CHAPTER 1: **EXECUTING SITE PRELIMINARY WORKS**

Unit of learning code CON/CU/BUT/CR/02/6

Related Unisdaeq1t of Competency in Occupational Standard: Perform Site Preliminary Works

1.1 Introduction to the unit of learning

This Unit describes the competencies required to perform site preliminary works. It involves determining site boundaries, clearing building site, hoarding/screening the site, surveying the building site, preparing site layout, testing building materials, demolishing unwanted structures and preparing site preliminary report.

1.2 Summary of Learning Outcomes

1. Determine site boundary and clear building site
2. Hoard/screen the building site
3. Survey building site
4. Prepare site layout
5. Demolish unwanted structures
6. Prepare site preliminary report

1.2.1 **Learning Outcome 1:** Determine site boundary and clear building site

1.2.1.1 Introduction to the learning outcome

This unit specifies the competencies required to determine site boundaries and clearing the construction site. it involves Site investigation in Land surveying, interpretation of building drawing, Building site conditions, Plant and equipment used in site clearance as well as Building safety regulations.

1.2.1.2 Performance Standard

1.1 Site boundary is identified as per local authority land survey maps
1.2 ***Clearing method*** is selected depending on ***site conditions***
1.3 Safety requirements are identified according to clearing methods and site conditions
1.4 Site is cleared as per set procedures and safety regulations
1.5 Debris disposal is carried out as per supervisor's instructions

1.2.1.3 Information Sheet

DEFINATIONS

i. SITE CLEARING

Site clearing is normally the first operation to be done when the alignment has been set out. It is done in order to prepare the site for the excavation and formation of the road.

It consists of the removal and disposal of all bushes, trees, fences and loose boulders as well as the grass within the top soil

ii. SITE GRUBBING
it refers to removal of underground roots that may remain in the soil. this includes the removal of all logs, brush and debris as well as grinding and removal of stumps

iii. SITE STRIPPING
Removing of top soil only those areas that will be disturbed by excavation, road building or compaction by equipment

iv. BUSH HOGGING
Also known as **brush hogging**, **brush** cutting or rough cut mowing, is a form of landscaping that eliminates heavy **brush** in order to prepare land for farming, hunting, development, and a variety of other uses.

v. DEMOLITION
lt is the dismantling, razing, destroying or wrecking of any building or structure or any part thereof. Demolition work involves many of the hazards associated with construction.

vi. GRADING
Removing dirt from an area in such a way that a slope is formed, allowing water to drain in a desired direction.

vii. SCRAPING

Clearing away debris to generally flatten and clean a site in preparation for other work.

viii. SITE CLEAN-UP

Hauling away debris left over from construction, and general final cleaning of a construction site in preparation for the building's sale, lease or occupation.

ix. SITE WORK

Any part of a construction project that does not involve the physical building structure. Site work refers to work done on the surrounding land.

x. SOIL REPORT

Information about a proposed construction site's soil conditions, including whether the soil is capable of holding heavy weights, has a tendency to shrink or expand, or other qualities that may affect a building's soundness.

xi. STUMP GRINDING

A method of stump removal in which the stump is ground into fine chips or sawdust until the stump is several inches below the soil level.

SITE CLEARANCE

Nature of site clearing

Clearing prepares the site for the construction activities which follow and makes the work easier and safer.

Clearing consists of the removal of:

- bush and scrub;
- trees, stumps and fences;
- grass and other vegetation;
- boulders.

The removal of trees and boulders can be very time-consuming and realignment of the road should be considered before starting major clearing work.

Some activities, i.e. tree felling and removal of big boulders require experienced workers and safety precautions.

- Site clearing is normally the first operation to be done when the alignment has been set out. It is done in order to prepare the site for the excavation and formation of the road.
- It consists of the removal and disposal of all bushes, trees, fences and loose boulders as well as the grass within the top soil.
- If it is necessary to remove crops or trees, the owners must be notified well in advance and given the possibility to harvest the crops themselves. All trees, crops and other things removed belong to the original owner and should be made available to him without delay. It is important that the supervisor keeps a record of all crops removed in case claims for compensation arise later on.
- Similarly, if fences have to be removed along the road, the owner should be informed and given time to make alternative arrangements, e.g. alternative grazing for the cattle.
- All questions have to be solved before the construction starts and the negotiations are normally carried out by the engineers

a. Bush clearing

Bush clearing consists of the cutting and removal of all bushes and shrubs within the clearing width (i.e. road width plus metres on each side).

It is important that the bushes are promptly removed from the cleared area as they will hinder the subsequent activities. Also thorns might injure workers who sometimes are barefoot.

Thorn bushes are difficult to handle for the clearing gang but a long stalk with a twig used as a hook is a most helpful implement.

The bushes have to be disposed of well outside the roadway or stocked in a cleared area for burning after the removal of trees and vegetation. Long grass should be cut close to the ground and removed outside the clearing area. If this is done systematically the danger of snakes and poisonous animals will also be considerably reduced.

Method used

- Set out the area to be cleared.

- Place the workers in such a way that they know which area to clear and that they have sufficient working space.

- Issue the necessary tools and start the work.

- Throw the bushes outside the cleared area or heap them in the middle of the clearing where they can be burned afterwards.

b. Tree and stump removal

With small-sized trees, a good way of removing both the tree and its stump is to pull down the whole tree. This can be done by attaching a long rope to the top of the tree and then excavating and removing the soil around the roots. Take care that the tree is secured and cannot fall until all workers are at a safe distance (at least twice the length of the tree) from it. The rope is then pulled in the direction in which the tree is supposed to fall.

Deep roots might have to be cut by axes but it is better if the tree can be pulled down with all roots coming out. The roots or stumps left in the ground will eventually rot away and leave holes which can undermine the strength of the road.

Larger sized trees should be felled by axe or bow-saw and the roots dug out and removed later. When the tree has been felled, it has to be cut in pieces which can be removed from the Site.

Extremely big roots, stumps or pieces of the tree trunk can be burned after grubbing has been done (the risk of bush fires is less when the grass and vegetation have been removed). It can also be necessary to let the wood dry a little before it can be burnt.

The tree trunk can also be split by means of chisels and sledge-hammers. Felling trees can be dangerous and should be done by careful and experienced workers who have been properly instructed by the supervisor.

Method used

- Secure a long, strong rope to the top of the tree to be removed (several ropes securing the tree in different directions in the case of big trees).

- Remove the soil around the roots first and deepest on the side to where you want the tree to fall; if the roots are very deep they can be cut after they have been excavated to at least 1 m depth.

- Pull down the tree with the rope.

- Cut the tree in smaller pieces which can be handled and remove them from the roadway; pieces which are too big to be moved can be burned when all the grass has been removed from around them.

Note: No people should be working on other activities in the danger area (a circle of twice the length of the tree) when the tree is being removed.

Tools

For excavation: hoes, mattocks and shovels.

For cutting: axes, mattocks, bow-saws.

Other: ropes, winch, handtong, grapple

c. Grubbing

Grubbing is to remove grass and other vegetation plus roots from the places where the road is to be built. It also includes the removal of topsoil where this is necessary. If the topsoil is exactly the same material as the soil below it, there is of course no reason to remove it. Topsoil should only be removed if it is weaker and different from the underlying material, e.g. containing humus and small roots. On most sandy soils the surface should be left undisturbed.

If the soil is to be excavated later (cuts) and dumped outside the road (spoiled) it is of course not necessary to do grubbing.

The best tools to be used in the activity are mattocks, hoes, spades, shovels and rakes.

Method used

- Set out the width to be cleared.
- Remove the topsoil together with the remaining vegetation and roots.
- Throw all removed material outside the clearing.

Note: Topsoil removal is only necessary when the top layer consists of humus, decayed vegetation, roots, etc. If the material of the top layer is not different from the soil beneath, topsoil removal is not necessary!

Control -The area should be free from grass, decayed vegetation and roots,

Tools

- Slashers.
- Hoes.
- Rakes.

d. Boulder removal

When big boulders occur in the alignment it means considerable extra work and it might be easier to change the alignment. This should always be considered before starting major boulder removal.

There are several ways of getting rid of boulders. Which method to use will depend on the size, shape and position of the boulder and on which tools and equipment are available.

The most common methods are:

- moving the boulder;
- burying the boulder;
- cracking the boulder.

1. Moving the boulder

This is usually the easiest method to remove boulders of less than ½ m^3. The boulder is dug out and moved by using crowbars as levers (M-6). Pieces of rails can be placed under the boulder to provide a good surface to slide on.

For moving bigger boulders, a winch can be useful.

2. Burying the boulders

If the boulder is bigger than ½ m^3 and/or lying deeply embedded in the ground it is often easier to dig a hole next to the boulder. It is necessary to try to correctly estimate the size of the boulder so that the hole can be made big enough. For this purpose it is required to remove the soil around the whole boulder. This will also allow you to determine the best direction to tilt it.

When the ground is too stony to allow a big enough hole to be dug, or when the boulder is extremely big, the cheapest solution may be to raise the level of the road so that the stony area is

covered. A combination of partly burying the boulders and raising the road level may also be considered.

The lifting and tilting of very big boulders is simplified if jacks are available but can also be done by using crowbars and long, strong wooden poles as levers. Propping up the boulders with stones or wedges as they are lifted is usually necessary to enable the levers to shift position.

3. Cracking the boulders to small pieces

If only the tip of a large boulder is sticking out above the level of the site surface it can be cracked by fire.

When the boulder has become very hot, pour cold water on it. At the same time the rock should be hammered with sledge-hammers. The heat makes the boulder expand (become bigger) and the cold water causes sudden contraction (shrinking). The contraction causes cracks in the boulder and by hammering on the parts near the cracks it will split.

Ensure that the workers hammering rocks have protective clothing and eye protection. If the rocks or boulders are cracked it is often possible to split them into smaller pieces by inserting chisels in the cracks and hammering them with. sledges.

Whenever rock is hammered workers must wear eye protectors.

Although not easily available, the use of explosives in cracking rocks and big boulders is very efficient. The blasting requires very skilled licensed blasters and specially trained supervisors for the drilling which can be done by hand, provided the correct tools are available.

Method used

Depending on the size, shape and position of the boulders, different methods are possible:

(a) moving boulders outside the roadway:

- this is generally only possible when the boulders are rather small, i.e. less than ½ m^3. The boulder is first dug out and then moved with, crowbars. To simplify this work, pieces of rail can be used on which to slide the boulder;

(b) burying boulders:

- if the boulder is bigger than ½ m^3 or is deeply embedded in the ground, it may be easier to dig a hole next to the boulder and bury it. In this case, estimate the size of the boulder and find out if it is possible to dig a sufficiently big hole next to it. If this is possible, dig the hole next to the boulder and tip it into the hole with crowbars and jacks or a winch.

If the ground is too stony to bury the boulder, investigate if the level of the road can be raised so that the boulder(s) is (are) covered.

Note: Often it will be possible to combine burying the boulder and raising the level of the road;

(c) cracking the boulder:

- if a boulder cannot be removed or buried, it may be possible to crack it into smaller pieces which can be removed. This can be done by heating and cooling the boulder/rock. Start a fire on

top of the boulder/rock and keep it going for a minimum of six hours but preferably longer. Then pour cold water on top and hammer the rock with sledge-hammers.

A weathered and cracked boulder/rock can often be split with wedges which are driven into the cracks with sledge-hammers.

Finally, blasting is an effective method but is seldom possible on smaller sites as specially trained and licensed supervisors are always required.

Tools

- Crowbars.
- Shovels.
- Pickaxes.
- Sledge-hammers.
- Plug and feathers.
- Wedges.
- Chisels and tongs.
- Winch.
- Safety items (glasses, gloves).

Objectives of Site Clearance

The objectives of any site clearance operation should be:

i. ***Enabling:***
  - ***rescue of trapped and injured persons;***
  - ***recovery of fatalities and/ or human remains;***
  - ***criminal and other investigations;***
  - ***recovery of personal and other items of value;***

ii. ***Safe removal and disposal of rubble and other debris;***

iii. ***Decontamination of rubble and debris and returning the area to an agreed level of safety;***

iv. ***Ensuring environmental impacts from site clearance are appropriately controlled;***

v. ***Facilitating the recovery process, to restore to a "new normal";***

vi. ***Maintaining normal services at an appropriate level, so far as is practicable.***

SAFETY IN SITE CLEARANCE

Safety precautions include:

1) Ensure that all workers have access to safety equipment including respirators, lifelines and safety nets. Respirators are especially necessary if there are still fumes and dust from the blasting

demolition process during site clearance. Lifelines and safety nets protect the workers from serious falls.

2) Ensure all workers are dressed in protective wear, gloves, ear, eye and face protection. Protective clothing and gloves will protect the workers from injuries from sharp pieces of debris like glass, dust from getting into the eyes and hard hats protect from falling objects like stones and equipment. Heavy industrial shoes will protect workers feet from sharp debris and glass. Ear protection protects the workers ears from excessive noise emanating from machinery and equipment used in the machinery removal of debris.

3) Ensure all workers are informed of safety precautions and emergency procedures.

4) The site clearance contractor plans the best methods and equipment to be used in the project, and which pose the least danger to the workers and others on site and to the passing public.

5) Explaining to the workers the risks and the safety precautions to be taken for their own safety and the safety of the people around.

6) Everyone on the site should be prepared for any emergencies during the project. Workers should be trained on how to respond in emergencies. Warning and safety signs should be erected and evacuation routes should be charted out.

7) The site should be clearly marked out and onlookers and especially children should not be allowed near the site. Non-workers and the passing public should be restricted from entering the site. This is a high-risk area what with heavy machinery, equipment and the like used in the machinery removal of debris and other contaminants.

8) Local medical and emergency hospitals should be identified and they phone numbers and addresses posted in a location that is accessible to everyone. This will facilitate speedy response in case of any emergencies.

9) Any equipment to be used for any machinery removal job is inspected for peak performance to minimize the risk of accidents during the project.

10) Precautionary measures should be inspected and approved by the local authorities prior to start of site clearance work. The local government authorities may offer or recommend specialist decontamination agencies to assist in the project. The site clearance agency will ensure that the site is cleared safely and returned to the owners for development.

Site Preparation in Construction

Site preparation is an activity that should be done accordingly for other construction activities to commence. The failure and success of site preparation set the condition and the tone for other construction activities executed on-site. The definition of site preparation is already enough to demonstrate the value of this activity to building construction. Also, deploying a construction schedule software is highly recommended as it also has given higher importance during the process.

Furthermore, site preparation is also defined as a set of activities and tasks before engineers commence work. For instance, if new building projects need to be executed on a site that partially served as a gym house, the old building must be removed. By doing so, a new building will be erected, and preparing the site is made easy.

Steps Involved in Site Preparation for Construction Projects

1. Site Clearing

Clearing the site is the very first step in site preparation. The entire site must be in a graded and cleared condition. The case involves the demolishing of buildings, the removal of trees, and eliminating any underground infrastructures. These obstacles should not hinder in the first place because it might affect the future building process. Completing the project might also at risk if clearing the site is not successful. Hence, it must be prioritized once and for all.

2. Site Surveying

You might not be sure if you are building on the right block if survey pegs do not determine the building block. A surveyor is responsible for surveying the site and lining out the exact area where the road project or structures to be built. The process for surveying land might not be an option but is mostly a requirement zoning and permitting processes. Besides, surveying is the translation of the contractor's set of plans into an actual representation of the project site.

3. Soil testing

Testing the soil is one of the most critical tasks that have to be done before the site is procured. The soil's main composition should be determined to test the ability to absorb water and examine the ability to withstand structure. The site engineer must insist on doing all necessary soil testing procedures before commencing any structural tasks.

If the soil at the site isn't suitable enough for future projects, there might be no other choice but to look for another site that has soil appropriate for the projects. A chart showcasing the different classes of soil is outlined below:

· Class A (Acceptable): mostly the rocks and sand have no little or no ground movement

· Class S (Satisfactory): slightly reactive clay sites that only have little ground movement

· Class M (Moderate): Moderately slit sites or reactive clay that can experience moderate ground movement

· Class H1 and H2 (Highly reactive): Clay sites are highly reactive that it can experience higher ground movement

· Class E (Extreme): Extremely reactive sites that are prone to experiencing extreme ground movement
· Class P (Problem): Sites that include softer soils like a slit or soft clay. Soil is subject to erosion, which cannot be classified otherwise.

4. Site Plan Design

After doing the soil testing, all necessary septic tanks and drainage should be installed. The next step will be modifying the design to indicate the placement of fixtures and septic tanks. Additionally, there should also be a permanent record of the areas located underground. A construction site is considered a living and breathing thing. Hence, it changes every single day as the water tank's placements slightly change. Underground rock formations often cause changes. The use of a crew scheduler superior is proven to be a helpful tool during site plan design. Moreover, the site plan shows all newly developed access roads for temporary storage areas and construction vehicles. The site plan also depicts where the building must be placed after it is constructed. Unlike any other steps taken during site preparation, revisions are carried out in the office, and the site plan is always updated in the field.

5. Site Investigation

Geotechnical site investigation is performed to characterized rock, soil, and groundwater condition of any proposed sites. A geotechnical site investigation is defined as evaluating site conditions and collecting data to construct and design the foundation of a structure. Parking lot, bridges, roads, and buildings are some of the typical samples.
Well-planned management and strategy of a geotechnical site investigation is the primary key in acquiring correct site information. This data is generally used for structure designing with minimum surprises for effort and estimates need. The preparation of reports and collection of geotechnical data must be considered in the following three stages. Take a look below:
· The project definition is usually prepared by the respective owner in conjunction with the architect. Thus, the project definition is expected to consist of engineering/architectural foundation criteria such as settlement and loading.
· The chosen geotechnical consultant must conduct project evaluation and preliminary site for the site investigations. It often consists of initial site reviews of past geotechnical investigations. This consensus by the owners and initial assessment is used to develop the proposed geotechnical site investigations' details.
· This site investigation can also determine if the building phase is done in 1-2 steps. A preliminary site visit is included by a particular geotechnical engineer and a groundwater expert. Both experts must have the practical experience to obtain visible data and performance information.

TOOLS AND EQUIPMENT USED IN SITE CLEARANCE

A. HAND TOOLS

These tools are used by do-it-yourselves who want to clear their land. In this matter, the tools are usually used for gardening or lawn work. Some of hand tools for clearing land are loppers,

pruners, hand saws, shovels, pickaxes, rakes and hoes. However, each tool has its function so that someone should choose the right tool before doing the land-clearing job.

(a) **Hoes**

The hoe is probably the most useful and widely used hand tool in the world. It is mostly used in construction sites and in all other kinds of work which involves excavation.

Figure 1 Hoe

The hoe consists of a blade and a handle. The blade can be fastened to the handle with an eye or a spoke.

Maintenance and repair

The hoe needs maintenance to be effective.

- The cutting edge should preferably be sharpened on a grinding wheel but a file (for metal) can also be used. It is important to sharpen the edges.
- If the blade has been chipped or pieces broken off, the hoe should not be used until it has been repaired.
- The repair can be done by cutting or filing the edge straight and then sharpening it.
- Handles must be well dried before they are shaped and fitted.
- One end of the handle should be bigger than the rest of the handle to prevent the blade from loosening. This type of handle is called conical.
- The length of the handle should be such that it is comfortable for most workers to use.

- It is recommended to use wedges to fix the handle effectively to the blade.

(b) **Forked hoes**

The forked hoe is a special type of hoe. Instead of a blade it has a number of prongs which can penetrate a cohesive or hard/stony soil easier than a blade.

Figure 2 Forked Hoe

The fastening of the handle is done in the same way as for the plain hoe.

When the prongs have become blunt, they should be sharpened on the inner face. This cannot easily be done in the field since a forge or grinding wheel is necessary. Keep a grinding wheel in the site store and instruct the storekeeper to inspect the tools at regular intervals and to sharpen them when necessary.

Using the hoe

Hoes can be effective in:

- excavation;
- loading of baskets or trays;
- spreading.

In excavation the plain hoe is best for rather soft soils with only little or no stones, while forked hoes are better on cohesive or hard and more stony soils.

When excavating it is least exhausting to work if one does not have to bend the back all the time.

(c) **Pickaxes and Mattocks**

Pickaxes and mattocks are also tools for excavation. They are more specialised for construction work than hoes and suitable for excavation in more stony soils.

Many different designs of pickaxes and mattocks are produced.

Figure 3 Mattock

Figure 4 Pickaxe

Both the pickaxe and the mattock are rather heavy; the pickaxe usually between 2.7 and 3.6 kg and the mattock between 1.8 and 2.7 kg.

Maintenance and repair

- Both tools need sharpening from time to time. The mattock, being less solid, can be sharpened on a grinding stone, while the pickaxe may need to be re-forged if sharpening at the site store proves too difficult.

- The handles must be stronger than the ones used for hoes but should be fastened in the same way, using wedges. As both ends of the pickaxe or mattock are used, the handle has to be straight.

- The cross-section of the handle should preferably be elliptical. It is recommended to procure handles with a raised safety grip which prevents the handle slipping out of the workers' hands.

Using pickaxes and mattocks

- Pickaxes are used to loosen stony material, mostly in quarries. It is important to stand somewhat lower than the level which is excavated. This helps to avoid unnecessary strain.
- The pickaxe should be aimed at softer material or cracks around the stones or harder material. The handle is then used as a lever to break loose the stone.
- The mattock has its best use in loosening the soil and cutting roots in firm soils. It is also useful in digging hard, non-cohesive soils, which are difficult to penetrate with a hoe and difficult to move with a forked hoe.

(d) **Crowbar**

The crowbar is, like the pickaxe, used mostly in stony or very hard soils.

Figure 5 Crowbar

The crowbar looks like a very simple tool but it has to be of a very strong material and have a good design to function well.

The bar itself is often round while the working end of the crowbar is either pointed or chisel formed. A pointed end is perhaps most common but the chisel end is more useful for leverage. The weight depends on the length and diameter. The diameter should be sufficient to give a good, firm grip (approximately 50 mm).

Maintenance

- A crowbar requires little maintenance. It might need sharpening after long use and it can get bent if its material is too soft.
- To straighten a crowbar it should be held in both hands and struck against a rock as shown in figure 17. Hold the crowbar loosely in the hands when doing this. The vibrations can be very strong!

Using the crowbar

The crowbar is mostly used for:

- breaking loose hard material in quarries;
- moving stones or other heavy things.

In quarries the crowbar is, combined with the pickaxe, an excellent tool for loosening the gravel. When stones or other heavy things have to be moved, the crowbar is very useful if it is applied correctly as a lever.

(e) **Shovels and spades**

The shovel is effective for scooping up material and throwing it either onto a trailer, truck or wheelbarrow or directly to where the material is needed.

Figure 6 SHOVEL

Contrary to a shovel a spade can also be used for loosening the soil. Spades have stronger blades than shovels. The blades are curved only in one direction. The handle should be long enough to allow the worker to throw the soil with little effort. For workers with an average stature a length of 65-70 cm is recommended.

Figure 7 SPADE

Shovels and spades should not have sharp rivets or joints which damage the hands of the user. When buying shovels or spades ensure that the joint blade/handle is smooth.

Maintenance and repair

- The blade of a good shovel will not bend or crack but will wear.
- The edge of the blade will be so worn that it becomes blunt and it will be difficult to push it into the soil.
- The worn blade can sometimes be cut and sharpened so that the shovel can be used again. This cutting requires very strong tools and should be done in a workshop.

Using shovels and spades

When the soil is loose, the shovel can be used directly to scoop it up and throw it elsewhere.

With harder soil the spade is more useful, because it can be pushed into the ground without bending the blade.

To help to push the blade into the ground, the worker can put his foot on the top of the blade and press down. To be able to do this the worker should have shoes with strong soles. Alternatively, a broad slotted piece of wood can be fitted onto the top of the blade to allow a barefooted worker to push the blade into the soil without hurting his foot.

When throwing the soil, the worker should throw it as far as possible towards where the loading or spreading is taking place.

(f) **Spreaders**

Spreaders are tools used for spreading out the soil on fills. A spreader can be a heavy rake but the best spreaders are specially made for the purpose.

They can be made of sheet metal (5-4 mm thickness) and have a ridge on the back for crushing lumps of soil. The optimum size of the teeth depends on the type of material to be spread and should be determined by experimentation.

Hoes and shovels are also sometimes used for spreading but they are less effective and more tiresome to use than a special spreader or heavy rake.

Maintenance and repair

Apart from replacing broken handles, a good spreader requires no routine maintenance.

Using the spreader

The spreader is very useful when forming a camber from soil which has been heaped along the centre-line. The soil should be raked from the centre towards the shoulders and lumps crushed with the back of the spreader.

(g) **Rammers**

The rammer is used for compacting soil and consists of a weight with a handle. It can be made of different kinds of material although rammers which totally consist of wood are usually not heavy enough.

There are two things which determine the effectiveness of a rammer: its weight and the area of the end which hits the ground. Ideally, the weight should be as large as possible and the area as small as possible. A rammer which can be handled by a worker should therefore have a weight of some 8-10 kg and a diameter of the bottom end of less than 10 cm.

The handle must be long enough to allow the worker to lift the rammer without bending his back.

Figure 8 Rammer

Maintenance and repair

No maintenance or repair should be needed.

Using the rammer

Rammers should be used in situations when mechanical compaction is difficult or not possible.

The soil should be spread in thin layers (not more than 10-15 cm thick).

A good and even compaction can be achieved if several workers with rammers are working side by side moving backwards. The pressure from the feet of workers also helps to compact the soil.

(h) **Wheelbarrows**

The wheelbarrow is one of the most useful and economic forms of transportation over short distances (usually not exceeding 150 metres).

Wheelbarrows can be of many different types and qualities. A good wheelbarrow should take a big load (struck capacity approximately 70 litres) and be easy to balance, push and tip. Unfortunately, many of the wheelbarrows which are made are small, of poor quality and difficult to push.

A wheelbarrow consists of a body or tray which rests on a chassis with attached handles and a wheel. It also has a stand.

The strongest and most comfortable wheelbarrows have pneumatic rubber wheels and a tray made of 1.6 mm steel sheet. The tray should be reinforced around the rim and attached to the chassis with bolts, nuts and washers. The clearance between wheel and tray should be minimum 50 mm.

Figure 9 Wheelbarrow

Maintenance and repair

Wheelbarrows need a lot of maintenance to remain serviceable. Each day all bolts and nuts should be tightened. If a bolt has been lost it must be replaced before the wheelbarrow is used again.

This means that there must be on the site a supply of spare bolts, nuts, spring washers, spanners and screwdrivers of the right size.

If the wheels are pneumatic, a pump is also necessary.

Using the wheelbarrow

If the ground is soft or very stony, planks should be laid to provide a smooth running surface for the wheelbarrows.

The best performance of a number of wheelbarrows is obtained if the hauling route can be made as one-way runs. This means that one run leads to the dumping place and another from it so that the haulers do not have to meet on a narrow hauling run.

PRECAUTIONS ON HANDTOOLS

- hand tools having oval eyes fitted with. oval-shaped handles are preferable to hand tools with round eyes and round handles. Although oval handles are more difficult to make and fit they allow a better grip and prevent the blade from twisting;

- hoes, forked hoes and mattocks should be sharpened on the inner face or front side (the side you are looking at when holding the tool);

- hoes should be replaced when their blade has become shorter than 150 mm;

- handles should be fixed securely. A good way is to use hardwood wedges for securing the handle. These wedges should be hammered into a small slot sawn into the blade-end of the handle;

- handles should be approximately 1 m long;

- hoes, forked hoes and mattocks can be sharpened with files, whetstones and grinding wheels. Instruct the storekeeper to regularly inspect the tools and to sharpen them when they become blunt;

- crowbars can be used as levers. If they are bent they can be straightened by striking them against a rock;

- shovels and spades should have smooth joints between handle and blade. No sharp rivets or metal should be sticking out;

- compaction with hand-rammers is best done by several workers working side by side moving backwards;

- wheelbarrows are a good way of transporting soil if the hauling distance does not exceed 150 metres;

- wheelbarrows should be inspected after each day's work. Nuts and bolts should be tightened and replaced if necessary;

- wheelbarrow runs should be provided on soft soil.

Tools and equipment for maintenance of hand tools

- A selection of flat, half round and round files,
- Whetstones.
- Grinding wheel.
- Vice.
- Clawhammer.
- Tenon saw.
- Hand drill and set of bits.
- Wood rasp.
- Wood chisel.

Tools and materials for maintenance of wheelbarrows

- Pump (if wheelbarrows are fitted with. pneumatic wheels)
- Bolts, nuts and spring washers.
- Spanners.
- Screwdrivers.

B. MOWERS

You can use a mower to clear large area of land covered with undergrowth. For areas that are walkable you can choose a self-propelled model. For areas that are very large you can use a tow-behind model that is commonly known as brush hog. These machines are good at clearing saplings, tough weed and grasses. They are extremely powerful and make the job a lot easier for you.

Figure 10 Mower

C. GRUBBER

The grubber is an effective grass removal equipment, ideal for those cases in which you just need to remove a small section of bushes or a few saplings here and there. For this you do not need equipment as powerful as the mower but something more powerful than the lawn mower and chainsaw. The grubber has spikes that can dig into a tree with a chain attached to the other end. A truck or tractor can be used to pull out the tree. This is available in different sizes and is the best way to remove one sapling at a time.

Figure 11 Grubber

D. <u>Excavators</u>

- **Excavators** are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform (known as the "house").
- The house sits atop an undercarriage with tracks or wheels.
- Excavators are also called diggers
- Excavators are used in many ways:
  - Digging of trenches, holes, foundations
  - Material handling
  - Brush cutting with hydraulic attachments

- Forestry work
- Demolition
- General grading/landscaping
- Heavy lift, e.g. lifting and placing of pipes
- Mining, especially, but not only open-pit mining
- River dredging
- Driving piles, in conjunction with a pile driver

Figure 12 Excavator

E. Back hoe

- Backhoes are mainly used to clean up construction areas, to dig holes in the ground, to smooth uneven ground, to make trenches, ditches and to help remove deep roots from trees.
- It can exert high tooth pressures and hence can excavate stiff material which normally cannot be excavated by dragline. Out put of hoe is greatest when the excavation is done near the machine, because cycle time of operation reduces.
- A **backhoe**, also called a **rear actor** or **back actor**, is a piece of excavating equipment or digger consisting of a digging bucket on the end of a two-part articulated arm. They are typically mounted on the back of a tractor or front loader.
- Also known as **hoe**, **back shovel** and **pull shovel**
- It is used to excavate below the natural surface on which it rests.
- Generally used to excavate trenches, pits for basements and also for grading works, which requires precise control of depths.
- The basic parts are boom, Jack boom, Boom foot drum, Boom sheave, Stick sheave, Stick, Bucket and Bucket sheave.

Figure 13 BACK HOE

Figure 14 Backhoe

Figure 15 Back actor

The section of the arm closest to the vehicle is known as the boom, and the section which carries the bucket is known as the **dipper** or dipper stick (the terms "boom" and "dipper" having been used previously on steam shovels). The boom is attached to the vehicle through a pivot known as the kingpost, which allows the arm to slew left and right, usually through a total of around 200 degrees. Modern backhoes are powered by hydraulics.

Applications:

- It is the most suitable machine for digging below the machine level, such as, trenches, footings, basements etc.
- It can be efficiently used to dress or trim the surface avoiding the use of manual effort for dressing the excavated the surface.

F. Front shovel

- A **front shovel** (also **stripping shovel** or **power shovel** or **electric mining shovel** or **Dipper Shovel's power shovel**) is a bucket-equipped machine, usually electrically powered, used for digging and loading earth or fragmented rock and for mineral extraction.
- They are mounted on crawler tracks.
- To excavate the earth and to load the trucks
- It is used to excavate earth of all classes except hard rock and load it into wagons.

- Size varies from $0.375m^3$ to $5m^3$.
- Basics parts of power shovel including the track system, cabin, cables, rack, stick, boom foot-pin, saddle block, boom, boom point sheaves and bucket.
- Power shovels are used principally for excavation and removal of overburden in open-cut mining operations, though it may include loading of minerals, such as coal. They are the modern equivalent of steam shovels, and operate in a similar fashion.
- Front shovel are mainly used for excavation purposes above its own track or wheel level.
- They are suitable for heavy positive cutting in all types of dry soils.

Figure 16 Shovel

Figure 17 Old Front Shovel

Figure 18 New Front Shovel

- A shovel's work cycle, or digging cycle, consists of four phases:
  G. digging
  H. swinging
  I. dumping
  J. returning

Applications of Front Shovel:

- Suitable for close range of work
- Capable of digging very hard materials,
- can remove big sized boulders.
- It is used in various types of jobs such as digging in gravel banks, clay pits, digging cuts in road works, road-side berms, etc.

Factors affecting output of power shovel

- Class of material
- Depth of cutting
- Angle of swing
- Job condition
- Management condition

- Size of hauling units
- Skill of the operator
- Physical condition of the shovel

H. Bulldozers

- A **bulldozer** is a crawler (continuous tracked tractor) equipped with a substantial metal plate (known as a blade) used to push large quantities of soil, sand, rubble, or other such material during construction or conversion work and typically equipped at the rear with a claw-like device (known as a ripper) to loosen densely-compacted materials.
- They are used for moving earth up to a distance of about 100m and act as a towing tractor and pusher to scraper machines. They can be track-mounted or wheel-mounted.
- The heavy blade attached to the tractor pushes the material from one place to another.
- The tractor can be of the crawler or the wheeled type.

❖ **Classification of bull dozer**

1. Position of blades
   - Bull dozers in which the blade perpendicular to the direction of movement
   - Angle dozers in which the blade is set at an angle with the direction of movement.
2. Based on mountings
   - Wheel mounted
   - Crawler mounted
3. Based on the control
   - Cable controlled
   - Hydraulically controlled

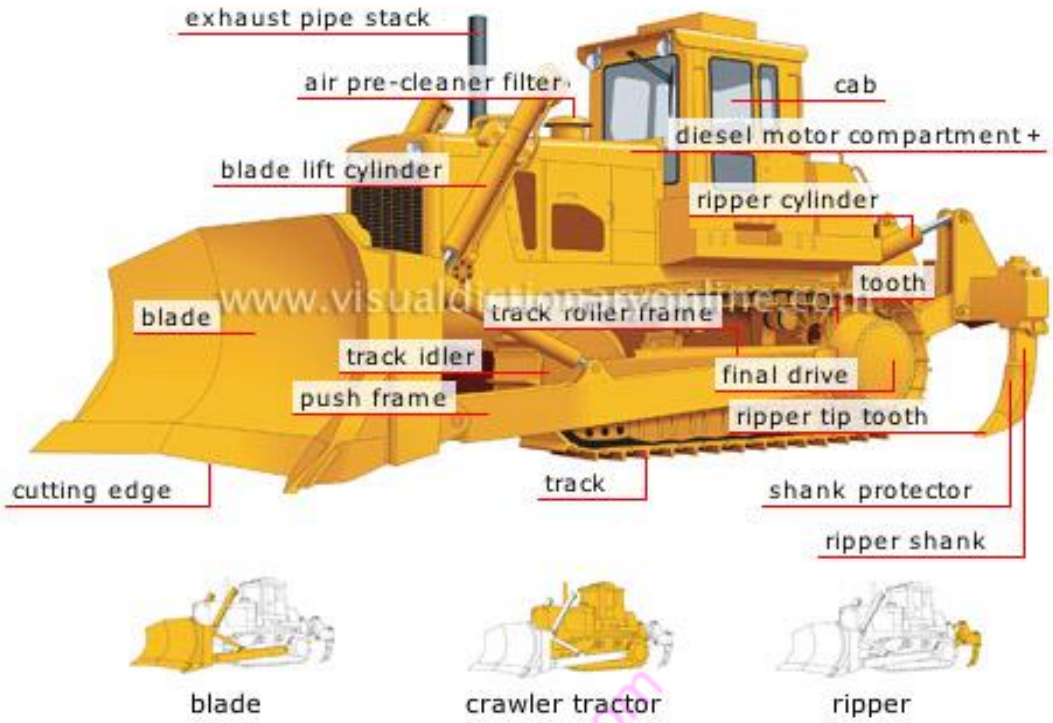

Figure 19 Bulldozer

Applications

1. For spreading the earth fill
2. For opening up pilot roads through mountainous and rocky terrains.
3. Clearing construction sites.
4. Maintaining haul roads
5. Clearing land from the trees and stumps
6. back-filling trenches at construction sites by dragging the earth from one place to another

I. Dumpers

- A **dumper** is a vehicle designed for carrying bulk material, often on building sites. Dumpers are distinguished from dump trucks by configuration: a dumper is usually an open 4-wheeled vehicle with the load skip in front of the driver, while a dump truck has its cab in front of the load.

- The skip can tip to dump the load; this is where the name "dumper" comes from. They are normally diesel powered. A towing eye is fitted for secondary use as a site tractor. Modern dumpers have payloads of up to 10 tones and usually steer by articulating at the middle of the chassis.
- High speed pneumatic wheeled trucks

3. Short chassis
4. Strong bodies
5. Loading, hauling and dumping is done very fast as compared to other equipment
6. Suitable for short hauls on rough roads
7. Especially where a shuttle movement is required.

Figure 20 DUMPER

J. Tippers

- A truck or lorry the rear platform of which can be raised at the front end to enable the load to be discharged by gravity also called **tip truck.**
- Tippers are suited for the rough and tumble of mining & quarrying operations, as well as for carrying bulk loads in construction and infrastructure industries. Complete maneuverability, high performance and long-term endurance are common to all trucks, resulting in lower operating costs.

Figure 21 TIPPER

1.2.1.4 Learning Activities

1. PRACTICAL ACTIVITY
   - Within the institution or around any allowed residence:
     i. identify any two of the following site condition
        - ✓ thorny bushes
        - ✓ shrubs
        - ✓ rock outcrops
        - ✓ Forests/thickets
        - ✓ Marshy/wetlands

     ii. mark boldly the area to be cleared

     iii. select the relevant tools and equipment to carry out site clearance and site stripping

1.2.1.5 Self-Assessment

Why is clearing done? .....

.....

.....

.....

Which are the normal clearing activities? .....

.....

.....

.....

Which are the most common methods of boulder removal? .....

.....

.....

.....

Describe how rocks can be cracked by fire? .....

.....

.....

.....

Why can boulder removal be dangerous? .....

What facilities should be available at the site store for the maintenance of hand tools?

.....

.....

.....

What is a good way to fix a handle to a tool head?

.....

.....

.....

What cross-section should a handle preferably have and for what reason?

.....

.....

.....

What can be done to improve the effective use of wheelbarrows for transport?

.....

1.2.1.6 Tools, Equipment, Supplies and Materials

Tools/Equipment:

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.1.7 References

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RESPONSES

A. Why is clearing done?

Clearing prepares the site for the construction activities which follow and makes the work easier and safer.

B. Which are the normal clearing activities

Clearing consists of the removal of:

- bush and scrub;
- trees, stumps and fences;
- grass and other vegetation;
- boulders.

C. Which are the most common methods of boulder removal?

The most common methods are:

- moving the boulder;
- burying the boulder;
- cracking the boulder.

D. Describe how rocks can be cracked by fire?

if a boulder cannot be removed or buried, it may be possible to crack it into smaller pieces which can be removed. This can be done by heating and cooling the boulder/rock. Start a fire on top of the boulder/rock and keep it going for a minimum of six hours but preferably longer. Then pour cold water on top and hammer the rock with sledge-hammers.

A weathered and cracked boulder/rock can often be split with wedges which are driven into the cracks with sledge-hammers.

E. Why can boulder removal be dangerous?

Due to their weight. they can roll over people and properties

F. What facilities should be available at the site store for the maintenance of hand tools?

- A selection of flat, half round and round files,
- Whetstones.
- Grinding wheel.
- Vice.

- Clawhammer.
- Tenon saw.
- Hand drill and set of bits.
- Wood rasp.
- Wood chisel.

G. What is a good way to fix a handle to a tool head?

dismantle then refix again

H. What cross-section should a handle preferably have and for what reason?

circular- for easy grip

I. What can be done to improve the effective use of wheelbarrows for transport?

Wheelbarrows need a lot of maintenance to remain serviceable. Each day all bolts and nuts should be tightened. If a bolt has been lost it must be replaced before the wheelbarrow is used again.

1.2.2 **Learning Outcome 2:** Hoard/screen the building site

1.2.3.1 Introduction to the learning outcome

This unit specifies the competencies required to identify materials required for the making site hoardings, fencing procedures as well as tools required when hoarding

1.2.3.2 Performance Standard

2.1 Hoarding/screening materials are identified
2.2 Building site is screened/hoarded as per client specifications and safety regulations

1.2.3.3 Information Sheet

DEFINITON OF HOARDING

• A temporary wooden/metal fence around a building or structure under construction or repair adjacent to a road, highway or a public footpath.

• Fences or scaffolds erected on the ground to form a barrier between pedestrians and building sites and/or

• overhead protective structures that are required for the protection of adjoining public areas and persons on a construction site.

SOME MATERIALS USED FOR HOARDING

The predominant materials used for the installation of protective hoardings are:

1. structural timber

In-ground timber hoarding has a great reputation as the most secure option for long-term installation and large construction sites. Timber hoarding boundary systems:

- Can be post mounted, set in concrete or can be installed using concrete blocks as a counterweight.
- Allow for painting in company colours and in high visibility colours, for additional safety and signage, site warnings and instructions.
- Can incorporate both pedestrian and vehicle gates, to allow access control.
- Use timber which is ethically sourced, to reduce environmental impact.
- Offer a limited re-use life, so depending on site conditions, a perimeter run of timber hoarding could be used across more than one site or project, allowing value for money. However, if repeated use over a longer lifespan is required, then steel hoardings may be a more suitable alternative.

2. structural steel

Known for its long-term durability and fire and arson resistance, steel hoardings are ideal for many types of construction sites as the system:

- Is compatible with various types of fencing options, creating hoardings to suit different purposes, eg: using anti-climb mesh panels for increased security.

- Can be freestanding and very quick to set up on a temporary or emergency basis.
- Offers increased environmental friendliness over timber hoarding, as steel is offers both strength and a much longer re-use life.
- Allows perimeter runs which can include gates for both pedestrians and vehicles.
- Is surprisingly portable for easy transportation and quick manual installation.
- Is available in a variety of colours for high visibility.
- Offers a good range of accessories available to allow lighting and signage for additional warning, information and security systems.

3. prefabricated steel
4. iron sheets
5. scaffolding

PURPOSE OF CONSTRUCTING HORDINGS

Site hoarding and **hoarding construction** are a temporary form of signage that is mandatory for any construction business undertaking building work. It is utilised for safety and security purposes, although it is also a great marketing tool that provides protection and is extremely cost effective.
There a variety of benefits regarding **building site hoarding**, including:

1. *Secures your project*

One of the main benefits of implementing **building site hoarding** is that it provides security for your construction site, which can help prevent theft and financial loss.

In accordance with the Construction Design and Management Regulations, all construction companies must ensure that they implement a form of prevention for unauthorised persons entering your construction site. This involves securing a perimeter and implementing suitable signs before any construction work is conducted.

3. *Protects the public*

A prominent advantage of **site hoarding** is that it protects the general public from serious injury, by creating barriers around safety hazards such as:

- On-site vehicles
- Falling objects
- Construction equipment
- Noise, dust or vibration
- Roadworks
- Slips and trips near pedestrian walkways

3. *Protect your project*

The great thing about **site hoarding** is that it not only protects the public, but it also protects your construction project before completion.
If you do not want your project to be revealed before it is completely finished, **site hoarding** can help to keep it under wraps.
The **site hoarding** will act as a visible barrier, allowing your business to work incognito. You can ensure the end result is perfected and fully ready, before making a grand reveal and impressing your customers with your innovative project.

4. *Cost-effective protection*

One of the most beneficial elements of **site hoarding** is its ability to provide a cost-effective solution for your construction business.
The **site hoarding** allows you to reduce protection and advertising costs, as our sustainable signage can be re-used for future projects.
It is also extremely easy to install, which means the installation period will be quick and cost-efficient.

5. ***Advertising***

Building site hoarding is not only a great form of protection, but it also enables you to create advertising campaigns to promote your project.
It is also a great way of advertising your brand. For example, you could utilise **printed site hoarding signs** for a shop opening, in order to showcase your brand or products before the big reveal.

SPECIAL CONDITIONS

At the planning stage of any proposed building or civil engineering works, specific consideration should be given, by those responsible for the design and the construction, to the safety of the workers and the public who will subsequently be affected by the plant associated with the process of the erection of such structures.

The Planning Authority strongly recommends that:

- all construction sites located alongside roads should be fully barricaded by protective hoarding.
- hoardings should be able to protect not only public from dangers within the site but also act as barrier or security to prevent persons from trespassing into the site.
- unless specified otherwise, the contractor shall provide, erect and maintain a continuous metal hoarding around the entire contract boundary before the commencement of the works .
- hoardings shall be erected at not less than 300mm away from any permanent structure such as a footway, drain, pipeline etc.
- hoardings should not be higher than 2000mm high and continuous down to the ground. Any hoarding structure to be erected above the designated height shall be at the discretion of the Planning Authority.
- all hoarding structures are to be properly designed and constructed in accordance to the specification of the Planning Authority and should be maintained in good condition.
- there should be an adequate safety distance between the worksite and the hoarding.
- there should be a minimum of two entry points to a site.
- the contractor shall provide metal gates/doors for the main and side entrances.
- the metal gate at the main entrance (for vehicular traffic) shall be closed after working hours when construction activities have been stopped.

- a side entrance beside the main gate shall be provided for passage of workers and visitors.
- the hoarding shall be constructed in accordance with the standard drawings and detailing.
- On all sides exposed to the public, hoardings should be free of all hazards to the public i.e. nails, sharp edges and corners of metal sheets.
- if ground level bracing is necessary across the pedestrian way, an unobstructed close-boarded or sheet timber walking platform is to be provided. Where pedestrians will be required to use the carriageway a public walkway of 1.3m minimum width must be provided and a 1.5m high barrier handrail of at least two evenly spaced horizontal members must be erected between the walkway and carriageway.
- there must be a clear passage continuously available for pedestrians under or through the scaffold with a minimum of 2.4m headroom. It must be at least 1.3m wide. All fittings lower than 2.6m must be adequately protected to prevent danger to pedestrians.
- Warning signs with the legend 'DANGER - MEN WORKING ABOVE' must be displayed at each end of the structure.

Benefits of buying (rather than hiring) building site hoarding

Yes, **site hoarding** is a temporary structure, but that doesn't necessarily mean that hiring is the best (and cheapest!) option. By their very nature, most construction projects last a long time and there's always a chance they could run over schedule. It's surprising how quickly a 'hire bill' can mount up.

Investing in your own building site hoarding is

- often the more cost-effective option. You're in control of how much you spend.
- The hoarding is yours to keep and – offering fantastic value for money – it can be used time and time again for future projects, either with the same graphics or new designs.
- Buying your own **building site hoarding** also allows you to customise the boards to tailor the design to your needs.

TYPES OF PROPER HOARDING DESIGNS

1. FREE-STANDING VERTICAL HOARDING

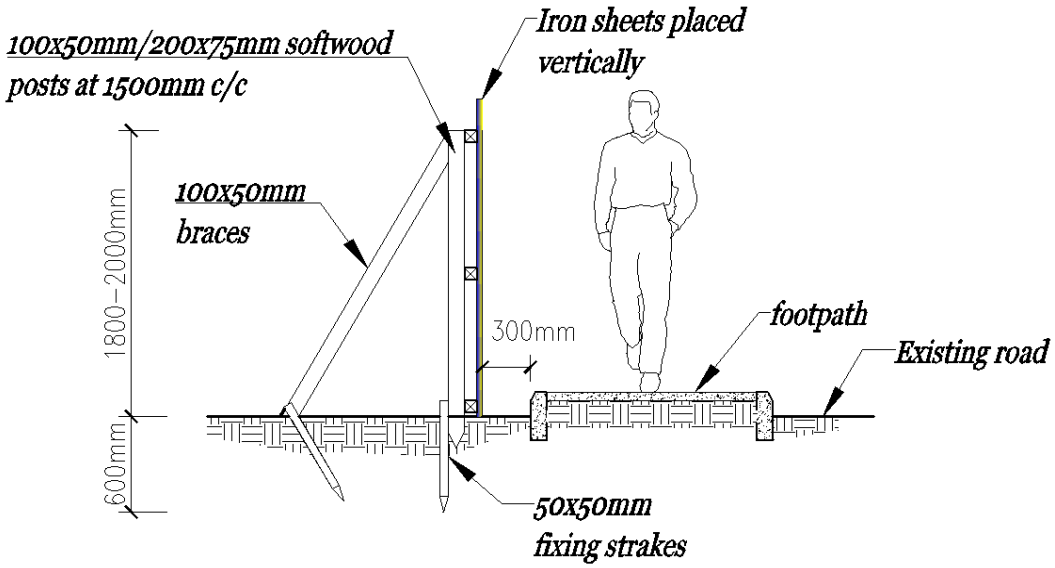

Figure 22

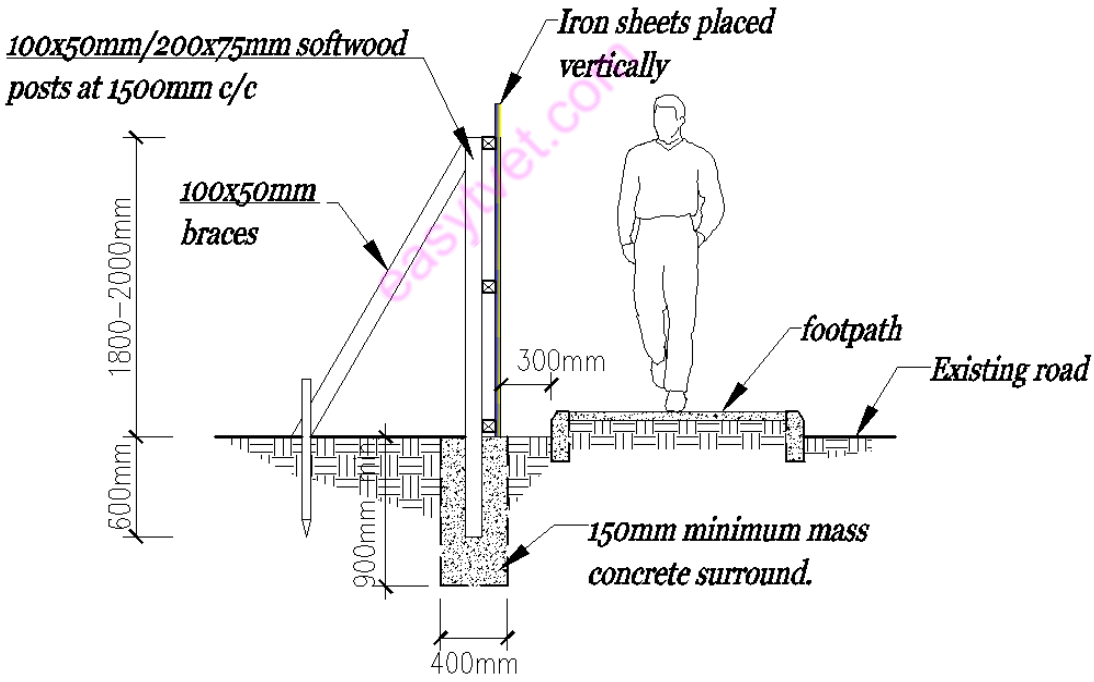

Figure 23

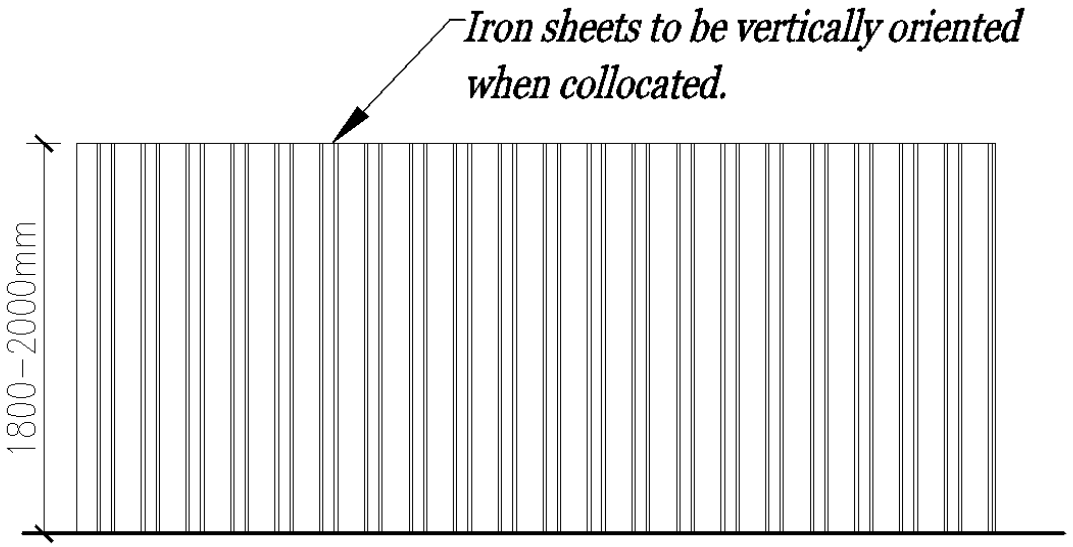

Figure 24

COVERED WALKWAY HOARDING

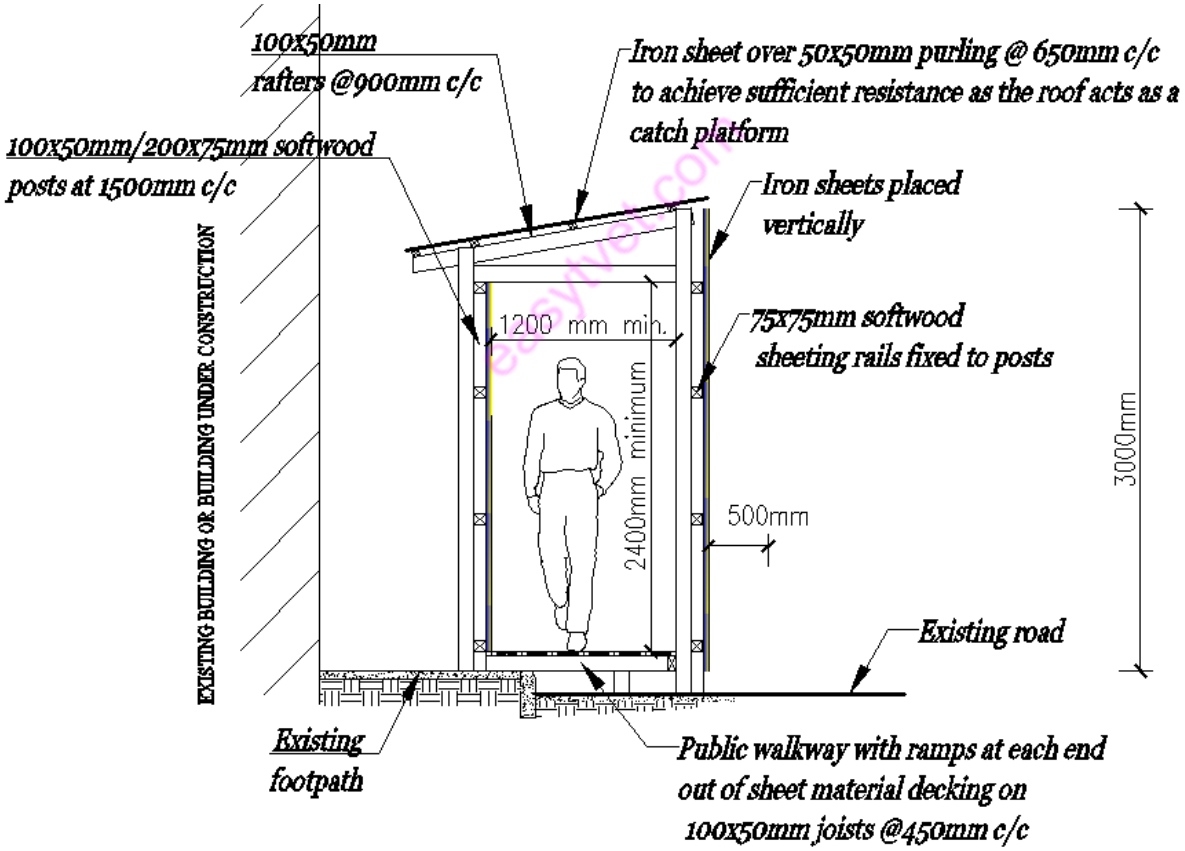

Figure 25

ADDITIONAL ELEMENTS/STRUCTURES TO HOARDINGS

- Where hoarding structures alone are not enough to fully meet the safety requirements on construction sites, mostly structures higher than 3m, other elements or structures such as safety nets and catch platforms are added above the hoarding structure.
- These additional structures act as protective barriers against dust particles and the fall of other debris from the construction site.
- Safety nets are also a system to protect others who will also be working at great heights so as to minimise any potential fall.

A. SAFETY NETS

- Every safety net shall be attached to sufficient anchorages or supports outside and beyond the area of possible fall and supported at a height sufficient to prevent dropping to any surface or object.

- Where a scaffold is erected in an area where the construction activities may pose hazards to pedestrian or vehicular traffic in the form of falling objects, peripheral nets should be used to envelope the scaffold.
- Every safety net or combination of safety nets shall be of sufficient size, strength and must be provided to the area of possible fall.

- No safety net and peripheral net that is broken should be installed.
- Safety net, peripheral net and their supports shall be inspected daily after each installation.

- Every safety net shall comply with any relevant international standard.eg:

  BSEN 1263-1 standard, whereby safety nets are to be made from polypropylene, a modern material which gives high energy absorption together durable use, with a mesh size of 100mm knot to knot. Safety nets are tested for a 100kg person falling 6m. They are installed using rope ties, complying with the BSEN 1263-1 standard

B. CATCH PLATFORMS

- Catch platforms should be erected along the exterior faces of the exterior walls to prevent injury to the public below.
- Catch platforms may be constructed of material other than wood provided such material is of equal strength and does not otherwise lessen the security against falling material.

- All loose materials at elevated areas should be secured so as to prevent them from being blown off the structure by strong gusts of wind.

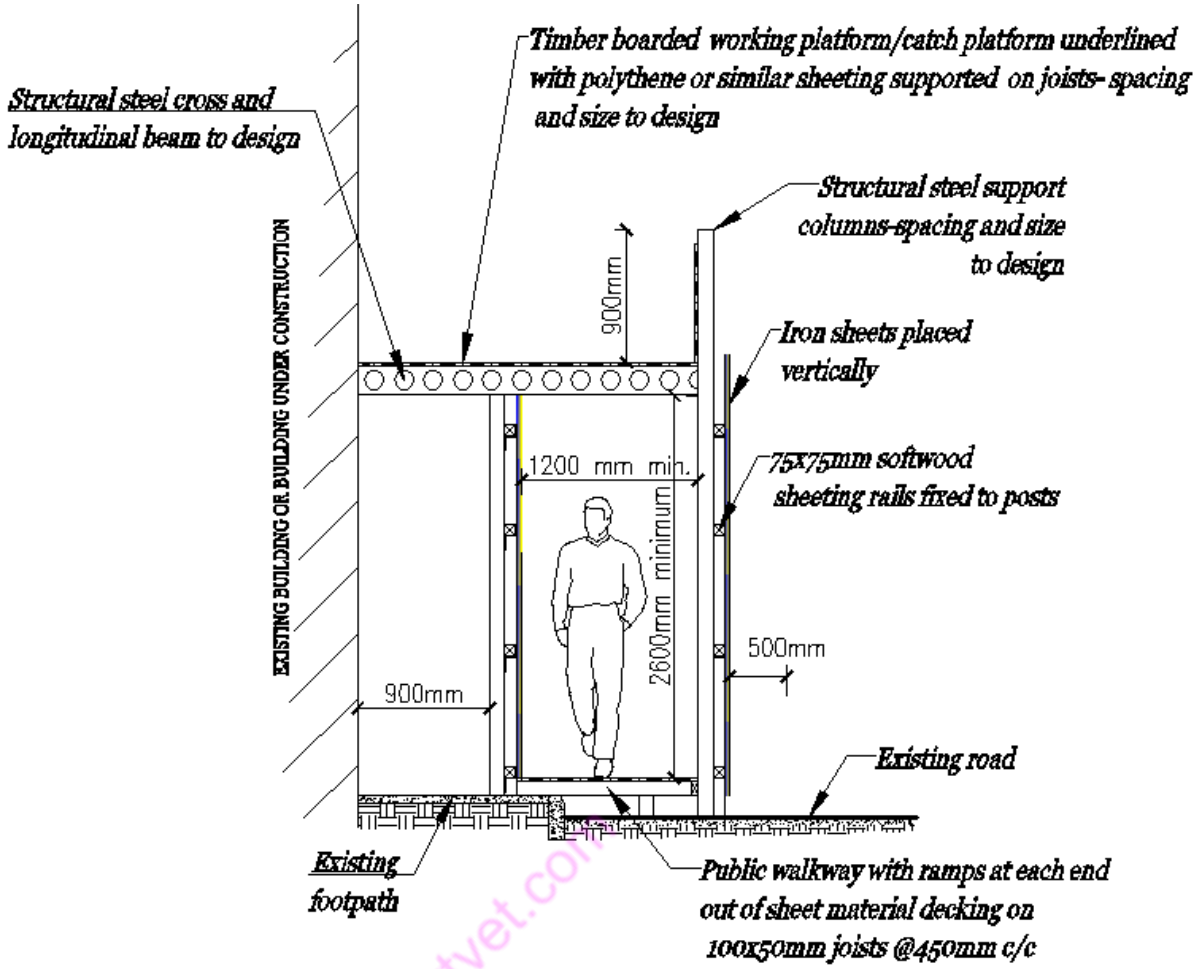

Figure 26

SITE HOARDING SAFETY REQUIREMENTS?

There are two primary site hoarding safety requirements.

- First of all, steps must be taken to provide adequate protection to the public while you are working. In essence, this is in line with the overall purpose of a construction site hording – safety.
- Second, unauthorized site access must be prevented. These requirements are outlined in the Construction Regulations 2007. As with most legislation, a lot of the information is weighed down with jargon.

Below are some of the key hoarding safety factors to consider.

a) Height Requirements

While there are no set limits to the height of a construction site hoarding, they must be too tall for people to scale them with ease. As such, site hoardings are typically fairly large and imposing to prevent unauthorised access and protect valuable equipment stored within.

b) Strength Requirements

Site hoardings must be sturdy and rigid, which is why we craft ours from ultra-durable timber. Construction site hoardings have the minimum requirement of being strong enough to stand up to mind, not be knocked down under force or penetrated for forced entry.

c) Access Requirements

Accessing a construction site hoarding has to be done in a controlled manner. As such, there cannot be wide open entries. To meet safety requirements, hoardings must feature secure gates or access points. This helps to monitor the number of people on site while ensuring the public can't wander in and out.

d) Display Requirements

Hoardings must effectively obscure the construction site. This regulation is in place to limit the likelihood of any theft while creating a visual boundary between the public and the sit, increasing privacy and safety.

1.2.3.4 Learning Activities

plan a visit to any construction site ongoing and

- explore on how hoardings have been used and erected,
- different design types and draw them
- learn about the security nets and catch platforms

1.2.3.5 Self-Assessment

a. what is site hoardings

b. is site hoardings a legal requirement?

c. what is the comparison between timber hoardings and galvanized steel hoardings in terms of durability, maintenance and security

d. which are Two forms of hoarding in common use:

1.2.3.6 Tools, Equipment, Supplies and Materials

Tools and equipment

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.3.7 References

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2. **Health and Safety Executive (HSE) (1998) Information Sheet No. 18,** ***Provision of Welfare Facilities at Fixed Construction Sites*****. HMSO, London.**

RESPONSES

a. what is site hoardings
it is a form of temporary fencing to the site where construction is taking place

b. is site hoardings a legal requirement?
yes- legally all construction sites must have site hoardings as per Health and Safety Act 1974

c. what is the comparison between timber hoardings and galvanized steel hoardings in terms of durability, maintenance and security

	Timber hoardings	**galvanized steel hoardings**
Durability	Not so durable	Very durable- its resistance to rust and no warping
Maintenance	Requires ongoing repair and maintenance to keep it intact and strong	Won't require much repair and maintenance
Security	With time the wood weakens and become easy to snap and be knocked over	So strong, sturdy and reliable barrier from public entrance

d. which are Two forms of hoarding in common use:

- **Vertical hoardings**- consist of a series of closed boarded panels securely fixed to resist wind loads and accidental impact loads. It can be free standing or fixed by stays to the external walls of an existing building.Protection should be given to persons from falling objects.
- **A fan hoarding** fulfills this function by being placed at a level above the normal traffic height and arranged in such a manner that any falling debris is directed back towards the building or scaffold.

1.2.3 **Learning Outcome 3;** Survey building site

1.2.4.1 Introduction to the learning outcome

This unit specifies the competencies required in Surveying building site. it involves choosing different survey methods, identifying tools and equipment to be used, carrying out levelling procedure and preparing contours from the reduced levels

1.2.4.2 Performance Standard

3.1 Survey method is selected according to the building design and client specifications
3.2 Survey instruments are identified according to the survey method
3.3 Reduced levels are obtained as per the site conditions
3.4 Ground contours are prepared according to the reduced levels
3.5 Services are located in relation to the site in accordance with set procedures

1.2.4.3 Information Sheet

DEFINATIONS

- **Geoid** is a surface coinciding with mean sea level in the oceans, and lying under the land.
- **Level surface** is a curved surface that at every point is perpendicular to the plumb line.
- **Level line;** is a line in a level surface, therefore a curved line.
- **Mean Sea Level (MSL):** is the average height of the sea's surface for all stages of the tide over a 19-year period.
- **Datum:** is a level surface to which elevations are referred (for instance mean sea level).
- **Elevation** is the vertical distance from a datum (usually mean sealevel) to a point or object.
- **Bench Mark (BM)** is a relatively permanent object, natural or artificial, having a marked point whose elevations above or below an adopted datum is known or assumed (metal disks set in concrete, large rocks, non movable parts of fire hydrants, and curbs.)
- **Level** is a name of instrument used in leveling which gives us a horizontal line of sight.
- **Focusing** : Aiming the telescope on rod and then focusing it for a clear vision of rod.
- **Line of collimation** The line of sight defined by cross hair as appears in the objective of telescope.
- **Height of collimation**: Elevation of line of sight obtained by adding backsight reading to the elevation of point on which BS reading is taken.
- **Back sight (BS):** The rod reading taken on the point of known elevation. It is the first rod reading at every level set up.
- **Foresight (FS**) : The rod reading taken on the point of unknown elevation or last rod reading in each level set up.
- **Intersight (IS)** : A (sight) reading between BS and FS on a point whose elevation is needed to be determined.

- **Turning Point (TP)** : Also called **Transfer Point (TP**) or **Change Point**. Selected and used to transfer elevation between benchmarks. On every turning point one foresight and one backsight are taken. Turning points should be selected so that they are
    1) identifiable
    2) at equal distance from level.
    3) at maximum distance
    4) solid
    5) sharp and
    6) fixed.

INTRODUCTION

- Surveying is defined as "taking a general view of, by observation and measurement determining the boundaries, size, position, quantity, condition, value etc. of land, estates, building, farms mines etc. and finally presenting the survey data in a suitable form". This covers the work of the valuation surveyor, the quantity surveyor, the building surveyor, the mining surveyor and so forth, as well as the land surveyor.

- Another school of thought define surveying "as the act of making measurement of the relative position of natural and man-made features on earth's surface and the presentation of this information either graphically or numerically.

The process of surveying is therefore in three stages namely:

(i) Taking a general view

This part of the definition is important as it indicates the need to obtain an overall picture of what is required before any type of survey work is undertaken. In land surveying, this is achieved during the reconnaissance study.

(ii) Observation and Measurement

This part of the definition denotes the next stage of any survey, which in land surveying constitutes the measurement to determine the relative position and sizes of natural and artificial features on the land.

(iii) Presentation of Data:

The data collected in any survey must be presented in a form which allows the information to be clearly interpreted and understood by others. This presentation may take the form of written report, bills of quantities, datasheets, drawings and in land surveying maps and plan showing the features on the land.

CLASSIFICATION OF SURVEYORS

Surveying is made up of various specializations known as sectors or classes as:

1. **General Practice Surveyors:**

- Surveyors under this class are mostly concerned with valuation and investment. Valuation surveyors deal with property markets, land and property values, valuation procedures and property law. Investment surveyors help investors to get the best possible return form property.
- They handle a selection of properties for purchase or sale by pension funds, insurance companies, charities and other major investors. They also specialize in housing policy advice, housing development and management.

2. Planning and Development Surveyors

- They are concerned with preparing planning applications and negotiating with local authorities' planners to obtain planning permission.

3. Building Surveyors

- Their work involves advising on the construction, maintenance, repair and refurbishment of all types of residential and commercial property.
- The analysis of building defects is an important part of a building surveyors discipline.

4. The Quantity Surveyors

- They evaluate project cost and advice on alternative proposals. They also ensure that each element of a project agrees with the cost plan allowance and that the overall project remains within budget.

5. Rural Practice Surveyors:

- Surveyors in rural practice advice land owners, farmers and others with interests in the country side.
- They are responsible for the management of country estates and farms, the planning and execution of development schemes for agriculture, forestation, recreation, sales of properties and livestock.

6. Mineral Surveyors

- They plan the development and future of mineral workings. They work with local authorities and the land owners on planning applications and appeals, mining laws and working rights, mining subsidence and damage, the environmental effects of land and rehabilitation of derelict land and deep underground mines.

7. Land surveyors:

- They measure land and its physical features accurately and record them in the form of a map or plan for the purpose of planning new building and by local authorities in managing roads, housing estates, and other facilities.
- They also undertake the positioning and monitoring for construction works.

BRANCHES OF SURVEYING

1. Aerial Surveying

- Aerial surveys are undertaken by using photographs taken with special cameras mounted in an aircraft viewed in pairs.

- The photographs produce three-dimensional images of ground features from which maps or numerical data can be produced usually with the aid of stereo plotting machines and computers.

2. Hydrographic Surveying (Hydro-Survey)

- Hydro survey is undertaken to gather information in the marine environment such as mapping out the coast lines and sea bed in order to produce navigational charts
- It is also used for off shore oil exploration and production, design, construction and maintenance of harbors, inland water routes, river and sea defense, pollution control and ocean studies.

3. Geodetic Survey:

- In geodetic survey, large areas of the earth surface are involved usually on national basis where survey stations are precisely located large distances apart. Account is taken of the curvature of the earth, hence it involves advanced mathematical theory and precise measurements are required to be made.
- Geodetic survey stations can be used to map out entire continent, measure the size and shape of the earth or in carrying out scientific studies such as determination of the Earth's magnetic field and direction of continental drifts.

4. Plane Surveying

- In plane surveying relatively small areas are involved and the area under consideration is taken to be a horizontal plane. It is divided into three branches.
  - ✓ Cadastral surveying
  - ✓ Topographical surveying
  - ✓ Engineering surveying

5. Cadastral surveying

- These are surveys undertaken to define and record the boundary of properties, legislative area and even countries.
- It may be almost entirely topographical where features define boundaries with the topographical details appearing on ordinance survey maps.
- In the other hand, accurately surveyed beacons or markers define boundaries, corner or line points and little account may be taken of the topographical features.

6. Topographical Survey

- These are surveys where the physical features on the earth are measured and maps/plans prepared to show their relative positions both horizontally and vertically.
- The relative positions and shape of natural and man –made features over an area are established usually for the purpose of producing a map of the area of for establishing geographical information system.

7. Engineering Survey

- These are surveys undertaken to provide special information for construction of Civil Engineering and building projects.
- The survey supply details for a particular engineering schemes and could include setting out of the work on the ground and dimensional control on such schemes.

RECONNAISSANCE:

- This is an exhaustive preliminary survey of the land to be surveyed. It may be either ground reconnaissance or aerial reconnaissance survey.
- Reconnaissance is made on arrival to site during which an overall picture or view of the area is obtained.
- The most suitable position of stations is selected, the purpose of the survey and the accuracy required will be drawn, and finally the method of observation will be established.

Objectives of reconnaissance

a. To ascertain the possibility of building or constructing route or track through the area.
b. To choose the best one or more routes and record on a map
c. To estimate probable cost and draft a report.

BASIC PRINCIPLES IN SURVEYING

1. PRINCIPLE OF WORKING FROM WHOLE TO PART

- It is a fundamental rule to always work from the whole to the part. This implies a precise control surveying as the first consideration followed by subsidiary detail surveying. This surveying principle involves laying down an overall system of stations whose positions are fixed to a fairly high degree of accuracy as control, and then the survey of details between the control points may be added on the frame by less elaborate methods.

- Once the overall size has been determined, the smaller areas can be surveyed in the knowledge that they must (and will if care is taken) put into the confines of the main overall frame.
- Errors which may inevitably arise are then contained within the framework of the control points and can be adjusted to it. Thus they have no chance of building up on accumulating throughout the whole survey.

2. CHECK ON MEASUREMENTS

- The second principle is that; all survey work must be checked in such away that an error will be apparent before the survey is completed.
- Concentration and care are necessary in order to ensure that all necessary measures are taken to the required standard of accuracy and that nothing is omitted. Hence they must be maintained in the field at all times.
- Survey records and computations such as field notes, level books, field books, setting out record books etc must be kept clean and complete with clear notes and diagrams so that the survey data can be clearly understood by others. Untidy and anonymous figures in the field books should be avoided.
- If the result of a computation has not been checked, it is considered unreliable and for this reason, frequent checks should be applied to every calculation procedure.
- As a check, the distances between stations are measured as they are plotted, to see that there is correspondence with the measured horizontal distance. Failure to match indicates an error in plotting or during the survey.
- If checks are not done on observations, expensive mistake may occur

ACCURACY AND PRECISION

These terms are used frequently in engineering surveying both by manufacturers when quoting specifications for their equipment and on site by surveyors to describe results obtained from field work.

• Accuracy allows a certain amount of tolerance (either plus or minus) in a measurement, while;

• Precision demands exact measurement. Since there is no such things as an absolutely exact measurement, a set of observations that are closely grouped together having small deviations from the sample mean will have a smallnstandard error and are said to be precise.

CHAIN SURVEYING

This is the simplest and oldest form of land surveying of an area using linear measurements only. It can be defined as the process of taking direct measurement, although not necessarily with a chain.

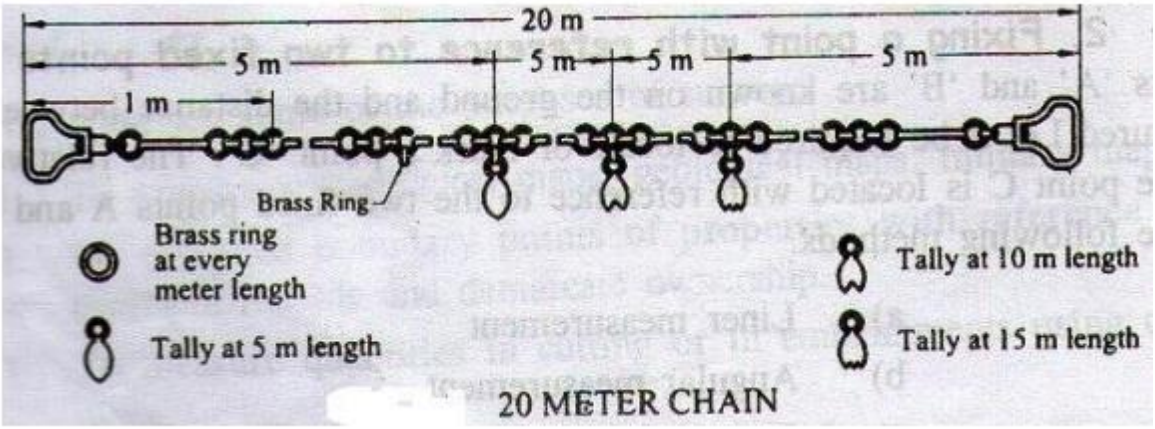
Instruments used for chain surveying:

The various instruments used in chain surveying are as follows.

- ü chain
- ü arrows
- ü pegs
- ü ranging rods
- ü offset rods
- ü plumb bob

1. Chain:

Chains are used to measure horizontal distances. Chains are formed of straight links of galvanized mild steel wire called links. The ends of each link are bent into a loop hand connected together by means of three oval rings which afford flexibility to the chain.



The chain s made of mind steel. The ends of the chin are provided with brass handles for dragging the chain on the ground. the outside of the handle is the zero point or the end point of the chain and the length of the chain measured from the outside of one handle to the outside of the other. The length of a link is the distance between the centers of the two consecutive middle rings.

The end links include the handles. Metallic tags are indicators of the chain to facilitate quick reading of fraction of a chain in surveying measurements. Metric survey chains are available in lengths of 20m and 30m. The 20m chain contains 100 links whereas 30m. Chain contains 150 links. One link of both the type of chain measure 20cm.

2. Arrows:

Arrows or making pins are made of tempered steel wire 4mm in diameter and generally 10 arrows are supplied with a chain. An arrow is inserted into the ground after the chain length is measured on the ground. Usually the length of an arrow is 40cm and one end of it is made sharp and the other end is bent into a circle for facility of carrying.

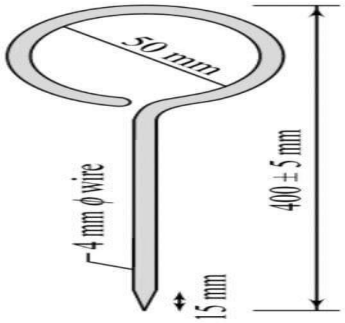


Figure 27 ARROW

3. **Pegs:**

Wooden pegs are used to mark the positions of the stations terminal points of a survey line. They are made of hard timber, generally 2.5cm or 3 cm square and 15cm long, tapered at the end.

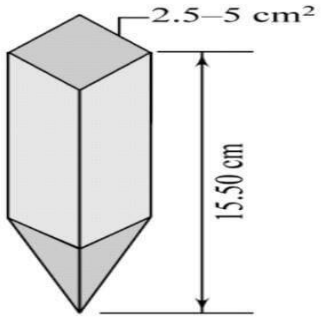


Figure 28: PEG

4. Ranging Rods

The ranging rods are used for making the positions of stations and for ranging the lines. They are made of ell seasoned straight grained timber teak. They circular in cross section of 3cm diameter and have a length of either 2 or 3cm, lengh being more common. They are shod at the bottom with a heavy iron points. In order to make them visible at a distance, they are pained alternatively black and white or red and white.

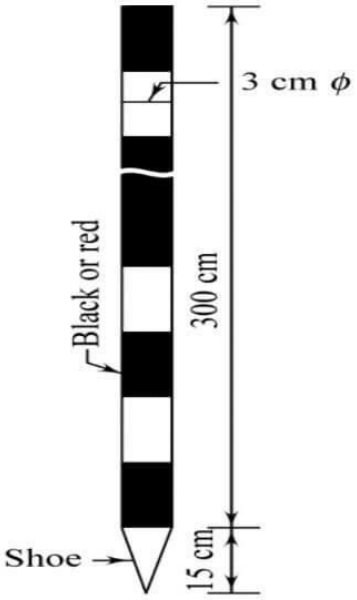


Figure 29: Ranging Rod

5. Offset

Offset rod is similar to that of ranging rod. They are should with pointed iron shoe at one end, ad provided with a notch or a hook at the other for pulling or pushing the chain through a hedges or other obstructions.

Figure 30: Offset

6. Plumb Bob

While chaining along sloping ground, a plump is required to transfer the points to the ground. It is also used for accurate centering of the theodolite compass, plane table etc over a station mark and for testing the vertically of ranging poles

7. Cross staff

This is the instrument used for setting out right angles to a chain line. It consists of either a frame or box with two pairs of vertical slits and is mounted on a pole shod for fixing in the ground

- ü Open cross staff
- ü French cross staff
- ü Adjustable cross staff

Principle of Chain Surveying

The rectangle is the simplest fig that can be plotted from the lengths of its sided. Based on this, the principle of chain surveying is to divide the area to be surveyed into a network of connected triangles. Hence chain surveying is some times called chain triangulation. The exact arrangement of triangles to be adopted depends upon the shape and configuration of the ground and obstacles met with. When it contains no angle smaller than 30degree greater than 120 degree.

Advantages and Disadvantages of chain surveying Advantages:

- ü Chain surveying is suitable for fairly level ground
- ü It does not require costly equipments
- ü It is used for preparing plans of smaller area
- ü It is simple

Disadvantages

- ü It is cannot used for large areas
- ü It is not always accurate

NECESSARY PRECAUTIONS IN USING CHAIN SURVEYING INSTRUMENTS

a. After use in wet weather, chains should be cleaned, and steel tapes should be dried and wiped with an oily rag.
b. A piece of coloured cloth should be tied to arrow (or ribbon – attached) to enable them to be seen clearly on the field.
c. Ranging rods should be erected as vertical as possible at the exact station point.
d. The operating tension and temperature for which steel bands/tapes are graduated should be indicated.
e. Linen tapes should be frequently tested for length (standardized) and always after repairs.
f. Always keep tapes reeled up when not in use.

GENERAL PROCEDURE IN MAKING A CHAIN SURVEY

1. ***Reconnaissance***: Walk over the area to be surveyed and note the general layout, the position of features and the shape of the area.
2. ***Choice of Stations:*** Decide upon the framework to be used and drive in the station pegs to mark the stations selected.
3. ***Station Marking:*** Station marks should where possible be tied - in to a permanent objects so that they may be easily replaced if moved or easily found during the survey. In soft ground wooden pegs may be used while rails may be used on roads or hard surfaces.
4. ***Witnessing***: This consists of making a sketch of the immediate area around the station showing existing permanent features, the position of the stations and its description and designation. Measurements are then made from at least three surrounding features to the station point and recorded on the sketch.

   The aim of witnessing is to re-locate a station again at much later date even by others after a long interval.
5. ***Offsetting:-*** Offsets are usually taken perpendicular to chain lines in order to dodge obstacles on the chain line.
6. ***Sketching*** the layout on the last page of the chain book, together with the date and the name of the surveyor, the longest line of the survey is usually taken as the base line and is measured first.

CRITERIA FOR SELECTING A SURVEY LINES/OFFSETS

During reconnaissance, the following points must be borne in mind as the criteria to provide the best arrangement of survey lines,

a. **Few survey lines:** the number of survey lines should be kept to a minimum but must be sufficient for the survey to be plotted and checked.
b. **Long base line:** A long line should be positioned right across the site to form a base on which to build the triangles.
c. Well-conditioned triangle with angles greater than 30 degrees and not exceeding 150degrees: It is preferable that the arcs used for plotting should intersect as close as 90o in order to provide sharp definition of the stations point.
d. **Check lines:** Every part of the survey should be provided with check lines that are positioned in such a way that they can be used for off- setting too, in order to save any unnecessary duplication of lines.
e. Obstacles such as steep slopes and rough ground should be avoided as far as possible.
f. Short offsets to survey lines (close feature preferably 2m)should be selected: So that measuring operated by one person can beused instead of tape which needs two people.
g. Stations should be positioned on the extension of a check line or triangle.Such points can be plotted without the need for intersecting arcs.

METHOD OF PLOTTING THE SURVEY

The chains survey network of lines is first plotted in pencil As follows:

(a) Base Line

The base line is positioned on the drawing sheet in such a way that the whole area will be contained within the limits of the paper. Its full length is then scaled off, including the position of any line stations along it.

(b) Triangles

• The length of one of the lines to the first point to be plotted is extracted from the field book and set to scale on a compass to draw an arc.
• The second arc length is similarly drawn at intersection to give the plot of the first point; the position of the check line is drawn. This is scaled and confirme to agree with the field measurement.
• Each triangle is plotted and checked in the same way until the whole framework has been plotted making sure that no check measurements have been omitted and that no plotting errors exist.

(c) Offsets

Offset measurements can be plotted using one of the two ways;
• The running chainage along the lines can be scaled off along the main lines on the plot and light pencil lines drawn perpendicular to them along which the offset distances are scaled.
• A proprietary offset scale can be used. This is a short scale graduated outwards its centre to enable offsets on either side of the survey line to be plotted. A long scale is laid on the paper parallel to the survey line so that the offset scale can slide along it with its zero coinciding all the time with the survey line whole the chainage of the offset scale can be read off the long scale.

(d) Detail Drawing

As the offsets are plotted they are joined up in pencil to correspond the features noted in the field book. Tie lines must be scaled to check the plotted positions of points as they arise.

(e) Fair Drawing

Once the pencil plot has been completed and checked the chain survey network of lines (not the offsets or tie lines) is inked in red and the fair drawing completed.

Obstacles in Chaining

The three main obstacles in chaining of a line are of the following types:

1. Chaining Free, Vision Obstructed
2. Chaining Obstructed, Vision Free
3. Chaining and Vision Both Obstructed.

It sometimes happens that a survey line passes through some object such as a pond, a building, a river, a hedge etc. which prevents the direct measurement of that part of the line which the object intersects. The interfering object in such a case is called on obstacle.

It is necessary to overcome obstacles so that chaining may be continued in a straight line. Special methods are, therefore, employed in measuring distances across the obstacles.

1. Chaining Free, Vision Obstructed:

In this type of obstacles, the ends of the lines are not intervisible e.g. rising ground, hill or jungle intervening.

Here two cases may arise:

(i) Both ends may be visible from any intermediate point lying on the line such as in the case of a hill. The obstacle of this kind may easily be crossed over by reciprocal ranging and length measured by stepping method of chaining.

(ii) Both ends may not be visible from any intermediate point such as in the case of a jungle. The obstacle of this kind may be crossed over by **"Random line method".** In fig. 3.20, let AB be the line whose length is required. From A, run a line AB' called a random line, in the approximate convenient direction of AB and continue it until point B is visible from B' Chain the line to B' where BB' is perpendicular to AB' and measure BB'.

Then $AB\sqrt{(AB')^2 + (BB')^2}$

If any other length AC' is measured along AB', a point C can be located on the line AB by measuring the perpendicular distance = $CC' = -BB' \times \frac{AC'}{AB'}$

Similarly a number of points can be located on the true line. The line is then cleared and chained.

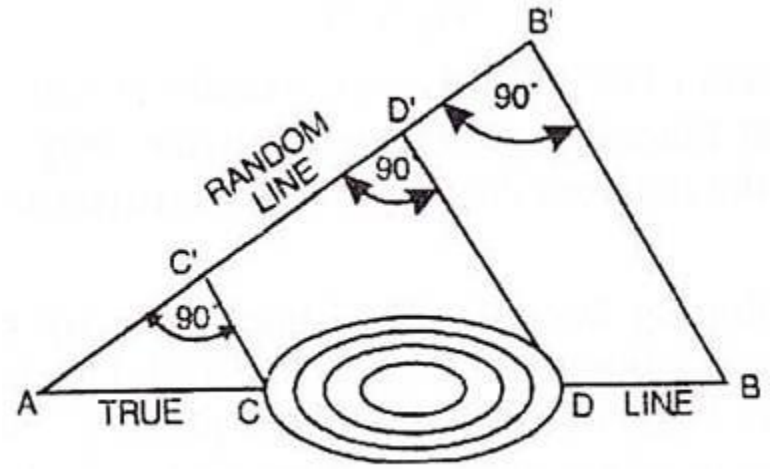


Fig 3.20

2. Chaining Obstructed, Vision Free:

The typical obstacle of this type is a sheet of water, the width of which in the direction of measurement exceeds the length of the chain or tape. The problem consists in finding the distance between convenient points on the chain line on either side of obstacle.

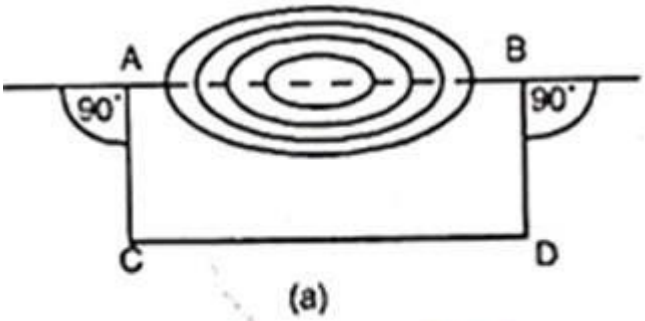
Two cases may arise:

(a) When the obstacle can be chained around, e.g. a pond, a thorny hedge etc.

(b) When the obstacle cannot be chained around e.g. a river.

Case: (i) The distance between two points A and B on either side of the pond may be determined by any of the following methods convenient at site:

(a) Set out equal perpendiculars AC and BD [Fig. 3.21 (a)]. Measure CD which is equal to AB.



(a)

Fig 3.21(a)

(b) Erect perpendicular AC [Fig .3.21(b)] of such a length that CB clears the obstacle and measure AC and CB.

Then $AB\sqrt{(BC)^2 + (AC)^2}$

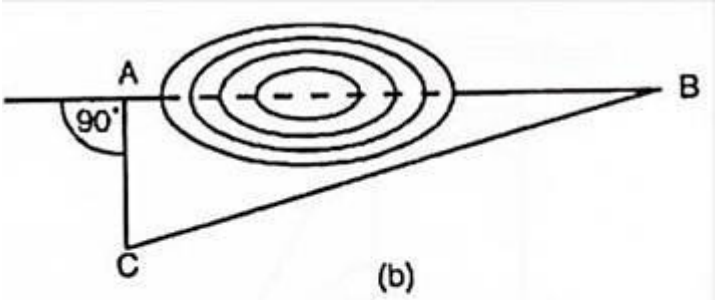


Fig. 3.21. (b)

(c) Find by optical square or a cross-staff a point C such that ∠ACB is right angle [Fig. 3.21(c)] Measure AC and BC.

Then $AB\sqrt{(AC)^2 + (BC)^2}$

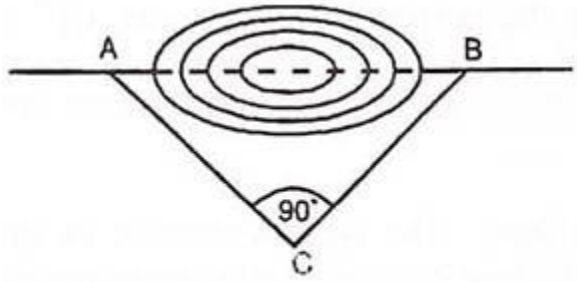


Fig 3.21 (c)

(d) Mark a point C so that CA and CB clear the obstacle [Fig. 3.21. (d)]. Range E in line with AC so that CE = AC. Then range D in the line with BC so that CD = BC. The triangles CAB and CED are congruent. Therefore DE = AB.

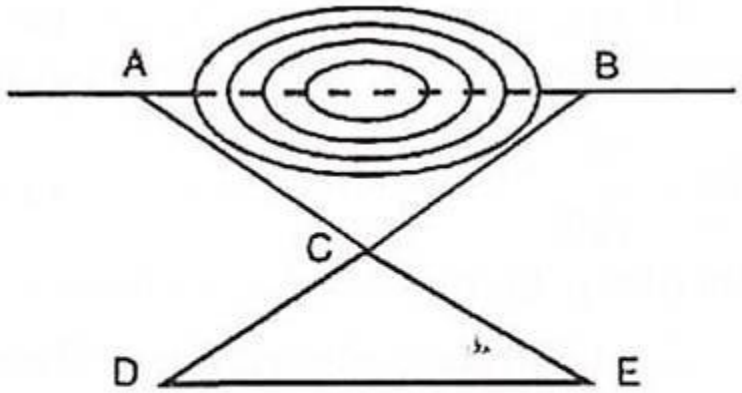


Fig 3.21 (d)

Case (ii): Any one of the following methods may be employed to find the width of the river along the direction of the chain line:

(a) Select two points A and B on the chain line on opposite banks of the river. [Fig. 3.22 (a)]. From A and C, erect perpendicular or parallel lines AD and CE, such that E, D and B are in line. Measure AC, AD and CE. If a line DF is drawn parallel to AC, meeting CE in F, the triangles ABD and FDE are similar.

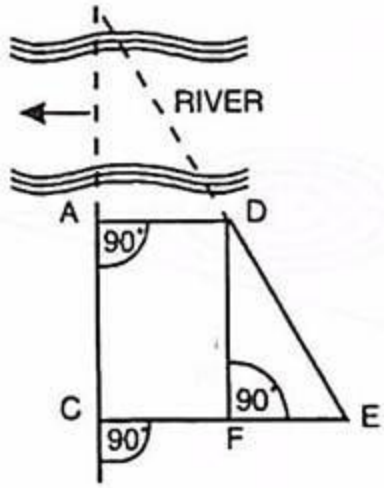


Fig. 3.22. (a)

$$\therefore \quad \frac{AB}{AD}=\frac{DF}{FE} \text{ (but DF = AC, and FE = CE – CF = CE – AD.}$$

$$\text{or} \quad \frac{AB}{AD}=\frac{AC}{CE-AD}$$

$$\text{or} \quad AB = \frac{AD \times AC}{CE-AD}$$

(b) Select two points A and B on the chain line on either side of the river [Fig. 3.22. (b)]. Set a perpendicular AC and mark its midpoint D. From C, erect CE perpendicular to AC such that E, D and B are in the same range and measure CE. Then triangles ABD and CED are congruent. Therefore AB = CE.

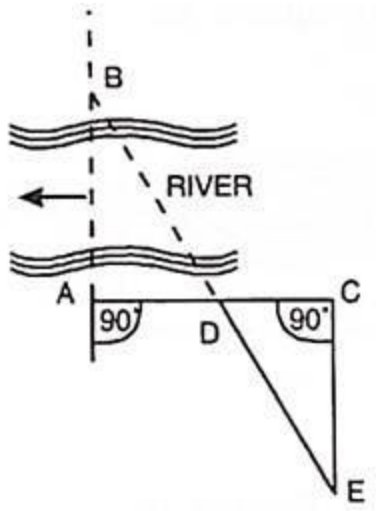


Fig. 3.22 (b)

(c) Select two points A and B as before [Fig. 3.22 (c)]. Erect a perpendicular AC and using an optical square at C, find D on the chain line so that ∠BCD is a right angle. Measure AC and AD. Triangles ABC and ACD are similar.

$$\text{Therefore,} \frac{AB}{AC}=\frac{AC}{AD} \text{ or } AB=\frac{(AC)^2}{AD}$$

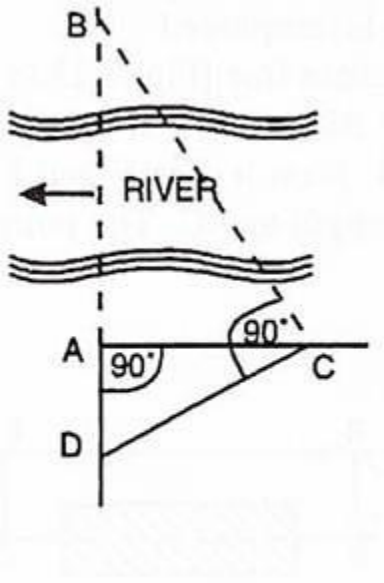


Fig. 3.22. (c)

(d) Fix two points A and B as before [Fig. 3.22 (d)].

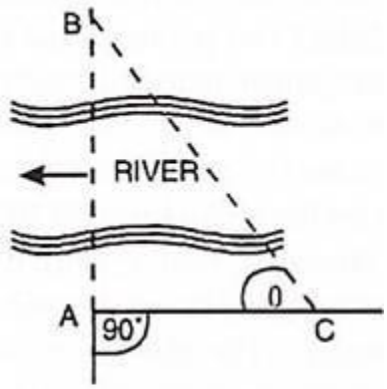


Fig. 3.22 (d)

Erect a perpendicular AC of such a length that triangle ABC is well conditioned. Measure AC and the angle ACB with prismatic compass or box-sextant or with any other angle measuring instrument.

$$Then\ \frac{AB}{AC} = tan\theta$$

$$\text{or } AB = AC.\tan\theta$$

(e) If a survey line crosses the river obliquely, then the following method is used to find the width of the river:

Select two points A and B as before [Fig. 3.22. (e)].

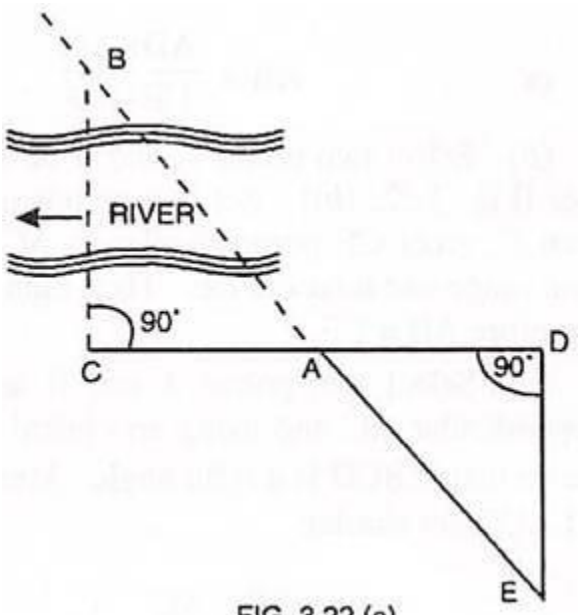


FIG. 3.22 (e)

At A, set out a line AC in a convenient direction so that C is the foot of the perpendicular from B on AC. Produce CA to D and measure AD = AC. At D, erect a perpendicular DE, E being a point on the chain line. Then triangles ABC and AED are congruent. Therefore AB = AE (the oblique width of the river.

3. Chaining and Vision Both Obstructed:

A building is a typical example of this class of obstacles. The problem in this case consists both in prolonging the line beyond the obstacle and finding the distance across it.

Any one of the following methods may be employed:

(a) Select two points A and B on the chain line [Fig. 3.23 (a)]. At A and B, erect equal perpendiculars AC and BD. Join CD and produce it past the obstacle. Select two points E and F on it. At E and F, set out perpendiculars EG and FH, each equal in length to AC. The points G and H then lie on the chain line and BG = DE.

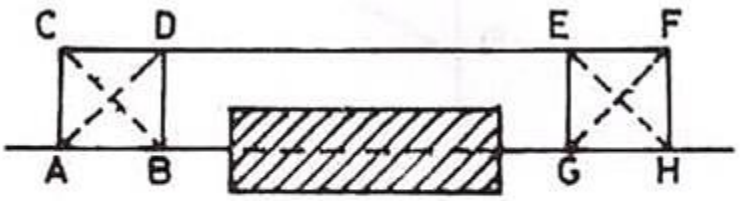


Fig. 3.23. (a)

The direction and length of perpendiculars must be set out with great accuracy. The check can be made by measuring diagonals of the rectangles. For the same rectangle, diagonals should be equal. Here AD should be equal to BC, and EH equal to FG.

(b) Choose two points A and B on the chain line [Fig. 3.23. (b)]. With AB as base, construct an equilateral triangle ABC by swinging equal arcs with a tape. Produce AC to D and take a point E of DA. Again contract an equilateral triangle DEF with DE as the base.

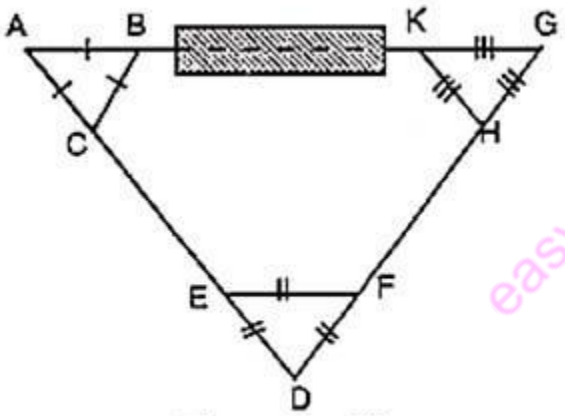


Fig.3.23 . (b)

Produce the line DF to G such that DG = DA. ADG then forms an equilateral triangle and G is a point on the chain line. Determine the second point K on the chain line by forming an equilateral triangle GHK on GH as the base. The line joining KG determines the direction of the chain line past the obstacle, and the obstructed length BK = AG-AB-GK = DA – AB – GK.

Example:

There is an obstacle in the form of a pond on the main chain line AB. Two points C and D were taken on the opposite sides of the pond. On left of CD, a line CE was laid out 100 m in length and a second line CF, 80 m long was laid out on the right of CD such that E, D and F are in the same straight line. ED and DF were measured and found to be 60 m and 56 m respectively. Find out the obstructed length CD.

Solution:

In Fig. 3.24, CD is the obstructed length of the pond on the chain line AB. CE and CF are known to be 100 and 80 m respectively and EF = 60 + 56= 116 m.

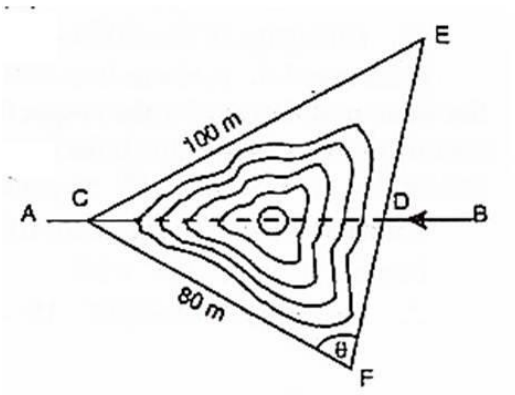


FIG. 3.24

Let angle CFE = θ, then in triangle CFE,

$$\cos\theta = \frac{FC^2 + FE^2 - CE^2}{2.FC.FE}$$

$$= \frac{80^2 + 116^2 - 100^2}{2 \times 80 \times 116}$$

Also in triangle CFD.

$$\cos\theta = \frac{FC^2 + FD^2 - CD^2}{2.FC.FD} = \frac{80^2 + 56^2 - CD^2}{2 \times 80 \times 56}$$

$$\therefore \quad \frac{80^2 + 116^2 - 100^2}{2 \times 80 \times 116} = \frac{80^2 + 56^2 - CD^2}{2 \times 80 \times 56}$$

or CD = **69.123 m (Ans.)**

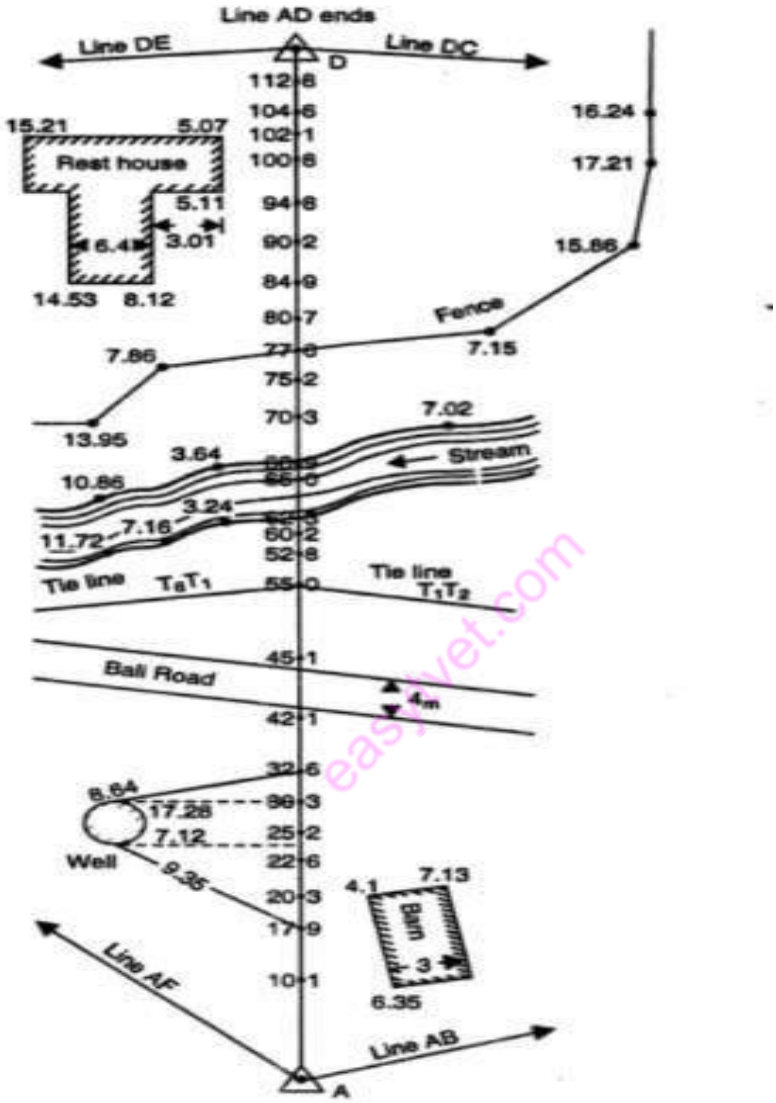
Recording the measurements in the Field Book (Field Measurement Book)

The book in which the chain or tape measurements are entered is called the field book. It is an oblong book of size about 20 cm x 12 cm and opens lengthwise.

The main requirements of the field book are that it should contain good quality stout opaque paper. it should be well-bound and of a size convenient for the pocket.

The chain line may be represented either by a single line or by two lines spaced about 1 to 2 cm apart. ruled down the middle of each page.

The double line field book as per below drawing no-1 is most commonly used for ordinary work, the distance along the chain being entered between the two lines of the page.



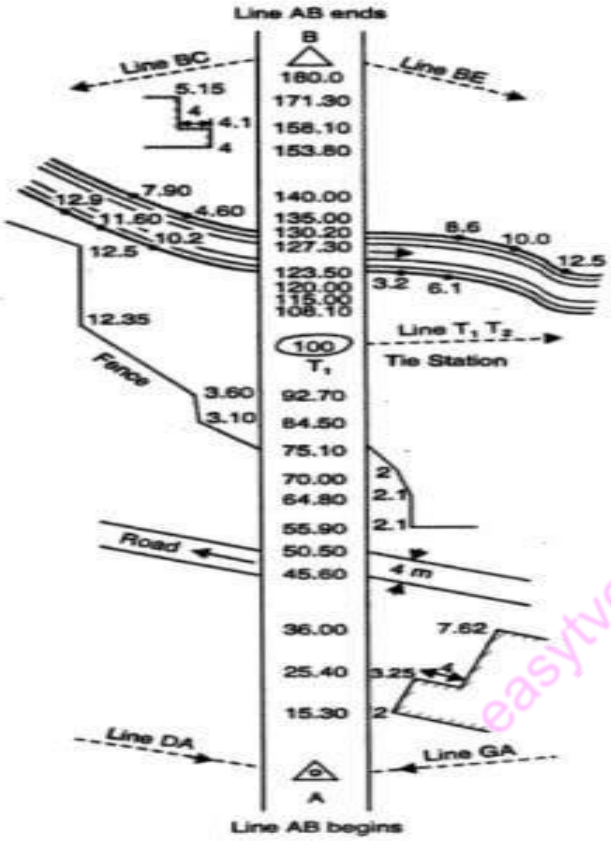
Single Line Filed Book No 1

Single line field book as per above drawing no-1 is used for a comparatively large scale and most detailed dimension work.

A chain line is started from the bottom of the page and works upwards.

All distances along the chain line are entered in the space between the two ruled lines while the offsets are entered either to the left or to the right of the chain line, as the case may be.

Offsets are entered in the order they appear at the chain line. As the various details within offsetting distances are reached, they are sketched and entered as shown in as per the above single line filed drawing no-1 and as per below drawing no-2 Every chain line must be stained from a fresh page. All the pages must be machine numbered.



Double Line Filed Book Drawing No 2

ERRORS IN CHAIN SURVEYING

Sources of errors

(a) Gross errors

i. Displacement of arrows or station marks.
ii. Miscounting tape length
iii. Misreading the tape
iv. Wrong booking

(b) Systematic error (cumulative error).

i. Poor ranging
ii. Poor straightening
iii. Wrong length of tape
iv. Slope

v. Sag
vi. Temperature variation

(c) Random or accidental or compensating errors
i. Holding and marking
ii. Variation in tension

LEVELING:

It is a branch of survey to measure a height of specified relative points to a datum.

TYPES OF LEVELING:

Three types of leveling are:
(1) Profile leveling
(2) Reciprocal leveling
(3) Differential leveling

IMPORTANCE OF LEVELING IN FIELD WORK:

- It help the surveyor to make counter map of land surface or sea surface.
- It help surveyor to lay a ground level on which they can built a building.
- It help pipe transport engineer to ensure appropriate slope of land that will allow smooth movement of liquid.

OBJECTIVE OF LEVELING:

- To enable students have a hands on experience in setting and working with the instrument and collect the data of the relevant field work.
- To increase the student's knowledge in leveling procedure.
- To calculate reduced level of each station.

ERRORS IN LEVELING: (SYSTEMATIC & RANDOM ERROR)

- Collimation / parallax
- Change point / staff instability
- Refraction

TERMS INVOLVE IN LEVELING:

(1) BACK SIGHT (B.S):

The first reading which we take after set a instrument or at bench mark on the field.

(2) FORE SIGHT (F.S):

The last reading which we take before shifting our instrument or at change point or turning point.

(3) INTERMEDIATE SIGHT (I.S):

The reading between b.s and f.s is called intermediate sight.
(Video related to B.S , I.S , F.S)

(4) BENCH MARK:

The point whose elevation is known called bench mark. Usually we take m.s.l (mean sea level) or surveyor also shift bench mark according to field.

(5) LINE OF SIGHT:
The line which passes through the optical center of eye piece and coming out to eye.

(5) STAFF READING:
The reading takes on the field through instrument.

(6) HEIGHT OF INSTRUMENT:
It is the sum of staff reading which we take on the ground and bench mark (known elevation).

<u>INSTRUMENTS IN LEVELLING:</u>
In modern technique we use following instruments to find out reduced level OR height.

1. Auto level
2. Dumpy level
3. laser level
4. Total Station as a Level
5. Staff

<u>(1) AUTO LEVEL:</u>

Figure 3:31

This is auto level parts and their description are given to you in picture.

(2)DUMPY LEVEL:

The dumpy level is mainly used in surveying for the following purposes:

- To determine relative height and distance among different locations of a surveying land.
- To determine relative distance among different locations of a surveying land.

Figure 3:32

Table 3 ***DIFFERENCE BETWEEN DUMPY LEVEL AND AUTO LEVEL:***

S.NO:	DUMPY LEVEL	AUTO LEVEL
1	In the dumpy level survey, staff reading need to be adjusted as inverted level staff reading is seen in the eyepiece.	In the auto level, no adjustment for staff reading is required as the actual reading is seen from the eyepiece.
2	In the dumpy level, to level the bubble, one has to keep bubble parallel to two leveling screws and then right angle to the third screw.	In the auto level, the bubble can be adjusted from any side and any angle with any 3 screws available.
3	Line of sight is manually adjusted in dumpy level.	The auto level has an internal compensatory machine which automatically adjusts the line of sight.
4	It difficult to make an accurate measurement with dumpy level.	The measurement accuracy of the auto level is higher than the dumpy level.

(3) LASER LEVEL:

The laser level is a control tool consisting of a laser beam projector that can be affixed to a tripod. The modern is 360 degree rotatory laser from which we can easily find all reduced level of any building, room, or object which are in 3D.

Figure 3:33

The above video usually used to do leveling in agriculture field.

(4) TOTAL STATION: (AS A LEVEL)

We also use total station as a leveling just we have to change the (CNFG) setting and function enter a bench mark place a target rod in any where in the range of total station it will give us calculate reduced level of that station.

Figure 3:34

(5) STAFF:

Figure 3:35

HOW TO READ THE STAFF READING:

Above small whole number two lines lines are given one is black and the other is white.
White one count as odd digit.(lower black end)
Black one count as even digit.(upper black end)
The large red number count as one foot and the small one count as: e.g: 7.4 (7 taken from large red mark and four taken as one tenth of foot.

When you see through a eye piece you can see this;

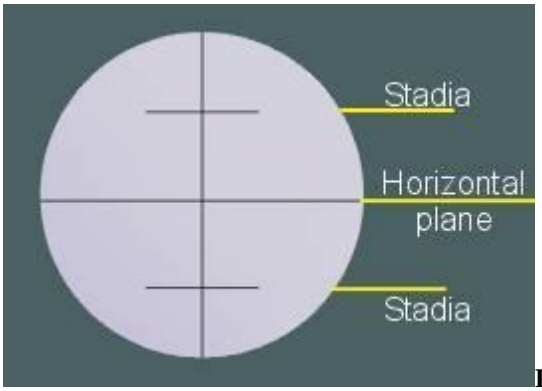


Figure 3:36

The horizontal plane line touch any staff digit that one is considered your staff reading.

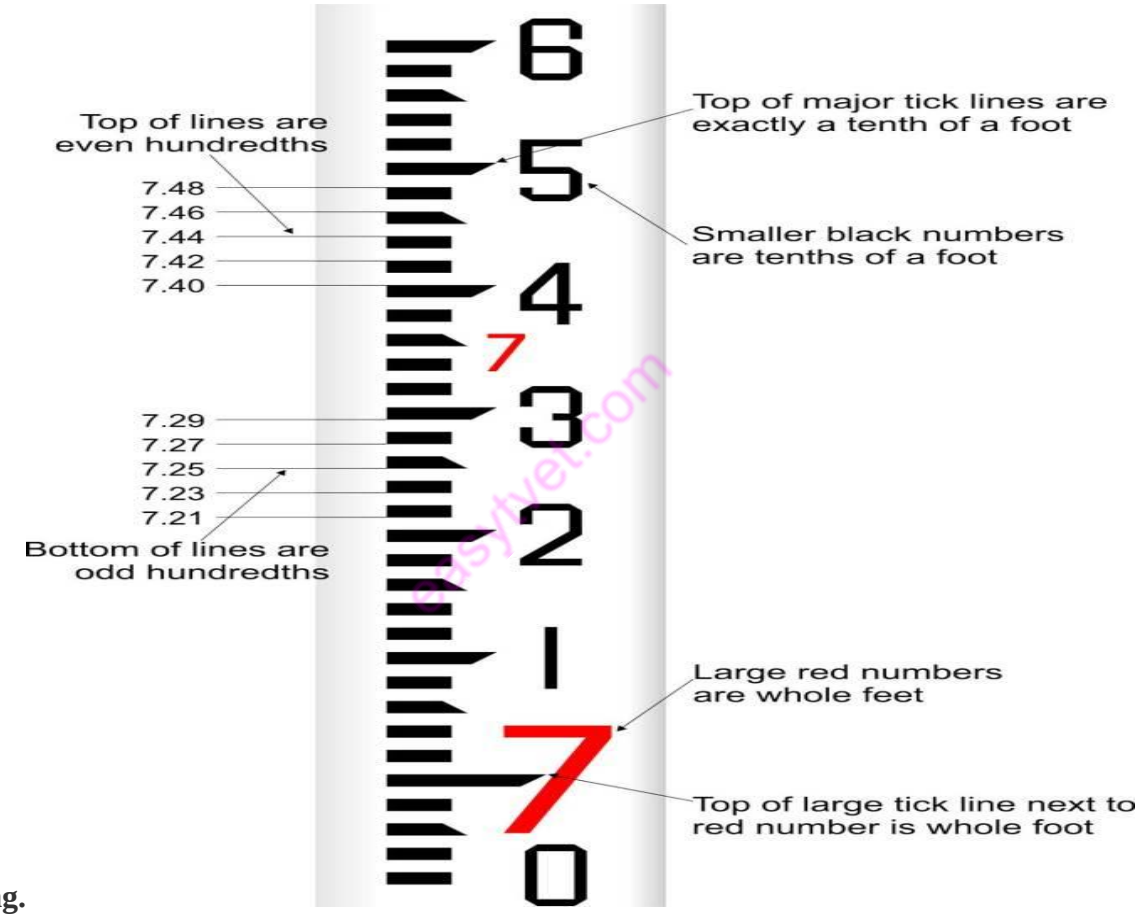


Figure 3:37

TYPES OF LEVELING.

(1) PROFILE LEVELING:

Profile leveling is a process of determining the elevations of points along the center line of a track on land in which linear engineering work is to be laid

USES:

Used in designing linear facilities.

♦ Highways
♦ Railways
♦ Transmission lines
♦ Canals
♦ Sewers
♦ Water mains

PROCEDURE IN LEVELING

- The level of set up at some convenient position P1 and a back sight was taken to the first TBM. The foot of the staff being held on TBM and the staff held vertically.
- The staff is moved to points A and B in turn and readings taken. These are the intermediate sights respectively
- In order to read D, a change point is chosen at C and the staff is moved to C. This is the foresight for the first point (P1).
- While the staff remains at C1 the instrument is moved to another position (P2). A reading is taken from the new position of the staff at C. This is the back sight for P2.
- The staff is moved to D and E in turn and the intermediate sight readings taken respectively.
- Finally, the level is moved to P3 and a back sight is taken to E, while the foresight is also taken to the final TBM.
- The final staff position is at a point of known reduced level as leveling field work must start and finish at points of known reduced level; otherwise it is not possible to detect misclosure in the leveling.

BOOKING AND REDUCTION OF LEVEL

There are two method of booking and reduction of level namely;

- Rise and fall method
- Height of instrument method (Height of collimation method)
-

1. HEIGHT OF COLLIMATION METHOD

The following formula will serve as a guide to the reduction of level by this method;
(i) B. S + R. L = H. I
(ii) H. I – I .S = R. L (new)
(iii) H. I. (old) – F. S = R. L (new) at change point
(iv) R. L. (new) + B.S = H. I. (new)

Checking: The difference between the sum of B. S and the F. S should equal the known difference in height (R.L) between starting and finishing points.

2. *RISE AND FALL METHOD:*

QUESTION:

STATION	B.S	I.S	F.S	RISE	FALL	REDUCE LEVEL	REMARKS

B.M 761	2.11					22.13	Bench mark
10		1.14					
20		0.95					
30		0.84					
40		1.55					
50			1.88				Last reading

ANSWER:

STATION	B.S	I.S	F.S	RISE	FALL	REDUCED LEVEL	REMARKS
B.M 761	2.11					22.13	Bench mark
10		1.14		0.97		23.1	
20		0.95		0.19		23.9	
30		0.84		0.11		23.4	
40		1.55			0.71	22.69	
50			1.88		0.33	22.36	Last reading

ARITHMETIC CHECK:

B.S – F.S = RISE – FALL = Last(R.L) – First(R.L)

(0.97+0.19+0.11) – (0.71+0.33) = 22.36 – 22.13

0.23 = 0.23

COLLIMATION METHOD:

QUESTION:

STATION	B.S	I.S	F.S	H.I	REDUCED LEVEL	REMARKS
B.M 761	2.11				22.13	Bench mark
10		1.14				
20		0.95				

30		0.84				
40		1.55				
50			1.88			

ANSWER:

STATION	B.S	I.S	F.S	H.I	REDUCED LEVEL	REMARKS
B.M 761	2.11			24.24	22.13	Bench mark
10		1.14			23.1	
20		0.95			23.9	
30		0.84			23.4	
40		1.55			22.69	
50			1.88		22.36	Last reading

- ***ARITHMETIC CHECK:***

∑B.S – ∑F.S = Last(R.L) – First(R.L)

2.11 – 1.88 = 22.36 – 22.13

0.23 = 0.23

NOTE:

If any change point/turning point occur then we calculate new height of instrument by formula (H.I- F.S + B.S= New H.I).Remaining procedure remain same and in remarks we write change point (C.P).

By both method we get the same result

GRAPH:

It will be plotted between r.l (along y-axis) and horizontal distance (along x-axis).

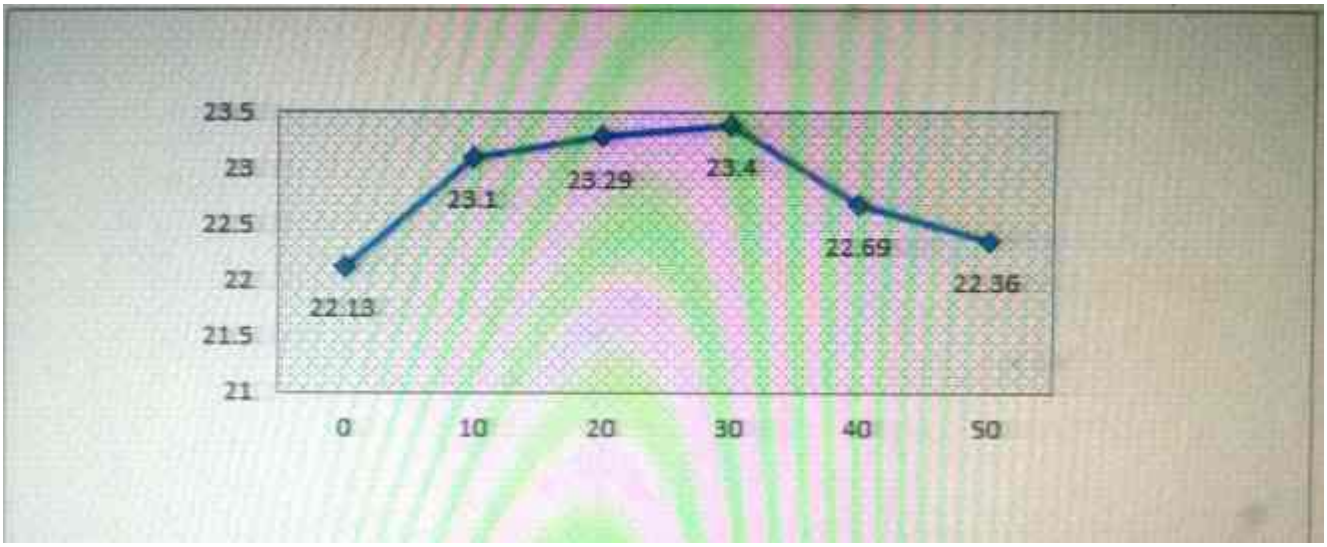


Figure3:38

This is profile leveling graph of given question.

ERRORS IN LEVELING:

(01) COLLIMATION ERROR:

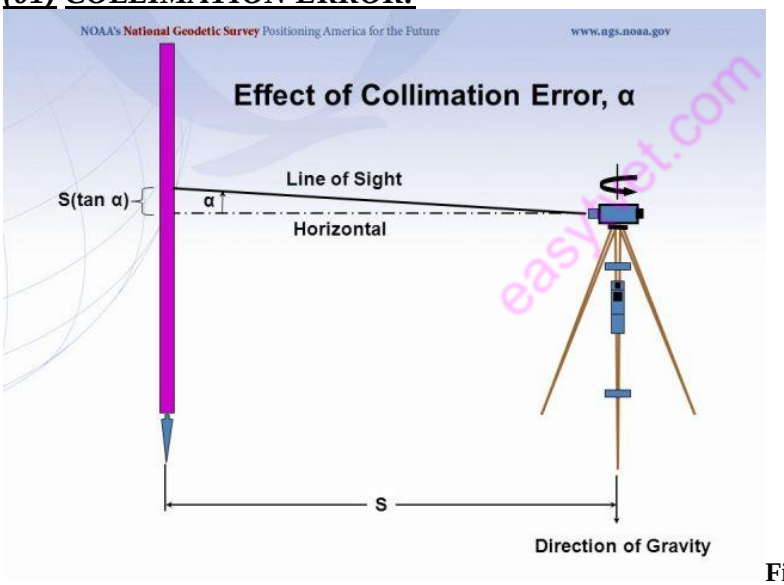


Figure 3:39

(02) CURVATURE ERROR:

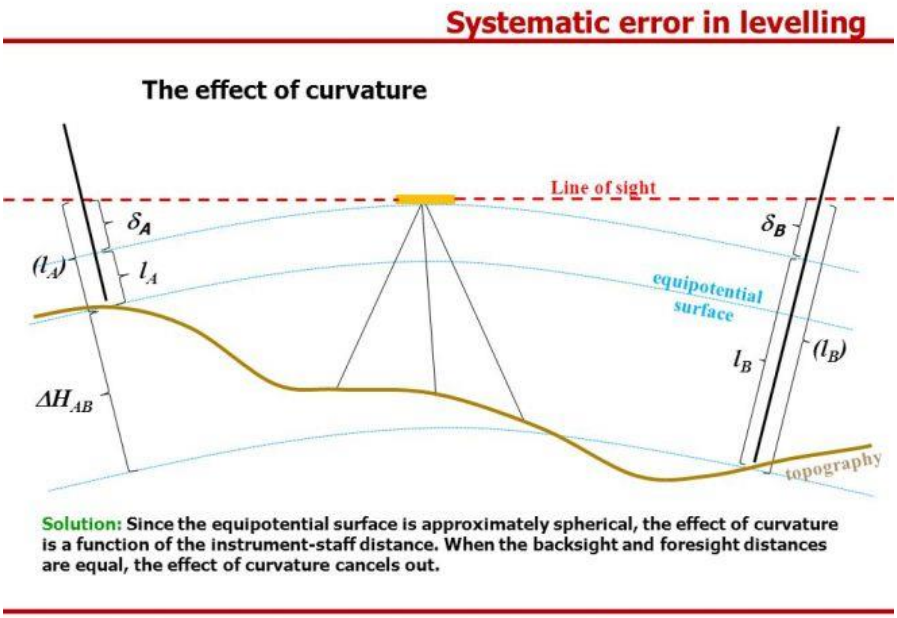


Figure 3:40

(03) REFRACTION:

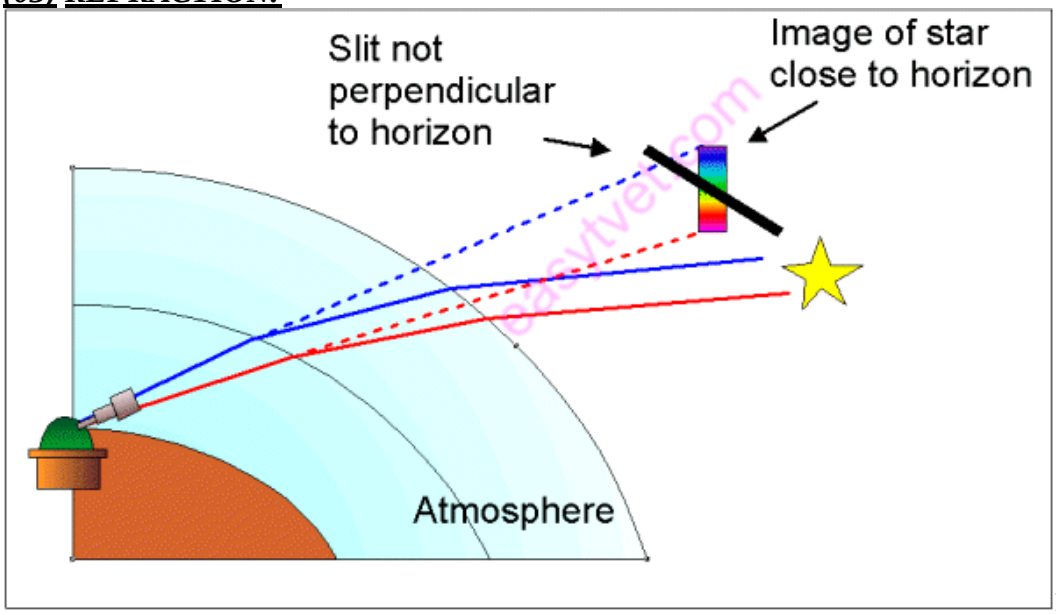


Figure 3:41

TRIGONOMETRIC LEVELLING:

The difference in elevation between a and b if the vertical angle(∝) or zenith angle (90°-∝) and the slope distance "s" are measured.

V= S sin∝ OR V= S cos(90°-∝)

Elevation at rod= (Elevation at Station- R.R+ HI+ V)

- **Trigonometric Leveling**
- The process of leveling in which the elevation of point or the difference between points is measured from the observed horizontal distances and vertical angles in the field is called trigonometric leveling.
- In this method, trigonometric relations are used to find the elevation of a point from angle and horizontal distance so, it is called as trigonometric leveling. It is also called as indirect leveling.

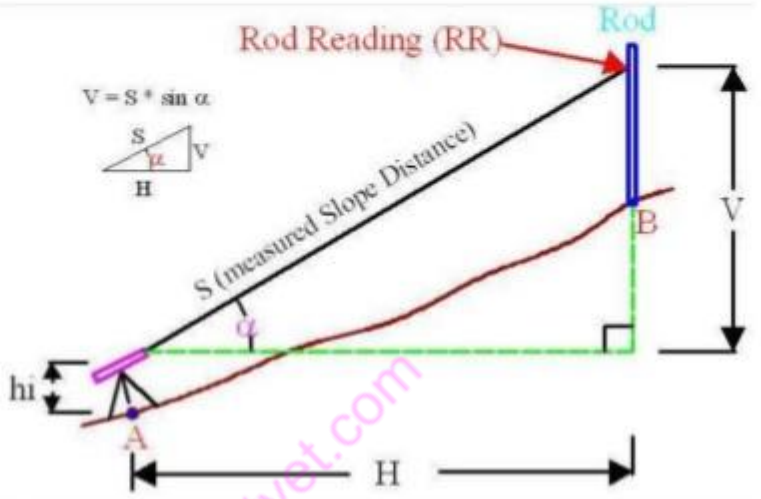


Figure 3:42

(2) RECIPROCAL LEVELLING:

We do a reciprocal levelling when we don't do a profile levelling or not take intermediate sight .

USES OF LEVELLING

Apart from the determination of difference in level between points on earth's surface, other uses of leveling include.

i. Taking of longitudinal section
ii. Cross- sections
iii. Contouring
iv. Setting out levels

A. Longitudinal Section

- In Engineering Surveying, a longitudinal section (or profile) is taken along the complete length of the existing ground level. Levelling can be used to measure heights at points on the centre line so that the profile can be plotted.
- Generally, this type of section provide data for determining the most economic formation level, this being the level to which existing ground is formed by construction methods.
- The optimum position for the formation level is usually found by using a computer aided design package but the longitudinal section is sometime drawn by hand and a mass – hand diagram prepared.

- In order to be able to plot levels obtained in addition to those taken at the centerline pegs, the position of each point on the centre line must be measured with tape and recorded.
- The method of broking longitudinal section should always be by the height of collimation method since many intermediate sights will be taken

B. Cross - sections

- In the construction of other projects such as roads and railways, existing ground level information at right angle to the centre line is required. This is provided by taking cross sections at right angles to the centre line such that information is obtained over the full width of the proposed construction.
- For the best possible accuracy in sectioning, a cross–section should be taken at every point leveled on the longitudinal section. In order to reduce the amount of field work involved, cross-section are taken at regular intervals along the centre- line usually where pegs have been established.
- A right angle is set out at each cross-section either by eye for short lengths or by theodolite for long distance or where greater accuracy is needed.

1. A ranging rod is placed on either side of the centre line to mark each cross – section.

C. Contouring

- A coutour is defined as an imaginary line joining points of the same height or elevation above or below a datum. These are shown so that the relief or topography of an area can be interpreted (a factor greatly used in civil engineering)
- The difference in height between successive contours is known as the vertical interval (VI) and this interval dictates the accuracy to which the ground is represented. The value of (VI) chosen for any application depends on;
    i. Scale of the plan
    ii. Intended use of the plan
    iii. The costs involved
    iv. The nature of the terrain
- Generally, a small vertical interval of up to 1m is required for engineering projects, large scale survey plans and surveys on fairly even sites. A wider vertical interval is used in hilly or broken terrain.
- Electronic instruments such as total stations are normally used to collect data for contouring and contours are plotted by using computer software and hardware.
- If drawn manually, contours can be obtained other directly or indirectly using mathematical polation or graphical interpolation techniques.

i. **Direct Contouring**:
The position of contours is located on the ground by leveling.

ii. **Indirect Contouring Method**:

Involves the height of points that do not in general coincide with the contour positions. Instead, the points leveled are used as a frame work on which contours are later interpolated on a drawing. The more common methods of indirect contouring involve taking levels either on a regular grid pattern or at carefully selected points.

iii. Grid leveling:

The area to be contoured is divided into a series of lines forming squares and ground levels are taken at the intersection of the grid lines. The sides of the squares can be 5 to 30m depending on

the accuracy required and the nature of the ground surface. The more irregular the ground surface the greater the concentration of grid points.

This method of contouring is ideally suited to gently sloping areas but the setting out of the grid on a large area can take a considerable time.
Furthermore, if visibility is restricted across the site, difficulties can occur when locating grid points.

Following the field work, the levels are reduced, the grid is plotted and the contours interpolated either graphically or mathematically, taking into account the general shape of the land as observed during the fieldwork.

iv. Contours from Selected Points

For large areas or areas containing a lot of detail, contours can be drawn from level taken at points of detail or at prominent points on open ground such as obvious changes of slope. These points will have been plotted on the plan by one of the methods of plotting with the position of each level or spot height forming a random pattern.
The contours are drawn by interpolation as in grid levelling.

Other methods of contouring are;

- Contouring by section.
- Contouring by radiating lines contouring by tacheometry.
- Interpolating contours.

CONTOUR CHARACTERISTICS

a. Contour lines close upon themselves some where each to its own elevation. If not within the limit of the map.
b. Contour lines cannot intersect one another whether they are of the same elevation or not.
c. Contour lines on the tops of ridges and in the bottom of valleys either close or run in pairs within the limits of the map, no single line can ever run between two of higher or lower elevation

d. Contour lines indicate uniform slopes when they are equally spaced, convex slopes when they are farther apart with increasing elevations and concave slopes when becoming closer together with increasing elevations

USES OF CONTOUR MAPS

a. Location of possible routes for roads, dams etc.
b. Laying out building sites: The position of hill tops, basins, steep slopes, etc can be seen from contour plans to avoid siting buildings on exposed hill top and risking possible soil creep, or in basins which may form natural drainage area.
c. Calculation of volumes.
d. Determination of intervisibility between stations.

SOURCES OF ERROR IN LEVELLING

There are five source of errors in leveling and their importance must be appreciated and precaution taken to reduce their effects.

These sources includes,

a. Instrumental error in equipment
b. Error in handling the equipments
c. Error due to displacement of equipments
d. Error in reading and booking
e. Error due to natural causes.

PRESERVATION OF SURVEY RECORDS

Survey records are preserved by the local authorities as follows:

1. **Maps/Plans**

- The survey regulation require that a copy of all plans, maps or diagrams which are prepared by any surveyor (public or private) must be lodged with the surveyor General of the State or his representative where the land is situated.
- Private surveyors will be issued with a certificate of deposit on payment of certain charge.
- All the maps/plans/drawing are expected to be kept good and safe within the survey department ensuring that they are made available for public inspection on request.

2. **Public inspection on request (Co-ordinates)**

- Each state survey department maintains a co-ordinate register where the coordinates of all cadastral control points and those of properties within the state are recorded. These are expected to be made available to the public on request. National frame work control co-ordinates are usually available at the Federal Survey Department.

3. **Priority Sheet (intelligence Chart)**

- This show application and grants of certificates of occupancy. It serves as a guide for prospective land seekers in finding at a glance spot of unoccupied sites in any locality of choice.

4. **Beacons Description**

- Beacons description could be of extreme value if good advantages of their existence could be taken by the owners or occupies of lands boundaries where they are placed and those charged with the responsibility of providing the public with utilities (water, electricity, telephone etc).
- The law imposes a penalty on land owner or occupier who fails to report any case of willful obliteration, removal or injury to any such beacons.

5. **Township Map Index**

- Each town or city should be covered by a number of large scale map sheets identified by numbers for easy reference. Township map indices are done at compilation state, fair drawing stage and those at reproduction stage usually distinguished by different colours.

6. **Base lines information**

- These include the standard length of bases, the temperature at which they have been determined, and the materials used for the erection of such bases. Licensed surveyors are expected by the survey regulations to obtain a certificate of standardization for their tapes at least once every year on payment of stipulated fee.

7. **Field Books Computation Sheets and Survey Records**

- These are usually kept together in a folder for each survey and keep in a record room in the survey department along with such other related information

Tacheometric Surveying

Tacheometry is a branch of angular surveying in which the horizontal and vertical distances are obtained by optical means as opposed to the ordinary process of chain and tape. This is done with the help of two special type of instruments- transit theodolite and stadia rod. On the other hand, other conventional surveying methods like chain surveying or traverse surveying need the surveyor to take a linear measurement on the field by a tape or a chain. These are relatively slower processes and also tiresome.

Uses of Tachometry

- Tachometry is used for preparation of topographic map where both horizontal and vertical distances are required to be measured;
- survey work in difficult terrain where direct methods of measurements are inconvenient;
- reconnaissance survey for highways and railways etc;
- Establishment of secondary control points.

Tacheometric Surveying Instruments

Tacheometric Surveying is done with the help of Tacheometer and Stadia Rod.

1. Tacheometer
2. Stadia Rod
3. Anallatic lens

Different Methods of Tacheometric Measurements

The various methods of the tacheometric survey may be classified as follows:

1. The Stadia System
    i. Fixed Hair Method
    ii. Movable Hair Method, or Subtense Method
2. The Tangential System
3. Measurements by means of Special Instruments

A brief description of these methods is given below.

Fixed Hair Method

- In this method, the angle at the instrument at A subtended by a known short distance along a staff kept at B is made with the help of a stadia diaphragm having stadia wires at fixed or constant distance apart.
- The readings are on the staff corresponding to all the three wires taken.
- The staff intercept which means the difference of the readings corresponding to the top and bottom stadia wires will, therefore, depend on the distance of the stadia/level staff from the tacheometer
- When the staff intercept is more than the length of the staff, the only half intercept is read.
- This is the most common method is tacheometry and the same 'stadia method' generally bears reference to this method.

Subtense Method

- This method is almost same as the stadia method except that the stadia interval is variable.
- A suitable arrangement is made to vary the distance between the stadia hair as to set them against the two targets on the staff kept at the point under observation.
- Thus, in this case, the staff intercept, i.e., the distance between the two targets is kept fixed while the stadia interval, i.e., the distance between the stadia hair is variable.
- As in the case of fixed hair method, inclined sights may also be taken.

Stadia Method

As in the field of tacheometric surveying 'Stadia Method' is the most widely used procedure so we will discuss the principle behind it. The stadia method follows the principle that in similar isosceles triangles the ratio of the perpendicular to the base is constant.

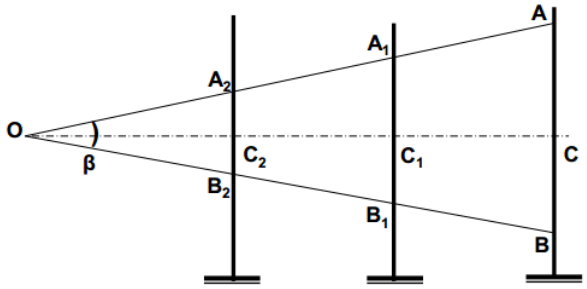


Figure 3:43

In fig. let two rays be equally inclined to the central ray. Here central ray is shown as OC. A_2B_2, A_1B_1, and AB are staff intercepts i.e difference between upper and lower stadia reading.

Evidently, $OC_2/A_2B_2 = OC_1/A_1B_1 = OC/AB = constant\ K = 0.5\cot(\beta/2)$

This constant depends entirely on the angle β. Let, the constant is found to be 100. It means the distance between the staff and the point O will be 100 times the staff intercept.

The Distance-Elevation Formulae For Horizontal Sight

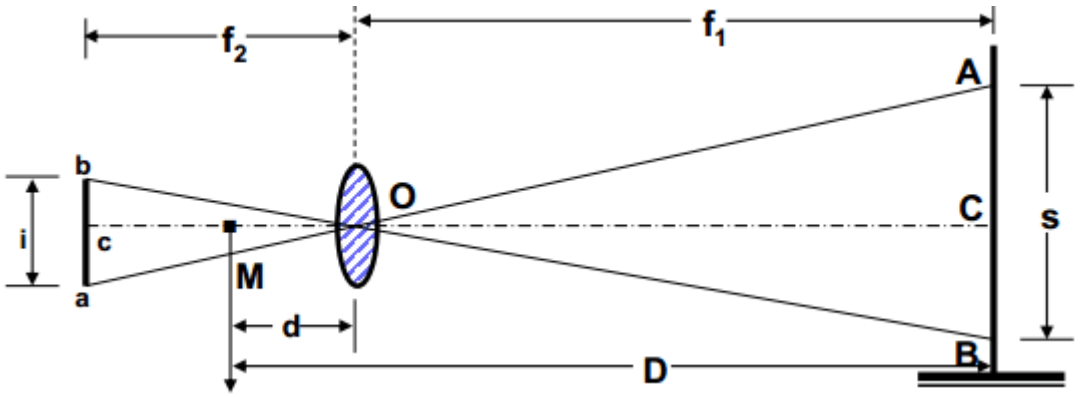


Figure 3:44

Suppose, the interval between stadia hairs is given by i=ab,
staff intercept is s,
f is the focal length of the objective,
D is the horizontal distance of the staff from the vertical axis of the instruments.

The horizontal distance between the axis and the staff is given by the following equation

$D = f_1 + d = f_1 = (s/i)*f+(f+d)$

This is the distance equation. Staff intercept is found by subtracting the reading of the upper and lower stadia reading.

The constant k = f/i is called the multiplying constant or stadia interval factor and the constant $(f + d) = C$ is known as the additive constant of the tacheometer but the latter one is made zero by using an anallatic lens in the instrument.

Uses of Stadia

The stadia method of surveying is particularly useful for following cases:

1. In differential leveling, the back sight and foresight distances are balanced conveniently if the level is equipped with stadia hairs.
2. In profile leveling and cross sectioning, stadia is a convenient means of finding distances from level to points on which rod readings are taken.
3. In rough trigonometric, or indirect, leveling with the transit, the stadia method is more rapid than any other method.
4. For traverse surveying of low relative accuracy, where only horizontal angles and distances are required, the stadia method is a useful rapid method.
5. On surveys of low relative accuracy - particularly topographic surveys-where both the relative location of points in a horizontal plane and the elevation of these points are desired, stadia is useful. The horizontal angles, vertical angles, and the stadia interval are observed, as each point is sighted; these three observations define the location of the point sighted.

Errors in Stadia Measurement

Most of the errors associated with stadia measurement are those occur during observations for horizontal angles and differences in elevation

Specific sources of errors in horizontal and vertical distances computed from observed stadia intervals are as follows:

1. **Error in Stadia Interval factor** -This produces a systematic error in distances proportional to the amount of error in the stadia interval factor.
2. **Error in staff graduations** -If the spaces on the rod are uniformly too long or too short, a systematic error proportional to the stadia interval is produced in each distance.
3. **Incorrect stadia Interval** -The stadia interval varies randomly owing to the inability of the instrument operator to observe the stadia interval exactly. In a series of connected observations (as a traverse) the error may be expected to vary as the square root of the number of sights. This is the principal error affecting the precision

Determination of Tacheometric Constants on Field

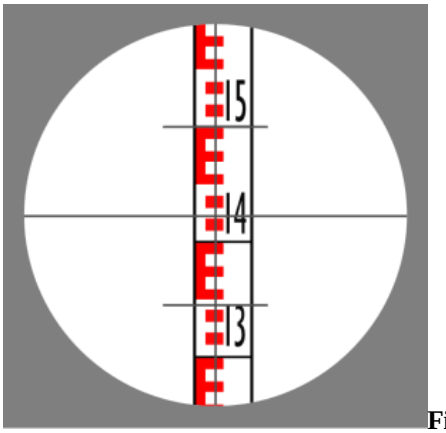


Figure 3:45

In most cases, we do not really know the value of f (focal length of the objective) so we have to determine the constant k and C on the field with a different approach as below:

1. Measure a line (about 100m long) on the fairly level ground and drive pegs at some interval, say 50 meters.
2. Keep the staff on the previously determined station and observe the corresponding staff intercepts (upper and lower stadia reading) with horizontal sight.
3. Knowing the values of D and s for different points, a number of simultaneous equations can be formed by substituting the values of D and s in equation D = k.s + C. The simultaneous solution of successive pairs will give the values of k and C, and the average of these can be found.

1.2.4.4 Learning Activities

by choosing the correct tools and equipment, carry out a chain survey process as well as leveling activity around your institution, record all the information and the plot the contour plan of the institution

1.2.4.5 Self-Assessment

1. What is the prominent point on the chain line and can be either at the beginning of the chain line or at the end?
   a) Subsidiary station
   b) Surveyor station
   c) Main station
   d) Tie stations
2. The book in which the chain or tape measurements are entered is called the _____
   a) Assistant book
   b) Surveyor book
   c) Field book
   d) Survey book

3. What is the size of a field book?
   a) 20 cm x 20 cm
   b) 25 cm x 20 cm
   c) 20 cm x 25 cm
   d) 25 cm x 25 cm
4. Which of the following is not used to represent the relative altitudes of the points on the map?
   a) Contour lines
   b) Hachures
   c) Shading
   d) Level lines

5. Which of the following indicates the elevations directly?
   a) Level line
   b) Line of sight
   c) Datum
   d) Contour
6. If the ground is undulating, rough, difficult and inaccessible. Under these circumstances _____ methods are used to obtain distances.
   a) Direct methods
   b) Indirect methods
   c) Chain surveying
   d) Tacheometry

7. Which of the following is an indirect method of surveying?
   a) Chain surveying
   b) Tacheometry
   c) Countouring
   d) All of the mentioned

1.2.4.6 Tools, Equipment, Supplies and Materials

Tools and equipment

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.4.7 References

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RESPONSES

1. What is the prominent point on the chain line and can be either at the beginning of the chain line or at the end?
   a) Subsidiary station
   b) Surveyor station
   c**) Main station**
   d) Tie stations

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   b) Surveyor book
   c) **Field book**
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   d) Tacheometry

7. Which of the following is an indirect method of surveying?
   a) Chain surveying
   b) **Tacheometry**
   c) Countouring
   d) All of the mentioned

1.2.4 Learning Outcome 4; Prepare Site Layout

1.2.4.1 Introduction to the learning outcome

This unit specifies the competencies required to prepare construction site layout. it involves site measurement, Site facilities and preparing Site layout as per the site plan

1.2.4.2 Performance Standard

4.1 Site dimensions are measured according to architectural drawings
4.2 ***Site facilities*** location are identified as per site plan
4.3 Site layout is prepared as per the site plan

1.2.4.3 Information Sheet

SITE LAYOUT

To enable construction work to take place the builder requires men, materials and plant, all of which have to be carefully controlled so that the men have the right machines in the most advantageous position, the materials stored so that they are readily available and not interfering with the general site circulation, and adequate storage space and site accommodation.

To ensure that a site is laid out in the most effective and efficient manner, much thought and consideration must be given to the task before the work actually starts. The period after tender acceptance and actual starting date, called the 'pre-construction period', is the time to carry out this exercise.

Any planned layout should be reviewed periodically and adjusted to suit the changing needs of the site activities. If this aspect of building construction is carefully considered, planned it will be reflected in the progress and profitability of the contract.

A study of the drawings, together with the bill of quantities and the specification preferably at the pre-tender stage will enable the builder to make a preliminary assessment of the size and complexity of the contract, the plant required and the amount of money which can reasonably be expended on labour-saving items such as concrete mixing and placing alternatives, handling and transporting equipment and off-site fabrication of such items as formwork and reinforcement.

A site investigation should be carried out, preferably by the site agent who will supervise the contract should the tender be successful. His report should include (access to site, security and) the following information:

1. **Available services** – available power and water supplies together with rates of payment, nuisance or value of services already on site, diversions required and the time element involved in carrying out any necessary diversions together with cost implications.
2. **Layout** – general site conditions such as nature of soil, height of water table, flooding risks, tidal waters, neighbouring properties and any demolition problems
3. **Labour**– travel distances, local or own labour resources to be used, availability of local labour and prevailing rates of pay, lodging and local catering facilities.

Objectives of a good Construction Site Layout

Site layout comprises the arrangement of site huts, storage sheds and compounds and the placing of loose material, mixing bays and so on.

1. Orderly layout shows new operatives that they are employed by an organisation with planning care and consideration in mind.
2. To the general public the impression created is one of efficiency, which is a good advertisement.
3. Through the period of the project, a good tidy site will often reflect the efficiency of the site supervisor; reduce waste and purposeless movement of plant and materials.
4. Well-laid out sites enhance security of materials, tools and equipment as the security personnel, night watchmen, flood lighting, storage areas will be in place.

PROBLEMS WITH WRONG SITE LAYOUT PLAN

Failure to plan the site layout in advance is a prime cause of operational inefficiency, and can increase the overall cost of a project substantially. In the absence of a precise site layout plan, the following problems may occur:

i. Material stacks wrongly located

Materials arriving on site are off-loaded into what someone guesses to be the correct location. This problem may involve double or triple handling of materials to another location. For example:

- They may stocked over a drainage line or near the edge of excavation;
- They are too far from the work area;
- They are too remote from the hoist or not within the radius of the crane;
- They impede the smooth flow of work traffic across the site;
- Their delivery was wrongly phased and they are not needed until much later in the project;
- They are fragile.

ii. Plant and equipment wrongly located.

For example:

- The mixer is inaccessible for the delivery of materials; not enough room for the storage of aggregates;
- Fixed cranes are unable to reach all parts of the works;
- Hoists have insufficient capacity or height to handle the loads or badly located in relation to the floor layout;

iii. Inadequate space allowed.

Where inadequate space is allowed for the stacking of materials or activities:

- Materials may be stacked to high or stacked on roadways causing hazards.
- Working areas may become too cramped or additional areas may have to be allocated with the consequent waste of time caused by having to travel between them.

iv. Site huts wrongly located in relation to their effective use, such as:

- Site office located too near noisy activities such as mixer, or located too near to site roads in dusty conditions, or too remote with insufficient overview of the site.

- Warehouses having inadequate access for loading and unloading or located in insecure area.

Planning Site Layouts

When planning site layouts the following must be taken into account:

1. Site activities
2. Efficiency
3. Movement
4. Control
5. Accommodation for staff and storage of materials

Site activities

The time needed for carrying out the principal activities can be estimated from the data obtained previously for preparing the material and labour requirements. With repetitive (or over-lapping) activities estimates will be required to determine the most economical balance of units which will allow simultaneous construction processes; this in turn will help to establish staff numbers, work areas and material storage requirements, access facilities and possibly plant types and numbers. If a particular process presents a choice in the way the result can be achieved the alternatives must be considered; for example, the rate of placing concrete will be determined by the output of the mixer and the speed of transporting the mix to the appropriate position. Alternatives, which can be considered are:

1. More than one mixer
2. Regulated supply of ready mixed concrete
3. On large contracts, pumping the concrete to the placing position.

Efficiency

To achieve maximum efficiency the site layout must aim at maintaining the desired output of the planned activities throughout the working day and this will depend largely upon the following factors:

1. Avoidance, as far as practicable, of double handling materials
2. Proper store-keeping arrangements to ensure that the materials are of the correct type, in the correct quantity and are available when required
3. Walking distances are kept to a minimum to reduce the non-productive time spent in covering the distances between working, rest and storage areas without interrupting the general circulation pattern.
4. Avoidance of loss by the elements by providing adequate protection for unfixed materials on site, thereby preventing time loss and cost of replacing damaged materials
5. Avoidance of loss by theft and vandalism by providing security arrangements in keeping with the value of the materials being protected and by making the task difficult for the would-be thief or vandal by having adequate hoardings and fences. Also to be avoided is the loss of materials due to pilfering by site staff who may consider this to be a perquisite of the industry. Such losses can be reduced by having an adequate system of stores' requisition and material checking procedures.
6. Minimizing on-site traffic congestion by planning delivery arrivals, having adequate parking facilities for site staff cars and mobile machinery when not in use, and by having sufficient turning circle room for the types of delivery vehicles likely to enter the site.

Movement

Apart from the circulation problems mentioned above the biggest problem is one of access. Vehicles delivering materials to the site should be able to do so without difficulty or delay. If it is anticipated that heavy vehicles will be operating on site it will be advantageous to lay the roads and paved areas, if these are part of the contract and will have adequate strength for the weight of the anticipated vehicles, at a very early stage in the contract. Otherwise lay only the hardcore layer at the initial stages or temporary roadways composed of railway sleepers, metal tracks or mats until a later stage in the contract, especially if such roads will only be required for a short period.

Control

This is mainly concerned with the overall supervision of the contract, including men, materials and the movement of both around the site. This control should form the hub of the activities, which logically develops into areas, or zones of control radiating from this hub or centre. Which zone is selected for storage, accommodation or specific activities is a matter of conjecture and the conditions prevailing on a particular site but as a rule the final layout will be one of compromise with storage and accommodation areas generally receiving priority.

Accommodation

Accommodation for staff is covered by the Construction (Health and Welfare) Regulations 1966, which sets out the minimum amount and type of accommodation which must legally be provided for the number of persons employed on the site and the anticipated duration of the contract. Apart from these minimum requirements the main areas of concern will be sizing, equipping and siting the various units of accommodation.

Methods of Site Layout

There are two methods used to ensure satisfactory site layout. Both entail the use of a site plan showing outline of building with drain and service runs (possibly to scale). The site planner may:

i) Cover site with sheet of plastic and draw on arrangement, simply rubbing out wrongly placed huts, and so on until the best solution is achieved.

ii) Prepare simple plywood or hardboard cut outs to scale, and place them around the plan until satisfied of the layout

By using these methods, the wrong positioning of necessary allocated area is reduced to a minimum and the moving of plant, materials and huts because of unforeseen service trenches is eliminated.

SITE LAYOUT FACILITIES

SITE LAYOUT
PLAN

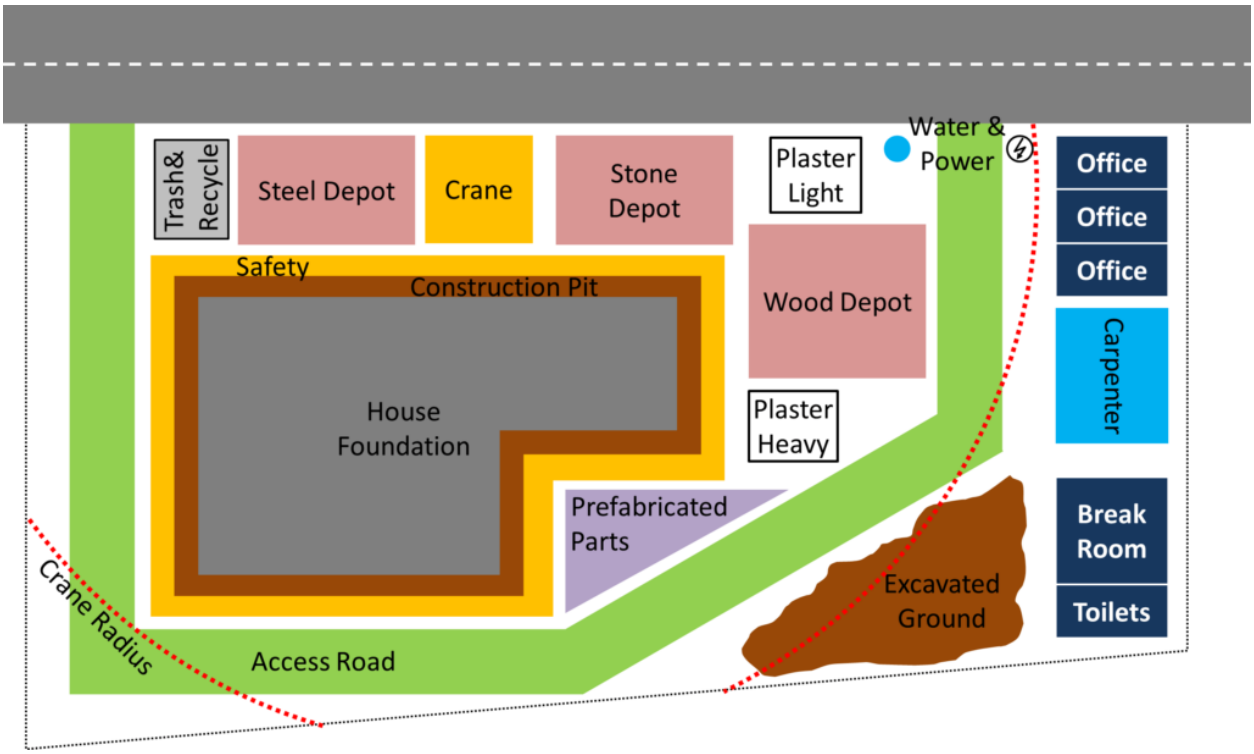

Figure 46

1. Access to site

Although particular circumstances of each site or job will determine the extent to which recommendations can be applied, the builder should provide:

- Such drainage required to keep site reasonably free from standing water. Particular attention should be paid to seasonal changes of the water table and permeability of sub-soil, information of which may be obtained from local knowledge or by trial pits or boreholes. If required, exclusion of water may be done by pumping using the most economical method.
- So that on- and off-site access to parts under construction provide roads, paths or rail facilities. Many projects often have to make new access to sites crossing over existing footways, and whether the access is of a permanent or temporary nature, the permission of the local authorities must be obtained.
- If the site is of a restricted nature (rights of way restrictions, local authority or police restrictions and bridge weight or height limitations on approach routes) the problem of unloading of materials or loading up spoil and rubbish for removal may cause interference with the flow of traffic. Adequate warning should be given to other road users by the display of notices, danger signs, warning lights or other suitable communications

2. Car Park

Site personnel, visitors or suppliers need adequate and secure parking space on the site. This need to be sited preferably in front of the site offices so that:

- the timekeeper can book in arrival and departure times of vehicles
- a material checker at the entrance to site can easily check and direct material supply
- site security may check and ensure that those leaving the site do not carry materials or components, tools or equipment with them.

3. Site Signboard

Uses of a site identification board include:

- It is an advertising aid, hence it should be clearly displayed
- It saves traffic and visitors problems in finding the site
- In sub-urban or rural locations 'finger boards', a form of signboard, is very useful in directing people to the site as street names are not always easy to locate.

Items appearing on a signboard for a proposed site include: Name of project, name of client, name of contractor, name of architect, name of Chief Engineer, name(s) of mechanical, civil, structural Engineer(s), name of quantity surveyor, name(s) of sub-contractor(s).

4. Amenities

Although minimum requirements covering operatives' welfare facilities on site depends on the size and nature of the site as regards other provisions, most sites will consist of hutments divided into three groups:

(a) Administrative offices
(b) Operatives' huts
(c) Storage and general

(b) Administrative offices

These will vary according to the size of the project, from a single hut for the site supervisor and possibly visiting clerk of works, to a complex of offices to house site supervisors, engineers, surveyors, planners, time clerks etc. Requirements for site administrative offices include:

i) Be constructed of materials that can be easily handled, transported, erected and disassembled.
ii) Be of sound construction
iii) Be water tight at the walls, floor(s), roofs
iv) Have adequate lighting and ventilation
v) Have suitable internal finishes and fixtures to impress visitors and provide suitable surroundings for meetings
vi) Be linked, from a simple sliding panel to a sophisticated intercom system for ready communications.

(c) Operatives' huts

Minimum recommendations for operatives' huts include:

i) Shelter from inclement weather e.g. rain, heat, snow, wind etc.
ii) Accommodation for clothing, provision for meals either from fenders or a serviced canteen
iii) Sanitary conveniences which include provisions for washing hands, drinking water and ablution for calls of nature.
iv) Ambulance room properly constructed and maintained

The above recommendations, if implemented, will improve working conditions on the site, leading to team spirit, high morale and good relations between operatives and management because it creates a feeling that the management is considering the workers. Further there will be reduced labour turnover; giving a more knowledgeable team with reduced need for retraining and higher productivity due to operatives working better if dry

clothes can be put on at start of each day and if hot meals can be easily obtained to replenish lost energy.

Operatives' huts should be placed in proximity to the administrative block (foreman's office) to check prolonged breaks or unscheduled visits to huts during the day.

5. Storage Areas

Storage areas for tools and equipment and materials may be manned or unmanned, open or under lock and key depending on:

Physical properties – size, shape, weight and mode of delivery will assist in determining the safe handling and stacking method(s) to be employed on site, which will in turn enable handling and storage costs to be estimated.

Protection – Building materials and components, tools, plant and equipment will usually require some form of weather protection to prevent deterioration, especially those materials classified as non-durable.

Security – many tools and equipment and building materials have a high resale and/or usage value to persons other than those for whom they were ordered and unless site security is adequate, losses due to theft, pilferage and vandalism can become unacceptable.

Organisation– this is the planning process of ensuring that all the materials and equipment are delivered to site at the correct time, in sufficient quantity, the right quality, the means of unloading is available and that adequate space for storage or stacking has been allocated throughout the duration they are on site.

6. Adjoining Property

Many sites are surrounded by other buildings. The precautions the site management ought to consider in relation to adjoining properties like buildings before starting the work include:

i) Maintain good relations with the owners of these properties right from the start. Preliminary information may help to reduce friction if problems with regard to dust, noise etc., occur during the course of the project, leading to dialogue rather than taking stronger, more direct action.

ii) Insure against mishaps and suggested damage to existing property by taking photographs and getting the owner to sign as correct

iii) Placing tell-tales over any faults to avoid legal battles later on if owner accuses builder of damage

7. Site Security

To enhance security at the site for materials, tools, equipment and plant, site personnel, vehicles and the construction work in progress, the site management need to consider local vandalism and pilfering record, security patrol facilities, need for night security, fencing and hoarding requirements.

Fencing

A building site and the compound can be given a degree of protection by surrounding with a fence. A fence is an erection put to a property to mark its extent without necessarily barring one from seeing inside.

The fence fulfills three functions:

1) Defines limit of the site or compound
2) Acts as deterrent to would-be trespassers and thieves
3) Provides protection to the public

A fence can be constructed to provide a physical barrier of solid construction or a visual barrier of open work construction. If the site is to be fenced as part of the contract it may be advantageous to carry out this work at the beginning of the site operations. The type of fencing chosen will depend upon:

i) The degree of security required
ii) Cost implications
iii) Type of neighbourhood, and
iv) Duration of contract

A security fence around the site or compound should be at least 1.8m high above the ground and include the minimum number of access points which should have a lockable barrier or gate. (See Fig. 1.3)

Hoardings

These are close boarded fences or barriers erected adjacent to a highway or public footpath to prevent unauthorized persons obtaining access to the site and to provide a degree of protection for the public from the dust and noise associated with building operations.

Under the Highways Act 1959 (Sec. 147 and 148) it is necessary to obtain written permission from the Local Authority to erect a hoarding. The person, which is in the form of a license, sets out the conditions and gives details of duration, provision of footway for the public and the need for lighting during the hours of darkness.

Two forms of hoarding are in common use:

(1) Vertical hoardings
(2) Fan hoardings

The vertical hoardings consist of a series of closed boarded panels securely fixed to resist wind loads and accidental impact loads. It can be free standing or fixed by stays to the external walls of an existing building.

Protection should be given to persons from falling objects. A fan hoarding fulfills this function by being placed at a level above the normal traffic height and arranged in such a manner that any falling debris is directed back towards the building or scaffold. (See Fig 1.4)

Examples of site layout

Figure below illustrates the layout of building materials and access roads for the purposes of servicing two hoists for the erection of a low-rise building. Comment on and criticize the present layout in relation to the positioning of both the materials and hoists.

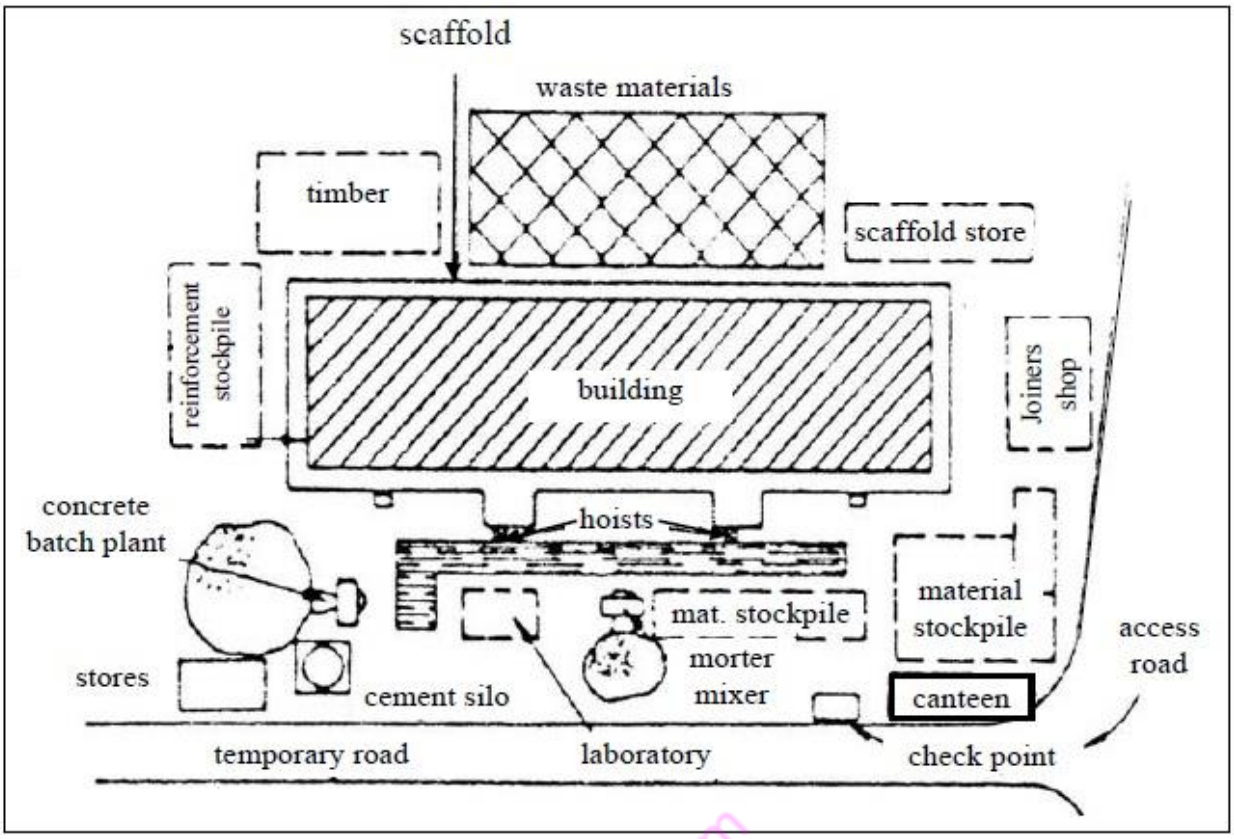

Figure 47

Criticism of existing site layout:

- Both hoists have separate scaffold staging, causing increased costs.
- Materials are not stockpiled near hoists.
- Entrance to the site is too narrow for truck to pass.
- Stores are located behind the batching plant so obscuring storeman's view and check point is separated from the stores.
- Concrete and mortar mixers are located too far from the hoists.
- Stockpiles are dispersed and hinder unloading.
- Temporary roads are long and narrow.
- Some stores are difficult to reach.

An improved site plan look like this:

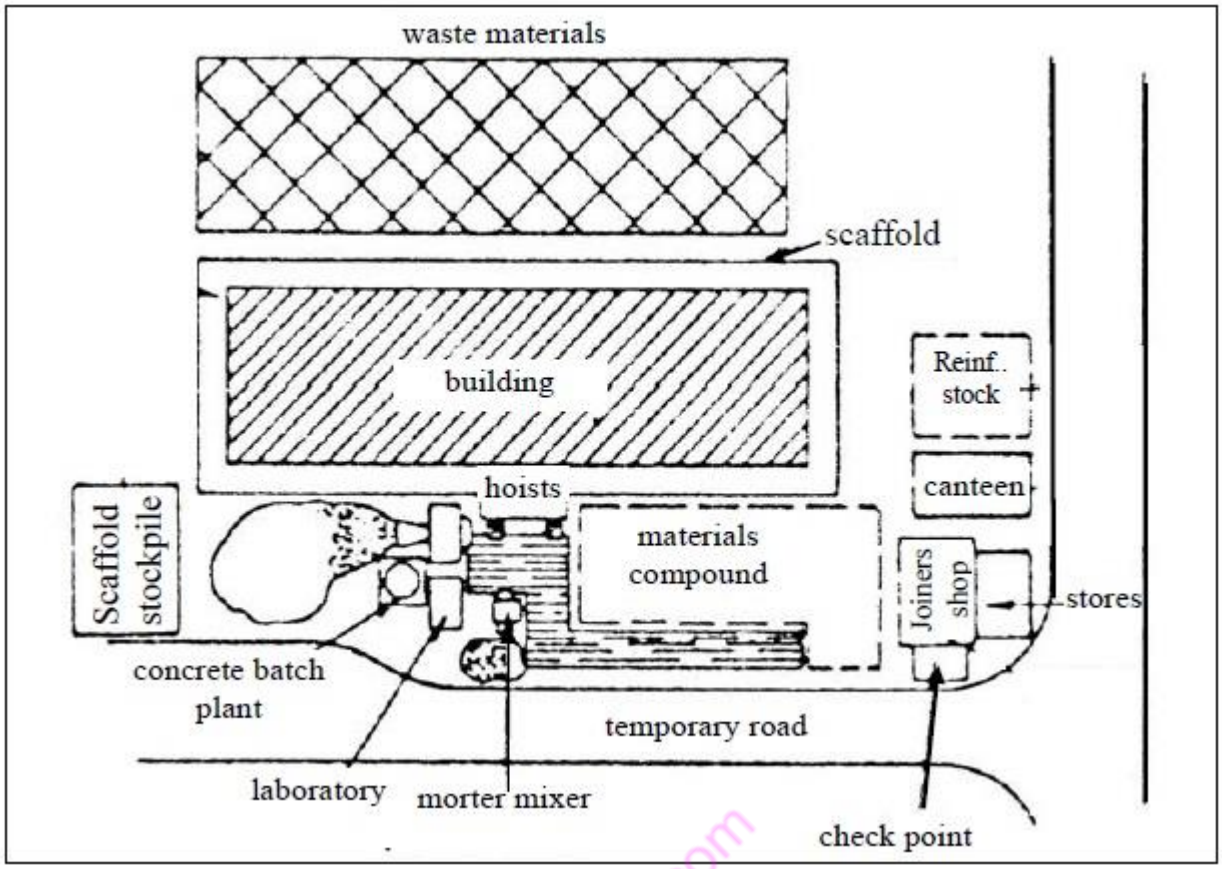

Figure 48

Suggested improved layout:

- Both hoists are housed in a common scaffold.
- Batching plants have direct discharge into dumpers.
- The access has been widened near the site entrance.
- The stores are located to give a good view of all materials stockpiles, and are sited near the temporary road.
- Concrete and mortar mixers are located near the hoists.
- The temporary road is shorter and wider.
- A compound is provided to police non-bulk materials.

1.2.4.4 Learning Activities

carry out a site visit to a large construction site and Sketch a site layout plan of construction site and show the major details.

1.2.4.5 Self-Assessment

a) To achieve maximum efficiency on a construction site, site layout planning must aim at maintaining desired output of planned activities throughout the working day. what are the FIVE site planning measures that may be taken to achieve this
b) Outline FOUR factors to be considered in the site layout planning.
c) what are the uses of a site identification board on a construction site?
d) which items should appear on a signboard for a proposed construction site.
e) Enumerate SIX welfare items that can be provided for workers on a construction site
f) which are the security measures to be put in place for the protection of a construction site.
g) Which areas should be considered when planning a site layout?

1.2.4.6 **Tools, Equipment, Supplies and Materials**

Tools and equipment

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.4.7 References

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Responses

a) To achieve maximum efficiency on a construction site, site layout planning must aim at maintaining desired output of planned activities throughout the working day.
what are the FIVE site planning measures that may be taken to achieve this.
   - ✓ **Site activities**
   - ✓ **Efficiency**
   - ✓ **Movement**
   - ✓ **Control**
   - ✓ **Accommodation for staff and storage of materials**

b) Outline factors to be considered in the site layout planning.
   - ✓ **site access**
   - ✓ **utility locations**
   - ✓ **soil conditions**
   - ✓ **safety and health conditions**
   - ✓ **temporary services**

c) what are the uses of a site identification board on a construction site?

d) which items should appear on a signboard for a proposed construction site.
   - ✓ **Name of project,**
   - ✓ **name of client,**
   - ✓ **name of contractor,**
   - ✓ **name of architect,**
   - ✓ **name of Chief Engineer,**
   - ✓ **name(s) of mechanical, civil, structural Engineer(s),**
   - ✓ **name of quantity surveyor,**
   - ✓ **name(s) of sub-contractor(s).**

e) Enumerate welfare items that can be provided for workers on a construction site
   - ✓ **allowances**
   - ✓ **accommodation**
   - ✓ **free lunch**
   - ✓ **free transport**

f) which are the security measures to be put in place for the protection of a construction site.
   - ✓ **installing fences around the site**
   - ✓ **constructing hoardings**
   - ✓ **putting a watchman**
   - ✓ **proper storage of materials and resources**

g) Which areas should be considered when planning a site layout?

Site layout plans might include locations for and sizes of:

- ✓ Zones for particular activities.
- ✓ Cranes (including radii and capacities).
- ✓ Site offices.
- ✓ Welfare facilities.
- ✓ Off-loading, temporary storage and storage areas (laydown area)
- ✓ Sub-contractor facilities.
- ✓ Car parking.
- ✓ Emergency routes and muster points.

1.2.5 Learning Outcome 5; Demolish unwanted structures

1.2.5.1 Introduction to the learning outcome

This unit specifies the competencies required to demolish unwanted structures. it involves methods of demolishing, Safety consideration during demolition as well as waste disposal of demolished debris as per set procedures

1.2.5.2 Performance Standard

5.1 Area to be demolished is identified as per client needs
5.2 Demolition method is determined according to area to be demolished and environmental conditions
5.3 Local authorities and surrounding occupants are informed of the demolition work
5.4 ***Building and structural surveys*** are carried out in accordance with building standards

5.5 Hazardous materials are removed according to safety regulations
5.6 Demolition plan is prepared according to the demolition method adopted
5.7 Safety procedures are adopted as per the demolition method
5.8 Unwanted structures are demolished and disposed as per set procedures

1.2.5.3 Information Sheet

Definitions

Demolition: The word demolition means destruction, breaking down or removal. Demolition of building is the process of dismantling or destroying of a structure after its life of serviceability by pre-planned and controlled methods.

Implosion: When explosives are used in the demolition of a building, it is termed as Implosion.

INTRODUCTION

Demolition of buildings and structures are required for various reasons. Demolition methods and processes for buildings and other structures are described.

As we know that every design of a building or a structure has a lifespan know as design life. The building is designed considering a span of life, say 80 -100 years. When this design life of the building is over, the structure is not safe for living and neighboring buildings.

There can be more reasons for demolition of a building, old structures are to be replaced by new ones. The structure lost its stability or having any structural damage. Small structures are demolished to build big structures etc.

Building Demolition Process

Different steps are involved in the process of demolition of building structures which are:

1. Surveying
2. Removal of hazardous materials
3. Preparation of plan
4. Safety measures

Surveying of Buildings for Demolition

Surveying means study of different parameters of the structure and its surroundings. There are two types of surveying are mainly conducted. They are

1. Building surveying
2. Structural surveying

1. Building Surveying

In survey of buildings for demolition, following process are carried out:

- Types of construction material used
- Usage of building prior and present during demolition.
- The presence of wastewater, hazardous materials, matters arising from toxic chemicals, flammable or explosive and radioactive materials, etc.
- Drainage conditions and possible problems on water pollution, flooding and erosion.
- Shared facilities with adjoining building, including common staircases, partition walls.
- Adjoining pedestrian and vehicular traffic conditions
- The sensitivity of neighborhood with respect to noise, dust, vibration and traffic impact.

2. Structural Surveying

In structural survey, following process are involved in demolition:

- The method of construction
- The structural system and structural conditions of basements, underground tanks or underground vaults.
- The original structural system employed in the design.
- The condition of the building.

Removal of Hazardous Materials

If hazardous materials like asbestos minerals, petroleum contamination, and radioactive metals are found in the investigation of site for demolition. Specialized personals are called for the removal of the hazardous materials from the site prior to the demolition of structure.

Preparation of Demolition Plan for Structures

A detailed demolition plan is made which illustrates the different process involved and they are:

- The location of the building to be demolished.
- The distances from the building to be demolished to its adjacent buildings, streets, structures and significant street furniture.
- The structural support systems of the building.

- A plan showing the procedure for the demolition of the building; detailed sequence of demolishing structural members; and the method of demolition to be adopted.
- A plan showing all precautionary measures for the protection of the public including hoardings, covered walkways, catch platforms, catch fans, scaffolding, protective screens and safety nets.
- Method of handling demolished building debris.
- Time required for the complete demolition process etc.

Safety Measures during Demolition of Building Structures

All the workers, site supervisors and engineers including plant and equipment operators are briefed with the potential hazards and process of demolitions.

All goods that are flammable are removed from the site unless it is used in the work involved. All the flammable materials like wood, timber, fuels etc. are stored in proper storage facilities. Firefighting appliances are stationed in the demolition site till the process is completed.

Due to the demolition of structure, many problems are faced by the workers, such as. exposure to dust, chemical exposure, heat stress and ventilation, noise exposure, medical and first aid facilities, sanitation and occupational diseases. To overcome these problems suitable measures are undertaken

SAFETY PRECAUTIONS :

Any demolition work should be proceeded by

i. Site survey which should be comprehensive

ii. Decide on the location and position of screens, scaffolds etc.,

iii. Protection of the public

iv. Methods to protect surrounding buildings from the danger of collapse.

v. Electric power to all services within the structures should be shut off. Similarly all Gas, water and steam service lines should be shut off.

vi. The structure to be demolish should be adequately fenced and cordoned off

vii. Display boards to be displayed prominently warning the public of the danger.

viii. Glass in doors and windows, loose objects and projecting parts to be removed.

SAFETY MEASURES IN DEMOLITION OF THE BUILDINGS:

a. Workers should not be deployed at different levels unless adequate precautions are taken to ensure safety of them

2) Demolition work should begin at the top of the structure and proceed downwards. .

3) Masonry concrete and other dismantled materials should not be allowed to accumulate in quantities which may endanger the stability of any floor or structural support.

4) Part of the structures, where necessary should be adequately shored, braced or otherwise supported.

5) If the structure is to be demolished by explosives, all safety measures pertaining to explosives such as transport, storage, handling, loading firing etc. should be strictly adhered to.

6) Foundation walls serving as retaining walls to support of adjoining structures should not be demolish until the adjoining structure have been under pinned or braced or earth supported by sheet pilling.

7) Stairs with hand railing should be kept in place as long as practicable to provide access and egress.

8) If the work of demolition is continued in night, all passageways, stairs and other parts of the structure where the workers have to pass and also to work should be adequately lit.

9) Workers should wear strictly safety belts, safety belts, safety helmets and hand glove.

10) If the demolition is carried out by machines such as power shovels, bulldozers etc. the safety measures relevant to operation and use of such machines should be adhered to.

11) If swinging weight such as ball is used for demolition, a safety zone having a width of at least 1.50 times the height of the building or structure should be maintained.

12) 12.Scaffolds used for demolition operations should be independent of the structure to be demolished.

13) If ladders are used for demolition, only travelling mechanical ladders should be used.

14) 14.The hoists or chutes, whenever it is practicable, should be used to lower the materials. Materials chutes should have a gate at the bottom with suitable means for regulating the flow of materials.

Safety measures in demolition of structural steel works:

1. The steel structures should be demolished from top tier by tier.

2. Removing the various members of the steel structures should be done in a planned manner.

3. All precautions should be taken to prevent danger from any sudden twist, spring or collapse of steel parts/work when it is cut or released.

4. Structural steel parts should be carefully lowered and not dropped from a height.

5. 5.Safety precautions of gas cutting of the steel members should be adhered to.

Safety measures in demolition of tall chimneys, minars, pylons etc.

1) Tall chimneys, minars, pylons, etc., should not be demolished by overturning or blasting unless a protected area of an adequate dimension in which the chimney or the structure can fall safely..

2) If the demolition of the tall structures are done by , blasting with explosives, it should be done with the services of specialized engineers . The entire operation should be under his supervision and control.

Safety measures in demolition of Industrial Structures:

1. The Safety measures in removing heavy and bulky machinery, plant and equipment should be observed in addition to some of the relevant safety measures already stated.

2. If the industrial Structure such as a nuclear power station the services of the specialist expert in the field of radio-activity and radiation should be utilized.

Demolition Methods for Buildings and other Structures

There are two types of demolition methods used for buildings and structures

1. Non-explosive demolition
2. Explosive demolition.

1. Non-Explosive Demolition Method

It means the demolition of a structure done with some equipment without the use of any explosive. Different equipment's used for the demolition activity are

a) Sledge hammer

It is a small handheld hammer used for the demolition of small wall or single column.

Figure 49

b) Excavators and Bulldozers

These are big machines uses to demolish building of small sizes. They are used for excavation of soil or transferring of debris to trucks etc.

Figure 50

c) Wrecking Balls

The building with the greater height up to (6-7 story) cannot be demolished with the help of excavators or bulldozers. In such cases crane with wrecking balls are used to perform the demolition activity. The wrecking ball crack is crack attached with a huge steel ball hanging from a steel rope.

The steel ball is pulled and released towards the building. The steel ball with force strikes the building and the part of the building is demolished. This method is not recommended as the trajectory of the steel ball cannot be controlled after it strikes the structure.

Figure 51

d) High Reach Excavators

High Reach Excavator machines are used in the demolition of tall building where demolition by explosion is not possible. The building of height up to 300ft can be demolished by this type of machine.

High reach excavators can be used for different use by doing some attachments such as:

- Excavators with shear attachments – excavators with shear attachments.
- Hydraulic hammers – Hydraulic hammers and remove steel reinforcement.

Figure 52

DEMOLITION METHODS AND COMMON TYPES

TOTAL DEMOLITION

The demolition of an entire structure or site. This would be most common in the case of community re-structure; for example, if there was an old retail centre that was not benefiting an area, the land could be used to build a housing estate, to provide additional housing for the community, and therefore demolition would be instructed.

SELECTIVE DEMOLITION

Removing specific parts of a building. Some old buildings stand the test of time and others don't. In this case, perhaps there is a really old section of a workplace or local amenity that is not performing as it should, but the entire building is not at a state of concern. Or perhaps it is a listed building, therefore you may be restricted as to what and how much you can demolish. So you could select a particular section of the building to demolish and build up from scratch. This also can add value to a current building too by performing construction in stages.

INTERIOR DEMOLITION

Demolition particular parts of the inside of a building, while protecting and maintaining the exterior structure. For example; partitions, walls, ceilings, etc. A great option for creating more space inside of a building or removing troubled areas.

DISMANTLING OR DECONSTRUCTION

This method involves the careful dismantlement or deconstruction of a building or structure in order to preserve parts for reuse, refurbishment or recycling. Dismantling structures is a lot more labour intensive than say total or explosive demolition.

2. Explosive Demolition Method for Building Structures

Implosion Method of Building Demolition

Implosion is the process of demolition of a building using explosives. If the supports of the building are removed, the structure collapses.

Using implosion technique, the main supports of the buildings such as column's, beams and slab are fixed with explosives. When these explosives are detonated, the column collapse and so is the structure.

Depending how the structure falls, there are two types of implosion:

a) Falling like a tree

Figure 53

In this type of implosion, the building is made to fall like a tree to the sideward. This is the commonly used type of implosion. When free space is available besides the building, this type of demolition is prescribed.

If the free space is available on the left side of the building, the explosives are set on the lower level of the building on the left side columns. As the explosives are detonated, the columns bursts, the building tends to falls towards the left side. Steel cables are tied to the building to control the falling direction of the building.

b) Falling into its own footprint

When the free spaces are not available around the building and the structure around the building are to be protected. This type of demolition is used. In this type of demolition, explosives are set in the floor below the middle part of the building.

Figure 54

These explosives are to be heavy as the explosion must demolish the building at once. If one part blast and followed by another. Then the building falls towards the first blasted part. So only less companies in the world are experienced in this type of demolition.

As the explosions are detonated, the upper part of building destroys and falls upon the lower building. Due to the heavy load and force the lower part of the building also collapses and falls on its own footprint.

WHY IS DEMOLITION IMPORTANT?

Building demolition needs to be done correctly, in a safe and correct manner is vital in order to base solid foundations for the next construction process. There are regulations to follow, Health and Safety laws to abide by, and a level of skill and knowledge involved – it's not just as simple as bulldozing down a building.

Before a demolition process begins, there are a number of factors to take into consideration. The following are:

- Liaise with the authority / business owner of the site pre-demolition to discuss any requirements. Whether it be safety measures to bear in mind, water damage, damage or collapse of the foundations, shoring or if they have any area of the building that requires protection or extra care as the work commences.

- Have the building surveyed prior to demolition, this will give you a professional understanding of the structural aspect of the building, and what could propose potential difficulties or risks. An R&D Survey or Dilapidation Survey will be carried out professionally in order to investigate hazardous conditions such as asbestos.

- Ensure everyone involved in the process adheres to the Construction Regulations (such as CDM 2015) prior to starting any work.

- Have approval from your local authorities

Hazardous Waste Removal

A major concern, especially for the demolition of older structures, is limiting the exposure of demolition workers and the surrounding population to toxic and potentially deadly waste

materials. Potential sources of hazardous waste at the demolition site include animal droppings, fungi and molds. Lead and asbestos abatement -- removal by highly trained crews with specialized equipment -- must be completed before the general demolition of the structure can begin. Inspections by government entities at the state and federal level are often required to ensure that hazardous waste removal adheres to regulations.

Debris Disposal

Clearing the site of demolition debris is the final stage of a demolition project. Before the job begins, the demolition company must determine where the debris will be discarded, as well as how to transport the debris from the demolition site. In some cases where demolition involves structures with underground features, some of the demolition debris may be used to fill in the underground excavation to level the entire site. Other considerations include using mulch or other means to limit dust from the newly cleared site from escaping into the atmosphere.

1.2.5.4 Learning Activities

A field Activity

Table 4: Field visit to a site undertaking demolition processes

Visit Objective/Aim	Indicators	Special Instruction
To identify the tools and equipment used in demolition activity	- list of tools and equipment - sketches	- Must correctly list and sketch tools and equipment used -Must indicate the function of each tool and equipment
To know how demolition process is carried out	- demolition work	Must know what happens in the task To write the procedure used of demolition
To enquire the preparation procedures undertaken before the actual demolition work	- notes on preparation stages - report copies	Must be include all storage and pumping appliances identified

1.2.5.5 Self-Assessment

1. What is demolition and why do i need it?
2. What happens to the building materials during demolition?
3. Do i need a demolitionist if i don't want my building destroyed?
4. What are the different types of demolition?
5. Do i need deconstruction or demolition?
6. Is my demolitionist regulated and safe?
7. Is demolition bad for the environment?
8. What can wreck house demolition do for me?

1.2.5.6 **Tools, Equipment, Supplies and Materials**

Tools and equipment

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.5.7 References

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Responses

What is Demolition and Why Do I Need It?

Demolition requires an experienced crew that understands a variety of techniques used to complete all sorts of demolition projects. From traditional implosion to projects that require large equipment like cranes and wrecking balls, demolitionists can assist with many construction projects. One common use for demolitionists is environmental remediation and the removal of harmful materials from a building.

What Happens to the Building Materials During Demolition?

Most of the building materials on a demolition project are reused, recycled, or salvaged. Common items that may be reused or recycled in some way include flooring, carpets, plasterboard, wood, roofing materials, ceiling tiles, and insulation material. It's even possible to save or salvage materials like concrete, brick, and porcelain, as well as soil.

Do I Need a Demolitionist If I Don't Want My Building Destroyed?

Demolition is a much more diverse process than just the implosion of buildings. Many demolition projects actually include interior demolition, which is a process where the inside of a structure is cleared out and readied for projects like upgrades and renovation. A demolition project may also require selective structure demolition, an example of which might be the removal of a wall or a room from a larger structure.

What are the Different Types of Demolition?

Demolition is a process that can be used on any number of different projects from industrial applications to commercial structures. Demolition conducted at sites like manufacturing facilities and chemical plants fall under industrial demolition and often require sophisticated engineering and equipment. Likewise, commercial demolition occurs at a commercial property like a hotel, office building, or retail store and may or may not involve work with hazardous materials.

Do I Need Deconstruction or Demolition?

Deconstruction is actually a type of demolition that's usually a more intense process designed to retain as much as possible in recycled and reusable materials from the deconstruction process. While traditional demolition projects often save more than 90 percent of materials removed from a site, deconstruction is often conducted by hand while demolition often employs more machinery.

Is My Demolitionist Regulated and Safe?

An experienced demolitionist must work with the local government to obtain permits that will allow a demolition project to proceed. Anyone who works as a demolitionist must navigate a variety of regulations since demolition is one of the most regulated industries. Working with what might be hazardous or toxic materials requires experience, as well as adherence to a variety of health and safety rules.

Is Demolition Bad for the Environment?

At first glance, demolition might not seem like a step an environmentalist might take to maintain the health of the ecosystem or environment, but demolitionists do indeed act as stewards of the environment. Many demolitionists complete their projects in the towns in which they live, which means caring for the environment and working on projects that may include work on historic buildings means working to improve the quality of life for all residents, business owners, and families.

What Can Wreckhouse Demolition Do for Me?

If you're undertaking a renovation or any project that may require extensive removal of materials, abatement of hazardous materials like asbestos, or other work, Wreckhouse Demolition can help. Contact us today to learn more about our demolition services for residential, industrial, commercial, and public works projects.

1.2.6. Learning Outcome 6; Prepare site preliminary report

1.2.6.1 Introduction to the learning outcome

This unit specifies the competencies required to prepare site preliminary report. it involves costing the preliminary site activities, enumerating challenges and achievements in undertaking site preliminary activities and compiling the site preliminary report.

1.2.6.2 Performance Standard

6.1 Cost of preliminary site activities are analyzed
6.2 Data on challenges and achievements are recorded and documented
6.3 Site preliminary report is prepared

1.2.6.3 Information Sheet

Reports generally involve presenting your investigation and analysis of information or an issue, recommending actions and making proposals.

There are many different types of reports, including business, scientific and research reports, but the basic steps for writing them are the same. These are outlined below.

- Step 1: Decide on the 'Terms of reference'
- Step 2: Decide on the procedure
- Step 3: Find the information
- Step 4: Decide on the structure
- Step 5: Draft the first part of your report
- Step 6: Analyse your findings and draw conclusions
- Step 7: Make recommendations
- Step 8: Draft the executive summary and table of contents
- Step 9: Compile a reference list
- Step 10: Revise your draft report

You can also check our information on assignment writing for tips on planning, finding information, writing and reviewing your work.

Step-by-step guide to writing an assignment

Step 1: Decide on the 'Terms of reference'

To decide on the terms of reference for your report, read your instructions and any other information you've been given about the report, and think about the purpose of the report:

- What is it about?
- What exactly is needed?
- Why is it needed?
- When do I need to do it?
- Who is it for, or who is it aimed at?

This will help you draft your Terms of reference.

Step 2: Decide on the procedure

This means planning your investigation or research, and how you'll write the report. Ask yourself:

- What information do I need?
- Do I need to do any background reading?
- What articles or documents do I need?
- Do I need to contact the library for assistance?
- Do I need to interview or observe people?
- Do I have to record data?
- How will I go about this?

Answering these questions will help you draft the procedure section of your report, which outlines the steps you've taken to carry out the investigation.

Step 3: Find the information

The next step is to find the information you need for your report. To do this you may need to read written material, observe people or activities, and/or talk to people.

Make sure the information you find is relevant and appropriate. Check the assessment requirements and guidelines and the marking schedule to make sure you're on the right track. If you're not sure how the marks will be assigned contact your lecturer.

What you find out will form the basis, or main body, of your report – the findings.

For more on finding information:

Research and reading

Steps for writing an assignment

Step 4: Decide on the structure

Reports generally have a similar structure, but some details may differ. How they differ usually depends on:

- The type of report – if it is a research report, laboratory report, business report, investigative report, etc.
- How formal the report has to be.
- The length of the report.

Depending on the type of report, the structure can include:

- A title page.
- Executive summary.
- Contents.
- An introduction.
- Terms of reference.
- Procedure.
- Findings.
- Conclusions.
- Recommendations.
- References/Bibliography.
- Appendices.
- The sections, of a report usually have headings and subheadings, which are usually numbered

The basic structure of a report (PDF 262 KB; opens in a new window)

Step 5: Draft the first part of your report

Once you have your structure, write down the headings and start to fill these in with the information you have gathered so far. By now you should be able to draft the terms of reference, procedure and findings, and start to work out what will go in the report's appendix.

Findings

The findings are result of your reading, observations, interviews and investigation. They form the basis of your report. Depending on the type of report you are writing, you may also wish to include photos, tables or graphs to make your report more readable and/or easier to follow.

Graphs - BBC Skillwise website (opens in a new window)

Appendices

As you are writing your draft decide what information will go in the appendix. These are used for information that:

- is too long to include in the body of the report, or
- supplements or complements the information in the report. For example, brochures, spreadsheets or large tables.

Formatting and presenting your assignment

Step 6: Analyse your findings and draw conclusions

The conclusion is where you analyse your findings and interpret what you have found. To do this, read through your findings and ask yourself:

- What have I found?
- What's significant or important about my findings?
- What do my findings suggest?

For example, your conclusion may describe how the information you collected explains why the situation occurred, what this means for the organisation, and what will happen if the situation continues (or doesn't continue).

Don’t include any new information in the conclusion.

Step 7: Make recommendations

Recommendations are what you think the solution to the problem is and/or what you think should happen next. To help you decide what to recommend:

- Reread your findings and conclusions.
- Think about what you want the person who asked for the report should to do or not do; what actions should they carry out?
- Check that your recommendations are practical and are based logically on your conclusions.
- Ensure you include enough detail for the reader to know what needs to be done and who should do it.

Your recommendations should be written as a numbered list, and ordered from most to least important.

Step 8: Draft the executive summary and table of contents

Some reports require an executive summary and/or list of contents. Even though these two sections come near the beginning of the report you won't be able to do them until you have finished it, and have your structure and recommendations finalised.

An executive summary is usually about 100 words long. It tells the readers what the report is about, and summarise the recommendations.

Step 9: Compile a reference list

This is a list of all the sources you've referred to in the report and uses APA referencing.

APA referencing

Step 10: Revise your draft report

It is always important to revise your work. Things you need to check include:

- If you have done what you were asked to do. Check the assignment question, the instructions/guidelines and the marking schedule to make sure.
- That the required sections are included, and are in the correct order.
- That your information is accurate, with no gaps.
- If your argument is logical. Does the information you present support your conclusions and recommendations?
- That all terms, symbols and abbreviations used have been explained.
- That any diagrams, tables, graphs and illustrations are numbered and labelled.
- That the formatting is correct, including your numbering, headings, are consistent throughout the report.
- That the report reads well, and your writing is as clear and effective as possible.

You might need to prepare several drafts before you are satisfied. If possible, get someone else to check your report.

EXAMPLE

LICENCE REFERENCE No.	**RISK ASSESSMENT METHODOLOGY STAGE & STEP**	**REPORT VERSION**
Insert licence reference number	Insert methodology stage and step, e.g. Stage 1 Step 1	Insert report version no., e.g. Draft, Final

INSERT COMPANY LOGO/HEADER

Guideline Template for Preliminary Site Assessment Report for the Environmental Protection Agency

(Month Year)
(LICENCE No.

INSTRUCTIONS ON USE OF THIS TEMPLATE

This document presents a guideline reporting template for stakeholders to use when reporting a Preliminary Site Assessment under the EPA Contaminated Land & Groundwater Risk Assessment Methodology. It is designed to assist stakeholders with the submission of the correct information in a suitable format to the EPA. It should be regarded as a comprehensive guide; it is not intended to be a wholly prescriptive template.

Where there are deficiencies or uncertainties in the information provided these should be clearly marked and annotated to indicate where further data gathering may be required.

In the template, those parts written in red indicate where relevant information and/or assessment should be entered. In entering this information the red text should be deleted or written over and the text reformatted to normal style.

For a glossary of terms and acronyms used in this template report and for a list of key technical guidance documents, refer to the 'Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites' (EPA, 2013).

Delete this page before submitting this report to the EPA

Licence Number

Project Title:	Preliminary Site Assessment Report
Licence No:	(complete)
Project No:	(complete)
Contract No:	(complete)
Report Ref:	(complete)
Status:	(Draft/2nd Draft/Final
Client:	(examples)) (complete)
Client	(complete)

(Consultancy company name and address)

Issued By:

Table 5: Document Production/Approval Record

	Name	**Signature**	**Date**	**Position**	**% Input**
Prepared by (consultan	Insert here	Insert here	Insert here	Insert here	Insert here
Approved by (consultant)	Insert here	Insert here	Insert here	Insert here	Insert here
Site Approval by	Insert here	Insert here	Insert here	Insert here	N/A

LIMITATION

All limitations that apply to the work should be summarised here, including reference to the original proposal for the work and the originally proposed project objectives and scope of works. State if these were achieved and the scope of works completed. Where the scope deviated significantly from the originally proposed scope this should be summarised herein (if a limitation). State the limit of liability, reliance, etc. that apply to this project.

TABLE OF CONTENTS

Update table of contents once all relevant report sections have been completed.

FIGURES (TO BE EXPECTED)

Figure 1	Site location plan
Figure 2	Site layout plan showing main buildings and infrastructure
Figure	Site plan(s) showing historical operational information and infrastructure (if significantly different)
Figure 4+	Site plan(s) showing, by COPC (Contaminants/Chemicals of Potential Concern) or COPC group, the main areas of potential concern identified
Figure 5+	Changes made to the Conceptual Site Model (CSM) (can be previous and current versions of CSM if this is the best way to illustrate this; in all cases the CSM should be illustrated in diagrammatic form)
Figure 6	

TABLES (TO BE EXPECTED)

Tables(s) Depending on site operational complexity, a series of tables are expected to be needed to present key information on:

- Hazardous & non-hazardous chemical and waste (product) inventories and annual throughput (current and former)
- Storage tank and drum storage capacities by chemical (waste) (current and former) and locations
- Chronology of chemical spill or leak history
- Preliminary list of COPCs and rationale for inclusion
- Chemicals not shortlisted and rationale for why not
- Additional COPCs that need to be added due to their detection above threshold values in previous site investigations or monitoring rounds

APPENDICES (THAT MAY BE EXPECTED TO BE USEFUL)

Appendix A	Annotated site plans (including historic copies; drain plans; etc.)
Appendix B	Annotated site aerial/other photographs showing key areas
Appendix C	Chemical inventory & throughput information
Appendix D	Waste inventory & throughput information
Appendix E	Chemical (process) effluent volumes & quality information
Appendix F	Environmental setting support information

EXECUTIVE SUMMARY

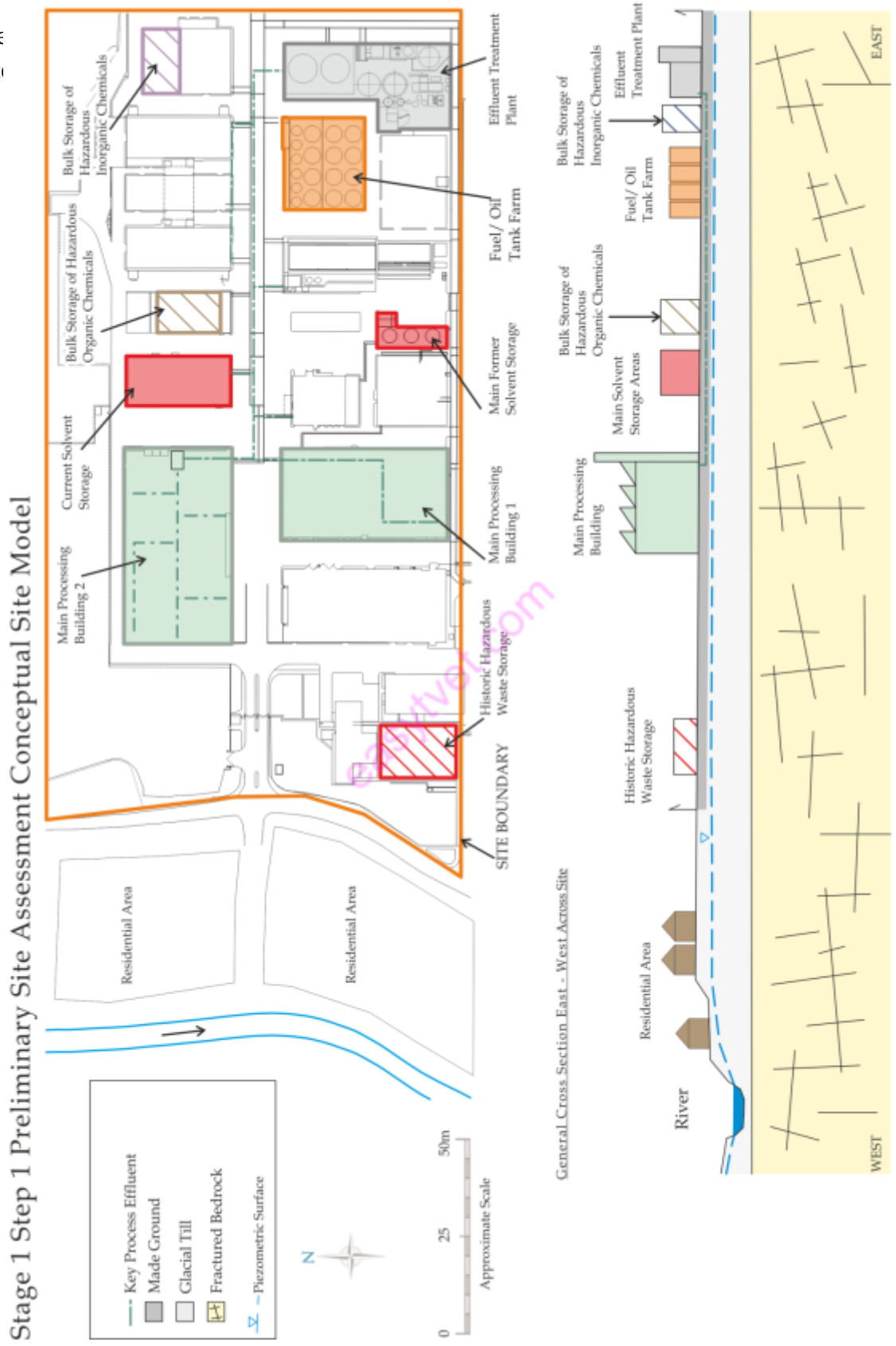
An Executive Summary is considered necessary for all reports of any size to allow a reader to quickly understand project objectives and scope of work and all the main findings.

This must include, as a separate page within the executive summary, the latest diagrammatic Conceptual Site Model (CSM) based on data and information collected during this phase of the site programme of works.

It must also include a flow chart illustrating where this report sits in the overall contaminated land and groundwater site assessment and corrective action process, confirming all aspects already completed (see attached example).

Table 6Replace this image with a diagrammatic Conceptual Site Model showing the current understanding of site circumstances.

Site
Lic



	EPA Contaminated Land & Groundwater Risk Assessment	Report Reference	Report Date	Status
STAGE 1: SITE CHARACTERISATION & ASSESSMENT				
1.1	**PRELIMINARY SITE ASSESSMENT**	(Insert this report author & reference)	(Insert this report date)	(Draft, Final, etc.)
1.2	**DETAILED SITE ASSESSMENT**			
1.3	**QUANTITATIVE RISK ASSESSMENT**			
STAGE 2: CORRECTIVE ACTION FEASIBILITY & DESIGN				
2.1	**OUTLINE CORRECTIVE ACTION STRATEGY**			
2.2	**FEASIBILITY STUDY &**			
2.3	**DETAILED DESIGN**			
2.4	**FINAL STRATEGY & IMPLEMENTATION**			
STAGE 3: CORRECTIVE ACTION IMPLEMENTATION & AFTERCARE				
3.1	**ENABLING WORKS**			
3.2	**CORRECTIVE ACTION IMPLEMENTATION &**			
3.3	**VERIFICATION**			
	AFTERCARE			

1. INTRODUCTION

1.1. PROJECT CONTRACTUAL BASIS AND PERSONNEL INVOLVED

Confirm the contractual basis for the work including the proposal reference number.

List the name and role of the main people who completed the work and their qualifications and years of experience, including the main subcontracted elements if applicable (e.g. sub- consultants; drilling contractor; laboratory analysis).

1.2. BACKGROUND INFORMATION

This section should succinctly inform the reader what the report is about. It should provide the licensee/site name, its location with reference to a site map and the activity at the site. It should be mentioned that this is a preliminary site assessment including a detailed source audit and desk-based hydrogeological assessment.

Summarise all key background information relevant to the assessment. This should include a summary of previous site work or other information that has previously been provided for the site by the client. For example when the consultant was asked to provide a proposal for the work, the site may have shared some useful information or allowed a site visit to consider the proposed programme of works. The main existing site reports and information that are relevant to the study should be listed and may include RMP (Residual Management Plan), CRAMP (Closure, Restoration, Aftercare & Management Plan) and ELRA (Environmental Liabilities Risk Assessment) documents and groundwater monitoring reports.

1.3.

1.4. PROJECT OBJECTIVES

Clearly define the project objectives as established prior to this phase of work commencing.

2. SCOPE OF WORKS

2.1.

Clearly summarise the scope of works that was developed to meet the defined project objectives and summarise any deviations from the originally planned scope.

SOURCE AUDIT FINDINGS – PRODUCTION & OPERATIONAL HISTORY

CURRENT SITE OPERATIONS

This section on current site operations is expected to include information on:

- Hazardous and non-hazardous chemical deliveries, storage and use (may need a particular emphasis on certain chemicals such as select organic solvents). Will need to refer to annual inventory and throughput information for all the main chemicals located on-site (purchasing records, asset registers, etc.) so that the main ones can be identified;
- Hazardous waste generation, storage and disposal, including how it is transferred off- site;
- Understanding of how hazardous raw materials are transferred to production areas and around the site is key (e.g. manifold; underground pipelines) as well as how and where hazardous wastes (liquids or leachable solids) are separated, transferred and stored;
- Product and by-product information when this could be significant in the context of site land and groundwater;
- Infrastructure information in the form of site layouts, testing and monitoring data (for production, storage and transfer areas including drainage and in-ground and below- ground structures in particular);
- Information on the integrity of containment mechanisms, nature and condition

of site surfacing, location of drains, services and other potential conduits for migration, e.g.

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Licence Number

are structures and site surfacing cracked or damaged, are there signs of staining, chemical attack to surfaces, are drains in good condition?

- All emissions to land, groundwater or surface water. Emissions specifically to subsurface infrastructure such as drains and sumps. This must include information on effluent quality (chemical content);
- Mass balance information for key chemicals (i.e. use in product; emissions; waste; recovery);
- Record of reportable environmental incidents/complaints;
- Environmental Management System findings (main environmental aspects linked to land and water).

2.2. PREVIOUS SITE OPERATIONS

This must consider, in as much detail as is needed, the site operational history and changes to the operational footprint over time (from the start).

While this is harder to understand than current operations, it is typically more crucial (so proportionately more time may have to be spent on this element). Should address the above listed aspects (under current operations) but also needs to consider how the building and infrastructure footprint for all chemical/waste storage–transfer–use areas has changed over time (if at all). This should also be captured on one or more site plan figures.

Key information sources and needs are expected to include, but may not be limited to, the following:

- Anecdotal evidence – this can be a very useful component of the information gathering exercise. Staff to consider interviewing should include long servers or past employees, particularly from EHS, production and technical backgrounds. Employees should be encouraged to discuss previous practices, which may not have been acceptable by today's standards;
- Old site plans, plus old and recent aerial photographs;
- Former production records and information (linked to the main hazardous chemical use information);
- Chemical spill/leak history, accidents, incidents (this may be anecdotal pre-licensing);
- Previous hazardous raw material inventories – purchasing;
- Previous hazardous waste inventories and manifests (it is noted that previous handling and storage of hazardous wastes is particularly important to understand);
- An understanding of the integrity of the site drainage system, tanks, bunds and their development over time. Production area floor drains, sumps and oil/water separators can be the highest risk areas. Understand if there has been a history of damage, upgrade and/or repair to these; maintenance records may assist;
- Understanding of previous direct emissions to land, groundwater or surface water;
- Support services (boiler houses and heating; maintenance shops – in particular the storage and use of degreasing or cleaning chemicals; bulk fuel storage and transfer; bulk heat exchange and refrigeration units);
- Former peripheral areas of the site where ad hoc or temporary storage (disposal) may have taken place, particularly in the past.

2.3. CHEMICALS OF POTENTIAL CONCERN

This section must provide detail of all identified Chemicals/Contaminants of Potential

Licence Number

Concern (COPC) based on the understanding of current and historical use of hazardous chemical and related substances at the site.

A list of COPCs must be provided with a summary statement on why they have been selected from an operational or other point of view. This may be expected to include but not be limited to volumes stored and/or throughput, how they have been stored and transferred, the amount of hazardous waste and/or effluent associated with them, and their specific chemical toxicity and mobility in soil and groundwater systems.

It is also very important to provide justification for excluding chemicals from the COPC list, if this has been done, particularly if they have been used or stored in relatively large volumes.

3.

The best way to summarise these findings is in a table or series of tables.

3.1.

SITE ENVIRONMENTAL SETTING

GENERAL INTRODUCTION

This should describe the overall site setting as evidenced from local Ordnance Survey maps and information and based on a reconnaissance of the site and its surrounding area as part of the source audit site visit. Of particular importance are expected to be:

- A description of the site location and topographic setting of the site
- Local land use and potential off-site sources of contamination
- Presence of residential properties and communities
- Location of surface water features including service channels, land drains, outfalls; the direction of flow, quality and classification

3.2.

- Possible local groundwater (water) users (e.g. old houses; presence of header tanks).

REGIONAL GEOLOGY AND HYDROGEOLOGY

In general, it is expected that the regional geology and regional hydrogeology information will be presented in two separate subsections.

Key data sources that are expected to support this section are:

- Bedrock geology maps; in addition to the stratigraphy and lithologies present in the area, where relevant this section should include material on the geological structure and references to fracture/joint patterns and faulting
- Bedrock and sand/gravel aquifer maps
- Interim groundwater vulnerability maps (County maps becoming available)
- Subsoil and soil maps, including soil permeability maps
- Groundwater recharge maps
- Groundwater Body (GWB) maps and reports; water body maps and reports

[1] Hunter-Williams et al. (Presentation to the International Association of Hydrogeologists (Irish Group) Conference, Tullamore, 2009)

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- Article 5 Risk Assessments for GWBs (and other waters)
- Draft River Basin Management Plans (RBMP) (2008)
- Groundwater-dependent terrestrial ecosystems
- Groundwater monitoring network quality and water level database.

In addition, there are a number of widely available reports on the geology and hydrogeology of Ireland as well as relevant scientific literature from which useful material can be obtained.

The section on the hydrogeology should include, after delineation of groundwater bodies and aquifer/aquitard units, a description of the type of permeability of the principal formations of interest, the hydraulic conditions, water table conditions, general hydrochemistry and water quality if known and aquifer vulnerability in addition to the aspects mentioned in the list of maps. The order should be roughly as outlined so that the reader can be formulating an initial conceptual model in their mind.

Details of any high-yielding wells in the area and their likely source protection zones, whether delineated or not, should also be included.

Aspects of the hydrology of the site should be described on a regional basis, especially if the site is large. Details of rainfall, potential and actual evapotranspiration and effective rainfall and their typical variations throughout the year should be provided.

3.3. SITE GEOLOGY AND HYDROGEOLOGY

This section will be based on information gained during the site visit (recognising that in many cases no new intrusive investigations will be carried out as part of this preliminary site assessment). Information sources to gain a better understanding of site-specific geology and hydrogeology are expected to include:

- Reconnaissance of the site and the local area during the site visit (audit)
- Presence of bedrock outcrops in the vicinity of the site
- Presence of surface waters on or close to the site
- Site geotechnical investigation reports (can be held by engineering department)
- Site environmental due diligence reports if the site has changed ownership in the past (site management or EHS department may have these)
- Other site investigation or monitoring reports for whatever purpose
- Well records and borehole logs for on-site abstraction well(s).

Other information sources that could be consulted include historic 6" Ordnance Survey maps, the original Geological Survey manuscript field slips (6" scale), the Teagasc series of County Maps, material in local authority files (e.g. EISs) and relevant scientific literature.

Information may include detailed descriptions of the geology encountered, including GWB units if penetrated, soil and aquifer property information (e.g. grain size, organic carbon content, hydraulic, permeability or well test data) and groundwater flow direction.

3.4. SUMMARY OF PREVIOUS SITE SAMPLING AND MONITORING DATA

There may be site investigation and/or monitoring data (for groundwater and soil) that may give clues to past issues or impacts. These are the same reports as indicated above in Section 3.3. There may also be groundwater quality data for on-site abstraction wells. The purpose of looking at this data and information, if it exists, is to try to focus the COPC list by scrutinising actual monitoring data. However, it will be important to judge openly the quality and relevance of such data to avoid misuse or over-interpretation. A clear statement must be made with respect to all such reports and data sources.

Some of the main information that may help to refine the COPC list (if it is suitably sourced and robust) would be expected to include:

- Soil quality data close to potential source areas (and the site generally)

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- Shallow or perched groundwater data close to potential source areas (and the site generally)
- Soil vapour data close to potential VOC source areas (and for the site generally)
- Deeper groundwater quality data close to or down-gradient of key areas (up-gradient also useful if site is within a non-greenfield area)
- Abstraction well water quality data, recognising the level of dilution of shallow contamination that this may entail (need to understand abstraction regime, well depth, etc.).

If there is good monitoring (chemical) data for key source areas or the COPCs already identified for the site then this should allow some level of refinement of the shortlist of COPCs. This may include justification for removal of some of the previously identified COPCs and/or the addition of other COPCs to the list due to their identified presence in soil and/or groundwater at the site. If COPCs are to be added due to their reported presence in soil and/or groundwater then it will be necessary to revisit the source audit process to enquire as to their potential use on-site (why they are there – could they relate to off-site sources, etc.?).

4. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

4.1. SUMMARY AND CONCLUSIONS

This section must bring together all the above findings in a concise and clear way so that the reader is able to understand where all the main potential source areas of soil and/or groundwater contamination are located on the site and what the environmental site setting and sensitivities are. Annotated, scaled, site plans should be used to present key source areas, with local area plans used as needed to provide sufficient specific detail. If there are a lot of COPCs then a number of such plans can be expected to be needed. Core figures may be expected to include:

- Site Plan showing all the main current chemical and waste storage areas, fixed transfer routes and production (use) areas, and the production effluent drainage network
- Site Plan showing all the main former chemical storage areas, fixed transfer routes and production (use) areas, if these were different
- Site plan(s) showing by COPC or COPC group the main areas of potential concern
- A more regional plan showing a summary of the main environmental setting and sensitivity information for the site area.

In most cases it will be expected that a preliminary Conceptual Site Model (CSM) will be presented, including text but also in diagrammatic form. The latter may be two-dimensional (potentially requiring plan and cross-sectional views) or three-dimensional.

4.2. RECOMMENDED WAY FORWARD

At this stage (Preliminary Site Assessment) it may be expected that this will be the first CSM generated for the site, but if this is not the case then the changes to the previous version and the basis for these must be summarised here.

This section must include a summary of what are considered to be the main data gaps that may limit understanding, and the recommended way these are to be addressed.

The final element of the section must provide some detail on the scope of proposed intrusive investigations that are expected to be necessary to understand the potential chemical character, magnitude and extent of soil- and groundwater-related contamination at the site.

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An outline of the following should be included:

- A figure showing provisional investigation locations
- An outline of the samples that may be collected and the tests that might be conducted on them
- An outline of in-situ tests that may be completed to assess site hydrogeology.

5. REFERENCES

A list of references and sources of information used in the report should be included in this section.

Respectfully submitted

On behalf of **Consultant Name**

Sign Here

(Project Manager/Project Director/Lead Consultant

1.2.6.4 Learning Activities

prepare a site preliminary report on the activities carried out when visiting the construction site concerning:

- site clearing
- site screening
- surveying
- demolition
- site layout plan
-

1.2.6.5 Self-Assessment

1. What are preliminary expenses in construction?
2. How do you write preliminaries?
3. What is Project Preliminary Report?

1.2.6.6 **Tools, Equipment, Supplies and Materials**

Tools and equipment

- measuring and drawing tools
- clearing plants and equipment
- computers/internet
- Masonry/building tools and equipment
- surveying tools and equipment /instrument
- Soil testing instruments/equipment

Materials and supplies

- Site survey maps
- Hoarding materials
- Demolition material
- Building Codes / regulations
- Sand
- Ballast
- Cement
- Damp proofing materials
- Anti-termite
- Reinforcement/reinforcing bar
- Dewatering equipment

Personal protective equipment (PPEs)

- dust coat
- First aid kits
- Overalls
- Gum boots
- Safety goggles
- Helmets
- Gloves

1.2.6.7 References

1. S. M. Vera, *Diff. Between Arch., Civil Eng And Bldg Eng World Wide*, (2013)
2. R. A. Jimoh and S. M. Adama, *Assessment of prelim. in relation to the total cost of renovation* work in public schools in Abuja , Nigeria, in ICEC IX World Congress Assessment, 1–9, (2011)

3. A. A. Abas, Z. Ismail, F. Ismail, and R. A. Arshad, Bills of Prelim. Pricing Trends for Malaysian Civil Infra. Works in Conventional Contract, (2017)
4. H. Adnan and A. Nawawi, Bills of Quantities: Perspectives of Contractor in Malaysia., J. Appl.…, 5, 863–873, (2011)

Responses

1. What are preliminary expenses in construction?

   Prelims are the cost of the site-specific overheads of any given project. They are the costs that are directly related to the running of the project that are not accounted for under labour or material. This may include such things as; Some personnel costs are also usually included under prelims.

2. How do you write preliminaries?
   - Choose your topic. If topic is assigned, stick to the topic! ...
   - Gather general information and **preliminary** resources. Work from the general to specific. ...
   - Develop a preliminary outline. ...
   - Collect specific resources. ...
   - Gather relevant information (taking notes) ...
   - Develop a final outline. ...
   - Prepare a rough draft. ...
   - Revise your rough draft.

3. **What is Project Preliminary Report?**

   Problem/need: A clear description of the problem or need the **project** aims to handle.

   Proposed solution: a brief description of how to address the problem/need.

   Work effort: An analysis summary of work relevant to the **project**.

   Status: current state of **project** work, including activities completed and unfinished.