Ethiopian TVET-System

Irrigation & Drainage Construction

Level II

Based on, March 2017G.C. Occupational Standard

Module Title: Preparing and Restoring Work Site

TTLM Code: EIS IDC2 TTLM 0920v2

This module includes the following Learning Guides

LG79: Plan and Prepare for work

LG Code: EIS IDC2 M19 0920 LO1-79

LG80: Prepare work site.

LG Code: EIS IDC2 M19 0920 LO2-80

LG81: Restore work site

LG Code: EIS IDC2 M19 0920 LO3-81

LG82: Review, record and report activities

LG Code: EIS IDC2 M19 0920 LO4-82

Instruction sheet	Learning guide – 79: Plan and Prepare for work

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

- Selecting and checking work site equipment, tools and materials
- Identifying personal protective equipment
- Understanding site preparation requirement
- Identifying and reporting potential risks
- Identifying risks and preventing damage to other utilities
- Performing site check using legislative and organizational requirement

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

- Select and check work site equipment, tools and materials as appropriate to meet task and safety specifications.
- Select, fit and use personal protective equipment
- Determine site preparation requirements from specifications, instructions and pre-work inspections.
- Identify and report Potential risks to public and environment.
- Performa site check according to legislative and organizational requirements to identify risks and prevent damage to other utilities.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6” in page 4, 12, 18, 25, 30 and 34 respectively.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3, Self-check 4 and Self- check 5” -” in page 11, 17, 24, 29, 33 and 36 respectively
5. If you accomplish the self-checks, do operation sheet in page 37 and 39
6. LAP Test in page 40

Information Sheet-1	Selecting work site equipment, tools and materials

1. 1. Introduction to Work site Equipment, Tools and Materials

Proper tools and equipment are essential for the effective operation of any civil works site. Equipping the construction site with the correct tools and equipment plays an essential role in achieving timely and good quality results. For every construction activity there is an optimal combination of tools, equipment and labour. Depending on the nature and Content of the works, the technical staff needs to know which tools to use and how to effectively combine them with manual labour.

Once on site, equipment requires trained operators and supervisory staff who are proficient in its operation and maintenance. Faulty equipment is a common reason for delays on construction sites. A major responsibility of the project management is to ensure that tools and equipment are maintained in a good condition and are readily available when required for the various work activities.

When applying labour-based work methods, the use of hand tools supported with selected items of light equipment can produce results comparable with those achieved when using only heavy equipment. For every construction activity there is an optimum combination of equipment and labour. In order to utilize the equipment and labour in the most effective way, the use of equipment needs to be carefully coordinated with the output of the work gangs.

The following are some equipments, tools and materials utilized in excavating, constructing and restoring construction work sites.

1.2. Hand tools

These are generally used for smaller depths of excavations in small areas. Man power is required to operate these tools. The tools come under this category are explained below.

Spade: Spade is a tool which consists metal plate having sharp edges; the plate is attached to long handle which is generally made up of wood. Because of its sharp edges the soil can be dig easily. The metal plate having less curvature in the spade so, we cannot lift the soil by spade.

Figure 1: Spade

Shovel: Shovel is tool which is used for the purpose of lifting of excavated soil. It is also similar to spade the difference between spade and shovel is the difference in leading edge. The curvature of metal plate of shovel is generally higher when compared to spade so we can hold the soil easily and lifted it. Shovel can also be used for digging purpose in case of soft soils, sand etc.

Figure 2: Shovel

Hoe: Hoe is an excavating tool which consists of a metal plate attached to a long handle with acute angle. The plate having sharp edge is used to excavate the soil. For small work of excavation, it is widely preferred tool. Sometimes metal plate is replaced by fork type plate.

Figure 3: hoe

Trowel: Trowel is hand sized tool which is generally used to dig the small trenches in soil or to remove the shallow roots in soil.

Rake: Rake is a tool which is having a horizontal rod having metal teeth and is used to remove the small layers of soil.

Figure 4: Rake

Pick axe: Pick axe consists hard spike attached perpendicular to handle. They are used for excavating small trenches in soil. Pick axe can cut the soil even if the soil is of hard type. The metal spike is pointed on one side and wide blade is provided on the other side.

Figure 5: Pick axe

Mattock: This looks like pickaxe. But serious digging is not possible with mattock. Generally, it is used as lifting tool because of its curve shapes metal at its bottom.

Figure 6: Mattock

1.3. Mechanical equipment

Excavator: An excavator is a piece of heavy construction equipment commonly used in the excavation of soils (basements, footings, trenches, pits, etc.), demolition, and material handling. Excavators may be track or wheel mounted and generally consist of an undercarriage, a housing, a cab, a two-part articulated arm (boom and stick), and a bucket.

Figure7: Excavator

Dozer: A dozer is a tractor-like piece of construction equipment equipped with a front-mounted blade. Dozers may be wheel mounted but are most often track mounted and commonly used in clearing and leveling of a job site and in pushing/spreading large quantities of materials.

Figure:9 Dozer

Grader: A grader is a wheeled piece of equipment with a center-mounted angled blade. Graders are primarily used to finish level grade.

Figure 10: Grader

Loader: Loaders may be wheel or tracks mounted and have a wide front-mounted bucket that can be raised, lowered, and dumped. Although able to excavate loose materials, loaders are more commonly used for landscaping, material handling, and loading of stockpiled materials into trucks to be hauled. There are three common classifications of loaders: skid steer loaders, wheel loaders, and track loaders. Because of their smaller size, versatile use (some with interchangeable bucket attachments), and greater affordability, skid steer loaders are the most widely used type of loader.

Figure 11: loader

1.4. Materials used in site restoration

Site restoration is work carried out on a capped, authorized landfill site (or part of it) to restore the area to an alternative use. The use of any material for site restoration work is to be treated as a taxable disposal. Vegetation, gardening supplies and plants are used for restoring construction work sites.

Top-soil to include manufactured top-soil containing organic material where it is required to complete the site restoration as specified in the environmental permit or planning permission to support the planting of grass, plants, shrubs or trees.

Self-Check -1	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. A tools used for the purpose of lifting excavation

   A. Grader
   B. Pick axe
   C. Shovel
   D. Loader

2. Equipment used to finish level grade

   A. Excavator
   B. Loader
   C. Grader
   D. shovel

3. Construction equipment used in excavation of soils, demolition and material handling

   A. Spade
   B. Excavator
   C. Loader
   D. grader

Note: **Satisfactory rating - 4 points and above Unsatisfactory - below 4 points**

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

Answer Sheet-1

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice answer questions

1. ----------
2. ----------
3. ----------

Information Sheet- 2	Identifying personal protective equipment

2.1. Personal protective equipment

Personal protective equipment is an important defense against certain types of injury. Injuries from falling and flying objects, for instance, can be reduced by wearing hard hats and eye protection. Everyone on a construction project must wear PPE.

It is mandatory for everyone on a construction project to wear head protection in the form of a hard hat that complies with the current Construction Regulation. Eye protection is strongly recommended to prevent injuries from construction operations such as chipping and drilling and site conditions such as dust. Personnel exposed for long periods to noisy equipment should wear hearing protection. Work in confined spaces such as manholes and valve chambers may require respiratory protection against hazardous atmospheres. Before any PPE is used it should be inspected to ensure:

- A good fit on the user
- Is being used correctly
- Is appropriate and effective to protect the wearer from the hazards it is intended to control
- Does not introduce any new hazards for the task to be performed

The following are types of PPE requires in construction works.

Body & Skin Protection shall be worn when there is remaining risks in the environment. Overall protects the normal clothes from dust, grease and other spilling materials. Types of body and skin protection include:

- Protective Clothing
- Sunscreen & insect repellent
- High visibility vests working at or near roadways or near moving traffic or moving plant
- Laboratory coats, heat resistant clothing, waterproof jackets.

Head protection shall be worn whenever there is a danger of falling objects, projectile objects or impacts to the head, people striking their heads on objects in the environment or require protection from UV rays. Types of head protection include:

- safety helmets & caps

- hats and hoods

Figure 12: Helmet

Ear protection: It protects the carrier from damages of the ears. Continuously working in a very noisy Environment harms the eardrums forever. Once the eardrums are damaged there is no Way of restoring the sense of hearing again. Types of hearing protection includes:

- Ear plugs
- Ear muffs
- Ear caps

Figure13: Ear protection tools

Hand Protection: shall be worn to protect the operator from contact with hazardous substances. Types of hand protection include:

- Special gloves - wrist or elbow length
- Cotton, rubber
- PVC & leather
- Stainless steel mesh

Foot protection: shall be worn wear there is a risk of objects dropping onto feet, or slip hazards present. Types of foot protection include:

- Steel capped boots
- Non slip shoes
- Waterproof boots

Figure14: Safety boots

Respiratory protection: shall be used when exposure to the work atmosphere may be injurious to health. Used during working in confined space such as manhole and valve chamber. Types of respiratory protection include:

- Face masks
- Half face respirators
- Air filter units
- Self-contained breathing apparatus

Figure 15: Respiratory protection tools

Fall Protection shall be used where a risk of falling is present. Types of fall protection include:

- Helmets

- Belts & harnesses
- Lanyards & pole straps

Figure 16: Safety belt

Overall: -Protects the normal clothes from dust, grease and other spilling materials

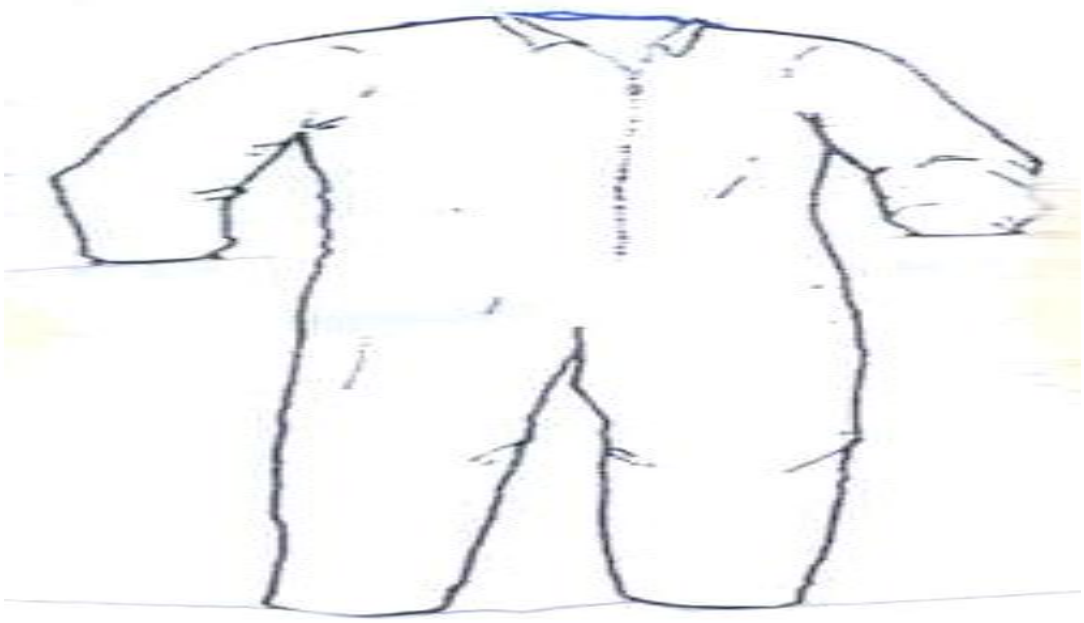


Figure 17: Overall clothes

Glove:-Protects the workers from oils, chemicals, and dust and other dangerous material that affect the skin.

Figure 18: Glove

Goggle: - Protects eyes of the workers during welding of metal works and when placing reinforcement in the form work.

Figure 19: Google

Self-Check -2	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. What type of breathing protection do you use in a space with little oxygen?
   A. disposable mask provided it is a good fit for your face
   B. Self-contained breathing apparatus
   C. A filter mask with the correct filter cartridge
   D. Half face respiratory
2. Before using an item of PPE, you should:
   A. Check the item for signs of wear and tear
   B. Check that the item fits correctly
   C. Ensure you have received training on how to use the item correctly
   D. All of the above
3. Shall be worn whenever there is a danger of falling objects
   A. Helmet C. Glove
   B. Goggle D. Safety boot
4. What is an example of safe behavior at the workplace?
   A. Speaking to others about unsafe actions
   B. Always wearing hearing protection
   C. Never using hazardous substances
   D. All

5. Eye protection should be:
   A. Durable C. Kept in good repair.
   B. Not interfere with vision. D. All of the above

Note: **Satisfactory rating - 5 points and above Unsatisfactory - below 5 points**

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

Score = _____

Rating: _____

Answer Sheet-2

Name: _____ Date: _____

Multiple choice answer questions

1. ---------- 3. ---------- 5. ----------
2. ---------- 4. ----------

Information Sheet- 3	Understanding site preparation requirement

3.1 Site preparation

Site preparation involves the demolition or wrecking of buildings and other structures, clearing of building sites and sale of materials from demolished structures. Site preparation also entails blasting, test drilling, landfill, leveling, earth-moving, excavating, land drainage and other land preparation. Site clearing is the process of clearing away the vegetation and surface soil of the construction site. There are several steps involved in a successful site clearing. Site preparation requirement determine from

- Specification
- Work instruction
- Pre-work inspection

Generally, construction site preparation may include the following activities.

- Reading plans
- locating public utilities
- Setting out site
- Battering, shoring, scaffolding
- Excavating, directing traffic and the public

3.1.1 Reading plans

Technical drawings are used to visualize just about anything that is manufactured, built or assembled. From idea to drawing to factory, mill or construction firm, a technical drawing describes shape, dimensions, materials, construction and overall look of the object being created. With a few tips and some insight about terms and meaning, anyone can visualize the final product from looking at a technical drawing

3.1.2 Locating public utilities

Services such as gas, electrical, telephone, and water lines must be located by the utility before excavation begins. Request locates for all the underground utilities in the area where excavation will be taking place. The contractor responsible for the work must contact the owners of any underground utilities that may be in that location or phone.

The service locates provided by the utility owner should indicate, using labeled stakes, flags, and/or paint marks, the centre line of the underground utility in the vicinity of the proposed excavation. The excavator should not work outside of the area covered by the locate stakeout

information without obtaining an additional stakeout. Locate stakeout accuracy should be considered to be 1 meter on either side of the surface centre line locate unless the locate instructions specifically indicate other boundary limits. Where the underground utility cannot be located within the locate stakeout limits, the utility owner should be contacted to assist with the locate area.

Mechanical excavation equipment should not be used within the boundary limits of the locate without first digging a hole or holes using the procedure below to determine the underground utility's exact center line and elevation.

Test holes should, in general, be excavated by one of the following methods:

(a) machine excavation immediately outside the boundary limits and then hand digging laterally until the underground utility is found; or

(b)

I. hand excavation perpendicular to the centre line of the locate in cuts of at least 1 foot in depth;
II. Mechanical equipment can then be used carefully to widen the hand-dug trench to within one foot of the depth of the hand-dug excavation;
III. Repeat steps (I) and (II) until the utility is located; or

(c**)** A hydro-excavation system — acceptable to the owner of the utility — which uses high-pressure water to break up the cover material and a vacuum system to remove it can be used to locate the underground utility. See the next section for more information about hydro excavation. Centre line locates should be provided and test holes dug where a representative of the utility identifies

- ✓ Alignment changes
- ✓ Changes in elevation.

Where an underground utility may need support or where it may shift because of disturbance of surrounding soil due to excavation, guidelines for excavation and support should be obtained from the owner of the utility.

3.1.3. Cave- in protection technique

Protective system is a method of protecting employees from cave-ins from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems,

- battering
- shoring
- scaffolding
- sloping and benching systems,
- shield systems, and
- other systems that provide the necessary protection

A. Battering

One fairly simple way of controlling the risk of ground collapse is to bench or batter the excavation walls. An excavated slope is safe when the ground is stable. That is, the slope does not flatten when left for a considerable period, there is no movement of material down the slope and the toe of the slope remains in the same place.

If excavation work is planned to be carried out without positive ground support (that is, shoring), the continuing safety of the excavation will depend on the conditions arising during construction. If the conditions during construction are not as expected, or if conditions change during the course of the work (for example different soils, heavy rain/flooding) action should be taken immediately to protect workers, other persons and property.

Implement appropriate control measures such as temporarily suspending work until the ground is stable or, if necessary, providing positive ground support. Battering means to form the face or side or wall of an excavation to an angle, usually less than the natural angle of repose, to prevent earth slip page. Battering is where the wall of an excavation is sloped back to a predetermined angle to ensure stability (see Figure). Battering prevents ground collapse by cutting the excavated face back to a safe slope. Battering should commence from the bottom of the excavation and in some circumstances, it may be appropriate to use a combination of the two methods on an excavation. Battering of excavation walls can minimize the risk of soil or rock slipping onto the excavation.

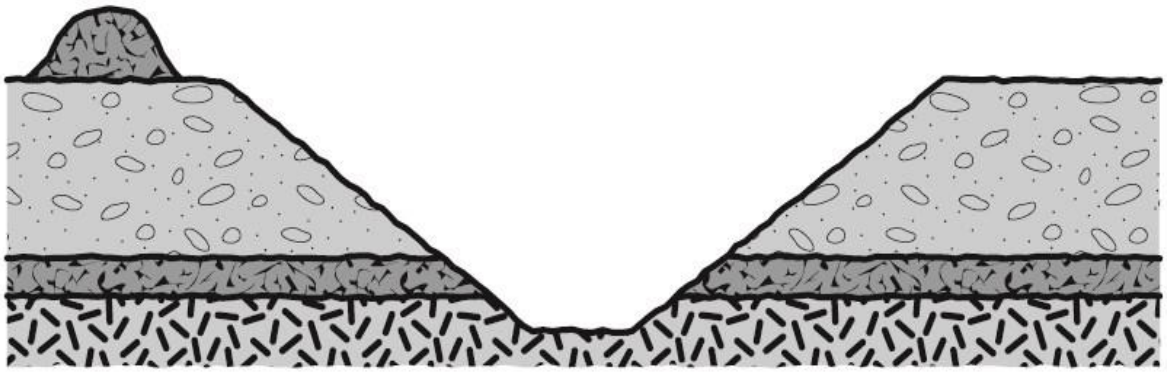


Figure 20: Battering

B. Shoring

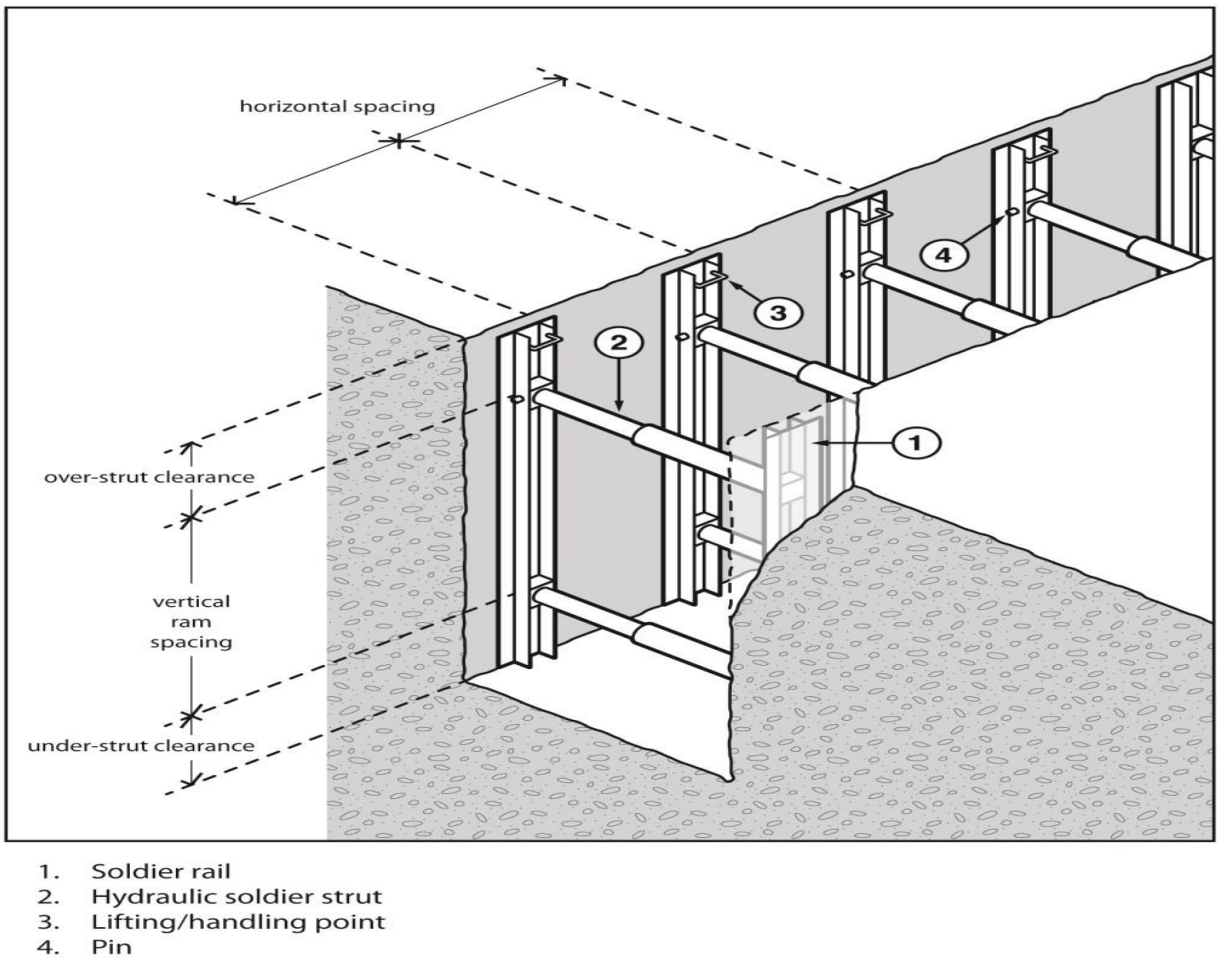
Shoring is a positive ground support system that can be used when the location or depth of an excavation makes battering and/or benching impracticable. It should always be designed for the specific workplace conditions by a competent person (for example an engineer). Shoring is the provision of support for excavated face(s) to prevent the movement of soil and therefore ground collapse. It is a common method of ground support in trench excavation where unstable ground conditions, such as soft ground or ground liable to be wet during excavation such as sand, silt or soft moist clay are often encountered.

Where ground is not self-supporting and benching or battering are not practical or effective control measures, shoring should be used. Shoring should also be used when there is a risk of a person being buried, struck or trapped by dislodged or falling material which forms the side of, or is adjacent to, the excavation work. Where such a risk also exists for those installing shoring, other appropriate control measures must be in place to ensure the health and safety of persons entering the excavation. Shoring the face of an excavation should progress as the excavation work progresses. Where earthmoving machinery is used risk assessment should be used to determine whether any part of the trench may be left unsupported.

The basic types of shoring are hydraulically operated metal shoring and timber shoring. The most common shoring used consists of hydraulic jacks and steel struts, walls and sheeting. Sometimes aluminum or timber components are used. The use of metal shoring has largely replaced timber shoring because of its ability to ensure even distribution of pressure along a trench line and it is easily adapted to various depths and trench widths. Some of the common types of shoring are:

- hydraulic systems

- steel sheet piling
- steel trench sheeting
- timber systems (e.g. soldier sets)
- precast concrete panels, and
- Ground anchors.



1. Soldier rail
2. Hydraulic soldier strut
3. Lifting/handling point
4. Pin

Figure 21: Shoring

C. Scaffolding: -is a temporary structure on the outside of a building, made of wooden planks and metal poles, used while building, repairing, or cleaning the materials used in such a structure.

3.1.4 Directing Traffic control

On trenching projects along public roadways, the construction crew must be protected from traffic. Regulations specify the following methods for protecting personnel:

- traffic control persons (TCPs) using signs

- warning signs
- Barriers
- Lane control devices
- flashing lights or flare

Self-Check -3	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page

1. The major activities perform during site preparation (2 point)
   A. Interpret plan
   B. Setting out
   C. Locating public utility
   D. All

2. Which of the following do not cause cave-ins? (2 point)
   A. Weather
   B. Shoring and Sloping
   C. Weight
   D. Vibration

3. Site preparation requirement determine from (2 point)
   A. Specification
   B. Work instruction
   C. Pre-work inspection
   D. All

4. Prevents ground collapse by cutting the excavated face back to a safe slope (2 point)
   A. Battering
   B. Shoring
   C. Shield
   D. Scaffolding

Note: **Satisfactory rating - 4 points and above Unsatisfactory - below 4 points**

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

Answer Sheet-3

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice answer questions

1. ----------
2. ----------
3. ----------
4. ----------

Information Sheet-4	Identifying and reporting potential risks

4.1. Potential risk

Most people have a good notion about how the terms risk, uncertainty and opportunity are related in their daily life. However, most people would have a problem when it comes to state a definition that clarify its whole content. It becomes clear that it exists a wide range of definitions when studying engineering and finance-based publications. In this section some of the most often used definitions will be presented and an explanation why it will become important to know about the existing differences will be given.

Risk is an event that occurs with a certain probability in combination with a consequence in the case of occurrence. Risk can in a simplistic approach be defined as:

Risk = probability of risk occurring x impact of risk occurring

Construction work is dangerous; and work involving trenching and excavating activities tends to be the most hazardous in the industry. Yet, we see trenching and excavating work going on all around us. Excavations are needed for the installation and repair of utility lines, replacement of water and sewer lines, swimming pool construction, even grave digging.

Excavation projects vary considerably, each with its own set of unique problems. Many who work in construction will tell you that accidents should be expected. Only informed and fully trained workers can recognize dangerous situations and therefore protect themselves. The top ten risks and hazards from working on construction sites are:

- Working at height.
- Moving objects.
- Slips, trips, and falls.
- Noise.
- Hand arm vibration syndrome.
- Material and manual handling.
- Collapsing trenches.
- Asbestos.

Falls are the leading cause of death in construction. Construction workers often work from great heights, such as the tops of buildings, tall scaffoldings, and ladders. Other potential hazards are numerous and can include: Collapsing trenches

.

4.2. Risk classification

Several studies have been made in order to identify various risk categories to enable a design of an effective risk classification system for construction projects. Today, a number of allocation approaches exist, separating risks into categories. Some literature gives the recommendation to allocate the risks based on its consequences on a project, while others suggest a categorization based on the risk source. Furthermore, a risk allocation approach based on the level of knowledge can be performed by using the following four categories.

- **Known knows**, is the condition of a risk where its source can be identified and a specific probability and consequence in the case of occurrence can be calculated.
- **Known unknowns**, is the condition of uncertainty where the risk source can be identified but the probability will remain unknown.
- **Unknown known**, is the condition of an uncertainty where someone has knowledge of both the risk source and its estimated probability but the information will be unknown for most concerned parties.
- **Unknown unknowns**, is the condition of uncertainty where the risk source cannot be identified, therefore there is no possibilities to calculate its probability or consequence.

4.3 The importance of risk identification

The primary aim with the risk identification process is to generate a list of risks with both negative and positive consequences, which is called risk register. The risk register should be as comprehensive as possible and include risks whether or not its consequences are under control of the organization. Claim that if a risk is not identified it cannot be controlled, transferred or in any other aspects managed. Projects within the construction industry are unique projects, which results in a demand of an individual identification phase for each project.

4.4. Risk analysis/quantification

The overall purpose with the risk analysis is to quantify the effects of the identified risks. The risk analysis techniques can be separated into three categories:

- qualitative,
- semi quantitative and

- Quantitative methods.

At the most fundamental level, each recorded risk should be analyzed and quantified independently from the other identified risks with regards to both its consequence and probability. In a more detailed analysis, decision makers should consider the interdependences of the present risks.

4.5Potential Hazards

There are many potential hazards when working in excavations and trenches. Probably the most common hazard at any work site is the threat of *cave-in*. A cave-in occurs when walls of an excavation collapse.

4.5.1Causes of Cave-Ins

Soil properties often vary widely from the top to the bottom and along the length of a trench. The main factors affecting trench stability are soil type, moisture, vibration, surcharge (excessive load), previous excavation, existing foundations, and weather.

Cave-ins can be deadly. Wall failures often occur suddenly, with little or no time for the worker to react. The weight of the soil crushes and twists the body, causing death or serious injury in a matter of minutes. Excavations need not be deep or large to create a life-threatening hazard, so every excavation must be taken seriously.

Why do cave-ins occur? Undisturbed soil is kept in place by natural horizontal and vertical forces of the nearby soil. When we dig in the earth, these natural forces are no longer able to hold back the soil left behind. With no support, eventually the laws of gravity take over, and the soil from the excavation walls move downward and inward into the excavation. The result is a cave-in. Cave-ins are more likely to occur in unprotected excavations where The excavation is dug in unstable soil, or in soil that has been dug in before;

- There is excessive vibration from construction equipment or vehicle traffic around the excavation ;
- Too much weight near the sides of an excavation, most frequently from equipment or the excavated material (spoil pile) too near to the edge;
- Water has collected in the excavation;
- Changes in weather conditions (freezing, melting, sudden heavy rain, etc.)

4.5.2 Confined spaces

A confined space is defined as a place

- that is partially or fully enclosed
- that is not both designed and constructed for continuous human occupancy, and
- Where atmospheric hazards may occur because of its construction, location, or contents, or because of work that is done in it.

All three criteria have to be met before a space is defined as a confined space.

In the sewer and waterman industry, confined spaces can be locations such as excavations, manholes, valve chambers, pump stations, and catch basins. The atmosphere in these spaces may be

- toxic
- oxygen-deficient
- oxygen-enriched
- Explosive.

Self-Check -4	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Who should you notify right away about an accident?
   A. The immediate supervisor
   B. The government's Health and Safety Inspection Service
   C. The medical department
   D. All
2. What is the objective of a task risk analysis?
   A. To control the risks associated with the work
   B. To prepare for the proper execution of the work
   C. To eliminate all risks
   D. To generate risk
3. Confined space may occurs in
   A. Manhole
   B. Catch basin
   C. Valve chamber
   D. all
4. The main factors affecting trench stability are
   A. soil type, moisture,
   B. Vibration
   C. surcharge (excessive load)
   D. all

Note: **Satisfactory rating - 4 points and above Unsatisfactory - below 4 points**

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

Answer Sheet-4

Score = _____

Name: _____ Date: _____ Rating: _____

Multiple choice questions

1. ----------
2. ----------
3. ----------
4. ----------

Information Sheet-5	Identifying risks and preventing damage to other utilities

5.1. Identify risks and prevent damage to utilities

Damage to underground utilities from excavation and trenching activities is more common than is generally believed. Many construction projects require some degree of excavation or trenching and it is critical that all efforts are made to prevent damage to these utilities.

Underground utilities can include, but are not limited to the following: communication lines, power lines, natural gas pipes, sewers and water pipes and alarm systems. Each type of underground utility presents its own hazards and protection problem. There is a significant injury exposure to workers from explosion, fire, asphyxiation, electrocution as well as potential large losses in the form of damaged equipment and business interruption.

There should be a written procedure for conducting utility locates. The procedure should include written documentation that the utility locate has been completed. Simply receiving verbal confirmation is not sufficient. Documentation confirming all necessary precautions have been taken is very important in the event a utility is damaged. Whenever excavation or trenching is performed, or heavy equipment is moved, the necessary precautions must be taken to identify utilities and minimize the potential for damage. An emergency plan should also be established in the event damage occurs.

Damage to underground services during excavation work causing electrocution, explosion, gas escape, flooding etc. Ingress of water causing flooding. Utility location marks are good while visible but only for 30 days. This means that as long as the marks are protected and not destroyed, you may dig for 30 days with your original marks. Communicate with respected body before you dig near those utilities like:

- Electric: Minimum of 18 inches, 36 preferred.
- Gas: No standard depth; 24 inches average, 36 preferred.
- Sewage: 24 to 36 inches in most parts of the country.
- Water: 36 inches is national standard; can be any depth if not subject to freeze.

There are many potential hazards when working in excavations and trenches. Probably the most common hazard at any work site is the threat of cave-in. A cave-in occurs when

walls of an excavation collapse. Cave-ins can be deadly. To prevent damage to utilities during excavation, follow these general trenching and excavation rules.

- Keep heavy equipment away from trench edges.
- Keep surcharge loads at least 2 feet (0.6 meters) from trench edges.
- Know where underground utilities are located.
- Test for low oxygen, hazardous fumes and toxic gases.
- Inspect trenches at the start of each shift.

5.2. Ways to Identify Risks

There are numerous ways to identify risks. Project managers may want to use a combination of these techniques. For example, the project team may review a checklist in one of their weekly meetings and review assumptions in a subsequent meeting. Here are seven of my favorite risk identification techniques:

- Interviews: Select key stakeholders. Plan the interviews. Define specific questions. Document the results of the interview.
- Brainstorming: Plan your brainstorming questions in advance. Here are questions I like to use:
  - ✓ Project objectives
  - ✓ Project tasks
- Checklists: See if your company has a list of the most common risks. If not, you may want to create such a list. After each project, conduct a post review where you capture the most significant risks. This list may be used for subsequent projects. Warning – checklists are great, but no checklist contains all the risks.
- Assumption Analysis: The Project Management Body of Knowledge (PMBOK) defines an assumption as “factors that are considered to be true, real, or certain without proof or demonstration.” Assumptions are sources of risks. Project managers should ask stakeholders, “What assumptions do you have concerning this project?” Document these assumptions and associated risks.
- Cause and Effect Diagrams: Cause and Effect diagrams are powerful. Project managers can use this simple method to help identify causes–facts that give rise to risks. If we address the causes, we can reduce or eliminate the risks.
- Nominal Group Technique (NGT): Many project managers are not familiar with the NGT technique. It is brainstorming on steroids. Input is collected and prioritized. The output of NGT is a prioritized list of risks.

- Affinity Diagram. This technique is a fun, creative, and beneficial exercise. Participants are asked to brainstorm risks. I ask participants to write each risk on a sticky note. Then participants sort the risks into groups or categories. Each group is given a title.

Self-Check -5	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Underground utility damage due to excavation, cause
   A. Flooding
   B. Gas scape
   C. Explosion
   D. All

2. One of the following is not underground utility
   A. Telephone line
   B. PVC pipe
   C. Sewer and water pipe
   D. Natural gas pipe

3. One of the following is ways of risk identification
   A. Interview
   B. Checklist
   C. Cause and effect diagram
   D. all

Note: **Satisfactory rating - 3 points and above** **Unsatisfactory - below 3 points**

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

Answer Sheet-5

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice questions

1. ----------
2. ----------
3. ----------

Information Sheet-6	Performing site check using legislative and organizational requirements

6.1. Legislative and organizational requirements

All people and organizations are required to comply with relevant legislation to which they are subjected. So, any construction excavation should be done according to the legislatives of organizational requirements.

Legislative and organizational requirement in construction site include:

- Organizational policies
- Standard operating procedures
- Water legislation and regulations
- Environmental protection
- OHS procedures
- Road signage
- Dangerous goods
- Codes of practice, associated standards and guidance material
- Relevant community planning and development agreements, such as land care agreements

I. **Organizational policies:** Company policies and procedures establish the rules of conduct within an organization, outlining the responsibilities of both employees and employers. Company policies and procedures are in place to protect the rights of workers as well as the business interests of employers.

II. **Standard operating procedures:** A standard operating procedure (SOP) is a set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations. SOPs aim to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

III. **Water legislation and regulations:** One example is the Clean Water Acts primary objective is to restore and maintain the integrity of the nation's waters. The objective translates into two fundamental national goals: to eliminate the discharge

of pollutants into the nation's waters, and to achieve water quality levels that are fishable and swimmable.

IV. **Environmental protection:** The Environment Protection Act 1997 (the Act) protects the environment from pollution and its effects. The Act provides the regulatory framework to help reduce and eliminate the discharge of pollutants into the air, land and water. The Act provides for "the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing".

V. **OHS procedures:** OHS Policies and Procedures are a major part of protecting the safety, health and welfare of people engaged in work or employment. Having a clear set of OHS Policies and Procedures will make it clear to all concerned where the guidelines and boundaries are in relation to the operation of the business.

Employees have the following three basic rights:

- Right to refuse unsafe work.
- Right to participate in the workplace health and safety activities through the Health and
- Safety Committee (HSC) or as a worker health and safety representative.

VI. Road signage: Traffic signs or road signs are signs erected at the side of or above roads to give instructions or provide information to road users.

The main signs are categorized into four meaning types:

- Guidance (white characters on blue in general – on green in expressways),
- Warning (black characters and symbols on yellow diamond),
- Regulation (red or blue circle, depending on prohibition or regulation),

VII. Dangerous goods: are substances or articles that pose a risk to people, property or the environment, due to their chemical or physical properties. They are usually classified with reference to their immediate risk. This is different from the definition of a hazardous substance which is defined in terms of the.

Self-Check -6	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. It is major part of protecting the safety, health and welfare of people engaged in work or employment
   A. Road signage
   B. OHS procedures
   C. Environmental protection
   D. Organizational policies
2. It is a set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations
   A. Water legislation and regulations
   B. OHS procedures
   C. Standard operating procedures
   D. Environmental protection
3. one of the following is legislative and organizational requirement
   A. code of practice
   B. OHS procedures
   C. associated standards and guidance material
   D. All

Note: **Satisfactory rating - 3 points and above** **Unsatisfactory - below 3 points**

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

Answer Sheet-6 Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice questions

1. ----------
2. ----------
3. ----------

Operation Sheet -1	Technique of site preparation

Procedures of site preparation

Step 1: Wear appropriate PPE

Step 1: Read and interpret site plan.

Step 2: Communicate with other responsible service providing bodies and locate all the utilities

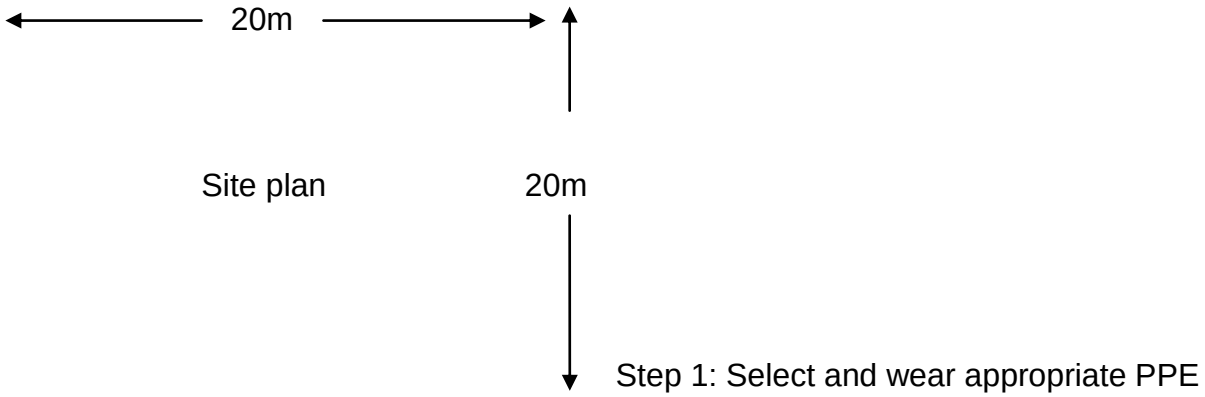
Step 3: Prepare and level your site

Step 4: Place gravel outside the building footprint

Step 5: Construction and delivery clearance

Operation Sheet -2	Steps of setting out a building using pegs

Procedure of setting out site

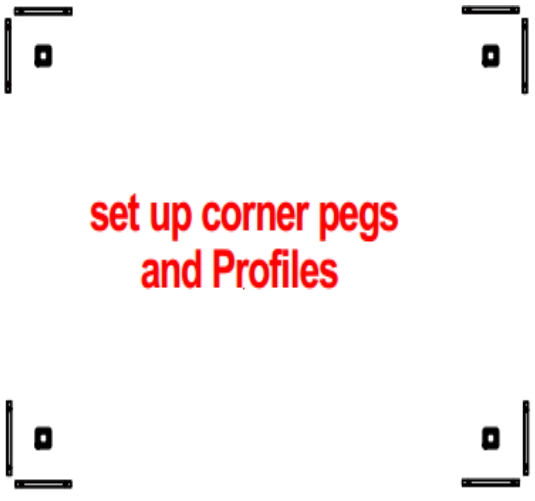


Step 2: Select and use appropriate tools and equipments

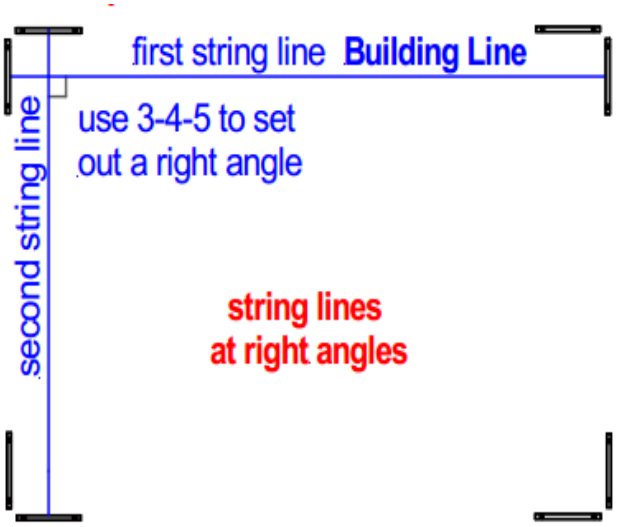
Step 3: Clear the site

Step 4: read and interpret project drawing

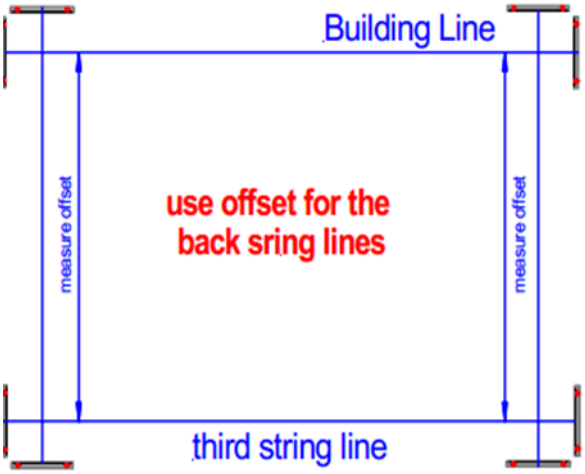
Step 5: set up corner pegs and Profiles



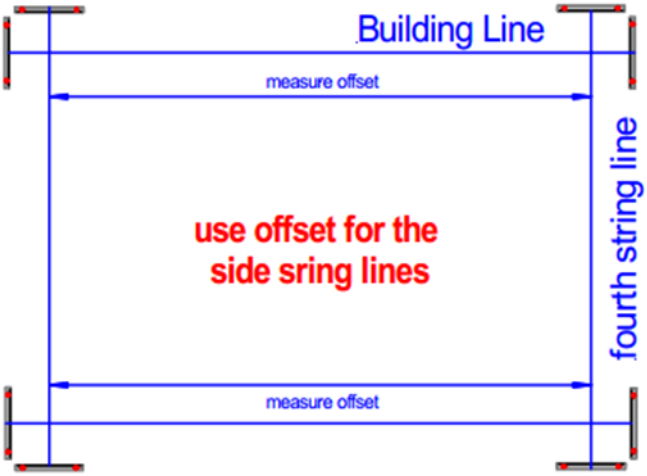
Step 6: string lines at right angles



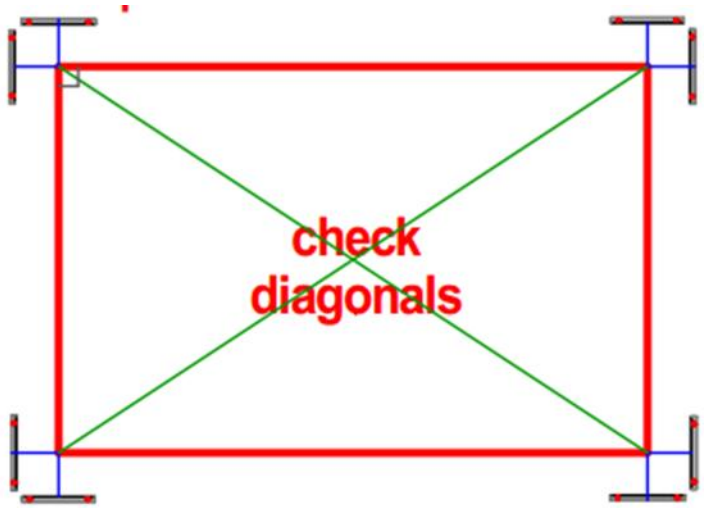
Step 7:use offset for the back string lines



Step 8: use offset for the side string lines



Step 9: check diagonals



Step 10: restore tools and equipment

Operation Sheet -3	**Steps of identifying and respond to operational problems**

The problem - solving approach can be broken down into seven steps.

Step 1: Identify problems

Step 1: Describe the current situation

Step 1: Take temporary countermeasures on the spot

Step 1: Find the root cause of the problem

Step 1: Propose solutions

Step 1: Establish an action plan

Step 1: Check the results

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

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

Task 1: Prepare site for excavation

Task 2: setting out site

Task 3: Identify and respond to workplace operational problems

Instruction Sheet	Learning Guide – 80: Prepare work site

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

- Positioning safety equipment and materials
- Storing and securing equipment and materials.
- Understanding regulatory and legislative requirements to use work site equipment, tools and materials
- Using manual or mechanical excavation equipment
- Using Appropriate drainage and diversion of site inflows

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

- Require Position Safety equipment and materials to prevent potential risks to public and environment.
- Store and secure Equipment and materials as necessary.
- Use Work site equipment, tools and materials according to regulatory and legislative requirements.
- Use manual or mechanical excavation equipment where required to achieve specifications.
- Use appropriate drainage and diversion of site inflows from work site without damage to environment.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4” in page 42, 50, 55, 60 and 64 respectively.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self- check 4” -” in page 49, 54, 59, 63 and 71 respectively
5. If you accomplish the self-checks, do operation sheet in page 72
6. LAP Test in page 73

Information Sheet-1	Positioning safety equipment and materials

1.1. Positioning safety equipment and materials

Construction work can be particularly hazardous. Personal protective equipment, fire safety, electrical safety, confined space entry, emergency preparedness, biological safety, chemical safety, hazardous waste disposal, vehicle safety and other precautions are essential for safe construction work. When visiting or working at construction sites:

- Do not walk, stand, or work under suspended loads. If you raise a load, be sure to crib, block, or otherwise secure the load as soon as possible.
- Avoid placing unusual strain on equipment or materials.

Public and site safety may be ensuring when using:

- Positioning signs
- Erecting barricades
- Controlling access

a. Positioning signs: Safety signs play an important role in keeping people safe in the workplace through raising awareness and highlighting potentially dangerous situations or activities. Safety sign provides information about safety or health and can be a signboard, colour, acoustic signal, verbal communication, or hand signal. A signboard is a sign that provides information or instruction using a combination of shape, colour and symbols but excludes information in writing. Red signs mean “DO NOT” (eg a stop sign) blue signs mean “MUST DO” (eg wear PPE).

Safety signs should be used in the following areas:

- anywhere containing a risk of serious injury, e.g. a fall risk;
- tasks or areas where correct PPE needs to be worn, e.g. hearing protection for noise exposure**;**

There are five types of safety signs:

- Prohibition Signs
- Mandatory Signs
- Warning Signs
- Danger Sign

- Limitation Sign
- Prohibition Signs: -are there to tell you not to do something. These signs have a red circle with a red diagonal line through it. The pictogram is black on a white background.
  - ✓ Colour**:** Red
  - ✓ Shape**:** Circle
  - ✓ Meaning: Do not, Never, Stop, No

Figure 21: Examples of prohibition sign

- **Mandatory Signs**: - are there to tell you to do something. These signs are round in shape. The pictogram is white on a blue background. The circle usually has a white border.
  - ✓ Colour: Blue
  - ✓ Shape: Circle
  - ✓ Meaning**:** Do this, You must, Obey

Figure 22: Example of mandatory sign

- Warning Signs: -are there to warn you of dangers. These signs are triangular in shape. The pictogram is black on a yellow background; the triangle has a black border.
- Colour: Yellow
- Shape: Triangle
- Meaning**:** Warning, Be careful, Be aware

Figure 23: Example of warning sign

Table1: Types of safety sign with example

Prohibition Sign	Meaning: -An action or activities not permitted. Do not, Never, Stop, No Colour: -red Shape: -circle	
Mandatory Sign	An instruction must be carried out. Colour: - Blue Shape: -Circle Meaning**:** Do this, you must, Obey	
Limitation Sign	Defined limit on an activity.	
Danger Sign	Indicate imminent risk of injury to particular hazard or hazardous situation that is likely to belief threating if ignored.	
Warning / Caution Sign	Indicate potential risk of injury due to a particular hazard or hazardous situation that is not likely to be life-threatening. Colour: - Yellow Shape: -Triangle Meaning**:** Warning, be careful, Be aware	

b. Erecting barricades: A barricade means a physical barrier, usually temporary, erected or placed to restrict the entry of persons to an area and/or prevent personnel being exposed to a hazard.

Barricades act as warning devices that alert others of the hazards created by construction activities and should be used to control traffic, both vehicular and pedestrian, safely through or around construction work sites. Two types of barricade

- Soft barricade
- Hard barricade

Soft barricades are those that use an approved tape to prevent or restrict access to an area, which are suitable in situations where physical protection by use of a hard barrier system is not warranted.

Hard barricades are a self-supporting fence, or a self -supporting series of continuous plastic, concrete or other solid barriers, erected or placed to restrict the entry of persons to an area, e.g. scaffold tubes, concertina / expandable barriers, water filled plastic or concrete modular devices.

Barricades are required around all construction sites and all excavations, holes, openings in floors or roofs, raised platforms, for certain types of overhead work, restriction of access areas and wherever it is necessary to warn people against the potential of falling. Barricades must be suitable for each area of use. Examples of barricades are plastic safety fencing, temporary cyclone fencing and portable manhole barricades. Yellow caution tape and/or cones are not considered acceptable barricades and should be used only temporary until suitable barricades are erected. Signs and illumination should be used appropriately. The following are examples of activities where barricades may be required:

- Wherever construction debris is dropped without the use of an enclosed chute.
- Areas with temporary wiring operating at more than 600 volts.
- Work areas for electrical equipment with exposed energized parts.
- The swing radius of the rotating superstructure of cranes or other equipment.
- Wherever equipment is left unattended near a roadway at night.
- Excavations.
- Areas used for the preparation of explosive charges or blasting operations.
- Street openings –manholes.
- Construction areas in energized electrical substations.

Barricading controls shall be implemented and authorized as part of the safe work system to protect persons from hazards such as:

- being struck by falling objects;

- being struck by moving plant;
- fall from height, including falling into open excavations, penetrations, and falls from unprotected edges such as removed flooring, walkways, stairs and / or hand railings.
- exposure to hazardous chemicals;
- unauthorized entry into a confined space or work area; and
- Any potentially hazardous work processes, for example, hot works, scaffolding, radiation work and work involving asbestos.

Table 2: Types of barricades and examples of signage

Type of Barricade	Examples of Signage Note signs may not be
Caution Barricade Tape (soft barricade)	
Danger Tape (soft barricade)	
Restricted Access Electrical Work Barricade Tape (soft barricade)	
Restricted Access (hard/solid barricade)	

1.2. Erection and Use of Barricade

The barricade shall be placed so that the whole area affected by the hazard is appropriately identified, taking the following factors into account:

- distance to/from the hazard;
- possible movement of an object inside the barricade if it falls;
- access and egress; and
- Sparks or slag generated from hot work activities.

An appropriate sign shall be affixed to barricades at all access points, indicating the following:

- the hazards present within the barricaded area; and
- The name and contact details of the person in charge of the barricaded area.

All barricades shall be fitted with signage at appropriate spacing intervals along the barricade to ensure the signage is visible from all entry points. The following table indicates the type of signage that is appropriate for each type of barricade.

Self-Check -1	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Public and site safety may ensure through
   A. Positioning signs
   B. Erecting barricades
   C. Controlling access
   D. All
2. A physical barrier, usually temporary, erected or placed to prevent personnel being exposed to a hazard.
   A. Barricades
   B. Signs
   C. Access control
   D. Excavator
3. What does a prohibitory sign at the construction site look like?
   A. Circular white sign with a blue symbol.
   B. Diamond-shaped orange sign that contains a white symbol.
   C. Circular white sign with a red border and a red diagonal line.
   D. Rectangular white sign with yellow symbol
4. Which is Mandatory Sign

A. 

B. 

C. 

D. 

Note: **Satisfactory rating - 4 points and above** **Unsatisfactory - below 4 points**

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

Answer Sheet-1

Name: _____ Date: _____

Score = _____

Rating: _____

Multiple choice Questions

1. ----------
2. ----------
3. ----------
4. ----------

Information Sheet- 2	Storing and securing equipment and materials

2.1 Introduction

Materials required in construction operations shall be stored, and handled in a manner to prevent deterioration and damage to the materials, ensure safety of workmen in handling operations and non-interference with public life including safety of public, prevention of damage to public property and natural environment.

Materials shall be stored and placed so as not to endanger the public, the workers or the adjoining property. Materials shall be stacked on well-drained, flat and unyielding surface. Material stacks shall not impose any undue stresses on walls or other structures.

Materials shall be separated according to kind, size and length and placed in neat, orderly piles. High piles shall be staggered back at suitable intervals in height. Piles of materials shall be arranged so as to allow a minimum 800 mm wide passageway in between for inspection and removal. All passageways shall be kept clear of dry vegetation, greasy substance and debris.

For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipment with proper access and proper maneuverability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipment at different stages of construction shall be considered.

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture, to avoid deterioration.

Special and specified care should be taken for inflammable and destructive chemicals and explosive during storage.

2.2. Storing equipments and materials

Safe storage of materials and equipment is essential for many businesses, such as construction job sites, laboratories, and other locations that handle chemicals, flammable gases and other hazardous materials. Storage methods and procedures are regulated for many such items; when in doubt it is always best to be cautious to prevent accidents. Locking storage cabinets and restricting access to storage areas will prevent unauthorized handling of stored items and minimize the possibility of theft.

2.3. Storage requirement by classification of materials

Stored materials shall be separately stored under following classifications, with appropriate care necessary precautions to each Classification:

a) Climatically Sensitive Materials
b) Durable Materials
c) Materials Vulnerable to Rough Handling
d) Inflammable and/or Fire Sensitive Materials
e) Hazardous Materials

Under each classification a list of commonly used materials are listed below. Other materials used but not mentioned here shall be treated under one or more of the above listed classifications which most closely match the unlisted material**.**

2.3.1 Climatically Sensitive Materials

Such material shall be stored in properly constructed sheds which must be stored in cool dry and well ventilated and confines, ensuring its storage without deterioration and without contact to ground and structural members, without exposure to moisture and heat, and away from direct sun.

Materials requiring breathing, such as timber and other natural products, shall be allowed ample air flow between successive layers of stacking.

Materials subject to deformation under stress shall be supported uniformly so as not to subject it to bending loads or excessive vertical load.

Materials subject to loss of quality through moisture shall be kept within impermeable wrapping, if not used within a reasonable period.

Example

- Cement
- Lime
- Timber

2.3.2. Durable materials

Steel reinforcement bars and structural steel shall be stored in a way to prevent distortion, corrosion, scaling and rusting. Reinforcement bars and structural steel sections shall be coated with cement wash before stacking, especially in humid areas. In case of long time storage or

storage in coastal areas, reinforcement bars and steel sections shall be stacked at least 200 mm above ground level.

Steel sections shall be stacked upon platforms, skids or any other suitable supports. Bars of different types, sizes and lengths and structural steel sections shall be stored separately to facilitate issues in required sizes and lengths without cutting from standard lengths. Ends of bars and sections of each type shall be painted with separate designated colors.

2.3.3. Materials Vulnerable to Rough Handling

Pipes shall be stored in stacks with stoppers provided at the bottom layer to keep the pipe stack stable. The stack, particularly of smaller diameter pipes, shall be in pyramid shape. Pipes shall not be stacked more than 1.5 m high.

Each stack shall have pipes of the same type and size only. Removal of pipes shall start from the top layer and by pulling from one end. A pipe shall not be stored inside another pipe. The pipes may also be placed alternately length and crosswise.

Asbestos cement pipes shall be unloaded at location, for example near trenches. Cast iron detachable joints and fittings shall be stacked under cover and separated from the asbestos cement pipes and fittings. Rubber rings shall be kept clean and away from grease, oil, heat and light.

Pipe shall be carried one at a time on shoulders by at least two workmen. Pipe fittings and joints shall be handled individually.

Black polyethylene pipes may be stored either under cover or in the open. However, natural coloured polyethylene pipes shall be stored under cover only and protected from direct sunlight.

2.3.4 Inflammable and/or Fire-Sensitive Materials

Materials under this classification shall be stored within fire-preventive confines, furnished with firefighting provisions. Buckets containing sand shall be kept ready for use. A 5 kg dry powder fire extinguisher conforming to accepted standards shall be kept at an easily accessible position. Besides, the areas shall be close to fire hydrants.

2.3.5 Hazardous Materials

Materials under this category are

(a) Those posing health hazard through breathing, such as asbestos, glass fiber, etc. or injurious and/or intoxicating fluids of various kinds,

(b) Materials corrosive to living bodies and

(c) Materials likely to explode under heat or pressure.

These should be stored in a manner specific to its properties, so as to prevent hazards of all kinds

2.4. Tool habits

A place for everything and everything in its place is just common sense. You cannot do an efficient, fast repair job if you have to stop and look around for each tool that you need. The following rules, if applied, will make your job easier.

- keep each tool in its proper storage place
- keep your tools in good condition
- keep your tool set complete
- use each tool only on the job for which it was designed
- never use damaged tools

2.4. Machinery and Equipment

Machinery such as forklifts, dozers, excavators, and loaders must be kept in a safe location where it is protected from unauthorized access, weather and accidental damage. they must be kept away from driveways, walkways and other areas where access is required. All equipment should be turned off when not in use. If there is a chance of oil, hydraulic fluid or other liquids leaking from the vehicle while it is stored, use a drip pan underneath it to catch any spills. Check the area frequently for such leaks and clean them up immediately if any are found, as these represent significant fall hazards for employee.

Self-Check -2	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Storing and securing equipment method
   A. stacking equipment
   B. Placing equipment in locked storage
   C. Using equipment box
   D. All
2. Example of climatically sensitive materials that must be stored in cool dry and well ventilated
   A. Steel bar
   B. Cement
   C. Aggregate
   D. Masonry block
3. Why we store and handle materials properly
   A. To prevent deterioration to the materials
   B. To prevent damage to the materials
   C. To ensure safety of workmen
   D. All

Note: **Satisfactory rating - 3 points and above Unsatisfactory - below 3 points**

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

Answer Sheet-2

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. ----------
2. ----------
3. ----------

Information Sheet-3	Using work site equipment, tools and materials

3.1. Excavation work site equipment, tools and materials

The following tools and equipment are used during site excavation and restoration

- Hand and power tools
- Lifting and winching equipment
- Mechanical excavation equipment
- Re vegetation and gardening supplies and plants
- Communication equipment
- Personal protective equipment

3.2. General Safety Guidelines for excavation tools

Be aware of all power lines and electrical circuits, water pipes, and other mechanical hazards in your work area, particularly those below the work surface, hidden from the operator's view, that may be contacted.

Wear proper apparel. Do not wear loose clothing, dangling objects or jewelry. Long hair must be restrained. Gloves should not be worn when operating certain power tools. Check appropriate tool manuals.

- Disconnect tools when not in use, before servicing and cleaning, and when
- changing accessories
- Keep people not involved with the work away from the work
- Secure work with clamps or a vise, freeing both hands to operate the tool
- Don’t hold the switch button while carrying a plugged-in tool
- Keep tools sharp and clean
- Always follow equipment and workshop instructions, including the use of recommended personal protection equipment
- At the end of each working day clean the tools and equipment you used and check them for any damage. If you note any damage, tag the tool as faulty and organize a repair or replacement
- Equipment and tools used are checked after use for damage, splits or cracks in accordance with organizational requirements.

- Lockout/tagout describes a set of safety practices and procedures that are intended to prevent workers from using equipment or materials determined to be unsafe or potentially unsafe.
- Equipment and tools are cleared and cleaned after use in accordance with organizational requirements
- Equipment and tools are lubricated after use in accordance with organizational requirements.
- Any damaged equipment and tools are repaired and/or replaced after use in accordance with organizational requirements.

3.2.1. Operation of power industrial machineries

When operating or maintaining powered industrial trucks, you and your employees must consider the following safety precautions:

- Fit high-lift rider trucks with an overhead guard if permitted by operating conditions.
- Equip fork trucks with vertical load backrest extensions according to manufacturers' specifications if the load presents a hazard.
- Locate battery-charging installations in designated areas.
- Provide facilities for flushing and neutralizing spilled electrolytes when changing or recharging batteries to prevent fires, to protect the charging apparatus from being damaged by the trucks, and to adequately ventilate fumes in the charging area from gassing batteries.
- Provide conveyor, overhead hoist, or equivalent materials handling equipment for handling batteries.
- Provide auxiliary directional lighting on the truck where general lighting is less than 2 lumens per square foot.
- Do not place arms and legs between the uprights of the mast or outside the running lines of the truck.
- Set brakes and put other adequate protection in place to prevent movement of trucks, trailers, or railroad cars when using powered industrial trucks to load or unload materials onto them.
- Provide sufficient headroom under overhead installations, lights, pipes, and sprinkler systems.

- Provide personnel on the loading platform with the means to shut off power to the truck whenever a truck is equipped with vertical only (or vertical and horizontal) controls elevatable with the lifting carriage or forks for lifting personnel.
- Secure duckboards or bridge plates properly so they won't move when equipment moves over them.
- Handle only stable or safely arranged loads.
- Exercise caution when handling tools.
- Disconnect batteries before repairing electrical systems on trucks.
- Ensure that replacement parts on industrial trucks are equivalent to the original ones.

3.2.2. Safety measures during operation of cranes

Employers must permit only thoroughly trained and competent workers to operate cranes. Operators should know what they are lifting and what it weighs. To reduce the severity of an injury, employers must take the following precautions:

- Equip all cranes that have adjustable booms with boom angle indicators.
- Provide cranes with telescoping booms with some means to determine boom lengths unless the load rating is independent of the boom length.
- Post load rating charts in the cab of cab-operated cranes. (All cranes do not have uniform capacities for the same boom length and radius in all directions around the chassis of the vehicle.)
- Require workers to always check the crane's load chart to ensure that the crane will not be overloaded by operating conditions.
- Instruct workers to plan lifts before starting them to ensure that they are safe.
- Tell workers to take additional precautions and exercise extra care when operating around power lines.
- Teach workers that outriggers on mobile cranes must rest on firm ground, on timbers, or be sufficiently cribbed to spread the weight of the crane and the load over a large enough area. (Some mobile cranes cannot operate with outriggers in the traveling position.)
- Direct workers to always keep hoisting chains and ropes free of kinks or twists and never wrapped around a load.
- Train workers to attach loads to the load hook by slings, fixtures, and other devices that have the capacity to support the load on the hook.
- Instruct workers to pad sharp edges of loads to prevent cutting slings.

- Teach workers to maintain proper sling angles so that slings are not loaded in excess of their capacity.
- Ensure that all cranes are inspected frequently by persons thoroughly familiar with the crane, the methods of inspecting the crane, and what can make the crane unserviceable. Crane activity, the severity of use, and environmental conditions should determine inspection schedules.
- Ensure that the critical parts of a crane—such as crane operating mechanisms, hooks, air, or hydraulic system components and other load-carrying components—are inspected daily for any maladjustment, deterioration, leakage, deformation, or other damage.

Self-Check -3	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. One of the following is a power tool
   A. Angle grinder
   B. Shovel
   C. Dozer
   D. Spade
2. Worksite tools and equipment are
   A. Hand and power tools
   B. Lifting and winching equipment
   C. Mechanical excavation equipment
   D. all
3. Who is responsible for making suitable resources available for use during lifting?
   A. The Occupational Health and Safety doctor.
   B. The employer.
   C. The safety officers.
   D. none

Note: **Satisfactory rating - 3 points and above Unsatisfactory - below 3 points**

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

Answer Sheet-3

Name: _____ Date: _____

Score = _____

Rating: _____

Short Answer Questions

1. ----------
2. ----------
3. ----------

Information Sheet-4	Using Manual or mechanical excavation equipment

4.1. Introduction to Excavation

Common excavation is the excavation of all materials that can be excavated, transported, and unloaded using heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by excavators equipped with attachments (shovel).

Excavation in construction includes earthwork, trenching, wall shafts, tunneling and underground. Excavation has a number of important applications including exploration, environmental restoration, mining and construction. Excavation is used in construction to create building foundations, reservoirs and roads.

4.2. Excavation tools equipments

Excavation equipments are earth-moving equipment covers a broad range of machines that can excavate and grade soil and rock, along with other jobs. There are two Types of excavation equipments.

- Manual excavating equipment
- Mechanical excavation equipments

A. Mechanical excavation equipments

The following are mechanical excavation used to for excavation

- Excavators
- Backhoe Loaders
- Bulldozers
- Skid-Steer Loaders
- Motor Graders
- Crawler Loaders
- Trenchers
- Scraper

B) Manual Excavation Tools

Carried out using the following hand tools manually.

- Spade

- Shovel
- Hoe
- Trowel
- Rake
- Mattock
- Tracked Excavator
- Wheeled Excavator
- picks crow-bars
- hand augers
- string lines
- pegs
- levels
- tape measures
- jack hammers

4.3. Selection of tool for the right job

It's the less obvious misuse of tools that gives us the most trouble, like using a screwdriver, a piece of pipe, or a file as a pry bar. Trouble also comes from trying to get by with a tool that's not the right size for the job. A common mistake is using a wrench that's the wrong size for the nut, or one with a handle that's too short. This can result in the wrench slipping off the nut leading to an injury. Don't take chances. Get the right tool, even if it takes you a few minutes longer.

- If you use hand tools, check them daily for damage and make sure it is the right tool for the job. These simple reminders can save you or a coworker from getting hurt:
- Don't use broken or damaged tools, dull cutting tools, or screwdrivers with worn tips.
- Cut in a direction away from your body.
- Make sure your grip and footing are secure when using large tools.
- Carry tools securely in a tool belt or box. Don't carry tools up ladders. Use a hoist or rope.
- Keep close track of tools when working at heights. A falling tool can kill a coworker.
- Pass a tool to another person by the handle; never toss it to them.
- Use the right personal protective equipment (PPE) for the job. Follow company instructions for selecting and using safety eyewear, steel-toed shoes, gloves, hard hats, etc.

- Never carry sharp or pointed tools such as a screwdriver in your pocket.

4.4. Handling tools and equipments safely on construction sites

Tools and equipment in the construction industry are very important and equally, may be very risky. It is therefore important to ensure that you are able to handle construction tools and equipment in the safest way possible. This goes a long way in ensuring that you will greatly lower the possibility of injuries and accidents from occurring. The maintenance of construction tools and equipment is paramount in ensuring that the tools are maintained at their best working condition. Lack of proper maintenance of construction tools is expensive in that it may bring about grave injuries and can equally bring about the breakdown of the equipment. Therefore it is important to ensure that tools used in the construction industry are well taken care of and properly maintained.

4.5. Regular cleaning of the tools

Clean construction tools and equipment after every single use. This is to ensure that rust and other related damage that occurs to construction tools due to dirt are greatly reduced. What is more amazing about regular cleaning of the tools is that it helps in ensuring that the life of the tools is extended. While cleaning these tools, you should use the recommended cleaning agents.

4.6. Regular inspection of equipment

It is paramount to monitor that regular inspection is undertaken on construction equipment to ensure that they are maintained at their best working conditions. Inspection is also quite important in that it helps in ensuring that defects in the tools are identified and rectified before they bring about a complete breakdown of the equipment. Damages can only be contained as they occur, before they become fully advanced. Other than inspection, it is also important to ensure that replacement of parts or of the whole equipment especially equipment that is prone to wear and tear.

Self-Check -4	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. One of the following is a manual excavation tools
   A. Excavator
   B. Pickaxe
   C. Bulldozer
   D. Motor grader
2. One is different from the other depending on type
   A. Pickaxe
   B. Shovel
   C. Spade
   D. Bulldoze

Note: **Satisfactory rating - 2 pointsand above** **Unsatisfactory - below 2 points**

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

Name: _____ Date: _____

Short Answer Questions

1. ----------
2. ----------

Information Sheet-5	Using Appropriate drainage and diversion of site inflows

5.1. Introduction to drainage and diversion inflows

Drainage is the natural or artificial removal of a surface's water and sub-surface water from an area with excess of water. Site drainage measures help prevent the flooding of property, drainage structures, waterways and roadways. A water diversion is the removal or transfer of water from one watershed to another. Diversion channels or floodways are man-made channels built to offer a different route for excess water to flow further mitigating the effects of flooding and restoring rivers to their natural water level. Temporary diversion methods are used to protect water quality by passing upstream flows around the active construction zone.

Examples:

- **Transverse Dikes:** These dikes can be built using material dredged from the river or transported from adjacent lands. The dike material, usually clay or silt, must be highly compacted and in many cases it is advisable to place riprap on the dike to increase its strength and protect it from erosion.

- **Water Traps:** Water traps are used to control the deleterious effects of runoff in a river basin and to facilitate water storage and the recharge of aquifers. They are built like an earth dam, usually 1 m to 3 m high, using local materials. The walls are compacted in 20 cm layers using the same equipment as is used to build a dam. The edges are trapezoidal with an embankment slope of 2.5:1 at high water and 2:1 at low water. The bottom width of the water trap is 2.5 m. They are normally located across a river bed, segmenting the channel into compartments.
  - ✓ diversion drains/ditches
  - ✓ silt fence
  - ✓ Fiber roll
  - ✓ Filter bund
  - ✓ Silt trap
  - ✓ Haul routes and site entrances
  - ✓ Surface drainage protection

5.2. Environmental damage minimizing techniques

Environmental protection is a practice of protecting the natural environment on individual, organizational or governmental levels, for the benefit of both the natural environment and humans.

When working in construction system maintenance one should be worried about the damage caused to the environment which starts for the workshop he is working. So, on the way of maintaining flow control device we have to aware that the environment should be protected.

Flow to be diverted from an outlet or drainage basin the flow can be thought of as leaving the normal drainage system at that point. It can be retrieved at a downstream outlet where the diverted flow then contributes to the flow at that outlet. If no downstream retrieval outlet point is specified, the flow simply leaves the system at the diverted outlet point and never returns the inflow for the diversion can be determined in one of two ways: either by using a cross-section for the main channel or by using a structure for the main channel. Damage to environment is avoided or minimised by using a range of techniques, including:

- Sediment control devices
- Erosion prevention
- Diversion and collection structures

5.2.1 Sediment control devices

Soil erosion is the process of the soil degradation or the reduction of the soil's quality under the effect of different factors. Once soil erosion occurs, sediment trapping or removal techniques can reduce the amount of sediment and associated pollutants that leave the site, thus protecting nearby streams, wetlands, and lakes. Sediment controls are usually placed around the perimeter of a disturbed area and where concentrated water leaves the site. Sediment control should be in place before land clearing and grading begins. It is important to note that sediment controls, if poorly maintained, can become sources of sediment and other pollutants during larger storms. The following are sediment control devices

- Bio-filter Bags
- Dewatering
- Filter Berm
- Inlet Protection
- Pre-Fabricated Barriers

- Sand Bags
- Sediment Basin
- Sediment Fence
- Sediment Trap
- Sidewalk Subgrade Gravel Barrier

Figure 24 (a): Sidewalk Subgrade Gravel Barrier Figure 24 (b) sediment trap

Figure 24 (c) Sediment fence **Figure 24 (d) Bio filter bag**

Figure 24 (e) Filter berm

Figure 24 (f) inlet protection

Figure 24 (g) Pre-fabricated barrier

5.2.2. Erosion prevention methods

Erosion is a natural process by which soil and rock material is loosened and transported. Erosion by the action of water, wind, and ice has produced some of the most spectacular landscapes. Natural erosion occurs primarily on a geologic timescale, but when human activities alter the landscape the process of erosion can be greatly accelerated. Construction site erosion causes serious and costly problems, both on-site and off-site. Waterborne soil erosion process begins by water falling as raindrops and flowing over bare soil surface.

When land is disturbed at a construction site, the erosion rate accelerates dramatically. Since ground cover on an undisturbed site protects the surface, the removal of that cover increases the site's susceptibility to erosion. Disturbed land may have an erosion rate 1,000 times greater than the pre-construction rate. Even though the process of construction requires that land be left bare for periods of time, proper planning and use of erosion prevention measures can reduce the impact of accelerated erosion caused by land development. There are two basic erosion control approaches as:

- Reducing runoff amount and
- Reducing runoff velocity.

https://www.youtube.com/watch?v=nujYG_b8lI8

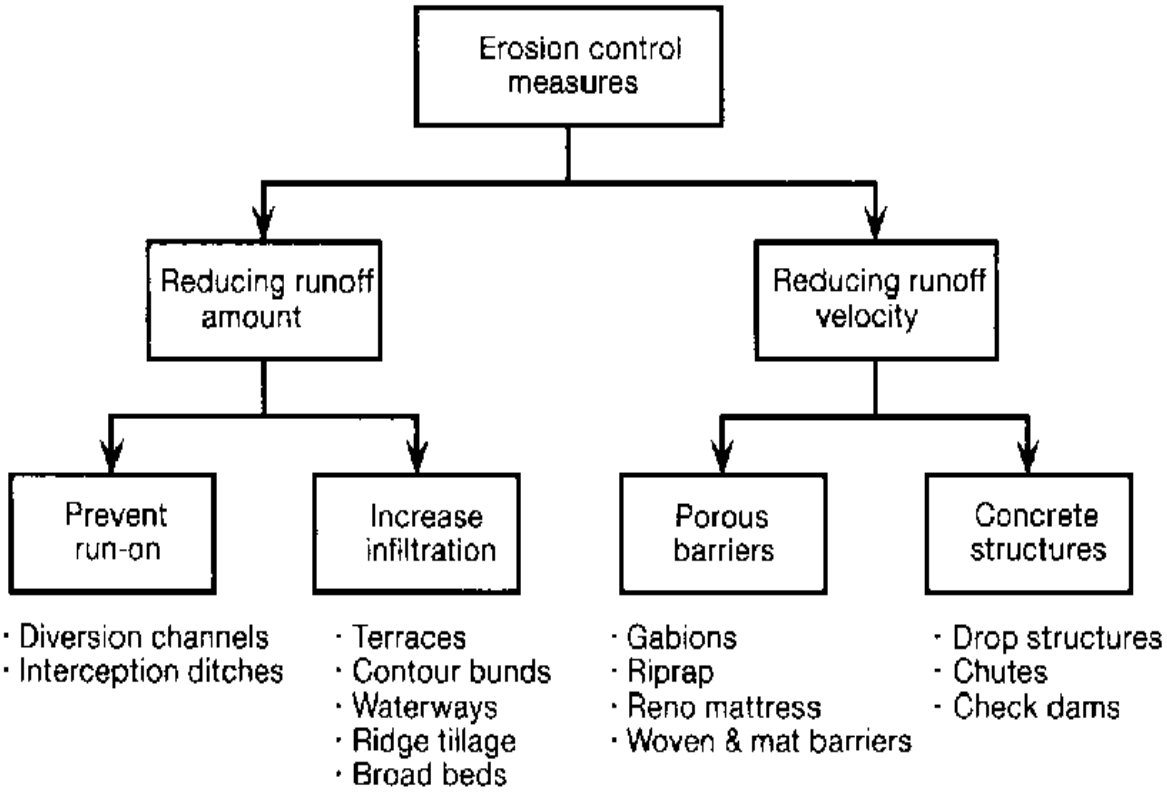


Figure 25: Method of erosion control measures

There are five main techniques that can be used in controlling soil erosion are.

They are as follows:

- Contour bunding and Farming
- Strip Cropping
- Terracing
- Gully Reclamation
- Shelter Belts.

5.2.3 Diversion and collection structures

Diversion and collection structures used to control runoff. The greater the volume and velocity of surface water runoff on construction sites, the more sediment and other pollutants are transported to streams, wetlands, and lakes. Diverting runoff away from exposed soils can greatly reduce the amount of soil eroded from a site. Decreasing runoff velocities reduces erosion and the amount of pollutants carried off-site.

Runoff controls divert runoff from exposed areas and reduce runoff velocities. Runoff control That divert runoff from exposed areas include pipe slope drains and diversion swales.

Runoff controls that reduce runoff velocities include check dams and sediment traps. The following are runoff control structures.

- **Check Dam**: -Small dams constructed across a swale or ditch to reduce velocities of concentrated flows, thereby reducing erosion in the swale or ditch. Check dams not only prevent gully erosion from occurring before vegetation is established, but also allow a significant amount of suspended sediment to settle out.
- **Diversion Dike**: -A ridge of compacted soil or a lined swale with vegetative lining located at the top, base or somewhere along a sloping disturbed area. The dike or swale intercepts and conveys smaller flows along low-gradient drainage ways to larger conveyances such as ditches or pipe slope drains or to a stabilized outlet. Dikes and swales may be used singly or in combination with each other
- **Outlet Protection**: -Outlet protection reduces the speed of concentrated flow, thereby preventing scour at conveyance outlets. By dissipating energy, outlet protection lowers the potential for downstream erosion. Outlet protection includes riprap-lined basins, concrete aprons, and settling basins. Outlet protection prevents scour at storm water outlets, and minimizes the potential for downstream erosion.
- **Pipe Slope Drain**: -A pipe extending from the top to the bottom of a cut or fills and discharging into a stabilized watercourse, sediment trapping device or onto a stabilized area. The pipe slope drain carries concentrated runoff down steep slopes without causing gullies, erosion, or saturation of slide prone soils.
    - ✓ Drop structure:-
    - ✓ Chutes
    - ✓ Gabions
    - ✓ Riprap

Figure 26: (a) Check dam

Figure 26: (b) diversion dike

Figure 26: (c) Outlet protection

Figure26: (d) pipe slope drain

Self-Check -5	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Environmental damage avoids or minimize by
   A. Sediment control device
   B. Stacking and securing
   C. Erecting barricades
   D. Scaffolding
2. Reduce velocities of concentrated flows and reducing erosion in ditch.
   A. Terracing
   B. Check dam
   C. Dewatering
   D. Pipe slope drain
3. One of the following is erosion controlling technics
   A. Strip Cropping
   B. Terracing
   C. Gully Reclamation
   D. All
4. One of the following is erosion control measure used to reduce runoff velocity
   A. Interception ditch
   B. Waterways
   C. Chutes
   D. Contour bunds
5. It is sediment control device
   A. Bio-filter Bags
   B. Filter Berm
   C. Sand Bags
   D. All

Note: **Satisfactory rating – 5 points and above** **Unsatisfactory - below 5 points**

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

Answer Sheet-5

Score = _____

Name: _____ Date: Rating: _____

Multiple choice questions

1. ----------
2. ----------
3. ----------
4. ----------
5. ----------

Operation Sheet -1	Technique of Storing construction tools and equipments

Procedure for tools and equipment storing

Step 1: Use and wear appropriate PPE

Step 2: Select appropriate tools and equipment

Step 3: Create appropriate room to store each tools and equipment

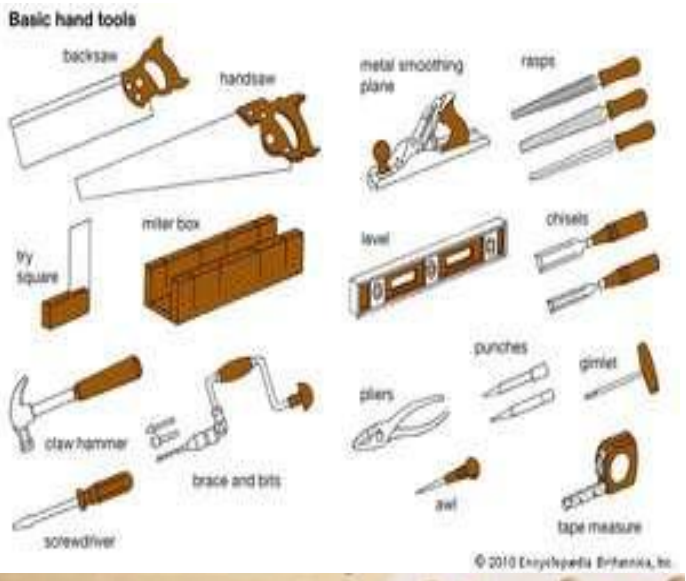
Step 4: Clean out the junk and clutter and make a space only for tools

Step 5: Sort each tool and equipments

Step 6: Clean out dirt and debris from tools and equipments

Step 7: Store tools and equipments properly

N.B: consider the following figure



LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **5** hours.

Task 1: Store construction tools and equipments in their appropriate place in the workshop

Instruction Sheet	Learning Guide – 81 Restore work site

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

- Using Equipment, tools and materials for work site restoration
- Backfilling and compacting excavations
- Removing excess soil, debris and unwanted materials
- Restoring work site.

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

- Equipment, tools and materials are used according to regulatory and legislative requirements.
- Excavations are backfilled and compacted according to specifications.
- Excess soil, debris and unwanted materials are removed from site.
- Work site is restored to meet environmental and organizational requirements.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4” in page 75, 78, 87 and 90 respectively.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self- check 4” -” in page 77, 86, 89 and 93 respectively
5. If you accomplish the self-checks, do operation sheet in page 94
6. LAP Test in page 95

Information Sheet-1	Using Equipment, tools and materials for restoring site

3.1. Construction site restoration

At the completion of any construction work site should be restored and environmental management should be practiced. All things which disturb the environment as the result of drainage system maintenance should be cleared off site.

On completion of backfill operations and other work, the entire site shall be cleared of all debris, and ground surface shall be finished to a neat workman like appearance. All damages done to the environment during the course of the drainage system maintenance should be restored as its regional position.

After construction, the goal is to restore the worksite to its pre-construction condition. To do this, it's a good idea to create a site restoration plan.

3.2. Purposes of construction site restoration

- **Runoff Reduction:** It is important to reduce runoff as much as possible. Runoff is created when rain falls and if the ground is not restored and runoff reduced after a construction project, it can lead to issues with erosion and habitat loss.
- **Water Quality Protection:** One of the most important parts of the restoration process is being in compliance with water quality and protection. It is imperative that chemicals and other hazardous materials are not dumped on land or in water and that they are properly disposed of to prevent harm to the water in the area.
- **Site Topography:** Restoring the site topography is another top concern when it comes to site restoration. It is important to document the existing topography so it can properly be replaced after the construction process.
- **Water Table:** When you pull water out of a site for construction purposes, the water table risks contamination, which can seep into the groundwater. It is important to return the water table back to its original position.

3.3. Tools and equipments used in Construction site restoration

- Mobile generators
- Backhoes
- Crawler loaders
- Dump trucks

- Dozer
- Grader machine
- Spades
- Wheel barrow
- Shovel
- PPE

Self-Check -1	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Purpose of site restoration is
   A. To reduce runoff
   B. To protect the water quality
   C. To protect water table contamination
   D. All
2. Site restoration equipment
   A. Dump truck
   B. Spade
   C. Wheelbarrow
   D. Shovel

Note: **Satisfactory rating – 2points and above** **Unsatisfactory - below 2 points**

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

Answer Sheet-1

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice questions

1. ----------
2. ----------

Information Sheet-2	Backfilling and compacting excavations

2.1. Backfilling

Backfilling is the process of putting soil back into a trench or foundation once excavation and the related work has been completed. It is an important part of the construction process. Backfilling happens after excavation, when the soil is compacted back into the trench or foundation. It is used to help protect foundations, roadways, walkways and other structures by using a mixture of soil, rocks, and stones. The backfill process requires skills and heavy equipment as well as knowledge of the specifications, contract requirements, and soil conditions.

The key points in the backfilling operations are:

- Use good quality backfill / surround material.
- Ensure no voids in surround
- Place backfill material in uniform layers not exceeding250mmun-compacted thickness.
- Balance fills either side as fill progresses.
- Compact each layer before adding next layer.
- Do not allow construction equipment over the structure, without adequate protection, until required minimum depth of cover is achieved
- Place and compact backfill parallel to structure

2.2. Backfilling and compaction for structures

- Use suitable material for all filling and backfilling operations.
  - ✓ Provide suitable material free from organic matter and deleterious substances
- Fill under structures: Deposit suitable materials in layers not exceeding 8" in depth and compact each layer using proper equipment.
  - ✓ Do not place rock that will not pass through a 6" diameter ring within the top 12" of the surface of the completed fill or rock that will not pass through a 3" diameter ring within the top 6" of the completed fill.
  - ✓ Do not place broken concrete, bricks, or asphaltic pavement in fills.
- Backfill excavations as promptly as progress of the Work permits, but not until completion of the following:

- ✓ Inspection and acceptance of construction below finish grade including, where applicable, damp proofing and waterproofing.
- ✓ Inspecting, testing, approving and recording locations of underground utilities.
- ✓ Removing concrete formwork.
- ✓ Removing shoring and bracing, and backfilling of voids with satisfactory materials.
- ✓ Removing trash and debris.
- ✓ Cast in place foundation walls have been in place seven days.

- Placing and compacting:
  - ✓ Place backfill and fill materials in layers not more than 8" in loose depth.
  - ✓ Before compacting, moisten or aerate each layer as necessary to provide the optimum moisture content with ±2%.
  - ✓ Compact each layer to required percentage of maximum density for area.
  - ✓ Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
  - ✓ Place backfill and fill materials evenly adjacent to structures, to required elevations
  - ✓ Take care to prevent wedging action of backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.
  - ✓ Do not operate heavy equipment closer to foundation or retaining walls than a distance equal to height to backfill above the footing.1)Compact remaining area using power driven hand tampers.
  - ✓ Where the construction includes basement or other underground walls having structural floors over them, do not backfill such walls until the structural floors are in place and have attained sufficient strength to support the walls.

2.3. Backfilling Techniques

Compacting in Trenches: After soil is backfilled into a trench, the loose material is compacted using some mechanical means, such as a compactor, an excavator, or a "jumping jack"-type compactor. As a general guide, soils should be compacted to at least the minimum percentages of maximum dry density.

Soil is typically backfilled in layers, or lifts. The soil lift will depend upon the nature of the backfill and the compaction equipment that is used. Water may be added during the compaction

process, to assist with compaction. The general process follows three steps that are repeated until the backfill are is at grade level:

- Backfill in layers of 4 to 6 inches, using non-organic fill material that is free of debris
- Compact with a 1,000-pound compactor, or as appropriate
- Water thoroughly

Water Jetting: Water jetting is a backfilling technique that does not involve mechanical compaction. Instead, the backfill is compacted by pressurized water applied to the bottom of the fill with a probe. Water jetting is recommended for sand or sandy soils or with highly fissured bedrock. It is not suitable for plastic soils or heavy clay soils. With the jetting technique, you pump the water under pressure and use the force of the jetted water to move the bedding or backfill material around. As with any backfilling, the material should be placed slowly and in lifts. After the water is applied, it is allowed to drain from the soil to improve compaction. Due to the mixing of water and soil, crews must take preventive measures to contain sediment-filled water and prevent it from entering drains and watercourses, all in accordance with EPA Guidelines.

Flow able Fill: Backfill can also be done using flow able fill, a cementations material with a low water-cement ratio that is delivered to the job site by a ready-mix truck. Typically, the utility pipe or other equipment in the trench is first covered with an aggregate material, then the flow able fill is placed in the trench directly from the truck, just like regular concrete. The aggregate surrounding the pipe provides for easier access to the pipe for future repairs. One of the challenges when using flow able fill is the liquidity of the fill. Contractors must contain or block the fill to prevent it from flowing into other trench areas.

2.4. Compacting

Soils are compacted to increase their density and shear strength and to decrease permeability and future settlement. In construction, compaction typically occurs rapidly and is performed by equipment. The method of compaction and type of equipment used highly depend on the accessibility and type of material to be compacted.

Soil compaction is an essential part of the construction process. It provides the necessary flat base which provides the crucial support for buildings, construction foundations, pavements, roads and various other construction structures.

The process of compaction gives the soil underneath these supports higher resistance and greater stability. Soil placed as engineering fill is compacted to a dense state to obtain satisfactory engineering properties such as, shear strength, compressibility, or permeability. In addition, foundation soils are often compacted to improve their engineering properties.

Prevent impact loading of any pipeline, shaft, structure, cabling, or other buried elements when placing and compacting backfill. There are a few common methods of backfilling and compacting backfill. Filling and compacting trenches for utility lines involves special considerations.

As a result, air and/or water is introduced to the soil mass and the soil increases in volume. To allow for construction of a structure, these air voids and water particles must be removed in order to be able to support what is being built. There are four ways of compaction: kneading, static, and dynamic or impact and vibratory compaction.

2.4.1. Objectives of soil compaction

Compaction of the soil and removing air voids generally increases the soil's sheer strength, decreases its compressibility, and decreases its permeability. It will reduce the voids ratio making it more difficult for water to flow through soil.

- Increase bearing capacity
- Increase durability
- Increase resistance to deformation
- Decrease frost damage
- Increase stability
- Decrease permeability

Soil can be cohesive or non-cohesive, where particles in cohesive soil bond one to another, while in non-cohesive soils, particles lie one on top of the other without bonding.

2.4.2. Compaction in different types of soils

The embankments are constructed with locally available soils, provided it fulfills the specified requirements. Procedure of compaction to be adopted will depend on the type of soil being used in construction. General guidelines to deal with compaction of various types of soils for attaining optimum dry density/relative density at minimum effort, have been briefly given as under:

Figure27: Compaction of Soils (Using loader)

2.4.3. Compaction of cohesion less gravely and sandy soil

Sandy & gravely soils should be compacted with vibratory rollers. If fines are less in these types of soils, it can be compacted with minimum number of passes of vibratory rollers without strict control of moisture to achieve desired Relative Density. With higher percentage fines, sandy and gravely soils need to be brought to OMC level to get effective compaction. Uniformly graded sand and gravel are difficult to be compacted. Top layer of sand and gravel remains loose in vibrating compaction.

Poorly graded sand and gravel with Cu < 2.0, should not be used in earthwork for the banks to safeguard against liquefaction under moving loads or especially due to earthquake tremor. Generally, fine sand is prone to liquefaction.

2.4.4 Compaction of silty – clayey soils

Silty soil is a fine-grained soil. These can be plastic or non-plastic depending upon the clay content in it. Silts and fine sands with high water content have a tendency to undergo liquefaction under vibrating rolling due to the pore water pressure generated by mechanical work. Silty soils can be compacted satisfactorily near about OMC either with smooth rollers or vibratory rollers. Vibratory roller will give high degree of compaction and higher lift. Compaction of silty clays will have to be handled in a manner similar to clays.

2.4.5. Compaction of clays

i) Water content plays very important role in compaction of clays. Main objective of compacting clays is to achieve uniform mass of soil with no voids between the lumps of clays. If moisture content is too high, roller tends to sink into the soil and if too low the chunks would not yield to rolling by rollers. Appropriate water content i.e.

ii) Thickness of layer should not be more than depth of feet of roller plus 50 mm. Pad foot vibratory roller with drum module weight of 7tonne (total static weight of 11 tons) for a lift thickness of 30 cm is found quite effective for compaction of clays.

2.5 Tools and equipments used in backfilling and compacting

Smooth wheeled vibratory roller of 10T weight. Smooth wheeled vibratory roller of 2T weight (to be used in the case it is found difficult to deploy 10T roller)

- Pneumatic roller / Plate Compactor
- Hydraulic excavator
- Tractor / trucks
- Spade
- Rammer
- Wedge
- Boning Rod
- Sledge Hammer
- Basket
- Iron Pan
- Line and Pins
- Hydraulic compactor
- Smooth wheel rollers
- Pneumatic tired rollers
- Sheep's foot rollers
- Vibratory rollers
- Vibrating plate compaction equipment
- Tamper
- Grid rollers

2.6. Backfilling materials

- **Course grained soil:** Coarse-grained soils include gravelly and sandy soils and range from clayey sands (SC) through the well-graded gravels of gravel-sand mixtures (GW) with little or no fines.
- **Fine graded Soils of low to medium plasticity:** In organic clays (CL) of low to medium plasticity (gravelly, sandy, or silty clays and lean clays) and inorganic silts and very fine sands (ML) of low plasticity (silty or clayey fine sands and clayey silts) are included in this category.
- **Commercial by-products:** The use of commercial by-products, such as furnace slag or fly ash as backfill material, may be advantageous where such products are locally available and where suitable natural materials cannot be found. Fly ash has been used as a lightweight backfill behind a 25-foot-high wall and as an additive to highly plastic clay. The suitability of these materials will depend upon the desirable characteristics of the backfill and the engineering characteristics of the products.
- **CLSM:**CLSM is a self-compacting, flow able, low-strength cementations material used primarily as backfill, void fill and utility bedding as an alternative to compacted fill. Conventional CLSM mixtures usually consist of water, Portland cement, fly ash or other similar products, fine or coarse aggregates or both. Fly ash obtained from thermal power plant was used
- **Backfilling by excavated material:** After completion of the foundation works, the spaces left in the pits and trenches shall be cleared of debris, brickbats, mortar droppings etc. prior to the start of backfilling. In case of plinth filling the backfilling as per the above procedure shall be continued up to the bottom of the plinth beam. The top surface at this stage shall be flooded with water for a minimum of 24 hrs. and defects in backfill shall be rectified and shall be trimmed to the desired level of slope, if any. Further filling within the plinth beams shall be controlled backfilling and soling as indicated in the relevant drawings.
- **Backfilling by sand**: Sand shall be used as filling material between foundations where space for proper compaction by mechanical means is not available and when directed by the Engineer-in-charge. Sand shall be spread in 200 mm thick layers, flooded with water and rammed. Top layer of sand shall be compacted by mechanical means.

2.6.1Quality checks for backfilling

The quality of the backfilling material and the whole process should be checked through:

- Recording initial ground level
- Sample is approved for back filling.
- Necessary marking/ reference points are established for final level of backfilling.
- Back filling is being carried out in layers (15cm to 20cm).
- Required watering, compaction is done.
- Required density is achieved.

Self-Check -2	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. Soils are compacted to----------
   A. increase their density and shear strength
   B. increase permeability and future settlement
   C. decrease resistance to deformation
   D. Decrease stability
2. Hand tool used for backfilling
   A. Hammer
   B. Tamper
   C. Spade
   D. Vibratory roller
3. It is used to compact the soil
   A. Tamper
   B. Spade
   C. Excavator
   D. Pickaxe
4. One of the following is a backfilling material
   A. Course grained soil
   B. Fine grained soil
   C. Silty clays and lean clays
   D. All
5. The key points in the backfilling operations are
   A. Use good quality backfill
   B. Ensure no voids in surround
   C. Balance fills either side as fill progresses
   D. all

Note: **Satisfactory rating - 5 points and above** **Unsatisfactory - below 5 points**

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

Answer Sheet-2

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. ----------
2. ----------
3. ----------
4. ----------
5. ----------

Information Sheet-3	Removing excess soil, debris and unwanted materials

3.1. Excess soil/debris and unwanted materials

Excess soil, debris and unwanted materials should be carted away according to the standard procedure after backfilling and compaction."Excess soil" is soil that has been excavated, mainly during construction activities, that cannot or will not be reused at the site where the soil was excavated and must be moved off site. In some cases, excess soil may be temporarily stored at another location before the excess soil is brought back to be used for a beneficial reuse at the site where the soil was originally excavated.

Excess soil must be managed in a sustainable manner in order to maintain a healthy economy while protecting the environment. Construction waste consists of unwanted material produced directly or incidentally by the construction or industries. This includes building materials such as insulation, nails, electrical wiring, shingle, and roofing as well as waste originating from site preparation such as dredging materials, tree stumps, and rubble. Construction waste may contain lead, asbestos, or other hazardous substances.

3.2. Methods of removing excess soil

Many construction and demolition materials are highly reusable or recyclable and many of these materials are still going to landfills. Like other recycling efforts, there are more management options for C&D debris that isn't mixed with other waste, so it's important to separate reusable or recyclable materials from other debris when possible.

Materials from construction sites that can generally be reused, recycled or composted include the following:

- Aluminum siding
- Architectural antiques
- Asphalt
- Asphalt shingles
- Brick/masonry
- Carpet
- Carpet pad
- Concrete
- Concrete painted with lead-based paint
- Gas pipe/metal pipe

- porcelain plumbing fixtures
- PVC pipe
- site clearance vegetative woody debris
- steel - structural or rebar
- untreated lumber and other wood
- vinyl siding; and
- wallboard/drywall (gypsum)

Ways of reusing construction left over's:

- Take advantage of the spring growing weather to create new gardens for vegetables or flowers. Build garden boxes or raised gardens and fill in this space with the extra soil you now have.
- Level out sloped areas in the garden which have always annoyed you.

There are two principal methods for forming soil stockpiles, based on their soil moisture and consistency.

Method 1: should be applied to soil that is in a dry and non-plastic state. The aim is to create a large core of dry soil, and to restrict the amount of water that can get into the stockpile during the storage period. Dry soil that is stored in this manner can remain so for a period of years and it is reusable within days of re-spreading.

Method 2: should be applied if the construction programme or prevailing weather conditions result in soil having to be stockpiled when wet and/or plastic in consistency. This method minimizes the amount of compaction, while at the same time maximizing the surface area of the stockpile to enable the soil to dry out further. It also allows the soil to be heaped up into a ‘Method 1’ type stockpile, once it has dried out.

Self-Check -3	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1**.** Restore work site activities

A. removing excess soil

B. removing Debris

C. removing unwanted materials

D. All

2. Construction waste consists of unwanted material produced directly or incidentally by the construction or industries. It includes

A. nails

B. dredging materials

C. tree stumps

D. All

Note: **Satisfactory rating - 2-point sand above** **Unsatisfactory - below 2points**

You can ask you teacher for the copy of the correct answers Answer Sheet-3

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice Questions

1. ----------
2. ----------

Information Sheet-4	Restoring work site

4.1. Surface Restoration

All areas disturbed as a result of construction shall be restored to their original condition as nearly as possible, or surfaced as shown on the Plans. All excess material shall be removed from the site. Any damaged concrete walks or driveways shall be restored. All dirt and debris that accumulates from the

Contractor's operations shall be removed from inlets, catch basins, connecting pipelines and similar structures. Any material entering manholes or ditch culverts from street resurfacing and trenching work shall be removed. Daily cleanup of all visible mud and debris is required. All open fields, unpaved public rights-of-way or easements, and other areas not used as driveways, as shown on the Plans or as directed by the Engineer, shall be restored by placement of 12 inches of topsoil, fine grading, and hydro seeding.

Surface Dressing - Slopes, sidewalk areas, planting areas, and roadway shall be smoothed and dressed to the required cross section and grade by means of a grading machine, insofar as it is possible to do without damaging the work or existing improvements, trees, and shrubs. Machine dressing shall be supplemented by handwork, as directed. Work site restoration includes the following activities: -

- Backfilling
- Compacting
- Planting or replanting vegetation
- Reinstating site

4.2. Planting or replanting vegetation

Trees and shrubs add beauty and value to residential and commercial property. They help modify microclimates around buildings and outdoor living areas. Best of all, trees and shrubs are not difficult to establish and maintain. To achieve success with landscape trees and shrubs, correct plant selection, proper timing of planting, and correct planting techniques should all be employed. Selection includes choosing the proper species and selecting the appropriate root condition for successful transplanting. Timing the planting operation can be crucial to the survival of many tree and shrub species. In addition, proper planting techniques are important

for economy of effort in the planting operation and for the long-term survival and vigor of the tree or shrub. It is all a matter of knowing what, when, and how to plant for success, Perform the following

- Plan before planting. Have a landscape plan.
- Handle the plants carefully at all times.
- Follow the recommendations on planting time.
- Make the hole large enough; make it at least 1 foot wider and the same depth as the soil ball, the container, or the bare root.
- Never plant deeper than the depth in which the plant was originally growing.
- Take proper precautions when planting in heavy, poorly drained, or sandy soils.
- Do not fertilize in the first year except at the first watering.
- Carry out an accurate watering program for the entire first season.

4.3. Reinstating site

To undertake soil reclamation, erosion protection, *Site* restoration and reinstatement, taking into account natural processes, operational requirements and technical feasibility, to deliver post-construction land to the conditions appropriate for its future intended use as agreed with the relevant authorities and/or landowner.

Specific objectives of Site reclamation and restoration are to:

- Achieve long-term stabilization against erosion;
- Restore to the maximum extent possible the hydrological regime and reinstate natural drainage of the land (including provisions to maintain the water balance of the site and protect from flooding where appropriate;
- Return the land to as close to original contour as allowed for by RF law and the landowner;
- Avoid import of foreign material where possible (e.g. reserve and reuse river gravel, bank boulders);
- Reinstate topsoil (in case it was stripped before construction activities);
- Re vegetate sites with suitable native plant species;
- Discourage illegal/increased access to previously inaccessible areas through the removal of temporary construction roads and appropriate use of fencing and other measures to restrict access where possible;

- Restore impacted habitats and ecological processes to their original status where this can technically be achieved;
- Utilize an appropriate combination of engineered solutions and soft bio-engineering techniques to gain the best environmental outcome; and
- Ensure that sites are suitable for future intended uses.

Construction work site restorations include:

- Cleaning up the construction site
- Applying best management measures for SWC
- Site maintenance
- Disposition of debris
- Clearing and grubbing
- Cleanup of new materials and equipment

Self-Check -4	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. One of the following is Work site restoration activities
   A. Backfilling
   B. Compacting
   C. Planting or replanting vegetation
   D. All
2. Construction work site restorations include
   A. Cleaning up the construction site
   B. Site maintenance
   C. Disposition of debris
   D. All
3. Specific objectives of Site reclamation and restoration are
   A. Achieve long-term stabilization against erosion
   B. Reinstate topsoil
   C. Ensure that sites are suitable for future intended uses
   D. All

Note: **Satisfactory rating - 3 point sand above** **Unsatisfactory - below 3points**

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

Answer Sheet-4

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice Questions

1. ----------
2. ----------

Operation Sheet -1	Technique of backfilling construction work site of concrete foundation

Processes

Step 1. Select and Wear appropriate PPE

Step 2. Select appropriate tools and equipment fitting for the purpose

Step 3. Be sure that the foundation cures for at least five to seven days.

Step 4. Determine the types of material you will use for foundation back fill.

Step 5. Back fill the entire section surrounding the foundation

Operation Sheet -2	Procedures of compacting construction work site in the field

Follow these procedures

Step1. Select and wear appropriate PPE

Step 2. Select fill material and borrow area

Step 3 Select compaction tools and equipment

Step 4. Compact the soil according to the standard

Step 5. Control compaction process

Operation Sheet -3	Procedures of Compacting construction work site using tamper

Procedure

Step 1: wear appropriate personal protective equipment

Step 2: prepare tools and equipment requires for compaction

Step 3: Refill the excavated area

Step 4: Compact the soil

Step 5: Compact again and again until the soil get its strength

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8hours.

Task 1: Back fill concrete foundation using hand tools

Task 2**:** Perform compaction of construction work site

Task 3: Perform compaction activities using tamper

Instruction Sheet	Learning Guide-82: Review, record and report activities

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

- Maintaining and storing equipment, tools and materials
- Maintaining workplace records

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

- Check, maintain and store Equipment, tools and materials according to manufacturer guidelines and organizational procedures.
- Maintain Workplace records as required.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4” in page 97 and 100 respectively.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self- check 4” -” in page 99 and 103 respectively
5. If you accomplish the self-checks, do operation sheet in page 104
6. LAP Test in page 106

Information Sheet-1	maintaining and storing equipment, tools and materials

1.1 Introduction to maintenance of tools and equipments

The technical meaning of maintenance involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure, and supporting utilities in industrial, business, governmental, and residential installations. Over time, this has come to include multiple wordings that describe various cost-effective practices to keep equipment operational; these activities take place either before or after a failure.

All tools, equipment and vehicles must be properly maintained so that workers are not endangered. Construction regulations require inspections of vehicles, tools, machines and equipment before use.

1.2. Purpose of equipment and tools maintenance

- To keep equipment/system operative.
- Attempttomaximizeperformanceof productionequipmentefficientlyandregularly
- Prevent break down or failures
- Minimize production loss from failures
- Increase reliability of the operating systems
- To keep operation safe
- To prevent leakages/losses
- To achieve product quality and customer satisfaction through adjusted and serviced equipment
- Maximize useful life of equipment
- Keep equipment safe and prevent safety hazards
- Minimize frequency and severity of interruptions
- Maximize production capacity through high utilization of facility

1.2. Key points for Maintenance of Equipment

- Maintain Tools and Identify when equipment requires maintenance.
  - ✓ Regularly check all equipment
  - ✓ Recognize and report unsafe equipment
  - ✓ Identify and be aware of scheduled maintenance

- ✓ Be aware of manufacturer's instructions
- ✓ Use safety equipment and guards as instructed¬Report all equipment issues with supervisors
- ✓ Use organizations appropriate documentation as supplied

- Store tools and equipment
  - ✓ Choose Correct conditions to store tools
  - ✓ Store in an appropriate safe location in accordance to the correct conditions
  - ✓ Store safely when transporting
- Consider the environment when cleaning equipment.
  - ✓ Contaminants into waterways
  - ✓ Wastage of water
  - ✓ Recycling

Self-Check -1	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. One of the following is not purpose of maintenance
   A. Minimize useful life of equipment
   B. Prevent breakdown or failures
   C. Keep equipment safe and prevent safety hazards
   D. To keep equipment/system operative
2. The correct way of storing tools and equipment
   A. Store safely when transporting
   B. Choose Correct conditions to store tools
   C. Store in an appropriate safe location
   D. All
3. One of the following is environment Consideration when cleaning equipment
   A. Contaminants into waterways
   B. Wastage of water
   C. Recycling
   D. All

Note: **Satisfactory rating - 3 point sand above** **Unsatisfactory - below 3 points**

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

Answer Sheet-1

Score = _____

Rating: _____

Name: _____ Date: _____

Multiple choice Questions

1. ----------
2. ----------

Information Sheet-2	Maintaining workplace records

2.1. Introduction to workplace records

Records to be maintained at construction sites play important role in construction activities. It is a document required to prove any construction activity has taken place at site during billing or any other claims.

These records have all the data of various construction activities carried out at site. If any additional work has been carried out and it is claimed during billing, these documents need to be produced as a proof. Maintenance of records also helps during audits of construction projects at any point of time. These documents help to defend any claims such as liquidated damages or false claims or violations of any guidelines by authorities or clients.

2.1 Records at Construction Site

The following are the various records that need to be maintained at construction site,

- Drawings
- Contract Agreement
- Time and Progress Charts
- Work Orders
- Works Diary
- Works Passing Records
- Tests Results Record
- Cement Register
- Register for Approval of Samples
- Records of Changes, Deviation Orders and Amendments
- Measurement Books
- Labour Attendance Record and Daily Wages Sheet
- Periodic Bills Record
- Daily reports or diaries
- Photographs and Video recordings
- Meeting Minutes
- Schedules
- Change Orders

- Project Correspondence Files
- Inspection Reports
- Cost Accounting Records
- Equipment Records

2.2. Purposes of records

Reasons for record keeping include in construction:

- Legal requirements
- Contractual requirements
- To control work
- To provide data for future work

Good records will help you do the following:

- Monitor the progress of your business
- Prepare your financial statements
- Identify sources of your income
- Keep track of your deductible expenses
- Keep track of your basis in property
- Prepare your tax returns
- Support items reported on your tax returns

The extent of the record keeping required will depend on the type of project. A balance must be maintained between keeping adequate records in preparation for a dispute arising, and attempting to record everything, which is can be difficult, time consuming and costly.

Some record-keeping requirements, such as recording the minutes of meetings for example, may be carried out at the discretion of the individual organization, with different frequency rates, levels of detail, and time for which records must be kept, appropriate for different situations. Other records may be a legal or contractual requirement, following prescribed rules.

2.3 Record Management

The purpose of record management is to ensure that business activity records of evidential quality are created, managed and disposed of in accordance with legal requirements. Records can include, but are not limited to, the following:

- Health and safety local action plans
- Internal evaluation reports
- Hazard and other registers
- Corrective actions register

2.4. Managing data and records across the data life cycle

Data processes should be designed to adequately mitigate and control and continuously review the data integrity risks associated with the steps of acquiring, processing, reviewing and reporting data as well as the physical flow of the data and associated metadata across this process through storage and retrieval.

Quality risk management of the data life cycle requires understanding the science and technology of the data process and their inherent limitations. Good data process design, based upon process understanding and the application of sound scientific principles, including quality risk management, would be expected to increase the assurance of data integrity as well as result in an effective and efficient business process.

Data integrity risks are likely to occur and be highest when data processes or specific data process steps are inconsistent, subjective, open to bias, unsecured, unnecessarily complex or redundant, undefined, not well understood, manual or paper-based, based upon unproven assumptions and/or not adhering to GDP. Good data process design should consider, for each step of the data process, ensuring and enhancing controls, whenever possible, that ensure each step is:

- consistent;
- objective, independent and secure
- simple and streamlined
- well-defined and understood
- automated
- scientifically and statistically sound;

Self-Check -2	Written Test

Direction I: Multiple choice questions

Instruction: Choice the best answer from the given alternative and write your answer on the answer sheet provided in the next page (2 point each)

1. The good data gathering should be
   A. objective, independent and secure
   B. well-defined and understood
   C. scientifically and statistically sound
   D. all

2. Reasons for record keeping in construction is
   A. Legal requirements
   B. To control work
   C. To provide data for future work
   D. all
3. The of the following is a record data maintained at construction site
   A. drawing
   B. work order
   C. test result record
   D. all

Note: **Satisfactory rating - 3-point sand above** **Unsatisfactory - below 3points**

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

Answer Sheet-2scors

Scoring=_____

Rating=_____

Name: _____ Date: _____

Multiple choice Questions

1. ----------

2. ----------

Operation Sheet -1	Procedure of maintaining excavation tools and equipments

Steps of tools and equipment maintenance

Step 1: Select and wear appropriate PPE

Step 2: Select appropriate tools and equipment

Step 3: Clean your tools. Cleaning the tools regularly is essential to their proper functioning

Step 4: Protect electrical cords. Airlines and electrical cords are prone to heavy damage since they are generally in the way of construction vehicles, and foot traffic

Step 5: Lubricate tools

Step 6: Inspect tools regularly

Step 7: Store tools with care

Operation Sheet -2	Techniques of maintaining construction work place documents

Steps of workplace maintenance

Step 1: Identify and handle records in accordance with enterprise procedures.

Step 1: Track location of records.

Step 1: Apply security controls to ensure the integrity of records is not compromised.

Step 1: Maintain workplace records systems.

Step 1: Identify problems and take appropriate action.

Operation Sheet -3	Techniques of creating a simple record keeping system in a work place

Procedures of record keeping

Step 1: Select and appropriate tools and equipments

Step 2: Capture the information.

Step 3: Check to make sure the information is complete and correct.

Step 4: Record the information to save it.

Step 5: Consolidate and review the information.

Step 6: Act based on what you know.

Operation Sheet -4	Techniques of managing construction records in a work place

Steps of record managing system

Step 1: Identify the functions and activities for which each program is responsible

Step 2: Determine what records are needed to document those activities and functions

Step 3: Create sufficient records to document those activities and functions.

Step 4: Maintain those records in a way that allows all persons who need access to find and retrieve what they need.

Step 5: Remove or destroy records only with authorization; don't retain records authorized for destruction.

Step 6: Keep official records separate from non-record materials.

Step 7: Make someone responsible for the records program.

Step 8: Transfer records identified as permanent to the National Archives as required.

Step 9: Protect vital records appropriate to their value.

Step 10: Protect records that contain security classified, confidential business, or other types of sensitive information with appropriate safeguards.

Step 11: Do all of this in a manner that is as cost effective as possible.

LAP Test -1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 8hours**.**

Task 1: Maintain excavation tools(shovel)

Task 2: Maintain construction work place documents found in your nearby construction firm

Task 3: Create a simple record keeping system in a given work place

Task 4: Manage construction records ina given work place

REFERENCES

1. Charles VelsonHorie (2010). *Materials for Conservation: Organic Consolidates, Adhesives and Coatings (2nd ed.);* Butterworth-Heineman.

2. Erik Sandberg-Diment (1984). *Personal computers preventive maintenance for an aging computer*; NY Times.com.
3. http://www.businessdictionary.com/definition/record.html
4. https://www.youtube.com/watch?v=0AiQPWL3epE
5. https://www.youtube.com/watch?v=kUqBUJEqwKA
6. https://www.youtube.com/watch?v=Rh3rJTVO3Fg
7. Jardine, A.K.S.; Lin, Banjevic (2006). *A review on machinery diagnostics and prognostics implementing condition-based maintenance:* Mechanical Systems and Signal Processing.

Liu,Jie; Wang, Golnaraghi (2010).*An enhanced diagnostic scheme for bearing condition monitoring*; IEEE Transactions on Instrumentation and Measurement.

MicharlDecourcy Hinds (1985). *Preventive Maintenance: A Checklist;* The New York Times.