Ethiopian TVET-System

Crop Production Level – II

Based on Version 3 March 2018 OS.

Training Module –Learning Guide 23-26

Unit of Competence: Apply Basic Leveling Activities

Module Title: Applying Basic Leveling Activities

TTLM Code: AGR CRP2 M07 TTLM 0919v1

October 2019

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This module includes the following Learning Guides

LG 24: Plan and prepare

LG Code: AGR CRP2 M07 LO1-LG-23

LG 25: Establish offsets for civil works

LG Code: AGR CRP2 M07 LO1-LG-24

LG 26: Set up and use levelling device

LG Code: AGR CRP2 M07 LO1-LG-25

LG 27: Clean up work area

LG Code: AGR CRP2 M07 LO1-LG-26

Instruction Sheet	Learning Guide 24

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

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

- Obtaining, confirming and applying work instructions
- Obtaining, confirming and applying safety requirements from the site safety plan
- Identifying and obtaining signage requirements
- Making, checking and rectifying or reporting selected tools and equipment to
- Checking leveling equipment for service ability and reporting any faults
- Identifying environmental protection requirements

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Obtain, confirm and apply work instructions to the allotted task
- Obtain safety requirements and confirm and apply to the allotted task
- Identify signage requirements
- Select tools and equipment, and rectify or report serviceability and any faults
- Check leveling equipment and report any faults
- Identify environmental protection requirements, confirm and apply to the allotted task.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6”.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3, Self-check 4, Self-check 5 and Self-check 6” **in page -6, 9, 11,17,19 and 21** respectively.

Information Sheet-1	Obtaining, confirming and applying work instruction

1.1. Introduction

A vertical control refers to the various heighting procedures used to obtain the points of interest above or below a reference datum. The most commonly used reference datum is mean sea level (MSL). There is no to such things as common global MSL, as it will vary from place to place depending up on the effect of local condition. It is important therefore that MSL is clearly defined whenever it is utilized.

The engineer is mainly more concerned with the relative height of one point above or below another, in order to ascertain the difference in height of the two points, rather than any relationship to MSL.

Definition of basic terms

1. **Datum: -** A datum is any reference surface to which the elevation (vertical distance) of a point is referred. The most commonly used datum is that of mean sea level.
2. **Elevation: -** Elevation is the vertical distance of a points above or below an assumed datum (level surface).
3. **Leveling: -** The process or methods of determining the vertical distance of a points relative to an assumed level surface.
4. **Level line: -** is the surface of which it has a constant height relative to mean sea level.
5. **Horizontal line: -** this is a line which is tangential to the level line or a line which is normal to direction of gravity.
6. **Bench Mark (BM):-** are permanent reference points or marks at which their elevation (reduced level) has been accurately determined by leveling from other permanent BM.
7. **Reduced level (RL):-** is the height above or below a reference datum- similar to elevation.
8. **Temporary bench mark (TBM):-** are marks set up on stable points near construction sites which all leveling operation on that particular site will be referred.
9. **Back Sight (BS):-** is the staff reading taken on points of known elevation at a BM or a turning point.
10. **Fore Sights (FS):-** is the staff reading on points whose elevation is to be determined as a turning point. It is the last staff reading denoting the shifting of the instruments.

11. **Intermediate Sights (IS):-** any other staff reading taken on a points at unknown elevation from the same set up of the level. All sights b/n BS & FS are IS.
12. **Turning points (TP):-** is a point denoting the shifting of the level. It is the point on which the back a fore sight are taken.
13. **Station: -** is a points of which whose elevation is to be determined.
14. **Height of instruments: -** is the elevation of plane of collimation (plane of sight) where the instrument is correctly leveled.

1.2. Uses of leveling

The most important aim of surveying is to determine the relative heights of different objects on or below the surface of the earth and to determine the undulation of the ground surface.

Leveling is done for the following purposes:

- To fix the alignments of roads, railways, irrigation canals and so on
- To prepare maps for fixing sites for reservoirs, dams.
- To prepare a layout map for water supply and drainage scheme

To determine the altitudes of different important points

1.3. Work instructions to the allotted task

Whenever you're given instructions for a task or project, you'll need to make sure that you clearly understand what you have to do. Instructions may be provided in written or verbal form, or sometimes a mix of the two. Being able to give and receive instructions effectively is an important part of communication on the worksite. Here are a few tips to help you out if you're given instructions that are unclear or incomplete or if you have trouble understanding them.

• Take notes. It's hard to remember everything by keeping it in your head. Writing a few notes helps remind you what needs to be done.

• Ask questions. Don't be afraid to ask for more information or for clarification on something. Something simple like, 'I don't quite get what you mean by…' or 'Could you tell me a bit more about how to…' is a good way to get the details you need.

• Be aware of language. You may be teamed up with people from other countries or cultures who don't speak English as well as you do. This can sometimes make communication difficult, but be patient. Listen carefully, speak clearly, take notes and ask questions until both you and the other person(s) are sure the instructions and/or information have been communicated correctly.

• Confirm the instructions before you start the task. Never walk away feeling unsure about what you've got to do. A good way of confirming is to say something like, 'OK, before I go, I'll

just check I've got this right…', then refer to your notes, run through the key points or steps, and ask for confirmation that you've got all the information you need.

• Sequence the instructions. Putting instructions and/or steps into the order you'll be completing them makes them much easier to follow.

1.3. Assuring quality requirements

As with all construction tasks there are quality requirements related to carrying out leveling operations. If you're unsure about quality requirements – whether in relation to the work you're doing, the materials you're using, or some other area;

– always check with your supervisor. Although there is no specific standard for levelling, information related to carrying out levelling operations can be found in some of the standards for leveling elements that rely on correct establishment of ground level.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What is leveling? (5pts)
2. List the importance of leveling (5 points)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points **Unsatisfactory - below 7 points**

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

Information Sheet-2	Obtaining, confirming and applying safety requirements from the site safety plan

2.1. Planning work activities

Before going out for any field activity planning the activities to be performed is the first basic step, i.e. planning work activity. Planning work activity consists of determining what the job require, selecting and checking the necessary tools and equipments for the job, identifying and fulfilling the occupational health and safety requirements for the job, and selecting and checking the required personal protective equipments.

2.2. Determining job requirements

Leveling has its own job requirements like every other jobs. Before going out to the field work the leveling or need to decide on what is required to accomplish the job. These requirements can range from secondary data to tools and equipments. The surveyor, for instance, may need map, contours, spot levels, boundaries of the area (or site). Also he/she may need to know about any buried services and physical features on the area that can affect the job. Aspects like nature of the job, amount of cut and fill expected, the situation or environment that the job is to be carried out can influence requirements of a job.

2.3. Apply safety requirement

Safety is the most important issue in all tasks. All workers, no matter what task they're completing, must comply with all site safety Regulations and procedures.

You may think that carrying out levelling operations is low risk; however, it has some specific safety issues that you need to be aware of.

• **Movement around the site** – Constant moving around the site presents safety risks such as trip hazards, uneven or unstable ground. You also run the risk of bumping into obstacles.

• **Manual handling** – Although the equipment you use for levelling tasks is small and easy to transport, you may need to interact with other equipment and materials on a building site which are large, heavy and awkward to move.

• **Focus and concentration** – Because levelling requires you to focus and pay close attention to what you're doing to ensure you're being precise, it can be easy to lose awareness of your surroundings and what's happening around you.

• **Environment** – Levelling operations take place outside, and often before any building structures are up to provide shade or shelter. You may be exposed to elements such as sun, wind and rain.

• **Dust** – The quality of the air on site may cause you respiratory problems and it can obstruct your vision while you're levelling.

• **Noise**– Building sites can be noisy at times, which may make it hard for you to concentrate. Noise is also a safety issue because you may not be able to hear what's happening around you.

• **Human traffic** – Building sites are often busy with lots of workers moving around.

It's inevitable that people will get in each other's way sometimes.

• **Mechanical traffic** – There will be times when you'll be positioned in a place where you may not be seen easily seen by others – particularly if someone's driving a large vehicle. You may also have to take a level from a point on the kerb or roadside of the site, which puts you at risk from moving vehicles.

• **High-risk situations**–There are always areas of high risk such as demolition, excavation, confined spaces and heights that you'll need to be aware of. For example, you may be required to complete alevelling task for services and footings in an open trench.

2.4. Occupational health and safety

A field leveling party frequently works its way through rugged terrain a long distance away from any professional medical assistance. Navigating through brush, felling trees, and crossing streams are all hazardous as are the use of such edged tools as machetes, brush hooks, axes, and hatchets. Besides those dangers which are inherent in the work itself, a survey party may be exposed to a variety of natural dangers, such as those created by weather conditions, poisonous plants, reptiles, and insects. In some areas there may be dangerous wild animals, or even dangerous domestic animals such as vicious dogs or angry bulls. When a leveling party is working along a roadway, there is the ever-present danger of being struck by a vehicle. In the midst of such a variety of dangers, the only way to prevent injury is to be continually aware of the hazards around you. Every person in a survey party must be aware of all existing hazards, be able to recognize a hazardous situation approaching, and be trained to take appropriate preventive measures.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the importance of work plan activities? (5pts)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points Unsatisfactory - below 7 points

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

Information Sheet-3	Identifying and obtaining signage requirements

3.1. ACCIDENT PREVENTION SIGN REQUIREMENTS

DANGER; Indicates a specific immediate and grave danger, a hazard capable of producing irreversible damage or injury, and prohibition against harmful activity.

CAUTION; Call attention to a specific potential hazard capable of resulting in severe, but not irreversible, injury or damage.

GENERAL SAFETY; Includes notices of general practice and rules relating to health, first aid, medical equipment, sanitation, housekeeping, and general safety.

FIRE AND EMERGENCY; Used only to label or points the way to fire extinguishing equipment, fires escapes and exits, gas shutoff valves, sprinkler drains, and emergency procedures.

INFORMATION; Provide information of a general nature, such as designation of facilities or services, in order to avoid confusion or misunderstanding.

EXIT; Used to indicate exits. Lettered in legible letters, not less than 6 in (15.2 cm) high, on a white field.The principal stroke of the letters shall be at least 3/4 in (5.1 cm) in width.

ACCIDENT PREVENTION COLOR CODING

Red; Red shall be the color used for identifying dangerous conditions, emergency controls, fire detection equipment and fire suppression systems, and containers of flammable liquids.

Orange; Orange shall be the color used for designating dangerous parts of machines and energized equipment.

Yellow; Yellow shall be the color for designating conditions requiring caution, marking dangerous chemicals, marking physical hazards, and markings for ionizing radiation.

Green; Green shall be the color for designating safety equipment and operator devices and the location of first-aid and safety equipment (other than firefighting equipment).

Blue; Blue shall be the color used for designating information of a non-safety nature.

Purple; Purple shall be the color used to designate ionizing radiation hazards.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List accidental sign requirements? (10pts)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points **Unsatisfactory - below 7 points**

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

Information Sheet-4	Selected tools and equipment

Depending on the task, levelling operations on site are carried out using a variety of tools. Some of these tools are very simple and quick to use while others are more complicated and require greater control for precision levelling.

May include, but not limited to:

- Levelling devices, wooded/steel pegs, straight edges, hammers and chalk line
- Levelling devices are to include, string lines, tape measures, survey pegs, levelling staffs and plumb bobs
- Levelling devices may include optical square, inclinometers, batter pegs/boards
- All work place documents, procedures associated with the use of tools and equipment shall comply with establishment procedures and manufacturer's instructions levelling devices may include profile board, string and line level, ranging pole, tape measure, and pegs.

Spirit level

A spirit level consists of a body (generally made from aluminium) with an inset glass tube filled with a liquid that contains a bubble of air.

The position of the bubble in relation to permanent markings on the glass indicates whether a surface is plumb (vertical) or level (horizontal).

Line level

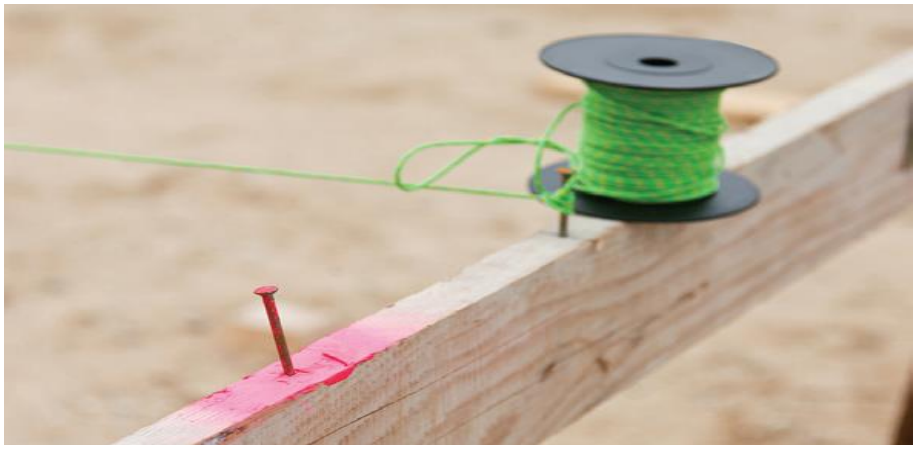
A line level is a miniature spirit level with a hook on each end to allow the instrument to be suspended on a taut stringline. It's used to transfer height levels from one point to another. Line levels are not very accurate and are used mostly used to, for example, check falls in concrete paths.

Water level

Due to the effects of gravity, still water is level, so a clear plastic tube filled with water is a very simple tool that can be used to transfer heights on a construction site from one point to another. Water levels are particularly useful to quickly transfer height measurements from one room to another when there is no clear line of sight.

String line

A string line is one of the oldest and most basic hand tools used in building and construction. It's typically used in the setting out of buildings to create a straight line between two level points.



Plumb-bob

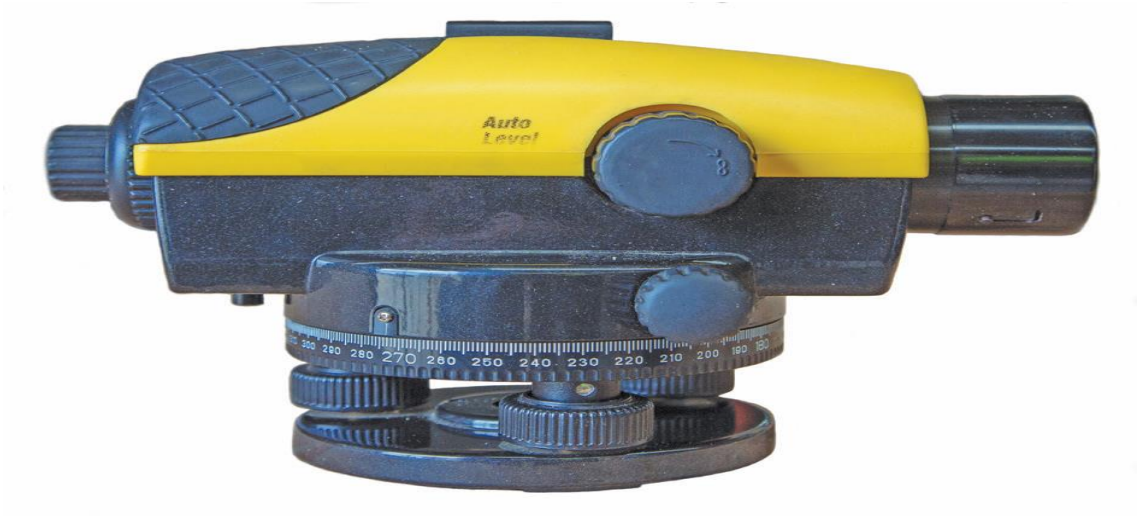
Plumb-bobs (also known as plumb lines) are heavy metal objects with a pointed tip attached to the end of a stringline. Using gravity, they accurately transfer points vertically, eg from ceiling to floor, and can be used to check that a surface is plumb (vertically straight). Plumb-bobs can be awkward to use in windy conditions.

Straight edge

Straight edges have a long, straight body made from wood or metal and can be used with spirit levels to transfer levels over short distances. They are generally available in lengths of 1.5–4 m.

Optical level

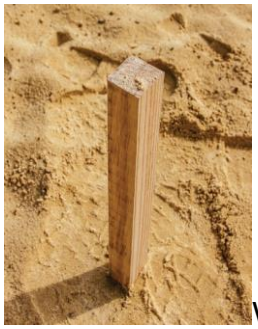
Optical levels are used to find precise height measurements and to check and transfer level information over longer distances than the simpler levelling tools described so far. An optical level is basically a telescope (usually with a magnification of around 20×) mounted on a swivelling base. It's adjusted with an attached spirit level so that the view through the telescope (the line of sight) is straight along the horizontal plane.



Tripod

Measuring tape

Marking tool



Wooden peg

Steel peg

Cutting and percussion tools

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List tools for levelling? (9pts)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points Unsatisfactory - below 7 points

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

Information Sheet-5	Checking leveling equipment for service ability and reporting any faults

5.1. Check-up leveling equipment for serviceability

Instrument is accurately set up and tested for operation before levelling, including levelling equipment/device tolerance checks. Tools and equipment selected to carry out tasks are consistent with job requirements, checked for serviceability, and any faults are rectified or reported prior to commencement.

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What are the importance's of check-up leveling equipment?

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points **Unsatisfactory - below 7 points**

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

Information Sheet-6	Identifying environmental protection requirements

Most of field works have the potential to affect the environment negatively. Although levelling tasks are generally considered to have very little environmental impact as they don't use resources heavily, create a lot of waste or require much clean-up, environmental issues still need to be considered. Most construction companies or worksites will have an environmental management plan (EMP) or policies and procedures for ensuring that projects have as little impact as possible. It's everyone's responsibility to work in a way that has as low an impact on the environment as possible.

As part of your planning and preparation, make sure you:

• Check if there's an existing EMP for the company, worksite and project.

• Comply with waste management and clean-up procedures as required.

Self-Check 6	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What is the importance of Identifying environmental protection requirements? (5pts)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 7 points **Unsatisfactory - below 7 points**

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

Instruction Sheet	Learning Guide 25

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

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

- Establishing offset and recovery pegs
- Re-establishing earthwork and pavement control lines
- Establishing drainage offsets from survey control

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Establishing offset and recovery pegs
- Re-establishing earthwork and pavement control lines
- Establishing drainage offsets from survey control

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3”.
4. Accomplish the “Self-check 1, Self-check 2, and Self-check 3” **in page -32, 34 and 37** respectively.

Information Sheet-1	Establishing offset and recovery pegs

1 .Offset and recovery pegs are established from survey controls to plans and drawings to meet project requirements

Construction surveying is the orderly process of obtaining data for various phases of construction activity. It includes the following surveys: reconnaissance, preliminary, final location, and construction layout. The reconnaissance and preliminary surveys are used to determine the best location. The remaining surveys are conducted after a location has been established. The purpose of construction surveys is to control construction activities. The number and extent of surveys conducted is governed by the time available, the standard of construction desired, and the availability of personnel and materials. In the combat zone, roads and airfields are constructed with only minimum preplanning and construction control activities. However, extensive surveys may be conducted for a deliberate project in the communications zone. The quality and efficiency of construction is directly proportional to the number and extent of surveys and other preplanning activities. After completing a thorough construction survey, transfer the design information from paper to the field by construction stakes. These stakes are the guides and reference markers for earthwork operations. Mark the stakes so that the construction will conform to the planned line and grade of the road or airfield and the information on the stakes will be properly interpreted by construction crews.

- **RECONNAISSANCE SURVEY**

The reconnaissance survey provides the basis for selecting acceptable sites and routes and furnishes information for use on subsequent surveys. If the location cannot be selected on the basis of this work, it must be determined by the preliminary survey.

- **PRELIMINARY SURVEY**

The preliminary survey is a detailed study of a location tentatively selected on the basis of reconnaissance, survey information, and recommendations. It consists of running a traverse along a proposed route, recording topography, and plotting results. For roads, it may be necessary to conduct several preliminary surveys if the reconnaissance party has investigated more than one suitable route. Establish, station, and profile the route centerline with horizontal and vertical control points set. Take cross-section readings to allow rough calculations of the earthwork involved. (Sometimes cross sections may be taken during the reconnaissance survey if the conditions warrant.) If the best available route has not been chosen, select it at this time.

The airfield survey consists of establishing controls, noting terrain features, measuring glide-angle clearance, making soil profiles, and investigating drainage patterns and approaches. Accurately establish the final centerline during the survey.

- **FINAL LOCATION SURVEY**

When time permits, conduct a final location survey. Establish permanent bench marks for vertical control and well-marked points for horizontal control. These points arc called hubs because of the short, square stake used. On most surveys, the hub is driven flush with the ground, and a tack in its top marks the exact point for angular and linear measurements. The hub location is indicated by a flat guard stake extended above the ground and driven at a slope so its top is over the hub. Hubs are 2 inches by 2 inches and the guards are flat stakes, about 3/4 inch by 3 inch.

Horizontal Control

The purpose of horizontal control is to accurately determine points for the various facilities of an engineering project. Establish permanent, well-marked points for horizontal control and reference them at the site before construction begins. On a large facility, establish a grid network and use it for this control. Tie the network into the military grid system in the particular area, if such a system has been established. On an airfield, place control points beyond the clear zone. These points define the centerline of the runway and other important sections of the airfield.

As the taxiways and other facilities are laid out, establish and reference new control points. In laying out the centerline, place target boards at each end of the runway so the instrument person can make frequent checks on alignment while the line is being staked out. Target boards may be set up on any line that requires precision alignment. Reference control stakes to ensure replacement, if they are disturbed or lost. Locate the target board just beyond the outermost control-point stake.

Vertical Control

Vertical control methods determine the difference in elevation between points. If available, establish a level reference surface or datum from a known bench mark. Differences in elevation, with corrections, are subtracted from or added to this assigned value, resulting in the elevation of the points. Take the datum of the bench mark system from a known elevation or barometer reading or make an arbitrary assumption.

- **CONSTRUCTION LAYOUT SURVEY**

The construction layout survey is the final preconstruction operation. It provides alignments, grades, and locations that guide construction operations. The survey includes determining

exact placement of the centerline; laying out curves; setting all remaining stakes, grades, and shoulders; staking out necessary structures; laying out culvert sites; and performing other work required to begin construction. Continue this survey until construction is completed.

- **CONSTRUCTION STAKES**

Use construction stakes for centerline, slope, offset, shoulder, grade, reference, ditch, culvert, and intermediate slakes and for temporary bench marks. The stakes should be approximately 1 inch by 3 inches by 2 feet. Use finished lumber when possible. If it is not possible to use finished lumber, use small trees or branches blazed on both sides and cut to length. Finished grade stakes and temporary bench marks are 2 inches by 2 inches by 12 inches. Place stakes using a three-to five-person crew equipped with transit, level, rod, tape, ax, sledgehammer, and machete.

The primary functions of construction stakes are to indicate facility alignment control elevations, guide equipment operators, and eliminate unnecessary work. They also determine the width of clearing required by indicating the limits of the cut and fill at right angles to the centerline of a road.

Mark and place construction stakes to conform to the planned line and grade of the proposed facility. Use colored marking crayons to mark the stakes. Use a uniform system so the information on the stakes can be properly interpreted by the construction crew.

Construction stakes indicate--

- The stationing or location of any part of the facility in relation to its starting point. If the stake is located at a critical point such as a point of curvature (PC), point of intersection (PI), or point of tangency (PT) of a curve, note this on the stake.
- The height of cut or fill from the existing ground surface to the top of the sub-grade for centerline stakes or to the shoulder grade for shoulder or slope stakes.
- The horizontal distance from the centerline to the stake location.
- The side-slope ratio used on slope stakes.

The number and location of stakes used differ between roads and airfields. A typical set of construction stakes consists of a centerline stake and two slope stakes and is referred to as a three-point system. Point one is the centerline of the facility. Points two and three are the construction limits of the cut and fill at right angles to the centerline.

- **CENTERLINE OR ALIGNMENT STAKES**

The centerline or alignment (hub) stakes are placed on the centerline of a road or airfield and indicate its alignment, location, and direction. They are the first stakes placed and must be located accurately. These stakes are used as reference points in locating the remaining

stakes. Centerline stakes are placed at 100-foot (or 30-meter) intervals. On rough ground or sharp horizontal and vertical curves, place the stakes closer together. On horizontal curves, also stake the PC, PI, and PT. On vertical curves, also stake the point of vertical curvature (PVC), the point of vertical intersection (PVI), the point of vertical tangency (PVT), and the low point (LP) or high point (HP) of the curve.

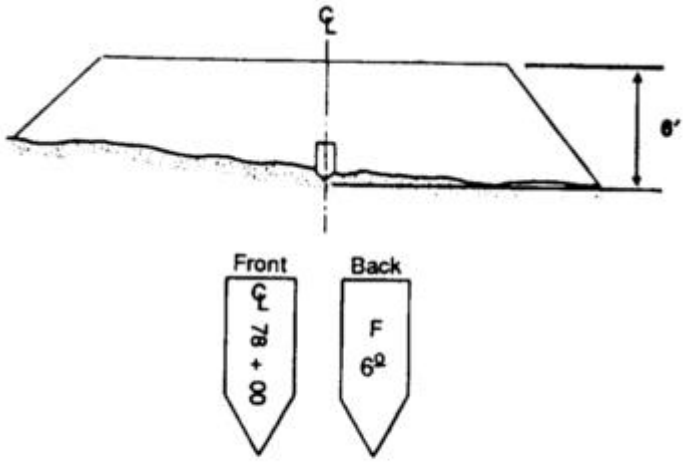


Figure 3-1. Centerline stakes

Place centerline stakes with the broad sides perpendicular to the centerline. The side of the stake that faces the starting point is the front. Mark the front of the stake with a ℄ for centerline and, if applicable, PC, PI, or PT. Also mark on the front the distance from zero or the starting point in 100-foot stations and the fractional part of a station, if used. For example, 6 + 54^{22} marked on a stake indicates it is 654.22 feet from the origin of the facility and is known as the station of this point. Stations are used in locating sections of construction and in preparing reports.

Place the amount of cut or fill required at the station on the reverse side of the stake. A cut is marked C; a fill, F. A centerline stake, placed at station 78 + 00 and requiring a fill of 6.0 feet to bring this station up to the final grade line, would be placed and shown as indicated in Figure 3-1.

The amount of cut or fill indicates the difference between the final grade line and the ground line where the stake is emplaced. A point on the stake is seldom used as the line of reference to the final grade.

To prevent misinterpretation of the amount of cut or fill, mark decimal parts of a foot, as shown in Figure 3-1. The decimal part is written smaller, raised, and underlined. Facing the direction of increasing stations, the centerline forms the dividing line between the right and

left sides of the area to be graded. When facing either side of the centerline, it is customary to refer to the areas as the right or left side.

OFFSET STAKES

Equipment used on a cut or fill section may destroy or remove many of the grade (centerline, shoulder, or slope) stakes. To prevent loss of man-hours and repetition of survey work, caution construction crews to protect grade stakes whenever possible. Place offset stakes beyond construction limits to avoid resurveying portions of the road to relocate these stakes. Figure 3-3 shows offset stakes used to relocate the original stakes.

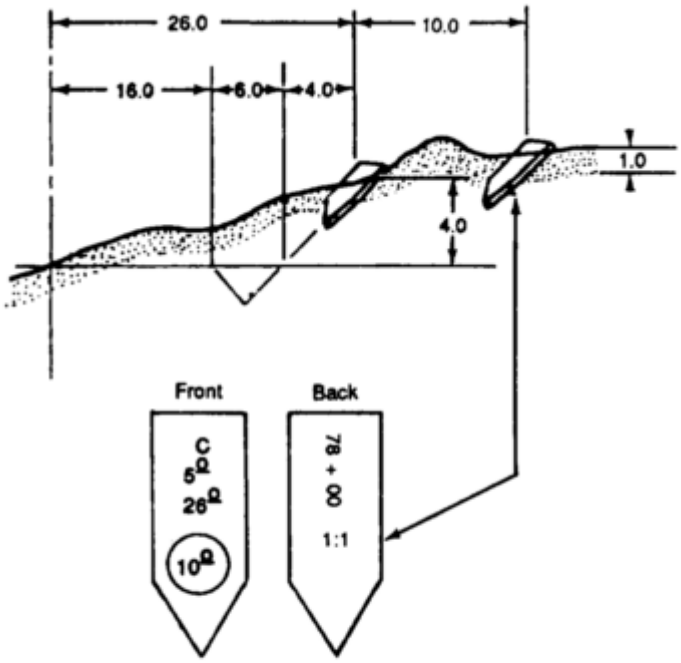


Figure 3-3. Marking and placement of offset stakes

Place offset stakes on a line at right angles to the centerline of the facility. From these, the slope stakes can easily be located. After relocating a slope stake, relocate the centerline stake by measuring toward the centerline of the road the horizontal distance indicated on the slope stake and placing the new centerline stake there.

An offset stake contains all the information given on the original slope stake plus the difference in elevation and horizontal distance from the original slope stake to the offset stake. Mark the offset distance on the front of the stake and circle it to indicate it is an offset reference. If the offset stake is at a different elevation from the slope stake, the cut or fill value must be increased or decreased by the difference in elevation. An offset stake placed a horizontal distance of 10 feet from and 1 foot above the right slope stake would be placed

and marked as shown in Figure 3-3. Coordination between the surveyor and grade supervisor concerning the meaning of the markings is most important regardless of the type of marking used.

- **FINISH-GRADE STAKES**

Use wooden stakes, 2 inches by 2 inches, with tops colored red or blue, for finish-grade stakes. Blue or red tops, as they are called, indicate the actual finished elevation of the final grade to which the completed facility is to be constructed. They are used when the grade is within a short distance of the final elevation. Do not use these stakes in combat road construction except in areas with steep slopes. This type of stake normally requires a guard stake to protect it and indicate its location. On large projects, it may be impractical to use guards with each stake.

There are no markings on finish-grade stakes other than the color on the top. These stakes may be set for use with the top of the stake exactly at the finished grade or with the top of the stake above the finished grade, as decided upon by the surveyor and construction foreman.

With the stakes set and marked at a predetermined distance above the finished grade, stretch a string between two stakes across the work and use a graduated ruler or stick to check the elevation. On an airfield layout, place these stakes along the centerline, edge of pavement, intermediate lines, shoulder lines, and ditch slopes. For road work, place stakes along the centerline and the edge of the shoulder; they may or may not be placed on the slopes.

- **REFERENCE STAKES**

Many hubs marking the location of highways and airfields are uprooted or covered during construction. They must be replaced, often more than once, before construction is completed. AS an aid in relocating a point which may become hidden by vegetation, or as a means of replacing points which may have been destroyed, measurements are made to nearby permanent or semi-permanent objects. This process is known as referencing or witnessing a point. On many surveys, permanent objects may not be available as witnesses. In such cases, additional stakes may be driven. These stakes usually are approximately 2 inches by 2 inches by 18 inches.

There are no markings on a reference stake. A point can be referenced by a known distance and a known angle or by two known distances. A transit must be used in the first case and may be used to advantage in the second. The method of using two known distances can be used, however, when a transit is not available. Place two points at measured distances from the point to be referenced. Use two tapes to relocate the original point or stake. Hold the zero

end of one tape on one reference point and the zero end of the other tape on the other reference point. The point of intersection of the two tapes at the respective distances gives the location of the point in question.

To be of most value in replacing a missing station or point, the reference stakes or witnesses will be less than 100 feet from the point and, if possible, the arcs should inter sect at approximately right angles. Place them outside the construction limits, and indicate their location by blazing trees or additional stakes. Normally, the location of the reference stakes can be obtained from the surveyor's notebook.

- **CULVERT STAKES**

Culvert stakes are located on a line parallel to and offset a few feet from the centerline. The information required on the culvert stakes includes the distance from the stake to the centerline, the vertical distance to the invert, and the station number. Once the survey crew has finished staking out the culvert, the construction supervisor can place the pipe accurately by using batter boards.

- **BENCH MARKS**

Vertical control of a road or airfield must be maintained during construction. To do this, points of known elevation must be established. Obtain elevations from permanent monuments, known as bench marks, established by geodetic surveys. From these bench marks, run a line of levels and set temporary bench marks (TBMs). On small projects the TBMs frequently are set by running the levels from a point of assumed elevation. This is especially true of construction in combat areas.

Usually, TBMs are placed at 500- to 1,000-foot (or 150- to 300-meter) intervals and are placed off the limits of construction. Stakes 2 inches by 2 inches, solidly emplaced in the ground, may be used for this purpose. However, a nail driven into a tree, a manhole cover, or a pipe driven into the ground may also be used. Frequently, reference points serve as TBMs. The TBMs are set before setting the centerline stakes because vertical control must be established before construction begins.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Define the following words (phrases)(8)?
   A. reconnaissance survey
   B. preliminary survey

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 6 points **Unsatisfactory - below 6 points**

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

Information Sheet-2	Re-establishing earthwork and pavement control lines

2.1. Earthwork and pavement control lines are re-established from offsets and/or recovery pegs in accordance with plans, drawings and specifications

Earthwork computations involve the calculation of earthwork volumes, the determination of final grades, the balancing of cuts and fills, and the planning of the most economical haul of material. The exactness with which earthwork computations are made depends upon the extent and accuracy of field measurements, which in turn arc controlled by the time available and the type of construction involved. To plan a schedule, the quantity of earthwork and the soil and haul conditions must be known so the most efficient type and quantity of earthmoving equipment can be chosen and the appropriate time allotted.

2.2. FACTOR INFLUENCING EARTHWORK

Shrinkage

Shrinkage has occurred when 1 cubic yard of earth, as measured in place before excavation, occupies less than 1 cubic yard of space when excavated, hauled to an embankment, and compacted. This difference is due to the combined effects of the loss of material during hauling and compaction to a greater-than-original density by the heavy equipment used in making the embankment.

Shrinkage is small in granular materials such as sand and gravel, and is large in ordinary earth containing appreciable percentages of silt, loam, or clay.

Shrinkage is very high (possibly 70 percent) for shallow cuts containing humus, which is discarded as unsuitable for embankments. These shallow cuts (usually 4 to 8 inches deep) are called stripping.

Loose and swell refer to a condition which is the reverse of shrinkage. The earth assumes a larger volume than its natural state when stockpiled or loaded into a truck. This factor ranges from 10 to 40 percent swell and is usually uniform for a given material.

Shrinkage, however, varies with changes in the soil constituents and with changes in moisture content and the type of equipment used. Consequently, a percentage allowance assumed in design may eventually prove to be 5 percent or more in error. A common shrinkage allowance is 10 to 30 percent for ordinary earth.

Settlement refers to subsidence of the completed embankment. It is due to slow additional compaction under traffic and to gradual plastic flow of the foundation material beneath the embankment.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. what is settlement? (8)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 6 points Unsatisfactory - below 6 points

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

Information Sheet-3	Establishing drainage offsets from survey control

3.1. Establishing drainage offsets from survey control

A culvert is an opening (usually a pipe) in the embankment that allows water to pass from one side to the other. Culverts are placed in valleys that would otherwise be dammed by the highway embankment. Culverts may be concrete or metal pipe, pipe arches, or concrete box culverts. The amount of water passing through and the height of the fill determine the size and type of culvert to be installed. If the culvert is to be constructed for a flowing stream, a channel change is usually required. The culvert is constructed on the new channel alignment and the stream is then diverted through it. If the channel is dry at the time of construction, the contractor might be required to partially build the embankment before placing pipe. To lay out culvert installations, perform the following steps:

- Consult the contract plans for station and offset for ends of the installation.

You might be required to field fit culverts. If so, find the slope catch in the channel bottom for each end of the culvert. Check the templates to be sure widening for guardrail has been included if necessary.

- Set a hub and tack at the indicated positions for each end of the culvert. Typically we set an offset reference point 10 feet past the end of the pipe with a grade to the pipe.
- Measure distance between hubs.
- Set a parallel offset line at a distance convenient for the contractor. Usually 10 feet is adequate.
- Beginning at the downstream end, set and station hubs along the offset line.
- At the downstream end, set a second hub to ensure proper positioning of the first section of pipe.
- Obtain elevations on all offset hubs and corresponding ground elevations at the center line of the pipe.
- When the trench will be excavated to a depth of 4 feet or more, obtain elevations at the horizontal limits of the trench.
- Compute the flow line grade of the culvert for each offset hub. Subtract from hub elevation.
- Mark and place stakes at the hubs, recording the station, offset, code number, and cut.
- Check all computations and check all stakes for accuracy in recording.

- Complete the sketch on Form 422-637 along with other required data and submit to supervisor. Sewers are a closed system of watertight pipes that generally begin and end in some sort of drainage structure.

Storm sewers, manholes, or catch basins are located to allow water in or out of the system and provide access for cleanout. Manholes are usually spaced at a maximum of 300 feet. Catch basins are spaced often enough to drain the roadway.

Sanitary sewers have manholes for maintenance but no other openings. In sewer design, the crowns of all pipes coincide at the center of the manhole. Therefore, water running through a small pipe into a larger pipe at a manhole will fall by the difference in pipe size. On the drainage plan sheets of the contract plans you will find a circled number and a line drawn to each drainage structure. The drainage profile sheets show the station, offset, flow line grade, and top of grate elevations for each installation. The top of grate elevation is for the center and is usually at the pavement elevation for manholes, and 1 inch below the pavement elevation for catch basins and grate inlets. The grates are to be set on the same slope as the pavement. Communication between the crew and the contractor is “very important” when setting elevations for top of grate inlets. Make sure the contractor and inspector know that the elevations are already set 1 inch below the pavement elevation. Grades are critical, especially for sanitary sewers. Therefore, pay close attention to elevations. The “structure notes” section of the contract plans tabulates the lengths, size, type of pipe, appurtenances, and any special note for each installation.

In laying out sewers, the following steps are taken: Study the plans, special provisions, structure note sheets, *Standard Specifications,* and appropriate standard drawings before starting. This is most important. In studying the system you are staking, be sure to consider the whole system, not just the area you are working in. You might pick up an error on the plans before it gets constructed. Make sure that the back edges of catch basins will be in the curb line and that manhole lids are not in the curb line. Establish the locations at the center of manholes, catch basins, or any other connections by setting a guinea. A hub and tack serves no purpose since it will get dug out. Set an offset hub at the same offset distance as for the pipe. Then set a second offset hub in line with the first. This will allow the contractor and inspector to be sure of accurate placement of the structure.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What is culvert? (4)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 6 points Unsatisfactory - below 6 points

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

Instruction Sheet	Learning Guide 26

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

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

- Identifying heights or levels to be transferred/established
- Setting-up and using leveling instruments standard safe operating procedures
- Transferring heights
- Documenting and closing results of levelling procedure

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify heights or levels to be transfer/establish
- Use leveling instruments
- Transfer heights
- Document results of leveling procedure and close out to organizational requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self-check 4,” **in page -42, 44, 54 and 56** respectively.

Information Sheet-1	Identifying heights or levels to be transferred/established

1.1. Identifying the required measurement points

The first step in a levelling task is to identify what you are to measure and why you are to measure it. For example, you may need to transfer a level from the datum to another part of the site or determine the levels for the groundwork in the area where the new structure will stand. The site plans give you an overview of the site and the proposed structures. It should also provide important information such as the position and value of the datum. From this you can identify the points at which level measurements can or should be taken.

1.2. Positioning the instrument

Once you've identified the points you need to measure, you'll be able to choose the type and path of level traverse most suited to the task and the best position(s) for the levelling instrument. This position is called a **station**. The first station should be placed where there's a clear view to the datum and the points where the level measurements are required. If the points are across a large distance or if there is an obstruction, eg a tree, structure or slope, you may need to move the instrument to a new position (Station 2) to take some of the level measurements.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What is first step in a leveling task (5)?

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 3 points Unsatisfactory - below 3 points

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

Information Sheet-2	Setting-up and using leveling instruments standard safe operating procedures

2.1. Taking and booking levels

Once the position of the initial station (Station 1) has been identified, the instrument is Set-up and tested, and the first set of measurement readings are taken and booked.

Taking the back sight

The first level measured in a level traverse (or section of a traverse) is called the **Back sight**.

The staff is positioned over the datum point and a reading is taken from station1.

In the field book:

a) Record the station number

b) Record the height of datum as the first entry in the reduced level column

c) Record the back sight reading on the same line in the back sight column

d) Use the Comments column to identify the point.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. The first level measured in a level traverse (or section of a traverse is ___.? (5)?

Answer

Score = _____

Rating: _____

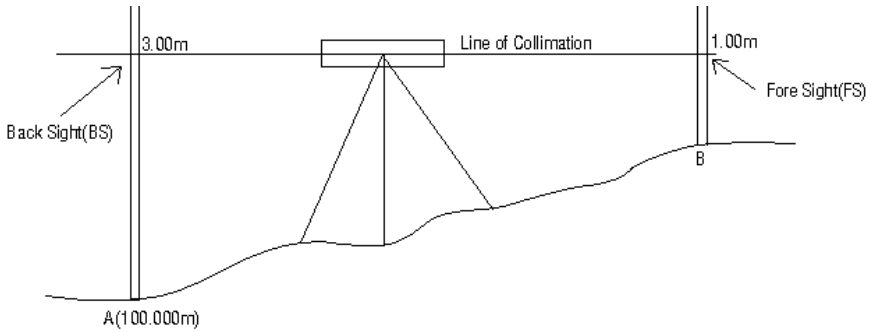
Note: Satisfactory rating – 3 points Unsatisfactory - below 3 points

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

Information Sheet-3	Transferring heights

Principle of leveling

The instruments are set up and correctly leveled in order to make the line of sight through the telescope horizontal. Consider fig below.

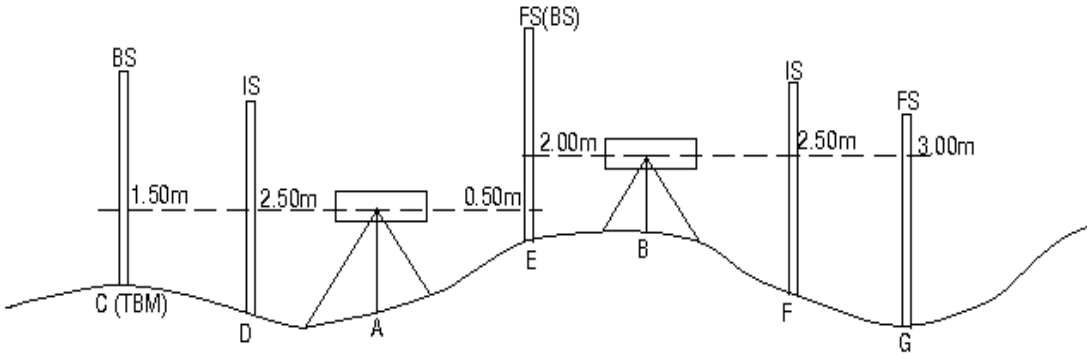


With the instruments set up approximately midway between ground points A & B. If the reduced level (RL) of po[RLA + BS = HPC]als to 100.000m above a certain reference datum then the reading at 3.00m on vertically held staff at A gives the reduced level of horizontal line of sights as 103.000m. This sights on to A is termed as back sights (BS) and reduced level of the line of sights is called height of plane of collimations (HPC) Thus,

The reading of 1.00m on to staff at B is called fore sight (FS) and shows the ground point B to be 1.00 below HPC there fore its RL_B = (103.000 – 1.000)

= 102.000m

Then this is the basic concept of leveling which is then developed in to following leveling.



Let RL be reduced level

R = Staff reading.

Then RLC = TMB

RLD = RLC + (RC – RD)

RLE = RLC + (RC – RE)

RLF = RLE + (RE – RF)

RLG = RLE + (RE – RG)

3.1. Height of instrument method

The height of plane of collimation methods sometimes called height of instruments. The height of collimation is obtained by adding the staff reading, which must be back sight, to know RL of the points on which the staff stands. All other reading are deducted from the height of collimation until the instruments setting is changed. Where upon the new height of collimation is determined by adding the back sight to the RL of the change points.

The reading and Computed values are booked is a level books which is specifically printed for this purpose.

Staff position	**BS**	**IS**	**FS**	**HPC(HI)**	**RL**	**Distance**

Note: The arithmetic check to be applied to this system of booking are

$$\sum(BS) - \sum(FS) = \text{Last RL} - \text{First RL}$$

$\sum$(All except the first) = $\sum$(each HPC) * (No. IS and FSs deducted from it) - $\sum$(FS + IS)

This second check is cumbersome and is often ignored so that as consequence, the intermediate RL are unchecked.

In this case, errors could go unchecked (compared with rise and fall method where errors in all RLs are detected). Reduction is easier in height or collimation method (or height of instrument method) as sometimes called leveling is taken from each position of instruments.

3.2. Rise and fall method

The readings are booked in a level book, which is specially printed for the purpose as shown in the following table

Staff Position	BS	IS	FS	Rise	Fall	RL	Remark

The reductions of these readings are carried out in the same book. Each reading entered on different line in the applicable column except where the points, where a foresight and back sight occupy the same line.

Note: - The very important check must be applied to the reductions.

$$\sum BS - \sum FS = \sum Rise - \sum Fall = Last\ RL - First\ RL$$

It follows from the above that the first two checks should be carried out and verified before working out the reduced level.

The comparison of line of collimation method and Rise – fall method

Height of collimation	Rise fall method
1. It is more rapid & save time	1. It is laborious to compute the rise & fall then RL
2. This method is use for reduction of level for construction work Such as longitudinal or cross sectional leveling operation.	2. It is well adopted for determining d/c in elevation of two points.
3. There is no check for reduction of RLs of intermediate site	3. There is complete check on reduction of RLs of IS.
4. There are only two arithmetic checks.	4. Three arithmetic check.
5. Errors if any in IS are not detected	5. Errors in IS are detected.

Misclosure, Limits and its distribution

Misclosure is leveling operation are an indication of the accuracy of the work. It is important to realize the amounts of misclosure in leveling can only be assessed by

1. Connecting the leveling back to the BM from which it started or
2. Connecting in to another BM of known ground elevation.

When the misclosure is assessed, one must then decide if it is acceptable or not.

In many cases depending upon the terrain and the kinds of work the Engineer decide based upon the tolerance required.

Alternating the permissible may be based on the distance traveled or no. of set up involved.

A Common Criteria used to assess the misclosure (E) is

$$= m\sqrt{k}$$

Where K = distance leveled in Km.

M = Constant in mm (usually from 2-12 mm)

In many case in Engineering the distance involved is quite short but the no. of setup is quite high, in which case the following criteria must be used.

$$E = M\sqrt{n}$$

Where n = No ob instrument setup

M = Constant is in mm ($\pm$ 5)

If the misclosure is outside the allowable then the leveling must be repeated and if it is with in the misclosure has to be contributed equally to all

$$\text{Correction per set up} = \frac{E}{n}$$

Mistakes & errors in Leveling

Some of the mistakes commonly made in leveling are

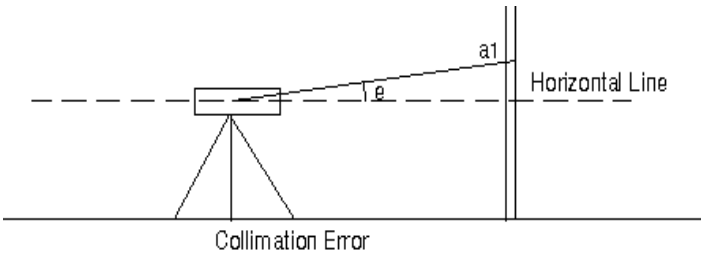
1. Confusion of numbers in reading the staff. Example 2.345 instead of 3.345
2. Recording the back sight is foresight column and vice- versa.
3. Faulty addition a subtraction of back sight of foresight is checking every page between bench marks.
4. Rods or staff not held in the same point for foresight and back sight in turning point. etc.
5. Instrumental level.

The errors in leveling might occur due to

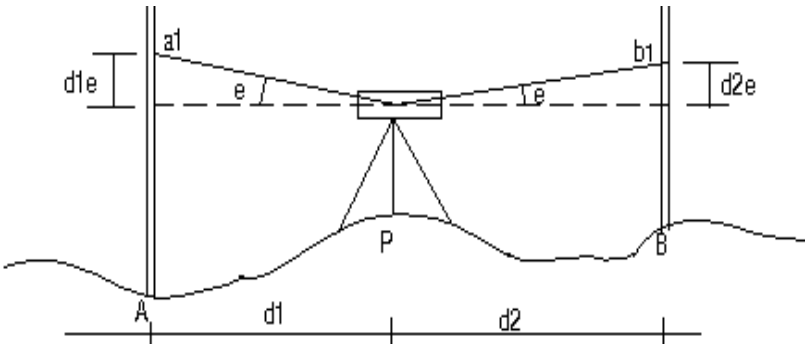
1. Instrumental error
2. Field error.
3. Effect of curvature refraction.

Instrumental error: - these are error which occurs due to the defects of instrument such as:

Collimation error-*:* The error occurs if the line of the sight is not truly horizontal when the tubular bubble is centered i.e the line of sight is inclined up or down from the horizontal. A Cheek known as Tow –peg' test is used.



Two – peg test: - On relative flat site establish tow pegs A & B about 50m apart and set up the instruments of P at points half way between them. After careful leveling and focusing, sight on the staff held at A and record reading a1. Repeat with the staff held at B and record reading b1. Assume the line of collimation is not horizontal but inclined at an angle e, the collimation error then the true difference in elevation between A & B is given by

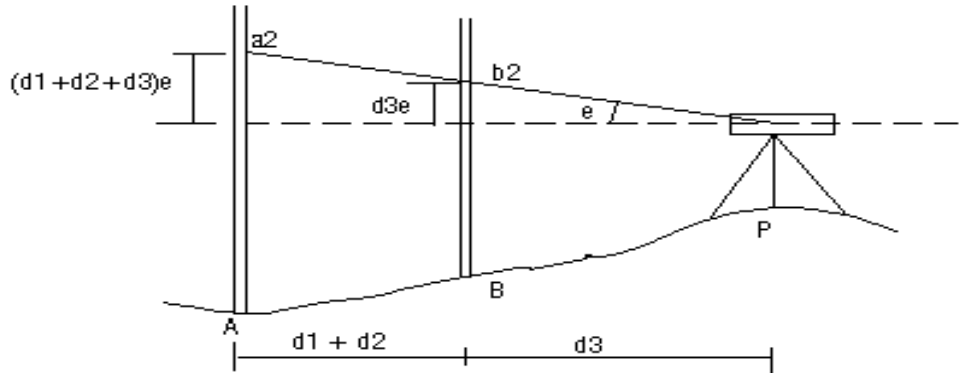


$\Delta h_{AB} = (a_1 - d_1e) - (b_1 - d_2e)$

Since the instrument is mid – way between A & B

$d_1 = d_2 \Rightarrow \Delta h_{AB} = a_1 - b_1$ …….. 1

To check this again set up the leveling at P of a distance of d_3 (25m) form A or B.



$\Delta h_{AB} = [a_2 – (d_1 + d_2 + d_3).e] – [b_2 – (d_3.e)]$

$= (a_2 – b_2) – (d_1 + d_2).e$ …….. 2

Equating the two equations

$(a_1 – b_1) = (a_2 – b_2) – (d_1 + d_2).e.$ $\boxed{e = \frac{(a_2 - b_2) - (a_1 - b_1)}{2d_1}}$

Collimation error should be less than ±0.00005 rad (±0.5mm per 10m). If the error is greater than this the level should be adjusted with the instruments still set at a horizontal line of collimation would give a reading on the staff at A at

$a_1 – (d_1 + d_2 + d_3)e$

A) Defect of staff: - It is possible that the staff production may be incorrect and new or repaired. The staff shall be corrected using steel tape. Particular attention shall be said to the base of the staff to see. If this is the case then the staff has zero error. This does not affect the height difference if the same staff is used for all leveling. But introduce error if two staffs are to be used for the same series of leveling.

B) Tripod defects: - stability of tripod should be checked before any field work. If the metal shoes at the base of each leg are not loose once extended the leg can be tightened insufficiently.

2. Field Error: - These are errors which occur due to the following.

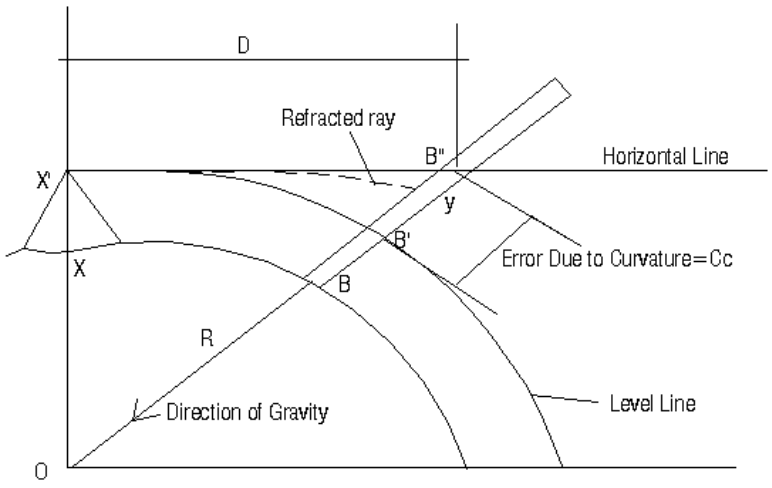
1) Staff not vertical

2) Handling the instruments & tripod

A) Staff not vertical: - Since the staff is used to measure the vertical distance between ground and the line of sight, failure to hold the staff vertical will result in incorrect reading.

B) Handling the instruments a tripod: - The HI may be altered for any set up if the tripod is held or leant against while leveling. If at any state the tripod is disturbed it will be necessary to repeat the instruments set up and all the reading taken from that instruments position.

3. Effect of Curvature & Refractions



The above two points X & B at exactly the same level. An instruments set up at X would give horizontal line of sight through X'. Theoretically, as B' is at the same level do X', the staff reading should be identical (B') but due to horizontal line reading is B'' (ignoring refraction).

Subtracting the vertical height XX' from BB'' indicates that point B is lower than point X by an amount B'B''.

The error (c) is caused by the curvature of the earth and its value may be calculated as follows.

Taking ΔX' B'' O

$(X'B'')^2 = (0'B'')^2 - (0X')^2$

$D^2 = (R + Cc)^2 - (R)^2$

$D^2 = R^2 + 2RCc + C^2c - R^2$

$\Rightarrow D^2 = Cc(2R + Cc) = 2RCc + Cc^2$

But Cc^2 is negligible compared to R then if the distance D is in kilometer and radius of the earth is assumed to be 6370km

$$Cc = 0.0785\ D^2$$ in meter

In practice the staff reading would not be B' but at y due to refraction or the line of sight through the atmosphere. In general it is considered that the effect is to bend the line of sight dawn, reducing the effect of curvature by $1/7^{th}$.

Thus the combined effect of curvature & refraction

$$Cc = 0.0673\ D^2$$ in meter

Reciprocal leveling: - By means of reciprocal leveling, the need for applying the above correction may be avoided. When it is necessary to carry leveling across a linear or any obstacles requiring long sight between two points so situated that no place to level can be found from where the length of foresight and back sight will be even approximately equal, a special method i.e. reciprocal leveling must be used to obtain accuracy and to eliminate the following.

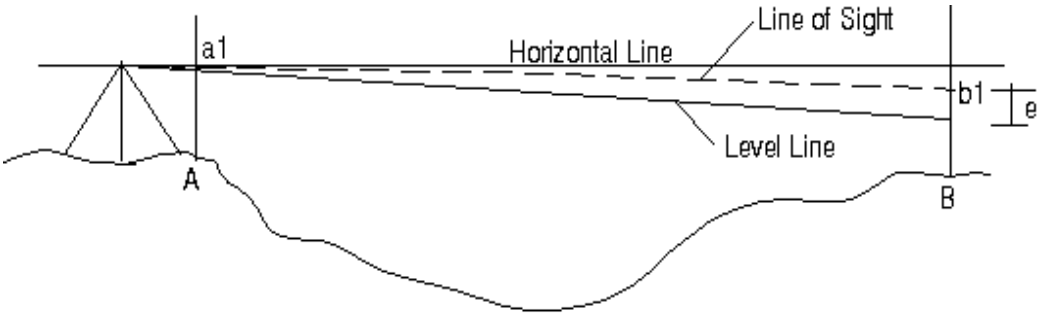
1. Error in instrument adjustment
2. Combined effect of earth's curvature and refraction of atmosphere.

The level set at a point near A and staff reading are taken on A and B with bubble in center of its ron since BM A is very near to the instruments no error due to curvature, refractions and collimation will be introduced in the staff reading of A but there will be on error e (or a collimation) is the staff reading at B.

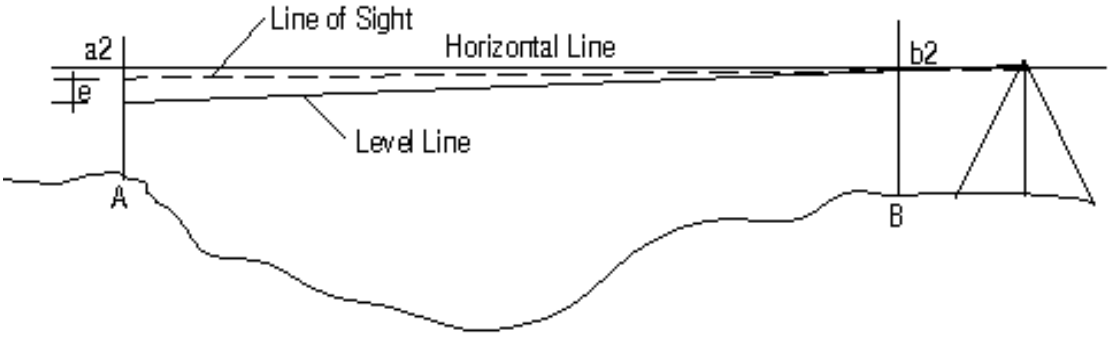
The level is then shifted to the other bank on a point very near BM, B and the reading are taken on staff held at B and A. Since B is very near, there will be no error due to three factors is reading the staff but the staff reading on A will have on error e.

Let – a1 and b1 be corresponding staff reading at A and B when the level is get at A

– a2 and b2, be corresponding staff reading at A and B when the level is set at B.



$\Delta h_{AB} = a1-(b1-e)$.....1



$\Delta h_{AB} = (a2 - e) - b2$.....2

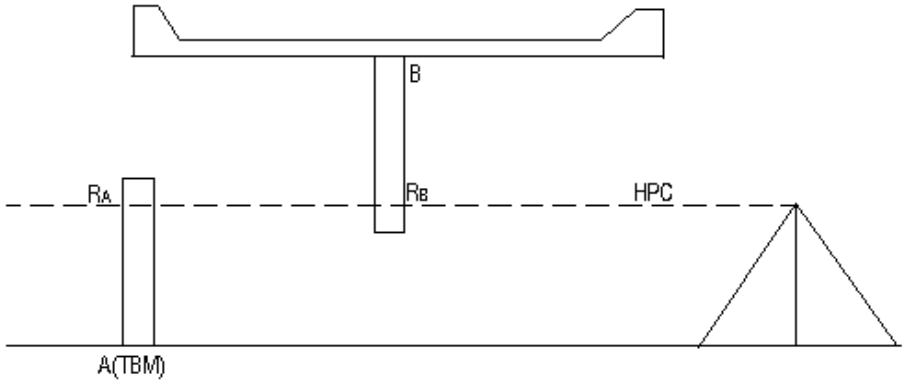
Taking the average of the two true difference in elevation

$2\Delta hAB = [a_1 – (b_1 – e) + (a_2 – e) – b_2]$

$\Delta h_{AB} = 1/2(a_1 – b_1) + (a_2 – b_2)$

The true difference in elevations, therefore equal to the mean of two apparent differences is elevations obtained by reciprocal observation.

Inverted staff reading:- Reduced levels of underside of structures (bridge softest) are determined by using staff in an inverted position , the inverted staff reading is booked in a relevant column of the level book with negative sign , so that when reading this reading from height of collimation of the level we get.



RLA = TBM

HPC = RLA + RA

RLB = HPC – (-RB)

= HPC + RB

Fly leveling: - The permanent bench mark man be located far away from starting points of proposed road. So, fly leveling should be done to connect the BM with starting points of the work in order to locates its RL and then calculate RLs of different points along the alignments.

Note: - In fly leveling only the back sight and foresight reading should be recorded.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the two methods of calculating the reduced level of measurement? (5)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 3 points Unsatisfactory - below 3 points

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

Information Sheet-4	Documenting and closing results of levelling procedure

4.1. Recording heights and levels on site

It's essential that you keep a record of the geographical position of the points of measurement taken in a levelling survey. This may be a physical marker like a survey peg, nail or chalk mark, or a diagram or sketch with the points and level measurements recorded.

Survey documentation of survey activity is very important. It allows field crews and offices to share information without having to survey the same areas more than once.

The final documentation of survey data allows the design team and other groups within the agency to use the same data for their own particular purposes. These guidelines should be used during the scoping phase of the project to determine preliminary survey cost estimates.

When document is prepared

What is a document?

What determines a need for preliminary levelling work or monumentation inventory?

Preliminary land leveling work is required if the proposed construction activity is not clearly within the limits of our existing right of way. A monumentation inventory is required if the proposed construction activity will physically impact the existing survey monuments.

What is a preliminary land levelling?

A preliminary land levelling is intended to be part of the scoping Package. The purpose of the levelling is to provide cost estimates for survey labor, documentation (mapping) and monumentation for a specific project. This leveling will help determine, at the scoping phase rather than midway through the project, the need for: preparing new or revising existing right of way plans, record of survey or type of Monumentation Map, and / or other levelling documents.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the tools use for recording heights?(5)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating –3 points Unsatisfactory -3 below points

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

Instruction Sheet	Learning Guide 27

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

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

- Clearing work area, disposing recycling waste materials
- Cleaning, checking, maintaining and storing tools and equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Clear work area and materials dispose of or recycle
- Clear, check, maintain and store tools and equipments

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1and Sheet 2”.
4. Accomplish the “Self-check 1 and Self-check 2” **in page -61 and 63** respectively.

Information Sheet-1	Clearing work area, disposing recycling waste materials

When you complete any task on a site, you must clear your work area to ensure the safety and convenience of your workmates, other leveling teams and the public. This process includes:

- Recycling or disposing of any waste material
- Cleaning, maintaining and storing equipment
- Safely filing or storing plans, documents and records
- Cleaning up the area.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What is the importance cleaning work area? (5)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 3 points Unsatisfactory - below 3 points

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

Information Sheet-2	Cleaning, checking, maintaining and storing tools and equipment

A very important part of planning for a levelling project is being able to identify the tools that are most appropriate for the task and making sure you have access to them where and when you need them.

• Check the condition of all tools before you start any work, and rectify or report any faults.

• Always read the manufacturers' instructions for any tools, equipment and materials you're not familiar with.

• Be aware of materials that may be hazardous. Look for warning labels and, if there's a safety data sheet (SDS), read it carefully.

• Never use a tool or piece of equipment for any purpose other than what it's designed for.

When you're calculating material quantities, always double-check the plan and/or instructions you're working from, and also your calculations, cleaning, maintaining and storing equipments appropriately. This will help you to avoid situations where you can't complete a task because you have either too much or not enough of a material you need.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. What are points underconsideration during cleaning? (5)

Answer

Score = _____

Rating: _____

Note: Satisfactory rating – 3 points Unsatisfactory - below 3 points

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

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