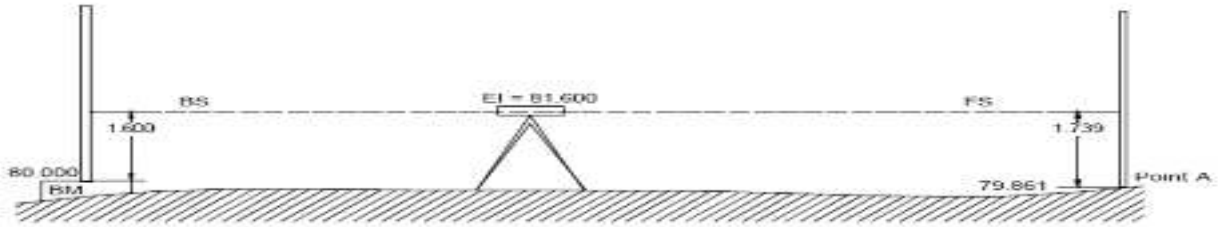
- Setting up of level
- Leveling of telescope
- Focusing of the eye peace
- Focusing of object glass
- Setting up the level

2.3.3. Classification of leveling

- Simple leveling
- Differential leveling

- Fly leveling
- Check leveling
- Profile leveling
- Cross leveling
- Reciprocal leveling
- Precise leveling
- Trigonometric leveling
- Barometric leveling
- Hypermetric leveling
- Geometric leveling

- *Simple levelling:- It is the simplest method used, when it is required to find the difference in elevation between 2 points.*



- *Differential Levelling:- This method is used to find the difference in the elevation between points if they are too far apart or the difference in elevation between them is too much.*

Fig.9. Simple leveling

- *Fly levelling:- Fly levelling is just like differential levelling carried out to check the accuracy of levelling work. In fly levelling only B.S. and F.S. are taken*

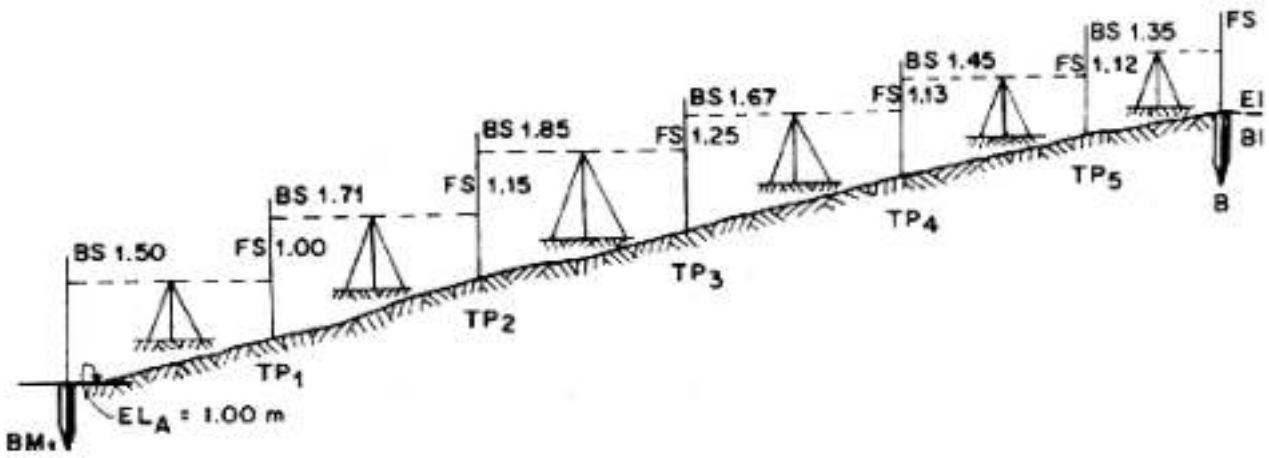


Fig.10. Fly leveling

Check leveling

This kind of levelling is carried out to check the accuracy of work. It is done at the end of the days work in the form of fly levelling to connect the finishing point and starting point.

Profile levelling or L Section

This method is used for taking levels along the center line of any alignment like road, railway canal etc. The object is to determine the undulations of the ground surface along the alignment

Cross sectioning

This operation is carried out perpendicular to alignment at an interval of 10, 20 ,30, 40 m. The idea is to make an estimate of earthwork.

2.4 Levelling staffs.

2.4.1. The leveling staff

There are several types of graduated staffs available (telescopic, folding). Readings are always in the metric system to the nearest millimeter. An example is given in Figure 4.

Always study the leveling staff you will be working with before you use it in the field.

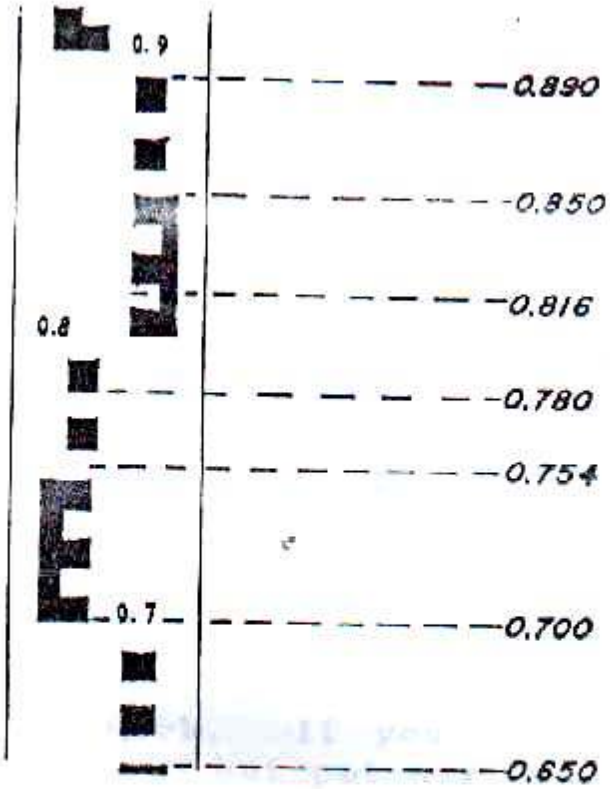


Fig.11.leveling staff

Leveling involves measuring vertical distances with reference to a horizontal plane or surface. To do this, a levelling staff is needed to measure vertical distances and an instrument known as a level is required to define the horizontal plane.

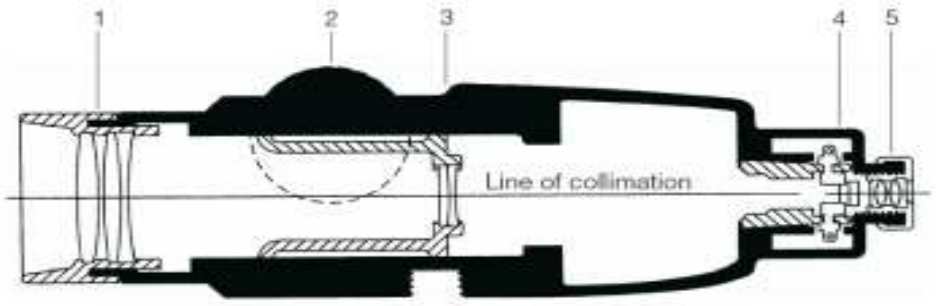
Fig .12.leveling staff

Automatic Level

4. Horizontal circle
5. Base plate
8. Collimator (sight)
9. Object lens

Fig .12.Automatic leveling

The main features of the telescope



1. Object lens
2. Focusing screw
3. Focusing lens
4. Diaphragm
5. Eyepiece

Fig .13.Telescope

The object lens, focusing lens, diaphragm and eye piece are all mounted on an optical axis called the line of collimation or the line of sight.

This is an imaginary line which joins the optical center of the object lens to the center of the cross hairs.

When looking through the eye piece of the surveying telescope, a set of lines called the cross hairs can be seen. These are used for taking measurements from the staff. These cross hairs are etched on a small sheet of glass known as the diaphragm.

To make the telescope work, the image of the staff is brought to a focus in the plane of the diaphragm using the focusing screw. The eyepiece is rotated so that the cross hairs are in focus and its focal point is also in the plane of the diaphragm. When looking into the telescope an observer will now see a magnified image of the levelling staff focused against the cross hairs.

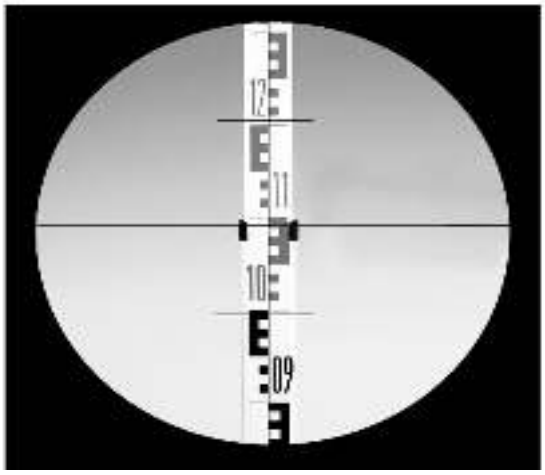


Fig .14.Staff

2.5 Moving devices with care.

2.5.1. CARE AND CLEANING OF THE LEVEL

When the level is carried on the shoulder, the clamps are required to be tight enough to prevent wear, but loose enough so the level gives if accidentally bumped.

When the level is carried inside a building, in dense growth, or anywhere there is a chance of being bumped, the level is carried under the arm with the instrument head in front of the carrier.

The level is carefully set down. The cross hairs could be broken or the instrument jarred out of adjustment by harsh treatment. When being transported in a vehicle, the level is packed in the level case and placed in a location to minimize vibration. The leveling screws are not tightened too tight as this could cause warping of the plate. The level is never left unguarded. The tripod legs are spread and pushed into the ground to prevent the level being knocked down. The instrument is protected from rain by a waterproof cover. If a waterproof cover is not available, the dust cap is placed on the objective lens as soon as possible and the instrument taken inside. When brought inside, excess moisture is wiped off the instrument immediately and the instrument allowed to thoroughly dry before being placed in the case.

Dust is removed with a camel hair brush, if available. The eye piece may be cleaned with alcohol and wiped with a
soft cloth.

Self-check-2

Test-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

A	B
---------1. Height	G. To find difference elevation between two point
---------2. Simple leveling	H. Use check the accuracy of levelling work
---------3. Fly leveling	I. Horizontal and vertical line
---------4. Leveling staff	J. Measure vertical line
---------5. Reciprocal leveling	K. Determine the difference of level between point
	L. Horizontal line

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

4. What is the purpose of leveling?
5. Write down at least leveling procedures?
6. What is the difference between leveling devices and leveling staff?

Part III: Short answer writing

Direction: Give short answer to the following questions. Time allotted for each item is 2mniut and each question carry 4 point.

6. Differential leveling
7. Check leveling
8. Profile leveling
9. Cross leveling

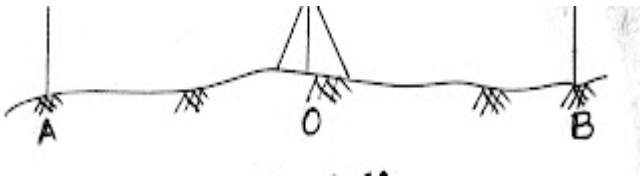
Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

You can ask you teacher for the copy of the correct answers

Operation sheet-2

- **Operation title: setting up leveling**
- **Purpose:** to set leveling for work and to read back sight and front sight

Instruction: Using the figure below set up leveling instrument at height 1.3m. You have read BS and FS at distance 50m and measure height difference you are expected to write the answer on the given line



Tools and requirement:

- Automatic levelling
- Tripod
- Leveling safe
- Meter

The following steps are taken when using a level to measure heights

1. Set up the tripod
2. Ensure the top is level
3. Push legs firmly into the ground
4. Attach level
5. Use foot screws to centralize the circular bubble
6. Test to see if the compensator is working
7. Remove parallax

Check leveling

This kind of levelling is carried out to check the accuracy of work. It is done at the end of the days work in the form of fly levelling to connect the finishing point and starting point.

Lap Test-2

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Lap Test-3- setup leveling device

Unit Three: Leveling operation

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Shoot and heights transferring levels
- Record required locations.
- Accuracy reading.
- Document results of leveling procedure

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Shooting and heights transferring levels
- Recording required locations.
- Identify and Check accuracy reading.
- Apply documenting results of leveling procedure

3.1. Shooting levels and transferring heights

3.1.1. Preparations

1. Make sure you take the following equipment to the field:
2. Dumpy level, titling level or even an automatic level instrument, provided with a horizontal circle;
3. The tripod belonging to the level instrument;
4. Measuring tape (30 m);
5. At least 3 ranging rods;
6. Sufficient pegs and prefab concrete benchmarks;
7. The level book and ball point;
8. Preferably 2 leveling staffs;
9. A change plate;
10. A pang and a spade.

When starting a survey, keep the following rules in mind, it will help you to reduce the chance on errors:

1. Do a collimation test (check) before you commence, it take s only 5 minutes and could save you day or more of re leveling.

2. Make sure your staff man holds the staff vertical. This can be done with the aid of a vertical bubble fixed to the staff or by means of moving the staff very slowly forward and backward over its vertical position. In latter case the surveyor should read the lowest value in sight, see Figure 8.

3. Make sure your staff man uses fixed change points or a change plate.

4. Try to keep your back sights and fore sights of roughly equal length.

5. Always finish your survey at the starting point or at another known bench mark.

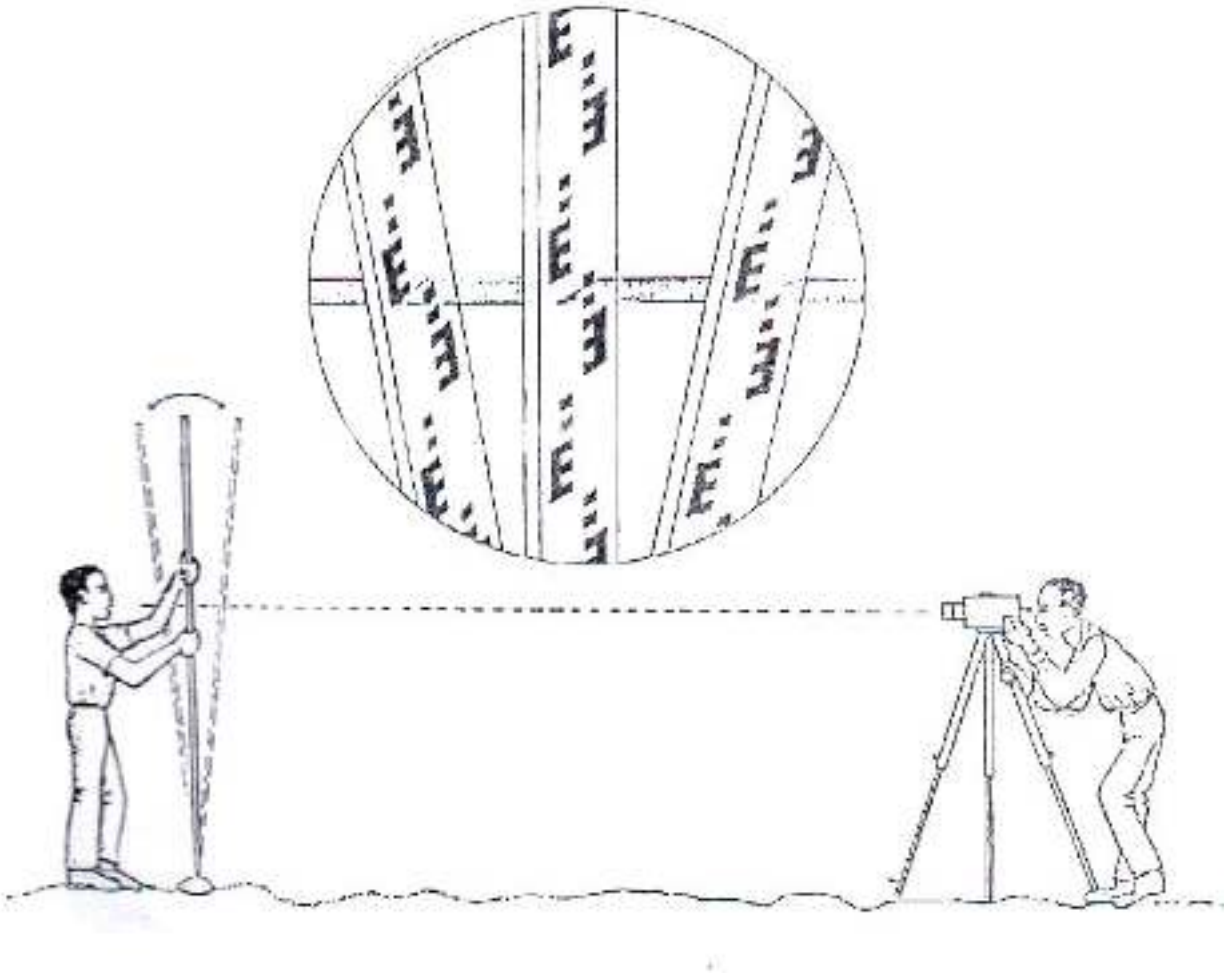


Fig.15.shooting

3.1.2. Leveling Terms

- **Station (STA)**
  - Point where the rod is placed for a reading
  - Stations typically use a “distance-numbering” identification system:
    - STA 0 + 00 = 0 hundred feet + 0 feet
    - STA 2 +75 = two hundred feet + 75 feet
    - STA 5 + 05 =?????????
- **Back sight**
  - A rod reading taken on a point of known elevation:
    - BM

- TBM
- Turning Point (TP)

➢ **Benchmark (BM)**

- A point of known elevation used as a reference point in a leveling survey.
- A BM has a precisely known elevation above "mean sea level."
- Established by a variety of government agencies.

➢ **Temporary Benchmark (TBM)** – Point of "assumed" elevation. Commonly used in "on-farm," local surveys.

➢ **Height of Instrument (HI)**

- Height (elevation) of the level's line of sight.

- HI = BS + Known Elevation

➢ **Elevation (ELEV)**

- Vertical distance above "mean sea level" of a point on the earth's surface.
- Depending on purpose of survey, may be determined to nearest:

➢ **Level surface (e.g. the geoid)**

- A water surface with no motion
- Gravity gradient is the normal to the level surface
- The Instrument's Bubble is in the normal (!)

➢ **Horizontal surface**

- At the instruments axis, the *horizontal* surface is tangent to the *level* surface
- Over short distances (<100 m) the horizontal surface and the level surface will coincide
- For long leveling lines the effects of the gravity field must be considered

➢ **Back sight (BS)**

- The *first* reading from a new instrument stand point (i.e. take the height to the instrument)

➢ **Fore sight (FS)**

- The *last* reading from the current instrument station (i.e. give the height to a benchmark)

➢ **Intermediate sight (IS)**

- Any sighting that is not a back sight or fore sight

3.2. Record required locations.

3.1.1. Introduction

Once the level is set up its important that the line of sight is horizontal. When the foot screws have been used to centralize the circular bubble, it is assumed that the compensator has set the line of sight to be horizontal.

However, most levels are not in perfect adjustment and when leveled their line of sight is never exactly horizontal.

If the line of sight is not horizontal when the instrument has been leveled, the level has a collimation error.

As most levels will have some level of collimation error, a method is required to check if the error is within acceptable limits. This is known as a two-peg test. This needs to be conducted when using a new or different level for the first time and at regular intervals thereafter.

There are two methods of recording,

1. Collimation Method

Level at B = height of collimation - reading at B

Level at D = height of collimation - reading at D

The collimation method is also known as the "height of instrument" method. Throughout the field work the instrument height is always known by taking the first sight on a. paint of known (or assumed) level. At any time therefore, the level of a point can be quickly worked out by subtracting its staff reading from the level of the instrument (instrument height). The method is convenient for obtaining the levels of many points from one set-up.
Thus the first point of reading should always be of known level, preferably a Bench Mark. The reading of the B.M is booked on the first line in the back sight column as this is the point of known level

The final reading on a change point is booked in the foresight column. Make sure your staff man uses good change points or change plates. Now the instrument can be moved to the next point, leveled up again and the same change point is read again and booked in

the back sight column and you can carry on ta king intermediate levels. To be able to check for errors you must end your survey at the benchmark you started from or at another benchmark with known elevation so that you can check for miss closure.

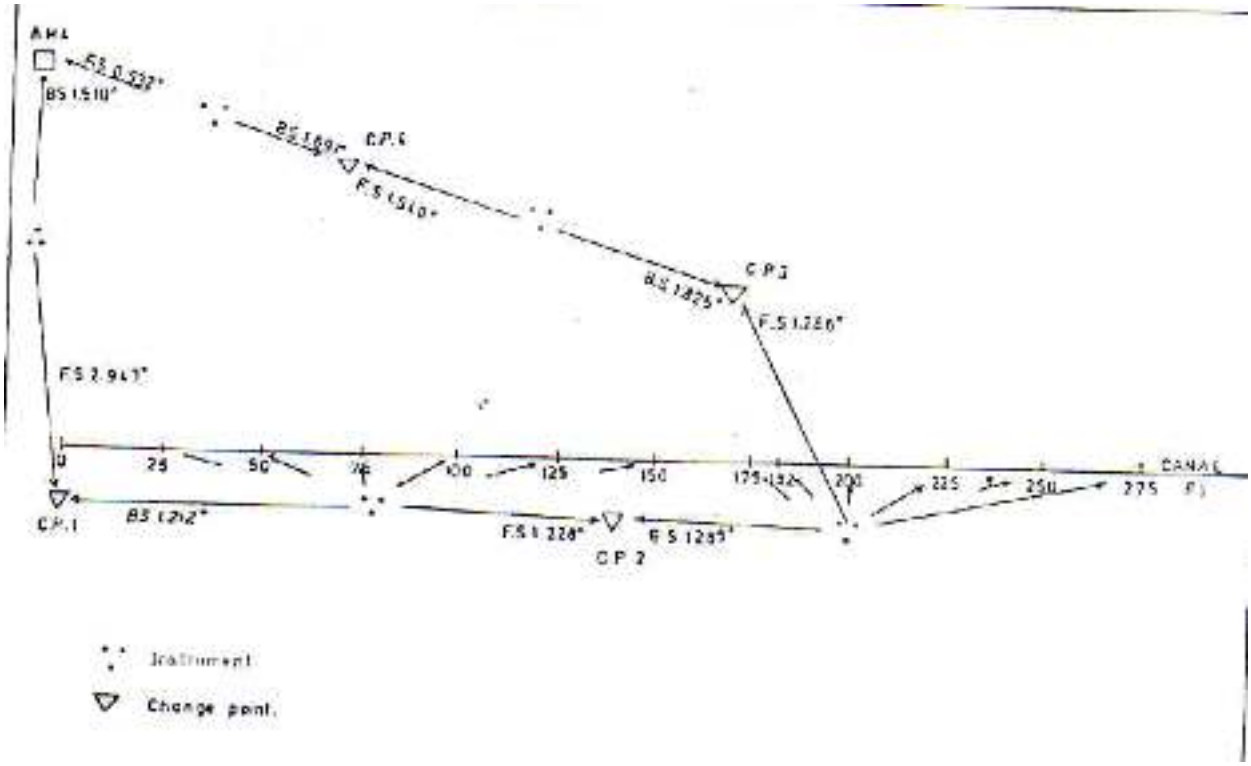


Fig.16. Collimation Method

2. Rise and Fall method

Note that, to obtain the rises and falls, you always have to subtract from the figures in the B.S or I.S columns the figures immediately below or one line down to the right. Once a fore sight has been subtracted, start again with the back sight on the same line, subtracting the I.S or the F.S, which ever may be on the next line down. Having obtained all falls and rises; the total rise or fall can be calculated by taking the difference between the sum of each column. This must agree exactly with the difference between the sum of B.S. and F.S.

The reduced level of each point is obtained by adding the rise or fall of the next station to the reduced level of the one preceding it. The final observed reduced level should be compared with the first (given) one and should agree with the calculated rise or fall between the two stations concerned.

Example 1

Rise and fall method (recording)

Instead of calculating the collimation (height of instrument), the rise or fall from one staff position to the next is calculated by subtracting the second reading from the first:

B.S (or I.S) F.S (or I.S)

1.510 - 2.943 = -1.433 (fall)

1.212 - 1.291 = -0.079 (fall)

1.291 - 1.404 = -0.113 (fall)

1.404 - 1.346 = +0.058 (rise)

.

3.3. Check accuracy reading.

All the measurements are done in metric and the value of the staff readings are rounded off to the nearest millimeter for ordinary site surveys discussed in this manual.

The maximum permissible error for such a survey is normally taken as 20 K mm, where K is the total distance leveled over in kilometers.

For instance, if the known difference in level between a B.M. No 1 and a B.M. No 2 is 2.876 m and the observed level difference from a level run with a length of 1.6 kilometers is 2.869 TO, the error is 2.876 - 2.869 = 0.007 m or 7 mm.
The permissible error is calculated with 20 K = 20 1.6 = 25 mm, and the conclusion is that the error Bade during the leveling is acceptable as it is smaller than 25 mm.
If we look at our example (see Fig. 6) we can estimate the length of the round trip at 100 + 200 + 235 = 535 m, say 550 m. The permissible error becomes 20 0.55 = 14.8 mm. Therefore the actual error of 6 mm is acceptable.

A. Check leveling

This kind of leveling is carried out to check the accuracy of work. It is done at the end of the days work in the form of fly levelling to connect the finishing point and starting point.

B. Profile levelling or L Section

This method is used for taking levels along the centre line of any alignment like road, railway canal etc. The object is to determine the undulations of the ground surface along the alignment

C. Cross sectioning

This operation is carried out perpendicular to alignment at an interval of 10, 20 ,30, 40 m. The idea is to make an estimate of earthwork.

D. Errors in Leveling

The following are the different sources of Errors

- Personal Error
- The Instruments may not be leveled
- The focusing of eye piece and objective glass may not be perfect
- The parallax may not be eliminated
- The position of staff may have changed
- Entry and recording in the field book may not be correct
- The staff may not be fully extended, may not be held vertical.

Instrumental Error:- The Permanent adjustment of the instrument may not be perfect
That is the line of collimation may not be horizontal line

- The internal arrangement of focusing tube may not be correct
- The graduation of the staff may not be perfect

Errors due to Natural Causes:- The Curvature of the Earth may affect the staff readings when the distance of sight is long. The effect of refraction may cause a wrong staff reading. There are some errors in staff readings due to high velocity wind

3.4. Document results of leveling procedure

Documents may be in any form or type of medium, and the definition of “document”

in ISO 9000:2015 clause 3.8.5 gives the following examples:

- Paper
- Magnetic
- electronic or optical computer disc
- photograph
- master sample

Self-check-3

Test-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

A	B
---------1. Bench mark	M. Point of known
---------2. Line of collimation	N. Intersections of cross hair
---------3. Height of instrument	O. Elevation of line of collimation
---------4. Elevation	P. Vertical distances
---------5. Hand level	Q. View metric

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. What is the purpose of leveling operation?

2. Write the basic rule of levelling?

Test III: Definition

1. Cross section leveling
2. Longitude leveling
3. Simple leveling

Part IV: Short answer writing

Direction: Give short answer to the following questions. Time allotted for each item is 2mniut and each question carry 4 point.

1. Back sight
3. Fore sight
4. Intermediate sight

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

Operation sheet-3

Operation title: leveling operation

Instruction: Readings obtained from a two peg test carried out on an automatic level with a staff placed on two pegs A and B 50m apart are: Staff reading at A = 1.283m Staff reading at B = 0.860m

With the level position 5m from peg B (L/10): Staff reading at A = 1.612m Staff reading at B =1.219m

Calculate the collimation error of the level per 50m of sighting distance

Solution

Tools and requirement:

- Automatic leveling
- Tripod
- Leveling safe
- Meter

The following steps are taken when using a level to measure heights

1. Set up the tripod

2. Ensure the top is level

3. Push legs firmly into the ground

4. Attach level

5. Use foot screws to centralize the circular bubble

6. Test to see if the compensator is working

7. Remove parallax

Check leveling

This kind of levelling is carried out to check the accuracy of work. It is done at the end of the days work in the form of fly levelling to connect the finishing point and starting point

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Lap Test-3-leveling shooting operation

Unit Four: Clean up

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- clean work area
- storing material
- check tools and equipment

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- clear work area
- Obtain, confirm, and storing material
- check, maintain and clean tools and equipment

4.1. Clearing work area

The cleaning regime of different tools is influenced by their purpose or use. Different cleaning routines For example, a broom used in a low-risk environment probably won't be cleaned after every use. However, a tank brush that's used for cleaning the interior of a batch tank should be cleaned and sanitized before and after each use. To avoid cross-contamination, tools used on food contact surfaces must be easily identifiable and kept separate from those used on non-food contact surfaces. Color coding is often a simple solution for achieving this level of intended segregation.

To ensure tools have a longer utility and lifespan, they must be properly cared for. Cleaning your tools should be approached in the same manner that you clean any other equipment or surface in your facility.

4.1.1. The cleaning principles are:

1. **Dry clean.** Remove visible and gross soils and debris.
2. **Pre-rinse.** Rinse all areas and surfaces until they are visibly free of soil.
3. **Wash (soap and scrub).** Use the right detergent in the right concentration with the right level of mechanical action in the right water temperature for the right contact time.
4. **Post-rinse.** Rinse away all visible detergents and remaining soil.
5. **Inspect.** Look again at crevices and other contamination traps to ensure they're free of soils and detergents. Determine whether steps 1-4 should be performed again.
6. **Sanitize.** Foam, wipe or spray sanitizing chemicals onto surfaces as per the appropriate instructions.
7. **Dry.** Ensure adequate time is allotted for equipment to thoroughly dry.
8. **Verification.** Gather proof that the cleaning performed achieved the expected level by following facility verification protocols.

4.2. Obtaining, confirming, and storing material

Care of equipment:

***The level*:** Before the level is removed from its box, the tripod should be set up in a firm position in such a way that it is horizontal. After the instrument is taken from its box, it should be handled by its bas when it is not on the tripod, and it should be carefully screwed on the tripod.

If possible, levels should not be set up on smooth hard surfaces, such as building floors, unless the tripod points can be either set in indentations in the floor or firmly held in place by some other means, perhaps by triangular frames made for that purpose.

If the objective lens or the eyepiece lens becomes so dusty that it interferes with vision, it may be cleaned with a camel's hair brush or with lens paper.

***Leveling screws*: -** If the instrument is in proper condition, these screws should turn easily and it should never be necessary to use more than the fingertips for turning them. When the level is taken indoors for storing or outdoors for use, its screws and clamps should be loosened because severe temperature changes may cause severe damage.

***Level rod*: -** The level rod should never be dragged on the ground and its metal base should never be allowed to strike rocks, pavement, or other hard objects, such use will gradually wear away the metal base and will thereby cause leveling errors due to the change in the length of the rod itself.

4.3. checking, maintaining and cleaning tools and equipment

As part of the care strategy, cleaning tools should be hung to thoroughly dry. Brushes, brooms and squeegees should be stored in wall brackets and shouldn't touch the walls or other cleaning tools while drying or while being stored.

In addition to keeping tools clean, facilities should also move beyond the concept of just fixing or replacing a tool when it is broken. A tool that breaks while in use can trigger significant downtime and operational losses. Several companies have transitioned to the practice of diagnostic maintenance, where the maintenance crew sets a troubleshooting and monitoring schedule to ensure that tools and equipment are functioning as intended.

Preventive maintenance has become the hallmark of ensuring consistent tool effectiveness and efficiency over time through the appropriate scheduling and servicing of a facility's cleaning products. Appropriate maintenance can also be combined with the 5S efficient workplace organization method, which involves sorting, setting-in-order, shining, standardizing and sustaining work tools. Solving problems before they affect food safety is the direction the food and beverage industry needs to head toward.

Proper use, care and maintenance of cleaning tools hangs on three primary considerations. First, there should be a validated protocol ensuring that the intended tasks are effective in decontaminating the tool. Second, care and maintenance must be regularly monitored by trained and competent personnel. Third, there must be a method of verifying cleaning effectiveness by another person through appropriate observation or tests.

Self-check-4

1. Define the term "maintenance"

_____

2. List four reasons why we clean.

3. List five back of house areas that will need cleaning.

5. Identify five items that would require cleaning in an office.

6. If a bar area is open from 5pm to midnight on Tuesday to Saturday, when would you clean it?

7. List three different types of hard floors that you would be required to clean.

8. Explain briefly what is meant by frequency of cleaning.

Reference

1. **Clean and maintain industrial work area and equipment**

D1.HHK.CL3.07

Assessor Manual

2. SURVEYING USING A LEVEL INSTRUMENT

AN INSTRUCTION MANUAL FOR SURVEYOR'S COURSE IN JAMAMA DISTRICT LOWER JUBA, SOMALIA

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MINISTRY OF LABOR AND SKILLS

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