Farm Machinery and Equipment Operation

Level – II

Based on March, 2022 Version II Occupational Standard

Module title: Conducting Backhoe/ Front-End Loader Operations

LG Code: AGR AMO2 M05 LO (1-4) LG (22-25)

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Introduction to the Module

This module covers the knowledge, attitude and skills required to Prepare for Work Operate backhoe/ loader; Carryout Lift, carry and place materials; Carry out machine maintenance; Check, Clean and store Backhoe/Loader.

LG #22 LO #1 : -Prepare for Works

Instruction sheet

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

- Identifying Compliance documentation relevant to conduct backhoe/loader tasks
- Identifying Work instructions and Safety requirements
- Conducting machine pre-operational checks
- Starting-up, parking and shutdown procedures
- Checking machine controls and functions and reporting faults.
- Identifying and implementing signage requirements
- Reading and interpreting site drawing and plans
- Selecting and fitting appropriate attachments
- Identifying Environmental protection requirements
- Identifying Basic principles of soil technology for civil works

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

- Compliance documentation relevant to conduct backhoe/loader tasks
- Work instructions and Safety requirements
- Conduct machine pre-operational checks
- Start-up, park and shutdown procedures
- Check machine controls and functions and reporting faults.
- Identify and implement signage requirements
- Reading and interpret site drawing and plans
- Select and fit appropriate attachments
- Environmental protection requirements
- Basic principles of soil technology for civil works

Learning Instructions:

1) Read the specific objectives of this Learning Guide.
2) Read the information written in the "Information Sheets". Try to understand what are being discussed.
3) Ask your teacher for assistance if you have hard time understanding them.
4) Accomplish the "Self-checks "
5) You will be also provided with additional reference reading materials regarding power train.
6) Ask your instructor for additional referencing videos and audios

Information Sheet 1

1.1. Compliance documentation relevant to conduct backhoe/loader tasks

A backhoe loader, also called a loader backhoe, loader excavator, digger in layman's terms, or colloquially shortened to backhoe within the industry, is a heavy equipment vehicle that consists of a tractor-like unit fitted with a loader-style shovel/bucket on the front and a backhoe on the back. Due to its (relatively) small size and versatility, backhoe loaders are very common in urban engineering and small construction projects (such as building a small house, fixing urban roads, etc.) as well as developing countries.

This type of machine is similar to and derived from what is now known as a TLB (Tractor-Loader-Backhoe), which is to say, an agricultural tractor fitted with a front loader and rear backhoe attachment.

1.1.1. Component Parts of Backhoe:

When construction crews need to accomplish landscaping tasks such as clearing trees, creating small ponds, or moving topsoil, they use a backhoe loader. These versatile machines are great assets to practically any construction. Thinking about a career in construction? The construction industry is full of opportunities for those with the right training and certification. Attaining proper training doesn't just set you up for success in construction but gives you a better understanding of the machinery and equipment you'll operate.

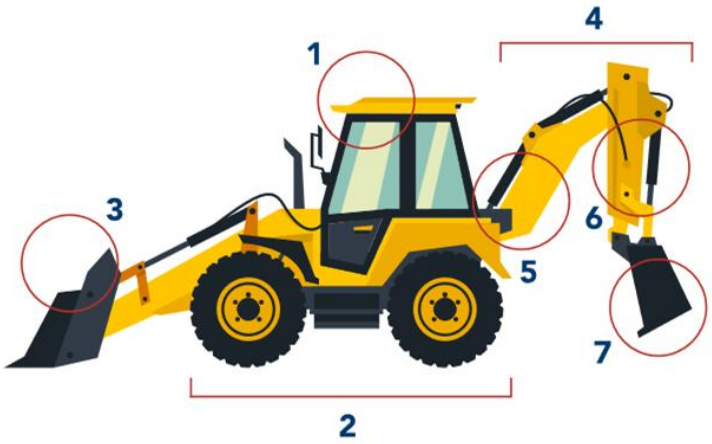

Figure 1.1 Component parts of Backhoe loader

https://www.youtube.com/watch?v=HIsWO1peKPQ (Accessed date 05/5/23)

The numbers that can be indicated from the above figure are parts of backhoe

1. **Cab**

The cab located on top of the tractor, is where you find the controls for the front loader backhoe. Some cabs are completely enclosed by safety glass, while others use an open canopy structure to protect the operator. Inside the cab, an operator can monitor their entire surroundings from a safe position. The chair inside the cab can rotate, allowing you to switch from using the front loader to the backhoe easily.

2. **Tractor**

Without the tractor, a backhoe loader would have a difficult time maneuvering in terrain. The tractor consists of large tires, a cab, and a

powerful engine. The main function of the tractor is to get the machine around the construction site. Once in position, the operator will park the tractor before using the backhoe or loader.

3. **Front loader**

Whether you're moving earth, pushing snow, or picking up debris and materials, you'll use the backhoe's front loader. A front loader is mainly just the large bucket used to move and transport materials from one spot to another. You might also find operators using the front loader to smooth out surfaces as well

4. **Backhoe**

The backhoe excavates or lifts heavy materials. The backhoe portion of the machine consists of three main components: the boom, the bucket, and the dipstick. In order to use the backhoe, you must first park the tractor in a stable position using stabilizer legs. Then you can use the backhoe to dig up trenches, holes, small ponds, or similar applications.

5. **The boom**

Located closest to the cab, the boom is the long piece of the backhoe arm attached to the tractor. The boom can lift, lower, or swing left and right. An operator controls the motion of the boom from the safety of the cabin.

6. **Dipper arm**

The other main part of a backhoe arm is the dipstick. The dipstick runs from the pivot to the bucket located at the end of the backhoe arm. The dipstick stabilizes the weight of the materials inside the bucket.

1.1.2. Components parts of front-end loader

Front end loader can be define as wheeled vehicle with a hydraulically operated scoop in front for excavating and loading loose material. Or a loader having a shovel or bucket at the end of an articulated arm located at the front of the vehicle.

On large projects materials like earth and aggregates will have to be lifted and dumped into carrier units for transporting over long distances. The loading is done by front end loaders in most cases because of their ease of operation and good production rate. Materials and structural members are required to be raised from the ground level to some height where they are required to be placed. This lifting is done by means of cranes in most cases.

The main components of a wheel loader include engine, torque converter, gearbox, front and rear drive axles, referred to as four major part.

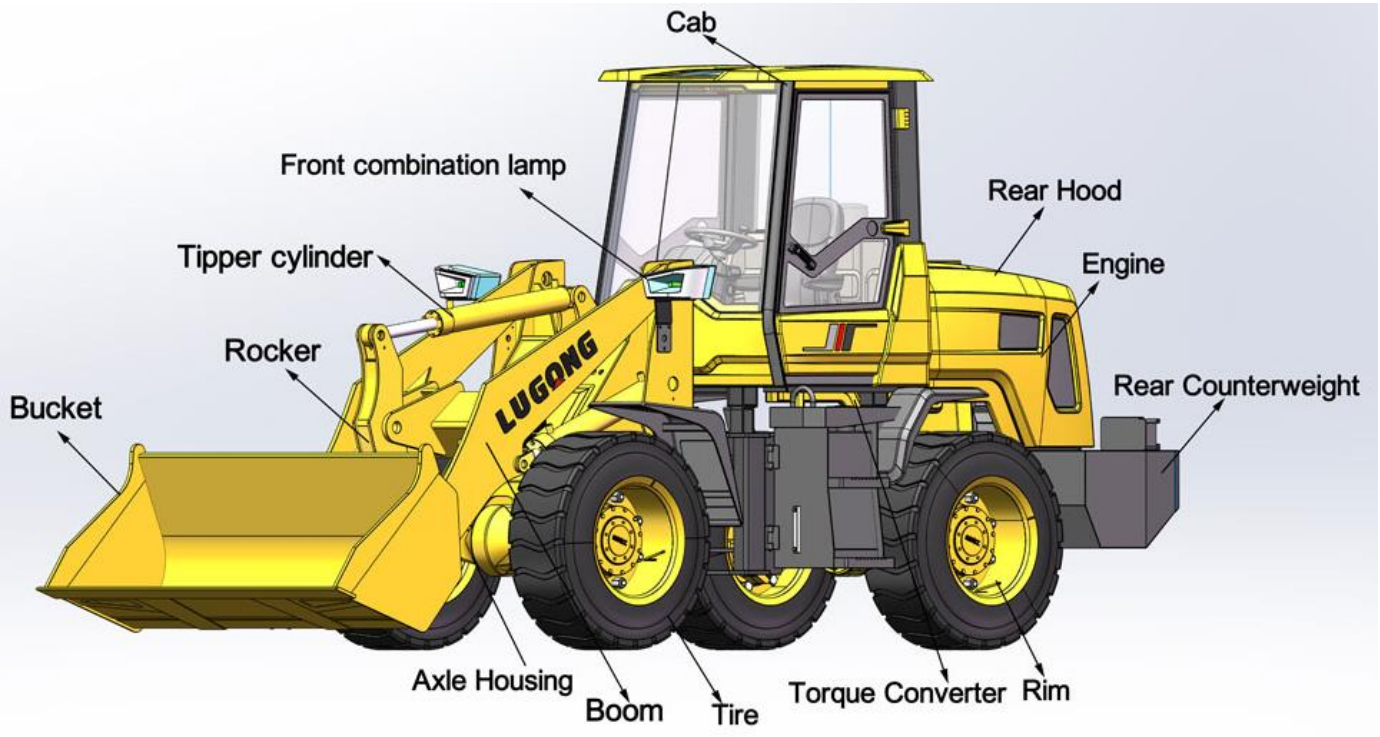

Figure 1.2 Component parts of front end loader

https://youtu.be/tqSr6e27J7w (Accessed date 05/05/23)

Front end loader is a common engineering transportation and agricultural equipment. The seemingly complex equipment includes these main parts and supporting parts. Today, let's take a look at the main components of a wheel loader.

The main components of a wheel loader include engine, torque converter, gearbox; front and rear drive axles, referred to as four major parts.

Common Components include

- Bucket
- Bucket link
- Bell crank
- Cylinder
- Cab
- Transmission
- Torque converter
- Engine
- Radiator
- Axle assembly
- Axle housing
- Rim
- Wheel assembly
- Steering cylinder
- Boom lift cylinder
- Boom

Different types of wheel loaders have different parts and components, so when selecting parts, you should note the brand and model of the equipment.

1.1.3. Benefits of using a front-end loader at job sites

These loading machines can provide numerous job site benefits from those benefits:

A. Maneuverability: The front-end loader's four-wheel-drive capabilities enable it to maneuver over rugged terrain quickly and easily, which increases productivity.

B. Power: Wheel loaders also have larger engines and are more powerful than most tractors, making them an excellent choice for heavy-duty farming tasks.

C. Mobility: Their speed enables these loaders to scoop materials, transport their load to the dumping vehicle and complete the process quickly over multiple trips.

D. Variety: Wheel loaders are available in different sizes and configurations, including compact, small, medium and large versions. Models are also available for specialty applications like waste and material handling.

1.1.4. Front-end loader features overview

The front-end loader's distinguishing characteristics include:

- Four wheels: These machines have wheels, leading many construction professionals and other users to refer to them as "wheel loaders."
- Large rectangular bucket: The bucket connects to the front of the machine via two hydraulically powered arms.
- Enclosed cab: The operator sits in a cab directly behind the hydraulic arms and controls the machine's horizontal movement and bucket. An expansive windshield promotes visibility and keeps out dirt and debris.
- Mounting systems: Many wheel loader models have couplers that enable operators to add and switch work tool attachments to enhance the machine's versatility and value.

1.1.5. Attachments compatible with front-end loaders

The right work tool attachment can transform a wheel loader into a multifunctional machine that can serve many purposes. For example, you can change the bucket to increase the loader's material handling capacity or volume. You can also add snow blades, rakes, grapples, buckets and many other options.

Besides increasing the loader's functionality, attachments can save time and reduce operating costs. Operators can move from one task to another by making a fast tool change, which they can do without leaving the cab if the model is equipped with quick couplers. Attachments can also prevent the need for and additional expense of using or acquiring multiple machines.

1.1.6. Difference between backhoe and front end loader

The backhoe loader is one of the most popular heavy earth moving equipment’s in the market today from the huge commercial sites to the smaller ones, you are bound to find a backhoe on every job site across the world. While some of the functions like moving dirt may be similar, the method and speed of time taken vary by a sizeable margin.

A loader is heavy equipment used in construction. A loader is also called a bucket loader, front loader/front end loader, shovel loader wheel loader etc. A loader is attached to the front end of the machine on which it is mounted. A loader is used for various moving and loading materials like asphalt, dirt, snow, demolition debris, gravel, logs raw minerals, rock salt, sand wood chips

etc. A loader is a type of tractor usually wheeled and at times tracked. The loader has a square bucket attached to the front at two booms to collect the loose material from the ground and move it from one place to another. A loader is usually used to collect piled material to an awaiting dumbstruck for transportation.

The assembly of the loader may be removable or attached permanently. The bucket can be replaced with other attachments like clamshell buckets, bale grapplers, forklifts etc. Large loaders with only a front bucket are called front loaders while the smaller machines with a small backhoe are called **backhoe loaders**. A loader is not the best machine for digging since it cannot dig very deep below the level of its wheel.

A backhoe loader is also known as a rear or back actor. The backhoe is an excavating equipment digger that has a bucket at the end of a two part articulated arm. The backhoe is usually mounted on the back end of the tractor. It is called backhoe due to its digging motion which is in the backward direction towards the machine unlike the way humans shovel things straight outwards. The backhoe is capable of digging much deeper compared to the loader. It is primarily use for excavations and material handling.

The bucket of the backhoe can be replaced with hydraulic power attachments like the tilt rotator, auger, grapple, breaker etc. The bucket of a backhoe is much smaller compared to that of a loader. While both the backhoe and the loader both move dirt, loaders are usually articulated while the backhoe is one articulated unit.

The boom stick and dipper arrangement make it easier for the backhoe to gig deep and with much faster cycles due to its hydraulic power. While both the machines have their differences, it is when both these machines come together that the much-loved backhoe loader takes shape to become one of the most versatile heavy equipment available in the market today.

1.1.7. Functions of back hoe/front-end Loader

Backhoe/Front end loader has many functions those functions include

- **Material removal**: The most common wheel loader use is scooping, transporting and loading loose materials at a construction, mining, or quarry and aggregates site.
- **Snow removal:** Equipping a loader with a snow blade lets it clear snow from highways, parking lots, city streets and even large driveways.
- **Agriculture**: Farmers can use a wheel loader for many purposes. A grapple attachment enables the machine to grasp, lift and transport bales of hay and load them onto a vehicle. The bucket can scoop feed, seeds or manure.
- **Material handling**: Installing a fork enables a front-end loader to serve as a lift truck to load and move heavy objects in an outdoor storage or warehousing area
- **Site clearing:** Demolition operations use wheel loaders to remove piles of rubble after bringing down a building or other large structures.
- **Waste handling**: Salvage yards and recycling yards can use a waste handler version to pick up and transport bales of trash to a dumping area.

1.2. Work instructions and Safety requirements

Work instructions refer to documented guidelines that clarify how to perform assignments. They provide precise descriptions of task-related steps to reduce potential setbacks, damages, and inconveniences. Work instructions are also known as work guides, job aids, or user manuals.

Work instructions include:

A. Plans

Loader Plans demystify the construction of a loader attachment for your tractor . Equipped with our experience and detailed information, you control your project's budget and schedule. Backhoe Loader Build Plans include:

- Complete build instructions
- Schematics for hydraulics
- 3D line-drawings
- A materials list for all steel, hydraulics and hardware
- A list of online suppliers

B. General backhoe loader instructions

Here are some of the items they are checking for; Perform a pre-inspection of the machine. Walk around the machine, and inspect for excessive wear, loose parts, leaks, cracks, or other damage. Check the engine compartment for excessive wear, loose parts, leaks, and fluid levels. Check the cab and other areas for excessive wear, damage, proper function, and cleanliness.

C. Safety instructions

According to WHO (1995), occupational safety and health can be defined as a multidisciplinary activity aiming at:

- Protection and promotion of the health of workers by eliminating occupational factors and conditions hazardous to health and safety at work
- Enhancement of physical, mental and social well-being of workers and support for the development and maintenance of their working capacity, as well as professional and social development at work
- Development and promotion of sustainable work environments and work organizations
- Placing and maintenance of worker in an occupational environment adapted to his physiological and psychological equipment.

Occupational health and safety is one of the most important aspects of human concern. It aims an adaptation of working environment to workers for the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations. The question of occupational health and safety, as a global issue, is now taking a new turn.

1.2.1. Personal protection equipment's (PPE) during operating backhoe/ front end loader

PPE, Personal Protective Equipment, are the tools that ensure the basic health protection and safety of users. PPE is any device or appliance designed to be worn by an individual when exposed to one or more health and safety hazards.

PPE includes all clothing and other work accessories designed to create a barrier against workplace hazards, and using PPE requires hazard awareness and training on the part of the user. Employees must be aware that the equipment does not eliminate the hazard; if the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition.

PPE includes the following

A. Protective hats

Head protection against impact blows must be able to withstand penetration and absorb the shock of a blow. In some cases, hats should also protect against electric shock. The wearer should be able to identify the type of helmet by looking inside the shell for the manufacturer.

Protective hats are made in the following types and classes:

- Type 1 - helmets with full brim, not less than 1 and 1/4 inches wide;
- Type 2 - brimless helmets with a peak extending forward from the crown.

For industrial purposes, three classes are recognized:

- Class A - general service, limited voltage protection;
- Class B - utility service, high-voltage protection; and
- Class C - special service, no voltage protection.

Hats and caps under Class A are intended for protection against impact hazards. They are used in mining, construction, shipbuilding, tunneling, lumbering, and manufacturing.

Figure 1.3 Head protection (Helmets)

B. Foot and leg protection

For protection of feet and legs from falling or rolling objects, sharp objects, molten metal, hot surfaces, and wet slippery surfaces, workers should use appropriate foot guards, safety shoes, or

boots and leggings. Leggings protect the lower leg and feet from molten metal or welding sparks. Safety snaps permit their rapid removal.

Safety shoes should be sturdy and have an impact-resistant toe. In some shoes, metal insoles protect against puncture wounds. Additional protection, such as metatarsal guards, may be found in some types of footwear

Figure 1.4 Feet and Leg Protector

C. Eye and Face Protection

Every protector shall be distinctly marked to facilitate identification of the manufacturer and must meet the following minimum requirements:

- Provide adequate protection against the particular hazards for which they are designed
- Be reasonably comfortable when worn under the designated conditions
- Fit snugly without interfering with the movements or vision of the wearer
- Be durable
- Be capable of being disinfected
- Be easily cleanable
- Be kept clean and in good repair.

D. Ear Protection

Exposure to high noise levels can cause hearing loss or impairment. It can create physical and psychological stress. There is no cure for noise-induced hearing loss, so the prevention of excessive noise exposure is the only way to avoid hearing damage. Specifically designed protection is required, depending on the type of noise encountered and the auditory condition of employee.

Figure 1.5 Ear protector

https://youtu.be/osGNCsNbjqo (Access date 3/05/23)

E. Arm and Hand Protection

Burns, cuts, electrical shock, amputation and absorption of chemicals are examples of hazards associated with arm and hand injuries. A wide assortment of gloves, hand pads, sleeves, and wrist-lets for protection from these hazards is available.

Figure 1.6 arm and hand protector

1.2.2. Safe work procedures for back hoe /front end loader

A. Before operating the backhoe loader

- Know your equipment and its limitations. Allow only trained personnel to operate or service this equipment.
- Read and understand all instructions and precautions found in both the tractor and the loader operator's manuals before using the loader. Lack of knowledge can lead to accidents.
- It is the owner's responsibility to ensure that anyone who will operate the loader reads this manual first and becomes familiar with the safe operation of the loader.
- For your safety, a ROPS with a seat belt is strongly recommended by KUBOTA in almost all applications. Do not wear the seat belt when a fold-able ROPS is down or a fixed ROPS is removed..
- Visually check for hydraulic leaks and broken, missing, or malfunctioning parts.
- Replace damaged or illegible safety labels. See following pages for required labels.
- When the front loader is mounted on the tractor, enter and exit the operator's seat only from left side of the tractor.
- Engage the loader control valve lock to prevent accidental actuation when the implement is not in use or during transport.
- Do not utilize the valve lock for machine maintenance or repair.
- Assemble, remove and reinstall the loader only as directed in this manual. Failure to do this could result in serious personal injury or death.
- Follow the precautions below when attaching implements.

B. During operating the backhoe loader

Special instructions:

i. Only persons who hold the appropriate National Certificate of Competency and who have been authorized to do so are to operate a tractor.

ii. This restriction does not apply to a person who is authorized to carry out maintenance or repairs to a tractor or an attachment.

Table1.1. Safe operating procedures and identified hazards

Task sequence	Identified hazards in task	Key processes to be followed	Precautions/PPE require
1. Pre-start checks	• Roll-over protection • Fuel and fluids • Tyre (rubber tyred units) • Tracks (tracked units) Bucket • Hydraulics	• Tractors must be fitted with an approved roll-over protective structure • (ROPS) unless specifically exempted by the appropriate statutory authority. • Check fuel, hydraulic oil, engine oil, transmission oil, coolant and battery. • Check tyre condition and pressures; remove any mud lumps from treads. • Check condition and tension of tracks • Inspect for worn or missing teeth or worn cutting edges. • Check arms and connections for excessive wear. • Check rams, hoses and connections for splits, leaks or fractures.	• Wear eye and hand protection. • Wear gloves.
2. Entry and exit	Slipping and falls	• Steps and ladders should be of a non-slip type. • Hand holds must be provided to assist operator to maintain 3 points of • Contact at all times while mounting or dismounting tractor.	
3. Operator position	• Seating • Seat belt • Controls • Cabin (if fitted) • Mirrors	• Seat should be well-sprung and adjustable to allow operator to maintain a • Comfortable operating position. • Seat belt must be fitted, correctly adjusted and worn when machine is used. • All levers and gauges must be clearly identified, within easy reach and be • Easily read. Preferred orientation should be such	• Adjust seat to suit personal need. • Seat belt must be worn when • Driving and operating.

		that all needles are in ● Vertical position during correct operating conditions. ● Adequate ventilation must be provided. ● Exhaust must be placed so as to not allow fumes to enter cabin. ● Clean and adjust mirrors before commencing work, and if bumped.	
4. Control	● Lights and alarms ● Steering and brakes ● Hydraulic controls	● Test all lights, indicators, horn and reversing alarm. ● Test steering both ways. Check braking and park brake operation. ● Lock separated brake pedals together if travelling. ● Test all hydraulic operations before loading bucket	Do not drive machine if faulty
5. Travel	● Passengers ● Loss of control ● Overturning	● Passengers must not be carried unless proper seat with seat belt fitted. ● Do not travel at speeds which may cause control to be lost over bumps, etc. ● Carry bucket as close to ground as possible and racked back for visibility. ● Avoid driving over obstacles, ditches, drains, etc which could affect control. ● Avoid travel across slope on a steep incline. ● Avoid sharp turns or turning at speed.	● Do not carry passenger unless ● dedicated seat is provided. ● Slow down to turn.
6. Operation	● Overturning ● Moving parts, crush injury ● Dust, falling	● Reduce speed when travelling with load in bucket. ● Carry bucket close to ground and racked back for stability and visibility.	NOTE: Wet materials will weigh more per unit than

	objects, noise	• Approach unit to be loaded at right angles, empty. • Avoid travelling and turning with bucket in raised position. • Do not load bucket in excess of working load limit of loader. • Nip and pinch points on articulated rollers must be highlighted and signed. • Appropriate protective equipment should be used where hazards may be encountered during operation. • Foot protection must be worn on sites where a hazard to feet may exist.	dry material. Keep clear of nip and pinch points on articulated loaders. Head, eye and hearing and foot protection may be required.
7. Parking	• Stability • Security	• Park on level ground if possible. • Position machine "up and down" the slope if parking on sloping ground. • Apply handbrake, place transmission in neutral or "park" position. • Lower bucket fully with front cutting edge flat on ground. • Switch off engine, remove keys and lock cabin	Never leave keys in ignition if machine is unattended.
8. Maintenance	• Burns • Over exertion/strain injury • Crush injury from falling object	• Allow engine to cool before removing radiator cap. • Rear tyres may be water-filled as ballast – always have valve stem at top • Position to check pressure or inflate tyre. Place valve at bottom position to • Drain water from tyre. Use mechanical aids to remove or replace assembly.	Hand protection should be worn. Wear type 1 footwear.

1.3. Conducting machine pre-operational checks

The pre-operational check covers a number of key components of the machine and helps to identify maintenance issues and repairs that may be required. It is important to assess the conditions observed during your inspection to determine the action required.

Performing the pre-operational check is important for the safety of the operator and every one in its working environment. Unfortunately this safety check is often forgotten or ignored. Not every operator is aware about the items that need to be check before he can start his machine and begin to perform his daily tasks.

1.4. Starting-up, parking and shutdown procedures

- **Equipment start-up** means the process of bringing a unit of equipment on-line from an inoperative condition such that normal production rates are being achieved.
- **Equipment Parking** or "Equipment Placement" means operating, parking, storing, locating, or placing heavy equipment, vehicles, cranes, storage containers, or other heavy equipment or objects on the ground's surface under which underground utilities might be located.
- **Equipment shutdown:** A system of equipment stoppage and emergency isolation valves that are used to isolate individual equipment within a process unit and prevent the release of potentially toxic material in the event of a fire, rupture, or loss of containment.

1.5. Checking machine controls and functions and reporting faults.

1.5.1. The basic controls of back hoe/front end loader

Before you start operating a backhoe loader it is important to become familiar with the controls and ensure you know fully understand which each one does before you begin using the machinery.

A. Left-arm controls - The left-hand lever controls the boom. To lift the boom up in the air, draw the lever towards you and to lower it to the ground push it away from yourself.

B. Right arm controls - The right-hand lever controls the stick, which is the rear arm, this is the part attached to the lever's bucket.

C. Stabilizing Controls - These are in the center of the right and left arm controls and they control the backhoe's stabilizer.

D. Boom Unlock - To keep the boom arm in position, you can lock it, and when you're ready to dig you can unlock the boom.

E. Throttle Control - This adjusts the engine throttle revolutions per minute.

Keep in mind that backhoe digging controls may vary from model to model. These controls are for a slightly older model. Digging controls on many newer model backhoes will resemble two ergonomic joysticks rather than levers. If these are the type of controls found, you will need to pull them back toward you and unlock them to use them by locating unlocking switches.

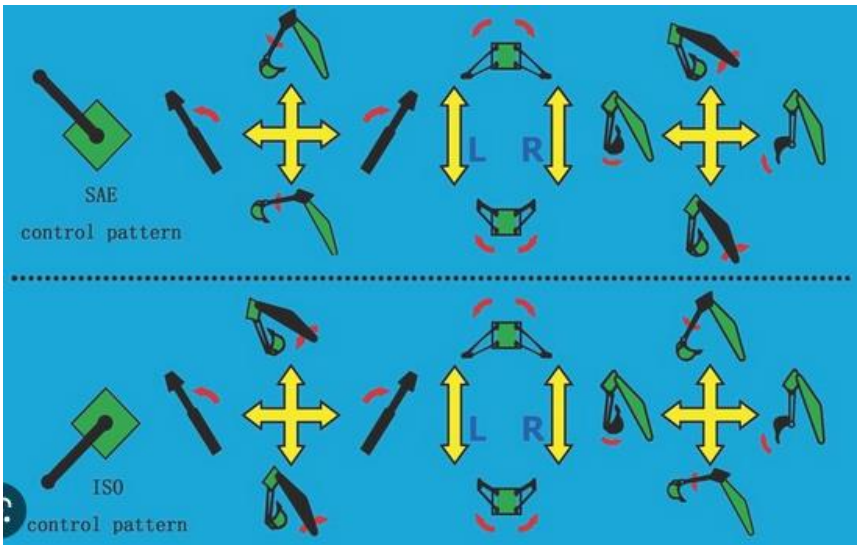

Figure 1.6 Backhoe controls

Before you can begin digging, the backhoe needs to be stabilized to account for digging loads. To stabilize the backhoe, you will do so with left and right-side stabilizers—also known as outriggers or jacks.

To control these, you'll find two levers either in the center-most section or off to the left on the floor. On older model machines whose controls resemble the diagram above, these will be the two smaller levers (**C. and D**.) between the larger left and right levers. On newer models, the stabilizer controls are two levers toward the floor to your left. These stabilizers can be moved independently to make the proper adjustments for stability on uneven surfaces or terrain or pushed down in tandem.

- **To raise or lower the left stabilizer:** push the left stabilizer lever (C.) forward (away from you) to increase the elevation of the left side of the backhoe.
- **To raise or lower the right backhoe stabilizer:** push the right stabilizer lever (D.) forward (away from you) to increase the elevation of the right side of the backhoe.

1.5.2. Reporting of faults on control system

Fault reporting is a maintenance concept that increases operational availability and that reduces operating cost by three mechanisms:

- Reduce labor-intensive diagnostic evaluation
- Eliminate diagnostic testing down-time
- Provide notification to management for degraded operation

That is a prerequisite for condition-based maintenance.

1.5.3. The main idea of fault diagnosis

The main idea of fault diagnosis is to determine the type, size and location of the fault as well as its time of detection, based on the available measurements of the system. A general scheme of model-based fault diagnosis is shown in **Figure 1.7.**

First, a signal called residual is generated using available input–output measurements from the system under consideration. When the system is fault free, then residual should be zero or close to zero, and otherwise when the fault is presented, residual should be different from zero. Fault

diagnosis in instrumentation is a vital skill for ensuring the accuracy, reliability, and safety of measurement and control systems

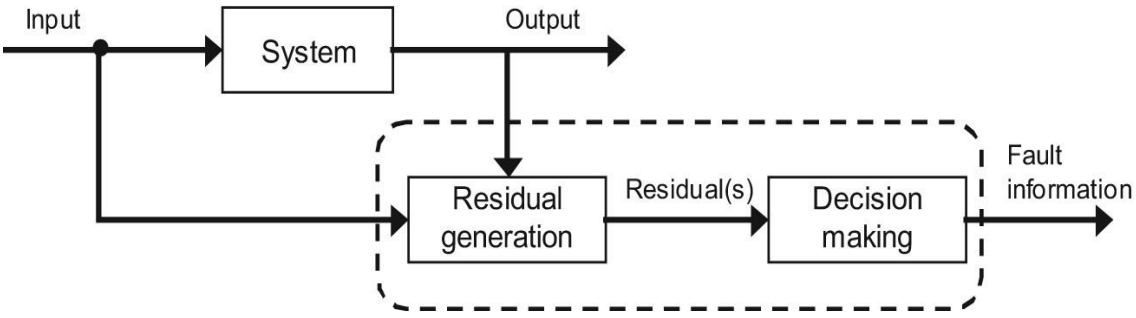

Figure 1.7 Flow of The main idea of fault diagnosis

1.5.4. Types of faults

Consider an open-loop dynamic system separated into three parts: actuator(s) plant dynamics and sensor(s) with input u(t) and measured output y(t). In fault diagnosis of dynamic systems, it is important to model all effects that can lead to alarms or false alarms. Faults can occur in the actuator(s), in the component(s) or parameter(s) of the plant dynamics and in the sensor(s). Modeling error(s) can be introduced between the actual system (actuators, plant dynamics and sensors) and its mathematical model. Finally, system noise (also called unknown input) and measurement noise should be taken into consideration to avoid triggering false alarms.

1.5.5. Classification of fault diagnosis methods

Generally Fault diagnosis methods are broadly classified into three main categories:

A. Model-based

Model-based fault diagnosis methods usually deploy a model developed based on some fundamental understanding of the physics of the plant or process. In general, model-based fault diagnosis methods are broadly classified as qualitative or quantitative. Quantitative model-based fault diagnosis is broadly classified into:

- Analytical redundancy
  - ✓ Analytical redundancy makes use of mathematical model of the system under consideration. In the fault diagnosis literature, very often, analytical redundancy is referred to as model-based fault diagnosis.

- Rarity space,
  - ✓ The basic idea of parity-space approach is to provide a proper check of the parity (consistency) of the input–output measurements of the system under consideration.
- Kalman filter (KF),
  - ✓ KF is used to design a state estimator with minimum estimation error. The prediction error of the KF can be used to form fault detection residual.
- parameter estimation
  - ✓ In some cases, a fault could occur due to changes in the system parameters parameter fault.
- Diagnostic observers.

B. Hardware-based

Hardware-based fault diagnosis methods do not deploy a mathematical model of the physics of the plant or process. In general, hardware-based fault diagnosis methods are broadly classified into hardware redundancy, voting techniques, special hardware, limit checking and frequency analysis.

C. History-based.

In fault diagnosis literature, one can find a huge overlap between model-based fault diagnosis and history-based fault diagnosis. As previously mentioned, model-based fault diagnosis methods usually deploy a model developed based on some fundamental understanding of the physics of the plant or process.

History-based fault diagnosis methods do not deploy a mathematical model of the physics of the plant or process, but a model derived from known and measured input and output process data. There is great quantity of literature on dynamic systems fault diagnosis ranging from analytical methods to artificial intelligence and statistical approaches. From a modeling prospective, there are methods that require accurate system models (plants), quantitative models or qualitative models.

However, there are methods that do not require any form of model information and rely only on historic system data. While there have been some excellent reviews in the field of fault

diagnosis, it is of interest that classification of fault diagnosis methods very often is not consistent. This is mainly due to the fact that researchers are often focused on a particular branch, such as analytical models, of the broad discipline of fault diagnosis. Classification of fault diagnosis methods is presented in this paper based on the contributions of various researchers.

This classification of fault diagnosis methods is shown in **Figure1.8**. Fault diagnosis methods are broadly classified into three main categories: model-based, hardware-based and history-based. Each category is discussed briefly in the following sections.

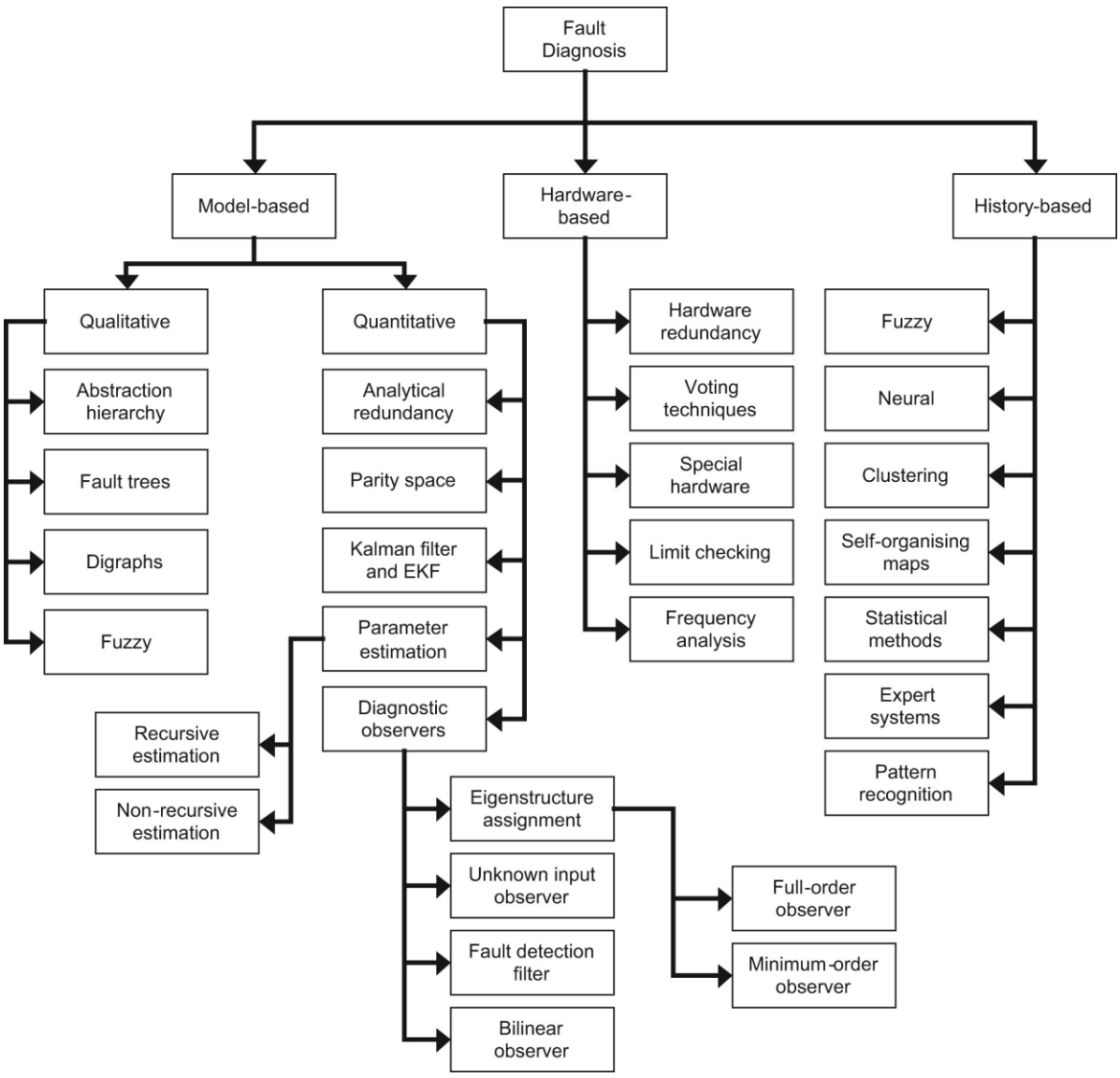

Figure 1.8 Classification of fault diagnosis methods

1.6. Identifying and implementing signage requirements

Safety signs can play a vital role in ensuring a safe workplace. Employers who implement effective, clear visual communication may enjoy fewer accidents and injuries, increased efficiency, and safe behavior throughout their facility. The American National Standards Institute (ANSI) and Occupational Safety and Health Administration (OSHA) identify different hazard signs.

Here are five ways to meet **OSHA** requirements for safety signage.

A. Understand ANSI and OSHA requirements for signage

OSHA's guideline for signs and tags that identify hazards outlines design requirements and specifies when safety signs must be used. These design elements are expanded upon in the ANSI standard, which utilizes alert symbols and pictograms to communicate hazards.

The ANSI standard dictates every aspect of sign designs, including:

- Standard sign and label colors
- Signal words (such as "**Danger"** and "**Warning**")
- Letter style and size
- Sign and label placement

B. Recognize the different types of safety signs

OSHA and ANSI have established three primary severity classifications for safety signs. They are danger signs, warning signs, and caution signs; each relates directly to the severity of hazards present (or potentially present).

- **Danger:** Danger signs signal the most serious hazards, where special precautions must be taken. The "DANGER" signal word is printed in white letters on a red background and is preceded by the safety alert symbol, which looks like an exclamation point inside a triangle. This type of sign indicates that death or serious injury is almost certain to occur if the hazard is not avoided.
- **Warning**: This sign describes a hazard that may result in death or serious injury, but where the overall risk is not severe enough to need a danger sign. A safety alert symbol precedes the "WARNING" signal word, which is printed in black on an orange background.

- **Caution:** The hazards described on a caution sign may result in minor or moderate injuries if not avoided. These typically caution against unsafe practices. On caution signs, the "CAUTION" signal word is printed in black on a yellow background header and is preceded by the safety alert symbol.

Figure1.9 Safety signs

C. Know the different types of safety signage

Safety signs and labels should be posted whenever hazards may be present throughout a facility. Yet other types of signs can help employees stay safe and productive without pointing out specific hazards. They include:

- **Notice**: Use notice signs to deliver information about a machine, building, area, or equipment. These signs outline procedures, maintenance information, instructions, rules, and directions unrelated to personal injuries.
- **General** safety signs: These offer broad safety-related messages, typically relating to health, medical equipment, sanitation, first aid, housekeeping, and suggested general safety measures.
- **Admittance**: Admittance signs alert and explain the dangers and consequences associated with entering a restricted area.
- **Fire safety:** Fire safety signs point out emergency firefighting equipment and fire exits.

- **Non-hazard signs:** These communicate general safety facility information, such as wayfinding directions procedures, usually through simple text and clear symbols. These should be never be used to communicate hazards, risks, or dangers; they are not technically safety signs but nevertheless promote a safer workplace.

Figure 1.10 different types of safety signage

D. Learn where to place safety signs

It can be tough to know when and where signs should be placed throughout a facility. For quick reference, here is a quick primer on sign placement. Once you've determined that safety signage is necessary, that signs must be placed "as close as safely possible" to the nearby hazard.

- **OSHA outlines different guidelines for placement, depending on the type of sign.**

Not sure which sign to place near a hazard? Here's a quick breakdown:

✓ **Danger signs must be** placed where a hazard poses an immediate danger and special precautions must be taken.

- ✓ **Caution signs** must be posted to warn of potential hazards; they may also be used to caution against unsafe practices.
- ✓ **Safety instruction signs** should be used wherever general instructions and safety suggestions can help workers perform their tasks in a safe manner.

E. Meet OSHA requirements for safety signage with the right gear

The right choice of materials will work on abrasive and uneven surfaces, remain bright in low-light areas, resist saltwater exposure, stay strong in greasy environments, or retain effectiveness in refrigerated settings.

1.7. Reading and interpreting site drawing and plans

A site plan is a graphic representation of all existing and proposed improvements to a site. Sometimes referred to as a plot plan, the site plan functions as a map for a development project, incorporating all aspects of landscaping, construction, paving, utilities, and terrain features in a single depiction.

A site plan or a plot plan is a type of drawing used by architects, landscape architects, urban planners, and engineers which shows existing and proposed conditions for a given area, typically a parcel of land which is to be modified. Sites plan typically show buildings, roads, sidewalks and paths/trails, parking, drainage facilities, sanitary sewer lines, water lines, lighting, and landscaping and garden elements.

Learning how to read plans is an essential skill for building a career as a construction worker. Construction drawings vary from simple to very complex, so understanding how to interpret the drawings is crucial for completing the project efficiently and accurately. The ability to read construction plans will not only increase your value to your current employer but is a staple to anyone serious about advancing their career as a professional contractor.

Aside from the apparent specs and dimensions, construction plans also help communicate what the project is about. They provide construction workers with other important information for the project including building codes, installation techniques, measurements, and quality standard.

1.8. Selecting and fitting appropriate attachments

When choosing a backhoe, it is important to consider the type of job that it will be used for. There are many different types of backhoes available on the market, each with its own set of features and benefits.

https://youtu.be/RHAiWM90fmY (Accessed date 05/05/23)

1.8.1. Types of backhoe loader attachments

Backhoe loaders are one of the most versatile and common pieces of equipment found on job sites across the board. They're compact and maneuverable construction machines that include a boom, stick and bucket to perform various jobs like digging and transporting materials. Backhoes support a range of applications like construction, landscaping, demolition, quarries, and foresting, farming, manufacturing, mining and residential projects.

1.8.2. Backhoe-specific work tools

- Augers
- Compactors such as
  - ✓ vibratory plate and
  - ✓ compacting wheel
- Cold planers
- Couplers such as dual pin grabber and pin puller style
- Rear buckets such as
  - ✓ heavy duty,
  - ✓ ditch cleaning and
  - ✓ high capacity buckets
- Hammers
- Rippers
- Thumbs

Types of loader attachments include

A. Augers

Augers are used to drill into dirt but also can drill into rocky soil using a heavy-duty spiral. Auger motor heads have a high torque level to drill through hard soil types, including clay and ice. Two types of augers exist, including:

- Direct drive augers use a hydraulic motor which create a balance between the machine's hydraulic torque and speed of the auger head.
- These are best used in light and medium duty applications.

- Augers can drill holes for postholes, foundations for buildings, areas for wells and divots for planting trees.

https://youtu.be/B2YmZRALRgY (Accessed date 04/05/23)

B. Brooms

Brooms are a simple front-end add-on that helps keep your work zones clear of debris. They're ideal for cleaning up job sites in large sweeps to maximize safety. Perfect for ground-clearing jobs, brooms can shift heavy materials like rubble and broken concrete as well as finer ones like sand and dirt.

Figure 1.11 Brooms

C. Buckets (Front and Rear)

Front buckets and rear backhoe bucket attachments are among the most common, even with other types of heavy equipment units. Different kinds of buckets are available to optimize the digging process while withstanding tough working conditions:

- General purpose
- Grading (mud)
- Multi-purpose
- Soil excavation
- Heavy duty
- Heavy duty rock
- High capacity
- Tilting
- Cemetery
- Cribbing
- Ditch clean

Figure 1.12 bucket

D. Compactors

Backhoe compactors are straightforward add-ons and often used to pack down materials like gravel or dirt to prevent settling or set pipe. These attachments support industries like construction and pipelines.

Figure1.13. Compactor

E. Couplers

- While it's essential to research which attachment best suits your backhoe loader, you must also consider the right couplers.
- A quick coupler allows you to swap out attachments without manually doing it yourself which encourages productivity and is a safer method.
- You and your crew can complete fast and easy attachment changes right in the field.

Figure1.14. Coupler

F. Hammers

- Hammer backhoe attachments break up materials like concrete and rocks.
- Most commonly seen on demolition, quarry and construction sites, hammer work tools are also ideal for utility contractors who need to break into concrete or rocky conditions.
- When you need an attachment to break through and destroy asphalt, concrete and other robust resources, hammers make short work of it.

Figure1.15. Hammer attachment

G. Rippers

Rippers rip through materials to help workers cut through the frozen, icy ground and thicker materials such as rock and asphalt.

- Ripper backhoe loader attachments are like a large tooth with a sharp end, equipped to withstand heavy workloads and some of your toughest jobs in the field.

Figure1.16 Ripper

H. Snow plows and pushes

- If you work in environments where snow is common, snow plows and snow pushes are ideal attachments to add to your fleet.
- Both remove snow from sites, roads, driveways or anywhere else you see fit. Their efficient and unique designs help to quickly remove snow.

Figure1.17 Snow plows

I. Thumb:-

- Thumb add-ons go hand-in-hand with breaker attachments.
- Thumbs help to clean up broken chunks of concrete or transport massive tree trunks across the job site.
- Thumbs allow you to safely move irregular objects securely and precisely.

Figure1.18 Thump

https://youtu.be/FgP2DQ8WZJk (Accessed date 03/05/23)

1.8.3. Capabilities of backhoe attachments

Selecting the appropriate add-on enhances productivity while also saving time and money. Replacing a standard backhoe bucket with a work tool attachment depends on the job site environment, tasks and future projects. Understanding the capabilities of different backhoe attachments can help when making a decision.

1.8.4. How to choose the right backhoe attachment

Whether you're looking to dig, scrape, drill, lift or rip, choosing the right work tool comes down to knowing which one will reap the most advantages for the different tasks you have lined up. Several things to consider are

- The type of job site
- The attachment's size
- The toughest soil conditions you operate in and
- Your unit's tipping load.

1.8.5. Benefits of using different types of backhoe attachments

The main benefits of using different types of attachment is listed below

- Competitive advantage
- Decrease Labour cost
- Enhanced operation abilities
- Increased accuracy and reliability
- Limited need for other equipment
- Reduced down time
- Safe work site

1.9. Environmental protection requirements

Protection of the environment and improvement of air quality is an important objective of the many countries. Most of the countries also work on noise reduction and the elimination of fluorinated greenhouse gases used in mobile air-conditioning systems.

A. Emissions

Pollutant emissions from non-road mobile machinery (NRMM) significantly contribute to air pollution by emitting carbon oxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter.

Road transport is a major source of greenhouse gas emissions, producing around 15% of the CO2 emissions. Many counties focus on the reduction of emissions from the following vehicle categories in particular:

Many factors affect the exhaust emissions of construction equipment, and it can be difficult to measure and quantify their degree of impact on the rate of emissions. However, overall, the factors can be categorized into four groups: equipment type and condition, equipment maintenance, operating conditions, and equipment operations.

- light-duty vehicles (cars and vans)
- heavy duty vehicles (coaches, buses, trucks)

B. Noise problem

The noise generated when using machines is the main reason for the high noise levels at work. As opposed to the noise emission describing the noise exposure at a place, the noise emission describes the airborne noise emission of a machine, determined under standardized installation and operating conditions and without noise influences from other sources, as well as without reflected noise. Thus, emission is a source-internal feature. Parameters of the noise emission include the sound power level LWA and the emission sound pressure level LpA at the workstation

C. Soil erosion and compaction

Machine traffic is implemented with particular intensity from late spring to harvest, and it is responsible for soil compaction, which likely affects soil hydraulic properties, runoff, and soil erosion. Additionally, the hydraulic and physical properties of soil are highly influenced by vineyards' inter-rows soil management.

1.10. Basic principles of soil technology for civil works

The term "soil" can have different meanings, depending upon the field in which it is considered. To a geologist, it is the material in the relative thin zone of the Earth's surface within which roots occur, and which are formed as the products of past surface processes. The rest of the crust is grouped under the term "rock". To a pedologist, it is the substance existing on the surface, which supports plant life. To an engineer, it is a material that can be:

- Built on: Foundations of buildings, bridges
- Built in: Basements, culverts, tunnels
- Built with: Embankments, roads, dams
- Supported: Retaining walls

Soil, in the engineering sense, comprises all materials found in the surface layer of the earth's crust that are loose enough to be moved by spade or shovel. Such materials are natural systems that are normally composed of solid, liquid, and gaseous phases. The solid phases are contributed by particulate matter of inorganic or organic character. The liquid phase is usually an aqueous electrolyte solution. The gaseous phase in contact and exchange with the atmosphere may have a different composition from the latter, depending on location and biologic activity within the soil.

Since water and air content vary with variation in environmental conditions, soils are normally characterized by their particulate components, while the air and water contents are considered together as porosity.

1.10.1. Géotechnical Properties of soil

Geotechnical properties of soil are very important in the geotechnical design and evaluation of the condition of the soil. Soil is a material that generally does not have consistency in its properties. However, during the designs, we have to make sure that there is adequate consistency in the soil properties. Otherwise, it could lead to the settlement of the foundation and lead many other issues connected with that.

1.10.2. Classification of soil

Soil is classified into four types:

A. Sandy soil.
B. Silt Soil.
C. Clay Soil.
D. Loamy Soil
E. Gravel
F. Blended soil
G. Organic matter

A. Sandy soil

The first type of soil is sand. It consists of small particles of weathered rock. Sandy soils are one of the poorest types of soil for growing plants because it has very low nutrients and poor water holding capacity, which makes it hard for the plant's roots to absorb water. This type of soil is very good for the drainage system. Sandy soil is usually formed by the breakdown or fragmentation of rocks like granite, limestone and quartz.

Figure 1.19 sandy soils

B. Silt Soil

Silt, which is known to have much smaller particles compared to sandy soil and is made up of rock and other mineral particles, which are smaller than sand and larger than clay. It is the smooth and fine quality of the soil that holds water better than sand. Silt is easily transported by moving currents and it is mainly found near the river, lakes and other water bodies. The silt soil is more fertile compared to the other three types of soil. Therefore, it is also used in agricultural practices to improve soil fertility.

Figure 1.20 silt soil

C. Clay Soil

Clay is the smallest particle among the other two types of soil. The particles in this soil are tightly packed together with each other with very little or no airspace. This soil has very good water storage qualities and makes it hard for moisture and air to penetrate into it. It is very sticky to the touch when wet but smooth when dried. Clay is the densest and heaviest type of soil which does not drain well or provide space for plant roots to flourish.

Figure 1.21 Clay soil

D. Loamy Soil

Loam is the fourth type of soil. It is a combination of sand, silt and clay such that the beneficial properties of each are included. For instance, it has the ability to retain moisture and nutrients; hence, it is more suitable for farming. This soil is also referred to as agricultural soil as it includes an equilibrium of all three types of soil materials, being sandy, clay, and silt, and it also happens to have humus. Apart from these, it also has higher calcium and pH levels because of its inorganic origins.

Figure 1.22 loamy soil

E. Rocky or gravelly soil

Gravel soil means stone screened from river sand or quarried and washed free of clay and clay coatings. Concrete aggregate designated as Class II by the department of transportation is acceptable. Gravel is very small, irregular pieces of rock and stone. It is more rough and rocky than sand, and smaller than stones. Soil that is rocky or gravelly will have a large proportion of rocks or gravel.

F. Blended materials

Blended topsoil can contain a mix of soil, organic materials (compost), sand or peat-free soil conditioners. It could contain two or more of these components and in varying amounts to create a soil for a specific purpose.

G. Organic matter

Most soil organic matter originates from plant tissue. Plant residues contain 60-90 percent moisture. The remaining dry matter consists of carbon (C), oxygen, hydrogen (H) and small amounts of sulphur (S), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg).

1.10.3. Soil properties checked during the designs.

A. Grain size distribution

As the name implies, it is the change in the size of the soil particles. This is also called the particle size distribution. The grained size distribution can be obtained from the sieve analysis test. For the fine grain soils, hydrometer analysis is used to find the grain sizes.

B. Weight volume relationship

The soil contains solid partials, water and air. When we find the relationship between the weight and volume of the soil, the void ratio is come to the action.

Void ration = V = Volume of Voids / Volume of Solid

Thus, the dry density of the soil can be specified as follows.

C. Dry Density

$\gamma d = Gs\gamma w / (1 + e)$

Where, γd – dry density of soil

Gs – Specific gravity of soil

γw – Density of water

D. Saturated Density

$\gamma sat = [Gs\gamma w + e\gamma w] / (1 + e)$

E. Atterberg Limits

Atterberg limits are widely used in the soil classifications. It is kind of measure of the soil properties. It reflects the behavior of the soil.

A soil has four main stages.

i. Solid state
ii. Semisolid state
iii. Plastic state
iv. Semiliquid state

The moisture content of the soil is causing the soil change to above stages.

There are three limits in the Atterberg limits.

i. Liquid Limit (LL)

ii. Plastic Limit (PL)

iii. Shrinkage Limit (SL)

The difference between the liquid limit and the plastic limit is used to calculate the plastic index (PI) of the soil.

PI = LL – PL

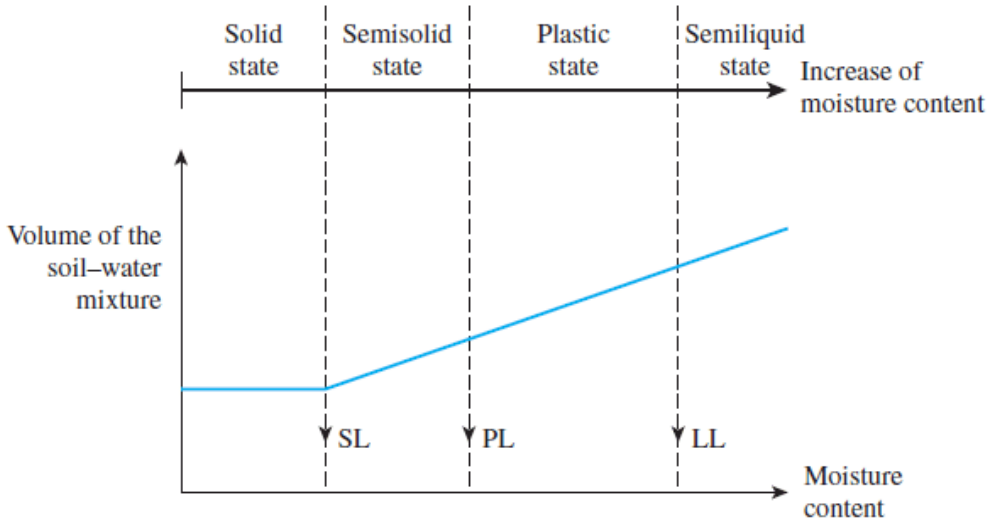

Figure 1.23 Atterberg Limits

1.10.4. Basic earthworks calculations

The term earthwork includes all clearing, grubbing, roadway and drainage excavation, excavation for structures, embankments, borrow, overhaul, machine grading, subgrade scarifying, rock fill, and all the operations of preparing the subgrade foundation for highway or runway pavement. The quantity and cost of earthwork are calculated in terms of cubic meters of excavation in its original position on the basis of cross-section notes from field measurements. Modern grading operations are carried on by power equipment including power shovels, scrapers, bulldozers, blade graders, rollers, dragline excavators, motor trucks, tractors, etc

A. Volume of earthwork

The volume of earthwork may be found by means of either the average end area or the Prismoidal formula. Although the former is less exact than the latter, it is generally accepted as the standard earthwork formula, on account of its simplicity.

- **Average End Area Formula.** The volume of a right prism equals the average area multiplied by the length. Assuming the average area to be the same as the average end area,

Volume = V = ½ (A1 + A2)L

In which: A1 and A2 = area of end sections (m2)

L = length of solid (m)

This formula is applied to areas of any shape, but the results are slightly too large.

The error is small if the sections do not change rapidly.

- **Prismoidal Formula**. A prismoid is a solid whose ends are parallel and whose sides are plane or wrapped surfaces.

V = L/6 (A1 + 4Am + A2)

In which L is the distance between the two parallel bases A1 and A2 and Am is a section midway between the two end bases and parallel to them. Am is not an average of A1 and A2, but each of its linear dimensions is an average of the corresponding dimensions of A1 and A2.

B. Cut and fill earthwork volume calculassions

Cut and Fill is a common method to adjust a land surface as needed. During these process amounts of soil or other material on the surface, are either added or removed so we manage to form the surface as needed for our projects. In these cases, usually, the extracted material is also used as the fill material, like soil in plenty of earthworks.

Earthworks take place in many engineering projects, like road works, quarries, mining projects, and more. To be able to calculate the soil volume that will be needed to be removed or added is very important to plan our projects in terms of cost and time. The volume between each pair of sections is estimated by multiplying the average cut or fill area of the two sections by the distance between them. Once these volumes have been calculated for each pair of sections the total cut and fill volumes are obtained by adding them all together.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer for the following questions (1point each)

1. ___ is concerned with health and safety in its relation to work the working environment.

A.PPE B.OHS C. information D. maintenance

2. Which one of the following is **not** correct about main benefits of using backhoe attachment

A. Reduced down time **C.** Enhanced operation abilities

B. Increase Labour cost **D.** Increased accuracy and reliability

3. _____is the type of fault diagnosis methods usually deploy a model developed based on some fundamental understanding of the physics of the plant or process.

D. Hardware-based **F.** Model-based

E. History-based. **G.** Non

4. _____signal that indicates or notifies the most serious hazards, where special precautions must be taken.

A. Danger **C.** Caution

B. Warning **D.** Notice

Part II: Give Short Answer for the following Questions (2 points each)

1. Write the component parts of backhoe and front end loader and their functions
2. What is the difference between front end and backhoe loader
3. Write the main benefits of using backhoe/front end loader?
4. Explain OHS and what is the importance of safety in operation of loader
5. Write at least 10 the pre operational checks for Loader operation
6. List and explain the basic controls of backhoe loader
7. What is the important of Reporting of faults on control system
8. What is the function of signage for operating Backhoe loader
9. Write different types of backhoe loader
10. What are main benefits of using different types of attachment

Note: Satisfactory rating – 12 points Unsatisfactory - below 12point

Operation Sheet 1

1.1, Conducting Pre operational checks

A. Materials and equipment's used for pre operational checks

- PPE
- Tire labor
- Wrenches
- First aid kit
- Backhoe loader

B. Steps/Techniques for checking

- **Follow the checklist**

✓ **Pre-Start Checklist**

Before firing up heavy equipment, conduct the following checks:

- Parking: Check if the equipment is parked in a safe place.
- Hazards: Check for overhead or tripping hazards.
- Seat belt: Check if the seat belt works by inserting it into the buckle. After hearing the click sound, gently tug to see if it works properly.
- Parts: Check worn, damaged or loose parts.
- Leaks: Check for puddles or wet spots under the equipment.
- Fluids: Check power steering fluid levels, engine oil fluid levels and windshield washer fluids.
- Undercarriage: Check for missing or worn-out rollers, excavators or track tension and replace if needed.
- Oil: Check oil level.
- Engine: Check knocks, oil pressure and leaks. Assess guards and covers in the engine compartment and make sure they are properly installed. Verify if hoses and belts are properly connected.
- Engine support, main springs, springs and equalizer bar: Check shackle bolts and shifted spring leaf.
- Idlers and sprockets: Check for sharp sprocket teeth, crack in spokes

- Gauges and lights: Check if the speedometer is working and. Check lights and gauges are mounted properly and if they are functioning.
- Tires: Check for nails, screws or other debris mounted in the tires. Check for cuts, sag, general wear or holes and replace them if needed.
- Rims: Check rims for visible damage and replace them if needed. Check if bolts or nuts are in place.
- Valves: Check if caps are in place and securely screwed.
- Steering wheel: Ensure the steering wheel doesn't turn freely. Check for excessive play.
- Belts: Check for splits and cracks.
- Hoses: Check for holes, cracks, pinches or looseness.
- Suspension system: Check if the equipment vibrates or bounces when in use
- Battery: Ensure battery is connected and charged, check battery cables, connections and clamps for corrosion and limpness and replace them if needed.
- Fan and fan belts: Check tension and check for cracks and frays.
- Cooling system: Check for damage and leaks.
- Radiator guards and belly plate: Check for debris and ensure they're properly mounted
- Fuel system: Check for damage and leaks.
- Cab condition: Check mirrors, horn, glass, wiper blades and seat belts.

✓ **Warm-Up Checklist**

When the equipment has been working for five to 10 minutes, perform the following checks:

- Alarms: Check back up alarms.
- Horn: Check if the horn is working.
- Air filter system: Clean the filter or replace it if needed.
- Lights: Check signal lights, brake lights, headlights, backup lights and high beams to make sure they're working.
- Hydraulic system: Check hydraulic systems and lines and check for irregular noises.
- Fluid levels: Check hydraulic oil, engine steering tank, engine coolant, power terrain and swing drives.

- Brakes: Check if the brakes work properly and replace worn-out brake pads. Check for fluid and air leaks. Assess the parking brake.

✓ **Shutdown Checklist**

- Once your shift has ended, conduct the following tasks to streamline pre-start checks for the next day:
- Fuel tank: Fill up the gas tank until it reaches full capacity. Ensure the fuel tank cap is securely screwed.
- Engine: Before shutting down the equipment, wait five minutes for the equipment to remain idle.
- Parking: Park the equipment in a safe place, ideally where trees aren't around to prevent the risk of damage from falling debris.

1.2, Start-up, park and shutdown procedures

A. Materials and equipment's used

- PPE
- First aid kit
- Tire Labour

B. Steps/ Techniques

- **Start-up**

✓ Before starting the engine, move the joystick for hydraulic control forward and backward or side to side and then release the control.

✓ Make sure that the joystick control automatically returns to the neutral position.

✓ Press and release the forward and reverse travel control pedals on the operator's station floor.

✓ Make sure these controls return to the neutral position and that dirt, mud, snow or any other foreign objects do not interfere with the operation of these controls.

✓ If any of the hydraulic controls do not automatically return to the neutral position, do not use the machine until repairs have been completed.

✓ Turn on the master power switch. This switch is located on the rear section of the machine, directly behind the right rear wheel.

✓ Remove protective cover from the master switch.

- ✓ Insert master power key.
- ✓ Rotate the master power key to the “on” position and leave key in the switch.
- ✓ Sit in the operator’s seat. Turn the key to the “run” position, and then fasten the seatbelt to the buckle and close the left protection bar.
- ✓ Make sure that the pedals are in neutral position.
- ✓ Make sure that the hydraulic outlets lever is in the center position.
- ✓ Move the throttle lever to about halfway between fast and idle engine speeds.
- ✓ Rotate the ignition key switch to the “heat” position for about 10 seconds.
- ✓ Rotate and hold the ignition key switch in the “start” position until the engine starts.
- ✓ As soon as the engine starts, release the starter key. The key will automatically return to the run position.
- ✓ Leave the throttle setting at about the halfway position and allow the engine to idle. This will begin warming the engine coolant and hydraulic oil.
- ✓ If the engine does not start, repeat steps two through seven.
- ✓ In cold weather, after about five minutes of engine idling, slowly operate all of the main hydraulic controls to cycle warm hydraulic oil through the hydraulic lines into the cylinders and hydraulic motors.
- ✓ Allow the engine to idle for another five minutes before beginning any machine operations.

- **Machine warm-up**
  - ✓ Allow machine to warm up (per O&MM)
  - ✓ The implement lockout must be in the unlocked position before hydraulic controls will function
  - ✓ Engage and disengage attachment controls
  - ✓ Cycle all controls to allow warm oil to circulate through all hydraulic cylinders
  - ✓ Perform steering, service brake, and parking brake operation checks
  - ✓ Check secondary steering operation (if equipped)
  - ✓ Check gauges, indicators, and action light frequently

- **Moving the machine**
  - ✓ Make sure area is clear by sounding horn and waiting 3-5 seconds before moving machine.
  - ✓ Raise all lowered implements
  - ✓ Depress the service brake pedal
  - ✓ Release the parking brake
  - ✓ Move the transmission control to desired direction
  - ✓ Release the service brake pedal
  - ✓ Depress accelerator

- **Machine shut down**
  - ✓ Park the machine on a solid, level area and set the parking brake.
  - ✓ Lower the loader arm and attachment to the ground.
  - ✓ Idle the engine for several minutes to allow the machine to cool down.
  - ✓ Rotate the ignition key switch to the "0" position and remove the key.
  - ✓ In case of storage or prolonged stop, remove the master power key.
  - ✓ Clean off any accumulated mud and/or dirt from the machine's operating surfaces.

- **Parking the Backhoe/Loader**
  - ✓ Stop the backhoe/loader on a flat level surface in the designated area and keep the access points clear.
  - ✓ Park the backhoe/loader away from overhangs, excavations, access ways and tidal or flood areas.
  - ✓ If the backhoe/loader must be parked on a sloping surface it should be facing across the slope.
  - ✓ Keep the backhoe/loader away from refueling sites and areas when parking or you can block the rest of the machines on the site from accessing fuel.
  - ✓ Apply all locks and brakes

LAP TEST-1	Performance Test

Name……. **ID……..**

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **4** hour. The project is expected from each student to do it.

Task-1 Perform pre operational checks

Task-2 perform start, park and shutdown of Backhoe loader

LG #23 LO #2- Operate backhoe/ loader

Instruction sheet

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

- Identifying site hazards associated with backhoe/loader operations
- Evaluating work activity and determining most productive operating technique.
- Selecting and modifying loading technique.
- Demonstrating safe towing practices.
- Operating backhoe.

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

- Identify site hazards associated with backhoe/loader operations
- Evaluate work activity and determining most productive operating technique.
- Select and modify loading technique.
- Demonstrate safe towing practices.
- Operate backhoe.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1. Identifying site hazards associated with backhoe/loader

2.1.1. Backhoe loader hazards

In the context of occupational health and safety, a hazard is any object, situation, or behavior that has the potential to cause injury, illness, damage to property, or harm to the environment. Health and safety hazards exist in every workplace. Some are easily identified and corrected, while others are inevitable parts of the job and must be mitigated and managed through various control measures

Backhoes and loaders are useful tools on farms and ranches. Accidents involving backhoes and loaders occur and are often tragic. While accidents may be similar to those that happen to tractors the additional of an attached backhoe and/or loader increases the likelihood of an accident due to increased height and length of the machine.

Common accidents with these machines are overturns, falls, run overs and contact with other people and other objects. Because of the size of these machines and added features, increased diligence is needed to prevent accidents.

Most fatal and serious injuries involving loader occur when the excavator is:

- Moving – and strikes a pedestrian, particularly while reversing;
- Slewing – trapping a person between the excavator and a fixed structure or vehicle;
- Working – when the moving bucket or other attachment strikes a pedestrian or when the bucket inadvertently falls from the excavator.

2.1.2. Causes of injuries with backhoes and loaders

- Overturns caused by turning uphill on a steep slope.
- Loaders may overturn if the bucket is raised too high when loaded especially on uneven ground and in turns
- Turning too fast on a downhill slop may also cause an overturn.

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Figure 2.1 backhoe on downhill slop

https://youtu.be/SociqWyTB5Y(Accesses date 03/06/23).

- The higher the bucket is raised, the more unstable that the tractor is.
- Poor maintenance and work around machines.
- Hazards include leaving shields off or wearing loosely secured clothing while working around turning PTO shafts
- Hitting an object such as a ditch, stump, or whole while moving can cause an overturn or cause the operator or an extra rider to fall off and be runover.
- Starting the tractor in gear.
- If a person is either behind or in front of the tractor wheels they could be run over before they can get out of the way should the tractor move after started.

- Falls caused by slipping on the platform or steps while mounting or dismounting or by falling out of the bucket as it is being used to transport or lift a another worker.

Figure 2.2 fall caused by slipping on the platform

- A common accident when using industrial equipment occurs when the loader falls on another person or when a load falls due to inadequate ropes, chains, or cables to lift objects, or inattentive operators.
- Excavating unstable soil, undercutting a bank with a backhoe, or operating too close to a steep bank or excavation can result in an overturn.
- Improper equipment transport. Among the hazards are failure to properly tie down backhoes and loaders to trucks or trailers and failure to have proper lights and slow-moving-vehicle signs. Not observing traffic rules when on public roadways also can cause accidents.

2.1.3. Preventing injuries from backhoes and loaders

- Slow down when conditions dictate to do so.
- Know the machine that your are operating. Read and review the operator's manual. Get familiar with the controls before working with the backhoe or loader.
- Know the area where you are operating. Locate ditches, stumps, debris, and undercut banks and avoid these hazards by keeping a safe distance away.
- When front-end loaders carry high loads, be aware of overhead obstacles such as power lines.

- Keep the bucket as low as possible to ensure stability and increase your visibility and to become aware of bystanders. Raise the loader only when necessary to dump.
- When excavating with a backhoe, never undercut the area beneath the backhoe stabilizers
- Do not allow extra riders PERIOD.
- Make sure that the machine is not in gear before starting. Always start from the driver's seat.
- Make sure no one is in front of the wheels when starting the machine.
- Add ballast or rear weight when a heavy load makes this precaution necessary.
- When excavating with the backhoe on a hill, swing the backhoe uphill to dump the load in order to maintain stability. Dumping downhill may cause the machine to tip.
- Always shut off the engine, lower the bucket and backhoe, and apply the parking brake before dismounting the machine.
- Use extreme caution when back filling. The weight of the fill material added to the weight of the loader could cause the edge of a new excavation site to collapse. Before starting to back fill, walk over the area and test the soil for stability.
- Keep steps and platforms clean and uncluttered of parts, tools and debris. Do not mount or dismount when the machine is moving. gripping soles.

Figure 2.3 Keep steps and platforms clean

- Never use a front end loader as a man lift as the hydraulic system may fail or someone can accidentally touch the controls causing the worker to fall. Use proper lift equipment for the job.

- Use machines equipped with roll over protective structure (ROPS) and seat belts. Seat belts will prevent the operator from being thrown out and crushed in a rollover.

Figure 2.4 Use machines equipped with roll over protective structure

- Be sure the area is safe and clear of bystanders before you start excavating or moving the backhoe.
- Keep rear-view mirrors clean and in good condition.
- Use back up alarms when in reverse gear.
- Know you equipment and its capacity.
- Train all workers in proper, safe operation of the equipment.
- When lifting objects, use cables and chains in good condition and strong enough for the job.
- Operate the backhoe or loader only from the operator's seat.
- When transporting equipment, be alert to potential hazards, caused by poor visibility, adverse ground conditions, excessive speed, unstable loads, or other vehicles in the area.
- Use slow-moving-vehicle signs on the tractor and have the proper lights:
- Flashing yellow and solid red for the rear and flashing yellow lights for the front as well as head-lights.
- Turn headlights on when transporting on public roadways.

- Be aware of the environment around you at all times. This includes low hanging power lines, tree limbs, bridges, or other obstacles.
- Know where gas, power, and phone lines are buried before you start to dig.
- Be careful when lifting round objects such as bales, poles, etc., in the bucket.
- Raising the bucket too high or tipping the bucket too far back could result in these objects rolling rearward down the loader arms onto the operator.
- Visually check for hydraulic leaks or malfunctioning parts.
- Make sure hydraulic lines are connected properly after repairs, otherwise an accident is likely to occur when a control operates in a direction other than it should.

2.2. Evaluating work activity and determining most productive operating technique

Productivity in construction is defined as a unit output per hour. An accurate prediction of the productivity of construction equipment is critical for construction management. Equipment Productivity Determination estimating actual productivity is an essential element in estimating the time and cost required to complete construction operations.

Terminologies

Peak Productivity (Qp): is the ideal or theoretical productivity governed by design limitations only.

QP= VxFsxFf

Where: Qp = Peak Productivity

V = Volume carried/ bucket capacity

Fs = Bank Volume/loose volume

Ff = Bucket fill factor

Actual Productivity: Productivity of equipment after taking care of effective working hours and job management factor on the peak productivity.

Qa= QpxFwxFj

Where Qa = Actual Productivity

Qp = Peak Productivity

fw = Factor to take care of effective working hours

fj= Factors to take care of the management conditions

2.3. Selecting and modifying loading technique.

Loading and unloading can be dangerous. Machinery can seriously hurt people. Heavy loads, moving or overturning vehicles and working at height can all lead to injuries or death. This guidance should be followed to help avoid problems.

- **Guidance**

Loading and unloading areas should be:

- ✓ Clear of other traffic, pedestrians and people not involved in loading or unloading.
- ✓ Clear of overhead electric cables so there is no chance touching them, or of electricity jumping to 'earth' through machinery, loads or people.
- ✓ Level. To maintain stability, trailers should be parked on firm level ground,
- ✓ Loads should be spread as evenly as possible, during both loading and unloading. Uneven loads can make the vehicle or trailer unstable.
- ✓ Loads should be secured, or arranged so that they do not slide around. Racking may help stability.
- ✓ Safety equipment must be considered. Mechanical equipment and heavy moving loads are dangerous.
- ✓ Ensure the vehicle or trailer has its brakes applied and all stabilizers are used. The vehicle should be as stable as possible.
- ✓ In some workplaces it may be possible to install a harness system to protect people working at height.
- ✓ Vehicles must never be overloaded. Overloaded vehicles can become unstable, difficult to steer or be less able to brake.
- ✓ Always check the floor or deck of the loading area before loading to make sure it is safe. Look out for debris, broken boarding, etc.
- ✓ Loading should allow for safe unloading.
- ✓ Loads must be suitably packaged. When pallets are used, the driver needs to check that:
  - ➢ They are in good condition
  - ➢ Loads are properly secured to them.
  - ➢ Loads are safe on the vehicle. They may need to be securely attached to make sure they cannot fall off.

- ✓ Tailgates and sideboards must be closed when possible. If over-hang cannot be avoided, it must be kept to a minimum.
- ✓ If more than one company is involved, they should agree in advance how loading and unloading will happen..
- ✓ Some goods are difficult to secure during transport. Hauliers and recipients will need to exchange information about loads in advance so that they can agree safe unloading procedures.
- ✓ There must be safeguards against drivers accidentally driving away too early. This does happen, and is extremely dangerous. Measures could include:.

2.4. Demonstrating safe towing practices.

Towing means the moving or removing from public or private property or from a storage facility by a motor vehicle of a consumer's non-commercial motor vehicle that is damaged as a result of an accident or otherwise disabled, recovered after being stolen or is parked illegally or otherwise without authorization, parked during a time at which such parking is not permitted or otherwise parked without authorization or the immobilization of or preparation for moving or removing of such motor vehicle, for which a service charge is made, either directly or indirectly.

Here is a 6-step safety checklist for how to tow

- Figure out your tow capacity
- Proper weight distribution
- Hitch your trailer correctly
- Secure your load
- Check tires & lights
- Test the brakes

Figure 2.4 backhoe towing

2.5. Operating backhoe.

Operating the loader is relatively simple because it only dumps, raises and lowers. The main loader control is a joystick on the right-hand side of the operator. When you push it away from you, the arms lower. To dump out the bucket, you move the joystick to the right. To scoop the bucket in, you move the joystick to the left. When operating a backhoe/loader it is important for you to feel confident in your machine and to know its capabilities,

2.5.1. Operating techniques

A. General Driving

General driving techniques include:

- Be alert to hazards and dangers at all times.
- Be careful not to drive over or too close to trench areas or be in a position that the machine may be exposed to an open or unprotected edge of a trench
- Watch the terrain for hazards such as tree stumps.
- Keep clear of holes and soft areas.
- Travel downhill in gear and do not travel across steep slopes.
- If you are tired, sick, medicated or have drugs or alcohol in your system – don't drive.
- Do not carry passengers.
- Have the bucket close to the ground.
- Cross rail lines at an angle

B. Reversing.

- Reversing techniques include:
- Make sure the way is clear before starting to reverse.
- Look behind you and keep looking in the direction you are travelling.
- Turn the seat to face the direction of travel or work (if possible).

C. Maneuvering.

- Room and space for movement are often limited but techniques can improve with practice.
- Look out for other plant, structures, stockpiles and roadway

- Be familiar with the worksite and your work area.
  Know the limitations of machine.
- Talk to other operators about tips for improving operation and manoeuvring.

D. Braking.

- Have machine sympathy.
- Don't brake too suddenly unless in case of accident.
- Allow enough distance to stop, particularly with a loaded bucket

F. Attachment operation.

Very piece of equipment has design limits and operational recommendations. This applies both to the attachment and the backhoe/loader as a vehicle. Operating within the specifications, recommendations and design limits ensures you do not damage either the backhoe/loader or the attachments. How each attachment is used will be outlined in the operator's manual and shown to you during your equipment induction and familiarization process.

G. Bucket loading.

- Apply the correct technique for the type of bucket you are using.
- Talk to more experienced operators and ask for mentoring if you feel you need help.
- Don't overload the bucket.
- Efficiency and effectiveness in loading comes with practice.

H. Load carrying.

- Load carrying techniques include:
- Carry the load low to the ground wherever possible.
- Travel at a safe speed.
- Keep the machine balanced.
- Try to avoid spillages.

Backhoe/loader operations include

- Mixing materials
- Stripping and spreeding materials
- Cutting and boxing
- Trench excavation
- Backfilling
- Leveling
- Load vehicles and equipmen

2.6. Moving backhoe/loader safely

Moving larger plant and equipment between worksites is normally done on a float (trailer) because the machines are too slow, or not allowed to drive on the road.

Make sure that an approved traffic management plan is in place. This may include:

- Stopping other traffic to allow the equipment to move freely.
- Using escort vehicles where needed.
- Sometimes a haul vehicle crossing will be established to allow materials movement across public roadways.

It's also not a small move financially, either. Think about it: most backhoe loaders can only travel up to 22 mph, and consume about 1.1 gallons of fuel per hour – and that's a minimum. Now, take these numbers and consider how many miles you'd have to drive to get the backhoe loader from point A to point B, and the results will most likely hurt your pockets.

A backhoe may be equipped with a steer and a set of sturdy wheels, but it isn't designed to move across long distances. Thus, transporting it to various construction site locations could be challenging. Preparation is key for successful backhoe transport it used to

- Perform a documented risk assessment
- Outfit sites & people with PPE (personal protective equipment)
- Determine the weight and dimensions of your backhoe loader
- Inspect Your Truck and Trailer

2.6.1. Load & transfer a backhoe

Transporting a backhoe can be difficult, time-consuming, and expensive. Preparation, communication, compliance with local, state, and federal regulations, and strict safety procedures are musts for any machine going from Point A to Point B. Many times it is easier to hire a professional transport provider to move a backhoe for you, especially over longer distances. VeriTread can help you with all of your backhoe transport needs.

Figure 2.5 Load & transfer a backhoe

2.6.2. Shipping your backhoe loader

The best way to ship a backhoe loader is by using an open-air trailer, like a flatbed truck. Because of its rather unusual shape, there's always the question of whether the equipment would even fit properly inside the container with closed trailers. But, if you go with the open-air method, you don't have to worry about that. If you have a loader backhoe in need of long-haul transport, you'll want the right truck, trailer, and driver to haul it to its rural or urban destination at the right price. There are a few things you'll need to do to prepare your backhoe loader for the trip before you book the services of a hauler, which is easy and transparent to do through FR8Star.

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Give Short Answer for the following Questions (2 points each)

1. What are the Most fatal and serious injuries involving loader occur when the excavating?.
2. Write Causes of injuries with backhoes and loaders?
3. Write Equipment Productivity Determination methods?
4. Define the term Towing?
5. Write the step of safety checklist for how to tow ?

Note: Satisfactory rating 10points Unsatisfactory - below 10 points

Operation sheet 2

2.1. Operating backhoe

A. Materials required for operating

- PPE
- Operators manual
- First aid kit
- Backhoe/front end loader

B. Techniques /Steps to operate

Step1. Check out the machine you're going to operate.

Figure 2.6 Backhoe loader

Step 2. Read the operator's manual of the machine you will operate.

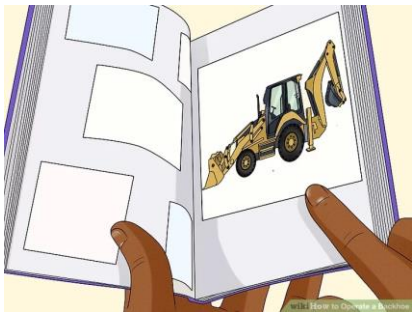

Figure 2.7 Operators manual

Step 3 Climb up on the machine you have chosen.

Figure 2.8 Climb up on the machine

Step 4 Check all fluid levels before you start the machine.

Figure 2. 9 Checking all fluid levels

Step5 Crank the engine, allowing it to warm up for a few minutes before attempting to engage the transmission or operating any controls.

Figure 2.10 crank the engine

Step 6 Check to make sure all attachments are clear of the ground, including the stabilizers, the front bucket, and the backhoe boom.

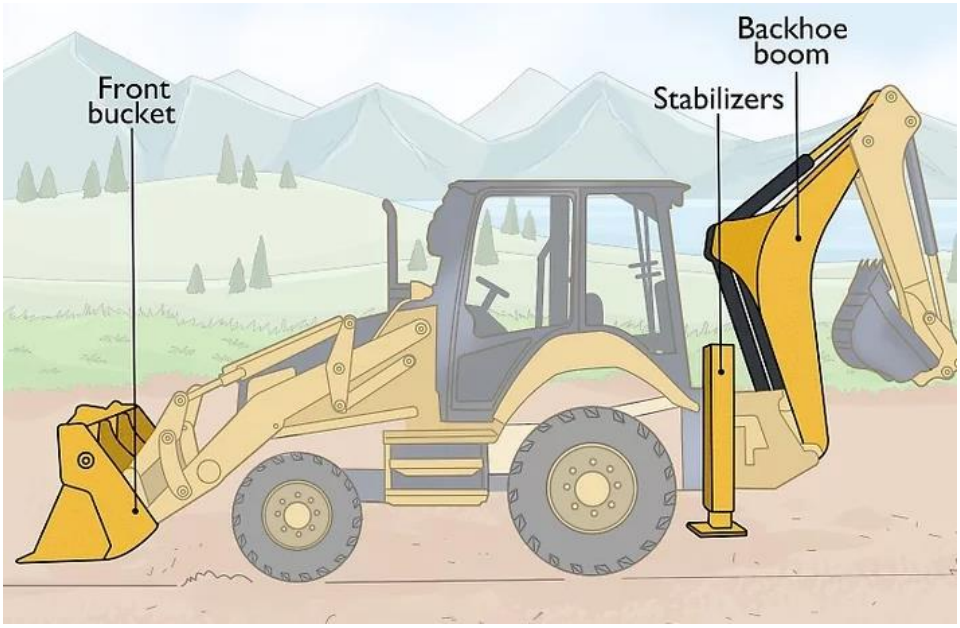

Figure 2.11 Backhoe with its attachment

Step 7 Release the parking brake, and shift the transmission into forward, then drive it slowly around while you get the hang of steering and braking the machine.

Figure 2.12 Release the parking brake

Step 8 Raise and lower the front end loader bucket (if equipped) to get the feel of it.

Figure 2.13 Raise and lower the front end loader bucket

Step 9 Park the machine in an area suitable for practice digging with the backhoe.

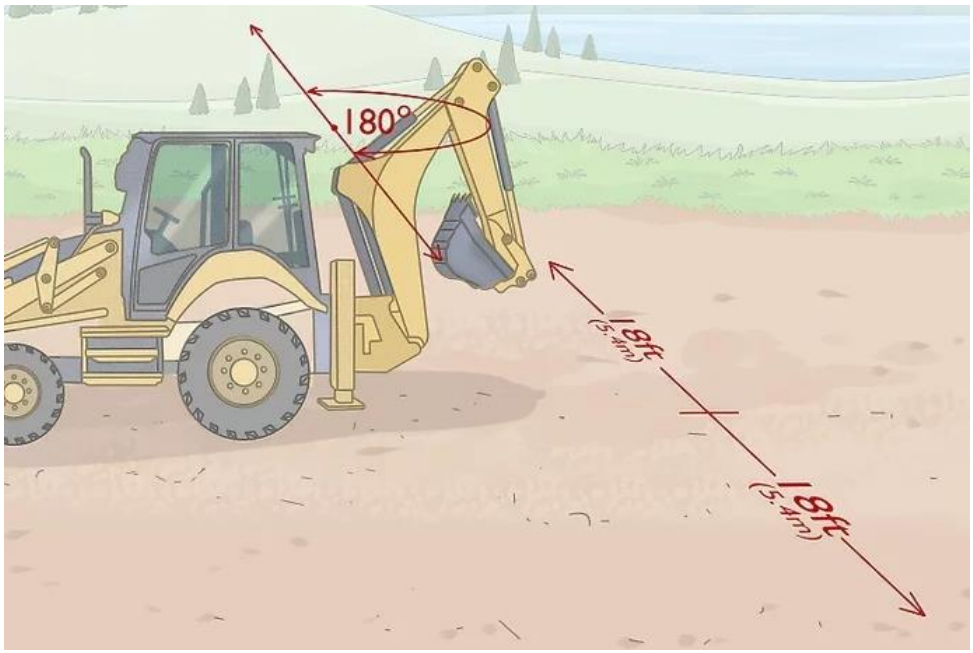

Figure 2.14 Park the machine in an area

Step10. Set the throttle to rev the engine to about 850 Rotations Per Minute (not too fast until

Figure 2.15 set the throttle

Step11. Lower the stabilizers until they raise the rear of the tractor so the back wheels no longer touch the ground.

Figure 2.16 Lower the stabilizers

Step12. Unlock the back boom.

Figure 2.17 unlock the back boom.

Step 13 Find a comfortable operation configuration.

Figure 2.18 find a comfortable operation configuration

Step 14. Push the left lever further outward after the boom is unlocked to lower the main boom, or nearest section of the backhoe boom.

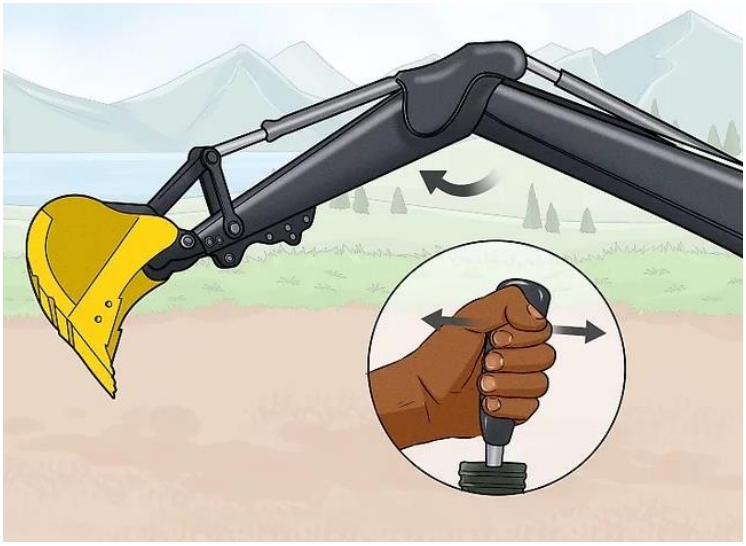

Figure 2.19 push the left lever

Step 15 .Position the bucket over the spot you want to begin digging, and then push the right control stick to the right to open the bucket for scooping, then lower the main boom to engage the soil.

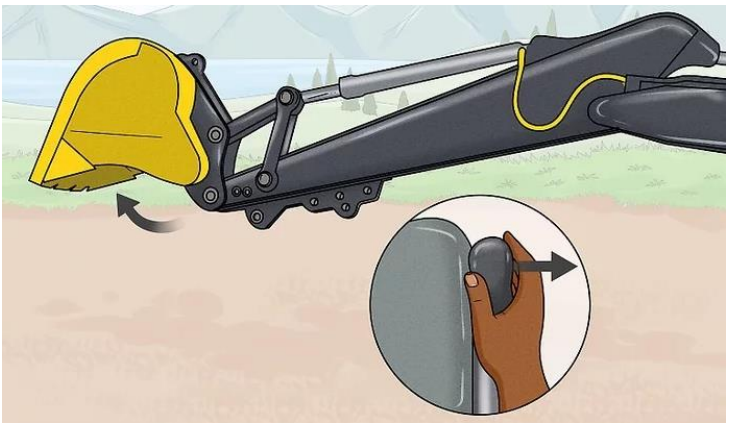

Figure 2.20 Position the bucket over the spot

Step 16 Raise the boom with the left control arm by pulling it.

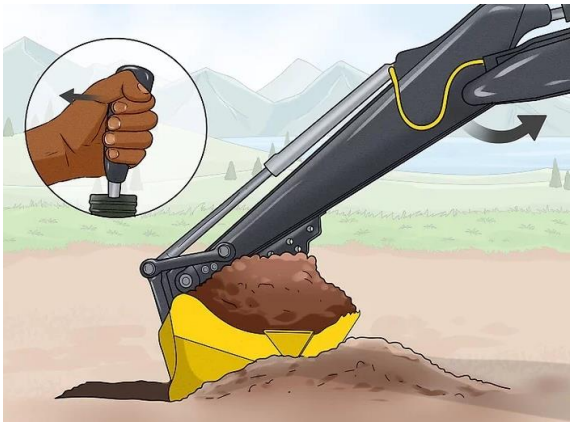

Figure 2.21 raise the boom

Step 17 Swing the bucket to the side you're going to dump the load of dirt you scooped from the hole by pushing the left control lever in the direction you want the boom to swing.

Figure 2.22 Swing the bucket

Step 18 Swing the bucket back to the starting position by pushing the left control stick the direction you want the boom to go, then repeat the process.

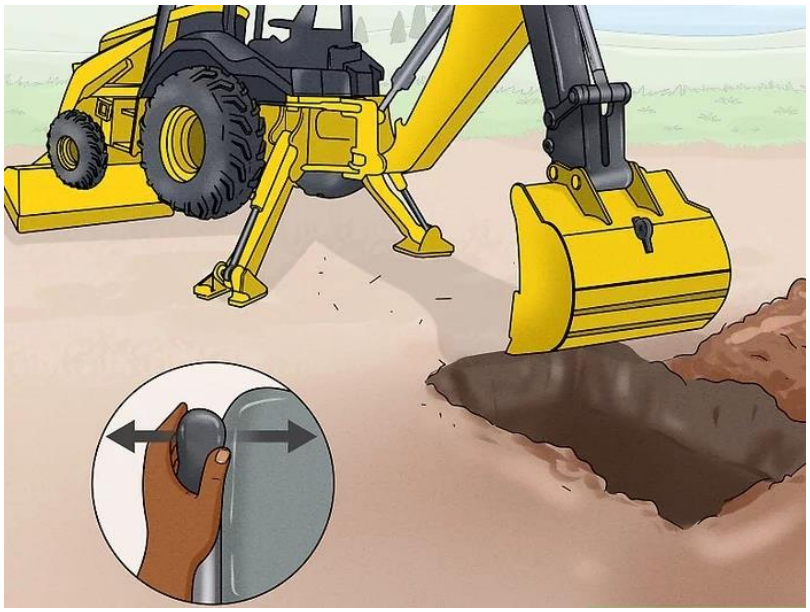

Figure 2.23 Swing the bucket back to the starting position

Step 19 Put the front bucket down on the ground when you finish the operating period.

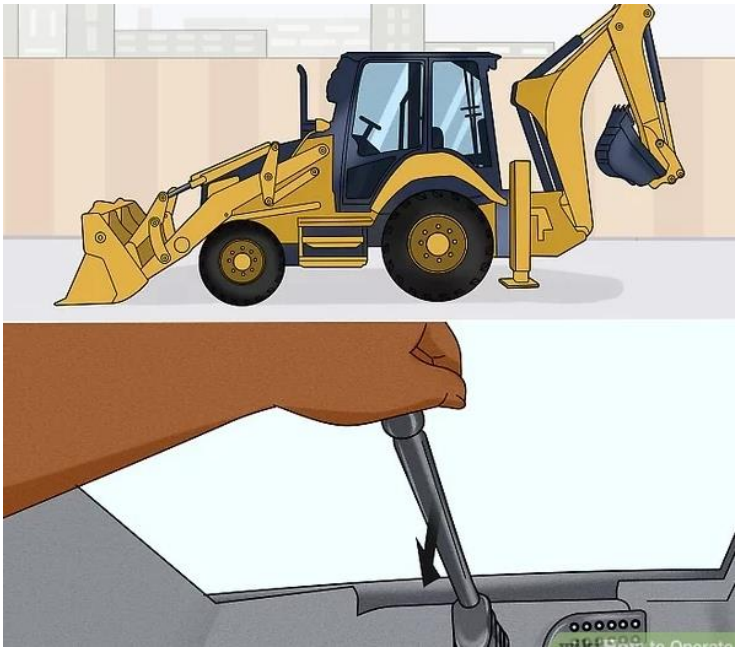

Figure 2.24 put the front bucket down

2.2. Towing and disconnecting backhoe loader attachments

A. Materials required

- PPE
- Backhoe
- First aid kit

B. Steps to tow and disconnect with attachment

- Operate this vehicle as per the operator manual instructions at all times and sop 01 tractor operations operational safety checks connect attachments
- Ensure the attachment is on flat/level ground.
- Locate the joystick for operation of the hydraulics on the loader arms.
- Move the joystick to test movement of loader arms and tilt operations.
- Drive up to attachment slowly and lower arms down to same height and give a slight crowd angle.
- Lift/align loader arms on loader onto top securing lugs of attachment and lift up and crowd back arms to allow attachment to enter bottom securing position.
- Lift loader to about 50 cm off ground apply hand brake, put tractor in neutral and turn off.
- Manually insert pins.
- Dismount from tractor and ensure locking pins should slide down over bottom bar.

https://youtu.be/mYk6AYNGKcE (Accessed date 04/06/23)

Disconnect attachments

- Ensure the attachment is on flat/level ground.
- Apply the park brake.
- Dismount and manually unlock pins safety latch on attachment.
- Remount back into cab.
- Then with the Joy stick crowd the attachment forward and down which will release the bucket/attachment.
- Once detached back away from Attachment
- Once Detached apply park brake.

2.3. Loading & securing your backhoe loader safely

A. Materials and equipment's

- PPE
- Back how
- Wrench
- First aid kit

B. Steps to loading & securing your backhoe loader

- Designate Duties
  - ✓ Make sure everyone involved in loading the backhoe has been trained properly. Not only do they need to know what they're doing, but also how their actions might cause damage or injury if carried out improperly.
  - ✓ Use an open-air trailer. The best way to transport a backhoe is through an open-air trailer, which is typically 75 to 80 feet in length and hauls a two-level trailer without a roof and sides..
- Make sure the trailer you are loading onto is on flat, level ground
  - ✓ A tilted trailer can cause rollover problems that are easily avoidable.
  - ✓ Determine the Backhoe's Dimensions. Another way to ensure your heavy equipment is safe during the transportation is by determining its dimensions before loading it onto the trailer. The backhoe's length, width, and weight are vital factors to be considered when choosing the best vehicle to transport it.

Figure 2.25 Tilted roller

- Be aware of all obstacles in your area
  - Adjust your loading strategy to avoid hitting any nearby objects and move everything to a safe distance if possible.
- Check that your truck can handle the load and is parked and secure
  - Use the parking brakes and wheel chocks on the front and rear wheels of the trailer to prevent unwanted movement.
- Check your trailer deck
  - Make sure it is as clean as possible and ready to accept the load. A clean work area has the fewest problems.

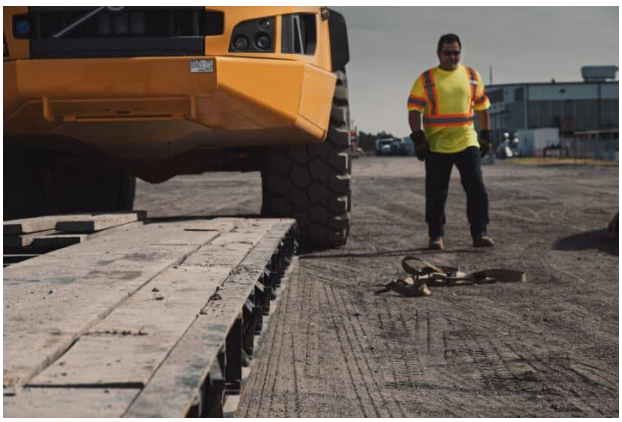

Figure 2.26 Trailer deck

- Line up and approach the trailer, straight on.
- Use a spotter if your view is obstructed

Figure 2.27 Trailer straight on.

- Secure Your Backhoe Loader for Transport.

Figure 2.28 Secure Your Backhoe

- All equipment attachments, work tools, and other accessory equipment must be lowered and secured before transportation.
- Retract booms and buckets and secure them in place.
- Secure equipment components (lock all doors, covers, tailgates, and articulation points).

Figure 2.29 Attachment point

- Verify Driver Visibility
- Make sure the driver has a clear view of what's going on around them.

LAP TEST-2	Performance Test

Name……. **ID……..**

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **40 Hour**. The project is expected from each student to do it.

Task-1 Perform operating Backhoe loader

Task-2 Perform towing backhoe loader

Task-3 Perform loading & securing your backhoe loader

LG #24 LO #3: Carry out Lift, carry and place materials

Instruction sheet

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

- Communicating practices associated with transportation and lifting of materials
- Selecting and attaching slings and lifting gear
- Positioning and locating machinery
- Slinging, lifting, carrying and placing of materials
- Techniques for calculating safe working loads
- Moving load

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

- Communicate practices associated with transportation and lifting of materials
- Select and attach slings and lifting gear
- Position and locate machinery
- Sling, lift, carry and place of materials
- Techniques for calculating safe working loads
- Move load

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Information Sheet 3

3.1. Communication practices associated with transportation and lifting of materials

Poor communication can have disastrous consequences on work sites. Heavy equipment operators can face immense pressure to ensure their work is carried out safely and on time, but can also often feel cut off or isolated from the rest of the crew. When there isn't an open line of communication between equipment operators and crew members, you run a high chance of something going wrong. It's not always obvious when you need to improve communication for your heavy equipment operators, but if any of these signs are appearing, it might be time.

3.1.1. Reasons why heavy equipment operators need better communication

a. Safety Concerns

Safety should always come first, and improving communication will no doubt improve the safety for heavy equipment operators and other workers on site. If there is an accident, workplace communication will always be examined closely, so it is worth ensuring clear and effective lines of communication are in place for everybody's best interests.

b. Missing Deadlines

Missing deadlines will cost your business money. Anyone can have an off day, but if operators are struggling to keep up with workloads, or projects are regularly being pushed out, you may need to look at your team communication. Clear and direct communication will help team members understand roles and responsibility which will also help heavy equipment operators work more efficiently. You may find tiny improvements can snowball into big savings.

c. Long Waits

Operators can sometimes spend a lot of time waiting on site, rather than working. Or the rest of the team can be left waiting for operators to deliver. This waste of time is a common problem for many work sites. Heavy equipment operators are often working with a different project crew, so they have to be able to adapt to different working rhythms. Clear communication between operators and the rest of the crew will help reduce the time spent waiting around on site and increase productivity.

d. Equipment Damage

Are equipment repair or replacement costs impacting your profit margin? When operators try to rush to complete tasks, there is a good chance equipment is being pushed beyond its limits. If real-time communication between operators and other team members is poor, you run a very high risk of accidents or equipment damage. Improving communication helps to reduce operator error, equipment damage, and keeps the work site safe.

e. Stress or Morale

Heavy equipment operators understand the dangers that come with their work, and the responsibility to ensure they work safely. However, poor communication, isolation from the project, or feeling like they have been set up to fail, all contribute to high stress and low morale – two things you never want on site. Improving communication ensures nobody feels out of the loop and allows all workers to operate their equipment safely.

3.2. Selecting and attaching slings and lifting gear

- Sling is a removable accessory that enables a machine or device, such as a crane for example, to lift a load by linking the lifting device and the load to be lifted (object, vehicle, etc.).
- Slings are essential lifting devices for all lifting operations. This term includes different types of equipment.

Lifting gear inspection is a detailed visual and operational inspection whereby individual lifting gear items are examined to ensure their integrity and ongoing safe operation for lifting operations. Lifting gear inspections are performed on a regular basis depending on the standards and specifications of the equipment and its usage.

A sling is a removable accessory that enables a machine or device, such as a crane for example, to lift a load by linking the lifting device and the load to be lifted (object, vehicle, etc.). Slings are essential lifting devices for all lifting operations. This term includes different types of equipment. It is recommended to use, store and clean the lifting slings in a specific way in order to preserve them and guarantee safety during use.

3.2.1. Component parts of slings

A. Under The Hook

To connect crane hook and load safely, the so-called "under-the-hook devices" are needed. Here you learn about the device group slings. Slings are used to connect crane and load and enable safe transport. Due to a variety of lifting applications various sling options are possible, chain slings, wire rope slings and textile slings.

B. Crane Hook Often the crane hook cannot lift loads directly so between the crane hook and the Load, further components are needed.

C. Slings: Slings ("hangers") are used to create a connection between the crane hook and the load in most case, chain slings , wire rope slings or textile slings are used.

D. Lifting Points: A common method of establishing a connection is us to use lifting points that can be attached to the Load

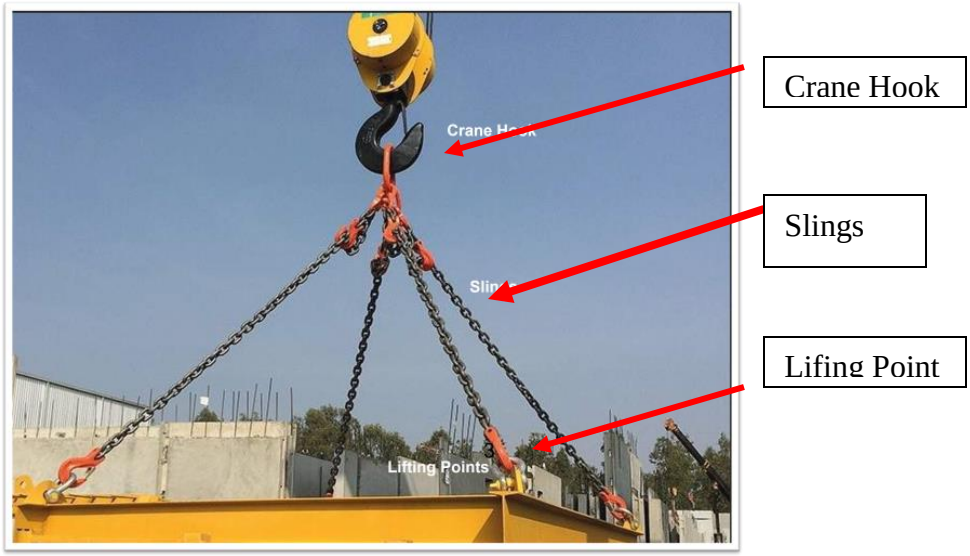

Figure 3.1 Component parts of slings

https://youtu.be/5fc1K3w9VDs (Accessed date 05/05/23)

3.2.2. The different types of slings

There are several types of single or multi-strand lifting slings, made of textile (polyester, UHMWPE, aramid, etc.), rope, metal cable or even chain. Slings can be equipped with metal components such as hooks, rings or shackles at their ends.

There are different types of slings but the most commons are

A. Chain Slings

Chain slings use tested, short-link chains, standardized in different grades for lifting purposes. The standards prescribe high requirements on performance and quality and make sling chains a high-quality and top performance product, that can be used worldwide. As safety is the top priority of sling chains, every individual link is tested beyond the working load limit and every individual lot is checked on the quality of the production. This guarantees best quality and highest safety of sling chains for use.

Figure 3.2.Chain slings

B. Textile Slings

Textile slings consist of textile fabrics and are standardized for general lifting purposes. Only high-strength multifilament made of technical yarns (polyamide (PA), polyester (PES), polypropylene (PP)) is permitted to be used for textile slings. For lifting purposes, textile webbing slings and round slings are used. pewag offers webbing slings and round slings as well as additionally needed equipment required for textile slings.

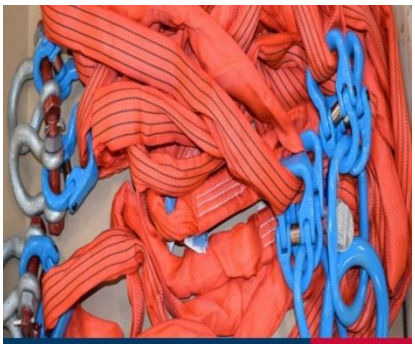

Figure 3.3 textile slings

C. Wire Rope Slings

Wire ropes consist of individual steel wires which together form a strand. In a pattern (“lay”) the strand is wound around an inner filler material (“core”). In order to be connectable to other components, wire ropes need an end connection. By the type of end connection and the material of the core (fiber or steel), the wire ropes differ from each other.

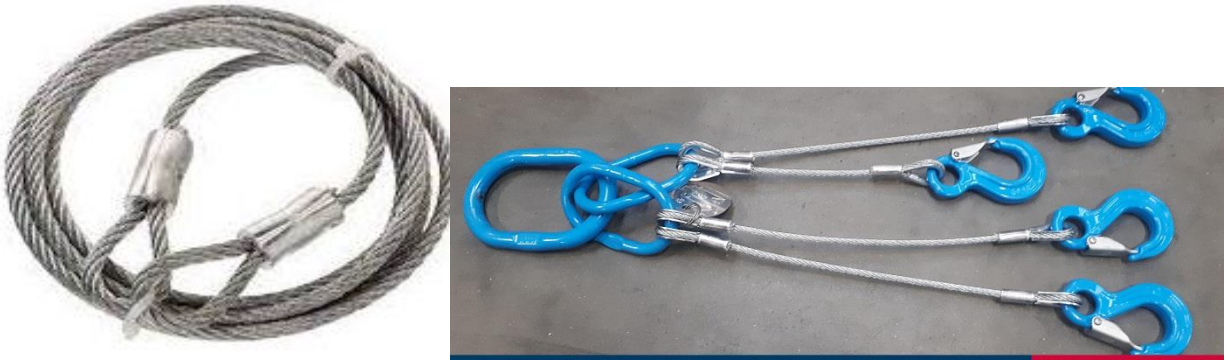

Figure 3.4 wire rope slings

D. Assembly of chain slings

Slings are assembled with different accessories, depending on the application and usage A chain sling is a modular system, consisting of: master links, end fittings, connecting links and shortening devices.

Lifting slings are designed to move large, bulky, heavy loads that would be extremely difficult if not impossible to move manually. They provide a direct connection from your lifting equipment, be it an electric hoist, or a crane to the load that you are using. Whenever you are lifting with lifting slings it is important that you take the following steps into consideration.

3.2.3. That should you know or determine before choosing a sling

Be sure you know the correct use of the equipment, the slinging procedures and the sling strength factors to be applied before lifting. Always check the manufacturers' information before using.

Always determine:

- The weight of the load.
- The center of gravity of the load.
- The best slinging configuration that provides the proper balance for the load.

- The working load limit of the sling.
- The work rated load of the attachments and components of the sling.
- Other physical characteristics of the load
- The environmental conditions (temperature, humidity, presence of corrosive agents).
- The characteristics of different types of slings.

3.2.3. Select Lifting Gear

- When using the backhoe/loader for lifting, make sure it is fitted with the correct lifting attachment or that the machine has the appropriate lifting lugs. Always use an approved lifting lug or lift connection that is clearly marked with the Safe Working Load (SWL).
- Lifting gear needs to be selected based on the type, size, weight and shape of the load to be lifted. Only a licensed dogger or rigger is authorised to select and inspect lifting gear, determine the weight of loads and select and apply slinging techniques

A. Types of lifting gear

Lifting gear that may be used with the backhoe/loader includes:

- Wire rope slings – also known as Flexible Steel Wire Rope (FSWR).
- Chain slings.
- Synthetic slings.
- Eye bolts, shackles and hooks – used to attach lifting gear to the load and backhoe/loader

B. Inspect and connect lifting gear

- Slings and other lifting gear must be inspected before and after use for any signs of damage or wear. All faults must be reported in accordance with site procedures and the equipment must be isolated (removed from service).
- Once the correct attachment and lifting gear has been chosen and inspected by a licensed dogger or rigger, you need to make sure it is connected to the backhoe/loader properly.
- Slings should only be attached to manufacturer approved lifting lugs using a shackle that is rated to lift the load.

3.3. Positioning and locating machinery

Before lifting a load with slings you need to get the backhoe/loader into the right position. Make sure:

- The machine is on firm level ground.
- The load, backhoe/loader and lifting gear can all be safely accessed.
- Any other personnel, plant and equipment not directly involved are a safe distance away.
- You have enough overhead clearance to lift the load.
- You have enough room to move once you have lifted the load, especially if you need to travel with it.
- The backhoe/loader is in line with the load so it will not swing when it is lifted. This could include being at a 90 degree angle to the excavation area.
- You have a clear line of sight to the excavations and areas you will be lifting loads into.
- You have enough swing room to operate the backhoe/loader safely.
- You are using extended or engaged stabilizers for additional support.

3.4. Slinging, lifting, carrying and placing of materials

The term Lifting can be defined as to take hold of and raise something in order to remove, carry, or move it to a different position. Using backhoes and excavators on sites to lift and place heavy construction materials saves time and money, but doing the job safely demands special care.

Following are five quick tips to help you get started toward safely completing these tasks. For specific guidelines, consult the operator's manual for the particular machine that will be used.

A. Ensure the machine can handle the load

Exceeding the lifting capacity of an excavator or backhoe-loader could cause it to become unstable, increasing the risk of tipping or loss of control of the machine or load. This may result in injury to personnel and damage to the machine, site or payload. It can also place undue stress on systems and components, which may lead to maintenance issues, failures and costly downtime and repairs down the road.

B. Understand the machine's load charts

Manufacturers determine how much weight an excavator or backhoe-loader model and configuration can safely lift. Machine capacity is constantly changing based on the boom's working range and position.

C. Determine the total weight of the load

Prior to any lift, it's vital that you know the weight of the material to be moved. Many types of construction materials, such as concrete pipe, will have weights available from the supplier. Be sure to contact the proper individual on site who can provide this information.

Yet, knowing a load's weight is only the starting point. The total load weight must also take into account the machine configuration and any items that may add weight to the lifting end of the machine, such as buckets, thumbs and couplers. The weight of these items must be subtracted from the total weight the unit can lift at the particular reach or angle required.

If the total weight of a load can't be determined, proceed with caution. Conduct a test lift if there is any question about the machine's ability to handle the load, making sure the load is picked close to the machine, kept close to the ground and slowly extended and swung into place.

D. Check the site and the machine

Before starting the lift, check the surrounding area for obstacles or hazards (e.g., overhead utilities) within the lift zone. Make sure the machine is positioned on a firm, level and stable surface. Avoid lifting on soft, uneven or unstable ground. Use mats, wood platforms or steel plates to provide a more solid work platform if needed.

The operator should check that the controls are set to the preferred control pattern and that he or she is familiar with the functions of that particular machine. A safety check should also be conducted on the machine to ensure it is in good condition and is operating properly.

E. Keep it low and slow

Keep in mind that an excavator or backhoe-loader will have its highest lifting capacity closer to the machine. Lift the load squarely over the side or end of the machine. Keep the load as close to

the machine and the ground as possible as you move it, then extend the load out to place it in the desired location. Use slow movements to help ensure a controlled operation.

3.5. Techniques for calculating safe working loads

Safe Working Load It is sometimes stated as the Normal Working Load (NWL) is the maximum safe force that a piece of lifting equipment, lifting device or accessory can exert to lift, suspend, or lower a given mass without fear of breaking. In simple terms, safe working load of any lifting equipment or lifting accessories is the maximum weight of a load it can carry at any given time safely.

In Health and Safety, it is expected that all manufacturers of lifting equipment and lifting accessories should specify the safe working load of that equipment/accessory to prevent overload. Overload of equipment can result to accidental release of the load or toppling of the lifting equipment which could cause serious injury or death.

To ensure safe lifting, risk assessment must be carried out for all lifting exercises. One of the things to consider during the risk assessment is the lifting machinery, lifting accessories and the load.

3.5.1. Calculating safe working load (SWL)

The SWL is determined by dividing the minimum breaking strength (MBS) of a component by a safety factor assigned to that type and use of equipment. The safety factor generally ranges from 4 to 6 unless a failure of the equipment could pose a risk to life; in that instance the safety factor would be a 10. For example, if a line has an MBS of 1,000 pounds and a safety factor of 5, then the SWL would be 200 pounds. 1000 / 5 = 200. Also called working load limit (WLL).

NOTE: SWL is no longer used to identify the maximum capacity of equipment due to it being too vague and leaving it open for legal issues. The US and European standards switched to The Working Load Limit' standard shortly after.

In other way we can calculate SWL by the following methods To calculate the SWL, you need to know the diameter of the cable or rope. While you may find this on the packaging, you can also calculate it manually by measuring it yourself. Ensure that you enclose all of the strands of rope when measuring the diameter, and measure from the top of one strand to the top of the strand

which is directly opposite. If you're worried about the accuracy of your measurements, conduct your measurements three times at different places on the cable, and use the average of your three measurements as the diameter of the rope.

Once you know the diameter of the rope, you can apply it to the formula, which is SWL = D2 x 8. D represents the diameter of the rope in inches. If you're working with a 1.5-inch diameter cable, for example, then the formula would be SWL = 1.52 x 8 or SWL = 2.25 x 8. This calculation means the SWL of a 1.5-inch diameter rope is 18 tons.

3.6. Moving load

A moving load is a load that moves over a certain distance. Let's narrow it down to a moving load acting on a structure. In case of buildings, the loads that affect the floor of the building, such as people and furniture, can be all called moving loads.

3.6.1. Types of moving load

A. Single moving load

For a single moving load, the maximum moment occurs when the load is at the mid span and the maximum shear occurs when the load is very near the support (usually assumed to lie over the support).

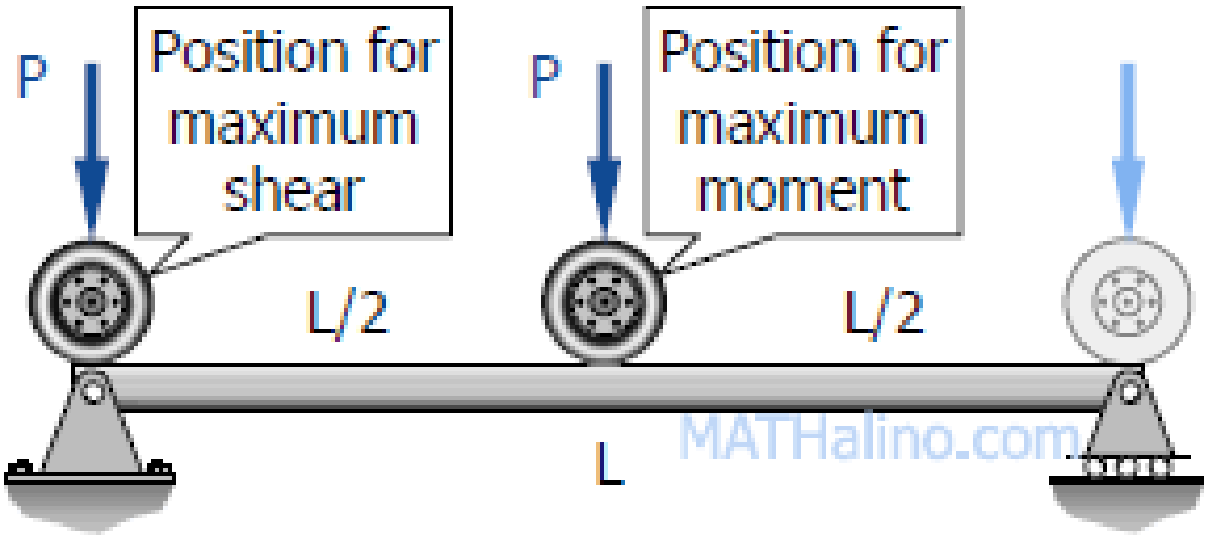

Figure 3.5 Single moving loads

Mmax=PL/4 and Vmax=P

B. Two moving loads

For two moving loads, the maximum shear occurs at the reaction when the larger load is over that support. The maximum moment is given by

$$M_{max} = \frac{(PL - P_s d)^2}{4PL}$$

Where Ps is the smaller load, Pb is the bigger load, and P is the total load (P = Ps + Pb).

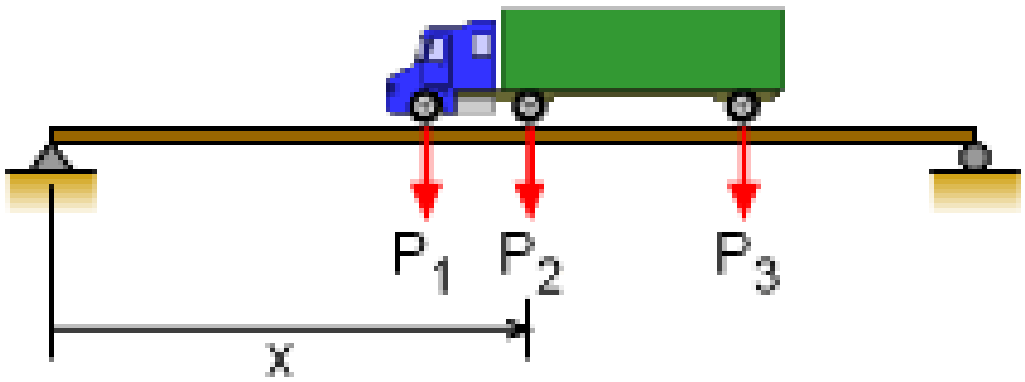

Figure 2.6 Two moving loads

C. Three or more moving loads

In general, the bending moment under a particular load is a maximum when the center of the beam is midway between that load and the resultant of all the loads then on the span. With this rule, we compute the maximum moment under each load, and use the biggest of the moments for the design. Usually, the biggest of these moments occurs under the biggest load.

The maximum shear occurs at the reaction where the resultant load is nearest. Usually, it happens if the biggest load is over that support and as many a possible of the remaining loads are still on the span. In determining the largest moment and shear, it is sometimes necessary to check the condition when the bigger loads are on the span and the rest of the smaller loads are outside.

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Write Short Answers for the following Questions (2 points each)

1. What are the consequences of poor communication in work site?
2. Write the Reasons why heavy equipment operators need better communication?
3. What mean slings?
4. What are the component parts of slings and their function?
5. What are the criteria's for choosing slings?
6. How to calculate safe working load (SWL)?

Note: Satisfactory rating 12 points Unsatisfactory – below 12 points

Operation sheet 3

3.1. Lifting and slinging.

A. Required tools and equipment:

- PPE
- Maintenance manual
- Operators manual
- Tire labor

B. Techniques/Steps for safe lifting and slinging.

- **Pre use check.**

Before any lifting and slinging takes place a pre shift check must be carried out on the equipment used. This includes checking for, rips, tears, cracks, stitching coming loose, wear, clasps, discoloration, tags, to name just a few. Report any faults immediately.

- **Select the correct lifting equipment.**

Before lifting a load makes sure the weight, size, material, shape etc of the load is taken into account before selecting the correct lifting equipment.

- **Make sure the load is secure.**

The correct method of securing the load when lifting and slinging is essential. Always double check the load is secure and will not come loose in transport. Remember a choke hitch reduces what the sling can lift by 20%.

- **Lifting and slinging angles.**

The best way to lift any load is vertical/straight up. Sometimes multi connection points are needed to secure the load, especially on long/wide loads.

- ✓ Remember that the lifting angle (including/working angle) will decrease what the sling can lift as the angle gets bigger.
- ✓ The recommended including angle between the two legs of a sling is 90 degrees. Always read the slings tag.

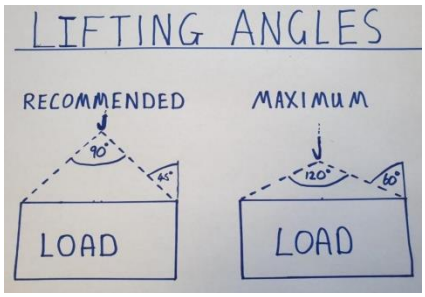

Figure 3.7 Lifting and slinging recommended angles

- **Check the area.**

Before moving the load, check the route to make sure all precautions are taken to reduce the risk of an accident.

- **Moving the load.**

The make sure loads are carried at ground level. Under no circumstances must loads be carried over people's head's. Hand signals can be used if necessary.

- **Lowering loads.**
  - ✓ Always ensure the load has a destination location before moving. Lower loads carefully ensuring the load is stable once in place.
  - ✓ Never drag material slings or chains from underneath a load, place on runners/skids if necessary.
- **Post operational check.**
  - ✓ A check should be completed once the lifting and slinging is done. This is to so you are confident that everything is functioning as it should.
  - ✓ Make sure no damage has occurred while using the equipment and report any faults immediately.
- **Storage of the lifting and slinging equipment.**
  - ✓ All of the equipment should be stored correctly when the job has been completed. Firstly when the equipment is stored correctly it is easily found when you need it again. Secondly, it ensures the equipment is not damaged.
  - ✓ Store all equipment in the correct locations. Furthermore it also prevents slipping and tripping accidents in the workplace.

LAP TEST-3	Performance Test

Name……. **ID……..**

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hour. The project is expected from each student to do it.

Task-1 Perform lifting and slinging.

LG #25 LO #4 : Clean machinery and equipment

Instruction sheet

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

- Clearing work area and disposing or recycling materials
- Cleaning, checking, maintaining and storing plant, tools and equipment
- Cleaning and storing removed attachments

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

- Clear work area and disposing or recycling materials
- Clean check, maintain and store plant, tools and equipment
- Clean and store removed attachments

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets". Try to understand what are being discussed.
3. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks "
5. You will be also provided with additional reference reading materials regarding identifying risks.
6. Do the "LAP test"
7. Ask your instructor for additional referencing videos and audios

Information Sheet 4

4.1. Clearing work area and disposing or recycling materials

Clear all surface objects, including trees, logs, roots of downed trees, brush, residue of agricultural crops, grass, weeds, asphalt, concrete, masonry, and other unwanted material, such as Lumber, trash, and loose debris. Preserve trees, shrubs, plants, and other objects to remain within the established limits. Protect remaining trees and shrubbery from injury or damage. No trees shall be removed until all tree protection zones are established and approved by the Engineer. Cut trees to be removed without injuring trees and shrubbery that are to remain

Before you get started, it helps to have the following tools and equipment:

- Air compressor
- Flashlight
- Engine cleaner or degreaser
- Plastic bags
- Gloves
- Pressure washer

4.2. Cleaning, checking, maintaining and storing plant, tools and equipment

Dirt is a sure sign your equipment's been working hard, but it can also put your equipment and people at risk. Cleaning heavy equipment will help it operate efficiently, retain its value and keep employees safe.

4.2.1. Maintain your tools

- Clean Your Tools
- Store Tools Properly
- Inspect Your Tools Regularly
- Sharpen Your Tools
- Keep Your Tools Lubricated
- Keep Away From Moisture
- Cool down heated tools

4.2.2. Maintaining the backhoe

- Before performing maintenance, lower the attachment to the ground, turn off the engine, remove the key and apply the brakes.
- Never perform any work on the attachment unless you are authorized and qualified to do.

4.3. Cleaning and storing removed attachments

4.3.1. Cleaning Attachments

- Attachments need to be kept in good working order. This requires correct maintenance such as cleaning the attachments, and storing them in designated storage locations.
- Clean equipment of all dirt, oil and excess grease to help you avoid overlooking worn or damaged components.
- Things to consider if your attachments require manual cleaning: Some materials that you work with can become extremely hot and sticky, and could possibly burn through your clothing and skin. Use appropriate cleaning instruments and wear personal protective equipment (PPE) as required.
- Backhoe/loader attachments such as ripping tynes can be sharp. Clean with care

Figure 4.1 Cleaning removed attachment

- **Stages of cleaning**

✓ **Pre-Clean**

The first stage of cleaning is to remove loose debris and substances from the contaminated surface you're cleaning. You can do this by wiping with a disposable towel, sweeping, or rinsing. The aim is to remove as much loose debris as possible to prepare the area for the next stage of cleaning.

✓ **Main Clean**

The second stage of cleaning is to loosen any substances, dirt, grease, and debris that you were unable to remove during the pre-clean stage. This involves using hot water and a detergent. You may be able to wipe away the loosened substances right away with something suitable, such as a cloth or mop, or you may have to allow the disinfectant to do its work for a certain amount of contact time before doing so.

✓ **Rinse**

The third stage of cleaning is to remove all the loosened substances, dirt, and debris as well as the detergent that was present in the second stage.

✓ **Disinfection**

The fourth stage of cleaning is to disinfect the surface, which will destroy bacteria and other microorganisms. Follow the instructions for any products or equipment you use.

✓ **Final Rinse**

The fifth stage of cleaning is to remove any disinfectants from the previous stage using clean, hot water. This step may not always be carried out however, depending on the disinfectant and surface you're cleaning. As stated in the previous stage, follow the manufacturer's guidance and seek further advice if needed.

✓ **Drying**

The sixth and final stage of cleaning is to dry the surface, and it's recommended that you air dry where possible. You must not air dry any drying cloths that are damp from use and reuse them, as bacteria could grow on the cloths and pose a contamination risk.

4.3.2. Storing Backhoe attachment

- Most attachments will have designated storage locations as outlined in the site requirements.
- This is to ensure the attachment can be found quickly and easily the next time it is needed, and so that it is kept free from damage.

Storage requirements could include:

- Must be stored in a padded hard case box – particularly with laser levels.
- Must be stored in particular environmental conditions such as a certain temperature.
- Reading, knowing and understanding the particular requirements for each attachment is the only way of ensuring items are correctly cleaned and stored.
- Refer to the manufacturer's guidelines, operator's manual and worksite procedures for each item.

Figure 4.2 storing backhoe attachments

Self-check 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Write the Short Answer for the following Questions (2 points each)

1. Write Stages of cleaning for any machinery
2. Why we clean backhoe
3. What are the pre conditions to be fulfilled before cleaning any machinery
4. What is the requirements of storage

Note: Satisfactory rating -8- points Unsatisfactory – below 8 points

Operation sheet 4

4.1. Cleaning the Backhoe

A. Required tools and equipment:

- Jack,
- Maintenance manual
- Combination wrench,
- Hammer,
- compressor,
- Wire brush, screw driv

Consumable Materials: Water, first aid kit, waste bin, Lubricant,

B. Steps/techniques to cleaning backhoe

- Before you dive into the cleaning process, make sure you have:
  - ✓ Insulated coveralls that protect your arms and legs from flying debris and hot water
  - ✓ Anti-slip footwear with toe protection
  - ✓ Face and eye protection to prevent burns and contamination
  - ✓ Heavy-duty gloves to protect your hands

- Put on protective gear like gloves, a mask, and eye protection.
- Remove floor mats (if you have them) and scrub with a brush and cleaning solution. Rinse with a hose and let air dry.
- Using a shop vac or cordless vacuum, remove all loose dirt and debris from the interior. Make sure to vacuum any crevasses where dirt gets trapped.
- Using the automotive cleaner, wipe down vinyl, plastic, and leather surfaces.
- Clean windows with glass cleaner and LCD screens and monitors with touchscreen compatible cleaner. Be careful not to spray the cleaner directly on screens.
- Mop the floor using dish soap mixed with water. You may need to empty your mop bucket several times. Hose or rinse off.
- For the seat, wet the material and scrub it using an upholstery cleaner. Vacuum with the wet/dry vac to remove the water (and stains). A portable carpet cleaner can also be used.

LAP TEST-4	Performance Test

Name……. **ID……..**

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2 hour**. The project is expected from each student to do it.

Task-1 Perform cleaning Backhoe and its attachments

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