TVET CERTIFICATE V in Land Surveying

SETTING OUT OF STRUCTURES

LSVSS501

PERFORM OF SETTING OUT OF STRUCTURES

Competence

Learning hours

100

REQF Level: 5

Credits: 10

Sector: Construction and Building Services

Sub-sector: Land surveying

Module Note Issue date: June, 2020

Purpose statement

This module describes the skills, knowledge and attitudes required to perform setting out of structures. At the end of this module, participants will be able to perform setting out of buildings, setting out of pipeline, setting out of dam, setting out of electrical line and to perform as built surveying of different structure.

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Learning Unit 1.PERFORM SETTING OUT OF BUILDINGS

LO1.1: Identify building elements and setting out terminologies

- **Topic 1: Building elements**

1. Foundation: foundation in construction is a lower portion of building structure that transfers its gravity loads to the earth. Foundations are generally broken into two categories: shallow foundations and deep foundations. A tall building must have a strong foundation if it is to stand for a long time.

The **purpose** of a **foundation** is to hold up and hold together the structure above it. ...

A properly-built foundation increases the amount of abuse a house structure can take and remain safe for the people inside it. Foundations are buried in the ground and hold buildings up.

- **Sub-soil:** The soil below the foundation or the soil on which the foundation is constructed.
- **Footing:** The lowermost part of the foundation contact with the sub-soil.

Function of a foundation

- Distribute the loads of the whole structure (building, bridge, antenna) over a large area,
- To give a leveled surface and hard to elevate the super- structure,
- To increase the stability of the structure against overturning,
- It resists against insects, animals and water penetration,
- It resists against soil movements due to movement and stress in the soil.

What are the conditions which may affect the foundation?

- The load bearing capacity of the soil (ground)
- The depth of the foundation
- The distance from the trees to the foundation (roots of the trees)
- The height of the ground water table
- The variation in ground water table

- Total weight of the building
- The previous uses of the building site

2. Plinth: is the part of the superstructure between the top of the tie beam at the finished ground level (the top level of the soil surrounding the structure that has been prepared and leveled prior to construction) and the floor level of the building(the ground floor level inside the building).

The function of plinth

The plinth distributes that weight outwards, dispersing it more evenly through the ground or floor. That's the most important function of a plinth; however, it can also be used to physically separate structures like houses from the ground. What is plinth height?

Plinth Level: - The level at which Substructure ends and superstructure starts is called Plinth level. ... The plinth height is in between 300mm – 450 mm from ground level. It is recommended that the minimum plinth height of 150 mm is adopted from the top of the road. Damp proof course (DPC) is laid on Plinth level

3. A wall: is a structure that defines an area, carries a load; provides security, shelter, or soundproofing; or is decorative. There are many kinds of walls, including: Walls in buildings that form a fundamental part of the superstructure or separate interior rooms, sometimes for fire safety.

A **wall** is usually a solid structure that defines and protects an area. Most commonly,

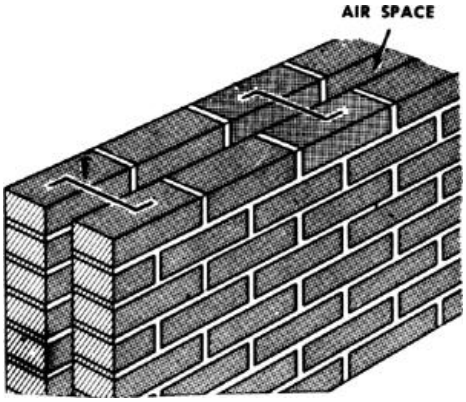
- A wall delineates a building and
- Supports its **superstructure**,
- Separates space in buildings into ***rooms***.

Types of walls

Walls can be classified into many categories based on the principles element (consideration). In this context we can distinguish walls based upon:

- The materials for their construction (Brick wall, concrete wall, steel wall, timber wall and block wall etc)
- Their location(Extern wall and internal wall)
- Their construction methods (Solid wall and Cavity wall)

Example of cavity wall:



- Based on the loading system

Retaining wall: is a special type of wall that may be either external to a building or part of a building that serves to provide a barrier to the movement of earth, stone or water.

- The ground surface or water on one side of a retaining wall will be noticeably higher than on the other side

Gabions: are rectangular wire baskets, usually of **zinc**-protected **steel (galvanized steel**) that are filled with fractured stone of medium size. These will act as a single unit and are stacked with setbacks to form a revetment or retaining wall. They have the advantage of:

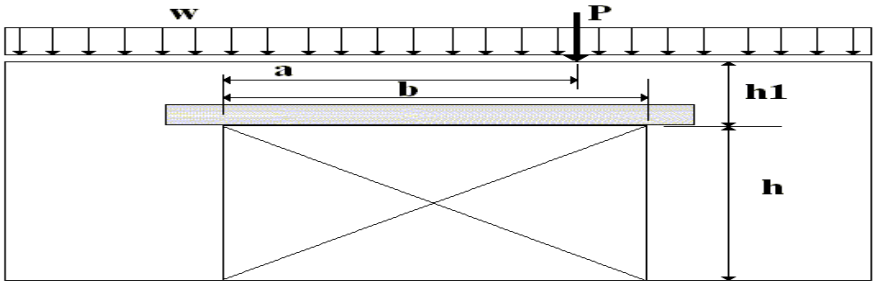
- Being both well drained and flexible,
- Resisting to flood, water flow from above, frost damage, and soil flow.

4. Floor: A floor in building construction is a leveled surface which can support the objects, occupants etc. Different flooring types are there based on different factors.

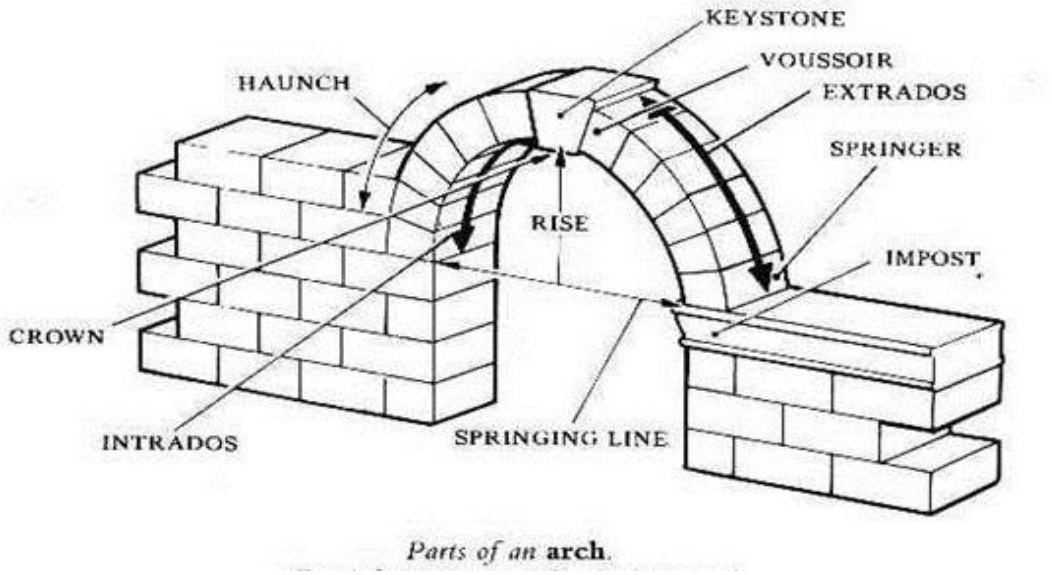
5. Lintel: Lintel is a horizontal building component that lies across an opening and holds the weight of the structure above it. It is generally placed between two vertical supports.

Lintel is made of Lime, Steel, Wood, Concrete, RCC, Stone etc.

When Lintel is a structural member, it is also referred as Lintel Beam. Lintel may be cast in-situ or pre-casted and erected at location



6. Arches: An arch is a curved structure constructed in building units joined together with a mortar that is constructed over the opening for transmitting loads over it to the supports.



Parts of an **arch**.

7. **Beam**: A beam is a structural member used for bearing loads. It is typically used for resisting vertical loads, shear forces and bending moments. Beams are characterized by their manner of support, profile (shape of cross-section), length, and their material.

Beams are used for resisting vertical loads, shear forces and bending moments. S

The four different types of beams are:

 Simply Supported Beam.

 Fixed Beam.

 Cantilever Beam.

 Continuously Supported Beam.

8. Slab: In context to Civil Engineering, it is Concrete Slab. It is a flat piece of concrete, put on the walls or columns of a structure. ... When slabs are supported by columns arranged generally in rows so that the slabs can deflect in two directions they are usually referred to as two-way slabs.

What is the difference between beam and slab?

Difference in structural role: Slabs usually carry a uniformly distributed load and form the floor or roof of the building, and are designed to transfer the load to columns (basically the edges on which the slab rests), while beams are designed to resist flexural effects (bending) due to that load

- **Types of concrete Flat Slabs**

There are four different types of concrete Flat Slabs:

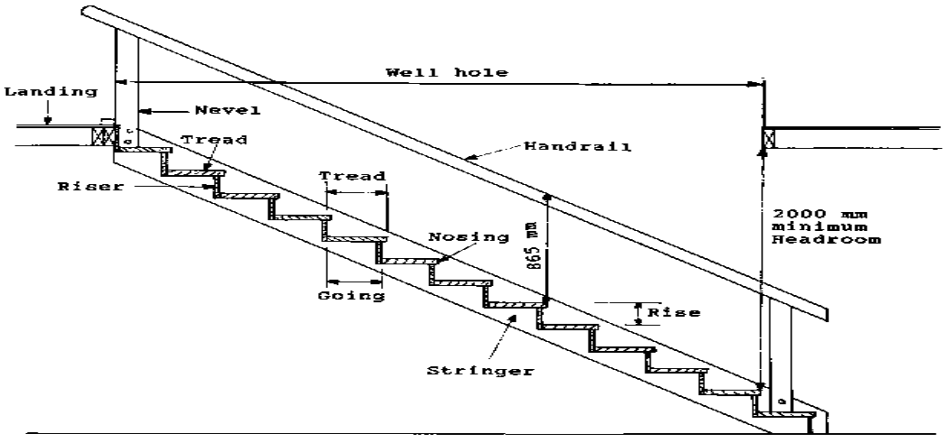
- ✓ Slab without drop and column without column head (capital).
- ✓ Slab with drop and column without column head.
- ✓ Slab without drop and column with column head.
- ✓ Slab with drop and column with column head.

9. Openings in building: provide light, ventilation and climate control for rooms. At the same time, they are essential functional and design elements of facades, enabling communication between indoor and outdoor spaces as transparent or translucent structural components.

10. Ventilation: the movement of fresh air around a closed space, or the system

Ventilation is needed to provide oxygen for metabolism and to dilute metabolic pollutants (carbon dioxide and odour). ... Ventilation is additionally used for cooling and (particularly in dwellings) to provide oxygen to combustion appliances.

11. Stairs: a set of steps leading from one floor of a building to another, typically inside the building.



Types of Stairs

- ✓ Straight Stairs.
- ✓ Straight Stair with a central landing.
- ✓ L Shaped Stair.
- ✓ L Shaped Winder Stairs.
- ✓ Spiral Stairs.
- ✓ Curved Staircase.
- ✓ Library Ladder.

12. Lump: Lump is an unstopped gradually sloping structure which facilitates the vertical movement to access different levels (floors/stories) of a building. It is designed especially to help peoples who have physical disability, to enable the movement of the wheel chair. The slop of the lump is ranged between 1/20 to1/12

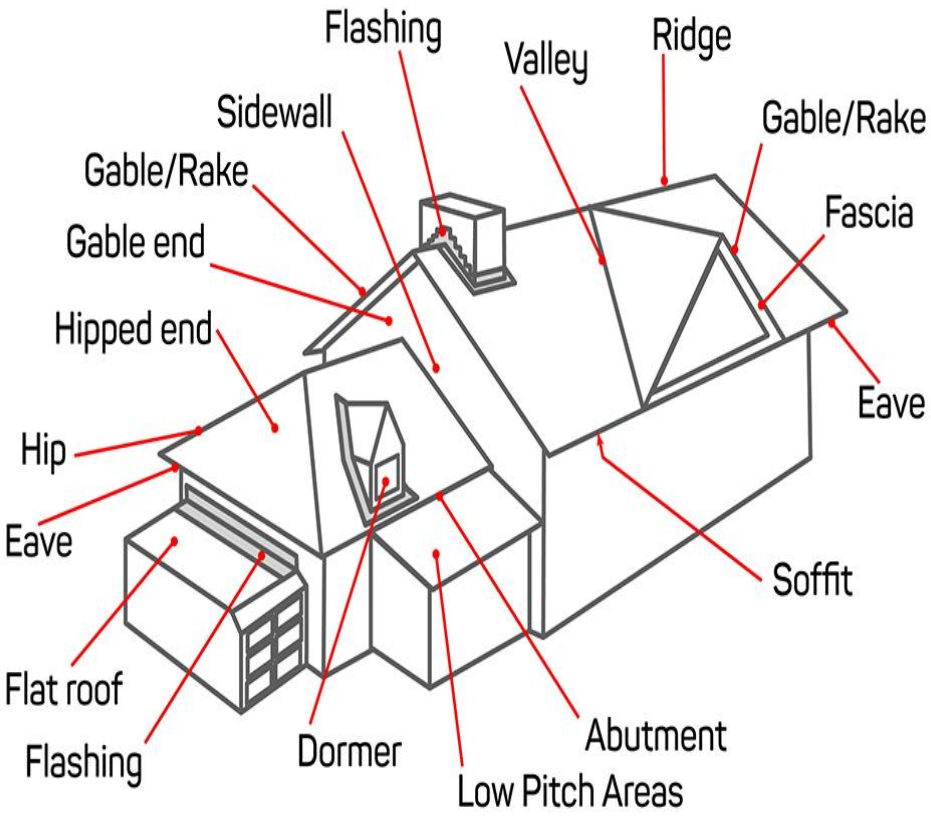
13. Ceiling: is an overhead interior surface that covers the upper limits of a room. It is not generally considered a structural element, but a finished surface concealing the underside of

the roof structure or the floor of a story above. Ceilings can be decorated to taste, and there are many fine examples of frescoes and artwork on ceilings especially in religious buildings.

14. Trusses: Trusses are most commonly used in bridges, roofs and towers. A truss is made up of a web of triangles joined together to enable the even distribution of weight and the handling of changing tension and compression without bending or shearing.

A truss is an assembly of beams or other elements that creates a rigid structure. In engineering, a truss is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object".

15. Roof: is covering of the top of a building. Roofs have been constructed in a wide variety of forms flat, pitched, domed, or in combinations. These are the components of house's roof



These are the parts of a house's roof:

- **Roof plane:** This is the surface of the roof. It is flat, but pitched or on an angle. It is also called the field of the roof.
- **Ridge:** This is the top or peak of the roof, where two roof planes meet.
- **Valley:** This is where two pitched roof faces connect and project inward. They are always at a lower slope than the adjoining roof planes.
- **Dormer:** This is a roof feature that projects out from the roof face. It usually houses a window and adds extra space and/or light to the room inside.
- **Abutment:** This is a spot where the roof face meets the wall of the home, instead of a roof ridge. Abutments are common on small home additions, such as door canopies, bay windows, attached sheds or garages.
- **Hip:** This is where two roof faces connect and project outward. A roof with hips will need a specific shingle, called hip and ridge shingles, to cover the hips.
- **Gable:** This is the triangular wall underneath where two roof planes meet. It's important to note that not all roofs have gables.
- **Hipped end:** The hipped end of the roof is the sloped roof face between two roof hips. A pyramid roof has four hipped ends. A hipped roof has only two hipped ends.
- **Gable end:** The gable end of the roof is the edge of a roof above the gable.
- **Eave:** This is where the roof hangs over the edge of the exterior wall.

16. Roof cover:

The roof covering may be:

- ✓ Galvanized Iron sheets (GI sheets)
- ✓ Wooden shingle
- ✓ Tiles
- ✓ Slates
- ✓ Slab

- **Topic 2: Definition of setting out terminologies**

1. **Setting out:**

- Setting out is the process of developing the physical positions of corners and walls of a building, and it's done by transferring dimensions from the layout plan (also called as setting out plan, demarcation plan) to the ground.
- Setting out is a procedure adopted to correctly position a specific design feature such as a building, a road, a bridge, a dam, etc., on the ground at the construction site.

It requires location of the control fixed during the original survey.

It is of prime importance that the establishment and referencing of survey control stations should be carried out at such places and in such a manner that they will survive the construction processes.

2. Setting out plan or layout plan:

Site layout plan (sometimes called a block plan) A site layout plan shows a detailed layout of the whole site and the relationship of the proposed works with the boundary of the property, nearby roads and neighboring buildings. ... Site layout plans should: show a scale bar or a measured dimension.

3. Check measurement: Check standard methodology is a tool for collecting data on the measurement process to expose errors that afflict the process over time.

What is the difference between checking and measurement?

Checking is verification of the correctness of the product, service, quality etc.

It means

- To check whether the employee has reported for duty at the specified time
- To check as to whether the item has been dispatched in time
- To check as to whether the number of items mentioned in the invoice and the delivered are one and the same

Measurement relates to quantitative aspects

For example

- To measure as to whether the weight of the product supplied is as per invoice

- To measure as to whether the size of the cloth is as per the indent

4. Temporary benchmark: (TBM) is a fixed point with a known elevation used for level control during construction works and surveys. Nails in road seals, or marks on kerb & channel are commonly used as temporary benchmarks.

5. Datum peg: This is a peg fixed at the corner of a site in which all the levels at the site are taken. This is a peg where every level at the site is taken.

6. Profile Board: A sight rail placed outside of an excavation, usually in pairs to mark out excavatable soil.

What is profile boards used for?

Commonly used setting out procedure for rural road works is based on the use of a series of profile boards and a string line level, thereby providing control of levels during construction.

The following points highlight the main factors to be considered in selection of suitable site.

Some of the factors are:

1. Availability of Raw-materials

2. Nearness to the Market

3. Nearness to Sources of Operating Power

4. Labor Supplies

5. Transportation

6. Finance

7. Climate

8. Industrial Inertia and Others.

7. Base line: A baseline is a straight reference line in respect to which the building's corners are located on the ground. It often coincides with the building line, which is the boundary of the area, or the outer boundary of a road or curb, often demarcated by the local authority.

Learning Outcome 1.2: identify methods of setting out of building

- **Topic 1: Identification of methods of setting out of building**

  ❖ **Setting out by intersection method**

✓ **Setting out by Pythagoras method**

- Typical builders square or steel square method
- 3-4-5 method or Pythagoras theorem " the square of hypothesis of right angle triangle is equal to the sum of square of the other two sides"
- Leveling instruments
- Prismatic square method

PROCEDURES

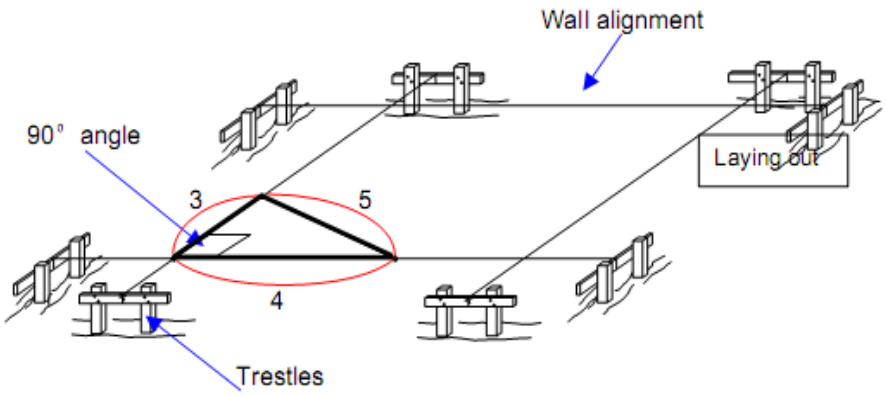
- **The 3,4,5 method**

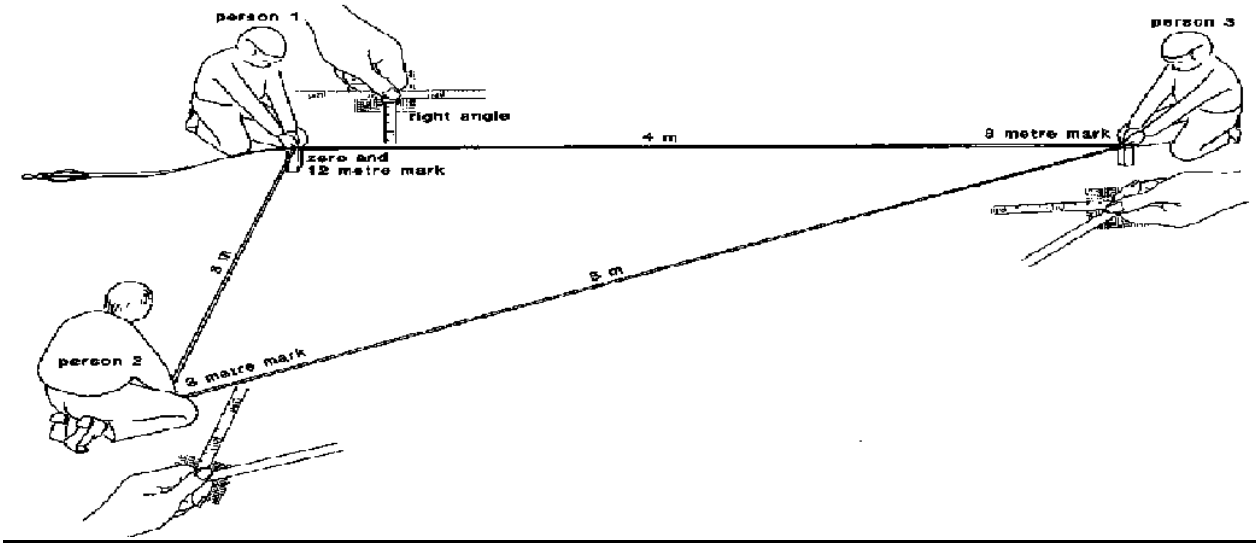
Mark out the base line from the road by measuring the required distance from the centre of the road or by stretching a line along an existing building to the proposed site.

The base line is then represented by a line known as front line or ranging line, which also marks the front wall of the buildings.

Mark out the overall length of the building by driving pegs at A and B along the front line obtain two steel tape measures. Mark out four equal distances on the front line starting from the corners peg at B. These distances may be in any unit of measurement, i.e. millimeters, meters, etc. Pull a tape measure from point B to C and ask an assistant to hold it, ready with a hammer and a peg.

Pull the second tape from the fourth mark at D on the front line to point E on the first tape, the distance 5m, if using metres, on tape DE should coincide with the point 3m on tape BEC. Then the angle B is 90^0(from, pythagoras'theorem). If the point do not coincide, the tape BC.

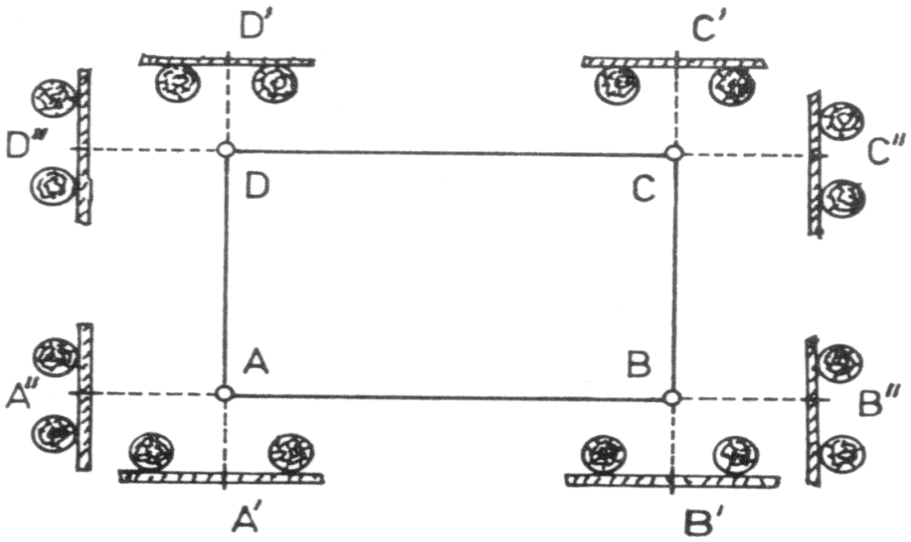


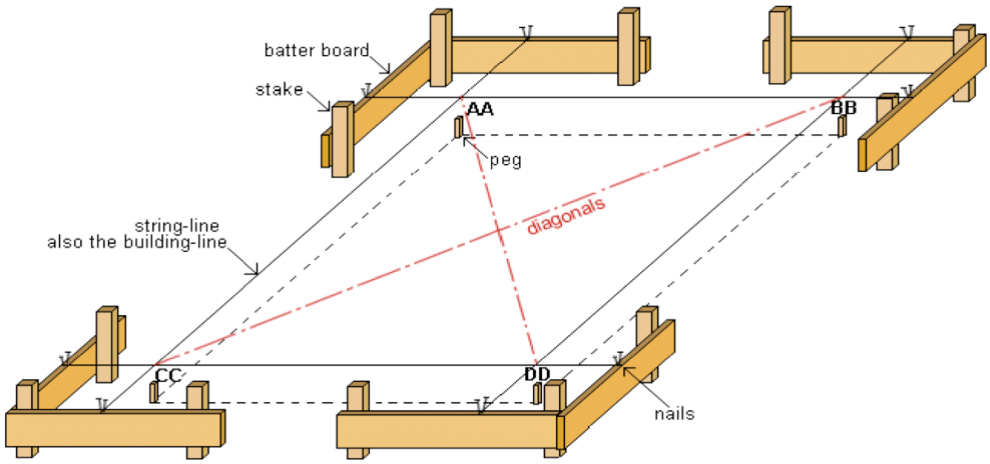


THE BUILDER'S SQUARE METHOD

- Set out the front line in the usual manner with pegs,
- Place the builder's square so that the front line touches one side of the square right through its length
- Stretch a line from the corner pegs so that it is parallel to the second side of the square and establishes the third peg.
- A corner of angle 90^0 is thus obtained.
- With the aid of tape measure, mark the length and breadth of the proposed building,
- Transferring the builder's square to the remaining corners and repeating the above operations, a simple rectangular building can be set out.
- After establishing the four corner pegs, profiles may be erected in the same way as described above.

Note that the builder's square method can only be used with accuracy for small buildings.





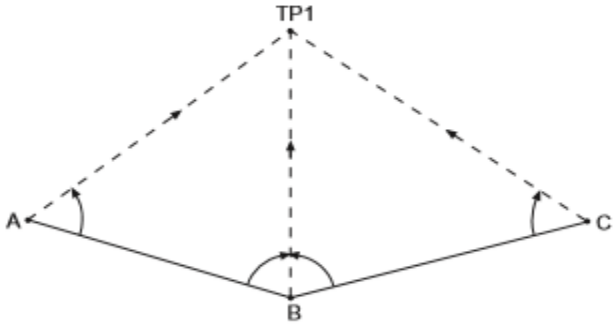
- **Topic 2. Basic setting-out procedures using coordinates**

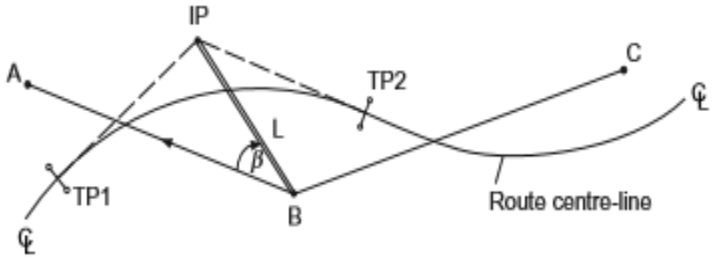
Plans are generally produced on a plane rectangular coordinate system, and hence salient points of the design may also be defined in terms of rectangular coordinates on the same system.

❖ **Polar coordinate methods**

- ✓ **Setting out of point:** Construction surveying or building surveying (otherwise known as "staking", "stake-out", "lay-out", "setting-out" or "BS") is to stake out reference points and markers that will guide the construction of new structures such as roads or buildings.

In Figure below A, B and C are control stations whose coordinates are known. It is required to locate point IP whose design coordinates are also known. The computation involved is as follows:





(1) From coordinates compute the bearing BA (this bearing may already be known from the initial control survey computations).

(2) From coordinates compute the horizontal length and bearing of B – IP.

(3) From the two bearings compute the setting-out angle AB (IP), i.e. β .

(4) Before proceeding into the field, draw a neat sketch of the situation showing all the setting-out data. Check the data from the plan or by independent computation.

The field work involved is as follows:

(1) Set up theodolite at B and back sight to A, note the horizontal circle reading.

(2) Add the angle β to the circle reading BA to obtain the circle reading B – IP. Set this reading on the theodolite to establish direction B – IP and measure out the horizontal distance L.

- ✓ **Setting out angle**

This technique, illustrated in Figure below, does not require linear measurement; hence, adverse ground conditions are immaterial and one does not have to consider tape corrections. The computation involved is as follows:

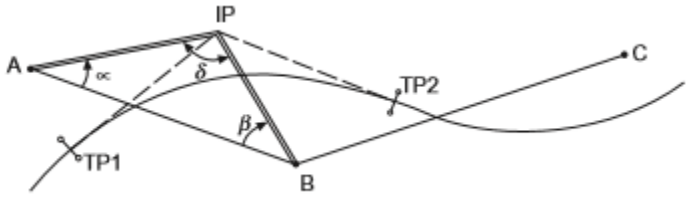
(1) From the coordinates of A, B and IP compute the bearings AB, A – IP and B – IP.

(2) From the bearings compute the angles α and β. The relevant field work, assuming two theodolites are available, is as follows:

(1) Set up a theodolite at A, back sight to B and turn off the angle α.

(2) Set up a theodolite at B, back sight to A and turn off the angle β

The intersection of the sight lines A – IP and B – IP locates the position of IP. The angle δ is measured as a check on the setting out.



- ✓ **Setting out profile:** What is profile in building construction?

A building profile is used to transfer the plan outline of a building onto the ground. ... Profile boards are boards used to create the building profile. Lines are stretched between saw-cuts or marks, so that set out points can be fixed.

- ✓ **Setting out a circular arc or curve:** The circular arc (curve) is set out by driving pegs at regular interval equal to the length of the normal chord. ... The underlying principle of this method is that the deflection angle to any point on the circular curve is measured by the one-half the angle subtended at the centre of the circle by the arc from the P.C. to that point.
- ✓ **Horizontal distance:** In plane surveying, the distance between two points means the horizontal distance. If the points are at different elevations, then the distance is the horizontal length between plumb lines at the points.

Learning Outcome 1.3: Select setting out materials, tools and equipment

- **Topic 1: Selection factors**

-Task to be accomplished: is an activity or piece of work which you have to do, usually as part of a larger project. Walker had the unenviable task of breaking the bad news to Hill

-Accuracy required: Accuracy is one important concept to keep in mind when taking any measurements. The level of accuracy needed determine equipments and methods applied in measurements.

Accuracy - degree of closeness of measurements a quantity to that quantity's actual (true) value. Mathematically, accuracy is defined as the number of significant digits included in a measurement.

-Safety issues

Safety is the state of being "safe", the condition of being protected from harm or other non desirable outcomes. Safety can also refer to the control of recognized hazards in order to achieve an acceptable level of risk

- Personnel level of competence: is a segment of the workforce with specialized knowhow, training and experience to carry out more-complex physical or mental tasks than routine job functions. Skilled labor is generally characterized by higher education, expertise levels attained through training and experience

- **Materials**
  - ✓ String for string lines
  - ✓ Timber for profiles and pegs
  - ✓ Straight edge
  - ✓ Nails

Tools

Tools are important in construction work. They are primarily used to put things together (e.g. hummers, nails,….)

- ✓ Tape measure
- ✓ Spirit level
- ✓ chain
- ✓ Pegs ,
- ✓ Hammer
- ✓ Hoe
- ✓ Machete
- ✓ Pic axe,
- ✓ Profile board
- ✓ PPE

- **Topic 2: Equipments/ Instruments**

- ✓ **A total station** is an electronic/optical instrument used in modern surveying and building construction that uses electronic transit theodolite in conjunction with electronic distance meter (EDM).It is also integrated with microprocessor, electronic data collector and storage system to compute
- ✓ **-Theodolite:** is an instrument which replaced compass and level. It can measure both horizontal and vertical angles. If telescope is kept at zero reading of vertical angle it serves as an ordinary level.
- ✓ **-GPS receiver:**
- ✓ The advantages of using GPS are:
- ✓ 1. Can be used in day as well as in night.
- ✓ 2. Intervisibility of the two stations on the earth is not a requirement.
- ✓ 3. Time required for establishing the position of a point is much less.
- ✓ 4. Man power required is less.
- ✓ 5. Accuracy is high. Most expensive GPS provide accuracies within 10 mm.

Learning Outcome 1.4: Setting up of the instrument

- **Topic 1: Setting up the theodolite**

These are required for each setting up of the instrument and includes following,

- ✓ **Tripod set up**

This is to center the instrument exactly over the ground station which is indicated by optical plummet.

In this section we learn how to set up the tripod and roughly center and level it over a small positioning mark, such as a divot in a penny glued to the floor, a nail head, or any other small fixed object.

(a) Place the tripod over the positioning mark, setting the legs at a convenient height, and roughly center and level the tripod head by eye.

(b) Suspend the plumb bob included in the theodolite box from the hanger beneath the tripod head.

(c) Readjust the tripod to center the plumb bob over the positioning mark by moving all three tripod feet by the same amount in the same direction.

(d) Firmly fix the tripod feet in position. If necessary, adjust the heights of the tripod legs to re-center the tripod within 1 cm of the reference mark.

(e) Tighten the leg clamps on the tripod

- ✓ **Setting up (Seating and centering the theodolite)**

(a) Examine how the theodolite is seated in its box

(b) Lift the theodolite out of its box by the handle never by the telescope.

(c) Place the theodolite on the tripod head and screw in the centering screw while holding onto the handle

(d) Leave the centering screw just loose enough that the theodolite can still slide around the tripod head

(e) Looking through the optical plummet, focus the centering mark. Slide the theodolite on the tripod head until the reference mark is centered in the optical plummet

(f) Fully tighten the centering screw. Look through the optical plummet again and adjust the theodolite foot screws for fine alignment with the reference mark.

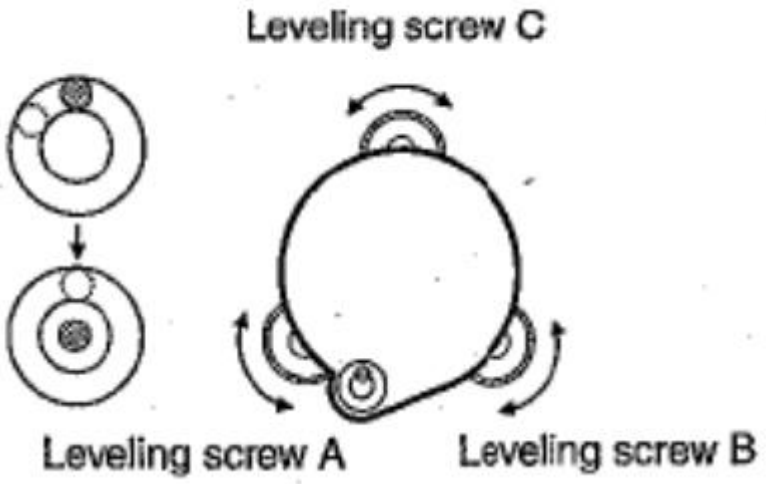
- ✓ **Leveling up**

It means to make the horizontal and vertical axes in their true position. It is indicated by the central position of plate level (bubble is centered in its central position).

(a) Referring to Fig. 2, roughly level the instrument using the circular level:

i. Turn the leveling screws A and B in opposite directions to center the bubble along the AB axis.

ii. Turn leveling screw C to bring the bubble to the center of the circular level.



- ✓ **Removal of parallax**

It is arised when the image formed by the objective is not in the plane of cross-hairs. Parallax is eliminated in two steps:

1. By focusing the eye-piece.
2. By focusing the objective

Focusing the eye-piece: To focus the eye-piece for distinct visions of the cross-hairs, move eyepiece in and out till the cross hairs are seen sharp and distinct

Focusing the objective: It is done for each independent observation to bring the image of the image of the object in the plane of cross hairs. It includes following steps of operation: First, direct the telescope towards the object for the observation. Next, turn the focusing screw until the image of the object appears clear and sharp as the observer looks through properly focused eye piece. if focusing has been done properly, there will be no parallax i.e. there will be no apparent movement of the image relative to the cross hairs if the observer moves his eye from one side to the other or from top to bottom

- **Topic 2: Setting up of the total station**

Step 1: Tripod Setup

1. Tripod legs should be equally spaced

2. Tripod head should be approximately level

3. Head should be directly over survey point

Step 2: Mount Instrument on Tripod

1. Place Instrument on Tripod

2. Secure with centering screw while bracing the instrument with the other hand

3. Insert battery in instrument before leveling

Step 3: Focus on Survey Point

Focus the optical plummet on the survey point

Step 4: Leveling the Instrument

1. Adjust the leveling foot screws to center the survey point in the optical plummet reticle

2. Center the bubble in the circular level by adjusting the tripod legs

Step 4: Leveling

1 .Loosen the horizontal clamp and turn instrument until plate level is parallel to 2 of the leveling foot screws

2. Center the bubble using the leveling screws- the bubble moves toward the screw that is turned clockwise

3. Rotate the instrument 90 degrees and level using the 3rd leveling screw

4. Observe the survey point in the optical plummet and center the point by loosening the centering screw and sliding the entire instrument

5. After re-tightening the centering screw check to make sure the plate level bubble is level in several directions

Step 5: Electronically Verify Leveling

1. Turn on the instrument by pressing and holding the “on” button (you should hear an audible beep)

2. The opening screen will be the “MEAS” screen. Select the [Tilt] function adjust the foot level screws to exactly center the electronic “bubble”

3. Rotate the instrument 90 degrees and repeat

Step 5: Adjust Image & Reticule Focus

1. Release the horizontal & vertical clamps and point telescope to a featureless light background

2. Adjust the reticle (i.e. cross-hair) focus adjustment until reticle image is sharply focused

3. Point telescope to target and adjust the focus ring until target is focused

Move your head from side-to-side to test for image shift (i.e. parallax). Repeat the reticle focus step if parallax is significant

4. NOTE: When the instrument operator changes the reticle focus may need to be adjusted

Learning Outcome 1.5: Establish benchmark

- **Topic1: Definition and types of benchmarks**

A benchmark is a point of reference by which something can be measured. In surveying, a "bench mark" (two words) is a post or other permanent mark established at a known elevation that is used as the basis for measuring the elevation of other topographical points.

Different types of Bench marks are:

a) GTS Bench mark (Great Trigonometrically Survey): GTS benchmarks are very accurate, and they are established by conducting high precise surveys. GTS benchmarks are decided by taking mean sea level as Datum. These are generally established by higher survey authorities of particular country in all points of the country. However, in the majority of the case, GTS benchmarks might be at much away distance in the area to be surveyed.

b) Permanent Bench mark: Permanent benchmarks are established with reference to GTS benchmarks. They are established by local state gorvnment agencies or railways at railways stations, public buildings, at bridges etc. permanent benchmarks are useful for future references also.

c) Arbitrary Bench mark: Arbitrary benchmarks in most engineering projects, the difference in elevation is much more important compared to a reduced level when it comes to mean sea level.

In these cases, the elevation of a permanent structure such as a corner of plinth of a building might be assumed to have an arbitrary reduced level, like 100.00m or 500.00m. all these benchmarks are quite useful in small projects.

d) Temporary Bench mark: (TBM) is a fixed point with a known elevation used for level control during construction works and surveys. Nails in road seals, or marks on kerb & channel are commonly used as temporary benchmarks.

Topic 2: Purpose of establishing benchmark before setting out:

- ✓ To base other points off of.
- ✓ Assign it an elevation, and other points that are surveyed off of that point will have a relative elevation rather than an absolute elevation.
- ✓ Bench mark is established to ensure all existing and proposed construction works can be linked by surveying equipment

Factors considered while setting bench mark

- ✓ Survey bench mark are selected and established on position on site according to site plan and specification
- ✓ Select a suitable site for a new bench mark

Learning Outcome 1.6: Setting out of external corners of building

- **Topic 1: Method of determining external corner of building**

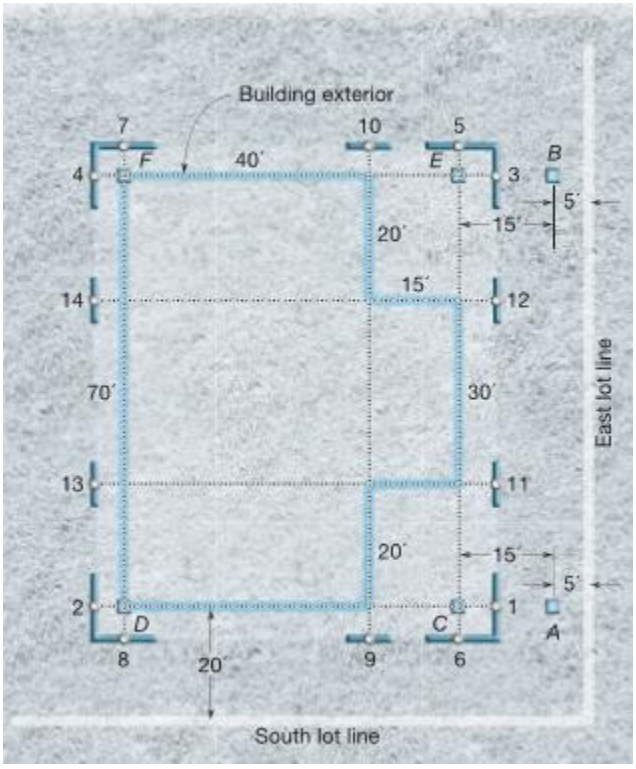
✓ **Angle method**

The following are recommended steps in the procedure

1. Set the peg A and B 3.00m inside the east plot line, with peg A 6.00m from the south plot line and peg B 20.00m from A. mark the points precisely with nails.

2. Set a total station instrument over peg A, back sight on peg B, and turn a clockwise angle of 270^0 to set better-board nails 1 and 2 and stake C and D.
3. Set the instrument over peg B, back sight on peg A, and turn a 90^0 angle. Set batter-board nails 3 and 4 stakes E and F.
4. Measure diagonals CF and DE and adjust if the error is small or re-stake if large.
5. Set the instrument over C back sight on E, and set batter-board nail 5 plunge the instrument and set nail 6.
6. Set the instrument over D, back sight on F, and set nail 7. Plunge and set nail 8.
7. Set batter-board nails 9, 10, 11, 12, 13 and 14 by measurements from established points.
8. Stretch the string lines to create the building's outline and check all diagonals.

Notes: when each batter board is set, it must be placed with its top at the proper elevation.



- ✓ **Offset method**

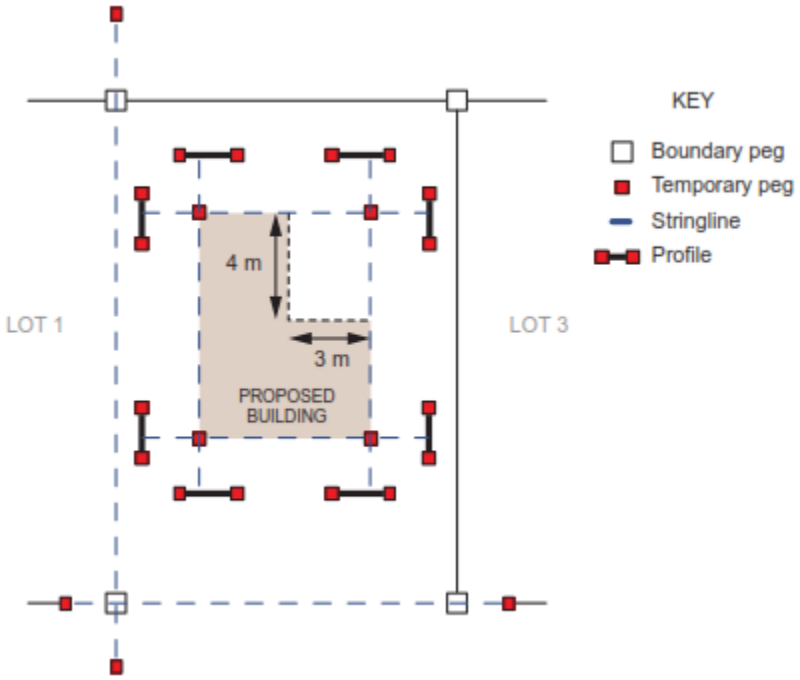
The following example shows the process for setting out an L-shaped building with two offset measurements.

Step 1

Set out the initial rectangular shape. Starting with a regular shape rather than a single reference line allows for greater accuracy and testing of overall dimensions.

Step 2

Determine the specified offset distances from the site plans. In this example, the offsets of the building are 3 m wide and 4 m deep.

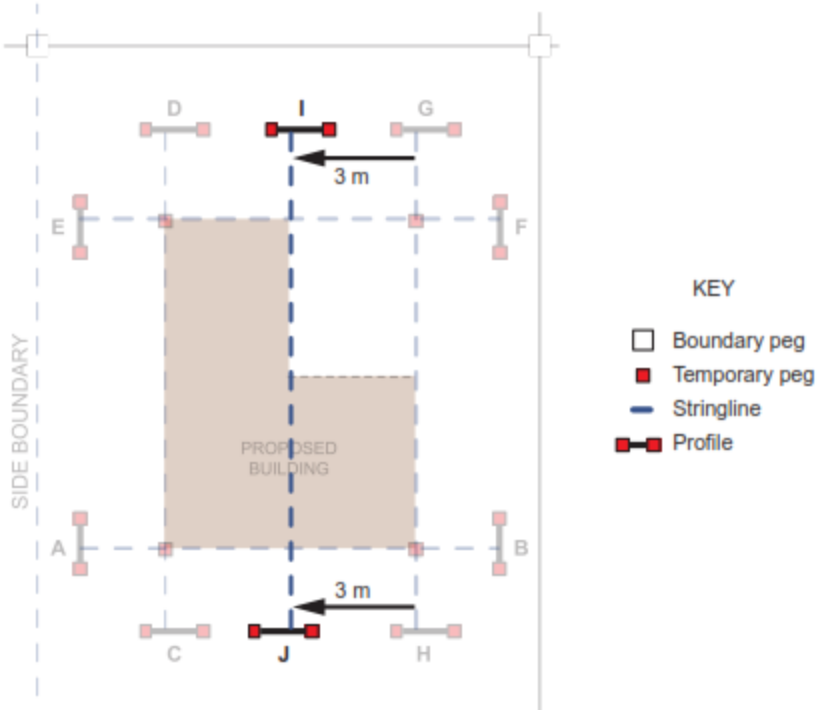


Step 3

a) Set up profiles **I** and **J** for the first offset building line.

b) Measure the distance identified as the offset width from profile **G** to profile **I**, and from profile **H** to profile **J**.

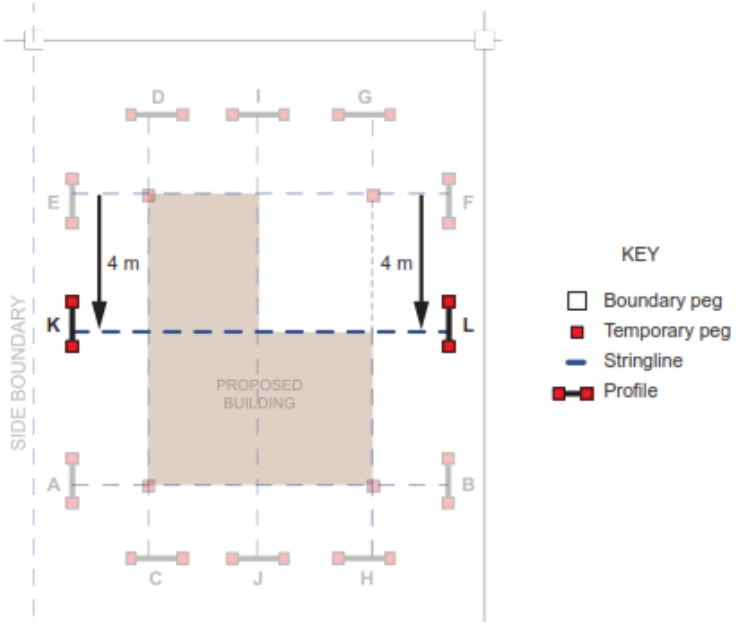
c) Fix a nail in the top of each new ledger at the mark and set the string line **I–J** taut between the nails to create the building line.



Step 4

a) To set out the second offset building line, position profiles **K** and **L** and measure the distance identified as the **offset depth** from profile **E** to profile **K**, and from profile **F** to profile **L**.

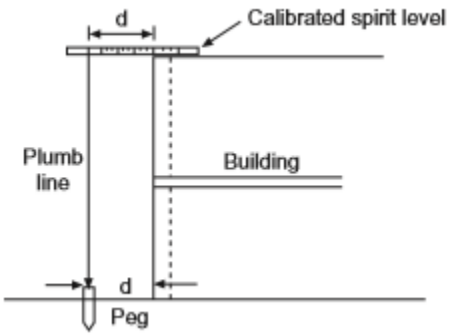
b) Fix a nail in the top of each new ledger at the mark, and set the string line **K–L** taut between the nails to create the final building line.



- **Topic 2: Controlling verticality**

✓ **Using plumb bob**

In low-rise construction a heavy plumb-bob (5 to 10 kg) may be used as shown in Figure 10.13. If the external wall was perfectly vertical then, when the plumb-bob coincides with the centre of the peg, distance d at the top level would equal the offset distance of the peg at the base. This concept can be used internally as well as externally, provided that holes and openings are available.



✓ **Using a Theodolite**

These methods assume that the theodolite is in perfect adjustment so that its line of sight will describe a vertical plane when rotated about its tilt axis.

A and B are offset pegs. The procedure is as follows.

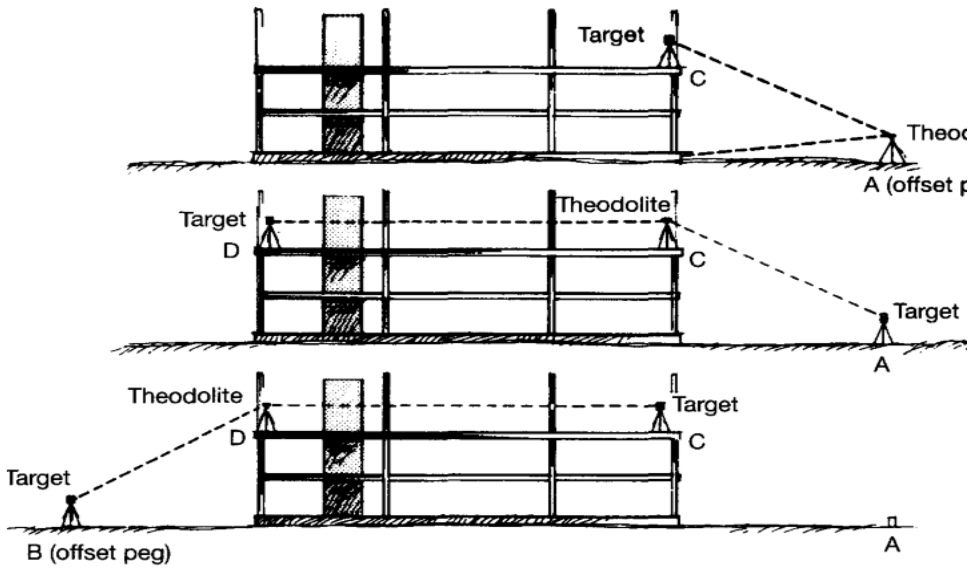
-the theodolite is set over offset peg A , carefully leveled and aligned on the reference line marked on the side of the slab

-The line of sight is transferred to the higher floor and a target accurately positioned at point C. A three-tripod traverse system is used and the target and theodolite are interchanged. The theodolite, now at C, is sighted onto the target at A, transited and used to line in second target at D. both face must be used and the mean position adopted for D.

-A three-tripod traverse system is again used between C and D and the theodolite checks the line by sighting down from D to the reference mark at B, again in using both faces.

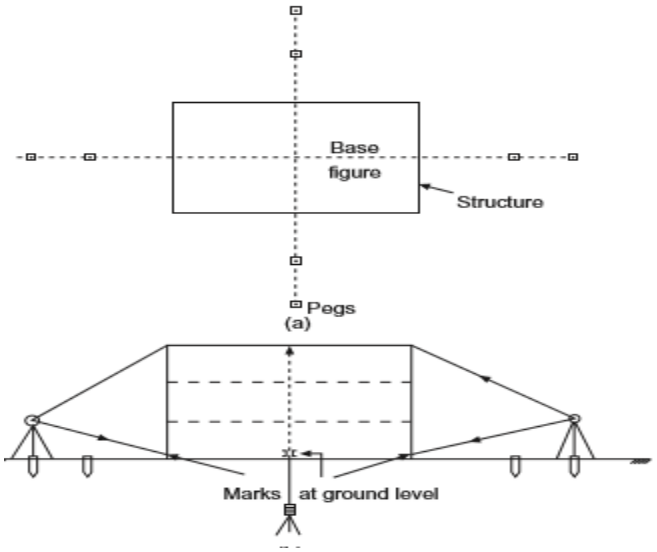
-It may be necessary to repeat the process if slight discrepancy is found

-The procedure is repeated along other side of the building.



- ✓ **Using optical plumbing**

For high-rise building the instrument most commonly used is an auto plumb. This instrument provides a vertical line of sight to an accuracy of ±1 second of arc (1 mm in 200 m). Any deviation from the vertical can be quantified and corrected by rotating the instrument through 90° and observing in all four quadrants; the four marks obtained would give a square, the diagonals of which would intersect at the correct centre point.



Learning Unit 2: PERFORM SETTING OUT OF PIPELINE

Learning Outcome 2.1: Identify setting out of pipe line terminologies

- **Topic 1: Description of pipeline terminologies**

✓ **Pipelines** are used to carry water for human consumption, storm water, sewage, oil, natural gas, and other fluids. Pipes, which carry storm runoff, are called storm sewers; those which transport sewage, sanitary sewers. Flow in these two types of sewers is usually by gravity, and therefore their alignments and grades must be set carefully. Flow in pipes carrying city water, oil, and natural gas is generally under pressure, so usually they need not be aligned to as high an order of accuracy.

✓ **Reference point**: Reference point Stationing. The fundamental system of measurement used by surveyors. For highway or pipeline projects, a starting reference station is first established, and all distances along the route centerline are measured from that point location.

✓ **Bell hole**: A bell hole is a hole dug into the ground over or alongside a pipeline to allow the line to be examined and to provide room for workmen to perform maintenance on pipeline. In a broader sense it is any hole, other than a ditch, that is opened for pipe line work. Technically speaking: A bell hole is an excavation made to permit a survey, inspection, maintenance, repair, or replacement of pipe sections.

The purpose of a bell hole is space in addition to safety. If the excavation of a bell hole is for the purpose of installing a valve, for example, a hole three times as wide as the trench gives laborers space for tools and supplies, and room to work around one another.

✓ **Berm:** A berm is a level space, shelf, or raised barrier (usually made of compacted soil) separating two areas. It can serve as a fortification line, a border/separation barrier, in industrial settings, or in many other applications.

What is the purpose of a berm?

Berms :Is a raised bank or path especially the bank of a canal opposite the towpath .Are simply mounded hills of soil that are constructed to serve a purpose in a landscaped area.

They can be used for aesthetics, excess rainwater drainage, separating different areas of the garden, accent walkways, and as foundations for privacy screens.

- ✓ **Boom:** Pipe layer also known as a side boom tractor, very significant to pipeline construction and maintenance
- ✓ **Bottle neck**: A bottleneck, in a process management context, is a point in a determined process where the flow of tasks gets impaired or even stops entirely. Bottlenecks most likely happen because there isn't enough capacity to handle all the task/information inflow – and by capacity we mean all kinds of capacity: data processing, software capacity, people, etc.
- ✓ **Bottle Neck:** in pipeline Area of pipeline right-of-way where the width of working space is reduced
- ✓ **Cap:** Last top pass of weld
- ✓ **Charge:** A designated form of explosive that is placed accordingly to break up rock for pipeline installation

Learning Outcome 2.2: Pipe line setting out materials, tools and equipment

- **Topic 1: Selection factors**

- Task to be accomplished

- Accuracy required

- Personnel level of competency

- ➢ **Materials**
- ✓ Nails
- ✓ Building lines
- ➢ **Tools**
- ✓ Tape measure
- ✓ Spirit level
- ✓ Chain

- ✓ Pegs
- ✓ Hammer,
- ✓ Hoe,
- ✓ Machete, Pic axe,
- ✓ Profile board, PPE
    - ➢ **Equipment/instruments**
- ✓ Total station
- ✓ Theodolite
- ✓ GPS receiver

Learning Outcome 2.3: Setting up of instrument

- **Topic 1: Steps of setting up an instrument**

➢ **Centering**

- Tripod setup

- Fix tripod leg

- Mount instrument on tripod

➢ **Levelling**

- Levelling the instrument

-Adjust the levelling with foot screws

➢ **Focusing**

- Focus eyepiece

-Focusing objective

Learning Outcome 2.4: Establish benchmark

- **Material used while making beacon to be fixed on benchmark**

- Stone,
- Cement ,
- Steel ,
- Sand and water

- **Purpose of establishing a bench mark while setting out pipe line**

✓ As describe previously bench mark is established to ensure all existing and proposed construction works can be linked by surveying equipment

✓ To compute the difference in elevation

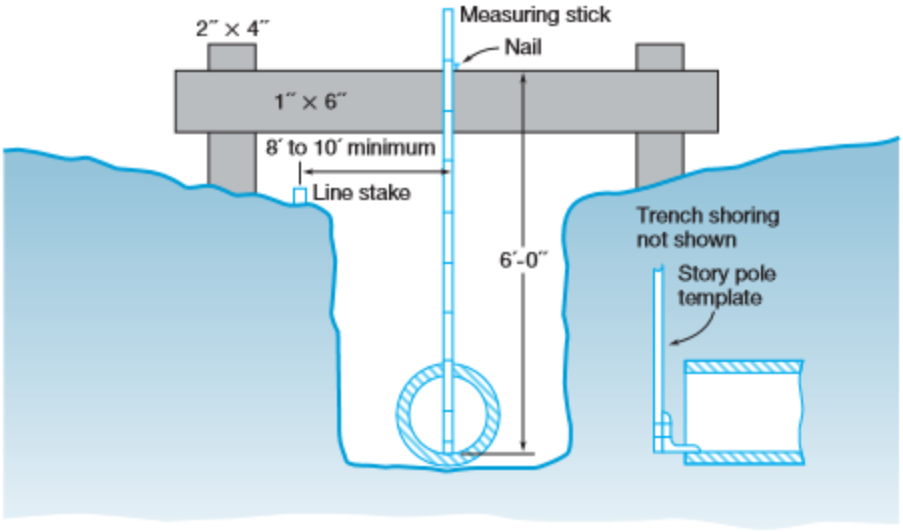
✓ Bench mark used to mark a point as an elevation reference.

Learning Outcome 2.5: Establish pipeline alignment and levels

- **Topic 1: Pipeline alignment**

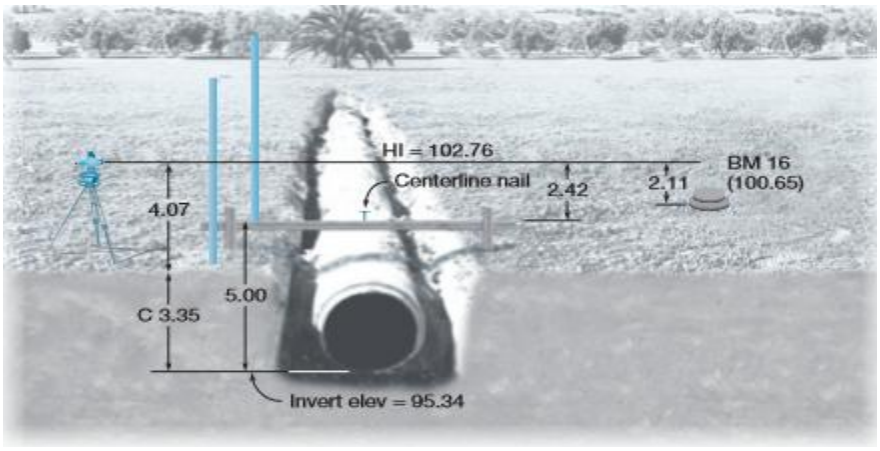
The alignment and grade for the pipeline are taken from the plans. An offset reference line parallel to the required centerline is established, usually at 25or 50-ft stations when the ground is reasonably uniform. Marks should be closer together on horizontal and vertical curves than on straight segments. For pipes of large diameter, stakes may be placed for each pipe length—say, 6 or 8 ft. On hard surfaces where stakes cannot be driven, points are marked by paint, spikes, or scratch marks.

Either batter boards or laser beams guide precise alignment and grade for pipe placement. Figure below shows one arrangement of a batter board for a sewer line. It is constructed using or boards nailed to posts, which have been pointed and driven into the ground on either side of the trench. Depending upon conditions, these may be placed at 50 ft, 25 ft, or any other convenient distance along the sewer line.



- **Staking pipe grade**

Staking pipeline grades is essentially the reverse of running profiles, although in both operations the centerline must first be marked and stationed in horizontal location. The actual profiling and staking are on an offset line. Information conveyed to the contractor on stakes for laying pipelines usually consists of two parts:(1) giving the depth of cut (or fill), normally only to the nearest 0.1 ft, to enable a rough trench to be excavated; and (2) providing precise grade information, generally to the nearest 0.01 ft, to guide in the actual placement of the pipe invert at its planned elevation. Cut (or fill) values for the first part are vertical distances from ground elevation at the offset stakes to the pipe invert. After the pipe's grade line has been computed and the offset line run, cuts (or fills) can be determined by a leveling process, illustrated in Figure 23.6 and the corresponding field notes given.



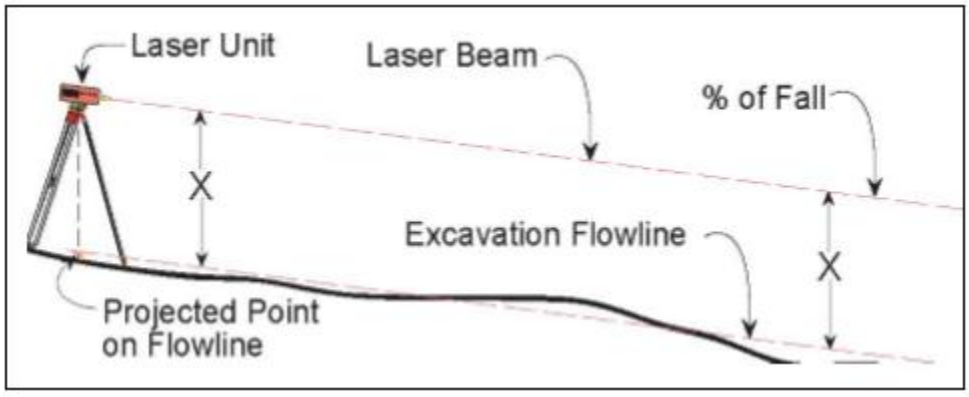
- **Laser layout**

When the Contractor uses laser grade control, the Technician is required to know the flow line fall expressed in "percent of fall". This value is computed by the formula:

$$\frac{\text{FL Elev. Upstream} - \text{FL Elev. Downstream}}{\text{Horizontal Length of Pipe}} \times 100\%$$

- **Laser grade control**

When using laser grade control, a known elevation point is first established, relative to the structure flow line. The laser is then set up a specified distance above that point and the percent of fall dialed in. To check the grade anywhere along the flow line, the predetermined distance is measured down from the laser beam.

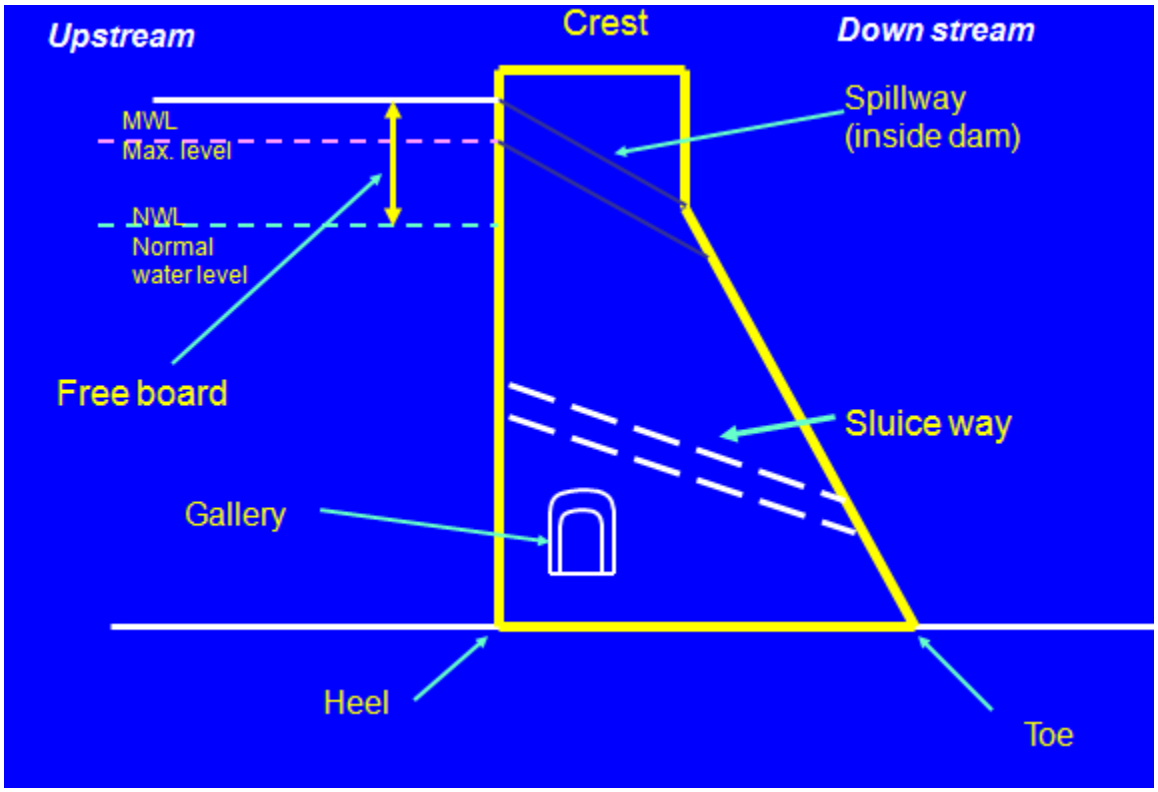


Learning Unit3: PERFORM SETTING OUT OF DAM

Learning outcome 3.1: Identify dam setting out terminologies

- **Topic 1: Identification of dam terminologies**

Different parts & terminologies of Dams:



- **Crest:** The top of the Dam. These may in some cases be used for providing a roadway or walkway over the dam**.**
- **Parapet walls:** Low Protective walls on either side of the roadway or walkway on the crest.
- **Heel:** Portion of Dam in contact with ground or river-bed at upstream side.
- **Toe:** Portion of dam in contact with ground or river-bed at downstream side.
- **Spillway:** It is the arrangement made (kind of passage) near the top of dam for the passage of surplus/ excessive water from the reservoir.
- **Abutments:** The valley slopes on either side of the dam wall to which the left & right end of dam are fixed to.

- **Gallery:** Level or gently sloping tunnel like passage (small room like space) at transverse or longitudinal within the dam with drain on floor for seepage water. These are generally provided for having space for drilling grout holes and drainage holes. These may also be used to accommodate the instrumentation for studying the performance of dam.
- **Sluice way:** Opening in the dam near the base, provided to clear the silt accumulation in the reservoir.
- **Free board:** The space between the highest level of water in the reservoir and the top of the dam.
- **Dead Storage level:** Level of permanent storage below which the water will not be withdrawn.
- **Diversion Tunnel:** Tunnel constructed to divert or change the direction of water to bypass the dam construction site. The dam is built while the river flows through the diversion tunnel.

✓ **Storage of water is utilized for following objectives:**

- Hydropower
- Irrigation
- Water for domestic consumption
- Drought and flood control
- For navigational facilities
- Other additional utilization is to develop fisheries

- **Topic 2: Factors affecting Dam Classification**

- Base on function served
- Base on hydraulic design
- Base on materials of construction

- Base on rigidity
- Based on the structural action

Base on function served

- Storage dams
- Detention dams
- Diversion dams
- Debris dams
- Coffer dams

Base on hydraulic design

- ***Overflow dams:*** An overflow dam is designed to act as an overflow structure. Thesurplus water which cannot be retained in the reservoir is permitted to pass over the crest of the overflow dam which acts as a spillway.
- ***Non-overflow dams:*** A non-overflow dam is designed such that there is no flow over it. Because there is no overflow, a non-overflow dam can be built of any material, such as concrete, masonry, earth, rock fill and timber.

Base on materials of construction

- ✓ Based on the materials used in construction, the dams are classified as follows:
- ✓ Masonry dam,
- ✓ Concrete dam,
- ✓ Earth dam,
- ✓ Rock fill dam,
- ✓ Timber dam,

- ✓ Steel dam,
- ✓ Combined concrete-cum-earth dam, and
- ✓ Composite dam

Based on the structural action: This is the most commonly used classification of dams. Based on the structural action, the dams are classified as

- ✓ Gravity dams,
- ✓ Earth dams,
- ✓ Rock fill dams,
- ✓ Arch dams,
- ✓ Buttress dams,
- ✓ Steel dams, and

Base on rigidity

- ✓ ***Rigid dams:*** A rigid dam is quite stiff. It is constructed of stiff materials such as concrete, masonry, steel and timber. These dams deflect and deform very little when subjected to water pressure and other forces.
- ✓ ***Non-rigid dams:*** A non-rigid dam is relatively less stiff compared to a rigid dam. The dams constructed of earth and rockfill are non-rigid dams. There are relatively large settlements and deformations in a non-rigid dam. Rockfill dams are actually neither fully rigid nor fully non-rigid.

Base on structural action

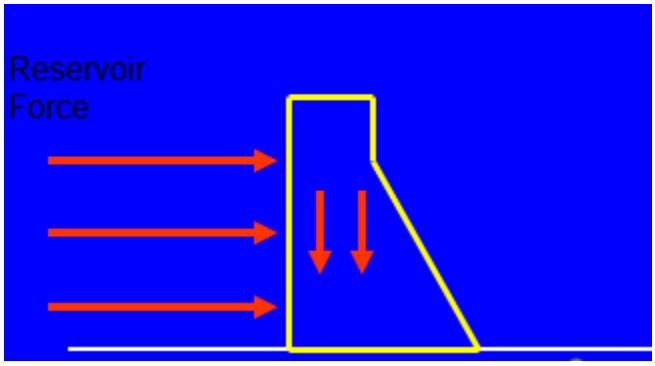
- ✓ Steel and timber Dams
- ✓ Concrete Dams

- ✓ Gravity Dams
- ✓ Buttress Dams
- ✓ Arch Dams
- ✓ Embankment Dams
- ✓ Earth Dams
- ✓ Rock fill Dams

- **Topic 3: Types of dams**

- ✓ **Gravity Dams**:

These dams are heavy and massive wall-like structures of concrete in which the whole weight acts vertically downwards



As the entire load is transmitted on the small area of foundation, such dams are constructed where rocks are competent and stable.

- ✓ **Buttress Dam:**

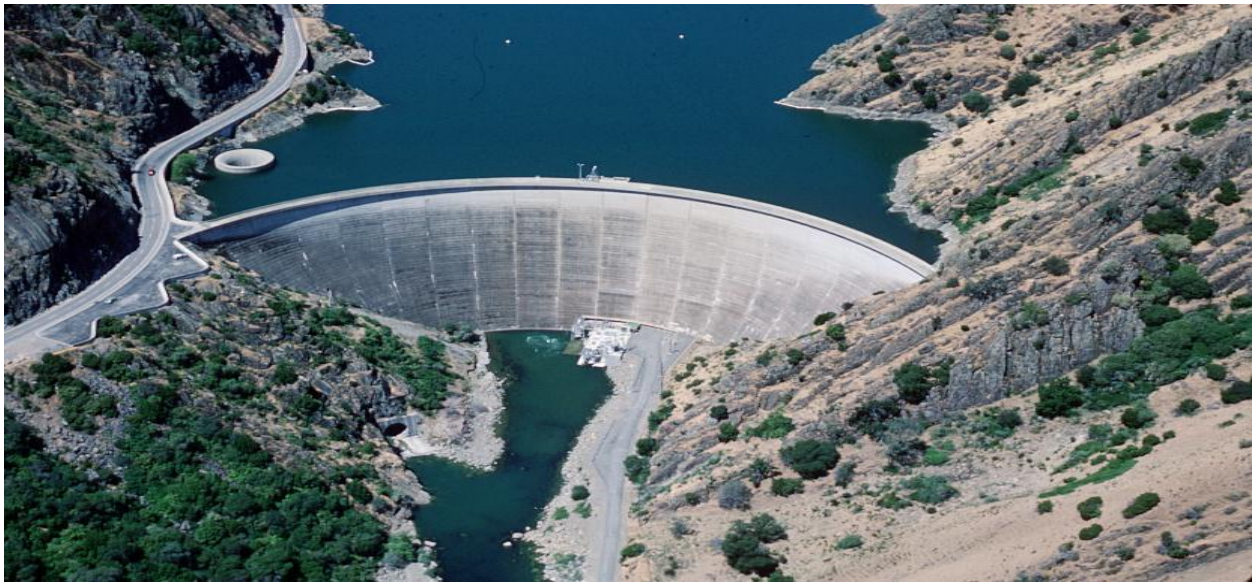
Buttress Dam – Is a gravity dam reinforced by structural supports

Buttress - a support that transmits a force from a roof or wall to another supporting structure

This type of structure can be considered even if the foundation rocks are little weaker

- ✓ **Arch Dams:**

- These type of dams are concrete or masonry dams which are curved or convex upstream in plan
- This shape helps to transmit the major part of the water load to the abutments
- Arch dams are built across ***narrow, deep river gorges, but now in recent years they have been considered even for little wider valleys.***



- ✓ **Earth Dams:**

They are trapezoidal in shape

Earth dams are constructed where the foundation or the underlying material or rocks are weak to support the masonry dam or where the suitable competent rocks are at greater depth.

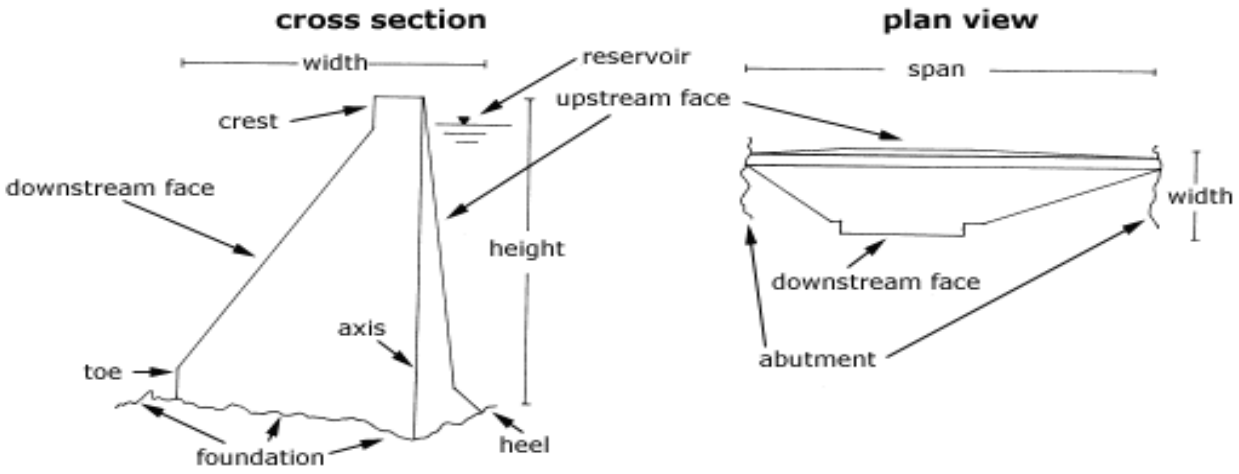
Earthen dams are relatively smaller in height and broad at the base

They are mainly built with clay, sand and gravel, hence they are also known as Earth fill dam or Rock fill dam

- ✓ **GRAVITY DAMS**

Gravity dams are dams which resist the horizontal thrust of the water entirely by their own weight.

They use their weight to hold back the water in the reservoir. Can be made of earth or rock fill or concrete.



Learning Outcome 3.2: Select dam setting out materials, tools and equipment

- **Topic 1: Selection factors**

✓ Task to be accomplished

✓ Accuracy required

✓ Personnel level of competency

➢ **Materials**

✓ Nails

✓ Building lines

➢ **Tools**

✓ Tape measure

✓ Chain

✓ Pegs

✓ Hammer

✓ Hoe

✓ Machete

- ✓ Pick axe
- ➢ **Equipment/instruments**
- ✓ Total station
- ✓ Theodolite
- ✓ Level

Learning Outcome 3.3: Setting up of the instrument

- **Topic 1: Steps of setting up an instrument**
  - **Centering**
- ✓ Tripod setup
- ✓ Fix tripod leg
- ✓ Mount instrument on tripod
  - **Leveling**
- ✓ Leveling the instrument
- ✓ Adjust the leveling with foot screws
  - **Focusing**
- ✓ Focus eyepiece
- ✓ Focusing objective

Learning Outcome 3.4: Establish dam external corners and levels

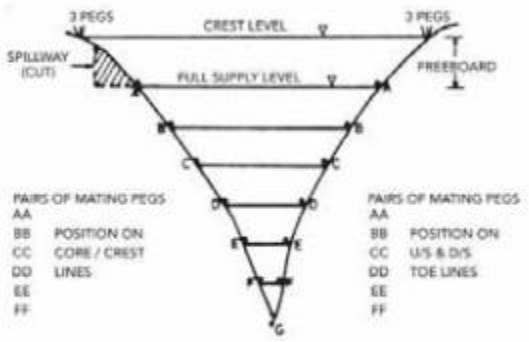
- **Topic 1: Dam external corners**
- ✓ Stake out corner points
- ✓ Verify corner angles
- ✓ Set profiles boards
- ✓ Verify distances
  - **Dam levels**
- ✓ Explore benchmarks
- ✓ Drawing consultation
- ✓ Set dam levels

Learning Outcome 3.5: Determine levels of dam layers

- **Topic 1: Steps of determining the levels of dam:**

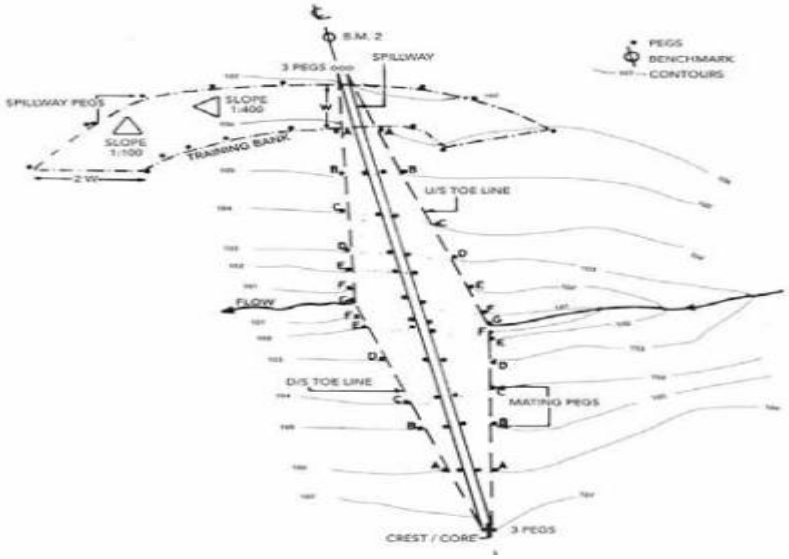
✓ Layers setting out: The centre-line pegs should be installed at the ends of the embankment and at every change in ground level. For each change in ground level a 'mating' peg (see **Figure 11a**) should be established by level or GPS on the opposite side of the valley, but still on the centre line. At each peg on the centre line of the embankment, the distances of the toe pegs upstream and downstream are calculated and set out at right angles as in **Figure 11b.**

Figure 11a - Mating pegs



3 Pegs at each end of the embankment
peg spillway as required

Figure 11b - Pegging layout



- ✓ Levels determination: Once all preliminary investigations have been made and a suitable site has been found, the next step is to carry out a detailed survey of the valley and reservoir area to allow more accurate estimates of quantities and to provide the necessary data for design work to be undertaken. The aim of such a survey is to present, on paper, a contour map of the reservoir up to and exceeding the maximum flood level, and to provide details for the location of the embankment, spillway and outlet works. From the contour map, the capacity of the reservoir can be assessed for varying dam heights.
- ✓ Slopes determination: Slope of dam layers may determined based on : slope stability analysis, Earth embankment dam, Embankment loading condition, soil properties/ parameters, critical slip center determination and shear strength reduction analysis.

Learning Unit4: PERFORM SETTING OUT OF ELECTRICAL LINE

Learning Outcome 4.1: Identify electrical line terminologies

- **Topic 1: Description of terms used in electrical alignment.**

- Tower base: The concrete base is driven in a hole from 0.5-1.5m depth (20-60"), depending the weight, the length and the design of your tower. ... To keep the liquid concrete in position, a wood form made of fire wood boards 5 cm thick (2") is constructed around the top of the hole.

- Tower: A transmission tower is a structure set up for the purpose of transmitting and receiving power, radio, telecommunication, electrical, television and other electromagnetic signals. Transmission towers can be separately identified as electric towers or cellular phone towers depending on the purpose they serve. Transmission towers are a common sight in industrialized states and cities.

Transmission towers are not only used for the purpose of transmitting electrical power over large distances, but they are now more commonly used for broadcasting, telecommunication and mobile telephony.

- Transformer: A transformer is an electrical apparatus designed to convert alternating current from one voltage to another. It can be designed to "step up" or "step down" voltages and works on the magnetic induction principle.

Transformers are electrical devices consisting of two or more coils of wire used to transfer electrical energy by means of a changing magnetic field the principle of transformer

The transformer is based on two principles: first, that an electric current can produce a magnetic field (electromagnetism), and, second that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil.

- Pylon: Pylons are very tall metal structures which hold electric cables high above the ground so that electricity can be transmitted over long distances.

A pylon is a large vertical steel tower-like structure that supports high-tension electrical cables.

Pylons are often made of steel or concrete, because they are strong substances that can hold a large amount of weight.

Type of pylon by function	
Anchor pylons or strainer pylons are employed at branch points as branch pylons and must occur at a maximum interval of 5 km, due to technical limitations on conductor length.	
Branch pylon is a pylon that is used to start a line branch. The branch pylon is responsible for holding up both the main-line and the start of the branch line, and must be structured so as to resist forces from both lines.	
A tension tower with phase transposition of a traction current line for single phase AC 110 kV, 16.67 Hz	

Type of pylon by material used	
Wood pylons: For support pylons a straight trunk impregnated with tar is usually used, which carries one or more cross beams with the conductor cables on the top. For anchor pylons constructions looking like a V or an A are used, because these can stand higher forces. Because of the limited height of available trees the maximum height of wood pylons is limited (approx. 30 metres). In Germany wood pylons are used as a rule only for lines with voltages up to approximately 30 kV, while in the U.S. wood pylons are used for lines with voltages up to 345 kV.	
Concrete pylon: or concrete pole, is an electricity pylon made from reinforced concrete. Concrete pylons are manufactured at the factory and put up at the power line's right of way. Concrete pylons, which are not prefabricated, are also used for constructions taller than 60 meters. One example is a 66 meters tall pylon of a 380 kV power line near Reutter West Power Plant in Berlin. Such pylons look like industrial chimneys and some of these structures are also used as chimneys. In China some tall pylons of power line crossings of wide rivers were built of concrete. The tallest of these pylons belong to the Yangtze Power line crossing at Nanjing with a height of 257 meters.	

- **Electrical cable:** An electrical cable is an assembly of one or more wires running side by side or bundled, which is used to carry electric current.

Electrical cables are used to connect two or more devices, enabling the transfer of electrical signals or power from one device to the other.

- **Beacon:** Beacons can be considered as permanent survey marks of any kind, and is made of concrete, iron or stone, and includes pillars and boundary posts so made. Beacons are used to demarcate the actual boundaries between one settlement and another. They are surveying tools and are of different sizes and types.

- **Transmission line**: A system of structures, wires, insulators and associated hardware that carry electric energy from one point to another in an electric power system.

Transmission lines are either overhead power lines or underground power cables. ... As electricity flows through the wires, some of it dissipates as heat through a process called resistance.

Learning Outcome 4.2: Select setting out materials, tools and equipment

- **Selection factors**
  - ✓ Task to be accomplished
  - ✓ Accuracy required
  - ✓ Personnel level of competency
  - ✓ Nature of the terrain
  - ✓ Type of structure
- **Materials**

✓ Nails used station marks of Trimble and where the reflector were held

✓ Building lines

- **Tools**
  - ✓ **Tape measure**
  - ✓ **chain**
  - ✓ **Pegs :** are used in other to locate where the poles must be
  - ✓ **Hammer:** On hard rock, it was used to fix the nails into the ground;

- ✓ **Hoe**
- ✓ **Machete:** used for cutting the trees to ensure the intervisibility.
- ✓ **Pick axe**

- **Equipment/instruments**

✓ **Total station:** for measure the distances and alignment of poles

✓ **GPS:** for collecting and storing the data

✓ **Theodolite:** for determination of angles and alignment

✓ **Level:** To determine height difference

Learning Outcome 4.3: Setting up of the instrument

As we have describe previously the instrument used were setting up with respect to the process below:

Steps of setting up a theodolite: tripod setup; Fix tripod leg; Mount instrument on tripod; Leveling the instrument; Adjust the leveling with foot screws; Focus on surveying point; Focusing eyepiece; Focusing objective.

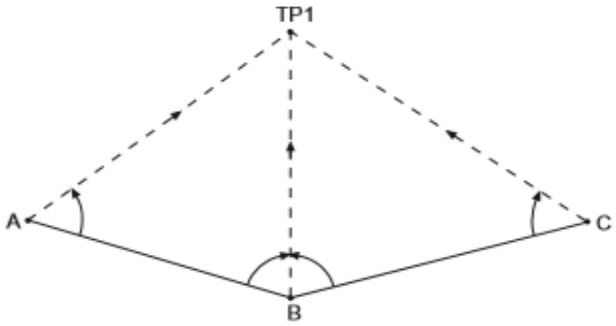
Setting up of total station: Tripod set up; Mount instrument on tripod; Focus on survey point; Leveling the instrument; electronically verify leveling; Adjust image and reticule focus

Learning Outcome 4.4: Setting out of electrical tower bases

- **Topic 1: Determination of tower base external corners**

✓ Stake out corner points: is to stake out reference points and markers that will guide the construction of new structures with respect to the location.

In Figure below A, B and C are control stations whose coordinates are known. It is required to locate point IP whose design coordinates are also known. The computation involved is as follows:



- ✓
- ✓ Verify corner angles
- ✓ Set profiles boards for each base station
- ✓ Verify distances

Learning Outcome 4.5: Alignment of electrical structures

- **Topic 1: Electrical line alignment**

After setting out the instrument we oriented the machine on the existing pole (considered as known point) as back sight and then return the instrument to the target as foresight. The successive point must be on the straight line; those points are called Alignment poles; and then measure the distance among the poles. If there is an obstacle encountered in order that the straight line is not possible at that point it will obliged to change materials poles.

LEARNING UNIT5: PERFORM AS BUILT SURVEY

Learning Outcome 5.1: Description of as built surveying

- **Topic 1: As built survey description**

Definition of as built survey: An As-built survey builds upon the base map of a project and includes research at local agencies, ground-level topography data, and the documentation of visible site improvements.

As-built surveys are needed to record variations from original Engineering plans to what is actually built. As-built surveys are required by many agencies to prove the location of a structure at a point in time. Many agencies need the as-built surveys for the actual locations of underground improvements.

As-built" or "as-constructed" surveys are performed several times during the course of a construction project to determine if work authorized has been completed according to the same design and dimension specifications set during the planning and actual site construction.

These can provide valuable information including whether the job is being done properly, what level of completion the project has reached, and if the construction that was authorized is actually what is taking place.

- **Topic 2: Purpose of as built survey**

- To show the property "as it is built" at a particular point in time.

- To show the current state of the site at various stages throughout the duration of a project.

- It also serves as a close-out document to verify that the work authorized was completed to plans and in compliance with all relevant standards and regulations.

- An As-built survey builds upon the base map of a project and includes research at local agencies, ground-level topography data, and the documentation of visible site improvements.

- To monitor the construction as it is occurring.

- Shows continual improvement to the land as they appear at a particular point of time during the course of construction.

- These surveys confirm the exact location of a structure or land feature such as a road or driveway as well as their proposed dimensions.

- **Topic 3: Elements of as built survey**

- **Horizontal measurement**: In plane surveying, the distance between two points means the horizontal distance. If the points are at different elevations, then the distance is the horizontal length between plumb lines at the points.

- **Vertical measurements**: A vertical jump or vertical leap is the act of raising one's center of mass higher in the vertical plane solely with the use of one's own muscles; it is a measure of how high an individual or athlete can elevate off the ground (jump) from a standstill.

- **Earthwork quantities:** Earthworks are engineering works created through the moving and/or processing of massive quantities of soil or unformed rock. Earthwork is done to reconfigure the topography of a site to achieve the design levels. Earthwork involves **cutting** and **filling** to achieve the required topography.

Cutting: Cutting is the process of excavating earth material from a work location to achieve the desired topography.

Filling: Filling is the process of moving the excavated material or additional earth material to a work location to achieve the desired topography.

Learning Outcome 5.2: Setting up of the instrument

As we have discussed before the following steps should be followed:

- ✓ Set up Instrument steps

Tripod setup

Fix tripod leg

Mount instrument on tripod

Focus on survey point

Leveling the instrument

Adjust the leveling with foot screws

Learning Outcome 5.3: Apply as built survey procedures

- **Topic 1: Procedures of performing as built survey**

✓ Consulting existing plans and documents: An as built survey builds upon the base map of project and includes research at local agencies, and the documentation of visible site improvement. The advantages of this survey are that the new base map can be updated to show the current conditions of the site.

✓ Data collection: Specify kind of instruments to be used depending on the accuracy needed, determination of method of surveying (Global Positioning System surveys, Aerial surveys, Route surveys, Construction surveys)

✓ Data processing: After data analysis and processing the output shows improvements to the land as they exist at a particular point in time. As built surveys help property owners plan future projects, protect their interest, and document project progress.

✓ Plan: To define the process for Final "As-Built" Plans and present some standards to assist those charged with the responsibility of recording final quantities and preparing final estimates for their utilization in delineating final quantities, revisions, and changes in the construction that must be reflected in the final estimates for the project.

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