SMALL SCALE IRRIGATION DEVELOPMENT LEVEL-I

Model TTLM

Learning Guide #05

Unit of Competence: Identifying Basic Irrigation Design and Surveying Tools

Module Title: Identifying Basic Irrigation Design and Surveying Tools

LG code: AGR SSI1M 07 Lo1-Lo3

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Nominal Duration: 30 Hours

Instruction Sheet	Learning Guide -05

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

- **Prepare materials, tools and equipment for irrigation design and surveying work.**
- **Undertake irrigation design and surveying tools**
- **Care and Handling of Surveying**

This guide will assist trainees to attain the learning outcome stated in the curriculum guide. Specifically, upon completion of this Learning Guide, trainees will be able to:

- Identify the required materials, tools, and equipment
- Conduct Checks on all materials, tools and equipment
- Select and checking Suitable personal protective equipment (PPE).
- Provide irrigation design and surveying support according to OHS requirement
- Identify and reporting OHS hazards.
- IdentifyElementary Surveying Equipment
- Identify principal surveying instruments and accessories
- IdentifyElectronic and Self-Leveling Surveying Equipment
- Maintain Tapes and Chains
- Transport Surveying Instruments and Accessories
- Mount Instruments on Tripod
- Clean and Storing Equipment
- Check and Adjusting Instruments

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the “Information Sheets”
3. Accomplish the “Self-check” questions
4. If you earned a satisfactory evaluation, you will proceed to the next “Information Sheet.” However, if your rating is unsatisfactory, see your teacher for further instructions.
5. Submit your accomplished Self-check.

6. Do the “LAP test” in page 12, 26 and 34. Request your teacher to evaluate your performance and outputs.

InformationSheet-1	Prepare materials, tools and equipment for irrigation design and surveying work

1.1Preparing and checking tools and equipment for irrigation design work

Irrigation design a condition that needs an account during the planning and development of the physical works of irrigation schemes and helps for the sustenance of the scheme. The main issues on the design of technical components are installation, operation and maintenance costs of irrigation systems, mechanisms to achieve efficient and equitable water allocation and to control water losses. These all have played a crucial role on the management and sustainability of smallholder irrigation schemes.Good system design is critical for uniform application of water to all plants in an irrigation zone. An irrigation design should be done by a competent, experienced person. Design is very important and cannot be covered in depth in the scope of this course. However, many factors related to design are covered in this course so that the owner and operator understand their importance to proper operation.

Surveying or **land surveying** is the technique, profession, and science of determining the terrestrial or three-dimensional positions of points and the distances and angles between them. A land surveying professional is called a **land surveyor**. These points are usually on the surface of the Earth, and they are often used to establish maps and boundaries for ownership, locations, such as building corners or the surface location of subsurface features, or other purposes required by government or civil law, such as property sales. They use tools and equipment, such as **measuring tapes,clinometer**, **engineering transit levels**, **theodolites**, **GPS**, **electronictheodolite**, **electronicdistancemeasuring**, **fieldbooks**, **special forms**, **GPS, topo maps, and surveying software**.

Surveying has been an element in the development of the human environment since the beginning of recorded history. The planning and execution of most forms of construction require it. It is also used in transport, communications, mapping, and the definition of legal boundaries for land ownership. It is an important tool for research in many other scientific disciplines.

- **Electronic theodolites**

In modern electronic theodolites, the readout of the horizontal and vertical circles is usually done with a rotary encoder. These produce signals indicating the altitude and azimuth of the telescope which are fed to a microprocessor. CCD sensors have been added to the focal plane of the telescope allowing both auto-targeting and the automated measurement of residual target offset. All this is implemented in embedded software of the processor.

Many modern theodolites are equipped with integrated electro-optical distance measuring devices, generally infrared based, allowing the measurement in one step of complete three-dimensional vectors—albeit in instrument-defined polar co-ordinates, which can then be transformed to a pre-existing co-ordinate system in the area by means of a sufficient number of control points. This technique is called a resection solution or free station position surveying and is widely used in mapping surveying.

Figure 1.1 A typical modern electronic theodolite: Nikon DTM-520

- **Clinometer**

is an instrument used for measuring angles of slope (or tilt), elevation, or depression of an object with respect to gravity's direction. It is also known as a tilt indicator, tilt sensor, tilt meter, slope alert, slope gauge, gradient meter, gradiometer, level gauge, level meter, declinometer, and pitch & roll indicator. Clinometers measure both inclines (positive slopes, as seen by an observer looking upwards) and declines (negative slopes, as seen by an observer looking downward) using three different units of measure: degrees, percent, and topo (see Grade (slope) for details). Astrolabes are inclinometers that were used for navigation and locating astronomical objects from ancient times to the Renaissance.

A tilt sensor can measure the tilting in often two axes of a reference plane in two axes. In contrast, a full motion would use at least three axes and often additional sensors. One way to measure tilt angle with reference to the earth's ground plane, is to use an accelerometer. Typical applications can be found in the industry and in game controllers. In aircraft, the "ball" in turn coordinators or turn and bank indicators is sometimes referred to as an inclinometer.

Figure 1.2 Clinometer

Measuring tape is a flexible ruler and used to measure distance. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners. Today it is ubiquitous, even appearing in miniature form as a keychain fob, or novelty item. Surveyors use tape measures in lengths of over 100 m.

Figure 1.3 Measuring tapes

Field books we sell high-quality Surveying Field Books, Engineering Field Books, Mining Field Books, Cross Section Field Books, Miners Field Books, Engineers Journals, Engineers Log Books, and Level Field Books. These field books work great for making field notes or keeping a field journal, logbook, or notebook. Most have grid lines and tables, graph paper, and some are hard cover, some are soft cover bound and spiral bound.

Figure 1.4 Field books

Special forms: used as an element on your landing page. They are commonly found on landing and contact pages, and allow users to input the requested data and then forward this data to you via email. They can also be used to allow the users to access special content upon submitting the form, such as a free guide, eBook or subscription to an email newsletter.

Levels and transit levels shop our selection of levels and transit levels. Many different users from land surveyors, builders, swimming pool contractors to concrete pros and anyone wanting to work from a level reference can benefit from using a level. These levels are many times called by various names such as; Optical Levels, Surveyors Levels, Transit Levels, Builders Levels, or Builders Transit Levels.

Figure 1.5 Levels and transit level

Topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. A topographic survey is typically published as a map series, made up of two or more map sheets that combine to form the whole map. A contour line is a line connecting places of equal elevation.

Electronic distance measuring instrument is a surveying instrument for measuring distance electronically between two points through electromagnetic waves.

Electronic distance measurement (EDM) is a method of determining the length between two points, using phase changes, that occur as electromagnetic energy waves travels from one end of the line to the other end. As a background, there are three methods of measuring distance between two points:

- **DDM or Direct distance measurement** – This is mainly done by chaining or taping.

- ➢ **ODM or Optical distance measurement** – This measurement is conducted by tachometry, horizontal telemetric method. These are carried out with the help of optical wedge attachments.
- ➢ **EDM or Electromagnetic distance measurement** – The method of direct distance measurement cannot be implemented in difficult terrains. When large amount of inconsistency in the terrain or large obstructions exist, this method is avoided.

EDM instruments are classified based on the type of carrier wave as

1. Infrared wave instruments.
2. Microwave instruments.
3. Light wave instruments.

GPS is a device that is capable of receiving information from GPS satellites and then to calculate the device's geographical position. Using suitable software, the device may display the position on a map, and it may offer directions. The Global Positioning System (GPS) is a global navigation satellite system (GNSS) made up of a network of a minimum of 24, but currently 30, satellites placed into orbit by the U.S. Department of Defense.

(https://en.wikipedia.org/wiki/GPS_navigation_device Us, 2018)

GPS devices may be able to indicate:

- traffic congestion and alternative routes,
- the roads or paths available
- roads or paths that might be taken to get to the destination,
- if some roads are busy (now or historically) the best route to take,
- The location of food, banks, hotels, fuel, airports or other places of interests,
- the shortest route between the two locations,
- the different options to drive on highway or back roads.

Figure 1.6 GPS

Surveying (or land surveying) software assists in the process of evaluating a 3D landscape to determine the angles and distances between a series of points. Measuring the positioning of these points is typically used to establish maps and boundaries for buildings and other subterranean civic projects.

1.2 Conducting Checks on all materials, tools and equipment

Before you go to the field work you should have to check the sufficiency of the material (availability), faulty items reported and check on the quality of tools to operate on the field. Before and after using the different materials in the field it is very important to check the equipment. This makes the equipment free from some things unpleasant, undesirable, damaging that happen unexpected during work operation in the work place. If the materials are damaged it is possible to report to the supervisor immediately. A good care should be taken of the tools, which would then have a long life. It is not wise to keep workers sitting idle at critical periods of work because of shortage of tools. All tools should be hung or otherwise stored in fixed place. They should be stored in-groups of similar articles so that checking to ensure that all have been returned after work done at a glance.

1.3 Selecting and checking Suitable personal protective equipment (PPE)

Personal protective equipment's (PPE): are devices worn, put on, tied on, or inserted in such as hearing protectors inserted in the ears of workers for protection against industrial hazard health hazards and accidents.

Personal protective equipment's are used:

- ♠ As supplementary means of protection, and
- ♠ As direct means of protection

These materials include:

- ⇒ Protective clothing,
- ⇒ Eye and face protectors,
- ⇒ Ear protectors,
- ⇒ Head protectors(safety helmets),
- ⇒ Respiratory protectors,

⇒ Hands and arm protectors,

⇒ Foot and leg protectors,

⇒ Other personal protective equipment's.

Consider these factors when selecting PPE:

- Type of hazardous materials, processes, and equipment involved
- Routes of potential exposure (ingestion, inhalation, injection, or dermal contact)
- Available engineering controls
- Correct size for maximum protection
- Minimal interference with movement

1.4 Providing irrigation design and surveying support according to OHS requirements and workplace information

What is occupational health and safety?

Occupational health is concerned with health in its relation to work and the working environment. OHS is aiming at the adaptation of work to man and of each man to his job.

Occupational health and safety is a discipline with a broad scope involving many specialized fields. In its broadest sense, it should aim at:

- the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations;
- the prevention among workers of adverse effects on health caused by their working conditions;
- the protection of workers in their employment from risks resulting from factors adverse to health;
- the placing and maintenance of workers in an occupational environment adapted to physical and mental needs;
- the adaptation of work to humans

Hazards are classified into five different types.

These are

- **physical** - includes floors, stairs, work platforms, steps, ladders, fire, falling objects, slippery surfaces, manual handling (lifting, pushing, pulling), excessively loud and prolonged noise, vibration, heat and cold, radiation, poor lighting, ventilation, air quality
- **mechanical and/or electrical** - includes electricity, machinery, equipment, pressure vessels, dangerous goods, forklifts, cranes, hoists
- **chemical** - includes chemical substances such as acids or poisons and those that could lead to fire or explosion, cleaning agents, dusts and fumes from various processes such as welding
- **biological** - includes bacteria, viruses, mildew, insects, vermin, animals
- **Psychosocial environment** - includes workplace stressors arising from a variety of sources.

1.5 Identifying and reporting OHS hazards

A hazard is a source or potential source of human injury, ill health, or disease.

Identifying hazards in the workplace are:

Step 1: Identify the hazards (Identify all hazards associated with the systems of work)

Step 2: Assess the risks (Assess the risks arising from the hazards)

Step 3: Control the risks (Decide on and use appropriate control measures)

Step 4: Monitor and review **(**A cyclical process frisk management programs)

1. Identify the hazards

Hazard identification is identifying all situations or events that could cause injury or illness. Hazards are classified into five different types. They are: Physical, mechanical and/or electrical, chemical, biological, psychosocial and environment hazards.

2. Assess the risks

Assessment of risks

When you identify a hazard, do a risk assessment. A risk assessment process means you

- Gather information about each identified hazard.
- Consider the number of people exposed to each hazard and the duration of the exposure.
- Use the information to assess the likelihood and consequence of each hazard.
- Use a risk assessment table to work out the risk associated with each hazard.

- Conduct regular, systematic inspections of the workplace.
- Observe what hazards exist in the workplace and ask, 'what if?'
- Listen to feedback from the people performing work tasks.
- Maintain records of the processes used to identify hazards.
- Talk to your health and safety representatives.

You should consider the following factors during the risk assessment process

- The nature of the hazard posing the risk
- Combinations of hazards

3. Control the risks

Control measures

The correct course of action once a hazard is identified is to use control measures. These generally fall into three categories. You can:

- eliminate the hazard
- minimize the risk
- Use 'back-up' controls when all other options in the previous categories have been exhausted

The best way to control a hazard is to eliminate it.

Minimizing the risk

- ✓ It can be done by: substitution (e. g. substitute a hazardous chemical with a less dangerous one), modification (e.g. redesign plant to reduce noise levels), isolation (e.g.isolate copying equipment and other machinery in soundproof rooms to reduce fumes and noise)

Or, Engineering controls

If you cannot eliminate a hazard of make a substitution to eliminate it, and then reduce the chance of hazardous contact. Redesign equipment, work processes or tools to reduce or eliminate the risk. For example,

- ♠ use mechanical aids to minimize manual handling injuries

Employees have a responsibility to use PPE in accordance with their training and safe usage requirements. For example

- ♠ wear earplugs in noisy areas

4. Monitor and review

A cyclical process

Risk management programs are cyclical, once current workplace hazards are successfully controlled the process does not stop. Systematic monitoring and reviews must be implemented because of the potential for new hazards to be introduced into a workplace.

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 do mean by irrigation design? (5 points)
2. What do mean by surveying? (5 points)
3. List the types of electromagnetic distance measuring waves? (3 points)
4. What does GPS device indicate? (5 points)
5. What tools and equipment are required for irrigation design and surveying work (5 pts.)
6. What are the factors considered when we select PPE. (3pts.)

Note: Satisfactory rating - 13 points and above Unsatisfactory - below 13 points

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

LAP Test1	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: _________________________ Time finished: ________________

Instructions:

1. You are required to perform any of the following:

   1.1 Request your teacher to arrange for you to visit the nearby irrigation design and surveying. You should identify important tools, materials and equipment. Submit your report to your teacher for evaluation.

1.2 Request a set of irrigation design and surveying equipment, then perform the following tasks in front of your teacher

- Name of the tool and
- Its application

1.3 Request your teacher for evaluation and feedback

Information sheet -2	Undertake irrigation design and surveying tools identification work

2.1. Identifying elementary surveying equipment

✓ **Chain and Tape:** chains or tapes are used to measure distances on the field.

A chain is made up of connected steel segments, or links, which each measure 20 cm. Sometimes a special joint or a tally marker is attached every 5 meters. Usually, a chain has a total length of 20 meters, including one handle at each end.

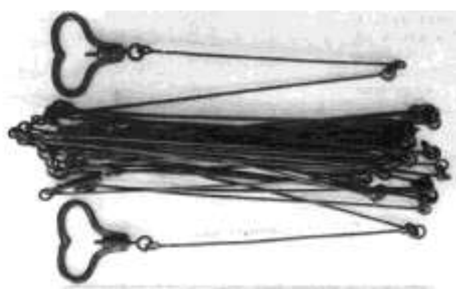


Figure 2.1 chain

✓ **Measuring tapes**are made of steel, coated linen, or synthetic material. They are available in lengths of 20, 30 and 50 m. Centimeters, decimeters and meters are usually indicated on the tape.

Figure 2.2 measuring tapes

- **Measuring Rod**A measuring rod (see Fig. 2.2) is a straight lath with a length varying from 2 m to 5 m. The rod is usually marked in the same way as a measuring tape, indicating centimeters, decimeters and meters.

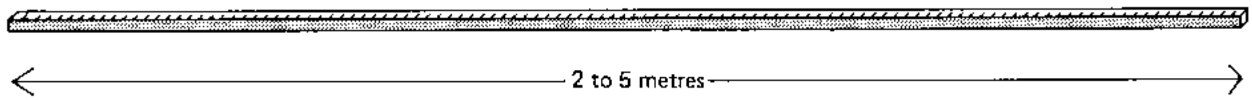


Figure 2.3 measuring rode

- **Plumb Bob:** A plumb bob is used to check if objects are vertical. A plumb bob consists of a piece of metal (called a bob) pointing downwards, which is attached to a cord (see Fig. 2.3). When the plumb bob is hanging free and not moving, the cord is vertical.

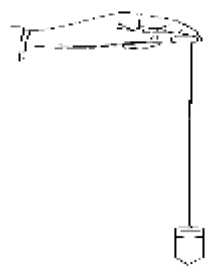


Figure 2.4 plumb bob

- **Carpenter Level:** A carpenter level is used to check if objects are horizontal or vertical. Within a carpenter level there are one or more curved glass tubes, called level tubes (see Fig. 2.4).

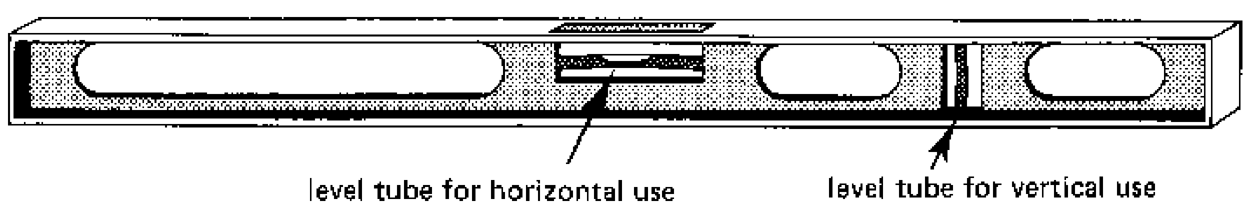


Figure 2.5 carpenter level

Each tube is sealed and partially filled with a liquid (water, oil or paraffin). The remaining space is air, visible as a bubble (see Fig. 2.6). On the glass tube there are two marks. Only when the carpenter level is horizontal (or vertical) is the air bubble exactly between these two marks.

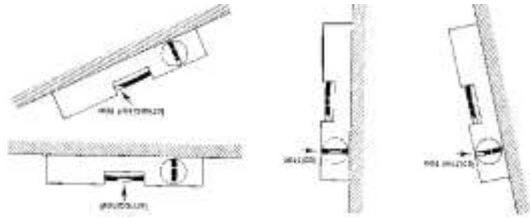


Figure 2.6 carpenter level

- ✓ **Ranging Poles:** Ranging poles (see Fig. 7) are used to mark areas and to set out straight lines on the field. They are also used to mark points which must be seen from a distance, in which case a flag may be attached to improve the visibility.
- ✓ **Ranging poles** are straight round stalks, 3 to 4 cm thick and about 2 m long. They are made of wood or metal. Ranging poles can also be home made from strong straight bamboo or tree branches. Rememberranging poles may never be curved.

Ranging **poles** are usually painted with alternate red-white or black-white bands. If possible, wooden ranging poles are reinforced at the bottom end by metal points.

Figure 2.7 Ranging pole

- ✓ **Pegs:** Pegs are used when certain points on the field require more permanent marking. Pegs are generally made of wood; sometimes pieces of tree-branches, properly sharpened, are good enough. The size of the pegs (40 to 60 cm) depends on the type of survey work they are used for and the type of soil they have to be driven in. The pegs should be driven vertically into the soil and the top should be clearly visible.

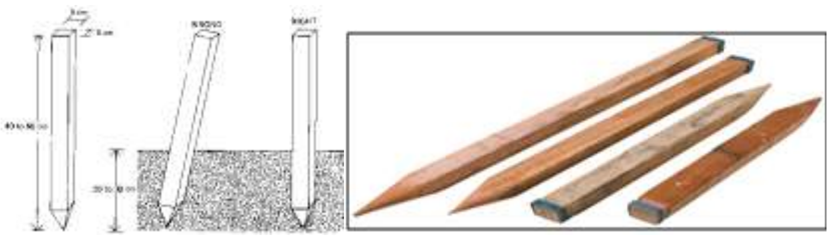


Figure 2.8 pegs

2.2 identifying the principal surveying instruments and accessories

Leveling and surveying methods are used for measurements of river channel and lake configurations.

Often, less accurate methods can be used for this work than for water-level recording stations, although the techniques are common

The principles of leveling lies in providing horizontal line of sight for reading a vertically held leveling staff on a point the reduced level of which is to be determined in a leveling operation
The major parts of a level are:

1. Telescope
2. A bubble
3. Vertical spindle
4. Leveling head
5. A tripod

The accessories of a level are:

a. Tripod
b. Leveling staff
c. The plumb bob
d. Tape
e. Peg

- ✓ Tripod: Consists of three legs solid or light weight framed construction, hinged to the tripod head, so that it can be folded and made portable.

Figure 2.9 Tripod

Older surveying tripods had slightly different features compared to modern ones. For example, on some older tripods, the instrument had its own footplate and did not need to move laterally relative to the tripod head. For this reason, the head of the tripod was not a flat footplate but was simply a large diameter fitting. Threads on the outside of the head engaged threads on the instrument's footplate. No other mounting screw was used.

Fixed length legs were also seen on older instruments. Instrument height was adjusted by changing the angle of the legs. Widely spaced tripod feet resulted in a lower instrument while closely spaced legs raised the instrument. This was considerably less convenient than having variable length legs.

Materials for older tripods were predominantly wood and brass, with some steel for high wear items like the feet or foot points.

Fig.2.10 head of a surveyor's tripod

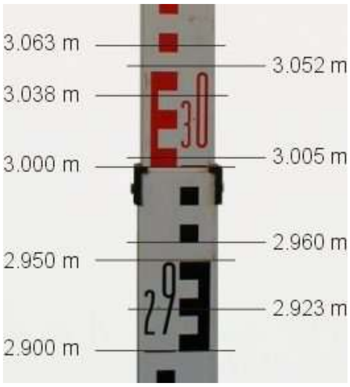
The platform is used to push the spike into the ground. Above the foot is the height adjustment.

The tripod is placed in the location where it is needed. The surveyor will press down on the legs' platforms to securely anchor the legs in soil or to force the feet to a low position on uneven, pock-marked pavement. Leg lengths are adjusted to bring the tripod head to a convenient height and make it roughly level.

Once the tripod is positioned and secure, the instrument is placed on the head. The mounting screw is pushed up under the instrument to engage the instrument's base and screwed tight when the instrument is in the correct position. The flat surface of the tripod head is called the foot plate and is used to support the adjustable feet of the instrument.

Positioning the tripod and instrument precisely over an indicated mark on the ground or benchmark requires techniques that are beyond the scope of this article.

The leveling staff: is a graduated rod of rectangular section. It is usually made of thick wood. It may be of fiberglass or metal.



A. Fig.2.11 graduated staff B. fig.2.12 reading the stuff where the two large cross hairs meet & the reading is 2.22m

2.3 Identifying and installing Electronic and Self-Leveling Surveying Equipment

1. Electronic distance-measuring (EDM) equipment

Modern Surveying Instruments and Their Uses

Following are the modern surveying instruments which are used for surveying:

1. Electronic Distance Measurement (EDM) Instruments

Direct measurement of distances and their directions can be obtained by using electronic instruments that rely on propagation, reflection and reception of either light waves or radio waves. They may be broadly classified into three types:

Electronic surveying instruments measure features, orientation and positioning of large-scale objects in engineering, construction, mapping, defense and other industries. Land surveying equipment assists with mapping, while construction surveying instruments are used to mark the position and layout of new structures. Electronic surveying instruments have made life easier for surveyors, who used to do their measurements using time-consuming conventional equipment such as chains, tapes, compasses and dumpy levels.

Electronic Theodolite

The electronic Theodolite is a measurement unit that is used to determine horizontal and vertical angles in a certain area. The horizontal and vertical readings are displayed simultaneously on an LCD panel.

Total Station

A Total Station is a light-weight instrument, integrating the technology of an electronic or digital theodolite, an electronic distance measuring device and a microprocessor in the same unit. It is used for distance and angular measurement, data processing, digital display of point details and data storage in an electronic field book. The digital panel displays the distances, angles, heights and the coordinates of the observed area. A microprocessor applies corrections for the Earth's curvature and refraction automatically.

Total Station

Total Station is a lightweight, compact and fully integrated electronic instrument combining the capability of an EDM and an angular measuring instrument such as wild theodolite.

Total Station can perform the following functions:

- Distance measurement
- Angular measurement
- Data processing
- Digital display of point details
- Storing data is an electronic field book

The important features of total station are,

- Keyboard-control – all the functions are controlled by operating key board.
- Digital panel – the panel displays the values of distance, angle, height and the coordinates of the observed point, where the reflector (target) is kept.
- Remote height object – the heights of some inaccessible objects such as towers can be read directly. The microprocessor provided in the instrument applies the correction for earth's curvature and mean refraction, automatically.
- Traversing program – the coordinates of the reflector and the angle or bearing on the reflector can be stored and can be recalled for next set up of instrument.

Setting out for distance direction and height -whenever a particular direction and horizontal distance is to be entered for the purpose of locating the point on the ground using a target, then the instrument displays the angle through which the theodolite has to be turned and the distance by which the reflector should move.

Global Positioning System: The U.S. Defense Department developed the Global Positioning System, which is widely used for surveying purposes. Satellites transfer information about the specific location to a GPS receiver. A surveying GPS receiver will then process the signals received and calculate the latitude, longitude and elevation of the area. The main benefit of this system is that you no longer need a line of sight between two surveying points.

Global Positioning System (GPS) is developed by U.S. Defense department and is called Navigational System with Time and Ranging Global Positioning System (NAVSTAR GPS) or simply GPS.

The user needs a GPS receiver to locate the position of any point on ground. The receive processes the signals received from the satellite and compute the position (latitude and longitude) and elevation of a point with reference to datum

Automatic Level: Automatic levels are electronic surveying instruments that contain optical compensators. This self-leveling feature enables it to maintain a level line of sight even though the instrument is slightly tilted. After the bubble was manually centered, the automatic compensator takes over and levels the line of sight.

An automatic level is a special leveling instrument used in surveying which contains an optical compensator which maintains line of sight or line of collimation even though instrument is slightly tilted.

Self-Level: The self – leveling level is similar to tilting level except that it has no micrometer screw. Instead, self –leveling level contains an internal compensator mechanism (a swinging prism or pendulum) that, when set close to level, automatically removes any remaining variation from level. This automatically reduces the need for setting the instrument for leveling as in the case of dumpy and tilting level. Self-leveling instruments are highly preferred instrument in surveying due to ease of use and minimal rapid set up time consuming.

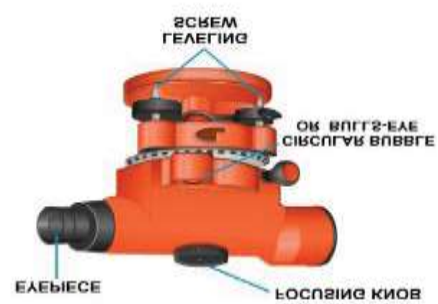


Fig. 2.13 Automatic level

2.3.1 Installing leveling instruments

Step 1: gather the survey equipment, stake, and tools. It is very important for every surveyor to have all of their equipment ready for the job ahead. One missing item could cost your organization time and money. Prepare the following items:Tripod, tribrach, total station, survey controller, power cable, communication cable, battery pack, survey controller, stake w/nail and survey marker and hammer.

Fig. 2.14 surveying equipment

Step 2: establish a new temporary benchmark.

Within our projects we typically need to establish a new point of reference with a temporary benchmark. Using a small nail tapped into the center of a wooden stake, pound the stake into, and as flush as possible, with the ground.

Fig. 2.15 establish benchmark

Step 3: set-up the tripod: While holding the tripod, loosen the tripod leg clamps and extend the tripod up to a height near your neck and chin. Tighten the leg clamps. Spread out the tripod legs evenly, about two to three feet for each leg, and center it over your benchmark stake. The top of your tri-pod should be mostly level and parallel with a horizontal plane.

Fig. 2.16set-up of tripod

Step 4: attach the tribrach and course level the tripod over the benchmark.A level instrument is a key to successful surveys. The tribrach features a level bubble and leveling screws to adjust the tripod's level as necessary. An optical plummet on the tribrach allows the surveyor to view the tribrach's center and place its cross-hairs precisely over the survey marker nail on the stake.

Center the tribrach on the tripod and attach it via the tripod connecting screw. While holding two tripod legs, keeping the tripod as level as possible, place the optical plummet cross-hairs over the center of the nail. With your foot, apply equal pressure along each tripod leg to ensure a stable connection with the ground.

Step 5: continue to level and adjust the tribraches necessary

Step 6: set the instrument on the tripod.

Fig. 2.17setting of tripod on the instrument

Remove the total station from the carrying case and secure it to the top of the tribrach with the tribrach/instrument lock. Be careful with this step as the instrument can cost up to $25,000! I know my bank account couldn't support that bill.

Step 7: connect power supply and communication cables.

Fig. 2.18connecting the power supply

Attach the battery pack to the tripod.Connect one cable from the battery pack to the instrument connection port.Connect the other cable from the battery to the survey controller.

Step 8: power-on the instrument and controller to access the fine level.

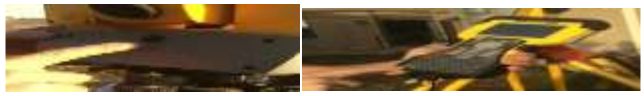


Fig. 2.19power on the instrument

Press the black button on the instrument to power it on.Press the green button on the survey controller to power it on. On the survey controller, use the stylus to open the survey controller program. The software will open fine-leveling automatically.

Step 9: fine level the instrument and compensate.

Fig. 2.20leveling of the instrument

To fine level the instrument, turn the total station so that its face-plate is parallel with two tribrach leveling screws. These two screws will be used to adjust the trunnion (left and right) and the sighting (forward and back).Now that the instrument has been successfully leveled, press the accept button so that the instrument can perform its compensation action.

Step 10: you're ready to survey!

Fig. 2.21 establish benchmark

The total station is now ready to begin surveying operations.

2.3.2 Installing electronic theodolite

- Parts of a Theodolite

Like other leveling instruments, a theodolite consists of a telescope mounted on a base. The telescope has a sight on the top of it that is used to align the target. The instrument has a focusing knob that is used to make the object clear. The telescope contains an eyepiece that the user looks through to find the target being sighted. An objective lens is also located on the telescope, but is on the opposite end as the eyepiece. The objective lens is used to sight the object, and with the help of the mirrors inside the telescope, allows the object to be magnified. The theodolite's base is threaded for easy mounting on a tripod.

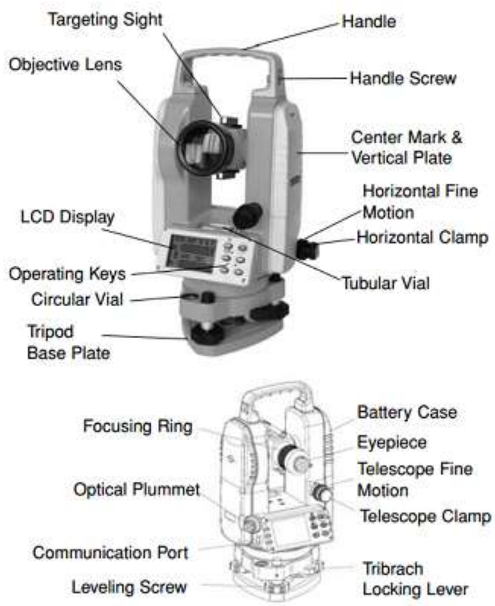


Fig. 2.22 establish benchmark

How Does a Theodolite Work?

A theodolite works by combining optical plummets (or plumb bobs), a spirit (bubble level), and graduated circles to find vertical and horizontal angles in surveying. An optical plummet ensures the theodolite is placed as close to exactly vertical above the survey point. The internal spirit level makes sure the device is level to to the horizon. The graduated circles, one vertical and one horizontal, allow the user to actually survey for angles.

How to install a Theodolite

1. Mark the point at which the theodolite will be set up with a surveyor's nail or a stake. This point is the basis for measuring angles and distances.
2. Set up the tripod. Make sure the height of the tripod allows the instrument (the theodolite) to be eye-level. The centered hole of the mounting plate should be over the nail or stake.
3. Drive the tripod legs into the ground using the brackets on the sides of each leg.

4. Mount the theodolite by placing it atop the tripod, and screw it in place with the mounting knob.
5. Measure the height between the ground and the instrument. This will be used a reference to other stations.
6. Level the theodolite by adjusting the tripod legs and using the bulls-eye level. You can make slight tunings with the leveling knobs to get it just right.
7. Adjust the small sight (the vertical plummet) found on the bottom of the theodolite. The vertical plummet allows you to do ensure the instrument remains over the nail or stake. Adjust the plummet using the knobs on the bottom.
8. Aim the crosshairs in the main scope at the point to be measured. Use the locking knobs on the side of the theodolite to keep it aimed on the point. Record the horizontal and vertical angles using the viewing scope found on the theodolite's side.

Self-Check 1	**Written Test**

Name: ___________________________ **Date:** ________________

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

1. List and discuss Elementary Surveying Equipment**?**(5 pts)
2. List the accessories parts of a level? (5pt)
3. List out the steps of installing leveling equipment? (5pt)
4. List out the steps of installing electronic theodolite? (5pt)
5. What is the differences between self and electronic surveying equipment? (5pts)
6. List the functions of total station? (5Pt)

Note: **Satisfactory rating – 15 points and above** **Unsatisfactory - below 10 points**

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

Operation sheet-2	**Investigate surveying tools and equipment**

Objectives: To know the functions of the tools and equipment in surveying.

Procedure:

1. Identify Electronic Surveying Equipment

2. Identify the parts of self-level.

LAP Test 2	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions:

1. You are required to perform any of the following:

1.2 Request your teacher to arrange for you to visit the nearby irrigation design and surveying. You should identify important elementary surveying instrument. Submit your report to your teacher for evaluation.

1.3 Request a set of elementary surveying equipment, principal surveying instrument and accessories , then perform the following tasks in front of your teacher

- Name of the tool and
- Its application

1.4 Request your teacher for evaluation and feedback

1.5 Identify electronic and self –leveling equipment

1.6 Request a set of electronic and self –leveling equipment, then perform the following tasks in front of your teacher

- Its application
- Installing electronic and self-leveling equipment

Information sheet -3	Care and handling of surveying instruments

3.1 Maintaining tapes and chains.

Proper care in the method by which equipment is used, stored, transported, and adjusted is a major factor in the successful completion of the survey. Lack of good maintenance practices not only causes unjustified replacement costs, but also can serious the efficiency and accuracy of the entire survey. When you purchase a surveying instrument, it will typically come with a product manual that shows you how to properly care for and maintain your product. It's so important to know these procedures and carry them out routinely.

General & routine care of survey equipment consist of:

- Keeping your equipment as clean and dry as possible.
- Always inspect your equipment for cracks or dents.
- Clean your equipment as frequently as possible.
- Cover your equipment when it is being left for long periods of time.

Here are some tips on surveying equipment maintenance so you can ensure your site measurements are precise.

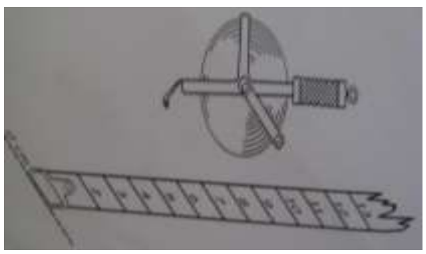
A. **Service annually:** utilities using total stations will want to make a habit of sending their equipment in once a year to be serviced. "We design our equipment specifically for the construction industry so that it is more rugged, robust and requires little maintenance. Even if there aren't any clear issues with a total station's site positioning capabilities, a regular service can prevent problems from developing.

B. **Calibrate regularly and check against control points:** Outside of an annual service, upkeep in the field for a total station should consist of a calibration at least every two weeks, as well as ensuring positioning accuracy by checking the instrument on a known point.

C. **Stay current on software upgrades:** Typically you'll see software being upgraded a couple times a year, and this will improve system performance and usually fix any bugs there may have been with previous software releases.

D. **Use the carrying case for storage and transport:** Surveying equipment comes equipped with a rugged carrying case, and it's important to make use of it.Before making the first set-up of the day, visually inspect the instrument for damage. Check the machined surfaces and the polished faces of the lenses and mirrors. Try the clamps and motions for smooth operation (absence of binding or gritty sound). Clean the exterior of the instrument frequently.

i. **Tapes** /TapingThe measurement of distance by using tapes is called taping. Tapes are made in variety of materials, lengths and weights. The precision of distance measured with tape depends upon the skill of the person, taping accessories, the ground situation and atmospheric condition.



Taping Techniques

- To measure the horizontal distance between any two points we use different techniques depending on the nature of the ground surface.
- Level ground with no obstacles: - In such types of ground, the tape is stretched directly on the surface and the distance is measured.

Taping procedure;

1st The two end stations of a line to be measured are marked with ranging poles

2nd A set of intermediate stations are established by ranging

3rd The rear tape man stands at the beginning of the survey line

4th The head tape man, with zero graduation end of the tape and with chaining pins goes along the line to the other end.

5th The rear tape man holds the end of the tape at the beginning station and the head tape man marks the zero end of the tape with a pin.

6th The rear tape man comes forward to the mark and the front (head) tape man continues moving forward as before.

7th In this way the measurements continue till all the survey lines are measured.

On level ground with obstacles: - In this case, both ends of the tape are kept off the ground at equal height and the distance is measured following the above procedures.

On sloping ground:-Two alternative techniques are mostly used;Tape breaking: this technique is applied on irregular excessive slopes.

Touching intermediate ranging poles. When the mark is set at this point, the rear tape man comes forward to the mark and the front tape man continues moving forward as before. When they finish the second measurement, the rear tape man removes the pins at his position and proceeds forward. In this way the measurements continue until all the survey lines are measured.

Taping accessories and their uses

- Accurate taping of a distance several hundred meters long can't be attained with tape alone. Accessory equipment is required. The following are some of the accessories required for accurate taping.

    A. Line rod (poles)
    B. Plumb bobs
    C. A set of taping pins (marking arrows)
    D. Hand level
    E. Spring balance

Care of tapes: Routine care extends tape life. The following are basic guidelines for the care of tapes:

- ✓ Do not place a tape where it can be stepped on or run over, unless the tape is flat, taut, and fully supported on a smooth surface. Keep the tape straight when in use. When pulling a slack tape, a loop can develop into a kink and easily break the tape. Avoid pulling a tape around poles or other objects, as a hard pull can stretch or break the tape.
- ✓ Do not wind tapes overly tight on their reels, as it can cause unwanted stresses and lead to stretching of the tape.
- ✓ After the day's work, clean tapes that are soiled. In wet weather, dry before storing. Clean rusty tapes with fine steel wool and cleaning solvent or kerosene. Use soap and water when tape is dirty or muddy. To prevent rust after cleaning, oil lightly and then dry the tape.
- ✓ Avoid storing in damp places.

ii. Chaining pins

These accessories are employed for marking the end of a tape as well as any intermediate points. A surveying pin is usually contracted from heavy gauge wire painted in alternating white and red stripes. When chaining, the individual at a rear of the chain place one pin at the starting point and the remaining pins are placed by the person at the head of the chain. The process repeated until the head person reaches the destination.

3.2 Transporting surveying instruments and accessories.

Care in transporting surveying equipment: the major damage to equipment and tools occurs when they are being placed into or taken out of the survey vehicle. Other damage occurs during transport, when equipment is jostled against other tools or equipment. Compartments (lined with carpeting, when possible) should be provided to keep equipment and supplies separated. This not only keeps the equipment from being damaged, it facilitates finding such items more rapidly. Heavier items should be carried in the lower parts of vehicles and they should never be in direct contact with other tools or equipment below them. Many instrument cases indicate the position in which they should be transported. Treat tribraches, prisms and tripods with care. Carry them in their shipping cases or cushion them with firm poly foam or excelsior-filled cases to protect them from jolting or vibrating excessively.

- **Vehicular transport**

Transport and store instruments in positions that are consistent with the carrying case design. For example, total stations should be carried and stored in their correct way.

- ✓ Ensure that tripod screws and hinges are kept tight.
- ✓ Always transport the level in a padded box.
- ✓ When removing from the box lift it by the center and not by the eyepiece or objective end of the telescope.
- ✓ Screw it firmly onto the tripod, whilst holding it in one hand (make certain that it is not cross-threaded and that threads are compatible).
- ✓ When carrying the level tripod assembly in the field, support it over the shoulder or, in bush, crooked over an arm with the telescope unclamped (i.e. Free to rotate).
- ✓ Automatic levels should not be carried in a vertical or near-vertical position, as the compensator will swing about and be prone to damage.
- ✓ Staves are too much of a precision item of equipment to be used in place of a slasher, vaulting pole, etc.

- ✓ Staves shall be transported in their protective cases to protect the face from damage.
- ✓ Wooden staves which become wet should be dismantled and dried out before storing away.

Any moisture which is evident in an instrument must be allowed to disperse by storing the level out of its case in a warm room. Should it persist after several days the instrument may require specialist servicing?

3.3. Performing mounting instruments on tripod

Demonstrate that instrument performs consistently as per specifications defined by the user and is appropriate for the intended use

Requirements

- ✓ Set up experiments to verify the performance of the instrument

When to do:

- ✓ After preventive maintenance
- ✓ After major module service
- ✓ After system reconfiguration

System must be in place to ensure that all instruments are calibrated and also to prevent use of an instrument that is not calibrated, unusable due to damage or malfunction, or has exceeded its established calibration interval. It identifies instruments that do not require calibration to be performed beyond the original or factory calibration to distinguish from those instruments that do require scheduled calibrations

3.4 Cleaning and storing equipment

- ✓ Survey equipment is used day in and day out in various conditions making it even more important to ensure that your equipment is being properly cleaned and maintained.
- ✓ Before making the first set up of the day, visually inspect the instrument for cracks, bumps, and dents. Check the machined surfaces and the polished faces of the lenses and mirrors. Try the clamps and motions for smooth operation (absence of binding or gritty sound).
- ✓ Frequently clean the instrument externally. Any accumulation of dirt and dust can scratch the machined or polished surface and cause friction or sticking in the motions.
- ✓ Dirt and dust should be removed only with a clean soft cloth or with a camel hair brush.
- ✓ Non-optical parts may be cleaned with a soft cloth or clean chamois.

- ✓ Clean the external surfaces of lenses with a fine lens brush and, if necessary, use a dry lens tissue.
- ✓ Instrument is wet or frost covered it should be remove it from its case, and leave it at room temperature to dry out.
- ✓ Do not use silicon treated tissues, as they can damage the coated optics.
- ✓ Any accumulation of dirt and dust can scratch the machined or polished surfaces and cause friction or sticking in the motions. Remove dirt and dust with a clean, soft cloth or with a camel-hair brush. Clean non-optical parts with a so ft cloth or clean chamois.
- ✓ Surveying equipment is being used under most stressful conditions. The equipment is exposed to extreme weather conditions, used in dusty construction areas and is subject to bumpy transportation.

  - ➢ **Clean with soap and water**

Most equipment can be expensive so replacing it constantly is not cost effective or even possible for some.

- ✓ Taking simple steps to keep your survey equipment maintained effectively can help you save time, money and ensure that your surveys are efficient and accurate.
- ✓ Using proper care methods when it comes to using your equipment, storing & transporting it can have a tremendous effect on the life expectancy of your equipment, as well as the quality.
- ✓ For cleaning your surveying tools, all you need is some soap and water. Because all the devices that Trimble makes are rated at ip67 so they can handle some moisture,"

There are two types of solid waste disposal methods from cleaning of tools and equipment

- ➢ **Incineration:**Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of both municipal solid waste and solid residue from waste water treatment. This process reduces the volumes of solid waste by 80 to 95 percent.[17] Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam, and ash.
- ➢ **Landfill:** A landfill site (also known as a tip, dump, rubbish dump, garbage dump or dumping ground is a site for the disposal of waste materials by burial. It

is the oldest form of waste treatment (although the burial part is modern; historically, refuse was just left in piles or thrown into pits). Historically, landfills have been the most common method of organized waste disposal and remain so in many places around the world.Some landfills are also used for waste management purposes, such as the temporary storage, consolidation and transfer, or processing of waste material (sorting, treatment, or recycling). Unless they are stabilized, these areas may experience severe shaking or soil liquefaction of the ground during a large earthquake.

3.5 Checking and adjusting instruments to work.

In all types of workplaces, there are different types of equipment and machinery that we use to carry out everyday tasks. All work equipment has the potential to cause problems in the workplace, so you need to ensure that it remains safe to use and that you're not putting employees at risk.

Work equipment is any equipment used at work, such as:

- ✓ Lifting equipment: including fork-lift trucks, vehicle hoists and lifting slings;
- ✓ Hand tools :including hammers, chisels, screwdrivers and saws;
- ✓ Transport equipment : including vans and forklift trucks;
- ✓ Display screen equipment: including computer displays and work stations.

In addition, workplace equipment can include:

- ✓ Respiratory protective equipment : including respirators and breathing apparatus;
- ✓ Personal protective equipment: including safety footwear, hard hats, goggles and respirators.

Are there any legal duties around work equipment?

If you own, operate or have control over work equipment, you need to ensure it is fit for purpose, and is being used safely and effectively under the provision and use of work equipment regulations. Power requires that work equipment is safe for use, used in accordance with requirements and is only used by employees who have been trained to use it.

What can I do to make sure that work equipment is safe?

- There are a number of measures you can take to ensure that risks created by work equipment are eliminated or controlled, including: Selecting suitable equipment and maintaining it properly;

- Carrying out a risk assessment to identify any risks presented by work equipment;
- Following the manufacturers' instructions for use and maintenance;
- Ensuring a robust system of defective fault reporting is in place, and that employees use this system.

Work equipment is only allowed to be used by people who have received adequate training.

Self-Check 3	Written Test

Name: ___________________________ Date: ________________

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

1. How can you care and handle surveying instruments? Explain it. (10pts)
2. What we are expected to do when transporting surveying instruments? (5pts)
3. Briefly explain the ways how we can check and adjust surveying tools for work? (5pts)
4. what are the types of waste disposal ? (5pts)

Note: Satisfactory rating – 12.5 points and above Unsatisfactory - below 10 points

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

LAP Test/ Job Sheet 3	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions:

1. You are required to perform the following activity:
   - ✓ Maintain tapes and chains
   - ✓ Mount tripod
   - ✓ Clean and store electronic theodolite, tripod, tapesand chains
   - ✓ Check and adjusting electronic theodolite, tripod, tapesand chains
2. Request your teacher for evaluation and feedback.

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