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HEAVY MACHINE OPERATOR

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LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - November, 2019

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Contents

Introduction

Welcome to Learner's Guide for the *Heavy Machinery Operator* Programme. It will help Learner's to complete the programme and to go on to complete further study or go straight into employment.

The *Heavy Machine Operator* programme is to engage young people with a programme of development that will provide them with the knowledge, skills and understanding to start this career in Pakistan. The programme has been developed to address specific issues, such as the national, regional and local cultures, the manpower availability within the country, and meeting and exceeding the needs and expectations of their companys.

The main elements of learner's guide are:

- **Introduction:**
  - This includes a brief description of guide and guidelines for Learner's to use it effectively
- **Modules:**
  - The modules form the sections in learner's guide
- **Learning Units:**
  - Learning Units are the main sections within each module
- **Learning outcomes**:
  - Learning outcomes of each learning units are taken from the curriculum document
- **Learning Elements:**
  - This is the main content of learner's guide with detail of the knowledge and skills (practical activities, projects, assignments, practices etc.) learners will require to achieve learning outcomes stated in the curriculum
  - This section will include examples, photographs and illustrations relating to each learning outcome
- **Summary of modules**:
  - Thiscontains the summary of the modules that make up learner's guide
- **Frequently asked questions**:
  - These have beenadded to provide further explanation and clarity on some of the difficult concepts and areas. This further helps Learners in preparing for the assessment.
- **Multiple choice questions for self-test**:

These are provided as an exercise at the end of learner's guide to help Learner's in preparing for the assessment

Overview of the Curriculum for Heavy Machine Operator:

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of Modules
LU1. Module A: **Contribute to Work Related Health and Safety (WHS) Initiatives** **Aim:** This unit describes the skills and knowledge required to manage the identification, review, development, implementation and evaluation of effective participation and consultation processes as an integral part of managing work health and safety (WHS).	**LU2.** Contribute to initiate work-related health and safety measures **LU3.** Contribute to establish work-related health and safety measures **LU4.** Contribute to ensure legal requirements of WHS measures **LU5.** Contribute to review WHS measures **LU6.** Evaluate the organization's WHS system **LU7.**	**06**	**24**	**30**
LU8. Module B: **LU9. Comply with Workplace Policy and Procedures** **Aim:** This unit describes the skills and knowledge required to implement a workplace policy & procedures and to modify the policy to suit changed circumstances. It applies to individuals with managerial responsibilities who undertake work developing approaches to create, monitor and improve strategies and policies within workplaces and engage with a range of relevant stakeholders and specialists.	**LU1.** Manage work timeframes **LU2.** Manage to convene meeting **LU3.** Decision making at workplace **LU4.** Set and meet own work priorities at instant **LU5.** Develop and maintain professional competence **LU6.** Follow and implement work safety requirements **LU10.**	**06**	**24**	**30**
LU11. **Module C**: **Perform Advanced Communication**	**LU12.** **LU1.** Demonstrate professional skills	**06**	**24**	**30**

Aim: This unit describes the performance outcomes, skills and knowledge required to develop communication skills used professionally. It covers plan and organise work and conduct trainings at workplace, along with demonstrating professional skills independently	**LU2.** Plan and Organize work **LU3.** Provide trainings at workplace			
Module D: **Develop Advance Computer Application Skills** **Aim:** This unit provides an overview of Microsoft Office programs to create personal, academic and business documents following current professional and/or industry standards, i.e. Data Entry, Power Point Presentation and managing data base and graphics for Design. It applies to individuals employed in a range of work environments who need to be able to present a set range of data in a simple and direct forms	**LU1.** Manage Information System to complete a task **LU2.** Prepare Presentation using computers **LU3.** Use Microsoft Access to manage database **LU4.** Develop graphics for Design	**08**	**32**	**40**
LU13. **LU14. Module E:** **Manage Human Resource Services** **LU15.** **Aim:** This unit describes the skills and knowledge required to plan, manage and	**LU1.** Determine strategies for delivery of human resource services **LU2.** Manage the delivery of human resource services **LU3.** Evaluate human resource service delivery **LU4.** Manage integration of business ethics in human resource practices	**04**	**16**	**20**

evaluate delivery of human resource services, integrating business ethics. It applies to individuals with responsibility for coordinating a range of human resource services across an organization. They may have staff reporting to them.				
LU16. Module F: Develop Entrepreneurial Skills **LU17.** **LU18. Aim:** This Competency Standard identifies the competencies required to develop entrepreneurial skills, in accordance with the organization's approved guidelines and procedures. You will be expected to develop a business plan, collect information regarding funding sources, develop a marketing plan and develop basic business communication skills. Your underpinning knowledge regarding entrepreneurial skills will be sufficient to provide you the basis for your work. **LU19.** **LU20.** **LU21.**	**LU1.** Develop a business plan **LU2.** Collect information regarding funding sources **LU3.** Develop a marketing plan **LU4.** Develop basic business communication skills **LU22.**	**06**	**24**	**30**
Module G: **Operate Excavator** **Aim:** This module covers the skills and knowledge required to Comply with safety requirements, Sets up equipment, Install attachments, Operate controls of Wheel Excavator, Operate controls of Crawler	**LU-1:** Safety requirements **LU-2:** Sets up equipment **LU-3:** Install attachments **LU-4:** Operate controls of Wheel Excavator **LU-5:** Operate controls of Crawler Excavator **LU-6:** Create slopes **LU-7:** Build, excavate, and maintain haul roads and ramps	**50**	**200**	**250**

Excavator, Create slopes, Build, excavate, and maintain haul roads and ramps, Create mass excavation, Excavate trenches, Excavate ditches, Load trucks, Cut and fills materials, Stock piles materials, Excavate and back fills trenches, Hoist objects, Clear land, Demolish buildings and other structures and Monitor performance of machines.	**LU-8:** Create mass excavation. **LU-9:** Excavate trenches **LU-10:** Excavate ditches **LU-11:** Load trucks **LU-12:** Cut and fills materials **LU-13:** Stock piles materials **LU-14:** Excavate and back fills trenches **LU-15:** Hoist objects **LU-16:** Clear land **LU-17:** Demolish buildings and other structures **LU-18:** Performance of machines			
Module H: **Operate Grader** **Aim:** This module covers the skills and knowledge required to Operate Controls, Apply grading fundamentals, Form and handle windrows, Strip surface materials, Cut and fill material, Maintain access roads, Create slopes, Create ditches, Create shouldering, Form sub-grade, Place aggregates to specified elevations (finish grading) and Clear snow and ice.	**LU-1:** Operate controls **LU-2:** Grading fundamentals **LU-3:** Form and handle windrows **LU-4:** Strip surface materials **LU-5:** Cut and fill material **LU-6:** Maintain access roads **LU-7:** Create slopes **LU-8:** Create ditches **LU-9:** Create shouldering **LU-10:** Form sub-Grade **LU-11:** Finish grading **LU-12:** Clear snow and ice	**40**	**160**	**200**
Module I: **Plan Work** **Aim:** This module covers the skills and knowledge required to Assess site hazards, Ensure work procedures, Follow symbols and markings, Follow survey markers, construction grades, and stakes, Monitor drawings and plans, Develop environmental concerns with site personnel, Demonstrate grades and stakes, Demonstrate grade checking devices, Review job specifications and safety considerations with site personnel.	**LU-1:** Site hazards **LU-2:** Work procedures **LU-3:** Symbols and markings **LU-4:** Survey markers, construction grades, and stakes **LU-5:** Drawings and plans **LU-6:** Environmental concerns with site personnel **LU-7:** Grades and stakes **LU-8:** Grade checking devices **LU-9:** Review job specifications and safety considerations with site personnel	**16**	**64**	**80**
	TOTAL	**142**	**568**	**710**

Modules

Module: Operate Excavator

Objective: This module covers the skills and knowledge required to Comply with safety requirements, Sets up equipment, Install attachments, Operate controls of Wheel Excavator, Operate controls of Crawler Excavator, Create Slopes, Build, excavate, and maintain haul roads and ramps, Create mass Excavation, Excavate trenches, Excavate ditches, Load Trucks, Cut and fills materials, Stock piles materials, Excavate and Back fills trenches, Hoist objects, Clear land, Demolish buildings and other structures and Monitor performance of machines.

Duration: 250 Hours **Theory: 50 Hours** **Practice: 200 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU-1: Comply with safety requirements	**The students will be able to** • Operate safety controls and equipment. • Respond to caution, warning and hazard signs, lights and symbols	• Explain safety equipment. • Describe safety controls and their operations • Describe warning, hazard signs, lights and symbols	

Here are some excavator safety tips you should consider when putting the equipment to work.

Excavator Safety Tips: Before Operation

- Seat belts are provided for comfort and security.
- Before going to work, be sure the mirrors are clean and set properly.
- Make a quick check of the controls. Be sure the control levers are operating properly.
- Check the propel system. It’s better to do this before operating so you can prevent accidents on the job.
- Call the area’s utility services to have the job site marked for underground lines or structures.

Excavator Safety Tips: During Operation

- Never permit riders in the bucket, cab, or anywhere else on the machine. Excavators only have one seat, which is meant for the operator.

- Never attempt to operate the excavator unless you are sitting in the seat and in full control.
- Reduce the excavator's speed when working on rough terrain or within congested areas.
- Carry the bucket low to the ground during transport. This will increase visibility and machine stability.
- When moving the excavator around the job site, select a route that is as flat as possible.
- Steer the machine as straight as possible and only make small gradual changes in direction when turning is needed.
- Travel directly up slopes vertically instead of diagonally.
- When propelling up slopes, the boom and the arm should be extended with the bucket carried low and rolled out. This will allow you to drop the bucket and prevent the equipment from sliding if necessary.
- When propelling down a slope, the bucket bottom should be low and parallel to the ground.
- In very steep or slippery conditions, you can use the boom and arm to help move up and down the slope. When going up a steep slope, extend the boom and arm, and when needed, lower the bucket and retract the arm to help pull the machine up. When traveling down a steep slope, position the bucket with the flat surface resting on the ground. While retracting the arm, raise the boom and propel the machine until the front of the tracks reach ground level.
- When using the excavator for trenching, make sure the machine is level by placing dirt underneath the tracks. Being level will make the trench vertical and will help to avoid cave-ins.
- For better stability, work with the propel motors to the rear of the machine.
- Dump spoil piles as far away from the excavation as possible to avoid cave-ins.
- When doing excavation jobs on slopes, level the machine by digging a shelf (or bench cut). Material removed from the upper slope can be used to build up the lower slope and create a level surface.
- On steep bench cuts, cut enough away from the upper bank to allow for adequate swing clearance when casting downslope.
- Never dig underneath the excavator.
- When backfilling a cave-in, the excavator's tracks should be at a 90-degree angle to the excavation with the propel motors to the rear of the machine.
- When loading trucks, never swing the excavator bucket or the truck cab. By swinging over the rear of the truck, any loose materials will fall on the ground or in the bed, rather than on the cab.
- Never attempt the clean the excavator's bucket by striking it on the ground or against another object.
- Never striking the bucket with the ground, when performing lowering position of the bucket.(Bucket ko zameen par rakhty huey zor sy zameen par nah marain).
- Never hit the bucket with anything during swing operation (Bucket ko swing karty huey kisi cheez sy Hit nah karain).
- Aviod the machine from swing operation while excavation is done by bucket (Jab bucket khodai ka rahi ho to machine ko swing nah karain).

Excavator Safety Tips: After Operation

- Park the machine on a safe ground surface in the parking area.
- Neutral all the operation levers especially boom,bucket and arm levers.
- When shutting down the unit, be sure it's parked on a level surface with the bucket attachment lowered to the ground.
- Turn off the auto-idle switch and run the engine at half throttle without load for a few minutes to help cool the turbocharger down.
- Set the RPM to low idle before shutting the engine off with the key switch.
- Don't forget to lock up the cab when exiting the equipment.

Video Lecture online link

https://www.youtube.com/watch?v=tG7OtESWHl0

https://www.youtube.com/watch?v=CDXS2ZFjvrc

https://www.youtube.com/watch?v=SRqkOhIR3PM

Understanding Construction Site Safety Signs

Health and safety signs are displayed everywhere on construction sites, from the site hoarding and entrance points to various locations throughout the site.If you work on construction sites or have just walked past one, you are likely to have spotted some of these health and safety signs. They come in bright colours, like red, green, blue and yellow.

What are these signs there for, and what do they mean?Construction site safety signs are not put up for decoration, each sign has a meaning, and each colour represents a different message.It is important to understand the instructions given to you by construction site safety signs, they are displayed to deliver a clear health and safety message. Failing to understand and follow the instructions given by a sign might mean you lose your job - or your life.Construction site safety signs are there for a reason. They deliver important bits of information to you, warning you of hazards to watch out for, or requirements that you must obey.

https://youtu.be/w2bhnqAHLVo

All safety signs have to conform to the Safety Signs Regulations. Being familiar with the different types of signs means we will be able to spot:

- Prohibition Signs
- Mandatory Signs
- Warning Signs
- Safe Condition Signs
- Fire Fighting Equipment Sign

So what do the different types of signs look like, and what do they mean?

Prohibition Signs

Examples: Stop, No Entry, No Smoking.

These have a red circle with a cross bar on white background. Any lettering is black.
Meaning: DO NOT. YOU MUST NOT. STOP IT IF YOU ARE.

Mandatory Signs

Examples: Hard Hats must be worn, Keep locked shut.

These have a solid blue circle with a white symbol and/or lettering.
Meaning: YOU MUST DO. OBEY.

Warning Signs

Examples: Danger, High Voltage, Asbestos, Work Overhead

These have a solid yellow triangle (point up) with a black border. Any symbol or lettering is also black on yellow.
Meaning: YOU HAVE BEEN WARNED, BE CAREFUL, BE AWARE.

Safe Condition Signs

Examples: Fire Exit, First Aid

These have a solid green square or oblong. White symbol or symbol and text.
Meaning: FOLLOW THIS SIGN TO REACH SAFETY.

Fire Equipment Signs

Examples: Fire Alarm, Hydrant, and Extinguisher.

These have a solid red rectangle with white symbols and/or lettering.

Meaning: HERE IS THE FIRE EQUIPMENT.
Now you should be able to understand construction site safety signs, and importantly, make sure that when you see one, you can follow the health and safety message and comply with the instruction.
Help raise awareness of site safety signs by downloading our free toolbox talk for safety signs, and check out the infographic below as a visual reminder.


HEALTH & SAFETY
SIGNS
PROHIBITION
Do Not
Red circle with a crossbar on a white background.
MANDATORY
You Must
Blue circle with white symbols and lettering.
WARNING
Be Aware
Yellow triangle with black border and lettering.
SAFE CONDITION
Follow Me
Green square or rectangle with white symbol and lettering.
FIRE EQUIPMENT
Here It Is
Red square or rectangle with white symbol and lettering.
www.haspod.com


CAUTION
HEAVY EQUIPMENT IN OPERATION
HEAVY EQUIPMENT IN OPERATION SIGNS

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU-2: Sets up equipment	**The students will be able to** • Adjust to factors affecting safe operation of equipment. • Maintain stability of equipment. • Position equipment correctly. • Communicate with traffic control person.	• Describe pre shift routine • Describe positioning of equipment • Explain different signals between operator and controller	

The Importance of Conducting a Pre-Shift Machine Inspection

An important responsibility for any heavy equipment operator is conducting a machine inspection. To ensure the operator's safety and that of other job site personnel, and to make sure the machine is in good operating condition, the operator should conduct a walkaround inspection of the machine before beginning operation. Walkaround inspections take only a few minutes, yet they are one of the best ways to prevent maintenance problems and discover any safety hazards. For example, when the operator finds a fluid leak, a loose hose fitting or some other problem before a failure, injuries can be avoided and repair time minimized.

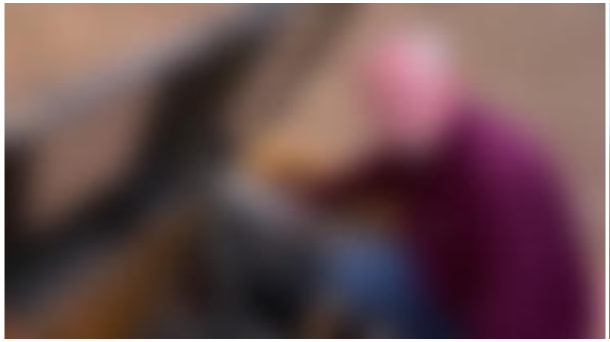
Each piece of machinery is different and therefore will have different parts that need to be checked during a walkaround inspection. The operator should refer to the Operation & Maintenance Manual for diagrams and information on the particular machine being inspected. Operators should use their senses of sight, smell, sound and touch.

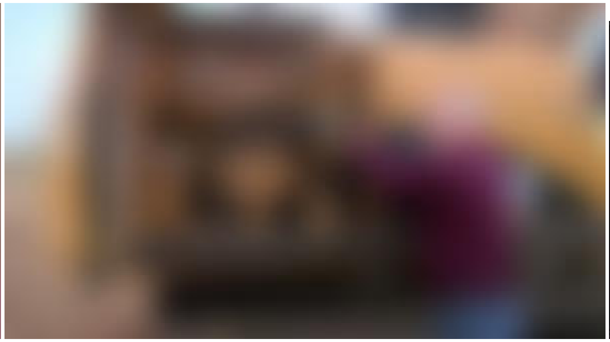
• Check the machine before beginning a shift and again at the end of the shift.
• Make sure to conduct the inspection the same direction every time.
• If anything is different on the machine from the way it was when the operator started that day, the information should be passed along the next operator and this detail placed on the shift report.

Making safety a priority begins with operator education and training. Using Cat Simulators as part of an overall training program is an excellent way to focus on safety. Cat Simulators include a Machine Walkaround featuring dozens of fault points to train and test the operator before he runs the actual equipment. Operators can learn proper procedures and good habits from simulator training and ensure the safety of personnel and machines on the job site.

Take a look at the Infographic to better understand the benefits of the Cat Simulators Walkaround. Contact a Cat Simulators Account Manager today at 1.309.266.2640 and find out how to integrate simulator training into your organization.

Image-1 **Image-2** **Image**





Pre Shift Inspection

Operator Hand Signal Guide

On construction sites, one of the most important jobs is that of the signal person. This person is responsible for signaling the crane operator with orders for the lift. To accurately and safely direct crane operators, the signal person must know and understand the operation signals used in the ASME 1926 regulations. The signal director must also understand the operations and limitations of the equipment they're directing, such as the crane's dynamics involved in swinging, raising, lowering loads, stopping loads, and boom deflection.

OSHA regulations require a signal person must be present on the job site when the load or area near the load is not in full view of the operator, when the equipment will need to move throughout the job and the direction of movement is obstructed, or when the operator or site manager believes a signal person should be present because of site safety conditions.

Hand signals offer advantages where radios or other electronic devices fall short. Such as:

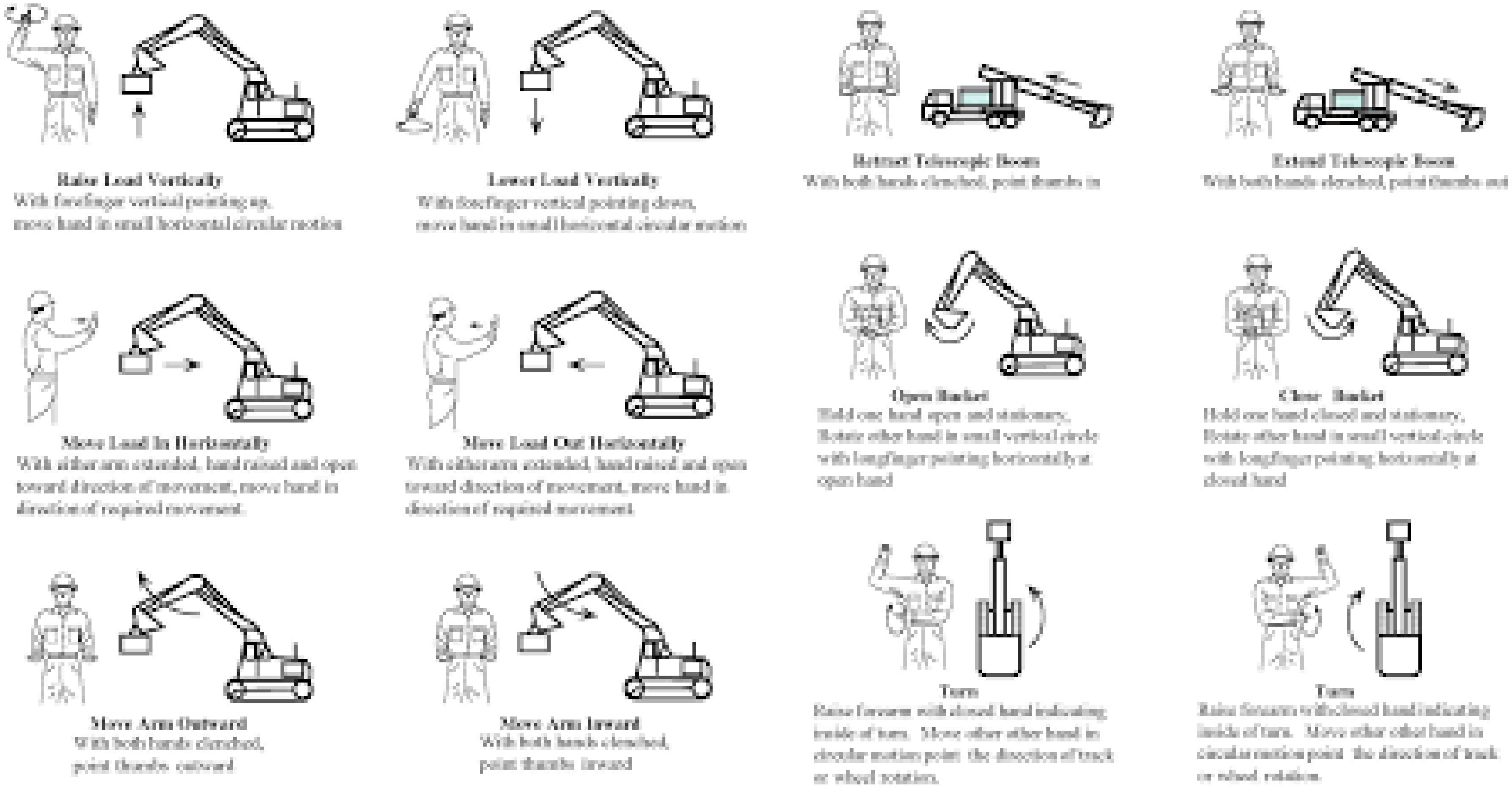
- Clarity - Standard hand signals minimize ambiguity because the signal person can only "speak" using signals, or a combination of signals, directly related to the crane controls.
- Speed - Visual signals are immediate. A skilled signal person can develop the ability to signal faster than the human tongue can form words.
- Distance - Verbal directions can be delayed, misheard or misunderstood depending on an electronic device's distance limitations. Hand signals eliminate this issue.
- Noise - Noise levels at construction sites can be overwhelming and verbal direction becomes lost in the clamor . Workers with or without hearing protection gear on busy sites don't need to rely on their hearing ability when using hand signals to communicate.
- Continuity - Hand signals are a 'common' language and will communicate a specific direction no matter what languages are spoken on the worksite.

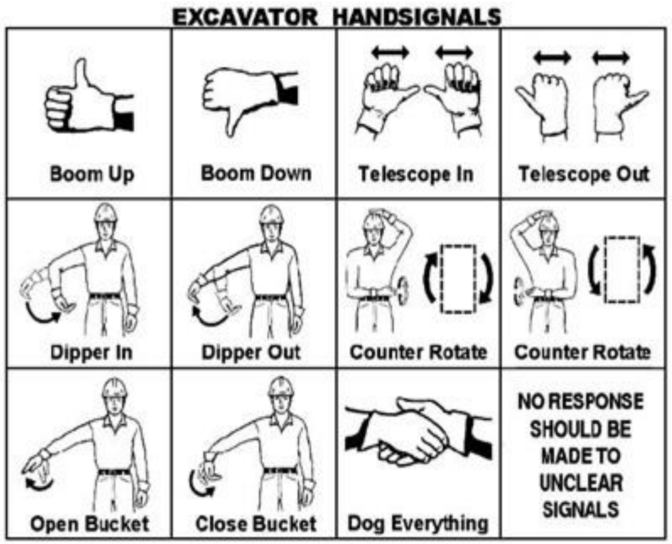
Hand signal guidelines:

- All lifts should employ a qualified signal person with knowledge of standard hand signals
- Ensure that the signal person and the driver/operator agree on hand signals before beginning
- The signal person should always maintain visual contact with the driver
- Drivers/operators should stop movement immediately if they lose sight of the signal person
- Provide the signal person with high-visibility clothing, especially during night operations

Accidents happen when hand signals are misunderstood or misinterpreted, so it is imperative the operator and signal person take the time to study and memorize the necessary signals.

Help your employees learn and review these signals to stay safe on your worksites.





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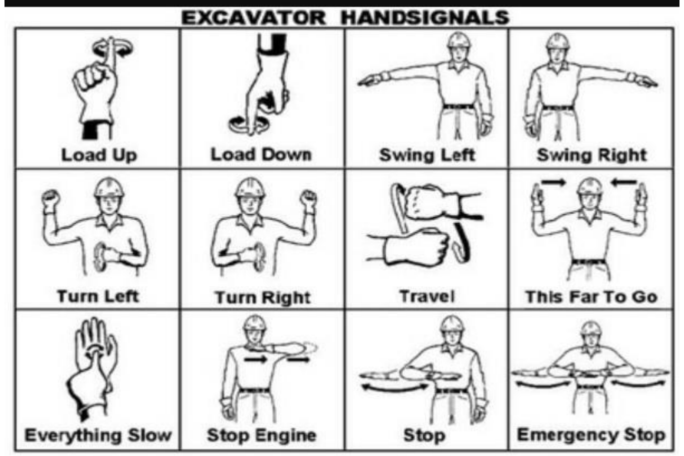

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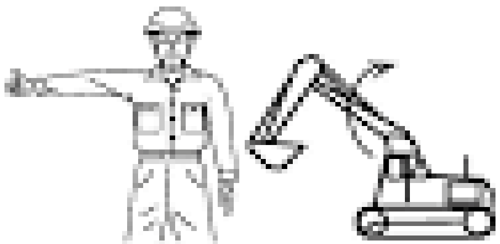
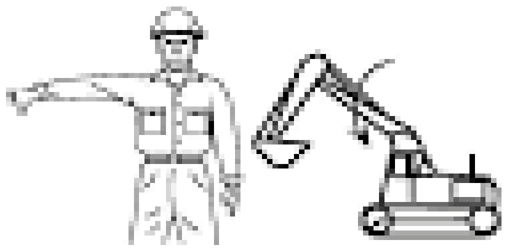


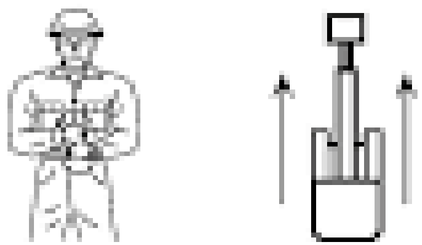
Raise Boom

With either arm extended horizontally, fingers closed, point thumb upward.



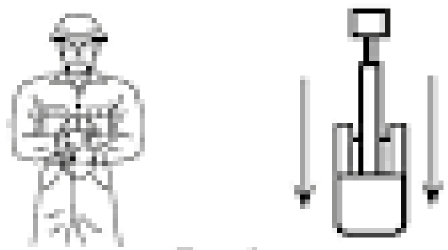
Lower Boom

With either arm extended horizontally, fingers closed, point thumb downward.



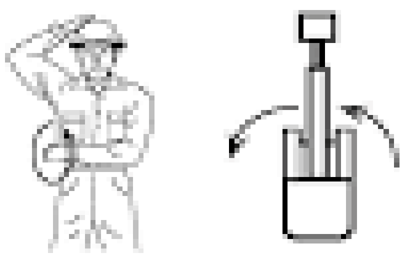
Travel

Move fists in vertical circle about each other in direction of track or wheel rotation.



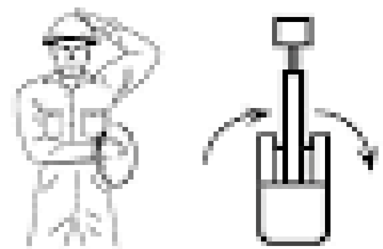
Travel

Move fists in vertical circle about each other in direction of track or wheel rotation.



Counter Rotate

Place hand on head indicating side of reverse track or wheel rotation. Move other hand in vertical circle indicating forward rotation of other track or wheel.



Counter Rotate

Place hand on head indicating side of reverse track or wheel rotation. Move other hand in vertical circle indicating forward rotation of other track or wheel.

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU-3: Install attachments	**The students will be able to** • Select appropriate tools. • Position equipment and attachment for installation. • Respond to hand signals. • Install attachments safely.	• Describe tools used for installment of attachments • Describe methods of installation of attachments	

EXCAVATORS ATTACHMENTS:

Excavators are enormously useful pieces of equipment that can make worksites run far more quickly and efficiently than they would if Learner tried to do everything manually. But the excavator itself is just the platform; the real benefits to the machine come from the wide range of specialised attachments that Learner can add to it that help facilitate digging, crushing, flattening, or just about every other task Learner could think of.

Hydraulic Breakers (Jack Hammers):

A hydraulic breaker is a powerful instrument, designed for digging downwards. Once fitted to an excavator, a breaker behaves like a hammer, punching down into material that is too difficult to "crack open" otherwise. It's often used in demolition for jobs that are too large for jackhammering, but are also unsafe for blasting (either for physical safety or environmental reasons). Hydraulic breakers work by applying a

Tilt Bucket:

The humble tilt bucket might just be the most iconic piece of equipment that people use on their excavators. It's a timeless tool that is designed to make the process of trenching and digging a snap, and no work site is complete without one. A good tilt bucket should feature two key things. Firstly, it should be shaped in just the right way to maximise the digging effectiveness of the bucket. There should be a sharp ridge on the edge to help the bucket penetrate the soil material. From there the bucket should be tilted at 45 degrees, which is the perfect angle for digging, while also keeping the material collected in the bucket.

Digging Bucket

he Digging Bucket is the most common excavator attachment. This also the standard bucket that comes with every excavator, so unless Learner specify what attachment Learner require at point of hire then it will come equipped with a digging bucket. Digging buckets are well designed "all-purpose" buckets and are used to plough through hard soil, rocks or even frost covered soil. Available in various sizes they come with short blunt teeth which are perfect for classic top soil excavations.

Rippers

The aptly named ripper tool does exactly that. Rips through compacted surfaces and whilst it is not the best treatment for tarmac or concrete surfaces, rippers can assist with minimal treatment of such area.

Flail Mower

Perhaps a flail mower isn't the first thing that comes to mind when talking about excavator attachments. The flail mower is generally forgotten about, but it's amazing what it is capable of doing. We sell these to suit 1.5-tonne to 8-tonne excavators. It means that people can start clearing scrubs on sides of roads and also for small land-clearing jobs.

Contractors go from clearing large highway roadsides to farm clearing and then into creaks and channels. It works the hydraulics but the rest of the machine generally works very easy when operating.

It has a feature that shuts down the flails quicker and also side chains – not rubber – to stop debris going into unwanted directions,

Post hole borers

An excavator's hydraulic pressure makes it perfect for mounting auger drives with post hole borers to prepare the ground for fence posts, plants or signposts.

We drill holes for everything from planting trees and erecting playground equipment, to building foundations and fencing. From domestic to commercial projects, there wouldn't be many projects which wouldn't require holes to be drilled.

Rock breakers

Since the first rock breaker, or hydraulic hammer, was invented by Atlas Copco forebear Krupp (or possibly by Montalbert, depending on who you ask) in the late 1960s, this excavator attachment has gone on to transform the construction, mining and quarrying industries.
QRB general manager, Fred Carlsson, put the rock breaker at number one on his list "as it is the highest value attachment required for most

Hydraulic grab

Adding a hydraulic grab or grapple to an excavator turns it into a versatile machine capable of handling rocks, logs, scrap materials and more– if you can grab it, you can move it.
The attachment's versatility is proven by the number of names given to it – they're also known as rock grabs, log grabs, static grabs, demolition grabs, stiff arm grabs and box tyne grapples.

Trenchers

Excavator are sold with a bucket which is used for digging trenches .

Rotary Twin Head Cutters

Also known as twin-header rock grinders, rotary cutters, hydraulic cutters or simply as twin-headers, this attachment is designed for a variety of applications. This includes trench work in hard and compacted ground, concrete and rock wall profiling, dredging, demolition and quarry work – really in circumstances where conventional digging systems and percussion tools have little effect.

Vibrating Compaction Plates

Also known as hydraulic compactors or compactor plates, vibrating compaction plates are designed for compacting soil, trenches and embankments as well as driving in and pulling out piles, posts and formwork. The vibration forces of the plates drive soil particles close together for solid, stable compaction in applications from narrow trenches to large backfill operations.

It's generally simple to connect a compactor plate to your machine's existing hydraulics, and is even easier if you have existing hydraulic hammer piping. Excavator-mounted vibrating plates have a number of benefits over manually operated compactors: they're safer as no one needs to actually stand in the workspace; they generally create less noise; they can be used anywhere the boom can place them; and much of the excavator load is partially transferred to the plate, thus accelerating the compaction process.

Sieve buckets

These buckets are used to sort a wide variety of materials from rock, gravel, soil, bricks and rubble to hot materials such as steel slag. Their applications are equally diverse, from recycling and demolition to feeding crusher units and the remediation of contaminated soil.

Also known as riddle buckets, sorting buckets, shaker buckets or skeleton buckets, they are filled with material and then shaken to allow finer pieces to fall through the grill while retaining larger objects, such as bricks and rubble. It goes without saying that you need to choose an aperture that suits the materials being sorted.

Detailed Excavator Attachments:

https://www.cat.com/en_US/products/new/attachment-solutions/attachments-by-equipment-type/excavator-attachments.html
http://www.amiattachments.com/excavator.php
https://www.epiroc.com/en-iq/products/excavator-attachments

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU4. Operate controls of Wheel Excavator	**The students will be able to** • Operate control smoothly and safely • Operate different operating controls simultaneously as required. • React to changing conditions/situations.	• Define basic operating functions. • Describe different operating controls and their functions • Describe different situations which an operator can encounter under different conditions • Describe smooth and safe handling of controls	

Define basic operating functions.

Excavator is the machine that can **excavate** the soil of various types forcefully and then using hydraulic system a hydraulic force is generated and utilizing this force bucket is pull back towards the machine. **Excavators** are mostly used for **digging** of soils and for loading dump trucks.

Excavators are used in many ways:

- Digging of trenches, holes, foundations.
- Material handling.
- Brush cutting with hydraulic saw and mower attachments.
- Forestry work.
- Forestry mulching.
- Construction.
- Demolition with hydraulic claw, cutter and breaker attachments.
- General grading/landscaping.

Describe different operating controls and their functions

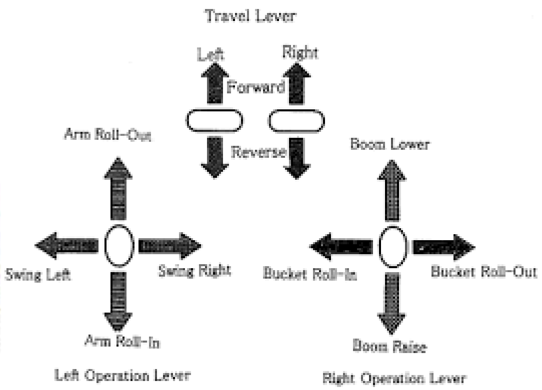
Excavators (hydraulic) are heavy construction equipment consisting of a boom, dipper (or stick). The arrangement of the pumps in the excavator unit changes with different manufacturers using. This allows a skilled operator to control all four functions simultaneously.

ISO controls

The most commonly used control pattern throughout the world is the ISO controls. In the ISO control pattern, the left hand joystick controls Swing (left & right) and the Stick Boom (away & close), and the right hand joystick controls the Main Boom (up & down) and Bucket motions (close & dump).

SAE controls

In the SAE control pattern, the left hand joystick controls Swing (left & right) and the Main Boom (up &down), and the right hand joystick controls the Stick Boom(away & close) and Bucket motions (close & dump).



Operating Control- 2

Practical Simulation of Wheeled Excavator Control Operations of Different models:

VOLVO:
https://www.youtube.com/watch?v=aiqc60l1ovk
https://www.youtube.com/watch?v=4WnShwggXME
https://www.youtube.com/watch?v=9hSjMSWllAg
https://www.youtube.com/watch?v=mFsbdMioawM
https://www.youtube.com/watch?v=g1brQlsqIx8

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU5. Operate controls of Crawler Excavator	**The students will be able to** • Operate control smoothly and safely • Operate different operating controls simultaneously as required. • React to changing conditions/situations.	• Define basic operating functions. • Describe different operating controls and their functions • Describe different situations which an operator can encounter under different conditions • Describe smooth and safe handling of controls	

Define basic operating functions.

Excavator is the machine that can **excavate** the soil of various types forcefully and then using hydraulic system a hydraulic force is generated and utilizing this force bucket is pull back towards the machine. **Excavators** are mostly used for **digging** of soils and for loading dump trucks.

Excavators are used in many ways:

- Digging of trenches, holes, foundations.
- Material handling.
- Brush cutting with hydraulic saw and mower attachments.
- Forestry work.
- Forestry mulching.
- Construction.
- Demolition with hydraulic claw, cutter and breaker attachments.
- General grading/landscaping.

Describe different operating controls and their functions

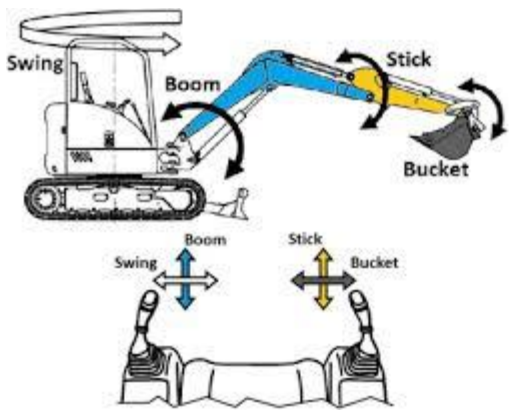
Excavators (hydraulic) are heavy construction equipment consisting of a boom, dipper (or stick). The arrangement of the pumps in the excavator unit changes with different manufacturers using. This allows a skilled operator to control all four functions simultaneously.

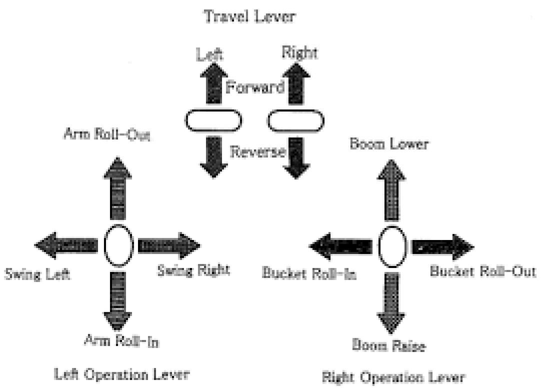
ISO controls

The most commonly used control pattern throughout the world is the ISO controls. In the ISO control pattern, the left hand joystick controls Swing *(left & right)* and the Stick Boom *(away & close)*, and the right hand joystick controls the Main Boom *(up & down)* and Bucket motions *(close & dump)*.

SAE controls

In the SAE control pattern, the left hand joystick controls Swing *(left & right)* and the Main Boom *(up &down)*, and the right hand joystick controls the Stick Boom*(away & close)* and Bucket motions *(close & dump)*





Practical Simulation of Crawler Excavator Control Operations of Different models:

KOMATSU:
https://www.youtube.com/watch?v=uutTJgY7Br0

CATERPILLAR:
https://www.youtube.com/watch?v=hlc-rM2VzyE
https://www.youtube.com/watch?v=kUs6G5iBGP0

Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU6. Create Slopes.	**The students will be able to** • Interpret specifications of slope. • Practice grade checking instruments • Fill cuts in the slope with a partial bucket technique.	• Describe stakes/specifications • Describe grade checking instruments • Describe methods of making slope in different conditions • Describe safety measures to be kept	

		in consideration while working on slopes • Describe problems faced while making slope	

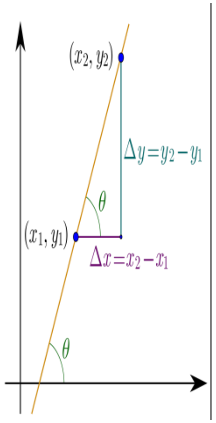
Describe stakes/specifications:

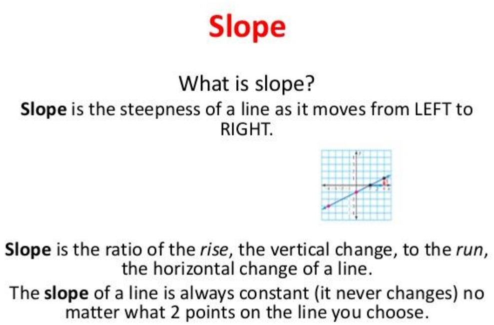
A stakes or post pointed at one end for driving into the ground as a boundary mark, part of a fence; support for a plant, etc. a post to which a person is bound for execution.

Specification: A Product design specification is a detailed document providing information about a designed product or process. For example, the design specification must include all necessary drawings, dimensions, environmental factors, ergonomic factors, aesthetic factors, maintenance that will be needed, etc.

Describe methods of making slope in different conditions

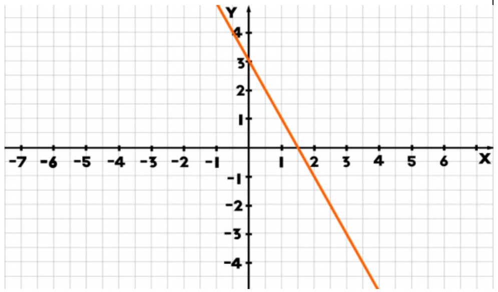
In mathematics, the slope or gradient of a line is a number that describes both the direction and the steepness of the line. ... Slope is calculated by finding the ratio of the "vertical change" to the "horizontal change" between (any) two distinct points on a line.

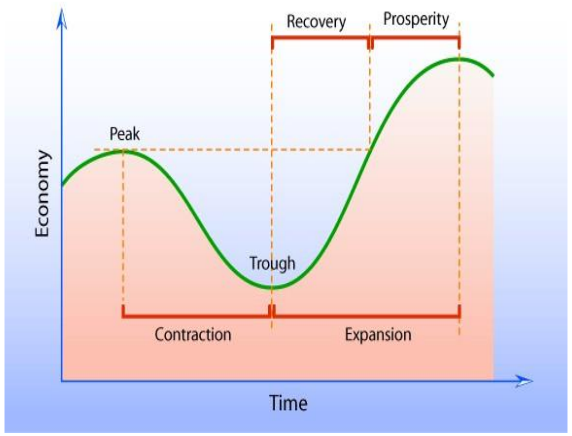




- **<u>Describe methods of making slope in different conditions:</u>**

Successful <u>design</u> of the slope requires <u>geological</u> information and site characteristics, e.g. properties of <u>soil</u>/<u>rock</u> mass, slope <u>geometry</u>, <u>ground water</u> conditions, alternation of materials by <u>faulting</u>, <u>joint</u> or <u>discontinuity</u> systems, movements and <u>tension</u> in joints, earthquake activity etc





- **<u>Describe safety measures to be kept in consideration while working on slopes</u>**

<u>WORK ON SLOPES</u>:

When properly equipped and run by skilled operators, excavators are excellent tools to complete work on slopes. But this type of work does require attention to detail not required when working on flat ground. An excavator is capable of climbing some pretty steep slopes. When working on slopes, it takes a lot of extra care.

1: First, you need to carefully assess the jobsite and the work to be performed. There is no way to foresee all the things that can go wrong while working in and around a slope.

2: The operator must assess the situation carefully on a case-by-case basis, and is responsible for the safety of himself or herself, the machine, surrounding equipment and the surrounding people.

3: Depending on the severity of the slope, traction will be a concern. Even with tracks, there is only so much traction available.

4: Ground-to-track shoe traction is the limiting factor for safe operation. If you cannot dig parallel to the tracks, pointed downhill, and not slide the machine toward the bucket, the slope and ground condition are too steep for safe un-tethered operation.

5: Orientation of the tracks is critical for safe operation. If you are working on a slope, you want to be sure the tracks are pointed up and down. Getting sideways on a steep slope can get real interesting in a hurry. If you are working uphill, you want the idlers forward. If you are working downhill, you want the idlers pointed down slope. The drive motors are heavier, so you want more weight behind you. The idlers are designed to take the digging forces of the machine and spread it through the frame via the through axles connected at both points. The drive motors are connected to one side of the frame. So the load factor, on a regular basis, [should be] over the idlers.

Practical Simulation:
https://www.youtube.com/watch?v=7ZgxzCO3hXE
https://www.youtube.com/watch?v=VUm-o_hj9o4
https://www.youtube.com/watch?v=LdgGvsYH_N0
https://www.youtube.com/watch?v=epaiv6DjGHY
https://www.youtube.com/watch?v=NI_2us0bG4k

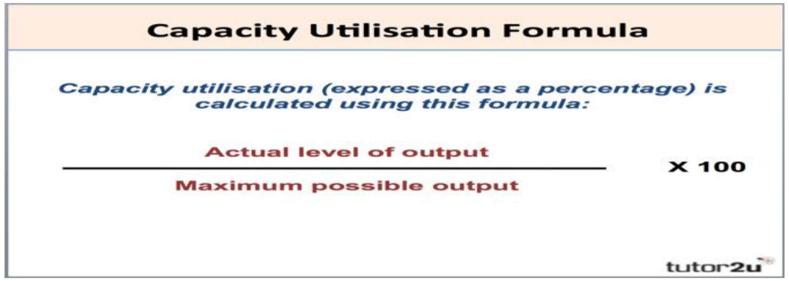
Ascending and descending on slopes:
https://www.youtube.com/watch?v=VxpDg0PMBWA

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU7. Build, excavate, and maintain haul roads and ramps	**The students will be able to** • Work around obstructions and hazards. • Practice grade checking devices. • Protect existing structures and utilities. • Build, excavate or maintain haul roads and ramps in accordance with job specifications.	• Define capacities & capabilities of Machine. • Describe nature of strata/soil • Describe method for estimation of excavation • Describe grade checking instruments • Explain utilities and their protection	

Define capacities & capabilities of Machine.

Capacity: It is often defined as the capability of an object, whether it is a machine, work center, or operator, to produce output for a specific time period, which can be an hour, a day, etc.

Capacity of Machine: It refers to the production capacity of workers or machines, and is usually expressed by "hours". The Process Capacity of workers is called human capacity, while that of machines is called machine capacity.



Capability refers to the higher level of ability that could be demonstrated under the right conditions.

Machine capability is the measure of the actual quality of a machine with respect to its specifications (abbreviation: cm: c stands for capability and m for machine). The capability of a machine or process to fulfill the defined requirements is often specified by characteristic values.

	Required Part Spec.	Machine Capability
1	Length	Max Length
2	Width	Max. Width
3	Height	Max. Height
4	Turning Dia.	Max. Turning Dia.
5	Turning Length	Max. Turning Length
6	Drilling Dia.	Max Drilling Dia.
7	Drilling Length	Max. Drilling length
8	Tolerance	Max. tolerance
9	Surface Finish	Max. Surface Finish

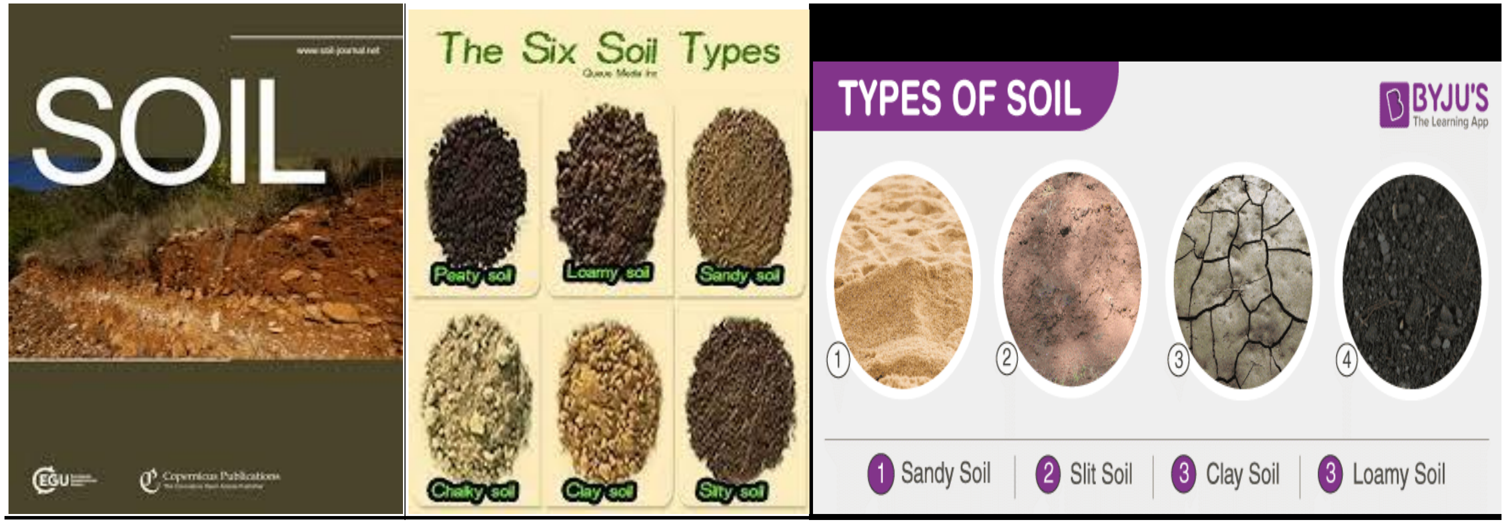
- **<u>Describe nature of strata/soil</u>**

Soil is made of mineral matter, organic matter, water, and air. Living organisms are also present in soil. Mineral matter began as rock, and soil generally has mineral particles of different sizes. Organic matter is partially decomposed plant and animal matter.

Soil is the outermost layer of the earth's crust. Depending on where you are on Earth, the layer of soil may be several inches thick or many feet deep. Soil is a complex material that supports life. It may take a thousand years for just 1 inch of soil to form. Therefore, managing soil properly for the benefit of future generations is critical.

<u>SOIL COMPONENTS:</u>

Soil is made of mineral matter, organic matter, water, and air. The solid mineral matter and organic matter make up about 50 percent of the soil. The average soil contains about 45 percent mineral matter and about 5 percent organic matter. These solids are not tightly packed. Instead, there are spaces between the solid particles called pore spaces. Pore spaces are filled with either water or air. In good soil, water makes up about 25 percent of the soil, and air makes up about 25 percent of the soil.



<u>Soil and its types</u>

<u>Describe method for estimation of excavation</u>

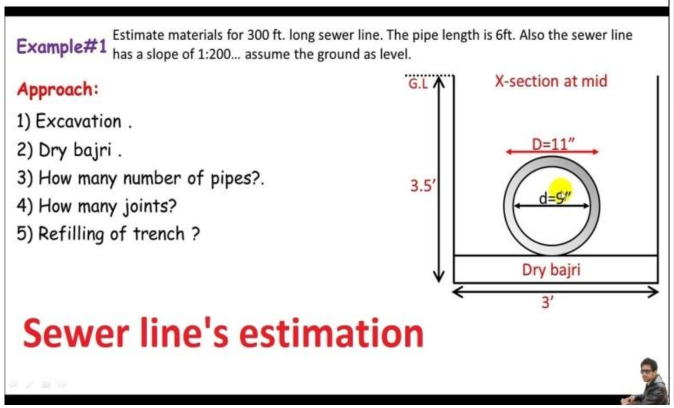
Estimation (or estimating) is the process of finding an estimate, or approximation, which is a value that is usable for some purpose even if input data may be incomplete, uncertain, or unstable.

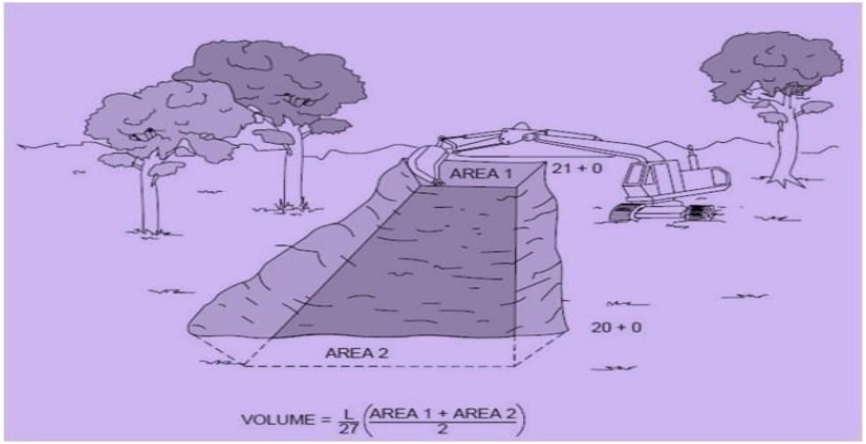
Different Types of Excavation:

- Channel excavation comprises removing materials from drainage ditches and channels, usually to alter water flow or to increase capacity
- Bridge
- Drainage/Structure
- Borrow
- Earth
- Dredging
- Muck.
- Footing.

Following are the different types of cost estimates used in construction,

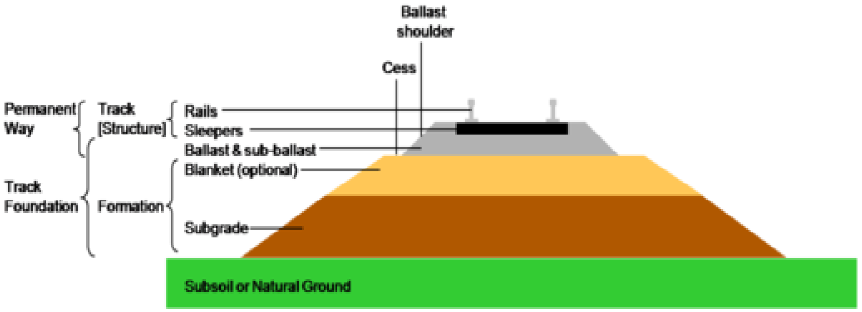
- Preliminary Cost Estimate.
- Plinth Area Cost Estimate.
- Cube Rate Cost Estimate.
- Approximate Quantity Method Cost Estimate.
- Detailed Cost Estimate.
- Revised Cost Estimate.
- Supplementary Cost Estimate.
- Annual Repair Cost Estimate.





Describe grade checking instruments

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope, for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage. The earthworks created for such a purpose are often called the sub-grade or finished contouring.



Theodolites

Flagging and Survey Markers

Surveying Magnetic Locators

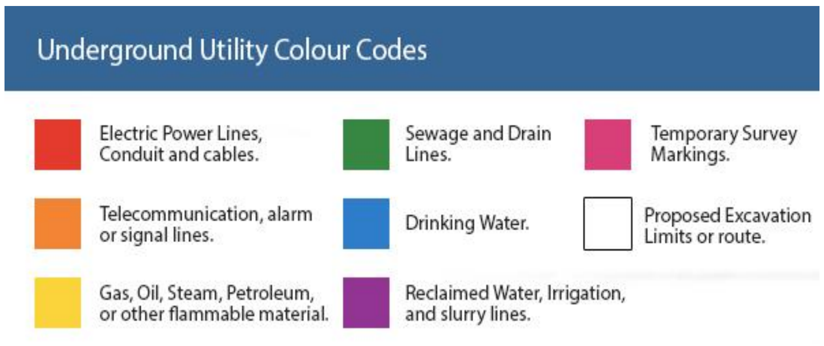
Automatic Lavels

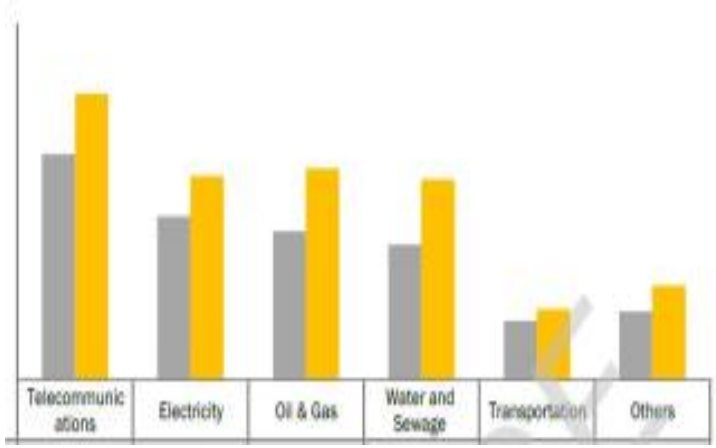
Serveying Tripods

Total Stations

Explain utilities and their protection

Utilities are generally considered to include: electricity, gas, water and sewage and communications services. Additional might include your cable, Internet and telephone services. During excavation operation, the above mentioned utilities must be protected from damage. Therefore the operator should gain knowledge about these utilities protection and also follow the given instructions during work.





Practical Simulation:
https://www.youtube.com/watch?v=_1RnuiU-eHk
https://www.youtube.com/watch?v=YAqGPqtNJgg
https://www.youtube.com/watch?v=06sZd0hkBjo
https://www.youtube.com/watch?v=fgGEpeJJrQQ
https://www.youtube.com/watch?v=sv7v9-7XXjI
https://www.youtube.com/watch?v=BKKkEIigw-I

HAUL & EXCAVATING ROADS:
https://www.youtube.com/watch?v=qYxO6gZaL0k
https://www.youtube.com/watch?v=ha5M5fnwJCU
https://www.youtube.com/watch?v=t6upvyQwPro
https://www.youtube.com/watch?v=OQaQ9tQDSeA
https://www.youtube.com/watch?v=4hWrkaIQhyE

Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU8. Create mass Excavation.	**The students will be able to** • Adopt laser location for line of sight as excavation progresses. • Perform straight edges and stable sides. • Dig offset from footing location. • Keep the machine level. • Level to very fine tolerance. • Adopt partial bucket technique.	• Describe types of soils and their characteristics • Describe attachments to be used for different types of soil • Describe techniques of excavation • Describe methods to keep the machine level • Describe precautions in mass excavation	

- **Describe types of soils and their characteristics**

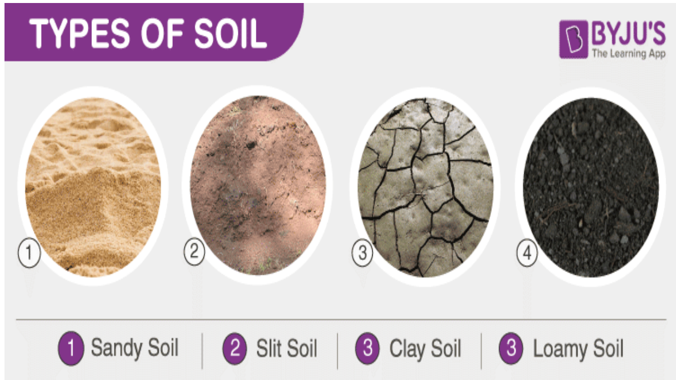
A soil type is a taxonomic unit in soil science. All soils that share a certain set of well-defined properties form a distinctive soil type. Soil type is a technical term of soil classification, the science that deals with the systematic categorization of soils. Every soil of the world belongs to a certain soil type. Soil type is an abstract term. In nature, you will not find soil types. You will find soils that belong to a certain soil type.

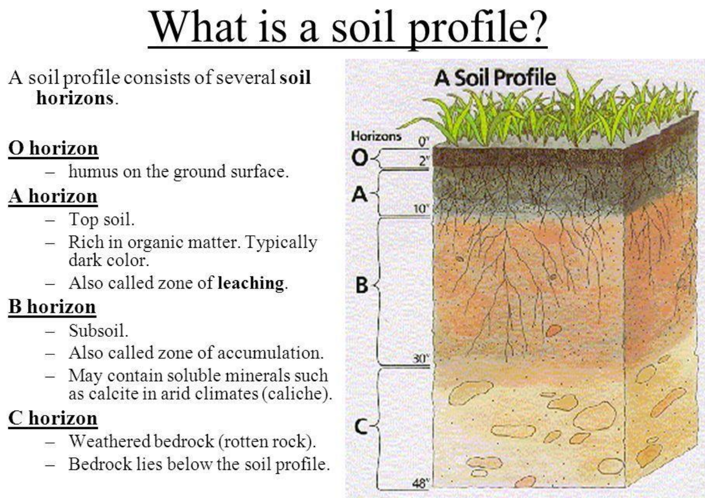
There are three basic types of soil: sand, silt and clay. But, most soils are composed of a combination of the different types.

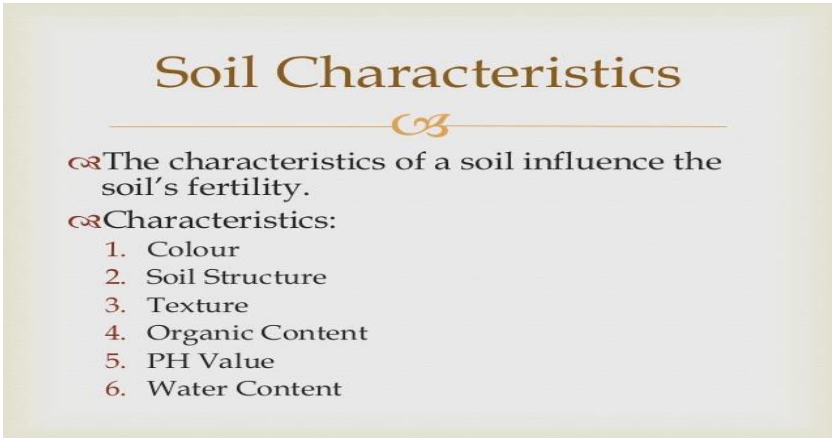
Characteristics:

Soil is a complex mixture of different materials. About half of most soils are inorganic materials, such as the products of weathered rock, including pebbles, sand, silt, and clay particles. About half of all soils are organic materials, formed from the partial breakdown and decomposition of plants and animals.

- Composition. The scientific study of soil is called pedology. The composition of the soil is placed into four different categories: inorganic material, organic material, water and air.
- Color. The color of the soil is another way to characterize soil.
- Texture.
- Structure.
- Soil Water.
- Organic Matter.
- Chemistry.







- **<u>Describe attachments to be used for different types of soil</u>**

When we talk about an excavator, one thing you should always remember is the different types of excavator buckets. Picking up one of these attachments is very much important to make a full use of the machine. These attachments vary because of the different soil conditions and it determines the kind of bucket that's to be used. You'll find that excavator bucket choice will lead to the success or failure of the work at hand. If you pick the right tool, then you can do the job fast but if not, you may have to suffer some consequences but nevertheless, every work can be done using different techniques. Here are some of the types of excavator attachments that you might want to be familiar with. The details of different buckets are mentioned below.

General Purpose Bucket:

The general purpose excavator buckets or GP buckets (General Purpose Bucket. Your GP bucket sometimes known as a trenching bucket will be used for all types of pipe and cable trenching, so it needs to be robust, strong and durable) is the most common attachment that you can find. In fact, it’s the most common attachment that you usually see on construction sites. These attachments come in smooth edges; it may have or may not have a set of teeth. This type of excavator bucket is usually used for digging medium sized materials like dirt and gravel.

General Purpose Bucket (GPB)

Heavy Duty Bucket:

Second type of excavator bucket would be the heavy duty one. It comes with thicker steel. It’s quite a better option as compared to the general purpose since you can use these for soils with dense dirt and thick mud or hard rock. It also comes with straight sides that will decrease the packing and do some load to dump cycle faster.

Heavy Duty Buckets

Rock Bucket:

Rock excavator buckets are types of excavators are also common. They are usually used for the toughest situations. These attachments are made with the thickest and strongest steels, tough wear strips and reinforcing wear plates which could make the bucket’s life a lot longer.

Rock Buckets

Ditch Bucket:

Next common excavator bucket would be the ditch bucket. It's compact and shallow and usually used in a confined space. This type of attachment usually comes with drainage holes with no teeth. It also has a flat front. These are mostly used for digging soils that are made of soft mud. Since they have no teeth, the soil can't easily escape its grip and could easily be transferred from one place to another.

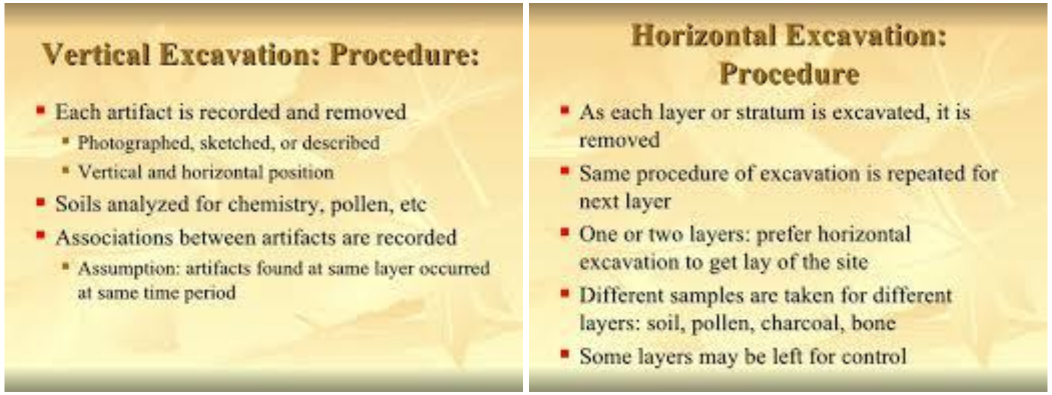
Ditch Bucket

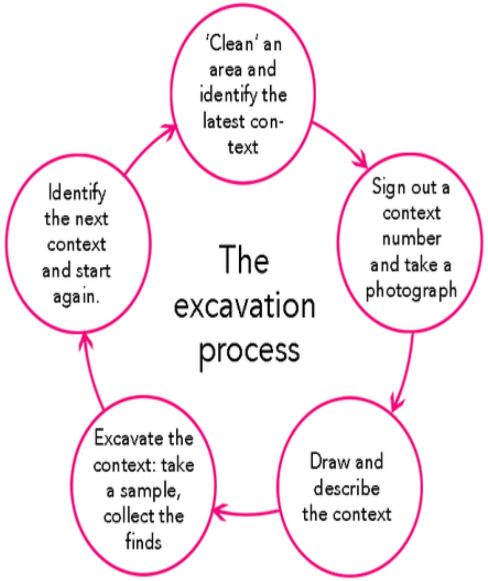
- **Describe techniques of excavation:**

Before any excavation is begun, the site must be located. Techniques used to find a site may include remote sensing (for example, by aerial photography), soil surveys, and walk-through or surface surveys. The digging of shovel tests, augured core samples and, less commonly, trenches may also be used to locate archaeological sites. Soil samples may be collected from various sites and depths to determine whether any buried features are present. Before beginning the actual excavation, an archaeologist prepares a topographical map of the site that includes such details as roads, buildings, bodies of water, and various survey points. This allows researchers to compare site location with natural landforms or regional terrain to establish settlement patterns, a theory about where people used to live and why they chose to live there.

Excavation involves the removal of soil, sediment, or rock that covers artefacts or other evidence of human activity. Early excavation techniques involved destructive random digging and removal of objects with little or no location data recorded. Modern excavations often involve slow, careful extraction of sediments in very thin layers, detailed sifting of sediment samples, and exacting measurement and recording of artefact location.

Excavation is classified as common excavation, rock excavation, or unclassified excavation in accordance with the following definitions. .Unclassified excavation is defined as the excavation of all materials encountered, including rock materials, regardless of their nature or the manner in which they are removed.





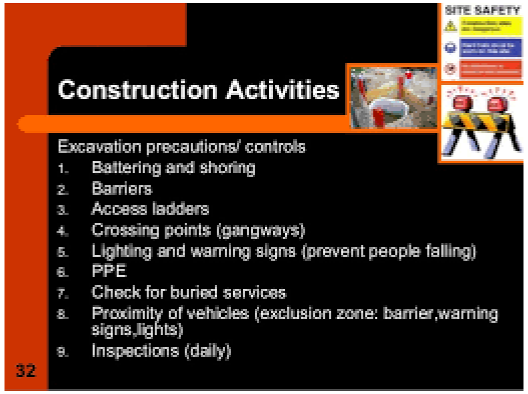
Describe precautions in mass excavation:

10 Excavation Safety Tips

To protect workers from injuries and fatalities, preventive measures should be implemented when workers begin excavating. According to OSHA, general safety measures to follow should cover the following:

1. Check weather conditions before work, be mindful of rain and storms.
2. Keep heavy equipment away from work place.
3. Be mindful of the location of utilities underground.
4. Always wear proper protective equipment.
5. Don't work beneath raised loads.
6. Conduct atmosphere tests. If low oxygen and toxic gases were detected.

7. Protective systems like benching, sloping, shoring and shielding must be created.
8. Planning and implementation of safety measures must be done by a competent person.
9. Use a checklist to perform regular self inspections.



Practical Simulation:
https://www.youtube.com/watch?v=imLgE2J7iyg

https://www.youtube.com/watch?v=MgXOY10GzUA

https://www.youtube.com/watch?v=cjd1EngfyEo

https://www.youtube.com/watch?v=DupofCsObs0

https://www.youtube.com/watch?v=OTNjJxDvg3g

https://www.youtube.com/watch?v=5jBPMyV8WTQ

https://www.youtube.com/watch?v=y4l-n8JF4gE

Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU9. Excavate trenches	**The students will be able to** • Work around site obstructions and hazards. • Maintain equipment in stable position and correct location for job. • Practice grade checking devices. • Excavate trench in accordance with job specifications. • Respond to hand signals.	• Describe special attachments to be used for making trenches • Describe problems faced while making trenches • Describe trenches to be made under different environment/conditions • Describe safety measures to be kept in mind while making trenches	

Describe special attachments to be used for making trenches:

Trenchers are pieces of earthmoving equipment that use a metal chain with teeth made of high-strength steel to rip into the ground like a chainsaw would into a tree. Similar to an excavator, a trencher rips up the soil and any roots in the way to create a trench.

Excavators are highly versatile and can be fitted with special attachments for specialty jobs. The most common uses for an excavator include: Material handling; Excavating trenches, holes, and foundations; Brush cutting.

An excavation is any man-made cut, cavity, trench, or depression in the earth's surface formed by earth removal. A trench is defined as a narrow underground excavation that is deeper than it is wide, and is no wider than 15 feet (4.5 meters).Dangers of Trenching and Excavation.

General Trenching and Excavation Rules

- Keep heavy equipment away from trench edges.
- Keep surcharge loads at least 2 feet (0.6 meters) from trench edges.
- Know where underground utilities are located.
- Test for low oxygen, hazardous fumes and toxic gases.
- Inspect trenches at the start of each shift.
- Inspect trenches following a rainstorm.
- Do not work under raised loads.

Trench Making Buckets

Describe safety measures to be kept in mind while making trenches:

Excavation and trenching are amongst the most dangerous operations in the construction industry. Dangers can include cave-ins, falling loads, hazardous atmospheres and hazards from using heavy equipment. Regular pre-work inspections can reduce hazards and serious risk of injury. Safety inspections should check for the type of excavation being conducted, support and warning systems in place, access areas, weather conditions, heavy equipment and PPE.

Trenches Excavation Safety Tips

To protect workers from injuries and fatalities, preventive measures should be implemented when workers begin excavating. According to OSHA, general safety measures to follow should cover the following:

1. Inspect trenches daily before work begins. Don't go near an unprotected trench.
2. Check weather conditions before work, be mindful of rain and storms.
3. Keep heavy equipment away from trench edges.
4. Be mindful of the location of utilities underground.
5. Always wear proper protective equipment.
6. Don't work beneath raised loads.
7. Conduct atmosphere tests. If low oxygen and toxic gases were detected, workers must not enter the trench.
8. Protective systems like benching, sloping, shoring and shielding must be created.
9. Planning and implementation of safety measures must be done by a competent person.
10. Use a checklist to perform regular self inspections

Practical Simulation:

https://www.youtube.com/watch?v=5JfpF8U7fRs

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

https://www.youtube.com/watch?v=RDKK1AtleQ8

https://www.youtube.com/watch?v=LtggM3hFJNU

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

https://www.youtube.com/watch?v=0oZ5aMFED2E

Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU10. Excavate ditches	**The students will be able to** • Work around site obstructions and hazards. • Maintain equipment in stable position and correct location for job. • Practice grade checking devices. • Excavate ditches in accordance with job specifications. • Respond to hand signals.	• Describe special attachments to be used for making ditch • Describe problems faced while making ditch • Describe ditches to be made under different environment/conditions • Describe safety measures to be kept in mind while making ditch • Describe hand signals and response	

Describe special attachments to be used for making ditch

Rockland DC buckets are wide and shallow to remove ditch sediment quickly and efficiently. Instead of cleaning ditches with a standard bucket, increase productivity by installing a Rockland DC bucket. DC buckets include drain holes. Bolt-on edges are standard.

Ditch Cleaning Bucket

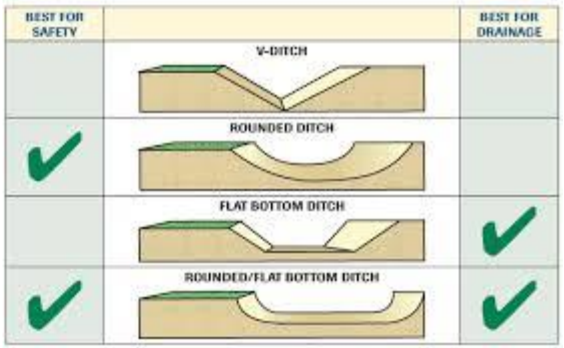
Match your customers' grading and backfill demands with ditch cleaning buckets. Available in standard and heavy duty.

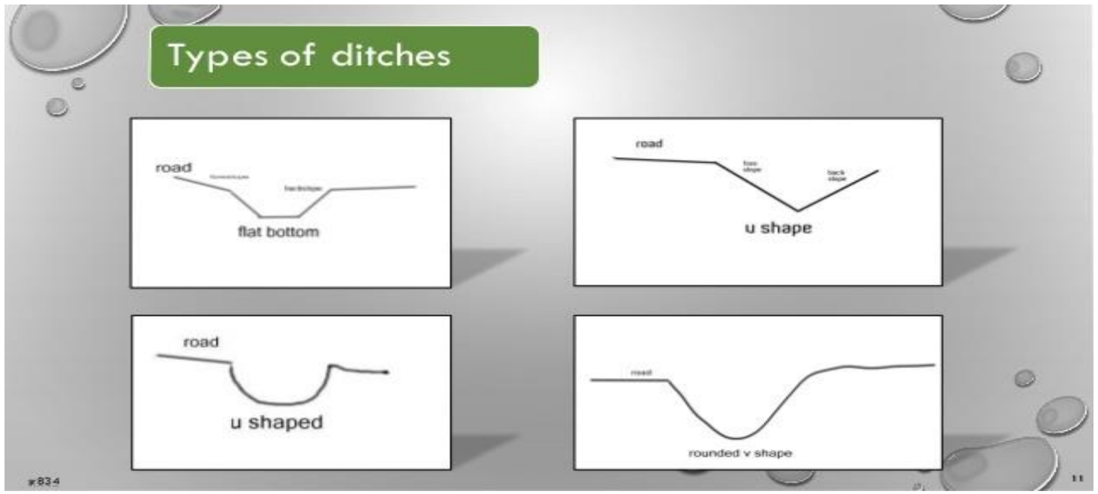
Ditch Cleaning Bucket

- **Built with folded top section for additional strength.**
- **Features high-quality, abrasion-resistant material for reduced weight.**
- **Offers greater durability from extra side and bottom wear plates made from heat-treated alloy steel.**
- **Work in wet conditions with side drainage holes.**
- **Reduced operating costs with reversible bolt-on cutting edge**

Describe ditches to be made under different environment/conditions

A ditch is a small to moderate depression created to channel water. A ditch can be used for drainage, to drain water from low-lying areas, alongside roadways or fields, or to channel water from a more distant source for plant irrigation. Ditches are commonly seen around farmland, especially in areas that have results in increasing environmental and eventually profound.





Describe hand signals and response:

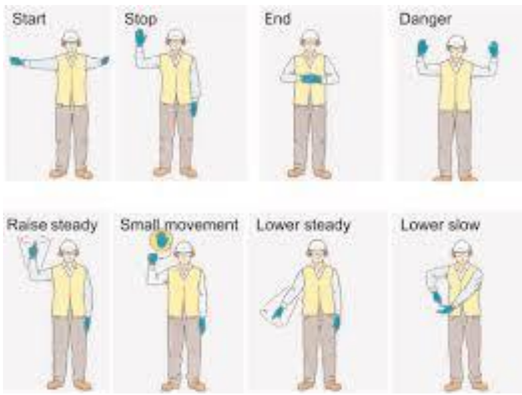
Excavator hand signals:

Explain dangers:

Excavators, backhoes, and other types of heavy equipment can cause injuries and fatalities to equipment operators and workers on foot during trenching operations.

Identify controls:

If a person could be endangered by equipment or its load, a signaler must be used to help the operator. The operator and the signaler must decide on a way to communicate with each other. Often the best way is to use clear, standard hand signals. Here are some standard hand signals for working with excavators.



Response of Hand Signals:
Best way is to use clear, standard **hand signals**. ... **Explain** dangers. No **response** should be made to unclear signals.

Practical Simulation:

https://www.youtube.com/watch?v=K7eOsZ7wlF4
https://www.youtube.com/watch?v=ptDi_cftPe4
https://www.youtube.com/watch?v=_N8HMF7t4EM
https://www.youtube.com/watch?v=NLCelK-24ec
https://www.youtube.com/watch?v=GU5mymiF2Nw
https://www.youtube.com/watch?v=UJeIeB23ooc

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU11. Load Trucks	**The students will be able to** • Work around obstructions and hazards. • Direct loading vehicle operators. • Align according to the position of truck. • Load transport vehicles in accordance with job specifications. • Respond to hand signals.	• Describe Loading techniques • Describe expected hazards • Describe how to avoid hazards while loading • Describe important signals followed while loading	

- **<u>Describe Loading techniques:</u>**

Excavators are used for the rapid removal of soil and other materials in mines, quarries, and construction sites. The automation of these machines offers promise for increasing productivity and improving safety. The surface mining of metals, quarrying of rock, and construction of highways require the rapid removal and handling of massive quantities of soil, ore, and rock. Typically, explosive or mechanical techniques are used to pulverize the material, and digging machines such as excavators load the material into trucks for haulage to landfills, storage areas, or processing plants.

An excavator sits atop a bench and loads material into trucks that queue up to its side. The operator is responsible for designating where the truck should park, digging material from the face and depositing it in the truck bed, and stopping for people and obstacles in the loading zone. Typically, loading a truck requires several passes, each of which takes 15 to 20 seconds. Reducing the time of each loading pass by even a second translates into an enormous gain across the entire job. The operator's performance peaks early in the work shift and degrades as the shift wears on.Scheduled idle times, such as lunch and other breaks, also diminish average production across a shift.



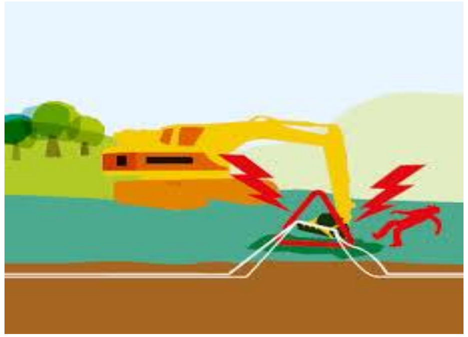
 

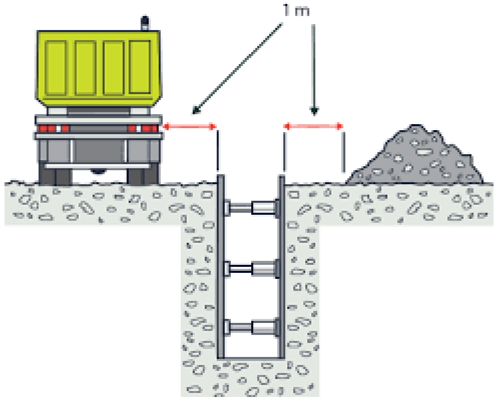
<u>Describe expected hazards:</u>

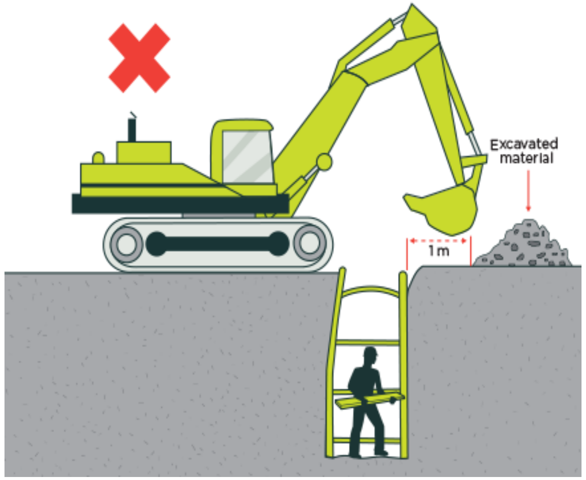
Heavy equipment like this dump truck have many blind spots. Be sure to keep your distance, wear high visibility clothing, and maintain eye contact with the driver.

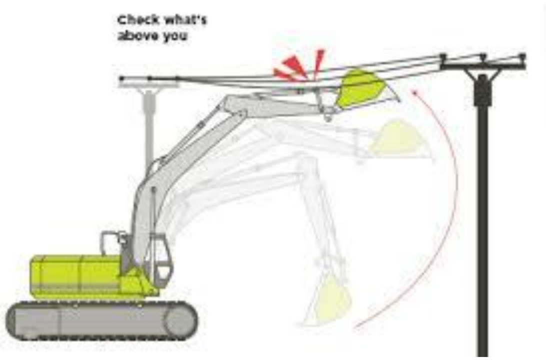
<u>Hazard:</u>

- Dust Inhalation.
- Electricity.
- Flying and falling objects and debris.
- Heat illness.
- Slips, trips and falls.




1 m


Excavated material
1m

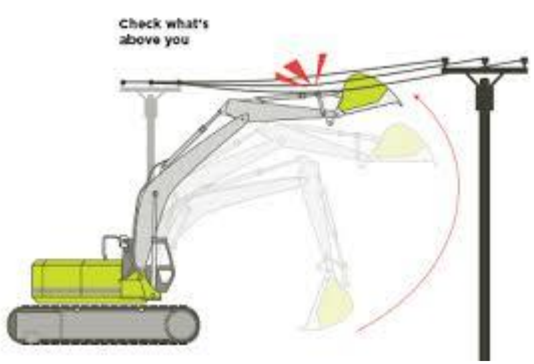

Check what's above you

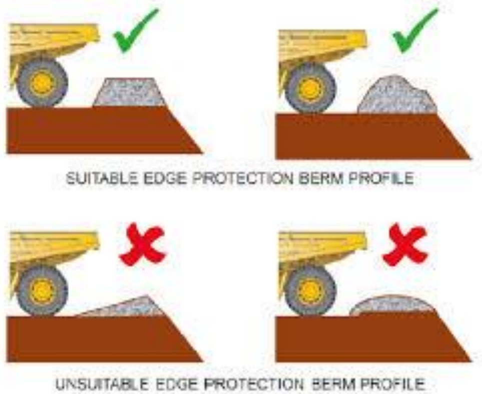
- **Describe how to avoid hazards while loading**

Heavy equipment such as cranes, maintainers, bull dozers, front loaders, dump trucks, excavators, etc. are used on virtually every single construction site. There are many hazards created by the use of this equipment for those who operate it and especially for those who work around the equipment.

All vehicles must have:

- A service brake system, an emergency brake system, and a parking brake system
- Working headlights, tail lights, and brake lights
- An audible warning device (horn)
- Intact windshield with working windshield wipers
- Ensure that all operators have been trained on the equipment they will use
- Check vehicles at the beginning of each shift to ensure that the parts, equipment, and accessories are in safe operating condition. Repair or replace any defective parts or equipment prior to use
- Do not operate vehicle in reverse with an obstructed rear view unless it has a reverse signal alarm capable of being heard above ambient noise levels or a signal observer indicates that it is safe to move
- Vehicles loaded from the top (e.g., dump trucks) must have cab shields or canopies to protect the operator while loading
- Ensure that vehicles used to transport workers have seats, with operable seat belts, firmly secured and adequate for the number of workers to be carried
- Equipment should have roll-over protection and protection from falling debris hazards as needed
- Prior to permitting construction equipment or vehicles onto an access roadway or grade, verify that the roadway or grade is constructed and maintained to safely accommodate the equipment and vehicles involved
- Do not modify the equipment's capacity or safety features without the manufacturer's written approval
- Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines





- **Describe important signals followed while loading**

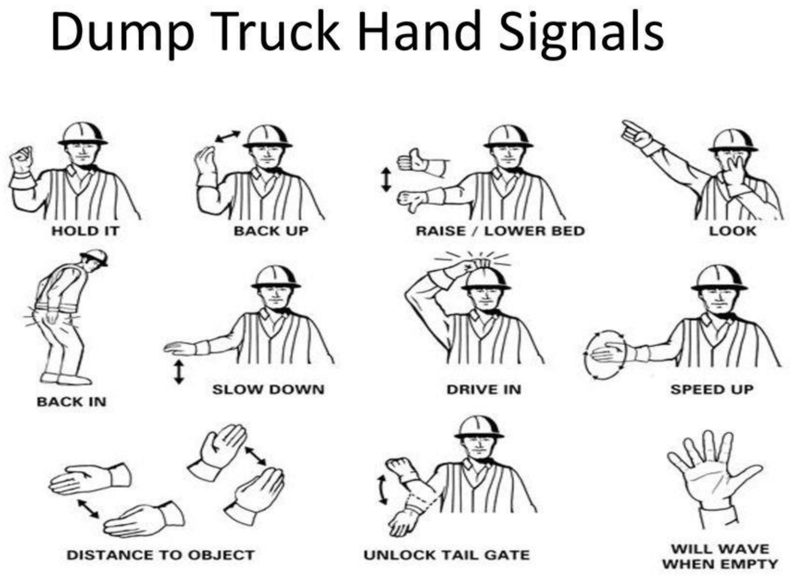
Excavator hand signals:

Explain dangers:

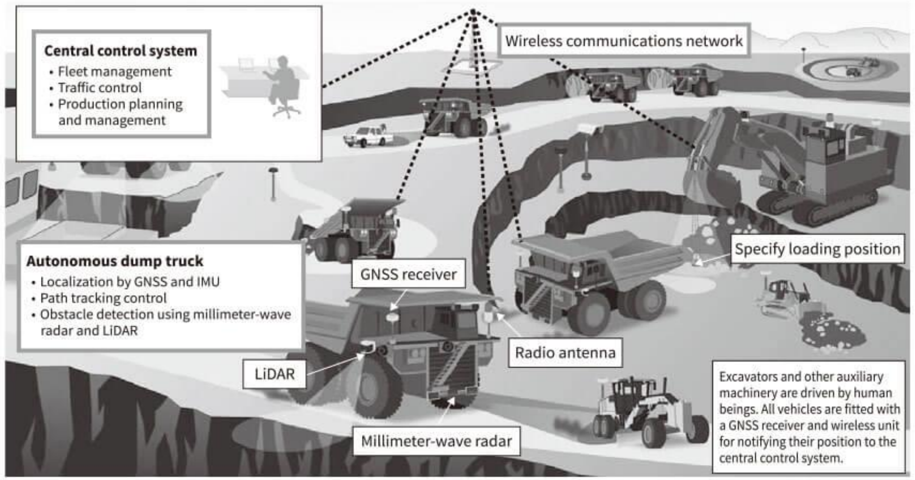
Excavators, backhoes, and other types of heavy equipment can cause injuries and fatalities to equipment operators and workers on foot during trenching operations**.**

Identify controls:

If a person could be endangered by equipment or its load, a signaler must be used to help the operator. The operator and the signaler must decide on a way to communicate with each other. Often the best way is to use clear, standard hand signals. Here are some standard hand signals for working with excavators.



TVET SSP does not secure copyright of these pictures



AHS: autonomous haulage system GNSS: global navigation satellite system IMU: inertial measurement unit LiDAR: light detection and ranging

Practical Simulation:

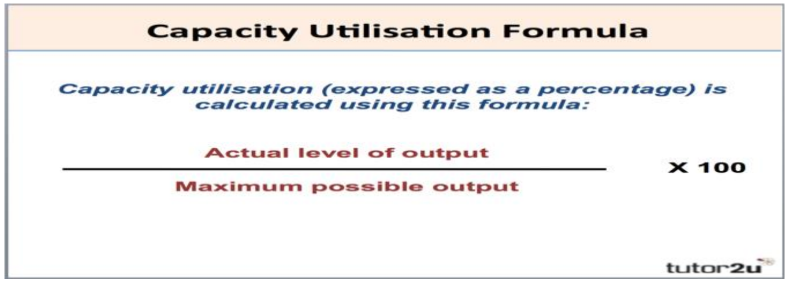
https://www.youtube.com/watch?v=3hWPei84YLs
https://www.youtube.com/watch?v=vv-esK_0IIs
https://www.youtube.com/watch?v=1k51V6J5Nmk
https://www.youtube.com/watch?v=N8W9h2MJNuE
https://www.youtube.com/watch?v=EDcTcLw42xE
https://www.youtube.com/watch?v=zAAkxXNUWnM

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU12. Cut and fills materials	**The students will be able to** • Work around site obstructions and hazards. • Position equipment correctly. • Practice grade checking devices. • Cut and fill material in accordance with job specifications • Tamp the filled material • Respond to hand signals.	• Define capacities & capabilities of Machine. • Describe method for estimation of cuts and fill • Describe grade checking instruments • Describe techniques how to cut humps and fill depressions • Describe how to tamp the filled material	

- **<u>Define capacities & capabilities of Machine.</u>**

<u>Capacity</u>: It is often defined as the capability of an object, whether it is a machine, work center, or operator, to produce output for a specific time period, which can be an hour, a day, etc.

<u>Capacity of Machine</u>: It refers to the production capacity of workers or machines, and is usually expressed by "hours". The Process Capacity of workers is called human capacity, while that of machines is called machine capacity.



<u>Capability</u> refers to the higher level of ability that could be demonstrated under the right conditions.

Machine capability is the measure of the actual quality of a machine with respect to its specifications (abbreviation: cm: c stands for capability and m for machine). The capability of a machine or process to fulfill the defined requirements is often specified by characteristic values.

	Required Part Spec.	Machine Capability
1	Length	Max Length
2	Width	Max. Width
3	Height	Max. Height
4	Turning Dia.	Max. Turning Dia.
5	Turning Length	Max. Turning Length
6	Drilling Dia.	Max Drilling Dia.
7	Drilling Length	Max. Drilling length
8	Tolerance	Max. tolerance
9	Surface Finish	Max. Surface Finish

- **Describe method for estimation of cuts and fill**

The cut or fill depth for each cell is found by subtracting the average existing level of the cell from the average proposed level. If the resultant depth is positive then this is a fill cell, while a negative value indicates a cut cell.
There are several methods for estimation of cuts and fill which are mentioned as follows.

CROSS-SECTION METHOD:

The cross section method involves plotting cross sections of the existing and proposed levels at regular intervals across the project site. For each of the cross sections, the cut area and the fill area is determined. 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.
There are several different methods used to determine the areas of cut and fill once the sections have been plotted. Perhaps the simplest (but most time consuming) method is to plot the sections on gridded paper and count the grid cells of the cut and fill areas. Multiplying the cell count by the area represented by each of the grid cells gives the cut or fill area for the section. Other methods include drawing the sections in CAD and exporting areas or calculating areas mathematically using the trapezoidal rule. The spreadsheet included with this article includes formulae which have automated the process of calculating section areas using the trapezoidal rule. This can save a great deal of time if you are using the cross section method.

Application of Typical Cross Section

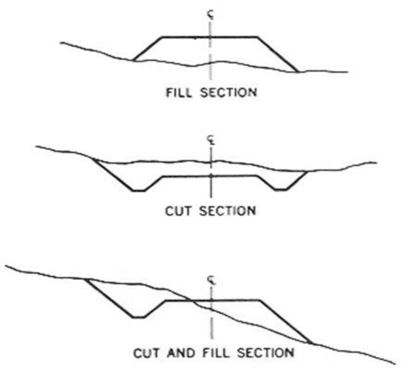
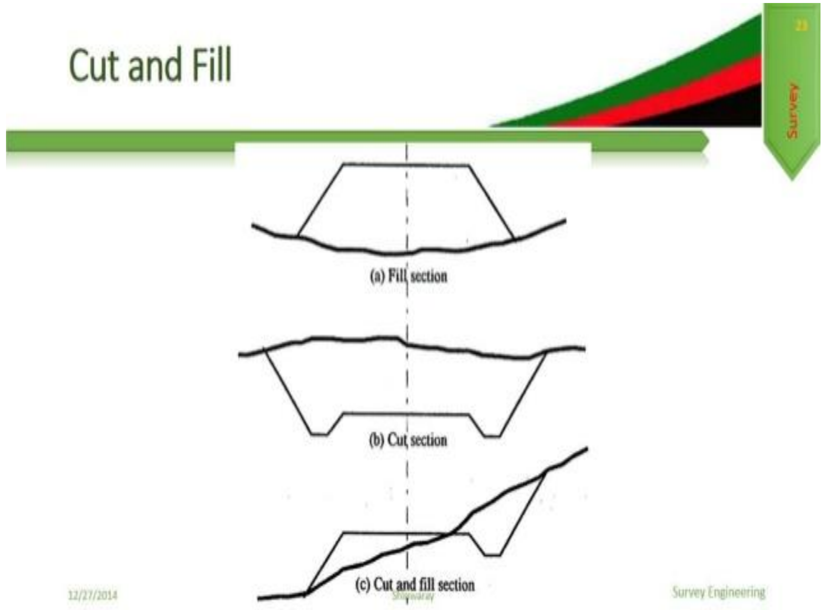


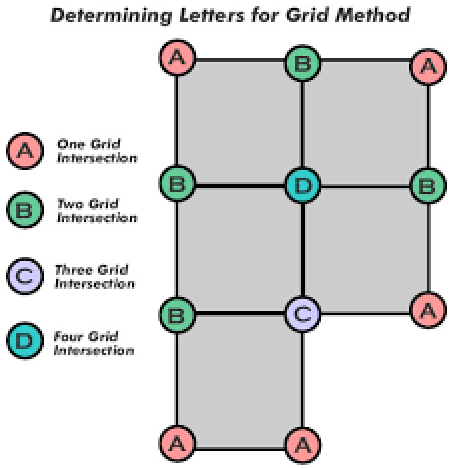
FIGURE 13-5 Original ground line and template sections.

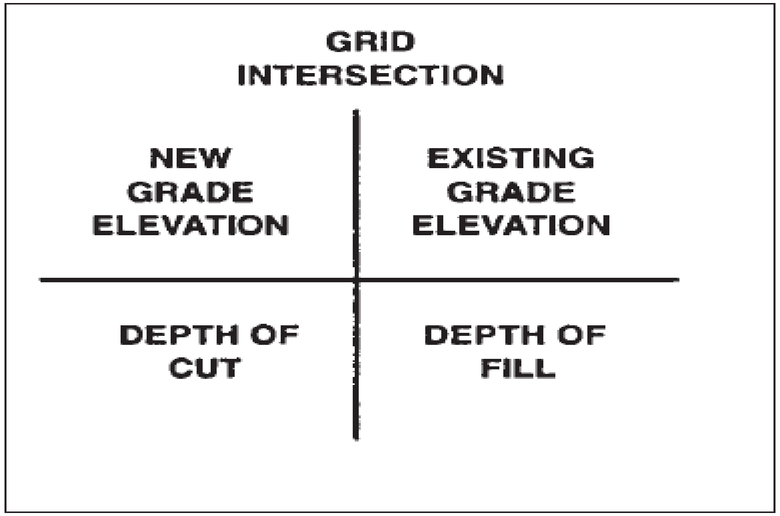
Wright and Dixon (2004) Fig 13-5



GRID METHOD

The grid method involves drawing a uniform grid onto a plan of the earthworks project, and taking off the existing and proposed ground levels at each node of the grid. With these values the average depth of cut or fill required on each cell of the grid is calculated, and the volume for each cell is obtained by multiplying the depth by the cell area. By adding the volumes for each cell together the total cut and fill volumes for the project can be estimated.

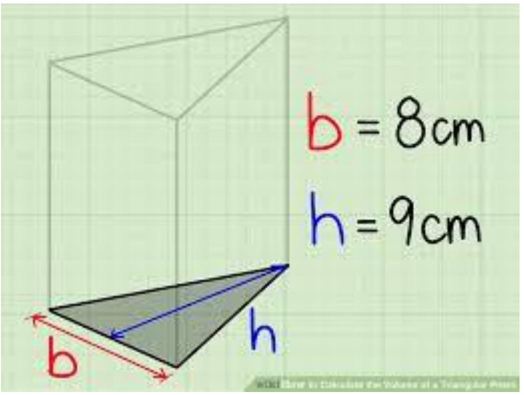


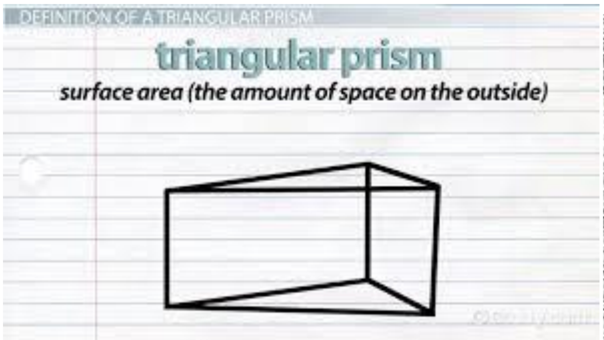


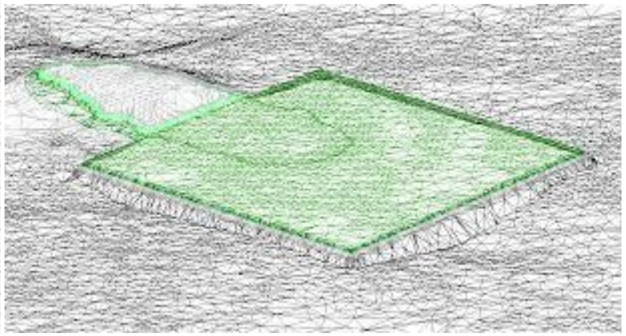
TRIANGULAR PRISMS

The third method that is commonly to used to calculate earthworks volumes is the triangular prisms method. This is by far the most technically difficult method, but is also the most accurate.

This method starts by triangulating the existing terrain. This involves joining the points in the terrain to create a continuous surface of connected triangles. This is known as a Triangulated Irregular Network, or TIN for short. This step is repeated for the proposed terrain.

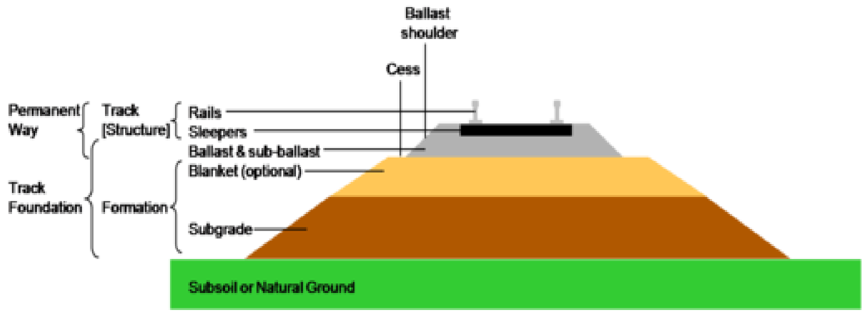






- **Describe grade checking instruments**

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope, for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage. The earthworks created for such a purpose are often called the sub-grade or finished contouring.



Theodolites **Flagging and Survey Markers**

Surveying Magnetic Locators

Automatic Lavels

Practical Simulation:
https://www.youtube.com/watch?v=Thve7EUXdZQ

Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU13. Stock piles materials	**The students will be able to** • Work around site obstructions and hazards. • Stockpile material in accordance with jobs specifications.	• Describe how to stock pile material in accordance with jobs specifications • Describe how to work around site obstructions and hazards.	

- Describe how to stock pile material in accordance with jobs specifications

Aggregates shall be produced in accordance with the applicable Specifications and shall be subject to testing after it has been placed in the stockpile. The suitability and location of stockpile sites, as well as access to the sites, will be subject to the approval of the Engineer.

Selection of Stockpile Sites:

The suitability and location of stockpile sites, as well as access to the sites, will be subject to the approval of the Engineer.

The Contractor shall provide stockpile sites, which shall be level, well-drained and have adequate bearing capacity to support the weight of the material which is to be placed thereon.

Stockpiles shall be constructed at locations and by methods that will neither interfere with nor damage utility lines, pipe lines or underground utilities.

Access to stockpiles shall be readily available at all times.

Construction of Stockpiles:

The Contractor shall clear the site of all debris, vegetation, rocks, snow and other objectionable material prior to placing any aggregate on the stockpile site. This work will not be paid for directly, but will be considered incidental to the Contract as a whole.

Where segregation is a concern the pile at the end of the discharge belt shall not be allowed to build up to a height greater than 3 m.

Stockpiling shall be performed using loaders, trucks or stacking conveyors.

When trucks or loaders are used, loads shall be spot dumped uniformly over the entire stockpile area. The aggregate shall be placed in layers not exceeding 1.25 m in depth. Each layer shall be completed and leveled prior to placing the succeeding layer.

BASE FOR STOCKPILES:

The base for stockpiles shall consist of sound, tough and durable pebbles or rock fragments and sand, all passing the maximum sieve size of the aggregate to be stockpiled and shall be free from roots, sod, or other deleterious substance.

When a base is required and there is no bid item, all costs in supplying, hauling and placing base material will be paid for as Extra Work.

Describe how to work around site obstructions and hazards:

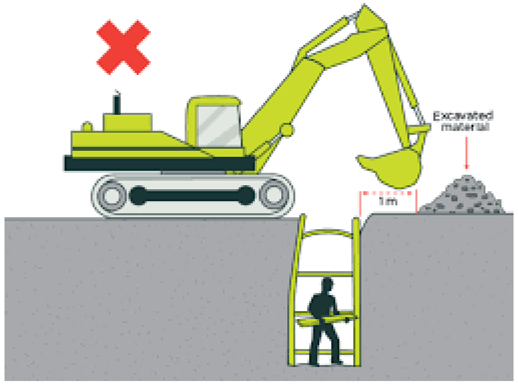
A construction site is any piece of land where a building is being built or repaired. Those who work on construction sites are often required to use large tools and pieces of machinery, work at height, and in environments where hazardous materials are present. Because of the nature of such work, working on construction sites can be dangerous.

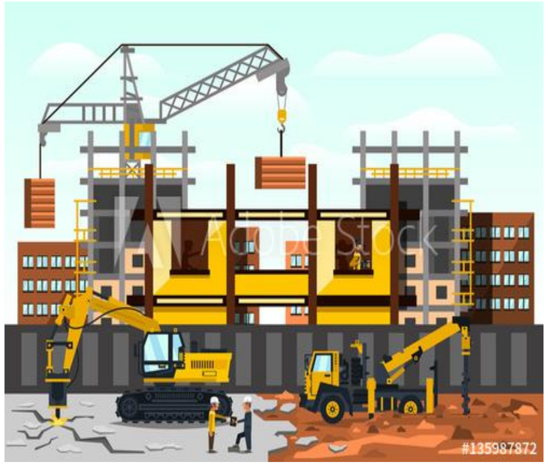
In order to control workplace hazards and eliminate or reduce the risk, you should take the following steps:

1. Identify the hazard by carrying out a workplace risk assessment;
2. Determine how employees might be at risk;
3. Evaluate the risks;
4. Record and review hazards at least annually, or earlier if something changes.

Potential hazards for workers in construction include:

- Falls (from heights);
- Trench collapse;
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment; and.
- Repetitive motion injuries





Practical Simulation:

https://www.youtube.com/watch?v=yPqjjM82otE
https://www.youtube.com/watch?v=JgN8xYSRTXk
https://www.youtube.com/watch?v=hIcNBY6CeKU
https://www.youtube.com/watch?v=1IBU6lF6Tbw

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU14. Excavate and Back fills trenches	**The students will be able to** • Work around site obstructions and hazards. • Ensure that structures or utility lines are not damaged during backfilling. • Maintain stability of equipment • Level or layer the material • Practice grade checking devices. • Backfill trenches/excavations in accordance with job specifications. • Respond to hand signals.	• Describe the techniques/methods of back filling • Describe safety precautions while backfilling	

- **Describe the techniques/methods of back filling**

Backfilling is the process of putting the soil back into a trench or foundation once excavation, and the related work has been completed. The backfill process requires skills and heavy equipment as well as knowledge of the specifications, contract requirements, and soil conditions. Every area of soil has unique characteristics, requiring different construction techniques to ensure optimum performance. Also, backfill crews must take care to prevent impact loading of any pipeline, shaft, structure, cabling, or other buried elements when placing and compacting backfill. There are a few common methods of backfilling and compacting backfill. Filling and compacting trenches for utility lines involves special considerations.

Soil is typically backfilled in layers or lifts. The soil lift will depend upon the nature of the backfill and the compaction equipment that is used. Water may be added during the compaction process, to assist with compaction. The general process follows three steps that are repeated until the backfill are is at grade level:

Backfill in layers of 4 to 6 inches, using non-organic fill material that is free of debris

1. **Compact with a 1,000-pound compactor, or as appropriate.**
2. **Water thoroughly**

Describe safety precautions while backfilling:

Safety plan:

1} Ensure that Jungle clearance is properly done and Remove nails, sharp edged items and other Hazardous materials / items [e.g.: snake dwelling mud holes] from the BORROWING SOURCE before commencing BORROWING activities.

2) Cover / barricade the unclosed utility manholes / pits if any.

3) Avoid using rebar cut pieces for signboards / barricading. If used - PVC rebar caps shall be fixed on top of it.

4) Signalman shall be kept near the FILLING area so as to alert the surrounding workers about movement of vehicles and deeply excavated pits.

5) Pits and diesel storage areas shall be barricaded.

6) Keep collection trays below excavation equipment's like compressors etc., so as to avoid spreading of fuels etc.,

7) Use PPE's [Gumboot, Hand glows, Helmet etc.].

8) Ensure back light and reverse horn for all the vehicles, which will be used for this filling work.

9) Fool proof system for reversal of vehicle to be ensured.

10) All the equipment's including plate compactor shall have the guard protection for belt moving portion.

Practical Simulation:

https://www.youtube.com/watch?v=3fwC3k8gdlM
https://www.youtube.com/watch?v=gPqdaUtcisk
https://www.youtube.com/watch?v=qyhr_XhiDDE
https://www.youtube.com/watch?v=SLAK0qInQpQ
https://www.youtube.com/watch?v=fGa9WGiWIZE
https://www.youtube.com/watch?v=bigI-grt5rw
https://www.youtube.com/watch?v=-VCI4AStfc4

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU15. Hoist objects	**The students will be able to** • Inspect rigging (ropes) components visually. • Identify and discard worn or damaged rigging components. • Communicate with appropriate personnel to replace worn or damaged components. • Work around obstructions and hazards. • Set up equipment in stable position and correct location for jobs. • Hoist materials in accordance with manufacturer's specifications, job specifications and legislation. • Respond to hand signals.	• Describe rigging components • Describe checking of damaged rigging components • Describe tools to be used for replacement of damaged rigging components • Describe hoist materials in accordance with manufacturer's specifications, job specifications and legislation	

- **Describe rigging components:**

Rigging is a noun, the equipment, and verb, the action of designing and installing the equipment, in the preparation to move objects. A team of riggers design and install the lifting or rolling equipment needed to raise, roll, slide or lift objects such as with a crane or block and tackle.

Rigging comes from rig, to set up or prepare. Rigging is the equipment such as wire rope, turnbuckles, clevis, jacks used with cranes and other lifting equipment in material handling and structure relocation. Rigging systems commonly include shackles, master links and slings, and lifting bags in underwater lifting.

Rigging points – specific places in the ceiling from which you're able to hang things within a venue. These are regulated and maintained by the venue to ensure the weight limits (and therefore, safety) are appropriate. ... Motors are connected to the rigging points, and the truss.

Blocks & Pulleys

These are widely used across the rigging industry for lifting exceptionally heavy objects. Blocks & pulleys help reduce the kind of force that is required to lift a heavy object. There are various types of blocks and pulleys available in the market including snatch blocks, swivel block, single & double pulleys and square blocks. Pulleys are usually used with rigging ropes typically by circling the rope via the pulley many times before actually hooking to the object to be carried.

Eye Bolts

Eye bolts come in a multitude of sizes and materials and you can choose the one depending on your needs. Acting like a riggers supply, eye bolts are just like anchor point for various rigging applications. Some of the most common types include shoulder eye bolts and straight eyebolts. The former are used for angular connections whereas the latter are used in straight line applications. What's more, there are also screw eye bolts, U-bolts and lag eye screw types of eyebolts found in the market.

Rigging Hooks

Differing in strength, capacity and design, there are lots of rigging hooks found these days. Applications differ depending whether it is a hoist hook, lifting/rigging hook or sling hook. One can easily find heavy duty sling hooks including swivel eye stainless steel hooks that have a working load limit exceeding 8000 lbs.

Wire ropes & accessories

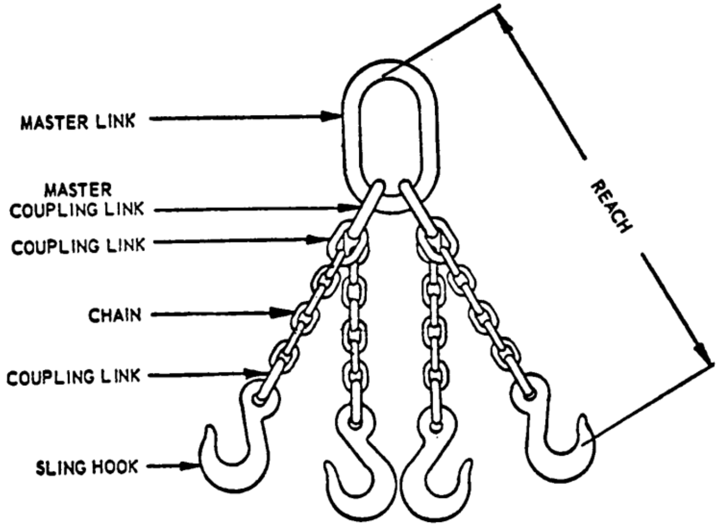
Wire ropes are widely used in rigging, mooring, lifting and many other similar operations. These days, wire ropes are mainly manufactured using stainless steel. Wire ropes come in different classifications with 6×19 and 6×37 being the most popular. Among the various wire rope accessories available include clips, thimbles, sleeves, stops etc.

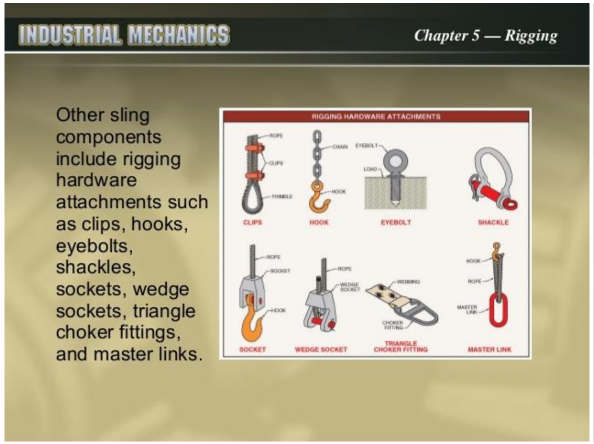
Stainless steel nuts

The use of stainless steel nuts depends on various rigging applications. The most common steel nuts you will find in the market include hex nuts, ball ends, dome nuts, wings nuts, and lifting eye nuts. Most of these rigging hardware are made from type 316 stainless steel. Furthermore, stainless steel nuts are mainly available in RH and LH thread.

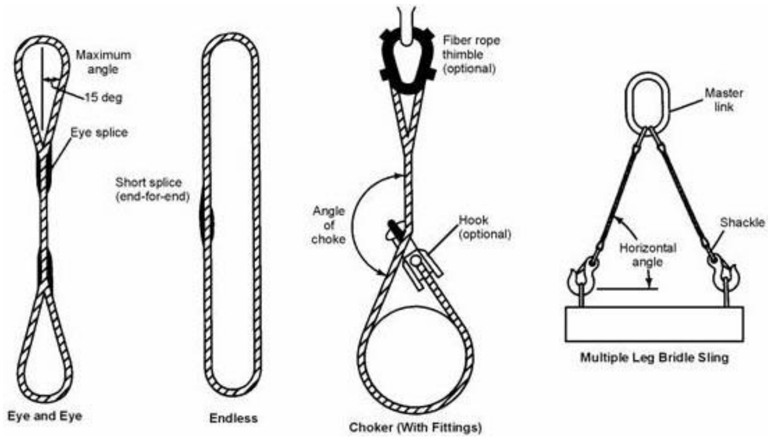
No matter which accessory or hardware you are about to use for rigging purposes, exercise great caution. Most importantly, keep inspecting and maintaining the rigging hardware on timely basis because infrequent maintenance often leads to damage which further can cause dangerous accidents. Always follow the manufacturer's guidelines when it comes to using rigging hardware.


Crane System
Rigging Gear
Anchor System
Lifting Clutch
Anchor


MASTER LINK
MASTER COUPLING LINK
COUPLING LINK
CHAIN
COUPLING LINK
SLING HOOK
REACH







Describe checking of damaged rigging components

Rigging safety is a critical part of shipyard and construction employment, used to lift heavy materials to heights with cranes and other devices. Riggers also act as signalman. Improper rigging of a load or a rigging failure can expose riggers and other workers nearby to a variety of potential hazards.

The most common problems tie back to misuse and abuse and lack of inspection. Some of the most common issues we see are: Hooks with missing or broken latches. Rigging hardware that's bent stretched, broken, or chopped in half.

The problem with rigging equipment is that its most commonly used in an environment that’s dirty, dusty, greasy, grimy, or just flat-out abusive. For slings, this usually means that they’re getting damaged, ripped off, covered in dirt or grease, or smudged to the point they’re no longer legible.

Another problem we see is that the end-user may have a solvent tank that they use to remove grease or grime from their equipment or machined parts. They’ll throw greasy web slings or round slings into that solvent tank to clean them off and mistakenly think they’re taking care of their rigging gear. You can’t do this with a synthetic sling—the chemicals in those solvent tanks will degrade the nylon or polyester fibbers in that sling and over time, this affects the integrity of that lifting sling.

Details of checking of damaged rigging components are mentioned below.

Slings shall be visually inspected by the person using the sling each day of their use. This visual observation should be concerned with discovering damage that may be an immediate hazard.

Kinking is caused by loops that have been drawn too tightly as a result of improper handling. Kinks are permanent distortions and will require the rope or the damaged section to be removed from service.

The following should be looked for in a pre-use inspection:

1) Broken wires.
2) Severe localized abrasion or scraping.
3) Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
4) Evidence of heat damage.
5) End attachments that are cracked, deformed, or worn to the extent that the strength of the sling is substantially affected
6) Severe corrosion.


STOP
Birdcaging
STOP
Corrosion
STOP
Severe
Wear

Describe tools to be used for replacement of damaged rigging components

A toolbox (also called toolkit, tool chest or workbox) is a box to organize, carry, and protect the owner's tools. They could be used for trade, a hobby, and their contents vary with the craft of the owner. A toolbox could refer to several types of storage to hold tools. It could mean a small portable box that can carry a few tools to a project location or a large storage system set on casters. Modern toolboxes are predominantly metal or plastic. Wood was the material of choice for toolboxes built beginning in the early 19th century.

Toolboxes can be mainly divided as 5 types. They are:

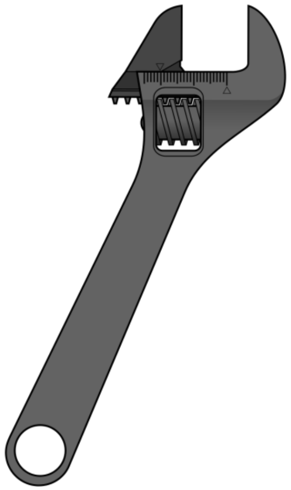
- Plastic
- Steel
- Aluminum
- Waterproof
- Cantilever

Small portable toolboxes are sometimes called hand boxes or portable tool storage. Most portable toolboxes have one handle on top and a lid that opens on a hinge. Many have a removable tote tray that sits on a flange inside the lip of the box, with a single larger compartment below.

When it comes to the disposal of rigging hardware, wire rope, or slings, the best practice is to render the items in question as unsalvageable, or in such a condition as to make further use impossible.

Adjustable Spanner:

An adjustable spanner (UK, and most other English-speaking countries) or adjustable wrench (US and Canada) is an open-end wrench with a movable jaw, allowing it to be used with different sizes of fastener head (nut, bolt, etc.) rather than just one fastener size, as with a conventional fixed spanner. Several other names are in use, including casually imprecise use of a US trademark as crescent wrench.



Breaker Bar:

A breaker bar (also known as a power bar) is a long non-racketing bar that is used with socket wrench-style sockets. They are used to break loose very tight fasteners because their additional length allows the same amount of force to generate significantly more torque than a standard length socket wrench. Their use prevents damage to the racketing mechanism of a socket wrench. Often, after the first half turn, the fastener is loose enough to be turned with a socket wrench.

Hammers:

A hammer is a tool consisting of a weighted "head" fixed to a long handle that is swung to deliver an impact to a small area of an object. This can be, for example, to drive nails into wood, to shape metal (as with a forge), or to crush rock. Hammers are used for a wide range of driving, shaping, and breaking applications.

The modern hammer head is typically made of steel which has been heat treated for hardness, and the handle (also called a haft or helve) is typically made of wood or plastic.

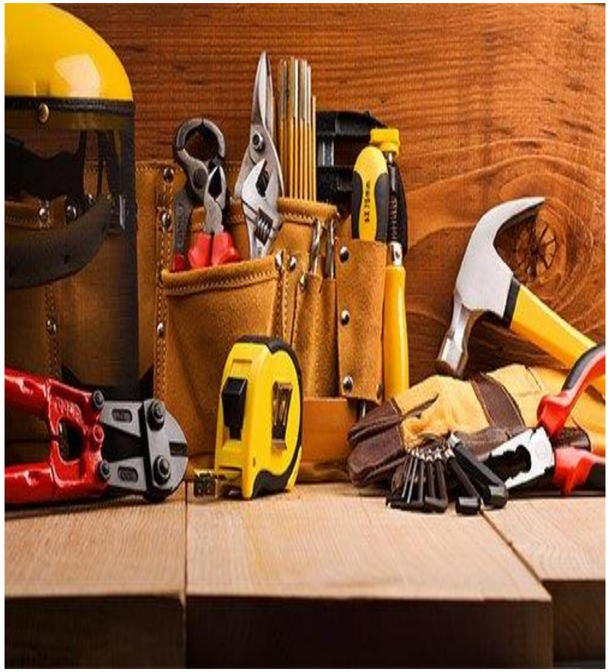
Wrench Spanner:

A wrench or spanner is a tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners, such as nuts and bolts or keep them from turning.

Wrenches—a very good name for this tool in that all too often it is the condition of a worker's back after miss using a wrench. It is not only a back that can be injured. Keep the jaws sharp. Keep the wrench clean and free of grease and oil.

Screwdrivers:

A screwdriver is a tool, manual or powered, for screwing (installing) and unscrewing (removing) screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle. The shaft is usually made of tough steel to resist bending or twisting. The tip may be hardened to resist wear, treated with a dark tip coating for improved visual contrast between tip and screw—or ridged or treated for additional 'grip'. Handles are typically wood, metal, or plastic and usually hexagonal, square, or oval in cross-section to improve grip and prevent the tool from rolling when set down. Some manual screwdrivers have interchangeable tips that fit into a socket on the end of the shaft and are held in mechanically or magnetically. These often have a hollow handle that contains various types and sizes of tips, and a reversible ratchet action that allows multiple full turns without repositioning the tip or the user's hand.



Describe hoist materials in accordance with manufacturer's specifications, job specifications and legislation

A hoist is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. It may be manually operated, electrically or pneumatically driven and may use chain, fibber or wire rope as its lifting medium. The most familiar form is an elevator, the car of which is raised and lowered by a hoist mechanism. Most hoists couple to their loads using a lifting hook.

The employer shall comply with the manufacturer's specifications and limitations applicable to the operation of all hoists and elevators. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a professional engineer competent in the field.




Practical Simulation:

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

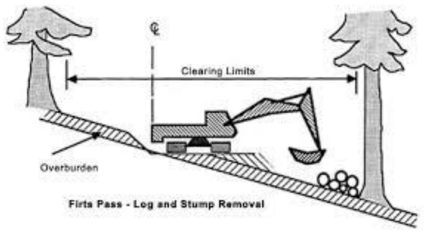
Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU16. Clear land	**The students will be able to** • Work around obstructions and hazards. • Install attachments. • Maintain haul roads as required. Clear land in accordance with job specifications.	• Describe types of obstructions and hazards • Describe how to work around obstructions and hazards • Describe precautions to be ensured while working around obstructions and hazards • Describe attachments for land clearing as per job specification	

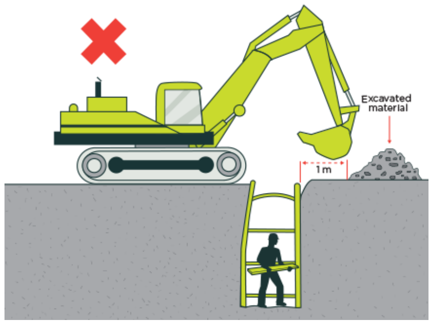
Describe types of obstructions and hazards

Obstructions:

An obstruction is something that blocks a road or path.

Obstruction is the act of deliberately delaying something or preventing something from happening, usually in business, law, or government. When working on specific types of structures such as electricity pylons and bridges, there can be additional hazards such as low-hanging wires and supports. In addition, are the any potential issues for the public such as roads or footpaths.





Hazards:

There are many definitions for hazard but the most common definition when talking about workplace health and safety is “A hazard is any source of potential damage, harm or adverse health effects on something or someone.”

- **Harm – physical injury or damage to health.**
- **Hazard – a potential source of harm to a worker**

Basically, a hazard is the potential for harm or an adverse effect (for example, to people as health effects, to organizations as property or equipment losses, or to the environment).

OR

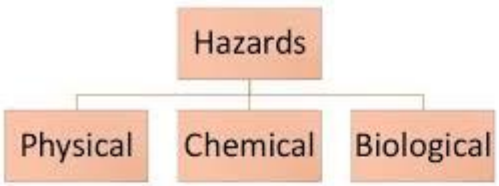
Hazard. ... A hazard is any agent that can cause harm or damage to humans, property, or the environment. Risk is defined as the probability that exposure to a hazard will lead to a negative consequence, or more simply, a hazard poses no risk if there is no exposure to that hazard.

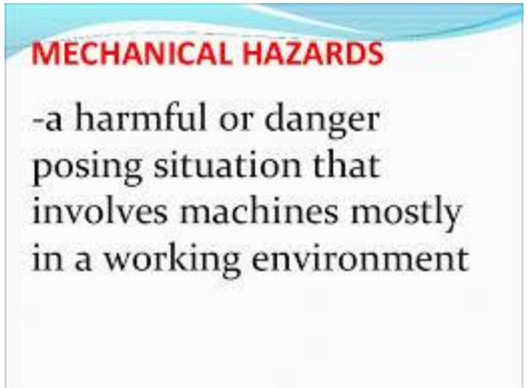
A common way to classify hazards is by category:

- **<u>Biological</u> – bacteria, viruses, insects, plants, birds, animals, and humans, etc.**
- **<u>Chemical</u> – depends on the physical, chemical and toxic properties of the chemical, <u>OR</u> Gases, dusts, fumes, vapors and liquids.**
- **<u>Ergonomic</u> – repetitive movements, improper set up of workstation, etc., <u>OR</u> poor design of equipment, workstation design, (postural) or workflow, manual handling, repetitive movement.**
- **<u>Physical</u> – radiation, magnetic fields, temperature extremes, pressure extremes (high pressure or vacuum), noise, etc., <u>OR</u> Slippery floors, objects in walkways, unsafe or misused machinery, excessive noise, poor lighting, fire**
- **<u>Psychosocial</u> – stress, violence, etc.,**
- **<u>Safety</u> – slipping/tripping hazards, inappropriate machine guarding, equipment malfunctions or breakdowns.**

More hazards

1. Falls into trenches or excavations.
2. Tripping over equipment, debris and spoil.
3. Excavated material or other objects falling on workers.
4. Exposure to underground services or overhead electrical cables.
5. Unstable adjacent structures.
6. Mishandled or poorly placed materials.





<u>Describe how to work around site obstructions and hazards:</u>

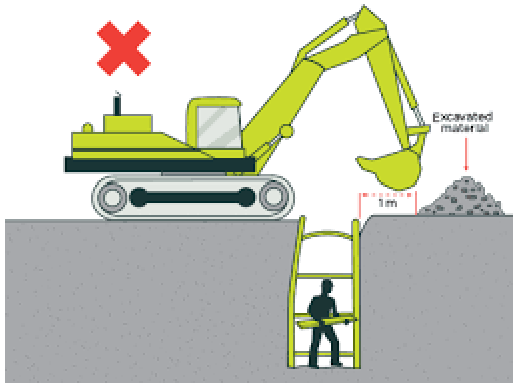
A construction site is any piece of land where a building is being built or repaired. Those who work on construction sites are often required to use large tools and pieces of machinery, work at height, and in environments where hazardous materials are present. Because of the nature of such work, working on construction sites can be dangerous.

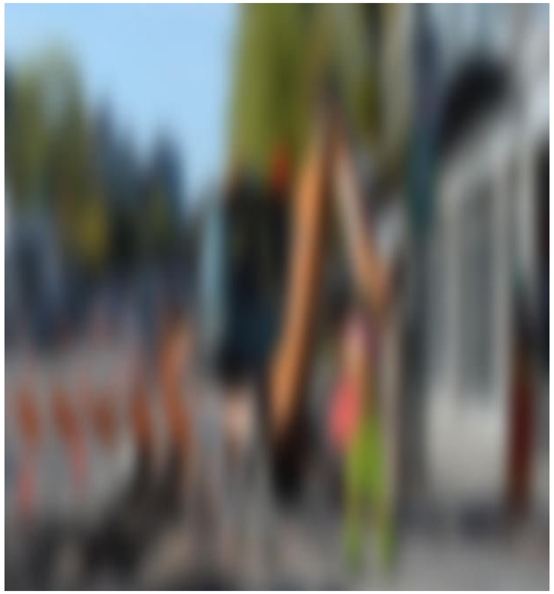
In order to control workplace hazards and eliminate or reduce the risk, you should take the following steps:

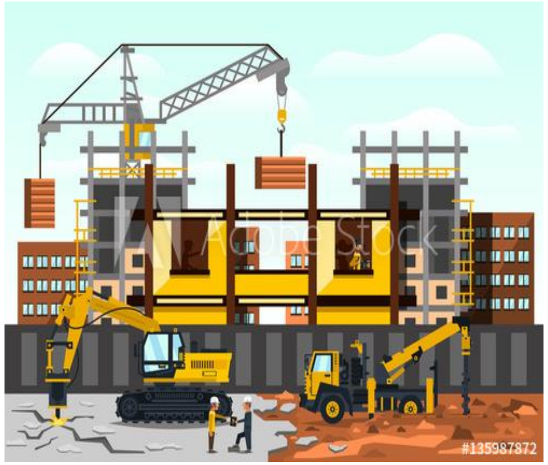
1. Identify the hazard by carrying out a workplace risk assessment;
2. Determine how employees might be at risk;
3. Evaluate the risks;
4. Record and review hazards at least annually, or earlier if something changes.

Potential hazards for workers in construction include:

- Falls (from heights);
- Trench collapse;
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment; and.
- Repetitive motion injuries







<u>Describe precautions to be ensured while working around obstructions and hazards:</u>

<u>The precautions to be taken are:</u>

1. Trench collapse should be avoided by battering the sides to a safe angle or by supporting them with sheeting or proprietary support systems. Support should be installed without delay as the work progresses. Ensure the workers are competent and experienced as far as possible and that they have clear instructions.
2. Excavated spoil, plant or materials should not be stored close to the sides of excavations as loose material can fall in. The extra loading can make the sides of the excavation more likely to collapse.
3. Prevent people from falling into excavations by substantial barriers around the edges. This must be done if the depth exceeds 2 metres but is recommended for excavations of lesser depths.
4. Prevent vehicles from falling into excavations or surcharging and causing the collapse of the sides of the excavation by keeping them out of the area. Baulks and barriers can be provided for this purpose and should be painted to be easily visible. If vehicles have to tip materials into excavations then they should be prevented from over-running into the excavation by using stop blocks.
5. Provide safe access in and out of the excavation.
6. Cable and / or pipe plans and service plans should be used to locate underground services which should be marked on the ground and where practicable digging should take place as far as possible from them. Use cable and pipe locators during the course of the excavation work. Great care should be taken to ensure that mechanical means of digging are not used within 0.5 metres of underground services and spades and shovels should be used instead of picks and forks which are more likely to pierce cables. Once services are located and exposed they should be supported. Both new and existing services should be permanently marked by the use of appropriate tapes over the service and by placing permanent markers above ground indicating the service type, depth, route etc.

Describe attachments for land clearing as per job specification:

Tree Puller: Jaws open to 11.5” to quickly pull out trees and fence posts. Hard stop at tip keeps small space between teeth when fully closed. This allows even small trees to be pulled without shearing them off. Single hydraulic cylinder is protected from debris and other objects.

Rakes:

A great tool for land clearing, the rake easily removes roots and stumps to clear land quickly. The thick cutting edge of the teeth greatly increases durability of the rake and curved tines offer maximum force projection.

Replaceable weld-on wear strips;

2. Simple installation- easily interchanges with bucket;

3. Can also be used with quick coupler;

4. Will work with any existing manual or hydraulic thumb;

5. Various widths available to fit your application;

6. Available for any size excavator;

7. Customized size and widths available to meet your needs.

Blade:

We find levelling blades on wheel excavators and shovels. The excavator blade is ideal for cleaning a workspace and useful for stabilizing the machine. It may be accompanied, on some machines, by outrigger. The height of the levelling blade is adjustable thanks to lifting cylinders. The blade is machined in HARDOX steel for better resistance and durability.





Practical Simulation:

https://www.youtube.com/watch?v=VehS5eR3dmc
https://www.youtube.com/watch?v=5WD2c8WL1vM
https://www.youtube.com/watch?v=4kJOLoWE69w
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Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU17. Demolish buildings and other structures	**The students will be able to** • Work around obstructions and hazards. • Position equipment safely while demolition and always have means of exit. • Demolish structures and remove demolished materials in accordance with job specifications. • Respond to hand signals.	• Describe attachments required for demolition of buildings and other structures • Describe safety precautions during demolition of buildings and other structures • Describe safe entrance into and exits from the site • Describe procedure of removal of demolished materials	

Describe attachments required for demolition of buildings and other structures:

Whether it be an industrial warehouse or a high-rise block of flats, each demolition project is totally unique. Demolishing a building certainly requires a lot of careful consideration – the way in which a structure is demolished and the machinery that is used is based on several varying factors including the materials used in the construction, its size, the surrounding environment and the location of the structure. Planning the correct Methodology and Plant and Equipment to use is the key to a successful project. At Hughes and Salvidge we carry out demolition work on a wide variety of building structures across several sectors, ranging from chemical plants and airports to tower blocks and schools. We ensure that every possible factor has been considered so that the correct method of demolition and machinery is chosen for the job in hand.

There are three main types of structural demolitions: Progressive demolition, deliberate collapse mechanisms, and Deconstruction. These are the alternative techniques that can be selected by the contractor in the selection process, conducted in the tendering stage.

Hydraulic excavators are essentially tracked plant that demolish small buildings. We operate 1 tonne to 100 tonne excavators and the range in both size and function allows the excavators to work on a variety of tasks within various project areas. At Hughes and Selvedge we use a variety of different attachments to suit the job in question. Another key benefit to using hydraulic excavators for demolition is their ability to perform a number of different tasks with the use of different attachments such as rotational grapples, pulverisers, steel shears and impact breakers.

High reach demolition excavators are more often used for tall buildings where explosive demolition is not appropriate or possible. Excavators with shear attachments are typically used to dismantle steel structural elements. Hydraulic hammers are often used for concrete structures and concrete processing attachments are used to crush concrete to a manageable size, and to remove reinforcing steel. For tall concrete buildings, where neither explosive nor high reach demolition with an excavator is safe or practical, the "inside-out" method is used, whereby remotely operated mini-excavators demolish the building from the inside, whilst maintaining the outer walls of the building as a scaffolding, as each floor is demolished.


CAT

- **Describe safety precautions during demolition of buildings and other structures:**

Top five safety precautions for demolition

Safety has and always will be the most important part of constructions, renovations and demolitions. Always having the best and most up-to-date equipment, as well as taking the necessary precautions, has saved countless lives throughout the years. These precautions are simple and easy things that you should always be sure to do. These precautions take just a few minutes to oversee, but could make the difference when it comes to a safe demolition. Here are the top five safety precautions for demolitions:

1. Equipment — Employees should always be knowledgeable of all aspects of work, regardless of their specialty or area of work. It's important that each and every employee understands what equipment should be worn and present throughout the demolition. Make sure that each employee also knows and understands how to use each piece of equipment properly. This quick and simple sweep to make sure each employee has all the proper equipment required can help save lives and prevent any or all future injuries as you go throughout the demolition. In addition, make sure that each employee has a hard hat, as well as a mask, gloves, and work boots.

2. Final sweep — Always do a final sweep before demolition begins. It's absolutely recommended to go into each and every room, including closets, bathrooms and hallways, to assure that everyone and everything is out of the building. It's necessary to assure that each worker is out of the building and at a safe distance before demolition begins. Likewise, make sure that the building is monitored by employees to make sure that unauthorized people do not get close to the demolition site. If others are present, make sure all equipment is equipped and readily available to any newcomers. Assign someone to assure the final sweep has been made. Make sure that everyone knows who to report to. Once the final sweep is done, notify the person in charge. The demolition can then take place safely.

3. Experienced and trained employees — It's absolutely necessary that only trained and experienced employees handle the more dangerous and explosive materials. These employees should be qualified, professional, mature and experienced enough to handle the responsibility and carefulness required by those handling explosives. These employees, if trained correctly, can **help prevent accidents** on the work site.

4. Brace ceilings and walkways — If for any reason anyone needs to enter the building, it's necessary for every ceiling and walkway to be braced. This will easily provide extra support in case an accident occurs, helping prevent a huge amount of accidents, injuries and even deaths.

5. Cleaning up debris — Make sure that all employees are wearing and equipped with the proper equipment to clean up any and all debris once the demolition has taken place. This equipment includes gloves, a mask and work boots. Most importantly, however, make sure that only authorized employees are present during the cleanup and demolition. This stage can be very dangerous, but taking these necessary steps can prevent an array of injuries and accidents.

Safety is always the most important thing while doing anything, especially throughout construction or demolitions. By doing these five simple things, you could easily save lives, reduce injuries and make the most of any demolition.

- **<u>Describe safe entrance into and exits from the site:</u>**

Access and egress refer to the rate or means of entry and exit to a workplace or work area. Routes that provide access and egress should be controlled, safe, suitably constructed, kept free of obstructions and well maintained. Serious injury can result from hazards such as fires, slips and trips, contact with moving vehicles, unauthorized entry into hazardous work areas, falls into floor openings and falls into water, when access and egress arrangements are not properly maintained.

Site Access:

It is extremely important to always know who is on site at any given time, and aware of personnel present in a particular work area. In the event of an emergency, such as a fire, it will then be possible to determine whether anyone has been unable to evacuate the site. It will also be possible to direct rescue services to the appropriate work area. You should, therefore, always follow the appropriate access control procedures every time you enter or exit a site or a controlled work area.

<u>Egress Routes:</u>

Egress routes need to be clearly marked out, well lit, unobstructed and well maintained if they are to allow personnel and others on site to exit quickly in the event of an emergency. For these reasons, you should never lay down or store tools, equipment, work pieces or other items on routes of egress. Operations should be planned so that they do not damage egress routes, and any accidental damage should be rectified immediately.

Slips, Trips and Falls:

Egress routes are often also access routes, and part of your work area. But even when they are not, access routes and work areas should be kept in a safe, unobstructed and well maintained condition, as this can help to reduce the risk of dangerous slip and trip accidents.

Slips and trips represent a significant cause of work related injury. Slips and trips can result from contamination, obstacles, inappropriate footwear, reduced visibility, the environment and people's attitudes. Good workmanship and good housekeeping are practices that can help to prevent accidents and fires. By removing debris, slag, packaging and other waste materials to waste skips, you can contribute significantly to good housekeeping. You can also reduce the risk of slips and trips by properly routing any cables or air hoses that you use, by placing fixed covers over small holes in flooring, by ensuring that you always wear appropriate footwear, by holding the handrails when you use stairs or access ladders, by considering whether the environment in which you will be working increases the risk of slips and trips and by taking responsibility for your own and your colleagues safety and appropriately containing any spills that you might discover.

Mobile Plant:

Each year, a number of people die as a result of being struck by a moving or falling object. In most cases, these deaths involved accidents relating to vehicles in the work place. It is important to separate vehicles and pedestrians in your work area, and to remember that only suitably trained, certified and authorised people should operate mobile plant, that you should always be aware of vehicle movements within your workplace and that you stick to pedestrian routes when going to or leaving your work area.

Arrangement of your Work Area:

Your work area should be organised to ensure that you have enough height and space for access and egress, as well as to move around and carry out operations safely. Low level ceilings or pipe-work should be highlighted. Particular safe working procedures are required in work areas with limited access and egress, including confined spaces.

Hazardous Work Areas:

Access restrictions, such as barriers, are required for hazardous work areas. Machine shops, elevated work platforms, confined spaces, roofs, floor openings and work areas over or near water pose significant hazards and it should not be possible for unauthorised personnel to enter these areas. Please stick to designated pedestrian walkways if you need to walk past or through these work areas and do not be tempted to cross barriers or take unnecessary short cuts. If you need to work in a hazardous area, you must follow the specific access procedures for your work area. This may include access control and equipment control. You may not be able to take personal items into certain work areas, such as confined spaces. You will also need to be familiar with the rescue plan established for some work areas, including confined spaces and work areas near water. If you operate powered access equipment, you must be suitably trained and authorised.


SITE SAFETY
Hard hat must be worn
Warning
Construction site
Keep out
Protective footwear must be worn
Danger
Demolition work in progress
High visibility jackets must be worn
No admittance for unauthorised personnel
Ear protectors must be worn
Site safety starts here


SITE SAFETY
Construction work in progress
Parents are advised to warn
children of the dangers of
entering this site
Danger
Demolition work in progress
No admittance for unauthorised personnel
Use ear protectors
This is a hard hat area
High visibility jackets must be worn
Protective footwear must be worn
Warning
Look out for overhead loads


07:22 A.M.
Entry Point
Enter
Clean
Exit
Exit Point
Dump truck
Excavator
Worker
Dozer
Load
Track Loader

Describe procedure of removal of demolished materials:

Demolition waste is waste debris from destruction of buildings, roads, bridges, or other structures. ... There is the potential to recycle many elements of demolition waste.

Home demolition generally involves a large, hydraulic excavator tearing down the house and putting the unwanted house materials into the back of a truck or dumpster. However, if are choosing to go the route of deconstruction—whether partial or complete—this process can take much longer.

The demolition contractor has the opportunity and responsibility to remove hazardous building components from a structure prior to demolition. Once a building is demolished, separating these materials becomes difficult or impossible! Some additional costs will be incurred from the time needed for removal and for appropriate management. Clients need to be educated to their responsibilities and potential liability for mismanagement.

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

Transportation for Your Demolition Waste

Whether you're taking on a large commercial project or a residential job, Homewood Disposal is ready to cater to your demolition needs. We know demolition creates heavy debris that requires removal. Your trash, materials, packaging, demolition debris, and scrap can all be hauled off by our special waste trucks. We offer roll off trucks, dump trailers and transfer trailers to meet all your demolition needs.

Removal of debris:

The person conducting a business or undertaking and/or the principal contractor in control of the workplace must manage the risks to health and safety arising from the storage, movement and disposal of construction materials and waste at the workplace.

Debris should be progressively removed to prevent any build up that could affect the integrity of a suspended floor of the building or structure, affect workplace access and egress, become a fire hazard, or cause a health and safety hazard.

Demolished materials should not be allowed to fall freely unless they are confined within a chute (or similar enclosure), shaft and/or exclusion zone.

A debris drop is a debris pile that is enclosed and where the risk of an object striking workers or the public has been eliminated. Debris drop zones should be clearly identified and any area where there is a risk that a worker or other persons at the workplace might be injured by falling or rebounding debris should be fenced or barricaded to prevent access.

If demolished materials are allowed to fall through internal floor openings in multi-storey buildings, such as lift shafts and/or debris drop zones, the following should apply:

„ at the working level, each opening should be protected by an adequate vehicle buffer at the working level, each opening should be protected by an adequate vehicle buffer other times. Vehicle buffers should be high enough to prevent the mobile plant from other times riding over them and solid enough to stop the fully loaded mobile plant, and at all levels below the working level, access to the area through or onto which material is falling should be prevented, either by sealing off the opening with guarding from floor to ceiling, or by erecting signs and barricades to prevent persons coming near the openings.

Practical Simulation:
https://www.youtube.com/watch?v=0y3f1_M2tYI
https://www.youtube.com/watch?v=RnU29z2IQIo
https://www.oshatrain.org/courses/mods/815m1.html
https://www.youtube.com/watch?v=g96QSY73_gw

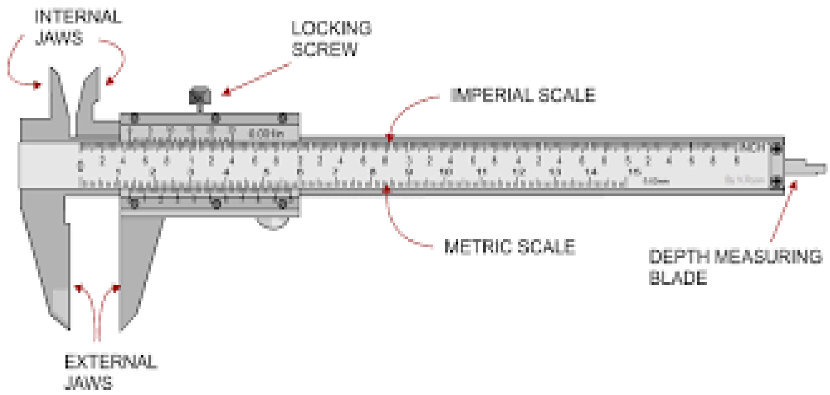
Learning Unit	**Learning Outcomes**	Learning Elements	Materials Required
LU18. Monitor performance of machines	**The students will be able to** • Interpret information from gauges and symbols. • Monitor performance using own senses. • Identify equipment problems.	• Describe information given on different gauges • Explain how to monitor performance of machine • Describe likely problems/down time to be encountered about the machine	

Describe information given on different gauges

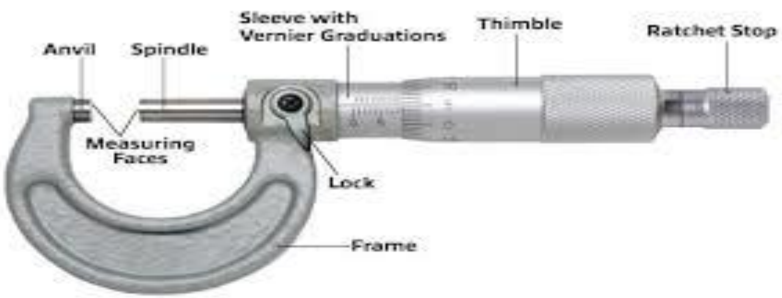
Absolute pressure gauges measure absolute pressure without the effect of barometric pressure variation and are used when monitoring condensation pressures and vapor pressures of liquids.

Types of Mechanical Gauges

Vernier Calipers: They are normally of two types- inside and outside caliper. They are used to measure internal and external size (for e.g. diameter) of an object. It requires external scale to compare the measured value. Some calipers are provided with measuring scale. Other types are odd leg and divider caliper. It is a precision tool used to measure a small distance with high accuracy. It has got two different jaws to measure outside and inside dimension of an object.It can be a scale, dial or digital type vernire caliper.



Micrometer: It is a fine precision tool which is used to measure small distances and is more accurate than the vernire caliper. Another type is a large micrometer caliper which is used to measure large outside diameter or distance.



Feeler gauge: Feelers gauges are a bunch of fine thickened steel strips with marked thickness which are used to measure gap width or clearance between surface and bearings.


Telescopic feeler gauge: It is also known as tongue gauge and it consists of long feeler gauge inside a cover with tongue or curved edge. The long feeler strips protrude out of the cover so that it can be inserted in to remote places where feeler gauge access is not possible.



Bore Gauge: A tool to accurately measure size of any hole is known as bore gauge, It can be a scale, dial or digital type instrument.


-0.15805

Depth gauge: A depth gauge is used to measure the depth of a slot, hole or any other surface of an object. It can be of scale, dial or digital type.

Pressue Gauges:

A pressure gauge is a fluid intensity measurement device. Pressure gauges are required for the set-up and tuning of fluid power machines, and are indispensable in troubleshooting them. Without pressure gauges, fluid power systems would be both unpredictable and unreliable. Gauges help to ensure there are no leaks or pressure changes that could affect the operating condition of the hydraulic system.

The hydraulic system is designed to work in a set pressure range so the gauge must be rated for that range. Hydraulic pressure gauges are available to measure up to 10,000 psi, although maximum hydraulic pressure is typically in the 3,000 to 5,000 psi range. Hydraulic gauges are often installed at or near the pump's pressure port for indication of system pressure, but can be installed anywhere on the machine where pressure needs to be monitored—especially if sub-circuits operate at a pressure rate different from pump pressure, such as after a reducing valve. Often, pressure-reducing valves have a gauge port to tap into, allowing you to directly monitor its downstream pressure setting.

Air Pressure Gauges

Pneumatic and compressed air systems are also rife with gauges, as pressure is also measured in many locations throughout the system. Pressure is measured at the receiver(s), as well as at every FRL or stand-alone regulator in the system. Sometimes pressure is measured at pneumatic actuators as well. Typically, pneumatic pressure gauges are rated for not much more than 300 psi, although typical systems run around 100 psi.

Pressure is measured in three ways—absolute, gauge and vacuum. Absolute pressure is a measure of actual pressure including ambient air, which is zero-referenced with a perfect vacuum, but can be as high as 14.7 psi at sea level. Absolute pressure readings are considered in applications interacting with ambient air, such as the compression ratio calculation for flow (cfm) requirements. Gauge pressure is zero-referenced against ambient pressure and is used in most applications operating in, but not with, ambient air, such as in fluid power systems. Disconnected from equipment, gauge pressure will read zero. Finally vacuum “pressure” is expressed in Torr, or referenced against ambient pressure, as with “in.-Hg” (inches of mercury) units, which measures pressure below ambient.

- **<u>Explain how to monitor performance of machine:</u>**

Machine monitoring, also called predictive maintenance or condition monitoring, is the practice of monitoring electrical equipment through sensors in order to accumulate diagnostic data.

Machine condition monitoring is the process of monitoring the condition of a machine with the intent to predict mechanical wear and failure. Vibration, noise, and temperature measurements are often used as key indicators of the state of the machine.

Production Performance. Capacity of a system to meet demand for deliveries or performance.

NOTE 1 availability, deliverability or other appropriate measures can be used to express production performance.

Heavy Equipment Monitoring Solution

Heavy earth moving equipment's like excavators, cranes, bulldozers are a huge investment for any business and it's every owner's concern to keep their equipment running at optimal capacity levels. If the equipment is left idle or overused, the maintenance cost of the equipment increases resulting in an increase in operational cost and reduced ROI. MosChip's telematics solutions empower users to increase operational efficiency and decrease the operating costs of their heavy equipment fleet.

Solution Benefits

Remote monitoring:

With GeoHEMs solution, you can monitor your heavy equipment from anywhere and know which the operator is working on machinery, the actual working hours and break hours. Reduce the time & cost of sending the employees to the site for equipment monitoring with remote monitoring solution.

Improve performance

Monitoring is the first step towards tighter control and it eventually leads to an increase in the overall performance. With our GeoHEMs solution for earth moving equipment you can monitor both the productivity of the equipment.

RPM monitoring

If you want to know how the usage of your machine on the field is and if there are any sudden variations in the fuel averages, you can opt for RPM monitoring, along with the fuel monitoring option. In addition to fuel usage, you can also analyse fuel consumption against the actual RPM and ensure the excavator is operated at the right RPM in the right terrain.

Monitor Fuel Usage

Fuel costs over 60% of the total operations cost of heavy earth moving equipment. With our GeoHEMs solution, know exactly how much you are spending on fuel by having a detailed analysis of fuel used, fuel filled, and fuel removed. You don't have to depend on erroneous and sometimes dishonest manual records.

Operator Monitoring

With the help of our solution identify the operators by providing them the access cards. This helps in ensuring that only authorized personnel with the access card can operate the machines. With the access cards, detailed attendance with time-in and time-out can also be checked. The solution also provides an additional camera to ensure and cross verify that the operators do not use the proxies.

Operational Reports

Get detailed reports on operator/machinery for day-to-day monitoring, operator productivity reports, machinery productivity report, over speeding, fuel usage etc. on a daily, weekly or monthly basis.

Describe likely problems/down time to be encountered about the machine:

The term downtime is used to refer to periods when a system is unavailable. Downtime or outage duration refers to a period of time that a system fails to provide or perform its primary function. Reliability, availability, recovery, and unavailability are related concepts.

Calculate Machine Down Time :

Divide the total number of units produced by the actual operating time to get the average production rate for your equipment. Multiply the total downtime by your average production rate to find the total number of units you failed to produce during planned production hours.

Down Time Cost:

It may be due to technical failure, machine adjustment, maintenance, or non-availability of inputs such as materials, labor, power.
Average downtime is usually built into the price of goods produced, to recover its cost from the sales revenue. Opposite of uptime. Also called waiting time.

How to Reduce Excavator Downtime:

The following tips should help ensure your excavator remains functioning at an optimum level.

1. Plan a Maintenance Strategy:

Unplanned maintenance leads to unplanned downtime and extra costs. The Virginia Cooperative Extension found that through maintenance, equipment repair costs could be reduced by up to 25 percent. While this is taken from an agricultural context, the concept relates closely to a construction and contracting environment — maintenance is paramount. GPS tracking technology could be a solution for improving maintenance management, as it can electronically monitor engine run time, eliminates idling and lower maintenance-related expenses.

More sophisticated machine monitoring can come in the form of telemetric, which lets you gather and analyze even more data, even more granularly. With the increasingly widespread use of telematics in the construction industry, machine maintenance strategy can be better planned for in near real time.

2. Conduct Regular Fluid Level and Filter Inspections:

Fluids such as engine oils, hydraulic fluid, grease and coolant all need to be checked according to a planned schedule. Furthermore, certain steps should be taken to make sure all members of your team are using the correct lubricants, at correct temperatures and at the correct intervals.

3. Be Vigilant About Undercarriage Inspections:

Marketing Manager for Doosan, Aaron Kleingartner, stresses the importance of undercarriage maintenance in tracked heavy equipment and asserts that, "If operators neglect to clean the undercarriage and are working in a colder climate, the mud, dirt and debris will freeze." Once that material freezes, it can start to rub on the bolts, loosen the guiding and seize up the rollers, leading to potential wear later on. Cleaning the undercarriage helps prevent unnecessary downtime."

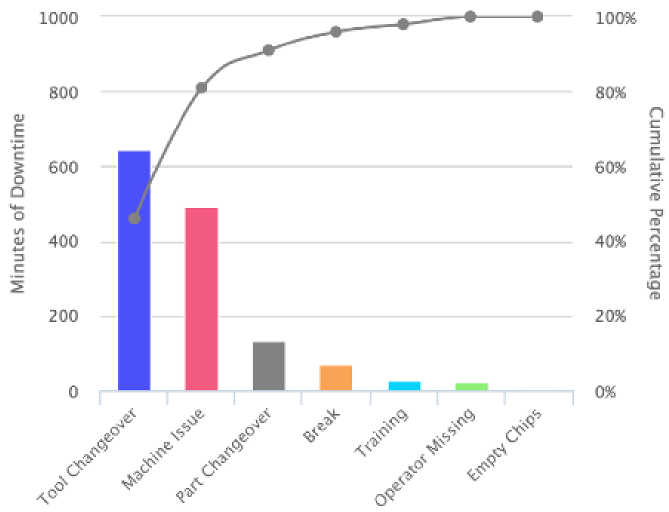
Specific attention should be focused on bolts, guiding and rollers. Excessive and uneven wear should be identified at the earliest opportunity and damaged or absent components within the undercarriage should be rectified immediately.

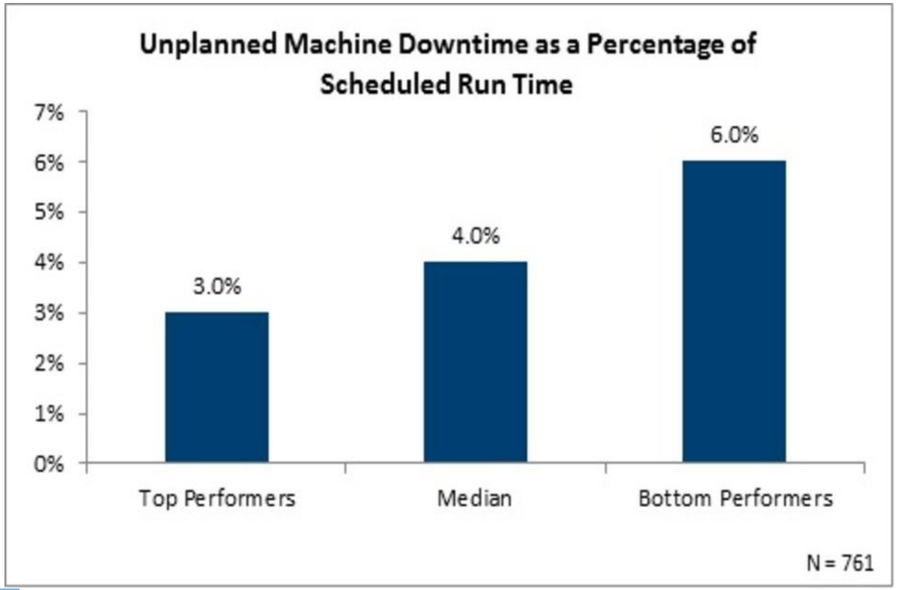
Along with cleanliness and inspection, basic principles should be adhered to, such as making wider turns, reducing time spent on slopes, avoiding harsher environments, minimizing any spinning and selecting the right shoe width.

4. Prepare Attachments in Advance:

Attachments are particularly useful and therefore need their own dedicated maintenance. Service teams should be advised to complete visual checks of cylinders, guards and all hydraulic hoses on the attachments, as these areas will be more prone to showing damage when it occurs. Furthermore, components which engage the ground, such as buckets, cutting edges or trencher teeth, are also at risk of being bent or broken.

Maintenance of your compact excavator is imperative to keep your balance sheet smooth and your clients satisfied, as unplanned downtime for your machine will lead to lost jobs and profits. Following the above tips should increase the uptime on your machine and help keep things running smoothly.





Practical Simulation:

https://www.sciencedirect.com/science/article/pii/S0888327016301881

Multiple Choice Questions

Question 1 What machine is use for excavation of land on mass scale?	A	Bull Dozer
	B	Excavator
	C	Wheel loader
	D	Grader
Question 2 What is the basic function of Excavator?	A	Create Slopes
	B	Build, excavate, and maintain haul roads and ramps
	C	Create mass Excavation
	D	All of the above
Question 3 Which 02 of the following are types of excavator?	A	Boom Excavator
	B	Wheel Excavator
	C	Crawler Excavator
	D	Articulated excavator

Question 4 What excavator is used to travel on short distances on road?

A Crawler Excavator

B Articulated excavator

C Boom excavator

D Wheel excavator

Question 5 Excavator is most useful machine because?

A It consume less fuel

B It does not require maintenance

C It is a multi-functional machine

D It is easy in operating

HEAVY MACHINE OPERATOR

Module-M

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - November, 2019

Module M: Operate Motor Grader

Objective: This module covers the skills and knowledge required to Operate Controls, Apply Grading Fundamentals, Form and handle windrows, Strip surface materials, Cut and fill material, Maintain access roads, Create slopes, Create ditches, Create shouldering, Form sub-Grade, Place aggregates to specified elevations (finish grading) and Clear snow and ice.

Duration: 110 Hours **Theory: 24 Hours** **Practice: 86 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU-1: Operate Controls	**The students will be able to** • Operate controls smoothly and safely • Operate different operating controls simultaneously as required • React to changing conditions/situations	• Define basic operating functions. • Describe different operating controls and their functions • Describe different situations which an operator can encounter under different conditions • Describe smooth and safe handling of controls	

Define basic operating functions.

There's a reason why motor graders are essential pieces of equipment for many types of businesses and industries. Whether your work involves road maintenance, commercial construction or a variety of other rugged applications, a quality motor grader helps get the job done in less time and effort and it is important to understand Motor Grader operations. You get the productivity of a powerful machine capable of operating in the most challenging work environments, with the versatility and precision to efficiently handle complex tasks.

Describe different operating controls and their functions:

The graders in this series have ten levers with which the three tools; front blade, main blade and ripper are controlled.

Steering Control:

Motor Grader have many complex controls in addition to the usual controls of motor speed, gear shifting, brakes and clutch. These additional controls include front wheel tilt, blade scraping angle, blade height, blade bank cutting angle, lateral blade shift, etc. Current models of road scrapers employ six different manual controls to effect these various controls. The operation of these various controls can be accomplished while the grader is moving in a straight line even if the grade is changed, as when tapering out a ditch. However, when the path is curved it is almost impossible for the operator to manually steer and operate the six controls. As a consequence, the work is often uneven and unsatisfactory, and only the most highly trained operators can turn out acceptable work.

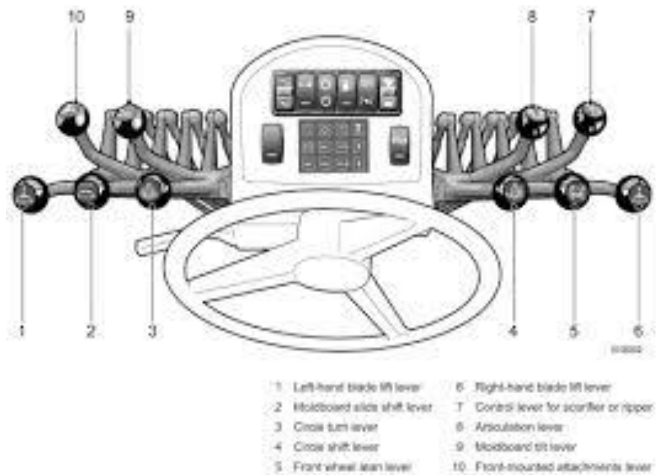
I have devised a steering system that is compatible with the six special controls, and which permits the most accurate steering even while the controls are being operated. This system basically includes steering control elements disposed one each immediately adjacent each of the six control levers or other manual control member. I prefer to have these steering control elements electrical in nature and this permits the use of punch button switches. The operator may then press a steering button with one or more fingers of the same hand that is operating one of the control levers. Control of the grading or scraping operation is assured since the operator does not have to remove his grasp of the grading controls to grab and operate a steering wheel.

It is therefore a general object of my invention to provide a steering system for road graders that can be manually operated simultaneously with manual operation of a multiplicity of manual grading controls.

Another object is to provide a road grader with a multiplicity of steering elements disposed respectively adjacent a multiplicity of grading control elements.

A further object is to provide an electrical steering control system for road scrapers, providing instant steering control.

Still another object is to provide a grader steering system having electrical switches disposed adjacent to grader controls of handy steering of a grader.



Levers Control:

The **grader** has a **lever** to lower and raise the blade for each end of its blade, so to do a complete lift or lower of the blade requires both hands to operate. **Road graders** also have a blade shift control. You can use this to position the blade how far left or right it is needed.

Practical Simulation of Grader Operating, different operating controls and their function:

https://www.youtube.com/watch?v=ufy4AJ7afTo
https://www.youtube.com/watch?v=7hhVYv40cfg
https://www.youtube.com/watch?v=QRgyqFcV6vY
https://www.youtube.com/watch?v=Nv0uHHfBWXE
https://www.youtube.com/watch?v=0v9hMVIRoDQ
https://www.youtube.com/watch?v=JnkSgW86VmM
https://www.youtube.com/watch?v=VRtLoLREIis
https://www.youtube.com/watch?v=CtI_0tEL2PY
https://www.youtube.com/watch?v=WGDBhU-dUAE
https://www.youtube.com/watch?v=tFa4GDOoeko

https://www.youtube.com/watch?v=S9XZrKbpxsE
https://www.youtube.com/watch?v=ELzTAaFd6S0
https://www.cat.com/en_ID/articles/support/technology/grade-control-formotorgraderstrainingvideos.html

Different types of Graders:
https://www.youtube.com/watch?v=e0U3Wds8_7M

SAFETY TIPS:
https://www.youtube.com/watch?v=yR7Xu8I1rZk
https://www.khplant.co.za/blog/category/tips-and-maintenance?page=1 (Very informative)

It's vital for the operator to perform a basic pre-use inspection of a motor grader. Ideally, operators should also perform periodic inspections during pauses in operation during the day and after shutting down.

Routine inspections can help prolong the life of a motor grader. They ensure early detection of visible signs of wear and tear or damage. Preventive maintenance and repairs can then be performed so that minor issues aren't allowed to develop into major, costly problems.

Inspections also have another critical purpose. They help keep people, including the operator, safe by picking up any visible signs that a motor grader isn't ready or fit for immediate use.

Here we've provided a basic inspection checklist for motor graders. If the result for any step is a fail (X), it's vital to correct the issue immediately or report it to the proper authority. **Click here** to download a print-friendly PDF version of the checklist below.

Inspection activity	**Pass (*) or Fail (X)**	**Notes/ issues detected**
Walk around the motor grader, performing a visual inspection for leaks or parts that are worn, damaged or missing. (Follow with more specific checks, as detailed below).		
Check the circle drive for leaks.		
Check the blade linkage for excessive play, damage and loose or missing parts, including bolts.		
Check the cutting edge for excessive wear or damage.		

Check the condition of tyres.		
Following recommendations in the operator's manual, clean and lubricate the following components: • blade circle • cylinders • pivot points • drawbar bale. *Safety note: When working in the pivot area, always lock the safety bar. Check the area with the attachments down and cycle the steering wheel to relieve pressure in the hydraulic system.*		
Check the hydraulic system, as follows: • check for leaks by looking and listening • check for loose connections · check for lines (hoses) that are bent, kinked, damaged or rubbing against other parts • check the hydraulic oil level. *Safety note: Always ensure that the engine is off, the system isn't under pressure and the cylinders aren't under a load when checking or repairing the hydraulic system.*		
Check the level of engine oil and top up if necessary, using the correct weight of oil.		
Check the fuel level and top up if necessary.		
Check the level of coolant in the radiator and top up if necessary. Also check the radiator cap, hoses, clamps and fan belts.		

Safety note: Don't remove radiator pressure when the radiator is hot.		
Check the level of oil for the power shift transmission.		
Check for any transmission leaks.		
Check the air flow system, as follows: · check the air restriction indicator, the air cleaner and its connections • replace the air filter if necessary · dump the dust cup, if the motor grader has one.		
Drain any condensate from air tanks and fuel sight bowls.		
Check belts for tension and condition.		
Check the battery, as follows: · check that battery connections aren't loose or corroded · check the electrolyte level and add water if necessary.		
Check electrical wire connections and insulation.		
Clean the windshield and mirrors, and, once you're seated in the cab, adjust the mirrors appropriately.		
Check that all safety devices work properly.		
Check that lights work.		

Motor Grader Safety Tips

- All operators should be trained to safely and properly use the grader, and they should be familiar with (and have access to) the instruction manual
- Always perform pre- and post-operation inspections on the machine
- Never use a motor grader with damaged components, malfunctioning controls or safety features, or other problems
- Know the ground conditions in the area you're working and traveling across, and the capabilities of the machine
- Have a communication system in place between the operator and ground crew
- Use a three-point approach whenever entering or exiting the heavy equipment
- Adjust the seat for comfortable operations and buckle your safety belt
- Make sure the floors, controls, and your hands are dry and free of anything that can cause slips
- Keep all windows clean and clear of dust, dirt, and other debris that can limit visibility
- Stay alert to all surroundings while operating a grader
- Watch out for overhead wires and other potential overhead hazards, as well as hazards in your path
- Maintain a safe, slow speed, especially around foot traffic and busy areas of the construction site
- Keep the motor grader in gear and at a safe speed when going down a hill or grade
- Work at reduced speed on grades and rough terrain
- Avoid turning on a slope
- Never drive along a ditch or excavation
- Yield the right-of-way to loaded heavy equipment and vehicles
- Check and double check behind you before backing up
- Mark each end of the moldboard with a colored flag while grading
- Use flashing safety lights while grading
- If the blade is carried or engaged at a sharp angle, be careful of puncturing the tire when articulating
- Park the motor grader on a level surface whenever possible and engage the hand brake; securely block the wheels when parking on a sloped surface
- Center and lock the blade when parking the machine
- Ground the blade whenever you leave the grader unattended
- Graders are single-person machines; nobody should ever ride along inside or on it
- Nobody should ever work beneath a raised blade
- Don't wear loose clothing, as it's a hazard around machines with moving parts
- Have all motor grader maintenance and repairs performed by qualified professionals
  - Job sites are, by nature, potentially hazardous to people and property, especially when there's **heavy machinery** and moving equipment – including motor graders – operating on site. Unfortunately, accidents can happen.

Types of job site accidents

- People on the ground or alighting from vehicles can be struck by the mouldboard, blade or grader itself, or crushed between the machine and an immovable object.

- Graders can collide with dump trucks, excavators, concrete mixers or other heavy-duty vehicles, machines and equipment typically used in road works or on construction sites.
- Contact with exposed power lines or electrical wiring can result in electrocution and associated second- or third-degree burns.
- Poor operating techniques may cause a grader to tip over, injuring or crushing the operator or others in the immediate vicinity.
- Although not all accidents can be anticipated and prevented, there are ways to maximise motor grader **safety on the job site** – before, during and after operation.

Motor grader safety tips: before operation

- It's essential to inspect a motor grader and the surrounding area properly to ensure that the machine can be operated safely.
- Every employer may require a slightly different inspection process, but certain, basic steps are always recommended. We offer this printable **motor grader inspection checklist** as an example of key steps for an operator to take.
- As part of a structured inspection process, check that all the components, operator controls and safety features are functioning as they should. If you detect any abnormalities, avoid using the machine until it has been repaired by someone suitably qualified and verified as safe to operate.
- Spend some time evaluating the work area, taking the types of surfaces, clearances and weight limitations into account. Assess exactly how to get the grader to the job site, and whether there are any potential hazards to consider en route.
- Clear the cab of any debris, and make sure the windows are free of dirt and dust. It's vital to have an unimpaired view of your surroundings, to the back, sides and front.
- Ensure you are seated comfortably, securely belted in and wearing the appropriate safety gear, as advised by your employer.
- Start the machine, and move the **blade** up and down, and left to right, and listen for any unusual vibrations or noises. These could alert you to possible defects.

Top tips for safe motor grader operation

- It's important to be fully alert and aware of other vehicles, people, surface conditions and overhead power lines when operating any heavy machinery.
- Drive at a slow, safe speed with the hazard lights on, especially in high traffic areas. Always use flashing lights and red flags attached to the mouldboard when grading.
- Reduce speed and keep the grader in gear when travelling over rough, uneven terrain, or on grades and hills.
- Avoid turning on a slope, when the vehicle is potentially unstable, and always double-check the area behind you, including your blind spots, before reversing the vehicle.

Best practice motor grader safety: after operation

- Once a grading job is complete, park the motor grader on a level surface and engage the hand brake. When parking on a slight incline or decline is unavoidable, block each wheel securely.

- Centre and lower the blade to the ground, lock it in place and remove the key from the ignition. Finally, perform any post-operation inspection steps required at your work site.

LU2. Apply Grading Fundamentals	**The students will be able to** • Apply wheel lean control • Apply frame articulation fundamentals • Select gear and engine speed • Apply grading tips Stockpile waste materials.	• Describe wheel lean control • Describe how to apply frame articulation fundamentals • Explain selection of gear and engine speed • Describe grading points	

Describe wheel lean control:

The precise origin of the pull grader has been lost to history. The first graders were simply dragged along the ground, and the first wheeled pull graders consisted of a fixed blade attached to the frame of a wagon. These blades could be raised or lowered by levers, but not angled, and the wheels were rigidly attached to the vehicle's frame. If the blade encountered a heavy load, the blade tended to slide away. The ability to angle the blade helped alleviate the problem but could not eliminate it.

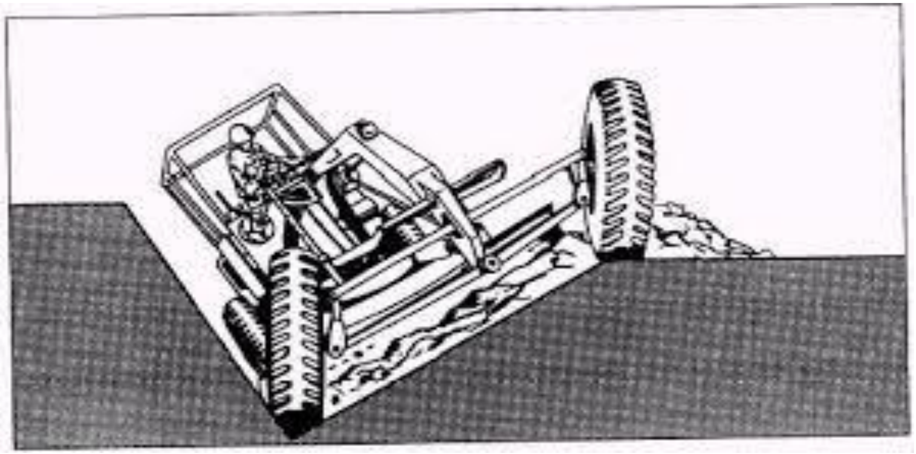
In 1885, J.D. Adams developed the leaning-wheel grader. The leaning wheel, combined with an angled blade, increased the grader's ability to excavate and move material in a specific direction. Adams sales literature explained the principle in the early 1900s:

"In considering the working principle of a grader, it is necessary to realize first that a grader's work is to move earth sideways and usually uphill. Thus, the load is a side-load.

"The man pushing the wheelbarrow leans toward and balances his weight against the load, because that is the natural way to move it with the least effort.

"That is the principle on which Adams Graders operate. They have Adjustable Leaning Wheels [that] the operator can lean in either direction to lean the weight of the grader toward and balance the weight against the side load of earth on the blade—the heavier the load, the more the operator leans the wheels and weight of the machine."

Although leaning wheels were eventually offered by most manufacturers, there was at least one exception. C.D. Edwards Manufacturing proclaimed in bold type in a circa 1924 catalogue, "Edwards graders are built with rigid wheels." Edwards claimed that leaning wheels were needed only to correct for imbalanced design, and that the perfect balance of their graders held them against the load. Edwards went so far as to say that the perfectly balanced straight-wheel grader was "the greatest development and stride forward over the adjustable wheel." Almost a century later, Adams' principle lives on.

Describe how to apply frame articulation fundamentals:

Introducing frame articulation:

The machine could operate more efficiently, especially in confined areas, than any previously built grader. The two steering methods combined let drivers “crab steer”, allowing for completely new uses.

Uses front and frame steering. As it gives the shortest turn radius, it’s good for close work, like in corners and cul-de-sacs. For constructing V ditches, spreading materials or operating in small areas, for short turns, V-ditch construction, spreading material and cutting high banks. If you want to change the cutting width of the moldboard and lessen blade loads without using the circle, this is the mode to use.

In 1885, “Little Wonder,” the first motor grader, was developed by JD Adams. It was a two-wheel horse-drawn grader, simple by today’s standards but the first real precursor to the earth-moving giants we know today.

Introducing frame articulation:

In 1967, the construction world was awed by the JD570, developed by John Deere. In addition to front-wheel steering, the JD570 featured frame articulation. The machine could operate more efficiently, especially in confined areas, than any previously built grader.

The two steering methods combined let drivers “crab steer”, allowing for completely new uses. The grader’s front wheels could be articulated to move on slopes, on windrows and in ditches, while the back wheels stayed on solid footing.

For steering, articulation helps operators greatly. Follow these steps:

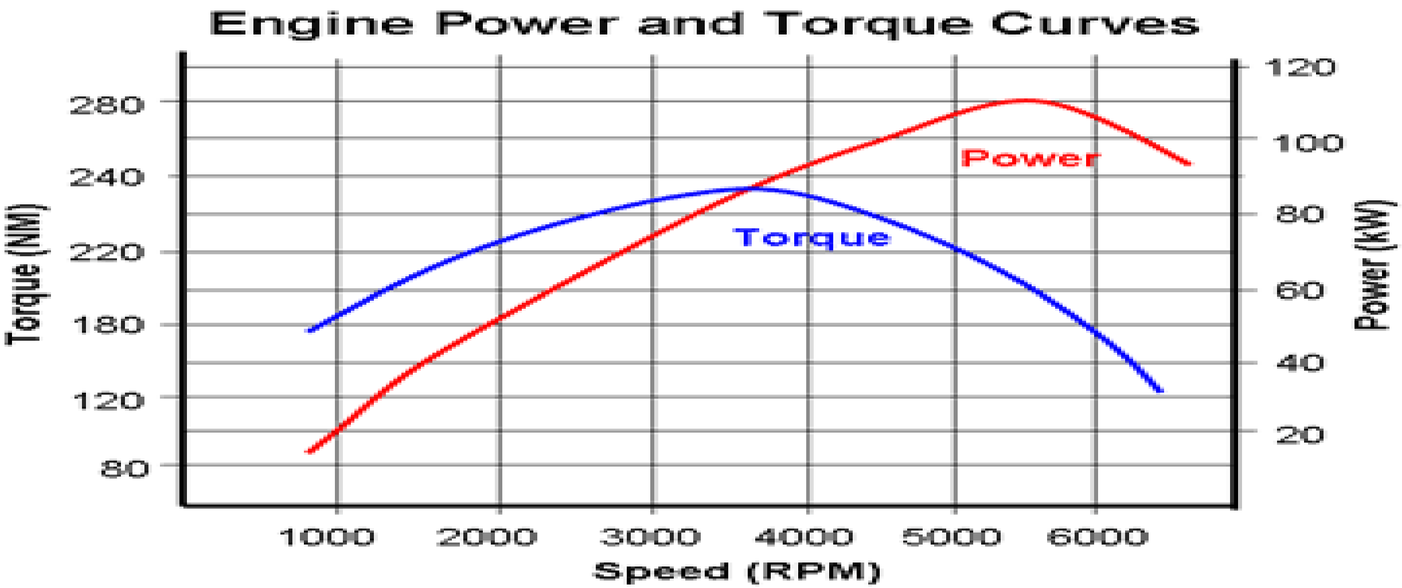
- Go into articulated mode.
- To steer left or right, have the rear module on centre. Without moving the steering wheel, articulate the rear module sharply.
- When turning, lean the wheels. This will decrease the turning radius.
- For turning right, lean the wheels to the right and articulate to the right. Vice versa for turning left.
- Finally, note that there's a tendency for the front of the machine to veer out of line. If this occurs, articulate the rear module in the opposite direction until the veering is corrected. Then hold the machine in line, keeping an eye on both the tires and the heel of the blade.



<u>Explain selection of gear and engine speed:</u>

To improve the fuel consumption of a motor grader, a method for shifting the power curve of the grader engine is proposed. The working principle, calculation method, and design procedure of the novel method are depicted. Considering the nonlinear and time-varying uncertainty of the load of a motor grader, the fuzzy adaptive control is provided to shift the power curve. The shifting action is decided by the gears and the corresponding engine speed together with the displacements of both the hydraulic pump and motor. As a result, the power line adapts to the frequent changes in different external loads. A prototype motor grader is developed to test the above-mentioned energy conservation method in different working conditions. The results show that the fuel consumption of the prototype motor is reduced by 23%–34% and the skip ratio is decreased by 10% compared with the traditional grader with only one power curve. The proposed shifting power curve method can be widely applied to other heavy-load construction machinery also.

With ever-increasing concerns on the energy diversification and environmental protection, the energy conservation technology has been widely used in automobile industry, such as a hybrid electric vehicle. As we know, the power of a construction machine is at least twice more than that of an automobile, for instance, the engine power of a 190HP motor grader is 142 kW and that of a Toyota Pries is only 73 kW, which considers both the engine and the electric motor. So, the energy conservation technology for a motor grader is much more important than an automobile. A motor grader, also known as a road grader, patrol, or maintainer, is a piece of heavy machinery used to create a smooth, wide, flat surface. Statistics data show that the fuel consumption takes up around 40% of the whole life cycle cost of the grader.



Describe grading points:

Previously, engineers more commonly used dozers for grading. However, due to the improved quality of the surface finish and faster grading process, the demand for motor graders has increased. For achieving specific grade results, you have to make sure that the turning circle and blade lift contact points are appropriately adjusted. Any improper adjustment will lead to some significant issues. Hence, maintaining motor graders for excellent accuracy is essential.

In recent years, grade control systems for motor graders, crawler dozers and excavators have revolutionised construction. This new technology increases grading accuracy and job efficiency by combining digital design data with in-cab guidance features.

Although this innovation does not come cheap, it's estimated that making use of a grade control system can increase productivity by up to 40 percent. It may also significantly reduce material, equipment and labour costs. Here's how you can maintain your motor grader.

1: Observe the circle and moldboard system:

Some of the essential components to sustain in a motor grader are as follows

- The circle and moldboard system
- Circle wear insects
- Cylinder ball joint shims
- Moldboard cutting edges
- Circle and pinion teeth

- Moldboard pivot joint
- Saddle assembly

Not appropriately maintaining these components can cause harm in the long run. Hence, it is highly recommended that at the end of the day, the turning circle, lift cylinders, and moldboard slide needs to be inspected for play.

2: Pay attention to the cutting edge

The cutting edge helps **motor graders** maintain its exceptional accuracy. Thus, you should replace it in case it is unevenly worn out. Cutting edges can also wear out irregularly from the middle and the corners, thus creating a rough surface.

It is, however, noteworthy that you should replace the cutting edge before it wears out on the moldboard bottom. The life expectancy of any cutting edge is dependent on how it is operated, blade down pressure, and how rough the material is.

3: Focus on the tires and drivetrain:

The tires and drivetrain play a vital role in achieving fine accuracy. Different tire pressure impacts the ability of your motor grader to reach its final grade. Hence, all tires need to have equal pressure. Inconsistent tire pressure can affect traction and machine response.

On the other hand, the most crucial thing in the drivetrain is to have a selection of ratios in the working range of the machine.

4: Utilize the available technology:

Nowadays, motor graders can be tailored for maximum productivity. Just having a basic understanding of the motor graders is not sufficient. Hence, you also need to understand the working of motor graders. Lack of knowledge can lead to more issues, further failing the machinery to accomplish its said purpose.

Purchasing high-quality motor grader equipment is essential. IB Store One offers motor graders with top-class controls, advanced electronics, hydraulics, and maximum productivity. Moreover, you can either choose to buy a new motor grader for your next project or rent it whenever necessary.

Grade control systems

2D and 3D machine guidance systems are in-cab technology designed for fine grading work. These sophisticated systems make use of sensors, lasers and transmitters to improve the efficiency, accuracy and productivity of motor graders, excavators and crawler dozers.

The choice of a 2D or 3D grade control system depends on the nature of the job-site. As grade control systems are designed to be user-friendly and are easily upgradable, operators can first familiarise themselves with a 2D system in preparation for the upgrade to a 3D grade control system.

2D grade control systems

A 2D grade control system gives the operator the precise vertical guidance necessary to achieve tight tolerances and a smooth finished grade on a single plane (either flat or slightly sloping surfaces).

The system uses lasers, angle sensors and rotational sensors to measure the lift, tilt and cross slope of either side of the blade, and uses a laser receiver for elevation control. This ensures 3-5 mm vertical accuracies and virtually removes the need for physical references (such as stakes).

3D grade control systems

A 3D grade control system uses elevation coordinates set up around the jobsite to grade valleys, ditches and contours more accurately and efficiently. The system uses design data loaded onto the machine's on-board computer and real-time GPS signals to calculate an accurate cutting-edge position.

The system then compares this data to the input design elevations to display cut-and-fill information. This means that the operator will use accurate design data, rather than potentially flawed reference points to complete the job.

As a result, the machine operator can complete a job without supervision and site design knowledge. The system is compatible with 3D design files from a broad range of design suites.

Aside from displaying multiple views of the different design target layers, a 3D system also records data on the progress and quality of the grade or excavation, and can transmit live point data, machine diagnostics and jobsite progress to an office computer.

Potential benefits of grade control systems

Improved accuracy

Grade control systems calculate more accurate estimates and provide exceptional grading accuracy. This eliminates grading errors and reduces the number of passes required.

Improved efficiency

Grade control systems eliminate the need for on-site reference points. As a result, the operator does not need to exit the cab to position or reposition references, allowing jobs to be completed more efficiently.

Reduced material and equipment costs

A grade control system will pay for itself over time by providing greater accuracy and savings on materials and equipment.

For example, mobilising a site for development without grade control requires two dozers, two articulated dump trucks, one excavator and one tractor. While with grade control, contractors only need one grade control-enabled dozer, two articulated dump trucks, one excavator and one tractor.

Reduced labour cost

When grade control systems are used, fewer people are needed on the ground. For example, without grade control, a cut-and-fill assignment typically requires one labourer and six operators. With grade control, the job requires no labourer and, on average, only five operators.

In addition, the use of a grade control system removes the need for a third-party surveyor – the technology performs this individual's function.

Improved site safety

All in all, having fewer people on the ground increases the safety of a job site.

Reduced need for highly skilled operators

With the use of a grade control system, operators do not need the same level of skill as when operating machinery without grade control. Therefore, grade control allows less-experienced operators to perform the tasks of highly skilled operators.

Motor grader maintenance tips

Motor graders are the stalwarts of the construction process. Given that these heavy-duty machines do the hard work, they need to be looked after so that they continue to perform optimally.

The entire motor grader machine is developed around its blade, or moldboard, and its precise movement – from the turntable and frame, to the hydraulic cylinders and gears. All these parts need to be well maintained.

In general, you should follow the manufacturer's guidelines for checking parts and getting them serviced, and don't overlook the basics, such as the fan belt, engine oil and battery contacts.

The blade/moldboard

This is the part that engages directly with the soil, so special attention needs to be given to its cutting edge.

Wear and tear on the cutting blade, or blades, attached to the moldboard is high, especially if the blade is pitched back, rather than at right angles. For this reason, blades need to be inspected and replaced regularly – in some instances, even per day. Depending on the surface being prepared, blades should be checked after every 25 to 50 hours of operation.

If the blade gets too worn down before it's replaced, the moldboard will be compromised. If you fail to maintain the blade's edges and the bolts that keep them in place, you may end up needing to replace the moldboard.

Blade slide and turntable

The blade slide allows the moldboard to move on a swivel track, and it should be checked every month or so. The bronze or metal shim glides that control the blade slide's movement can also wear down.

Fortunately, removing and replacing the glides, which are situated on four different points and should all be replaced simultaneously, is a quick and easy process. To ensure your machine gives you the fine cut you want, the brushings in the slide also can't give too much play. If the slide's movement is too loose, the clevis pins keeping it in place need to be replaced.

Air filters

If dirt clogs your machine's air filters, their efficacy will be compromised and the motor grader will consume more fuel.

Check your air filters as per manufacturer recommendations and keep an eye on the "restricted alert" signal, if your machine has one, which alerts you to problems with airflow. Pre-filters do a good job of reducing the amount of dirt that enters the air filter, so they can be fitted to prevent you having to change the air filter as often.

Scarifiers

Standard on some machines and optional on others, these lessen the work of the moldboard for rough grading or cut-outs. The "teeth" of the scarifier shouldn't wear down to the point of reaching the scarifier shank, or pocket. If that happens, you'll have to replace the shank − a far costlier task than replacing the teeth.

Operator station and controls

To ensure precision and operator safety, the seatbelt, floor mat and handles need to be checked regularly. Loose blade handles will also make jobs more difficult, especially where precise work is called for.

Tyres

Tyre traction affects the machine's grade, so tyre pressure needs to be carefully monitored. The tyre tread is also essential to the machine getting "good bite" on the ground. A half-inch deep is the absolute minimum for a grader's tyre tread.

In addition to the points above, general maintenance includes keeping an eye on the hydraulic cylinder; checking all seals; greasing and lubricating; and regularly checking for any suspicious leaks or drips.

Motor graders are sophisticated machines equipped to handle tough conditions, but they need to be operated properly and optimally. Beginner users, and even experienced operators, should take note of the proper procedures for operating them.

To begin, how should you start and shut down the machine? Here's a basic guide.

Starting up your motor grader

Make sure all your pre-start procedures have been followed. These include checking for any defects or potential problems while you grease the machine. Do any parts seem worn or broken? Are there any leaks? Check the fuel, coolant and oil levels; the power-steering reservoir and power-shift transmissions. Make sure you've done all the checks suggested in the Operator's manual. Then you're ready to start.

In neutral and with the parking brake on, open the throttle to a quarter and turn the starter. Depress the clutch to ease the starter load, and don't press on the starter for more than 30 seconds. If you do, you may need to wait a couple minutes before using the starter again.

Once the motor has started, idle for a few minutes as you check the gauges. Are all of them operating? Then check the controls, giving the hydraulic oil some time to warm up.

Shutting down the motor grader

When it comes time to shut down the machine, give it a few minutes to cool down. Two to three minutes should do it. Make sure you park the machine as near to level as possible, lower all hydraulic equipment to the ground and set the parking brake.

Once the machine is off, walk around the machine looking for any leaks (such as leaks in the hydraulic system hose or connections; fuel, coolant, grease or oil leaks) or loose, worn parts.

Finally, use the following checklist as part of your post-shutdown quality check:

- check for blade wear and tear (they should be wearing straight, not cupped in the middle)

- check the levels of the oil, coolant, fuel
- check for any dirt or mix that should be cleaned to prevent hindrances to the sliding surface, lubrication point or pivot setting.

Practical Simulations:

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

LU3. Form and handle windrows	**The students will be able to** • Choose gear and engine speed • Choose blade position • Cut material to form a windrow • Move material back over area	• Describe positions of blade for different tasks • Describe how to form a windrow and how to move material back	

Describe positions of blade for different tasks:

Motor grader also named as road grader is a self-propelled machine with an adjustable blade. Position of blade is between the front and rear axle. That blade is most commonly used for cutting, spreading and leveling of material.

Windrowing Position:

A windrow is a long ridge of loose material, for example on the edge of a dirt road or newly graded earthworks. It may also consist of road-building material laid down for collection by a paving machine.

As for most tasks you might perform using a motor grader, nothing beats experience – especially experience with a particular grader and given similar conditions to those you'll be facing during a new task.

However, there are some basic windrowing tips and tricks for operators to keep in mind.

A basic procedure for windrowing includes the following steps:

- position the motor grader squarely in front of the material to be cut
- ensure that the grader's blade is sharp and position the blade's toe behind the grader's right front tyre; for windrowing, it's best to keep a tight toe and loose heel
- slide the blade shift so that the heel of the blade is clear of the grader's left tandem drive wheel, to avoid driving over windrow
- lower the blade to begin cutting and drive the grader slowly, steadily and accurately along the required course; the material that spills off the blade will form a windrow
- once you reach the end of the material to be cut, raise the blade, stop the grader and carefully reverse, looking behind you, to the starting point
- move the grader slightly to the side of the previous window; on the relevant side, the grader's front tyre should be aligned right alongside the previous windrow

- lower the blade and make a light grading pass, watching that material flows freely off the blade and into the appropriate position.

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- move the grader slightly to the side of the previous window; on the relevant side, the grader's front tyre should be aligned right alongside the previous windrow
- lower the blade and make a light grading pass, watching that material flows freely off the blade and into the appropriate position.

As a windrow builds in size, it may be necessary to lean the tops of the motor grader's front tyres toward the windrow, to counteract any side drift that could pull the grader off course. A windrow is a long ridge of loose material, for example on the edge of a dirt road or newly graded earthworks. It may also consist of road-building material laid down for collection by a paving machine.

For motor grader operators, neat, even windrowing is something of an art. The video shows how it's done, in this case using a Caterpillar 140H motor grader.

However, be careful not to overload the grader or make the tyres spin, and remember that leaning the wheels also lowers the blade. If necessary, rather perform multiple passes, continuing until the windrow is the required size.

1) **Snow Removing Position:**

Motor graders have long been recognized as excellent tools for snow plowing. The introduction of high speed hydraulics and frame steering has made the motor grader even more productive in this application.

In addition to the standard moldboard, a grader can be equipped with a number of attachments to aid snow removal including snow wings, V Plows and straight blades.

Snow plowing techniques and the type of plowing equipment mounted on the motor grader vary greatly in different areas due to:

- Terrain
- Type of snow and its moisture content

- Depth of snowfall normally expected
- Normal wind velocity that can cause extremely tight drifting
- Length of time after the snowfall before plowing was started
- The amount of melting that has occurred
- Amount of dirt mixed with snow

A major factor is traction. Snow plowing usually occurs under poor traction conditions which often require different operating techniques and the use of tire chains. In snowplowing, operating speeds are normally higher than in earthmoving work. Normal work speeds are in the 5 to 20 mph range. The moldboard should be tipped well forward to prevent damage to the machine and road surface. This allows the cutting edge to ride over rather than try to cut minor obstructions, and may prevent operator injury, cutting edge breakage or machine damage.

When plowing snow, safety must always be your primary consideration. Objects can be hidden under the snow so wear your seat belt. Put a standard circle slip clutch attachment on the machine to prevent possible operator injury or machine damage. For safety, work in the direction of traffic when possible. Before moving or reversing the machine, check all directions to assure there are no people or vehicles in your path.

Blade float is frequently used in snow plowing work. This allows the blade to follow a varying surface using only the weight of the drawbar, circle and moldboard. Blade float prevents damage to uneven surfaces but requires a hard surface such as asphalt or frozen ground to prevent gouging the surface. In areas with loose gravel on the road surface, using blade float may windrow the gravel onto the road shoulder.

Motor graders provide the power and operator comfort you need to clear long stretches of road in a variety of conditions.

Snow Removal

1. Follow pre-start inspection procedures.

2. Review Operator's Manual or specific instructions.

Caution: Steps and irons could have ice on them.

3. Mount motor grader, using steps and grabbing irons.

4. Sit in operator's seat and secure seat belt.

5. Follow procedure for starting engine; allow proper warm up.

6. Check all gauges and controls for proper functioning.

7. Set engine-speed control as suggested in the Operator's Manual.

8. Position gearshift lever in proper gear.

9. Raise all implements.

10. Release the parking brake; proceed to work area.

11. Downshift to working speed.

12. Pitch moldboard forward.

13. Rotate circle to sidecast material.

14. Line up left front wheel of motor grader on center line of road.

15. Lean wheels in direction of sidecast snow.

16. Lower blade to touch pavement.

NOTE: Excessive down pressure reduces steering and traction.

17. Continue removing snow until destination is reached.

NOTE: Check blade wear frequently during operation to prevent moldboard damage.

18. Raise blade and turn machine around.

19. Reposition motor grader on opposite side of road for return pass.

20. Line up left side, placing wheel on grade area.
21. Lower blade to pavement and continue snow removal while making any adjustments necessary to avoid scarring road.

Finishing Operation Position:

To cut hard material or for finishing work, tip the moldboard further forward than the start position. When finishing, tip the moldboard top 4 to 5 inches ahead of the cutting edge so the cutting edge is approximately 90 degrees to the cut surface. This moldboard tip position will generally position the drawbar parallel to the finished grade. As always, road conditions and your fleet are factors in your agency’s road maintenance practices.

Ditch Making Position:

One of the important earth-moving jobs a motor grader is used for is cutting ditches. To do this well, an operator needs to know how to create proper crowns and slopes, and to be experienced in using a motor grader's features.

Ditch slopes should vary according to soil type, the gravel used, expected rainfall in the region and and so on. However, certain standard best practices are the same for cutting all ditches.

The basics: getting started

To start, lay out a line marked with visible stakes to help guide you to cut straight. Move the blade at a sharp angle, so its leading edge (toe) is pulled tight behind the front wheel and its heel is raised.

Now you're ready to do the marker pass. Drive along the line you've set out, cutting out about two to four centimetres. Take it easy – if you cut away too much at this point, you may run into steering trouble.

Keep the setting the same, but include the front wheel in the marker cut, with a bit of load on the machine to do the next pass. You should do this pass in first gear.

Next, for the material to be delivered on the outside of the wheels, tighten the blade on both ends. Straddle the windrow so it can be shifted from the bank of the ditch, rather than allowing it to become difficult to manage.

Deeper ditches will require that you repeat these steps, minus the marker pass one. To maintain a straight ditch, have the front wheels lean up the slope.

Ditch Construction

1. Follow pre-start inspection procedures.

2. Review Operator's Manual or specific instructions.

3. Mount motor grader, using steps and grabbing irons.

4. Sit in operator's seat and secure seat belt.

5. Follow procedure for starting engine; allow proper warm up.

6. Check all gauges and controls for proper functioning.

7. Set engine-speed control as suggested in the Operator's Manual.

8. Position gearshift lever in proper gear.

9. Raise all implements.

10. Release the parking brake; proceed to work area.

1 1 . Operate side shift to extreme left.

NOTE: With an articulated motor grader, articulate so that tandems run outside of the "V" where traction is better.

12. For cutting a ditch on the side of road, move in the same direction as the

traffic. Rotate circle until toe of blade is directly behind right front wheel.

13. Raise left lift cylinder to full up.

14. Lower right blade-lift cylinder to set blade tip for desired depth of cut.

15. Lean front wheels to left and make a 4 inch to 5 inch cut.

NOTE: Leaning will counteract side drift of blade. Keep blade toe in line with outside edge of lead tire while maintaining a straight line.

16. Continue cutting to desired depth, keeping front tire in bottom of ditch.

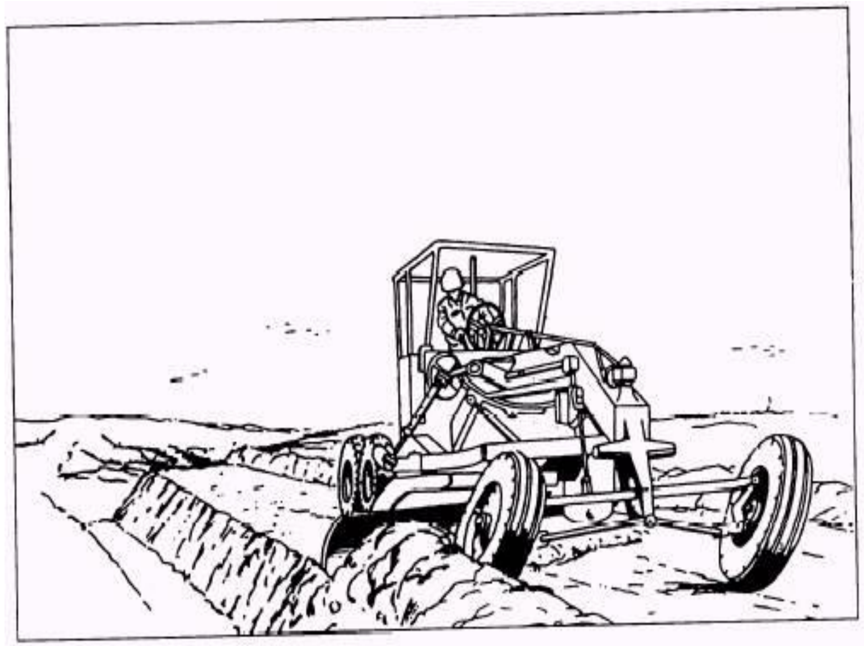
NOTE: Each ditch cut should be made as deep as possible with blade toe in line with center of lead tire, and without stalling grader.

17. Continue ditching and bringing successive cuts in from the edge of the

bank slope; blade toe will be in line with bottom of ditch on final cut.

18. Move motor grader off pavement to a safe level parking place.

19. Set the emergency brake.



Describe how to form a windrow and how to move material back:

Windrowing tips

As for most tasks you might perform using a motor grader, nothing beats experience – especially experience with a particular grader and given similar conditions to those you'll be facing during a new task.

However, there are some basic windrowing tips and tricks for operators to keep in mind.

A basic procedure for windrowing includes the following steps:

- position the motor grader squarely in front of the material to be cut
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- lower the blade to begin cutting and drive the grader slowly, steadily and accurately along the required course; the material that spills off the blade will form a windrow
- once you reach the end of the material to be cut, raise the blade, stop the grader and carefully reverse, looking behind you, to the starting point
- move the grader slightly to the side of the previous window; on the relevant side, the grader's front tyre should be aligned right alongside the previous windrow
- lower the blade and make a light grading pass, watching that material flows freely off the blade and into the appropriate position.

As a windrow builds in size, it may be necessary to lean the tops of the motor grader's front tyres toward the windrow, to counteract any side drift that could pull the grader off course.

However, be careful not to overload the grader or make the tyres spin, and remember that leaning the wheels also lowers the blade. If necessary, rather perform multiple passes, continuing until the windrow is the required size.

Practical Simulations:

https://www.youtube.com/watch?v=Z8hSPQ-gfgk
https://www.youtube.com/watch?v=jo5FI4MttsA

https://www.youtube.com/watch?v=gggvwZCjuSQ
https://www.youtube.com/watch?v=HGwdluZvCl8

LU4. Strip surface materials	**The students will be able to** • Distinguish waste layer from structural layer • Strip waste materials (usually organic) • Finish windrows of stripped material • Enter and exit machine	• Describe how to strip surface materials • Describe different layers of structures and how to distinguish between them	

Describe how to strip surface materials:

STRIPPING

Stripping consists of removing and disposing of the topsoil and sod that cannot be used as a sub grade, foundation under a fill, or borrow material. Examples of this material are organic soils, humus; peat, and muck, Unsuitable soil must be removed to a depth at which compaction and thickness requirements are satisfied. Stripping is done concurrently with clearing and grubbing by using bulldozers, graders, scrapers, and sometimes shovels. Good topsoil and sod should be stockpiled for later use on bare areas for dust or erosion control or for camouflage.

The grader is used 10 cut grass and weeds, remove small brush, and clear the area of dead vegetation. The terrain must be level and free from boulders and trees. Used with rippers and bulldozers, graders can windrow the cleared material for later removal by other equipment. The grader is extremely limited in most clearing operations.




Practical Simulations:

https://www.youtube.com/watch?v=Bhj_fV_PAxM
https://www.youtube.com/watch?v=rMSBplDsdAQ
https://www.youtube.com/watch?v=XcOVS1idcM4
https://www.youtube.com/watch?v=SplCD8HrFwk
https://www.youtube.com/watch?v=RPWAaWFUYO4

LU5. Cut and fill material	**The students will be able to** • Estimate the height of cut and fill • Choose blade tilt, angel and	• Explain how to cut and fill material • Explain how to grade the surface • Describe tilting of blade	

	position • Cut heights • Match blade load to available power and traction • Move material to low areas • Grade area to desired profile	• Explain how to Match blade load to available power and traction	

Explain how to cut and fill material:

In earthmoving, cut and fill is the process of constructing a railway, road or canal whereby the amount of material from cuts roughly matches the amount of fill needed to make nearby embankments, so minimizing the amount of construction labor.

Cut the material:

A grader, also commonly referred to as a road grader or a motor grader, is a construction machine with a long blade used to create a flat surface during the grading process.

Graders are commonly used in the construction and maintenance of dirt roads and gravel roads. In the construction of paved roads they are used to prepare the base course to create a wide flat surface upon which to place the road surface. Graders are also used to set native soil or gravel foundation pads to finish grade prior to the construction of large buildings. Graders can produce inclined surfaces, to give cant (camber or side slope) to roads. In some countries they are used to produce drainage ditches with shallow V-shaped cross-sections on either side of highways.

To cut hard material or for finishing work, tip the moldboard further forward than the start position. When finishing, tip the moldboard top 4 to 5 inches ahead of the cutting edge so the cutting edge is approximately 90 degrees to the cut surface. This moldboard tip position will generally position the drawbar parallel to the finished grade. As always, road conditions and your fleet are factors in your agency's road maintenance practices

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope,[1] for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage. The earthworks created for such a purpose are often called the sub-grade or finished contouring.

Fill the material:

The term 'fill' refers to material used to artificially raise existing ground levels. Bulk filling materials typically include soil, rocks and aggregates and coal ash. Soil is used for example, for the formation of embankments and other areas of landscape that require fill.

There are a variety of reasons for creating fills, among them reduction of grade along a route or elevation of the route above water, swampy ground, or areas where snow drifts frequently collect. Fills can also be used to cover tree stumps, rocks, or unstable soil, in which case material with a higher bearing capacity is placed on top of the obstacle in order to carry the weight of the roadway or railway and reduce differential settlement.

One of the most common types of backfill material is coarse-grained soil. Such material often consists of sandy soil types, gravel soils, or a mixture of both gravel and sand. This filler type is ideal for areas in need of compaction and foundation support, that might also benefit from a certain amount of drainage.

1. Coarse-Grained Soil

One of the most common types of backfill material is coarse-grained soil. Such material often consists of sandy soil types, gravel soils, or a mixture of both gravel and sand. This filler type is ideal for areas in need of compaction and foundation support, that might also benefit from a certain amount of drainage.

2. Rock

Another common type of fill material is crushed rock or stone. It’s most commonly used for projects where drainage is absolutely necessary, such as in septic tanks, or dams that need to provide a certain amount of water runoff. Rock and crushed stone are also frequently used in the construction of driveways, as a compacted base. Crushed stone also makes an ideal landscaping filler, providing maximum drainage while still protecting the ground from erosion.

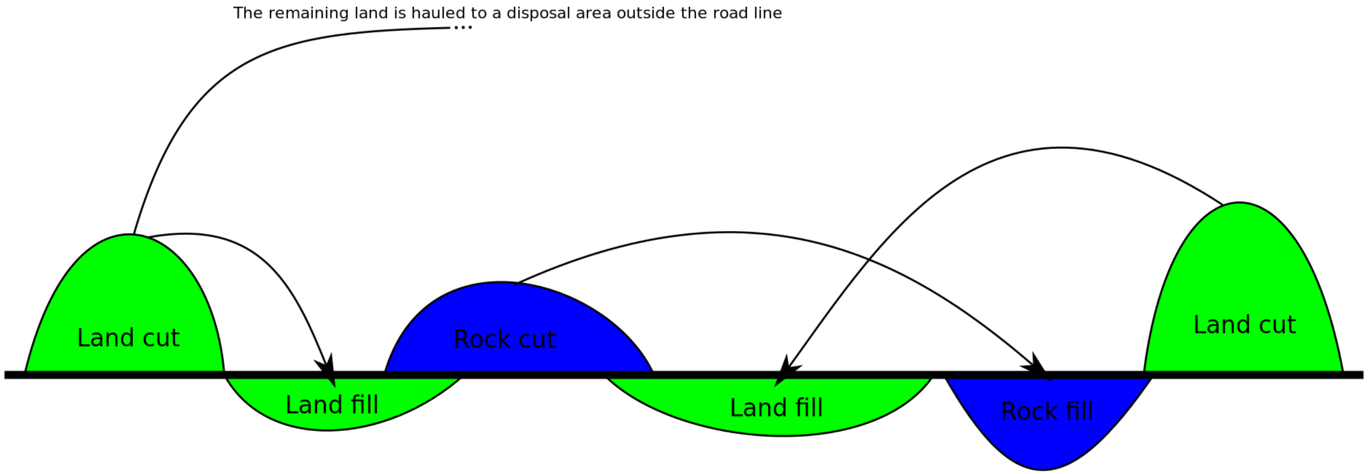
3. Fine-Grained Soil

Although not ideal for areas in need of drainage, fine-grained soil is another popular type of fill material used in construction. Since it’s much finer than other soil types, it can be easily compacted, providing a firm and solid base to build upon.

4. Commercial Byproducts

In addition to the many different filler types found in nature, there are also a few commercially made materials that may be used when natural fill material isn’t available. Slag and ash are both lightweight backfill materials that can be used in a variety of different scenarios; they can also be mixed with clay to form a highly plastic fill material.

Selecting the right type of backfill material can often be complicated, which is why the professionals from Manchester Aggregate Supply are always available to help you find a solution.

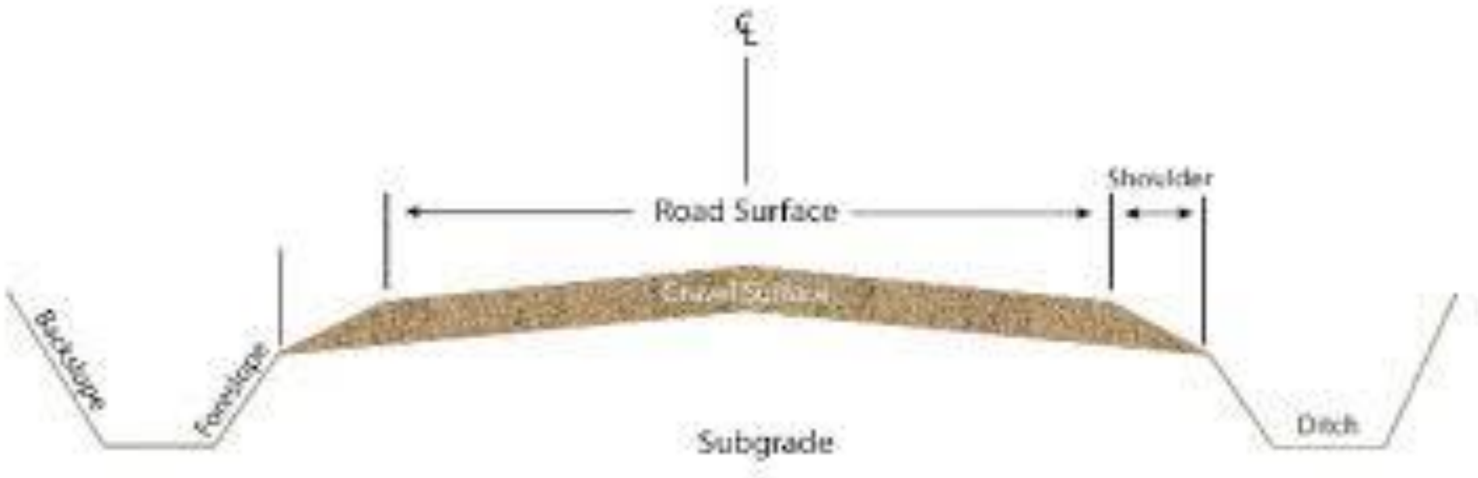

The remaining land is hauled to a disposal area outside the road line
Land cut
Rock cut
Land cut
Land fill
Land fill
Rock fill

- **<u>Explain how to grade the surface:</u>**

Grading is basic to the work of Landscape Architects concerned with design on the land. Grading is the act of altering the earth's surface by cutting and/or filling in order to provide areas for functional uses such as building platforms, recreational fields, circulqti6n, and land drainage.

Land grading — or land levelling takes place after a site has been excavated. Dirt is cut from higher spots and used to fill in low spots; thus, it is known as "cut and fill" grading. The purpose is to create a smooth landscape free of variations in elevation. This provides a level base for laying a foundation, planting cover crops, and other uses. A secondary purpose of grading services is to slope the land away from the construction site and provide adequate drainage. When construction takes place on uneven ground, water drainage is an important consideration. If the land has not been graded correctly, water won't drain properly; instead of being channelled away from the building, it could flow toward it. In such a case, during significant rainfall, water would accumulate around the building foundation, damage the cinder blocks, wash away the landscape vegetation, and pose a threat of interior flooding and water damage. Because of this, precise and reliable land grading services are crucial to any construction project. It not only assures a solid base on which to build, but it provides effective long-term water drainage and prevents damage to the topography and building.

The "rough grading" is performed by heavy equipment or engineering vehicles such as scrapers and bulldozers. A grader, also commonly referred to as a road grader or a motor grader, is a construction machine with a long blade used to create a flat surface during the grading process. Graders are commonly used in the construction and maintenance of dirt roads and gravel roads.



a alamy stock photo

CAT

- **<u>Describe tilting of blade:</u>**

The operator should also periodically change blade angles. Keeping the moldboard forward results in wear just along the front of the cutting edge. Periodically tilting it back – for example when carrying, mixing, spreading or combing material – will even out the wear across the edge, helping keep it even and sharp.

The hydraulic cylinder and piston units which have heretofore been used to control the tilt of the grader blade assembly have been subject to damage from masses of earth and rocks pushed up by the grader blade moldboard. In addition, the necessity for connecting the cylinder of a hydraulic cylinder and piston unit to the circle with the rod connected to the blade carrying means requires that the head end of the cylinder be mounted to pivot about a transverse axis, and elimination of excessively close manufacturing tolerances for such heavy equipment make it highly desirable that the head end of the cylinder be rotatable about an upright axis as well. However, double trunnion mountings are quite large and clumsy, and cannot be adequately protected against damage from dirt and dust in the very difficult environment in which such hydraulic cylinder units are used. In addition, the mounting of the tilt cylinder units on previously available motor graders has put them in such a position that very long and relatively expensive units have been required.



Explain how to Match blade load to available power and traction:

When it comes to grader productivity, what really matters is blade down pressure and blade pull force. The new G900B-Series generation of motor graders from Volvo Construction Equipment has the highest blade down pressure in each weight class, thanks to optimal overall machine balance and the distribution of the main grader components.

MATCHED PERFORMANCE/POWER:

The increased and reshaped power and torque curves of the engines have been carefully matched to meet the needs of the transmission. Volvo's eight forward gear/four reverse gear transmissions feature 'shuttle shift', a system that enables easy shifting between forward and reverse without the need to stop or use the inching pedal. Shift quality is computer controlled and transmissions provide a choice of auto shift modes and programmable target gears, allowing for optimal productivity and low fuel consumption. Auto shifting changes the gear in response to varying blade loads, resulting in less rework and longer transmission life. Smart Shift and Shuttle Shift are fitted as standard, with Smart Shift recalling the last forward or reverse gear used. Shuttle Shift allows quick direction changes, thereby reducing grader cycle times. Heavy duty inching clutches have been extensively tested. The optional transmission has more gears in a typical working range more slower gears for fine grading and more gears for fast travel, such as is needed in snow removal.

TRACTION REACTION:

Traction is dependent upon the weight over the drive wheels and the ground surface. Too much power to the back wheels when there is a lack of traction results in wheel spin, tyre wear and excess fuel usage. The engines fitted to the feature eight power curves that are based on transmission gear, to vary the power to match the level of traction available, and also optimizing the hydraulics and drive train. To improve traction, the transmission is sited ahead of the rear axle pivot point beneath the cab. This provides optimum weight distribution, assisting in blade down pressure at the front while at the same time weighing down the rear wheels and aiding drawbar pull values. Traction is further improved by an operator-controlled hydraulic differential lock system that reduces rear axle strain and tyre wear.


VOLVO
VOLVO


DEERE

Practical Simulations:

https://www.youtube.com/watch?v=Pt_1hJD4s50
https://www.youtube.com/watch?v=JiLwdiLnKWs

LU6. Maintain access roads	**The students will be able to** • Identify drainage structures, culverts and obstacles • Adjust windrow to allow traffic to continue • Choose blade position, wheel lean, articulation, gear and speed • Reshape and recover materials for the road surface • Cut shoulders and move material to center or from one side to another	• Describe drainage structures, culverts and obstacles • Explain how to reshape and recover materials for the road surface • Explain how to Cut shoulders and move material to center or from one side to another	

Describe drainage structures, culverts and obstacles:

Drainage Structures:

Drainage Structures is a system of drains (pipes, boreholes, and subterranean tunnels) intended to collect and draw off groundwater from structures. Layer drainage consists of drainpipes with filtration cushioning layers. The pipes are laid on water-resistant soil outside the structures to be protected.

The primary purpose of a road drainage system is to remove the water from the road and its surroundings. The road drainage system consists of two parts: dewatering and drainage."Runoff" covers the water flowing from the surface of the pavement via road shoulders and inner slopes to the ditches.

The primary purpose of a road drainage system is to remove the water from the road and its surroundings. The road drainage system consists of two parts: dewatering and drainage. "Dewatering" means the removal of rainwater from the surface of the road. "Drainage" on the other hand covers all the different infrastructural elements to keep the road structure dry.

4 Common Types of Drainage Patterns

Drainage patterns are classified on the basis of their form and texture. Read on to learn some common types of drainage patterns, such as: dendritic, deranged, centripetal and trellised.

Below are 4 common types of drainage patterns:

Dendrites:

A dendrites' drainage pattern is the most common form and looks like the branching pattern of tree roots. It develops in regions underlain by homogeneous material. That is, the subsurface geology has a similar resistance to weathering so there is no apparent control over the direction the tributaries take. Tributaries joining a larger stream at acute angle (less than 90 degrees).

Deranged:

Drainage patterns are found in areas recently disturbed by events like glacial activity or volcanic deposition. Over time, the stream will adjust the topography of such regions by transporting sediment to improve flow and channel pattern.

Centripetal:

The centripetal drainage pattern is just the opposite of the radial as streams flow toward a central depression. This pattern is typical in the western and south-western portions of the United States where basins exhibit interior drainage. During wetter portions of the year, these streams feed ephemeral lakes, which evaporate away during dry periods. Salt flats are created in these dry lake beds as salt dissolved in the lake water precipitates out of solution and is left behind when the water evaporates away.

Trellised:

It is a rectangular shaped drainage pattern that develops where bands of rocks vary in resistance. In some areas there are alternate bands of hard and soft rocks. The flowing water can erode the soft rocks and thus flows along the bands of soft rock. Many such water channels form a trellis. The streams (called subsequent rivers) cut out the valleys (called vales) and join the main river (called Consequent River) at right angles. The main river, by sheer force, cuts the hard rock and flows down the slope forming an escarpment and thus a river gap is created.




Culverts:

A **culvert** is a structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side. Typically embedded so as to be surrounded by soil, a culvert may be made from a pipe, reinforced concrete or other material. Culverts are commonly used both as cross-drains to relieve drainage of ditches at the roadside, and to pass water under a road at natural drainage and stream crossings. A culvert may be a bridge-like structure designed to allow vehicle or pedestrian traffic to cross over the waterway while allowing adequate passage for the water.

Culverts come in many sizes and shapes including round, elliptical, flat-bottomed, open-bottomed, pear-shaped, and box-like constructions. The culvert type and shape selection is based on a number of factors including requirements for hydraulic performance, limitations on upstream water surface elevation, and roadway embankment height.

Following are the different types of Culvert:

- Pipe culvert (single or multiple)
- Pipe-Arch culvert (single or multiple)
- Box culvert (single or multiple)
- Arch culvert.
- Bridge culvert.
- Metal box culvert.

Obstacles:

Here, obstacles are defined as actual arbitrary objects protruding from the ground plane in the road area, both static and moving ones. Road markers in the road area (e.g., pedestrian crossings) as well as a number of objects outside the road region are considered as the obstacles of no interest.

On-road obstacles detection should provide that:

1. The objects that are outside the road are eliminated.
2. Irregularities on the road surface that are not affecting the driving are not considered.
3. Static obstacles on the road are properly recognized in order to be avoided.
4. Vehicles on the road are detected in order to adjust own motion according to their relative distances and velocities.


STOP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- **Explain how to reshape and recover materials for the road surface:**

A road surface or pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway. In the past, gravel road surfaces, cobblestone and granite stets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete laid on a compacted base course. Asphalt mixtures have been used in pavement construction since the beginning of the twentieth century.

Distressed road materials can be reused when rehabilitating a roadway. The existing pavement is ground or broken up into small pieces, through a process called milling. It can then be transported to an asphalt or concrete plant and incorporated into new pavement, or recycled in place to form the base or sub base for new pavement. Some methods used include:

- Rubbishing of concrete pavement. Existing concrete pavement is broken into gravel-sized particles. Any steel reinforcing is removed, then the remaining gravel-sized particles are compacted and overlaid with asphalt pavement.
- Cold in-place recycling. Bituminous pavement is ground or milled into small particles. The asphalt millings are blended with a small amount of asphalt emulsion or foamed bitumen, paved and compacted, allowed to cure for seven to ten days, then overlaid with asphalt.
- Hot in-place recycling. Bituminous pavement is heated to 250 to 300 °F (120 to 150 °C), milled, combined with a rejuvenating agent or virgin asphalt binder, and compacted. It may then be overlaid with a new asphalt overlay. This process only recycles the top two inches (50 mm) or less, so it can be used to correct rutting, polishing or other surface defects. It is not a good procedure for roads with structural failures. It also generates high heat and vapor emissions, and may not be a good candidate for built-up areas.
- Full depth reclamation is a process which pulverizes the full thickness of the asphalt pavement and some of the underlying material to provide a uniform blend of material. A binding agent may be mixed in to form a base course for the new pavement, or it may be left unbound to form a sub base course. Common binding agents include asphalt emulsion, fly ash, Portland cement or calcium chloride. It can also be mixed with aggregate, recycled asphalt millings, or crushed Portland cement to improve the gradation of the material, and can provide a design life cycle of 30 years with proper lab testing and field verification.

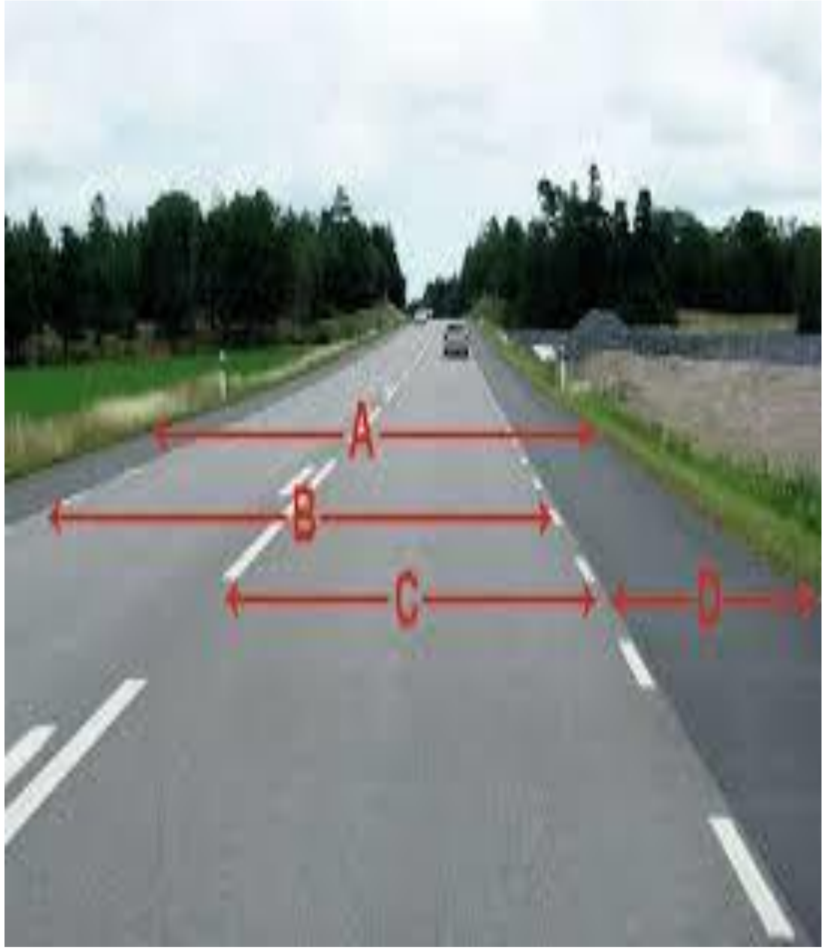
Explain how to Cut shoulders and move material to center or from one side to another

A shoulder or hard shoulder is an emergency stopping lane by the verge of a road or motorway, on the right in countries which drive on the right or on the left side in and other left-side driving countries. The shoulder is a strip of pavement outside an outer lane; it is provided for emergency use by traffic and to protect the pavement edges from traffic damage. A set of adjoining lanes and shoulders is called a roadway or carriageway.

In Civil engineering, A road shoulder is a strip of land immediately adjacent to the traffic lane of a road not bordered by kerbed & channel. The shoulder may be sealed in the case of highways and major roads, but it is typically unsealed and of a lesser depth and perhaps constructed of inferior material than the adjacent traffic lane.

- Emergency vehicles such as ambulances, fire trucks & police cars may use the shoulder to bypass traffic congestion.
- Active traffic management, used on busy multi-lane roads, may allow 'hard shoulder running' by general traffic at reduced speeds during periods of high traffic volumes.
- In some places a "bus bypass shoulder" may be provided which allows bus services to pass stationary traffic.
- Paved shoulders provide additional space should a motorist need to take evasive action (such as avoiding a wrong-way driver) or need to recover control of their vehicle before a run-off-road collision occurs.
- In some rural areas without sidewalks, pedestrians and cyclists may be allowed to walk or ride on the shoulders.
- On curbed roadways, shoulders move the gutter away from the travel lanes which reduces the risk of hydroplaning, and reduces splash and spray of stormwater onto pedestrians using any adjacent sidewalk.
- Paved shoulders move water away from the roadway before it can infiltrate into the road's subbase, increasing the life expectancy of the road surface.
- Shoulders help provide extra structural support of the roadway.
- When semi-truck drivers need sleep and there are no available parking spaces at truck stops and rest areas, either because there are no such facilities nearby or because all semi-truck parking spaces are filled to capacity, drivers may pull over to the highway shoulder and sleep in their truck cabin.
- In some countries, parking in the shoulder isn't prohibited by the law, and mushroom and berry pickers commonly use them on roads going through a forest.


SHOULDER USE
PERMITTED ON
GREEN ARROW
ONLY
Dynamic
Part-Time
Shoulder Use
General Purpose
Lanes Open
24 Hours


A
B
C
D

Gravel roads do take a fair amount of maintenance, especially in areas with heavy rainfall. Grading helps rejuvenate the road surface, eliminating problems such as corrugation and potholes.

The structure of a gravel road

The structure of a gravel road needs three basic elements in order to be suitable for ongoing maintenance. These are a crowned (canted with a sharp peak) driving surface, a shoulder that slopes away from the driving surface and a ditch on either side.

This structure ensures proper drainage and helps prevent potholes caused by standing water. Gravel roads that don't follow this basic

construction, don't perform well under the stress of constant traffic, especially heavy vehicles.

A badly graded road with potholes caused by poor drainage compared with a properly crowned road that drains well despite heavy rainfall.

The basic principles of grading a gravel road

These are some of the **things to be aware of when grading** a gravel road. Following these general principles will help maintain the integrity of the road and avoid damage to the surface.

Moldboard angle

When grading a gravel road, the ideal horizontal angle for the moldboard is between 30 and 45 degrees. This gives you the best control over the loose aggregate and makes sure it doesn't spill around the leading edge of the moldboard.

Moldboard pitch

The pitch of the moldboard is the angle that the blade edge touches the road surface at. If the pitch is too far back, the graded material won't move along the blade to the discharge end. Too far forward, and the blade won't scrape the road surface sufficiently.

Operating speed

The motor grader needs to be kept at a slow and steady pace no higher than 5-8 kph while grading. Excessive speed can lead to loping or bouncing which causes the blade to cut depressions and ridges in the road surface.

Crown

A crowned surface is necessary for drainage but if it's too high, it can lead to unsafe driving conditions. An excessive slope will cause drivers to drift towards the shoulder. 1.27 cm of crown per 30 cm on the cross slope is recommended.

Shoulder

The shoulders need to be sloped away from the crowned surface of the road to help facilitate drainage into the ditches. The area is more sloped than the crown but not so much that a vehicle could drive on it in an emergency, such as regaining control if they drift.

Ditches

The ditches on either side of the road need to be clear of debris to ensure proper drainage. The minimum recommended depth and width for these ditches is 30 cm. Areas with heavy water runoff will require larger ditches.

Potholes

In order to eliminate potholes, the road needs to be graded to the same depth as the pothole. Never fill a pothole in with loose aggregate, this won't last under traffic wear and the pothole will quickly reform.

Reconditioned graders from KH Plant

A motor grader is a worthy investment for ongoing gravel road maintenance. Brand-new graders are expensive, however, and a lot of companies might not be able to shoulder the cost.

Practical Simulations:

https://www.youtube.com/watch?v=XYaAIBE5TfE

https://www.youtube.com/watch?v=Hq5rO-8ERTc

https://www.youtube.com/watch?v=DyR-HeNsyII

https://www.youtube.com/watch?v=GHbSxLSZ-Pg

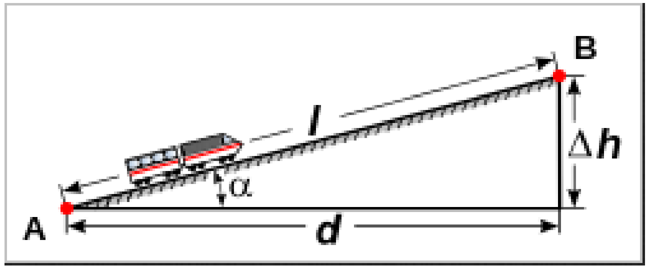
https://www.youtube.com/watch?v=X3d5QgTamME
https://www.youtube.com/watch?v=kysDqbO99N4
https://www.youtube.com/watch?v=ULe3ukFdFBY
https://www.youtube.com/watch?v=Cg6w9zC9dnM
https://www.youtube.com/watch?v=UDLRkE9D59E
https://www.youtube.com/watch?v=sK68zUMOUnc

LU7. Create slopes	**The students will be able to** • Identify required slope • Apply grade checking instruments • Choose blade position, wheel lean, articulation, gear and speed • Smooth the area at the base of the slope for smooth working platform • Start at the top of slope Shape the shoulder accurately	• Describe requirement and establishment of gradient and camber • Describe grade checking instruments • Explain how to smooth the area at the base of the slope • Explain layer by layer grading	

- **Describe requirement and establishment of gradient and camber:**

Gradient:

It is the slope provided to the surface of the road in the longitudinal direction for the vertical alignment of the road. Gradient is dependent on direction. What is uphill in one direction of travel is downhill on the other – and of course, how you deal with gradient depends on whether you are travelling uphill or downhill.

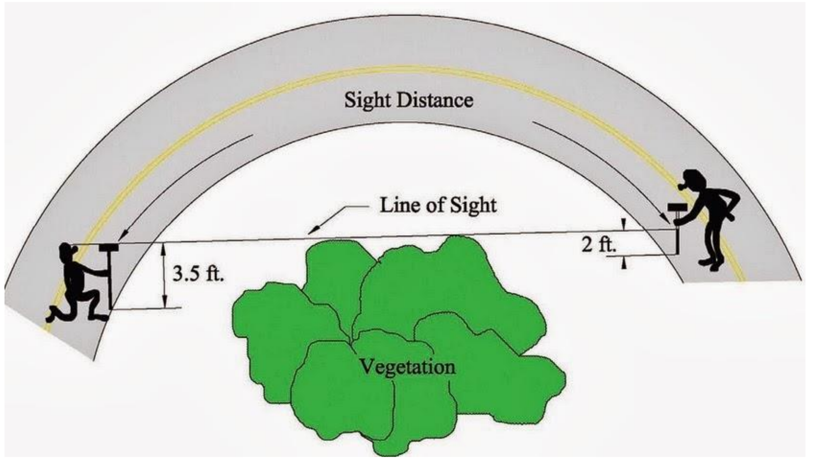


A vehicle on ascending gradient

- There are three kinds of gradients:

(a) Ruling Gradient (b) Limiting Gradient (c) Exceptional Gradient (d) Minimum Gradient.

- **Ruling gradient** is the design gradient, so it is used to design the road in the vertical alignment.
- **Limiting and exceptional gradients** are provided in the limited stretch of the roads where necessary and in case of the emergencies or exceptional cases when such need arises respectively.
- **Minimum gradient** is the gradient which is required as the minimum from the drainage point of view in case of the plane areas.
- **Sight Distance:** Sight distance at any instance is the distance along the centerline of the road which is visible to the eye of a driver at an height of 1.2 m from the road surface such that an obstruction of height 0.15 m is visible to him. The heights of the eye of the driver and the obstruction is standardized by the Indian Roads Congress.

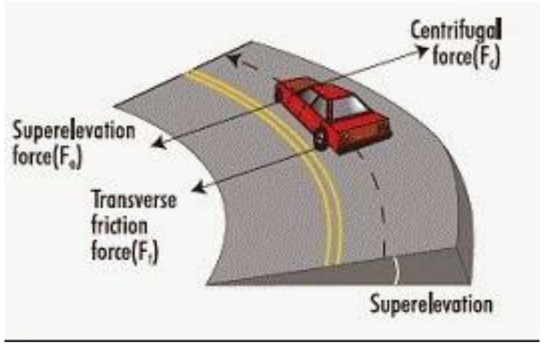


Sight Distance

Most important sight distance which are necessary to be studied here in the design point of view are:
(a) Stopping Sight distance
(b) Overtaking sight Distance

- **Stopping sight distance(SSD):** SSD is the sight distance which is necessary for a driver to stop a vehicle from the design speed to the 0 speed without any collision with the obstruction on the road. It is also known as the absolute minimum sight distance so this much sight distance is provided at all the cross section of the road.
- **Overtaking Sight Distance(OSD):** OSD is the sight distance which is necessary for a vehicle running at the design speed to overtake a slower moving vehicle without collision with the vehicles coming from the opposite direction. Generally It is not possible to provide the OSD at every cross section of the road so, it is provided after a stretch of the road.

- **Super- Elevation:** The outer edge of the road with respect to the inner edge of the road is raised in case of the horizontal curves, this is called super-elevation. Super-elevation is necessary to counter-act the centrifugal force due to the radius of the curve and speed of the vehicle.



Super-elevation

Gradient and vehicle performance
For engineers who are designing a road, the ability of vehicles to travel the road must be a primary input. Of course, subsequent analysis may look at cost/benefit figures, at environmental impact and so on. The following table, taken from (ref. 857), relates gradient with the performance of vehicles. Note that it deals with uphill and downhill gradients separately:

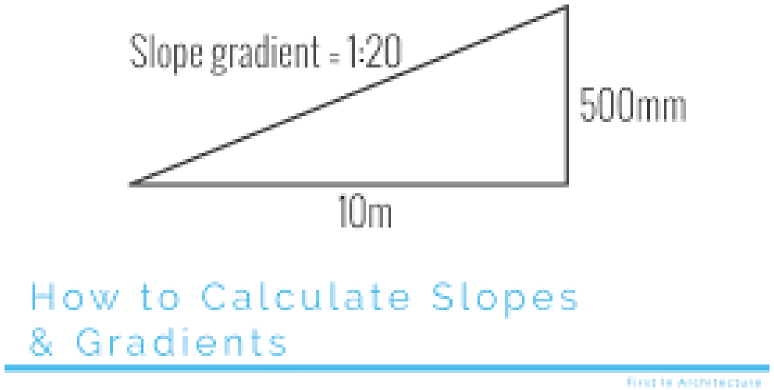
Table 10.1: Effect of Grade on Vehicle Type

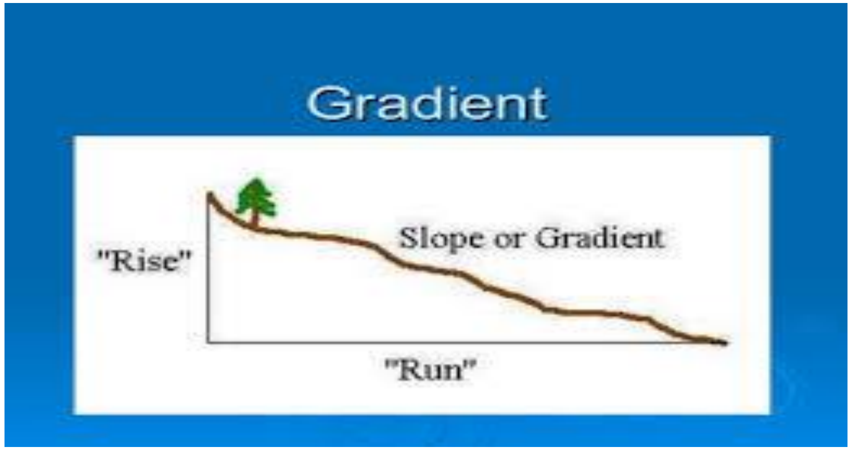
Grade	Reduction in Vehicle Speed as compared to Flat Grade %				Road Type Suitability
	Uphill		Downhill		
	Light Vehicle	Heavy Vehicle	Light Vehicle	Heavy Vehicle	
0-3	Minimal	Minimal	Minimal	Minimal	For use on all roads
3-6	Minimal	Some reduction on high speed roads	Minimal	Minimal	For use on low-moderate speed roads (incl. High traffic volumes roads)
6-9	Largely unaffected	Significantly slower	Minimal	Minimal for straight alignment. Substantial for winding alignment	For use on roads in mountainous terrain Usually need to provide auxiliary lanes if high traffic volumes
9-12	Slower	Much slower	Slower	Significantly slower for straight alignment. Much slower for winding alignment	Need to provide auxiliary lanes for moderate – high traffic volumes. Need to consider run-away vehicle facilities if proportion of commercial vehicles is high
12-15	10-15 km/h slower	15% max. Negotiable	10-15 km/h Slower	Extremely slow	Satisfactory on low volume roads (very few or no commercial vehicles)
15-33	Very slow	Not negotiable	Very slow	Not negotiable	Only to be used in extreme cases and be of short lengths (no commercial vehicles)

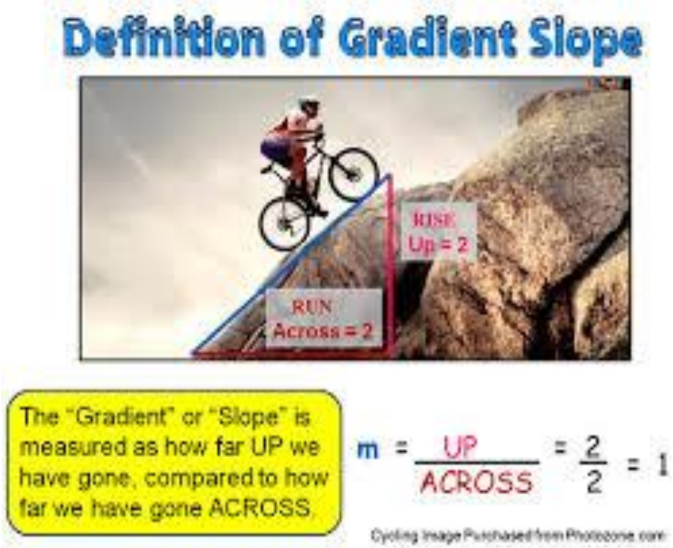
Source: Ref. 66

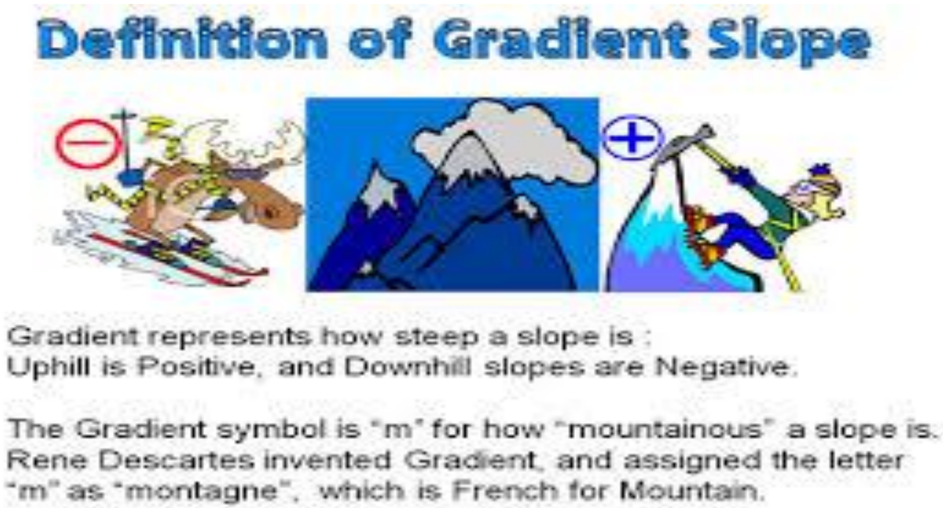
Table 8.3: General maximum grades (%)

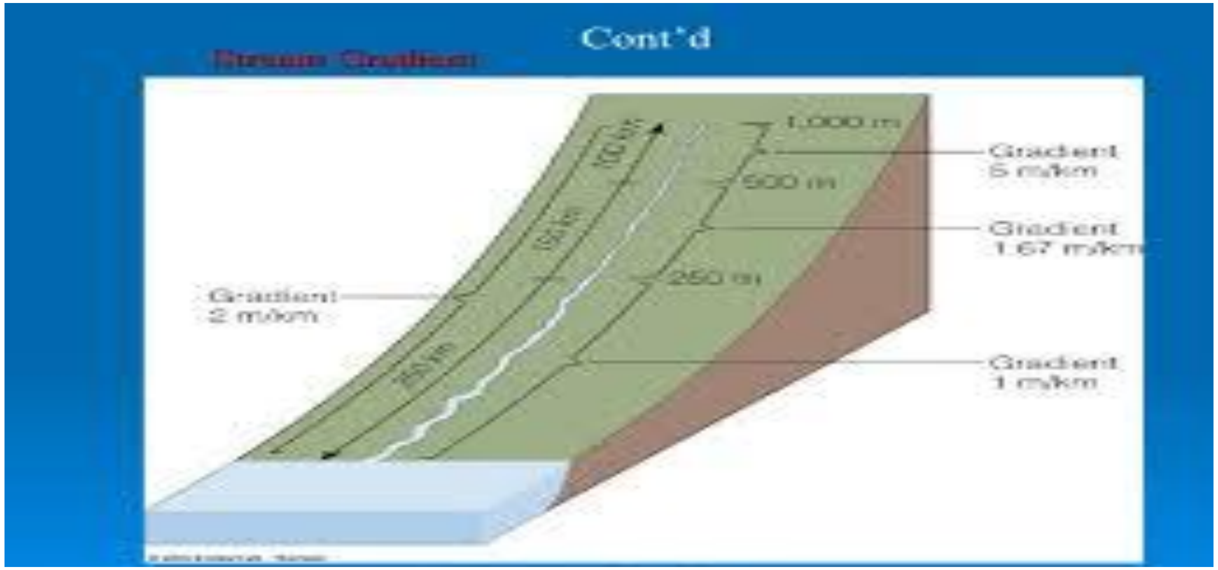
Operating speed (km/h)	Terrain		
	Flat	Rolling	Mountainous
60	6 – 8	7 – 9	9 – 10
80	4 – 6	5 – 7	7 – 9
100	3 – 5	4 – 6	6 – 8
120	3 – 5	4 – 6	–
130	3 – 5	4 – 6	–


Slope gradient = 1:20
500mm
10m
How to Calculate Slopes
& Gradients


Gradient
"Rise"
Slope or Gradient
"Run"


Definition of Gradient Slope
RISE
Up = 2
RUN
Across = 2
The "Gradient" or "Slope" is measured as how far UP we have gone, compared to how far we have gone ACROSS.
m = UP / ACROSS = 2/2 = 1
Cycling image Purchased from Photozone.com

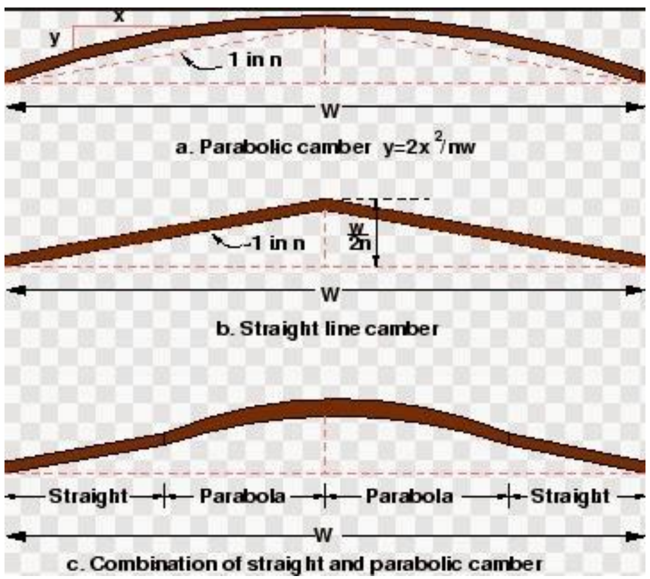

Definition of Gradient Slope
Gradient represents how steep a slope is :
Uphill is Positive, and Downhill slopes are Negative.
The Gradient symbol is "m" for how "mountainous" a slope is.
Rene Descartes invented Gradient, and assigned the letter "m" as "montagne", which is French for Mountain.



Camber:

Camber is the transverse slope provided to the road surface for the drainage of the rainwater for the better performance of the road. Camber can be written as 1 in n or x%.

Drainage of the rainwater is necessary
(1) To maintain the safe value of the friction between the road surface and the tyres
(2) To maintain the strength and durability of the surface concrete
(3) To maintain the durability and strength of the sub-grade soil which can be harmed if the infiltration of the water takes place to it.
There are generally three types of the cambers: (a) Straight Camber (b) Parabolic Camber (c) Mixed Camber.

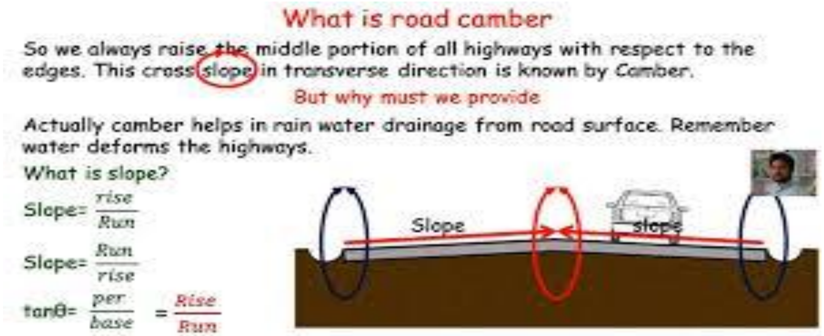


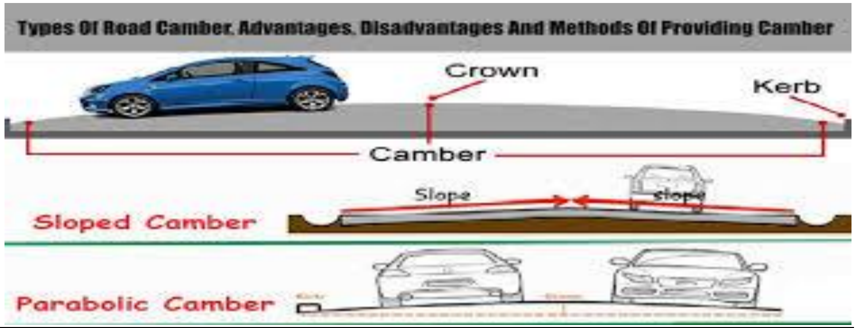
Types of Camber

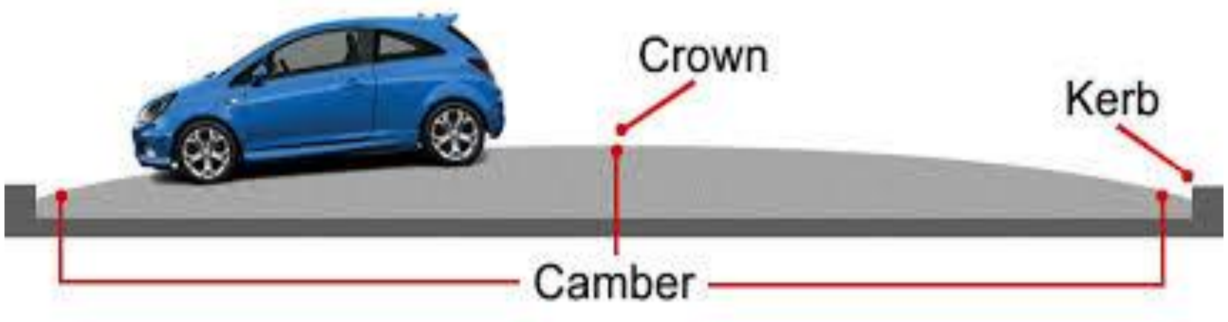
<u>(a) Straight Camber:</u> This type of camber is provided by meeting two straight surfaces at the crown. Crown is the central and top most point on the surface of the road. The edge shape produces inconvenience to the traffic so it is not used in general.

<u>(b) Parabolic Camber:</u> Parabolic camber is provided by providing a parabolic shape to the surface of the road. It is also not used in general because it has steep slopes towards the edges, which can create the outward thrust to the vehicles.

<u>(c) Mixed Camber:</u> Mixed camber is formed by use of the straight surfaces at the edges but parabolic surface at the centre. It is mostly used for the road construction because both the problem of the earlier two are solved if we use this camber.

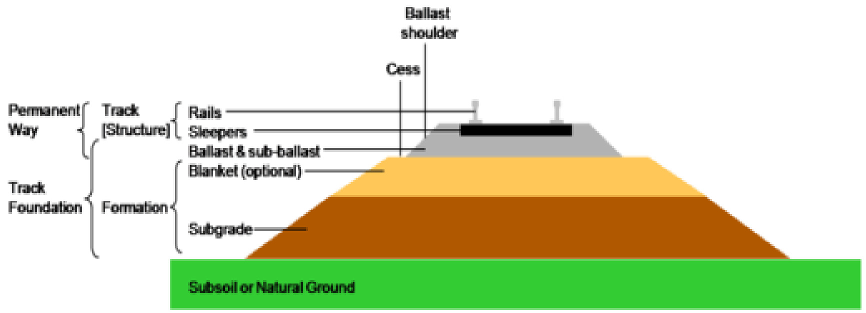






- **<u>Describe grade checking instruments:</u>**

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope, for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage. The earthworks created for such a purpose are often called the sub-grade or finished contouring.



Theodolites

Flagging and Survey Markers

Surveying Magnetic Locators

Automatic Lavels

Serveying Tripods  **Total Stations** 

Practical Simulations:
https://www.youtube.com/watch?v=5taF9EhyWF0
https://www.youtube.com/watch?v=1BO7NOGxf0Q
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https://www.youtube.com/watch?v=kRVwBqw6BpY
https://www.youtube.com/watch?v=aqcd-lDL_DA
https://www.youtube.com/watch?v=PwTsOWXT0Yo

LU8. Create ditches	**The students will be able to** • Identify the required profile using grade checking instruments • Choose blade position, wheel lean, articulation, gear and speed • Shape ditch by repeated passes.	• Describe ditches to be made under different environment/conditions • Describe safety measures to be kept in mind while making ditch • Describe problems faced while making ditch	

Typically, motor graders can be used for performing various tasks like making mix, laying a patch, widening shoulders, cutting back slopes, ditching, scarifying, drying material and removing snow. Among all, one of the most important earth-moving jobs that is performed by motor graders is cutting ditches. In order to carry out this task well, it is imperative that the motor grader operator is experienced enough to use well all the features of the motor grader. In addition, he should know about creating proper crowns and slopes.

Typically, ditch slopes differ on the grounds of soil type, the gravel used, ditch depth and width, expected rainfall in the region and so on. While the ditch slope types may differ, certain standard best practices remain the same for cutting all the ditches. The general rule is that wherever possible, the ditch slopes should be flatter than 2:1 or 50 per cent.

1) Ditch Making Position:

One of the important earth-moving jobs a motor grader is used for is cutting ditches. To do this well, an operator needs to know how to create proper crowns and slopes, and to be experienced in using a motor grader's features.

Ditch slopes should vary according to soil type, the gravel used, expected rainfall in the region and and so on. However, certain standard best practices are the same for cutting all ditches.

The basics: getting started

To start, lay out a line marked with visible stakes to help guide you to cut straight. Move the blade at a sharp angle, so its leading edge (toe) is pulled tight behind the front wheel and its heel is raised.

Now you're ready to do the marker pass. Drive along the line you've set out, cutting out about two to four centimetres. Take it easy – if you cut away too much at this point, you may run into steering trouble.

Keep the setting the same, but include the front wheel in the marker cut, with a bit of load on the machine to do the next pass. You should do this pass in first gear.

Next, for the material to be delivered on the outside of the wheels, tighten the blade on both ends. Straddle the windrow so it can be shifted from the bank of the ditch, rather than allowing it to become difficult to manage.

Deeper ditches will require that you repeat these steps, minus the marker pass one. To maintain a straight ditch, have the front wheels lean up the slope.


Various types of ditches and things to be kept in mind

In case of Vee-ditches, they should be at least 2-feet lower than the road wear surface but their depth can vary depending on road and soil type and available right of way. On the other hand, a flat-bottomed ditch can handle large amounts of rain or snowfall and cutting flat-bottomed ditches can supply extra material if it is needed to elevate the road. In regions subject to extreme precipitation, it is required to raise the travel surface high enough to prevent water from seeping under the road.

The basics for cutting ditches

1. To begin with, a line marked with visible stakes should be laid out. This can help you to cut straight. Then you need to move the blade at a sharp angle, so that its leading edge or toe is pulled tight behind the front wheel and its heel is raised. To simplify, the steps to establish a marking cut includes:

a) The moldboard should be high enough off the surface to allow unrestricted movement.

b) The blade should be pitched halfway.

c) You need to shift towards the centre until the left lift heel is straight up and down.

d) The moldboard should be rotated so that the toe is just behind the outside edge of the right front wheel.

e) If necessary, then you need to side shift the blade so as to extend the edge of the moldboard to the outside edge of the right front wheel.

f) The left lift cylinder should be raised all the way.

g) The front wheels should be leaned towards the left. The grader is then in the ditching position.

2. After following this step, it is easy to do the marker pass. Now, you have to drive along the line that is set, cutting out about two to four centimetres. Here, it is to be noted that if you cut away too much at this point, a steering trouble may arise.

3. Keeping the setting same, the front wheel should now be included in the marker cut, with a bit of load on the machine to do the next pass. This pass should be performed in the first gear only.

4. As the next step, in order to deliver the material on the outside of the wheels, on both the ends, the blade should be tighten. The windrow should be straddled so that it can be shifted from the bank of the ditch.

5. In case of deeper ditches, you will have to repeat these steps barring the marker pass one. In order to maintain a straight ditch, make it a point to have the front wheels lean up the slope.

What to be done for a back slope?

For a back slope, the following steps should be taken...

1. One set of wheels should be on the outer edge of the ditch and the other should be at the bottom of the ditch.

2. Always keep the leading edge down enough to cut the slope and the heel down. It should be angled in such a position to give the needed windrow.

You need to keep both the leading edge and heel of the blade inside the wheels and almost parallel with the machine so as to clean the windrow from the ditch thoroughly. When you are driving, one wheel should be in the bottom of the ditch and the other should be on the first slope. In order to avoid cutting too deep, both the ends of the blade should be set tight.

Finally, keep the blade set at the usual sharp angle and take the material up the slope for removal so as to clean the bottom of the ditch.

What to do in case of a flat-bottomed ditch?

The same procedure is used for creating a flat-bottomed ditch. However, one thing should be remembered that the blade level should be kept at a position so as to avoid material leaking into the bottom of the ditch. Do keep in mind that the angle of the blade determines the width of the slope.

Other things to be kept in mind

1. Ditches should be at least 2 feet lower than the road travel surface.

2. More forward tip is required for proper cutting-edge-to-material contact when you want to cut high bank slopes or deep ditches.

3. In case of soft shoulders, you can cut the ditches without rutting them by following few steps. This includes articulating toward the moldboard toe or the leading end far enough that the toe-side front wheel can be driven into the bottom of the ditch and the heavy tandems up on the road-wearing surface can be left behind. The link bar should be left in a centre position. Then the mouldboard should be circled to an angle which promotes smooth material flow up out of the ditch and side shift for the desired reach into the ditch.

4. The moldboard’s tailing end should always be raised to match the ditch slope. The top of the moldboard should be tipped about two inches in front of the cutting edge.

Thus, by keeping the above mentioned points in mind, an experienced motor grader operator can easily cut ditches and obtain the desired results.

One of the important earth-moving jobs a motor grader is used for is cutting ditches. To do this well, an operator needs to know how to create proper crowns and slopes, and to be experienced in using a motor grader's features.

Ditch slopes should vary according to soil type, the gravel used, expected rainfall in the region and and so on. However, certain standard best practices are the same for cutting all ditches.

The basics: getting started

To start, lay out a line marked with visible stakes to help guide you to cut straight. Move the blade at a sharp angle, so its leading edge (toe) is pulled tight behind the front wheel and its heel is raised.

Now you're ready to do the marker pass. Drive along the line you've set out, cutting out about two to four centimetres. Take it easy – if you cut away too much at this point, you may run into steering trouble.

Keep the setting the same, but include the front wheel in the marker cut, with a bit of load on the machine to do the next pass. You should do this pass in first gear.

Next, for the material to be delivered on the outside of the wheels, tighten the blade on both ends. Straddle the windrow so it can be shifted from the bank of the ditch, rather than allowing it to become difficult to manage.

Deeper ditches will require that you repeat these steps, minus the marker pass one. To maintain a straight ditch, have the front wheels lean up the slope.

Need a back slope?

For a back slope, follow these steps:

- have one set of wheels on the outer edge of the ditch; the other in the bottom of the ditch
- have the toe down enough to cut the slope and the heel down, angled just enough to give the windrow you need.

To do a thorough job of cleaning the windrow from the ditch, keep both the toe and heel of the blade inside the wheels, almost parallel with the machine. One wheel should be in the bottom of the ditch and the other should be on the first slope when you drive. Both ends of the blade should be set tight, to avoid cutting too deep.

Finally, to clean the bottom of the ditch, have the blade set at the usual sharp angle and take the material up the slope for removal.

What about a flat-bottomed ditch?

A flat-bottomed ditch is made using the same procedure, but keep the blade level to avoid material "leaking" into the bottom of the ditch. Remember that the width of the slope is determined by the angle of the blade.

- **<u>Describe safety measures to be kept in mind while making ditch:</u>**

Ditch Construction

1. Follow pre-start inspection procedures.
2. Review Operator's Manual or specific instructions.

3. Mount motor grader, using steps and grabbing irons.

4. Sit in operator's seat and secure seat belt.

5. Follow procedure for starting engine; allow proper warm up.

6. Check all gauges and controls for proper functioning.

7. Set engine-speed control as suggested in the Operator's Manual.

8. Position gearshift lever in proper gear.

9. Raise all implements.

10. Release the parking brake; proceed to work area.

1 1 . Operate side shift to extreme left.

NOTE: With an articulated motor grader, articulate so that tandems run outside of the "V" where traction is better.

12. For cutting a ditch on the side of road, move in the same direction as the

traffic. Rotate circle until toe of blade is directly behind right front wheel.

13. Raise left lift cylinder to full up.

14. Lower right blade-lift cylinder to set blade tip for desired depth of cut.

15. Lean front wheels to left and make a 4 inch to 5 inch cut.
NOTE: Leaning will counteract side drift of blade. Keep blade toe in line with outside edge of lead tire while maintaining a straight line.

16. Continue cutting to desired depth, keeping front tire in bottom of ditch.
NOTE: Each ditch cut should be made as deep as possible with blade toe in line with center of lead tire, and without stalling grader.

17. Continue ditching and bringing successive cuts in from the edge of the

bank slope; blade toe will be in line with bottom of ditch on final cut.

18. Move motor grader off pavement to a safe level parking place.

19. Set the emergency brake.

Practical Simulations:

https://www.youtube.com/watch?v=TKUNZUZ-yd0
https://www.youtube.com/watch?v=gwgD-1H0krU
https://www.youtube.com/watch?v=H40WCzrOw70
https://www.youtube.com/watch?v=zT5mS2slTwY
https://www.youtube.com/watch?v=KcMDdyHnUtU
https://www.youtube.com/watch?v=JpJ4Ay0ef0E
https://www.youtube.com/watch?v=6_vpjcGoJ_w
https://www.youtube.com/watch?v=bKanZ4MQKsk
https://www.youtube.com/watch?v=QuhMysOE3Eg

LU9. Create shouldering	**The students will be able to** • Choose blade position, wheel lean, articulation, gear and speed • Position grader with outer tires on pavement, and inner tires just off pavement on shoulder for left side shoulder • Position grader with inner tires on pavement, and outer tires just off pavement on shoulder for right side shoulder • Move only enough material to pavement edge to dress the shoulder • Roll the windrow back away from the pavement edge • Shape the shoulder accurately	• Describe shouldering and positioning of blade for this task • Explain how to dress the shoulders	

Practical Simulations:

https://www.youtube.com/watch?v=7NyybhhNJ2U
https://www.youtube.com/watch?v=HGwdluZvCl8
https://www.youtube.com/watch?v=Vn_eUZr1KZI
https://www.youtube.com/watch?v=NFH4LGo2yF8
https://www.youtube.com/watch?v=JiLwdiLnKWs

A shoulder, or hard shoulder is an emergency stopping lane by the verge of a roador motorway, on the right in countries which drive on the right, or on the left side in India, Japan, the UK, Australia, and other left-side driving countries. On a four-lane section, the paved width of the leftshoulder shall be at least 4 feet (1.2 meters). On sections with six or more lanes, a 10-foot (3.0-meter) paved width for the left shoulder should be provided. Where truck traffic exceeds 250 DDHV, a paved widthof 12 feet (3.6 meters) should be considered

When it comes to using your motor grader, every road grading job is different, with a unique set of variables that must be taken into account. Even those who've clocked up many hours operating a motor grader will say it takes time and patience to master the job.

Fortunately, the motor grader is a versatile machine that's fit for many tasks, from mixing asphalt to grading shoulders. Although each task may require different manoeuvres and tricks, some general tips can improve overall safety and help you achieve the best performance.

General operating tips

Master motor grader operators will tell you that it's vital to visualise the steps involved in each procedure. See the finished task in your mind's eye and ask yourself questions before you start – for example, do you need to fill low spots or cut high areas, and where will any water source fill in or drain out?

As well as visualising each task, general advice for operating motor graders includes the following tips:

- Avoid moving material more often than needed.
- Trimming is made much easier with good compaction. Use some weight on the blade to steady it, rather than being overly concerned with having material on the blade while trimming
- Get familiar with the five blade movements that are made possible by the hydraulic controls, as they're suited to different tasks. Some tasks require a combination of some or even all of the blade movements. Know what you want your blade to do before lowering it. Know the settings, and consider your angles and heights.
- You can choose to have either a loose blade, for mixing or spreading loose material, or a tight blade, for reshaping an area by cutting down into it. Most of your jobs will need these two options at different stages.
- Similarly, the moldboard can be lifted from both sides so the blade is at a level height (for leveling an area, for example), or you can have just one side raised, if your surface needs to slope.

Road grading and maintenance tips

Potholes are a major problem on national roads, and can cause serious motor vehicle accidents.

Depending on the quality of a road's surface materials, cover material can become displaced, creating ruts in the road and causing material to accumulate on the shoulder in places like traffic stops, hills or other areas where drivers tend to accelerate.

To start

To dress the road, there needs to be some moisture, whether from recent rains or hosed from a water truck. Ensure there is good drainage. The road crown should be in straight sections, while the curves should have super elevation.

Straights, slopes and bends

For a straight road, the wear surface should rise at about a 3 percent slope from the shoulder to the road centre. Of course, you need to take the gravel type and area's rainfall into account. Curved roads need to be flat, but with an incline that has a 6 percent slope down to the inside of the corner.

Trim cutting edges with a torch to keep them straight. Alternatively, you can drag the cutting edges along a smooth concrete surface, provided the blade is still fairly new and not worn too much. Check for wear, as you may need to replace them to avoid wear on the bottom of the moldboard, which would reduce the support needed for your cutting edge.

Shape the road crown. If you still have enough moisture on the ground, you can cut lightly in the spring.

Ditches and surfaces

When the surface is hard and dry, you can drag the cutting edge along the surface, but set it at about 90 degrees to the surface.

With ditches, consider the soil and road type, as well as the right of way. A rough guide is that they should be about 5 centimetres, or 2 inches, lower than the road wear surface.

In areas with high rainfall, elevate the road surface to avoid having water run beneath the road, which can also cause potholes.

Before grading, you need to choose the right speed and moldboard angle. Go slow for delicate work; fast if you're removing rocks from a road surface. Use a smooth motion, by making use of the many moldboard angles (between 10 to 45 degrees), rather than just bulldozing your way forward.

Potholes

Cut to the depth of a large pothole. To ensure it doesn't form again, don't fill it with loose material. That won't last under traffic wear. When doing maintenance, it's best to have the centre-shift lock pin centred, with the drawbar and circle also centred beneath the mainframe.

To keep your machine stable, the mainframe should either be straight or articulated only a little. Prevent the machine from bouncing by having the mainframe articulated towards the mouldboard's 'toe', at about 1 to 1.5 times the tyre width (around 2 to 5 degrees).

Cutting and moldboard position

To begin, the moldboard top should be about 5 centimetres ahead of the cutting edge. Adjust this position according to the material and other variables. Remember that tipping the moldboard forwards or backwards changes depth of cut across the entire moldboard.

As for wheel position, the top of the front wheels are usually leaned in the same direction that material comes off the moldboard. When the windrow gets heavy, they should be leaned in the direction of the windrow.

When working on side slopes or ditches, the front wheels should be in a vertical position. To ensure the front-axle doesn't reaching its oscillating limit when you're using articulation to work across a slope, lean the wheels down the slope. Wheel leans can also help an operator make steering adjustments without having to take hands off the hydraulic controls.

Be careful. If you use the full rear tip, you could run into penetration problems. If the cutting edges are worn, doing so could also damage the moldboard bottom or pivot area.

Over time, each operator develops an individual style and instincts, along with a knack for doing certain jobs. Start slow and steady, be patient and persistent, and you'll master the art of road maintenance with a motor grader.

LU10. Form sub-Grade	**The students will be able to** • Choose blade tilt, angel and position • Match blade load to available power and traction	• Describe sub grade • Describe method of removal of unsuitable material • Explain the blade position for sub grading	
	• Remove unsuitable material • Cut and fill load bearing soils to create desired profile • Shape for drainage and ditch as required		

- ## Describe sub grade:

In transport engineering, sub-grade is the native material underneath a constructed road, pavement or railway track (US: railroad track). It is also called formation level. The term can also refer to imported material that has been used to build an embankment.

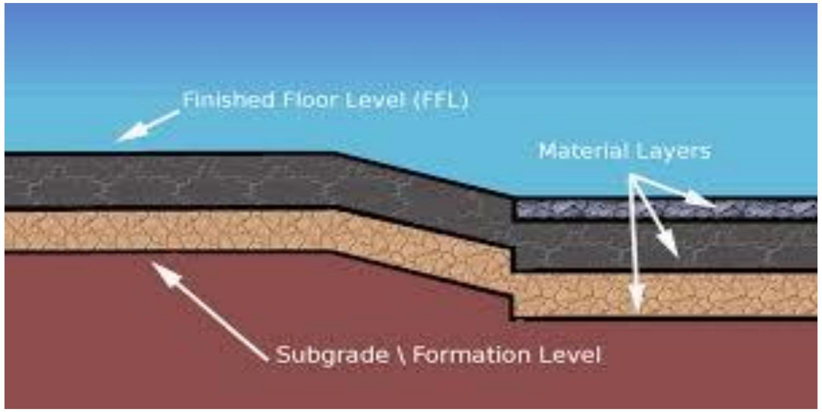
OR

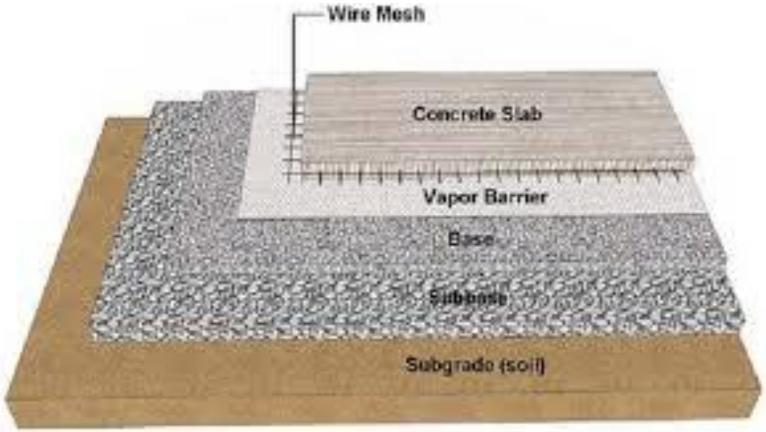
Sub-grade and Sub-base. In concrete paving terminology, the sub-grade is the soil the pavement is built on. Usually it is treated by compacting it sufficiently to prevent the pavement from settling. Sub-base is composed of the layer(s) of material between the sub-grade and the concrete pavement. In highway engineering**, sub-base** is the layer of aggregate material laid on the sub-grade, on which the base course layer is located. It may be omitted when there will be only foot traffic on the pavement, but it is necessary for surfaces used by vehicles. Sub-base is often the main load-bearing layer of the pavement.

Preparing Sub-grade Surface:

The sub-grade shall be scarified to a depth of 150 mm, unless otherwise specified. The loosened material shall be windrowed to the side, and the exposed surface shall be thoroughly compacted. The windrowed material shall then be uniformly mixed, shaped to conform to the dimensions, lines, grades and cross-section as established by the Consultant, and compacted to obtain an average of one hundred percent, and with no test results being less than ninety-seven percent of the maximum dry density at optimum moisture content established by the Moisture-Density Relation tests using Standard Compaction. Approved material shall be added or removed to restore true grade and cross-section as directed by the Consultant. When material varies from optimum moisture content, it shall be treated in the following manner.

When a deficiency in moisture content exists, the material shall be watered and thoroughly mixed until optimum moisture content is attained. When an excess in moisture content exists, the material shall be worked and aerated until optimum moisture content is attained.


Finished Floor Level (FFL)
Material Layers
Subgrade \ Formation Level


Wire Mesh
Concrete Slab
Vapor Barrier
Base
Subbase
Subgrade (soil)


Finally prepared subgrade

- **<u>Describe method of removal of unsuitable material:</u>**

Description: This work shall consist of removing, transporting and disposing of unsuitable material; and backfilling the excavated area with a porous granular embankment material when preparing the subgrade beneath the 12" Aggregate Subgrade shown on the plans.

Soil borings taken for this project indicate that at various locations, soft unstable soils of varying depths exist. These soils may need to be removed and replaced with porous granular embankment, special, prior to placing the bituminous base course or aggregate material.

At all locations the actual extent of removal and replacement shall be determined by the Engineer in the field at the time of construction. Undercuts deeper than the maximums indicated above shall be justified based upon cone Pinero meter testing.

A proof rolling procedure acceptable to the Engineer shall be followed in order to verify the stability of the sub-grade prior to the placement of earth embankment or porous granular embankment.



Practical Simulations:

https://www.youtube.com/watch?v=ECFFk5gGwVQ

https://www.youtube.com/watch?v=FluIlGd14lg

https://www.youtube.com/watch?v=Uy5UpSx3wAo

https://www.youtube.com/watch?v=xUyNFUgWeC0

https://www.youtube.com/watch?v=gepfvpetdN8

https://www.youtube.com/watch?v=3bYa12hfBSA

https://www.youtube.com/watch?v=BFyiK1YDTPM

https://www.youtube.com/watch?v=fkP7mFyyVk8
https://www.youtube.com/watch?v=SuOSR0z_Xzg
https://www.youtube.com/watch?v=W716TahW7Pw
https://www.youtube.com/watch?v=Eb4T9F8kEO0

LU11. Place aggregates to specified elevations (finish grading)	**The students will be able to** • Identify the required profile using grade checking instruments • Get the correct volume in the efficient placement • Position for efficient spreading • Get correct volume of aggregates • Shift the circle and blade towards the piles • Cut out windrows only as large as the machine can handle without tire spinning • Angle the blade as appropriate • Precise control to achieve elevations and shape to very accurate tolerances	• Describe how to accurately perform grading of aggregates • Describe identification of profile using grade checking instruments • Explain positioning of machine for efficient spreading • Explain how to avoid wastage of aggregates	

- **Describe how to accurately perform grading of aggregates:**

Grading of aggregates is determining the average grain size of the aggregates before they are used in construction.

This is applied to both coarse and fine aggregates. The aggregate sample is sieved through a set of sieves and weights retained on each sieve in percentage terms are summed up. Aggregates are an important part of a wide range of construction applications, used in domestic and commercial projects alike, and they make up a huge part of the composition of materials such as concrete and cement. Aggregates are, by definition, a collection of loose materials such as sand, gravel and crushed stone. They are sourced from quarries, pits and even from materials taken from the sea in some countries. Ready mixed concrete is made from around 80% aggregates, and asphalt consists of 95% aggregates. The use of tested, sized, and graded aggregates will assure quality materials for maintenance and construction of your roads. It is not the only item one must consider, but in consideration with the other factors that provide for a good road, well-prepared, sized, and graded aggregates must be especially emphasized.

- **<u>Describe identification of profile using grade checking instruments:</u>**

Laboratories are equipped to provide comprehensive aggregates and earthworks testing services which meet the appropriate British and European Standards together with Highways MCHW requirements.

As well as completing standard laboratory, grading, compaction and classification earthworks testing, we also provide engineering advice and assistance with the design and specification for a variety of earthworks operations, as well as undertaking on site monitoring and in-situ testing.

Mechanical, physical and chemical testing is undertaking for a variety of Clients on a wide range of natural and recycled aggregates to ensure they are fit for purpose.

Brasion test on aggregates is the measure of aggregate toughness and **abrasion resistance** such as crushing, degradation and disintegration. This test is carried out by AASHTO T 96 or ASTM C 131: Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
The aggregate used in surface course of the highway pavements are subjected to wearing due to movement of traffic.

When vehicles move on the road, the soil particles present between the pneumatic tyres and road surface cause abrasion of road aggregates. The steel rimmed wheels of animal driven vehicles also cause considerable abrasion of the road surface.

Therefore, the road aggregates should be hard enough to resist abrasion. Resistance to abrasion of aggregate is determined in laboratory by Los Angeles test machine.


Funnel
Cylinder
Scale
Spatula
Brush

Explain how to avoid wastage of aggregates:

Most new building sites require a constant supply of aggregates for a number of different purposes, ranging from pipe bedding through to creating level surfaces for driveways and roads.

Storage space:

When storing aggregates, the first thing to consider is how much space is needed for the stockpile. This can usually be calculated by looking at the amount of aggregates that are sold on a weekly or monthly basis and how often new stock is delivered to your unit. You may want to keep a slight excess of your most popular aggregates in order to deal with any unseen problems that could occur in the supply chain, allowing you to supply your customers if there are any delays in delivery. The last thing you want is your valued clients going elsewhere for their supplies, which could damage your hard-won relationship. By carefully designing your aggregate storage, you can prevent difficulties occurring when these materials need to be moved, ensuring that there is always a good mix of particle sizes throughout your aggregates.

Risks to personnel:

UK Health and Safety law says that you must conduct your business without putting either the public or your workers at risk. There are a number of dangers associated with storing aggregates, the most noticeable of which is the possibility that a stack could slide and crush or even bury a person. It's therefore of paramount importance that you make the correct provisions to ensure that your aggregate stores are secure and stored away from the perimeter fences of your premises.

Storage bins:

One way in which aggregates can be stored safely is in storage bins. These should have bottoms that slope towards the front of the container, allowing the aggregate to move in the bin, so it can be easily collected. You'll also want to avoid angular corners as these can often trap aggregates, making it difficult for the material to be removed from the bin. Try to keep bins as full as possible in order to ensure that there is an even mix of particle sizes throughout the aggregate.

Unloading:

It is important to make sure that aggregates are unloaded in the correct manner to ensure that a good stockpile of material is formed. It is therefore vital that each consignment of aggregates is dropped in the same place to form a pyramid of material with the weight distributed around the bottom of the stack, which should help with the unloading process. It is also vital to ensure that aggregates are not being unloaded from a high position as wind can scatter the smaller particles away from the stack. Once the aggregate has been unloaded into a conic pile then you may want to flatten it out into a single layer, as this will stop smaller particles from running down the stack where they can collect. Equally, if you're moving aggregate from a stockpile into a storage bin, make sure that you always load the bin directly from the top, as this will prevent the material from segregating into different-sized particles.

Potential contamination:

There are a number of ways in which your aggregate stockpile can become contaminated. These range from cross-contamination between different types of aggregates through plant material, such as leaves or even weeds growing in the stack, mixing with the material. It is even possible for contamination to occur if a bin that's used for storing an aggregate of one particular size is not completely emptied and cleaned before being used to store a different aggregate. It is important to make sure that you have a clear policy around contamination, storing your aggregates on hard pallets or bases that have good drainage and are non-water permeable. This is an especially useful practice if you are using mechanical loaders to move aggregates, as it will prevent them from scraping up ground dirt with the aggregate. Keep your piles of aggregates far enough apart to prevent them mixing with one another – you may even wish to put barriers in between different aggregates to prevent them mixing.

Aggregate moisture:

It is important for some aggregates to be stored in a moist condition. Typically, most aggregates that are stored in a stockpile or in a bin will need to be kept slightly wet, with the material containing both surface moisture and water within the aggregates' particles. This will prevent loss of aggregates where the finer particles can turn into dust and can easily becoming dislodged from the stock by the movement of air. The simplest way to ensure that the moisture content is constant is by sprinkling the aggregate with water at regular intervals to keep it constantly saturated. Where necessary special probes can be used to ensure that the moisture level within any aggregate stack or storage bin is at an optimum level, although these will work better with finer aggregates that coarse particles, which can damage the probes.

Important attitude:

Finally, one of the most important things to consider when storing aggregates is your attitude. It is essential to make sure that workers adhere to all policies and procedures at all times to ensure that your aggregates are always of a high quality and that they contain a good mix of different-sized particles. It only takes one break in procedure to damage the integrity of your aggregates, which can have harmful effects for your business if this in turn spoils a relationship with one of your clients. By staying vigilant and making sure that all members of your team know exactly what they need to do with regards to the storing of aggregates, you can stop such a situation from ever occurring.

Practical Simulations:

https://www.youtube.com/watch?v=WcXgiEpv_JU
https://www.youtube.com/watch?v=XCRf_PbnpvY
https://www.youtube.com/watch?v=t8HBGRZ3kMA
https://www.youtube.com/watch?v=dz9JyEXfpOI
https://www.youtube.com/watch?v=sQF03S8eldw
https://www.youtube.com/watch?v=TeNj2m38lt0
https://www.youtube.com/watch?v=Dx9SW7SuIfQ
https://www.youtube.com/watch?v=96CVwpWee18

https://www.youtube.com/watch?v=E94vwC6iIpc
https://www.youtube.com/watch?v=uRpzbvzhk0Y

LU12. Clear snow and ice	**The students will be able to** • Choose proper attachment, as chains, V-plow, wing plow, skid shoes and wing gates • Identify snow type, moisture content, density, weight, depth of snow, underlying surface, weather, visibility, traffic, obstacles and hidden structures • Mount chain on tires carefully • Drive the machine in higher speed to move snow across and off the blade	• Describe snow clearing attachments and working procedure for snow clearance • Describe safety precautions in snow clearance • Describe use of chains on wheels • Describe the procedure for identification of obstacles and hidden structures and their removal.	

- **Describe snow clearing attachments and working procedure for snow clearance:**

2) Snow Removing Position:

Motor graders have long been recognized as excellent tools for snow plowing. The introduction of high speed hydraulics and frame steering has made the motor grader even more productive in this application.

In addition to the standard moldboard, a grader can be equipped with a number of attachments to aid snow removal including snow wings, V Plows and straight blades.

Snow plowing techniques and the type of plowing equipment mounted on the motor grader vary greatly in different areas due to:

- Terrain
- Type of snow and its moisture content

- Depth of snowfall normally expected
- Normal wind velocity that can cause extremely tight drifting
- Length of time after the snowfall before plowing was started
- The amount of melting that has occurred
- Amount of dirt mixed with snow

A major factor is traction. Snow plowing usually occurs under poor traction conditions which often require different operating techniques and the use of tire chains. In snowplowing, operating speeds are normally higher than in earthmoving work. Normal work speeds are in the 5 to 20 mph range. The moldboard should be tipped well forward to prevent damage to the machine and road surface. This allows the cutting edge to ride over rather than try to cut minor obstructions, and may prevent operator injury, cutting edge breakage or machine damage.

When plowing snow, safety must always be your primary consideration. Objects can be hidden under the snow so wear your seat belt. Put a standard circle slip clutch attachment on the machine to prevent possible operator injury or machine damage. For safety, work in the direction of traffic when possible. Before moving or reversing the machine, check all directions to assure there are no people or vehicles in your path.

Blade float is frequently used in snow plowing work. This allows the blade to follow a varying surface using only the weight of the drawbar, circle and moldboard. Blade float prevents damage to uneven surfaces but requires a hard surface such as asphalt or frozen ground to prevent gouging the surface. In areas with loose gravel on the road surface, using blade float may windrow the gravel onto the road shoulder.

Motor graders provide the power and operator comfort you need to clear long stretches of road in a variety of conditions.

Snow Removal

1. Follow pre-start inspection procedures.

2. Review Operator's Manual or specific instructions.

Caution: Steps and irons could have ice on them.

3. Mount motor grader, using steps and grabbing irons.

4. Sit in operator's seat and secure seat belt.

5. Follow procedure for starting engine; allow proper warm up.

6. Check all gauges and controls for proper functioning.

7. Set engine-speed control as suggested in the Operator's Manual.

8. Position gearshift lever in proper gear.
9. Raise all implements.

10. Release the parking brake; proceed to work area.

11. Downshift to working speed.

12. Pitch moldboard forward.

13. Rotate circle to sidecast material.

14. Line up left front wheel of motor grader on center line of road.

15. Lean wheels in direction of side cast snow.

16. Lower blade to touch pavement.

NOTE: Excessive down pressure reduces steering and traction.

17. Continue removing snow until destination is reached.

NOTE: Check blade wear frequently during operation to prevent moldboard damage.

18. Raise blade and turn machine around.

19. Reposition motor grader on opposite side of road for return pass.

20. Line up left side, placing wheel on grade area.

21. Lower blade to pavement and continue snow removal while making any adjustments necessary to avoid scarring road.




- **<u>Describe safety precautions in snow clearance:</u>**

Snow plowing techniques and the type of plowing equipment mounted on the motor grader vary greatly in different areas due to:

Common safety precautions include:

- Terrain
- Type of snow and its moisture content
- Depth of snowfall normally expected
- Normal wind velocity that can cause extremely tight drifting
- Length of time after the snowfall before plowing was started
- The amount of melting that has occurred
- Amount of dirt mixed with snow

- Never place a person or body part between a moving piece of equipment and another structure, such as a wall or a piece of equipment.
- Always provide new employees ample time to get familiar with equipment and its operation before having them operate the equipment.

- Always wear appropriate personal protective equipment.
- Outfit all mobile equipment with the appropriate amount of safety and strobe lighting to alert traffic and pedestrians of moving equipment.

A major factor is traction. Snow ploughing usually occurs under poor traction conditions which often require different operating techniques and the use of tire chains. In snow ploughing, operating speeds are normally higher than in earthmoving work. Normal work speeds are in the 5 to 20 mph range. The mouldboard should be tipped well forward to prevent damage to the machine and road surface. This allows the cutting edge to ride over rather than try to cut minor obstructions, and may prevent operator injury, cutting edge breakage or machine damage.

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• Describe use of chains on wheels:

Snow chains, or **tire chains**, are devices fitted to the tires of vehicles to provide maximum traction when driving through snow and ice.

Snow chains attach to the drive wheels of a vehicle or special systems deploy chains which swing under the tires automatically. Although named after steel chain, snow chains may be made of other materials and in a variety of patterns and strengths. Chains are usually sold in pairs and often must be purchased to match a particular tire size (tire diameter and tread width), although some designs can be adjusted to fit various sizes of tire. Driving with chains reduces fuel efficiency, and can reduce the allowable speed of the automobile to approximately 50 km/h (30 mph), but increase traction and braking on snowy or icy surfaces. Some regions require chains to be used under some weather conditions, but other areas prohibit the use of chains, as they can deteriorate road surfaces.

In snowy conditions, transportation authorities may require that snow chains or other traction aids be installed on vehicles, or at least supplied for them. This can apply to all vehicles, or only those without other traction aids, such as four-wheel drive or special tires. Local requirements may be enforced at checkpoints or by other type of inspection. Snow chains should be installed on one or more drive axles of the vehicle, with requirements varying for dual-tire or multi-driven-axle vehicles that range from "one pair of tires on a driven axle" to "all tires on all driven axles", possibly also one or both steering (front) wheels, requiring snow chains whenever required by signage or conditions.




Practical Simulations:

https://www.youtube.com/watch?v=v2VAmkmUVhU
https://www.youtube.com/watch?v=j06Lv5QnAiw
https://www.youtube.com/watch?v=YyFYYos0c6Q
https://www.youtube.com/watch?v=UtugnShmTYY
https://www.youtube.com/watch?v=eKWBkCtgkAA
https://www.youtube.com/watch?v=BzGIF0bqudQ
https://www.youtube.com/watch?v=njMRu1HfDvM
https://www.youtube.com/watch?v=C-pPJKiPFno

MULTIPLE CHOICE QUESTIONS (MCQs)

Question 6 Which machine is used for fine grading

A Bull Dozer

B Wheel Loader

C Excavator

D Grader

Question 7 What are the functions of grader?

A Form and handle windrows

B Strip surface materials

C Cut and fill material

D All of the above

Question 8 The grader is used for

A Lifting material

B Fine Grading of the surface

C Breaking rocks

D Demolishing structures

Question 9 Motor Grader has a blade placed in?

A Front of the machine

B Between the machine

C Back of the machine

D None of the above

Question 10 Motor Grader operator needs to have knowledge of?

A Grading fundamentals

B Map orientation

C English language

D All of the above

HEAVY MACHINE OPERATOR

Module-N

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - November, 2019

Module N: Plan Work

Objective: This module covers the skills and knowledge required to Assess site hazards, Ensure work procedures, Follow symbols and markings, Follow survey markers, construction grades, and stakes, Monitor Drawings and plans, Develop environmental concerns with site personnel, Demonstrate grades and stakes, Demonstrate grade checking devices, Review job specifications and safety considerations with site personnel.

Duration: 57 Hours **Theory: 10 Hours** **Practice: 47 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Assess site hazards	• Inspect site visually • Communicate with site supervisor • Identify actual and potential hazards	• Describe visual inspection of site • Describe methods of communication with site supervisor • Describe how to read and understand the site plan/drawings • Describe potential hazards at site	

- **Describe visual inspection of site**

The first step in the risk management process is the identification of workplace hazards. This means looking for those things at the workplace that have the potential to cause harm.

The following are the other most important hazard recognition methods:

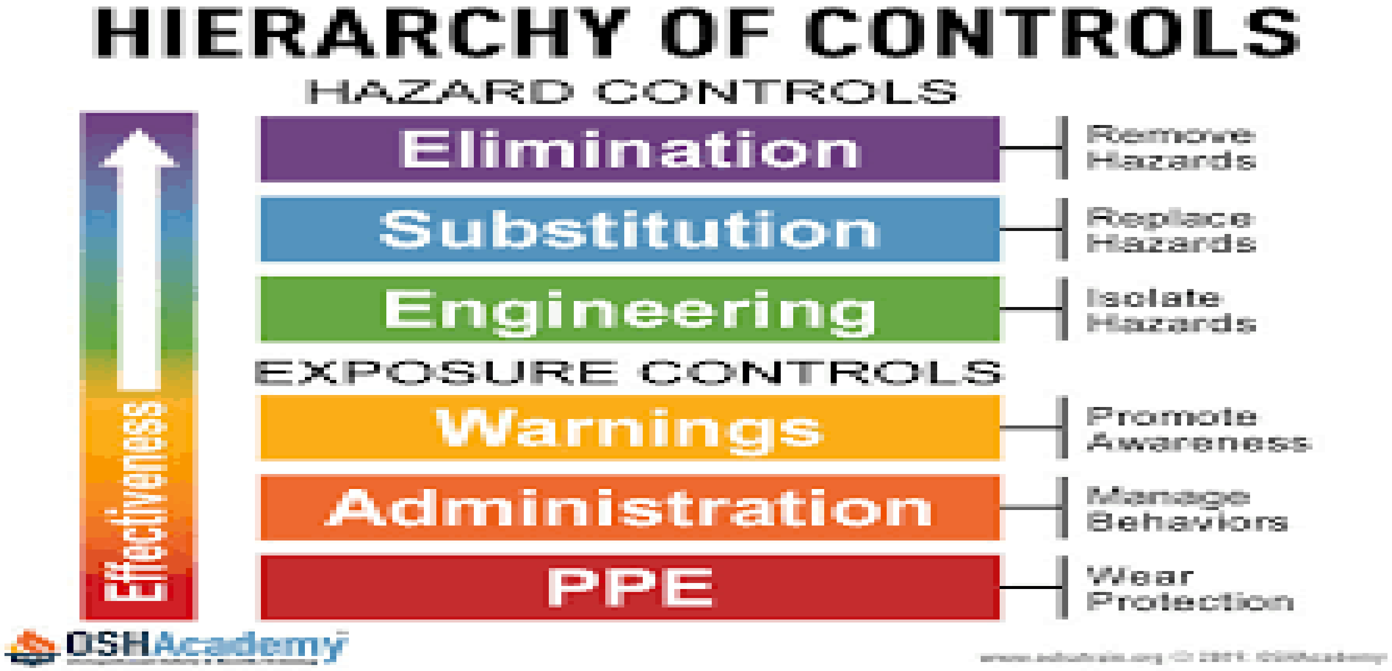
1) **Pre-Use Analysis** can be applied before any new equipment, device, instrumentation, personal protective equipment, machine, tool, plant facility, etc. are used. This method is applied before exposure to hazards.

Multi-Step Planning Process is applied before hazard exposure and applied to every task, job and activity. To apply this method simply asks a series of questions before doing the task, job or activity.

2) **Work Permit** is issued before the job, task or activity done. Some questions asked and a checklist shall be completed to assure that hazards are not overlooked. Generally the checklist includes the analysis of toxic gas (such as carbon monoxide, H_2S), oxygen sufficiency, flammable gas concentration, etc.
3) **Equipment Inspection** is implemented to any equipment before it is used or put into operation. Equipment inspection is planned and organized to check overall equipment conditions, safety protective equipment, guarding, emergency stop, etc.

4) **Suggestion Method** encourages to propose or suggest potential hazards (and controls) that are contained in a job, task or activity. Workers consider their past time experiences on the shop floor and field to give suggestions. This method can be used for improving current hazard identification list.
5) **Safety Patrol** can be carried out by every worker in the plant site, not only by persons who are in charge of health and safety matters. Safety patrol may be done during an equipment running, plant operation, plant shut down or whenever it is intended to identify potential hazards.
6) **Visual inspection and observation** is the most common and simple way to begin to look for hazards by regular walk- through visual inspections of the workplace. Look at each task the workers do, to see if any hazards are present, such as handling loads, using chemicals or equipments. It may also be helpful to observe workers performing their tasks and the activities involved, such as set-up, operation, cleaning, maintenance and inspection. This will provide the opportunity to see whether the documented procedure for performing the task is being followed by the workers, or whether workers are taking short cuts or speeding up work (e.g. by removing guards), etc.
7) **Structured approach** to improve the chances of identifying all of the hazards in the workplace, it will help to take an additional structured approach. It is done by dividing the workplace into groupings such as:

- locations, such as offices, grounds, warehouse or wet areas;
- functions or production processes, such as administration, cooking, washing, cleaning, receiving, forming, or finishing;
- roles, such as electricians, office workers or drivers, technicians;
- tasks, such as working on the lathe, loading the truck, decanting a substance or data processing.



- **<u>Describe methods of communication with site supervisor :</u>**

Corporate communication is a crucial element in the success of business operations. A big challenge, when it comes to internal communication within an organization, is communicating with top-level management. Your boss typically holds the key to your advancement within your company. They also have a tremendous amount of influence on how you perceive your work. You may wake up every day looking forward to work or you may dread every time you go in.

Your work will consume a large part of your life, and learning how to communicate with your boss makes sense if you want to enjoy your work. They have certain expectations, and it's up to you to figure out what they need ... especially if you want to advance your career, or at least, enjoy what you do.

<u>1. Stay on the same page:</u>

To be on the same page with your boss, you need to spend time with him or her. There is no shortcut. Getting more time on your boss's calendar, especially if you are an executive or middle manager, gives you more time to get into the details and stay on the same page.

In an ideal world, managers would need to interact with their juniors on a frequent basis. In reality though, juniors need to *act* to get the time they want with their bosses. The more time spent together, the easier it is for your boss to know if you are on the same page. This results in a less stressful working environment.

2. Think ahead and offer solutions to problems:

Communicating with your boss is similar to a game of chess ... it demands staying three steps ahead of your opponent to take the lead. If you can anticipate the needs of your boss before they arise, you will be seen as a leader and a problem solver. Paying attention to your boss's work habits and style of working will help you determine where and how to assist. Check out their upcoming schedules and deadlines and offer to help.

Remember, corporate communication is no longer just from the top-down. The more problems you can try and solve independently without going to your boss, the more likely you are going to impress. This also makes you seem more responsible and valuable ... qualities that your boss will love about you.

3. Offer suggestions that produce results:

There are many things you can do to get ahead in your career, like getting educated. Not surprisingly, improving your skills also improves your job performance. When you have a 360-degree viewpoint of your work, it's easy to identify pain points and offer suggestions that work. Communicate these suggestions to your boss.

4. Make your boss look good:

Find out what the boss wants from you by asking what you can do to improve ... or if there is anything you can do to make their day easier. Be careful not to lose perspective; you and your boss are not the same person. You need to focus on your own path and boost your own reputation as well.

Since your boss is being judged, not only by their individual performance, but also by the performance of employees, the best way to make your boss look good is to make yourself look good first.

5. Communicate effectively at work:

Very likely, your boss has a certain approach or style to effective corporate communications. Some bosses prefer to communicate over the phone rather than by email ... or vice versa. Knowing what your boss likes, or prefers, will help you better communicate with him or her.

Rather than insist on using email, sometimes picking up the phone would work best for them. Show your willingness to work with them in this area. They will appreciate it.

6. Communicate on a personal level:

You don't have to be friends with your boss to have a more personal conversation. Asking how their weekend went or how they're handling a certain situation doesn't require a close bond; it requires a genuine interest. When you can talk on a personal level with your boss, they are likely going to respond and give you time. Everyone appreciates a person who shows concern ... and your boss will too when you take the initiative.

7. Ask for feedback or help:

When you are doing a fine job, it is likely you won't hear from your boss often ... unless he is the demanding, micromanager type. However, don't be over-comfortable when your boss is not on your back... he/she may also be a disengaged boss. Either way, ask for feedback. This will help you find out if you are doing a good job or where you can improve. And it doesn't always have to be negative feedback. Ask what you did well and why it was appreciated. Ask what you can improve on. Be specific.

This kind of feedback not only gives *you* a more focused approach at work, but also gives you an idea of what your boss expects.

8. Offer your help on projects:

Between corporate meetings, responding to emails, and taking phone calls, your boss is likely to be one of the busiest people in the organization. As you can imagine, they will appreciate if you can offload some of their burden and help them meet their deadlines as well.

Offering to help also shows you can take on responsibility and take initiative.

9. Be accountable:

We all want praise and recognition at work when it is due, but rarely do we want to be blamed for something we did wrong. Being accountable will enable you take on responsibility for decisions and actions in the organization, and it helps you grow as a leader. Likely, your boss is also looking for people to delegate work to ... and if you take on the role, which also comes with accountability, it says a lot about you and your leadership qualities.

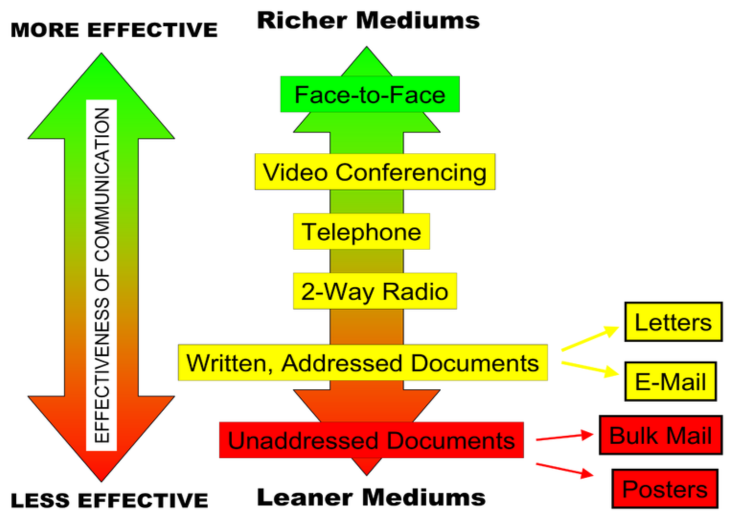
10. Don't complain behind their back:

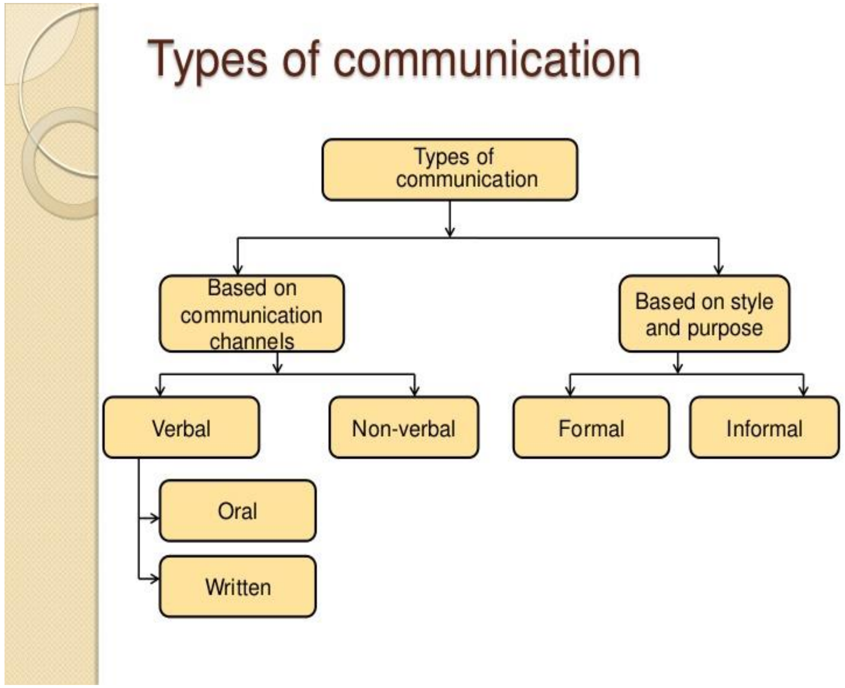
One of the easiest ways to lose your boss's trust is to complain behind their back. Gossip. We've all done it, but it's toxic. And no one likes a toxic influence in the workplace. You will quickly lose favor if you go down this road.

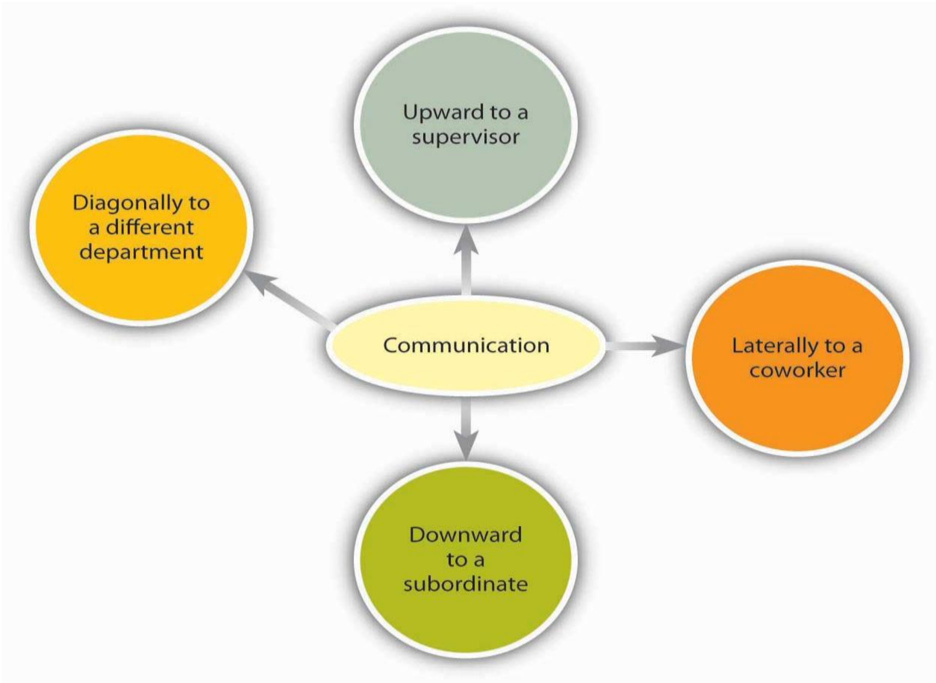
Resist the urge to talk bad about your boss with others in the workplace. Boss bashing says a lot about your character. Discrediting the boss is ultimately discrediting yourself too, since you report to him. It also demeans you, hurts the company, and you come across as both a hypocrite and a coward.

As an executive in a management position, never complain to subordinates. This brings you out as both frustrated and un-empowered which makes your boss less confident about you.

Figure: The flow of vertical communication







Site supervisor

The role of a site supervisor generally involves the management and supervision of a construction site in accordance with health and safety guidelines. It is the responsibility of the site supervisor to assess hazards, determine risks, conduct regular inspections, and maintain a safety programme.

The site supervisor will typically work closely with the site foreman, who is responsible for organising construction works on site, and report to the project manager.

Site supervisors should have relevant experience in construction or civil engineering, as well as appropriate health and safety training.

The responsibilities of a site supervisor may include:

- Supervising workers, subcontractors and work activities.
- Preparing and presenting site inductions, safety briefings and toolbox talks.
- Assessing and managing safety hazards.

- Ensuring appropriate site rules and welfare facilities are in place.
- Carrying out regular inspections.
- Helping project managers to plan the work programme.
- Helping co-ordinate deliveries of materials, plant and equipment.
- Completing records for site reports.
- Attending site management meetings.
- Carrying out regular inspections to ensure compliance with relevant legal requirements, processes and procedures.
- Raising safety concerns at the appropriate level.
- Resolving problems and implementing improvements.
- Organising and overseeing external inspections, such as with a health and safety inspector.
- Providing emergency first aid if required.

Relevant skills of a site supervisor include:

- A positive attitude.
- The ability to communicate with, motivate, and if necessary discipline the workforce.
- The ability to understand drawings and other contract documents.
- A good understanding of safety procedures.
- First aid training.
- Organisational skills.
- The ability to mediate to resolve issues.
- An understanding of legal responsibilities.
- An understanding of welfare and environmental issues.
- An understanding of occupational health and behavioural safety issues.

Site supervision is a vital role in the construction industry, where safety is a key issue – that needs a lot of attention! As the site supervisor, it's your job to both assess and manage safety hazards in the workplace. Responsibilities may also include managing and instructing the site workers, setting goals for the team, and seeing projects through to completion. Here, we're going to look at some of the main duties of the site supervisor, as well as some useful information if you're planning on training as a site supervisor.

The 3 Key Safety Responsibilities

Construction workers need to be aware of all safety hazards and precautions, so that they are safe even when the supervisor isn't there to oversee everything. That's why it is your duty to ensure all traders are inducted before they start work. Contractors need to be aware of site rules, and you should talk to them and their crews on a regular basis about on-site safety.

1. On Site

Your responsibility as a supervisor on site includes assessing various safety hazards, and determining the likelihood of an accident occurring. This involves conducting regular inspections to make sure everything is as it should be, which will involve looking for and fixing any hazards. If you can't fix a hazard, it is still your duty to raise the issue. It's also important that you have an idea of how much of a disruption any potential accidents could cause, and how much they would cost to resolve.

2. Site Workers

It is absolutely vital that each worker knows how to work safely and without risk to their health, and have absolute understanding of the organisation's rules. You can coach, help or guide them to become and remain competent in these areas, as well as others.

You should always know who is working on the site, and it is your responsibility that each individual knows of all potential safety hazards. You should also make yourself as contactable as possible, making sure the right people have your number.

You must make sure there is a safety programme/routine in place so that everyone knows the precautions and actions to take in case of an accident. It is your duty to ensure everyone knows of this, and you should determine the effectiveness of the controls in place. You should be capable of performing emergency first aid at work, so you may need to complete a course and acquire a 'first aid at work' certificate.

Here at SAMS, we offer a variety of courses, including a CIEH Introduction to First Aid, for those looking for a basic overview, as well as CIEH Level 2 Award in Emergency First Aid at Work.

3. Management Approach

As a site supervisor, your main priority is safety, but it may also be your responsibility to motivate and, in some, cases even discipline staff. You may be asked to mentor and encourage members of the team, which is why many companies look for a qualified supervisor with years of experience working as part of a team. It certainly isn't considered an entry level job. You need industry experience and, in some cases, training. This might be in a specific technical skill, or in something more general like business administration.

Are you looking for health and safety courses in Kent? SAMS offers a wide range of training coursesin health and safety management, providing you with the training you need to be the strongest site supervisor you can be. If you are looking to prepare you for dealing with your new responsibilities as a site supervisor then we strongly advise you take the SSSTS course or Site Supervisor Safety Training. Browse our range of training courses to find the right course for you.

- ## Describe potential hazards at site:

Construction Site Hazards:

Nearly 6.5 million people work at approximately 252,000 construction sites across the nation on any given day. The fatal injury rate for the construction industry is higher than the national average in this category for all industries.

Potential hazards for workers in construction include:

- Falls (from heights);
- Trench collapse;
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment; and
- Repetitive motion injuries.

  - "We kill about a person a week in construction" was the sobering statement from Head of Loughborough's Construction Health and Safety Research Unit, Alistair Gibb, in his TEDx Loughborough talk in 2013.
  - Gibb then explained the poor record of construction worker deaths, particularly during Olympic stadium building, which resulted in 29 fatalities in construction for the five games from Barcelona in 1992 to Bejing in 2008. As far as the 2012 London Olympics was concerned, Gibb shared that this was the Olympic record that Lord Coe really wanted to break, being adamant that "no one should die or be harmed" in the building of the London Olympic Stadium.
  - But with fatal accidents in construction industry being double the average of other sectors and with separate incidents and injury commonly accounting for around 2.2 million working days lost each year (HSE, average across 2013-2016) the construction industry is one of the riskiest out there … but what are the risks, and how can they be minimised?

Working at height

  - Unstable working surfaces, and particularly those off the ground, can be commonplace on construction sites. Add to this the multiple risks from restricted mobility and accessibility in high up places, plus the chance of human error, misuse or failure of safety equipment and it becomes apparent how falls from height accounted for 19% of the 65,000 non-fatal accidents on construction sites in 2015/16 and 25 worker deaths in 2016/17.

- **Minimise risks by:** implementing training in safe working practice; use and maintenance of PPE; installation of guardrail and fall protection systems; ensuring equipment is fit for tasks, ie: using the correct ladder / equipment as appropriate.

Collapse

- Construction involves buildings going up and coming down, as well as excavations and the building of trenches. At any given time, collapses could occur in excavations and trenches, scaffolding and walls, through undermining, dangerous structures and accidental collapse as structures are installed, erected or demolished.
- **Minimize risks by:** implementing protective systems for trenches and workers using them; including exit and inspection, retaining and remedial structures; appropriate risk assessment of buildings at risk of collapse or demolition schedules. For guidance creating construction site risk assessments check out the SafeSite Facilities guide.

Moving objects and vehicles

- With vehicles, plant, equipment and movement of materials, the busy nature of construction sites means that moving objects frequently results in on-site fatalities – 20 (11%) of deaths in 2015-16 alone. Particular risk comes from cranes and plant, including forklifts, plus the actual volume of traffic which can form part of a working site - let alone the heavy nature of the equipment and the materials they are transporting and dumping. On top of these factors, it's also significant that movement usually occurs within sites which are uneven, exposed to the elements and difficult to manoeuvre around.
- **Minimise risks by:** creating protected, designated working zones offering barrier protection to pedestrians; incorporating safety features to plant, such as rollover protection to plant including forklifts.

Electricity

- In 2016-2017, electrical hazards, such as shocks and arc flashes or blasts caused 8 worker deaths and numerous injuries. Electrics are hazardous for all workers, not just electricians, as many workers need to consider safety when working close to underground or overhead cables and at height near power lines. When working practices are disorganised and rushed, such as undertaking electrical work in wet conditions or using non-professionals to complete electrical work, electricity presents additional hazards.

- **Minimise risks by:** allowing only qualified electricians to undertake electrical works; adding safety warnings and barrier systems to protect those working alongside overhead cables and power lines; implementing good practice for workplace organisation and phases of work, to reduce risk of incidents.

Manual handling

- Many construction site activities involve manual handling, a hazard which puts workers at risk of musculoskeletal disorders. These account for 64% of construction worker's health complaints - over twice the amount of other industries, and are often the result of repetitive motion injuries, such as hand-arm vibration syndrome. Other physical disorders including back injury, commonly result from frequent use of vibrating power tools and ground working equipment.
- **Minimise risks by:** conducting full risk assessments and introducing protocols and working processes which eliminate risk of prolonged use; full and regular training in what constitutes safe manual handling; use of appropriate, well-maintained lifting equipment, including PPE.

Harmful materials

- Construction involves the use of innumerable tools and materials, many of which are potentially hazardous for workers. Failure to use PPE correctly, or using damaged or inadequate PPE can mean that workers are exposed to harmful materials such as asbestos and long-term risk from dust particles (emanating from plaster, brick, stone, cement).
- Unexpected collapse also means exposure to harmful materials whilst the repeated handling and use of toxic substances such as adhesives, solvents, paints and other corrosive chemical solutions also presents risk. Exposure to such harmful materials can lead to a

range of respiratory conditions, including COPD, asbestosis, asthma and silicosis, whilst harmful corrosive substances can lead to visual and mouth problems.

- **Minimise risks by:** implementing protocols for correct use, checking and maintenance of PPE; full risk assessment which includes storage and handling of harmful materials as well as good practice methods of movement, disposal and clearing of harmful materials; published emergency protocols to follow in the event of accident and spillage, to minimise risk and exposure to staff.

Noise

- The construction site working environment is busy and noisy. Sudden loud volume can be hazardous for workers, but it's also exposure to long-term, repetitive sounds such as drills and compressors which can lead to short or long term problems, including hearing loss. Construction site noise can also present a distraction which can result in accidents.
- **Minimise risks by:** correct use, checking and maintenance of PPE; additional noise risk assessments for workers and the public; role-specific risk assessment for workers undertaking particularly hazardous activities, such as using noisy ground-breaking equipment.

Slips trips and falls

- Hazards affecting balance account for the majority of work-related injuries in construction - 23% of all injuries in 2014/15 resulted from slips, trips and falls. Although it's not surprising that construction sites involve uneven surfaces and unstable terrain, it's surprising that so many accidents happen when many could be prevented.
- **Minimize risks by:** keeping walkways and stairways free of wet, debris and materials which could cause slips; use temporary surfaces to cover holes and excavations; deploy non trip footings; use warning signs; implement protocols for removing spills and for working in bad weather.

- Yet despite all these and more construction site hazards, the London Olympic Park was constructed without fatalities. In fact, the Olympic Delivery Authority's success in delivering this fatality-free major construction project was rewarded with a special Diamond Jubilee award from RoSPA. So what else did the ODA do to minimize risks?
- Dennis Hone, ODA chief executive revealed all in his comment during the awards, stating that "by creating a culture of teamwork and individual responsibility, incidents have been few and far between."
- So as well as looking at the hazards presented by construction sites and implementing rigorous risk assessment and management strategies, there is a clear message that whether you're a construction worker, site manager or company owner, taking responsibility for safety and communicating safety protocols are crucial for improving safety in this hazardous industry. As such, the ODA delivered not just a stunning build and a new record of no fatalities during construction, but also results that the construction industry needs to continue to build on, in order to stop killing a person each week – across all construction projects.

HAZARDS ON SITE

- Heat stress
- Noise
- Mineral dust exposure
- Mechanical hazards
- Electrical hazards
- Radiation
- Chemicals
- Ergonom
- Biologica
- Working
- Confined
- Lighting
- Drowning

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Five General Hazard Areas

1. **Materials** - liquids (i.e., acids, bases, toxins), solids (i.e., wood, metal, plastic), and gasses (flammables, and explosives).
2. **Equipment** - includes machinery, vehicles, tools, and devices.
3. **Environment** - noise, temperature extremes, atmospheres, biological, and workstation design.
4. **People** - anyone in the workplace (i.e., employees, guests, customers or contractors).
5. **System** - flawed policies, programs, plans, processes, procedures, and practices.

- ## Describe how to read and understand the site plan/drawings:

Def: 1) A **site plan** is an architectural plan, landscape architecture document, and a detailed engineering drawing of proposed improvements to a given lot. A site plan usually shows a building footprint, travel ways, parking, drainage facilities, sanitary sewer lines, water lines, trails, lighting, and landscaping and garden elements.
Such a plan of a site is a "graphic representation of the arrangement of buildings, parking, drives, landscaping and any other structure that is part of a development project".

Def: 2) A site plan is a "set of construction drawings that a builder or contractor uses to make improvements to a property. Counties can use the site plan to verify that development codes are being met and as a historical resource. Site plans are often prepared by a design consultant who must be either a licensed engineer, architect, landscape architect or land surveyor".

Def: 3) Site planning in landscape architecture and architecture refers to the organizational stage of the landscape design process. It involves the organization of land use zoning, access, circulation, privacy, security, shelter, land drainage, and other factors. This is done by arranging the compositional elements of landform, planting, water, buildings and paving and building. Site planning generally begins by assessing a potential site for development through site analysis. Information about slope, soils, hydrology, vegetation, parcel ownership, orientation, etc. are assessed and mapped. By determining areas that are poor for development (such as floodplain or steep slopes) and better for development, the planner or architect can assess optimal location and design a structure that works within this space.

How to read and understand the site plan/drawings:

Learning how to read construction 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.

Construction Plans are 2D Drawings:

Construction plans (blueprints) are 2-dimensional architectural drawings that explain the details of a project. They provide a unique visual representation of what exactly needs to be built. Information such as dimensions, parts, placement, and materials for each project can all be found in construction drawings to assure the project is completed correctly. 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 standards.

Construction Plans Come in Different Sizes:

Depending on the size and complexity of a project, some construction plans will require to be printed on oversized sheets while others may fit in the confines of a notebook.

With the continued advancement of technology throughout the construction industry, digital plans are becoming increasingly popular due to ease of making edits and sharing plans among construction team members. Regardless of how the plans are presented, the importance of understanding construction drawings remains a top priority. From residential construction jobs to large commercial projects, construction plans are required to estimate your costs for materials and labour, obtain your permits, establish a construction schedule, and complete the project in a timely manner. Every project is unique therefore how you interpret the information is critical. It is a lot like having your own language as a construction worker. You need to understand everything on the construction plan (blueprint) to complete the project under budget and ahead of schedule.

What is Included in a Set of Construction Plans?

When learning how to read construction plans, it is essential to understand what is contained within typical construction plans. Most include a cover page, time block, key notes, general notes, revision block, drawing scale and a legend.

It is crucial that you read everything and understand it before you estimate or start the construction project!

Cover Page:
This page usually contains a drawing of the actual project. It also includes the title block, revision block, notes, drawing scale and the legend.

Title Block:

construction work, you will want to make sure to read it thoroughly and understand it before starting the project!

The shape, size, and placement of the title block can vary. This area of the sheet contains important information about the project as well as the company, typically a professional design firm that created it. You will see things like copyright information, revision date, plan number, creation date, scale of the drawing, and sheet number. The title block's first section lists the blueprint's name, number, and address as well as the location, site, or vendor. If the drawing is part of a set, that information will also be included. This allows for easy filing and organization. Every block or cell contains an important piece of data. If there is a blank in the title block, the drawing is not ready for release. The authority (checker or engineer) will not sign it if there is missing information.

The second section of the title block contains routine information. Approval dates and signatures are located here. Should you need more information regarding a project's construction plans, this information should include contact information for further discussion.

The final section of the title block is the list of references. This section lists all other drawings that are related to the building, system, component, as well as all construction plans (blueprints) that were used as a reference or to inspire the project.

Revision Block:
Any time there is change to a building, system, or component, the drawing must be redrafted. Those changes are listed in the Revision Block – usually with a date as well.

Drawing Scale:

Construction plans (blueprints) are scaled down representations of the final project at a ratio of the actual size. For example, 1/8″ = 1′ (one eighth inch equals one foot). When construction plans are scaled, it helps to put the part into a print size drawing that is easily read by the crew.

Key Notes:

The notes will reveal any specifications, details, or information the designer (engineer) thinks may help you understand the drawing. Some notes may even include information as to when the project start time is, for example, “Do not begin work until 7 am.” Information like this can be beneficial to the crew and might even be a requirement of the municipality in which the work is taking place.

General Notes:

General notes eliminate the use of lengthy written explanations. It is a note that provides technical information that will apply to the entire drawing.

Legend:

When learning how to read construction plans, one of the most important components is the legend. The legend is used to define the symbols used in the construction plans (blueprint).

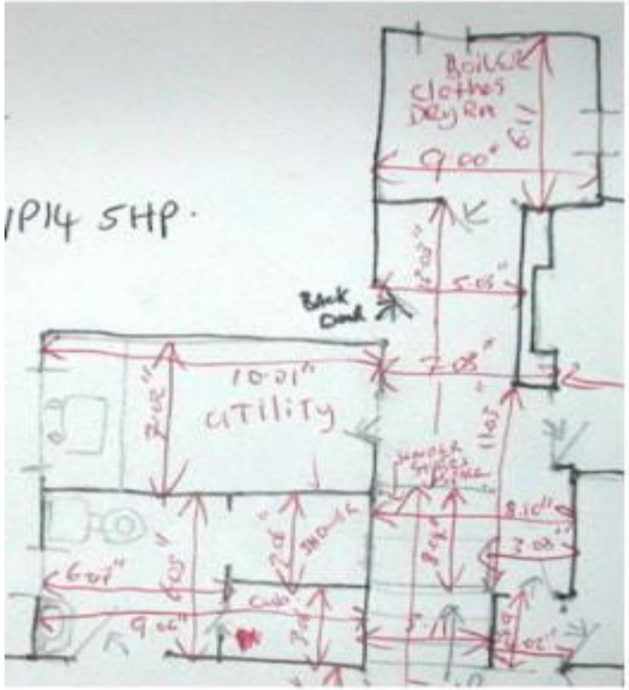
In some cases, similar symbols can have different meanings depending on the line of work being performed. Your company might also have their own symbols for certain items. The important thing is that you understand the meaning of the symbols regarding the plans you are reviewing.

In addition to the above mentioned construction plans are also often composed of industry-specific symbols. Be sure you understand what those symbols represent by reviewing the legend for the drawing that you’re working with.

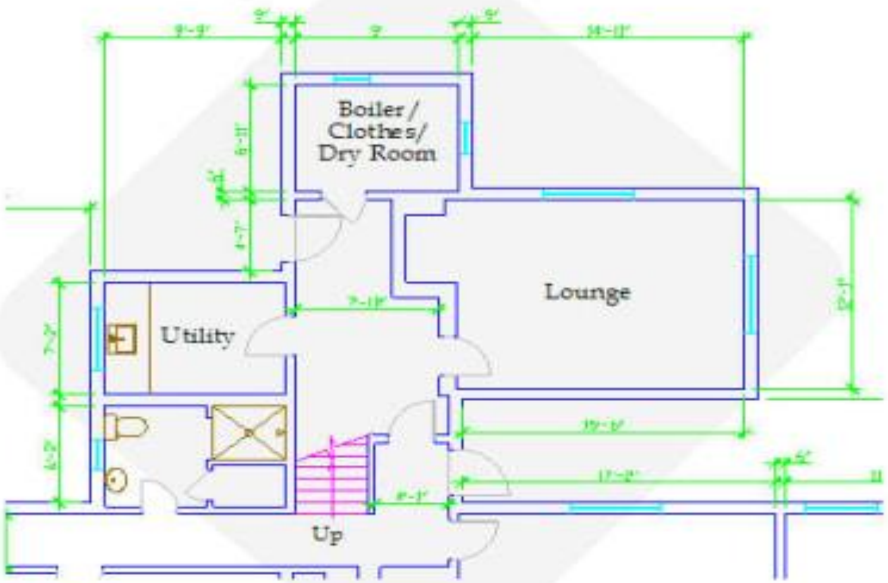
A roofing project, for example, will have symbols for items located on a roof such as HVAC units or skylights, while an electrical plan will have symbols for outlets and conduits.


sketch floor plans
an architect's TUTORIAL

Before



After




MASTER SUITE
14' x 17'
BREAKFAST NOOK
9' x 9'
COVERED PORCH
BEDROOM #3
11' x 12'
KITCHEN
LIVING ROOM
16' x 20'
BATH #2
M. BATH
W.I.R.
BEDROOM #2
11' x 12'
DINING ROOM
LAUNDRY
FOYER
2 CAR GARAGE
ENTRY

DECK
3.7 x 1.8
DECK
4.0 x 2.4
MASTER
BEDROOM
4.6 x 4.0
WIC
CLOSET
GREAT
ROOM
7.2 x 5.5
MASTER
BATH
2.9 x 3.2
POWDER
FOYER
DINING
ROOM
3.5 x 3.0
ENTRY
COURTYARD
KITCHEN
3.5 x 4.3
LAUNDRY
1.7 x 2.8
GOLF
CART
1-CAR
GARAGE
6.4 x 4.4
BATH
4.7 x 2.8
CLOSET
BEDROOM
4.0 x 3.9

Describe potential hazards at site:

A construction site is any piece of land where a building is being built or repaired. Those who work on construction sites are often required to use large tools and pieces of machinery, work at height, and in environments where hazardous materials are present. Because of the nature of such work, working on construction sites can be dangerous.

Ten Common Construction Site Hazards:

The top ten risks and hazards from working on construction sites are:

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

1. **Working at Height:**

The Health and Safety Executive (HSE) found that, in 2015/16, just over a quarter of worker fatalities were from a fall from height. This put working at height as the most common cause of fatal injuries to workers.

Suitable training is required for all employees who work at height. Employees should be trained in working on different pieces of equipment and surfaces, such as how to work safely on scaffolding, ladders, and roofs.

The law requires that all employers must assess the risks from working at height. A plan should then be devised to ensure all work is carried out safely. The employee must have received the correct training in working at height, and must be aware of the safety procedures they should follow when doing so.

Working at height must be properly planned and supervised, and certain approaches and precautions should be adopted. These are:

- Avoid working at height where possible. For example, if something can be assembled on ground level, do it there.
- Use equipment with an extra level of safety to reduce the risk of a fatal fall. For example, a scaffold with a double guard-rail.
- Minimize the consequences of a fall, for example by providing a safety net.

2. **Moving Objects:**

A construction site is an ever-changing environment, and construction hazards continue to increase as construction is underway. There are many moving objects commonly encountered on construction sites. These include overhead lifting equipment, supply vehicles, and diggers, all of which move around a usually uneven terrain.

Reducing risks should always be a priority. Workers should always:

- Avoid working close to the moving object.
- Be vigilant of their surroundings, especially if the object does not have lights or beepers.
- Wear Personal Protective Equipment (PPE), such as a high visibility jacket, to ensure they are seen.

3. **Slips, Trips, and Falls:**

Slips, trips, and falls can happen in almost any environment. As construction sites often have uneven terrain, buildings at various stages of completion, and unused materials on site, it is unsurprising that slips, trips, and falls are a common hazard.

HSE reports that several thousand construction workers are injured every year following a slip or trip, and that most of these could be avoided by effectively managing working areas and access routes, such as stairwells and footpaths.

Those in control of construction sites must effectively manage the site so that workers can move around it safely. Risks should always be reported and sorted to reduce the chances of injury.

Some causes of slips and trips and how to prevent them include:

- **Uneven surfaces** – The risk of these can be reduced by providing walkways that are clearly designated as walkways, having good conditions underfoot, and being well lit.

- **Obstacles** – Instances of slipping and tripping over obstacles can be dramatically reduced by everyone keeping their work and storage areas tidy and designating specific areas for waste collection.
- **Trailing cables –** Cordless tools should be used where possible. If this is not possible, cables should be run at high levels.
- **Wet or slippery surfaces** – If a surface is slippery with mud it should be treated with stone, and if it is slippery with ice it should be treated with grit. Any areas that are slippery should be signposted, and footwear with a good grip should be worn.

4. **Noise:**

Construction is noisy and, as a result, noise is a common construction hazard. Loud, repetitive, and excessive noise causes long term hearing problems, such as deafness. Noise can also be a dangerous distraction and may distract the worker from the task at hand, which can cause accidents. It is the employer’s responsibility to carry out a comprehensive noise risk assessment, and provide appropriate PPE where necessary.

5. **Hand Arm Vibration Syndrome:**

Hand Arm Vibration Syndrome (HAVS) is a painful and debilitating disease of the blood vessels, nerves, and joints. It is usually caused by the prolonged use of hand-held power tools, including vibratory power tools and ground working equipment.

HAVS is preventable, however once the damage is done, it is permanent. HSE reports that nearly 2 million people are at risk of developing HAVS. Damage from the disease can include the inability to do fine work, and cold temperatures can trigger painful attacks in the fingers.

Construction workers should be given appropriate protection when using vibrating tools, and equipment should be well maintained.

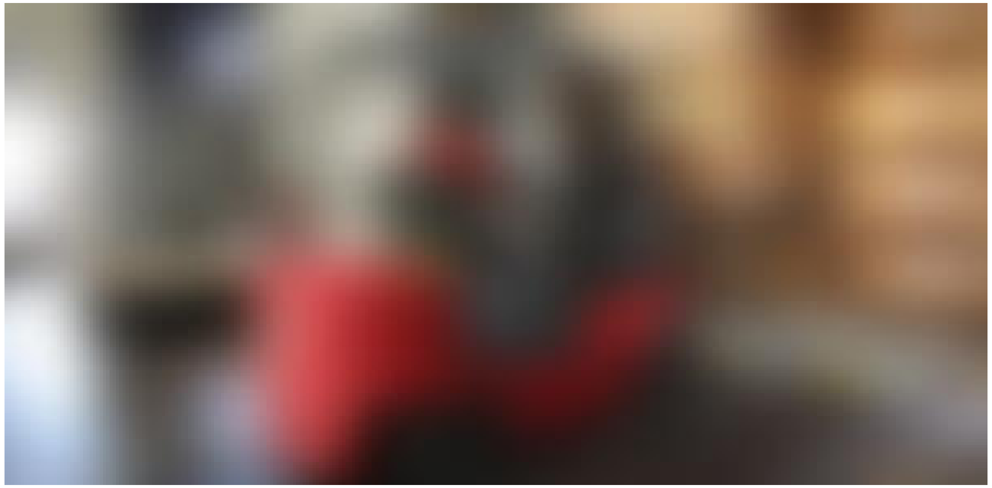

6. Material and Manual Handling:

Materials and equipment are constantly being lifted and moved around construction sites, whether this be manually or by equipment. Either way, handling carries a degree of risk.


KNOW THE COMMON HAZARDS
Here's a quick look at a few common hazards associated with forklifts.
Unsecured load may fall, crushing pedestrians or drivers.
Forklifts may tip over, due to excessive speed or imbalanced loads.
Drivers may not see pedestrians, leading to collisions and fatal accidents
Workers may fall if they stand on the forks.
FORKLIFT SAFETY
transit/safety.


Preventing Hazards
– Avoiding excess weight
• Do not exceed weight capacity of forklift.
• Center loads and secure to keep from shifting to maintain balance of weight

7. Collapsing Trenches:

A common occurrence on construction sites is the collapsing of trenches with workers inside. Further, a building that is being demolished or under construction can suddenly and unexpectedly collapse, which can seriously injure, or even kill, those inside. Precautions for collapse need to be taken before work starts. If the project requires a trench, site managers should:

- Consider the kind of support that is best suited for the trench.
- Ensure the trench is fully secure.
- Regularly inspect the trench both before and during the work shift.


PRO
SAFETY SOLUTIONS

8. Asbestos:

Asbestos refers to a set of six naturally occurring fibrous minerals. When materials that contain asbestos are disturbed or damaged, these fibres are released into the air. Inhaling these fibres can cause **fatal and serious diseases** such as lung cancer, asbestosis, and pleural thickening.

Asbestos kills around **5,000 workers per year**, and an average of 20 trades people die every week as a result of past exposure. An estimated 500,000 public buildings in the UK are thought to contain asbestos.

If there is asbestos on the construction site, workers must be informed where it is. They must be trained in what to do should they come across suspicious materials that may contain asbestos.

9. Electricity:

It is harmful to be exposed to electrical live parts. Harm can occur either by touching live parts directly, or indirectly by a conducting object or material. HSE reports that 1,000 electrical accidents at work are reported every year. Most of these accidents arise from contact with overhead or underground power cables and electrical equipment/machinery. Electric shocks are a common cause for falls from ladders, scaffolds, and other work platforms. There is also a growing number of electrocutions involving workers who are not qualified electricians, but who are carrying out electrical work on construction sites.




10. Airborne Fibers and Materials:

Unsurprisingly, a lot of dust is produced on construction sites. The dust on construction sites is often an invisible, fine, and toxic mixture of hazardous materials and fibres. This can damage the lungs and lead to diseases such as chronic obstructive pulmonary disease, asthma, and silicosis. It is the duty of all employers to ensure protective equipment is used. Simply providing it is not enough.

LU2. Ensure work procedures	• Identify equipment and attachments needed to do the job • Determine appropriate starting point • Identify access and exit points on site • Plan work procedures for efficiency, effectiveness and safety • Sequence job tasks to co-ordinate activities with others	• Describe and enlist equipment and attachments to perform the job • Describe the appropriate starting, exit and access points of site • Describe work procedures for efficiency, effectiveness and safety • Describe work activities and estimated completion time	

- **Describe and enlist equipment and attachments to perform the job:**

Tools are particularly important in construction work. They are primarily used to put things together (e.g., hammers and nail guns) or to take them apart (e.g., jackhammers and saws). Tools are often classified as *hand tools* and *power tools*. Hand tools include all non-powered tools, such as hammers and pliers. Power tools are divided into classes, depending on the power source: electrical tools (powered by electricity), pneumatic tools (powered by compressed air), liquid-fuel tools (usually powered by gasoline), powder-actuated tools (usually powered by an explosive and operated like a gun) and hydraulic tools (powered by pressure from a liquid). Each type presents some unique safety problems.

Hand tools include a wide range of tools, from axes to wrenches. The primary hazard from hand tools is being struck by the tool or by a piece of the material being worked on. Eye injuries are very common from the use of hand tools, as a piece of wood or metal can fly off and lodge in the eye. Some of the major problems are using the wrong tool for the job or a tool that has not been properly maintained. The size of the tool is important: some women and men with relatively small hands have difficulty with large tools. Dull tools can make the work much harder, require more force and result in more injuries. A chisel with a mushroomed head might shatter on impact and send fragments flying. It is also important to have the proper work surface. Cutting material at an awkward angle can result in a loss of balance and an injury. In addition, hand tools can produce sparks that can ignite explosions if the work is being done around flammable liquids or vapours. In such cases, spark-resistant tools, such as those made from brass or aluminium, are needed.

Power tools, in general, are more dangerous than hand tools, because the power of the tool is increased. The biggest dangers from power tools are from accidental start-up and slipping or losing one's balance during use. The power source itself can cause injuries or death, for example, through electrocution with electrical tools or gasoline explosions from liquid-fuel tools. Most power tools have a guard to protect the moving parts while the tool is not in operation. These guards need to be in working order and not overridden. A portable circular saw, for example, should have an upper guard covering the top half of the blade and a retractable lower guard which covers the teeth while the saw is not operating. The retractable guard should automatically return to cover the lower half of the blade when the tool is finished working. Power tools often also have safety switches that shut off the tool as soon as a switch is released. Other tools have catches that must be engaged before the tool can operate. One example is a fastening tool that must be pressed against the surface with a certain amount of pressure before it will fire.

One of the main hazards of *electrical tools* is the risk of electrocution. A frayed wire or a tool that does not have a ground (that directs the electrical circuit to the ground in an emergency) can result in electricity running through the body and death by electrocution. This can be prevented by using double-insulated tools (insulated wires in an insulated housing), grounded tools and ground-fault circuit interrupters (which will detect a leak of electricity from a wire and automatically shut off the tool); by never using electrical tools in damp or wet locations; and by wearing insulated gloves and safety footwear. Power cords have to be protected from abuse and damage.

Other types of power tools include powered abrasive-wheel tools, like grinding, cutting or buffing wheels, which present the risk of flying fragments coming off the wheel. The wheel should be tested to make sure it is not cracked and will not fly apart during use. It should spin freely on its spindle. The user should never stand directly in front of the wheel during start-up, in case it breaks. Eye protection is essential when using these tools.

Pneumatic tools include chippers, drills, hammers and sanders. Some pneumatic tools shoot fasteners at high speed and pressure into surfaces and, as a result, present the risk of shooting fasteners into the user or others. If the object being fastened is thin, the fastener may go through it and strike someone at a distance. These tools can also be noisy and cause hearing loss. Air hoses should be well connected before use to prevent them from disconnecting and whipping around. Air hoses should be protected from abuse and damage as well. Compressed-air guns should never be pointed at anyone or against oneself. Eye, face and hearing protection should be required. Jackhammer users should also wear foot protection in case these heavy tools are dropped.

Gas-powered tools present fuel explosion hazards, particularly during filling. They should be filled only after they have been shut down and allowed to cool off. Proper ventilation must be provided if they are being filled in a closed space. Using these tools in a closed space can also cause problems from carbon monoxide exposure.

Powder-actuated tools are like loaded guns and should be operated only by specially trained personnel. They should never be loaded until immediately before use and should never left loaded and unattended. Firing requires two motions: bringing the tool into position and pulling the trigger. Powder-actuated tools should require at least 5 pounds (2.3 kg) of pressure against the surface before they can be fired. These tools should not be used in explosive atmospheres. They should never be pointed at anyone and should be inspected before each use. These tools should have a safety shield at the end of the muzzle to prevent the release of flying fragments during firing. Defective tools should be taken out of service immediately and tagged or locked out to make sure no one else uses them until they are fixed. Powder-actuated fastening tools should not be fired into material where the fastener could pass through and hit somebody, nor should these tools be used near an edge where material might splinter and break off.

Hydraulic power tools should use a fire-resistant fluid and be operated under safe pressures. A jack should have a safety mechanism to prevent it from being jacked up too high and should display its load limit prominently. Jacks have to be set up on a level surface, centred, bear against a level surface and apply force evenly to be used safely.

In general, tools should be inspected before use, be well-maintained, be operated according to the manufacturer’s instructions and be operated with safety systems (e.g., guards). Users should have proper PPE, such as safety glasses.

Tools can present two other hazards that are often overlooked: vibration and sprains and strains. Power tools present a considerable vibration hazard to workers. The most well-known example is chain-saw vibration, which can result in “white-finger” disease, where the nerves and blood vessels in the hands are damaged. Other power tools can present hazardous exposures to vibration for construction workers. As much as possible, workers and contractors should purchase tools where vibration has been dampened or reduced; anti-vibration gloves have not been shown to solve this problem.

Poorly designed tools can also contribute to fatigue from awkward postures or grips, which, in turn, can also lead to accidents. Many tools are not designed for use by left-handed workers or individuals with small hands. Use of gloves can make it harder to grip a tool properly and requires tighter gripping of power tools, which can result in excessive fatigue. Use of tools by construction workers for repetitive jobs can also lead to cumulative trauma disorders, like carpal tunnel syndrome or tendinitis. Using the right tool for the job and choosing tools with the best design features that feel most comfortable in the hand while working can assist in avoiding these problems.

Equipment, Machinery and Materials:

Construction work has undergone major changes. Once dependent upon craftsmanship with simple mechanical aids, the industry now relies largely on machines and equipment.

New equipment, machinery, materials and methods have contributed to the industry's development. Around the middle of the 20th century, building cranes appeared, as did new materials like light-weight concrete. As time went on, the industry began using prefabricated construction units along with new techniques in the construction of buildings. Designers began to use computers. Thanks to such equipment as lifting devices, some of the work has become easier physically, but it has also become more complicated.

Instead of small, basic materials, such as bricks, tiles, board and light concrete, prefabricated construction units are commonly used today. Equipment has expanded from simple hand tools and transport facilities to complex machinery. Similarly, methods have changed, for instance, from wheel barrowing to the pumping of concrete and from manual lifting of materials to the lifting of integrated elements with the assistance of cranes.

• Describe the appropriate starting, exit and access points of site:

Starting Point of Site:

Site analysis is a preliminary phase of architectural and urban design processes dedicated to the study of the climatic, geographical, historical, legal, and infrastructural context of a specific site.

The result of this analytic process is a summary, usually a graphical sketch, which sets in relation the relevant environmental information with the morphology of the site in terms of parcel, topography, and built environment. This result is then used as a starting point for the development of environment-related strategies during the design process.

A number of graphical tools for site analysis have been developed to assist designers in this task. Examples of traditional climate-related site analysis tools are the Sundial, the Sun Path Diagram the Radiation Square the Wind Rose, and the Wind Square. These conventional methods of site analysis are efficient in simple sites with irrelevant close obstructions, where the analysis can be reduced to the parcel at the ground level or even exclusively to its centre point. More elaborated techniques, like Volumetric Site Analysis, can instead be used to study more intricate and obstructed sites like those of high and dense urban settings.

Numerous elements go into a given site analysis. These elements include location, neighbourhood context, site and zoning, legal elements, natural physical features, human-made features, circulation, utilities, sensory, human and cultural, and climate components. The following elements typically are considered in most sites:

- **Location:** The site should be related to major streets or landmarks previously existing. Aerial photographs help in this assessment stage. There should be documentation of distances and time from major places. This should be completed by either driving or walking the distance first-hand.

- **Neighborhood Context**: Zoning of the neighborhood is important and information of this type can typically be found at the municipal planning department of the site. Numerous issues at this stage require direct observation. Features of this sort include architectural patterns, street lighting, and condition of existing buildings. This would also include the immediate surroundings of the site. The reaction of the surrounding buildings towards the site and people moving around should be analyzed. Other important components of the neighborhood context include an analysis of existing paths (pedestrian, cyclist, and vehicle), landmarks and nodes. Landmarks are distinctive sites that provide way-finding for people in the area, and which define the character of a neighborhood. Nodes are key public gathering places that encourage people to linger and socialize.

- **Site and Zoning:** Site boundaries can be located by either verifying the dimensions physically or contacting the county tax assessor's office. Zoning classifications, set-backs, height restrictions, allowable site coverage, uses, and parking requirements are obtained by obtaining zoning classifications from a zoning map, which can be located from the city planning department. Infrastructure, social, and political boundaries.

- **Legal:** Typical legal information can be obtained from the deed to the property. The deed is held by the owner of the title insurance company. In the deed is information such as the property description, present ownership, and the governmental jurisdiction the site is located in, and the city or county.
- **Natural physical features:** Most of this information will be derived from the topographic features on the site. A contour map of this magnitude can be located from the survey engineer. Drainage problems as well as existing natural features of trees, ground cover, ground texture, and soil conditions on the site should be directly observed.

- **Human-made features:** Features located on the site such as buildings, walls, fences, patios, plazas, bus stop shelters should be noted. The site and location of such features should be directly measured. Documentation of existing historical districts should be made, some of which may already have reports completed. Locating this information can be done through the municipal planning department for the site.

- **Circulation:** The uses of streets, roads, alleys, sidewalks, and plazas are important in this inventory step. It is not necessarily an analysis of these elements but more an analysis of what occurs on these circulation gateways.

- **Utilities:** Information for utilities concerning the site can be found through the utility departments and companies in the local area. Generally, the company has a print of the drawing of this information needed. Information in this print includes the location of all utilities and their locations around or on the site itself.

- **Sensory:** Much of the sensory information collected will be done through first hand experience. The information is obtained from sketching and photographs (sometimes aerial photographs). Direct observation of other sensory elements of noise, odors, smoke, and pollutant areas must also be completed.

- **<u>Human and cultural:</u>** This information can be obtained through census statistics on the neighborhood. Information regarding these statistics is available from the local municipal planning agency. This information includes activities among people on the site and their relationships to these activities.
- **<u>Climate:</u>** This information can be obtained through the local weather service or any third party services such as Easy Site Analysis. Conditions such as <u>rainfall</u>, <u>snowfall</u>, <u>humidity</u>, and <u>temperature</u> over months must be considered and analyzed. The sun-path and vertical sun angles throughout an entire year are important to note.

<u>Exit Point of Site:</u>

The exit routes have to be located as far away from each other as possible so that if one route is blocked by fire or smoke, employees can use the other route to escape. However, a single exit route is allowed where the number of employees, the size of the building, or the arrangement of the workplace would enable all employees to exit safely during an emergency.

Fire escapes, accessible windows, or other means of escape should be available where only one exit route is provided. In some workplaces, more than two exit routes may be necessary to safely evacuate all employees.

An exit route is made up of three components:

1. **Exit access:** The portion of the exit route that leads to an exit.
2. **Exit:** The part of the exit route that is usually separated from other areas to provide a protected way of travel to the exit discharge.
3. **Exit discharge:** The part of the exit route that leads directly outside or to a street, walkway, refuge area, public way, or open space with access to the outside.

Other requirements that apply to exit routes include the following:

- Exit doors must be unlocked at all times.
- A side-hinged exit door must be used.
- Doors that connect any room to an exit route must swing out in the direction of travel.

- Exit routes must be at least 28 inches wide at all points.
- Exit routes must be unobstructed and free from clutter.
- Adequate lighting (including emergency lighting) must be provided so that an employee with normal vision can see along the exit route.
- Each exit must be clearly visible and marked by a sign reading “Exit”.
- Decorations or signs may not block the visibility of the exit route door.
- Signs must be posted along the exit route to show the nearest exit and how to get there.
- The line of sight to the exit sign must be clearly visible at all times.
- Any doors or passages that could be mistaken for an exit should be marked as “Not an Exit” or for its actual use (e.g., closet).
- Exit signs must be lit with a reliable light source and a distinctive color. The specific requirements require each sign to be illuminated to a surface value of at least five foot-candles (54 lux) and also allow for self-luminous or electroluminescent signs.

Tips on How to Prioritize, Organize, and Plan Your Work

Time is one of the most significant things that we have in the world. It is a necessary yet tragically limited resource. In this exceedingly frantic and fast-paced world, the ability to manage time properly is a must.

Time management is essential in achieving your goals and getting your work done. With time management comes organizing, planning, and prioritizing, but why would the interviewer ask about this? The company is interested in how well you manage your time because they want to see if you do your work in an organized way, they want to know your strategies for completing a given task in a short span of time, and they want to determine what your priorities are.

Prioritizing your work is not that easy. You have to identify which things need to be done first. It is a crucial process, but once you get used to it, organizing and planning will be less difficult. If you know how to effectively organize and prioritize your workload, you will learn how to be more efficient and productive.

How do you organize and plan your work? What are your priorities? There is no right or wrong way to answer these questions. The way you do things is ultimately up to you. People are different, so what works for you may not work for someone else. Still, there are some guidelines that can help you in prioritizing your work and answering questions about your time management skills.

1. Make your to-do list.

Listing on paper what you want to accomplish for the day is an effective way to remember the things you need to do. It can be a weekly to-do list, but daily ones are more effective. Write your list on a notepad, starting with the important tasks and then adding the less important ones.

2. Rank your to-do list.

After writing your tasks on a notepad, rank them from the most important to the least. Rewrite your list on another page, and make sure that your handwriting is legible. Tip: Did you know that usually bigger fonts can motivate you to complete the task more than small fonts?

3. Post your to-do list.

Put your to-do list somewhere you can always see it: on your planner or calendar, in your wallet or purse, cell phone (type it in your memo section), or on the board in your office. If you always see the list, you'll never forget that you have something to do.

4. Note your responsibilities.

Type or write in bulletpoints some notes about your reminder. For example, you can write the exact time when you have to finish the task, materials that you need for the task, or the name of the person that you're about to meet (if the task is a meeting). Notes are especially important for people who forget things easily.

5. Avoid unnecessary tasks.

When you're done writing your to-do list for the day/week, try to analyze the less important task/s in terms of whether you really need to do it/them. If so, then you may need to adjust your schedule for the day; if not, then you can allocate more time for the other tasks or you can just take that opportunity to rest.

6. Set realistic deadlines.

When you're working on something and a deadline was set by your boss, set your own deadline ahead of the deadline that your boss gave you. However, set realistic ones. Don't try to rush yourself just to finish it earlier. Take everything one step at a time and don't set yourself up for failure.

This is also applicable for your everyday work. Don't overwhelm yourself. You don't want to force yourself to finish something and then suffer the consequences of creating poor-quality work.

7. Set your break time.

Working all day with no break is not fun. If you're already tired, take a break. There's nothing wrong with a 10- to 15-minute food break or a quick nap. Drink coffee when you need or want to. Stretch when your body feels cramped. A rule of thumb: rest for ten minutes after every hour of work.

8. Put away distractions.

In this modern world, a lot of things can distract us from doing our work. These include camera phones, mobile devices, gadgets, the World Wide Web (especially Facebook and Twitter), and many more. How are you supposed to finish your work if you spend your time on these things?

Put away the things that distract you. Don't check your inbox every minute; you can do this during your breaks from work or schedule time slots in your day to check. Once you learn to pay less attention to these things, getting the job done will be much easier.

The key to productivity is good time management. Prioritizing is difficult but is also essential if you want to get things done. Aside from being more efficient and productive, it will also help you alleviate stress in your life. Learning how to prioritize is not an impossible task; you just have to determine what needs to be done and how much time you need to do it.

LU3. Follow symbols and markings	• Identify survey markers, grade and stakes • Differentiate between survey markers, construction grades and stakes	• Describe the method of survey markers, grade and stakes • Describe the difference between survey markers, construction grades and stakes	

- **Describe the method of survey markers, grade and stakes:**

Method of Survey Markers:

Survey markers, also called **survey marks**, **survey monuments**, **survey benchmarks** or **geodetic marks**, are objects placed to mark key survey points on the Earth's surface. They are used in geodetic and land surveying. Informally, such marks are referred to as benchmarks,[1] although strictly speaking the term "benchmark" is reserved for marks that indicate elevation. Horizontal position markers used for triangulation are also known as triangulation stations.
All sorts of different objects, ranging from the familiar brass disks to liquor bottles, clay pots, and rock cairns, have been used over the years as survey markers. Some truly monumental markers have been used to designate tri-points, or the meeting points of three or more countries. In the 19th century, these marks were often drill holes in rock ledges, crosses or triangles chiselled in rock, or copper or brass bolts sunk into bedrock.





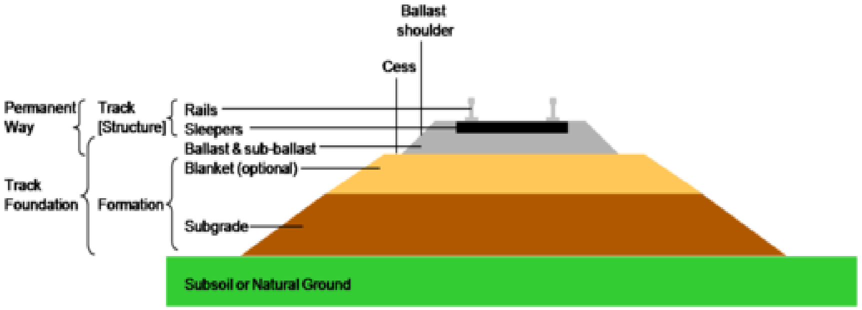


Method of Grading:

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope, for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage.

The earthworks created for such a purpose are often called the sub-grade or finished contouring. It is often done using heavy machinery like bulldozers and excavators to roughly prepare an area and then using a grader for a finer finish.

In the environmental design professions grading and regrading are a specifications and construction component in landscape design, landscape architecture, and architecture projects. It is used for buildings or outdoor amenities regarding foundations and footings, slope terracing and stabilizing, aesthetic contouring, and directing surface runoff drainage of storm water and domestic/irrigation runoff flows.



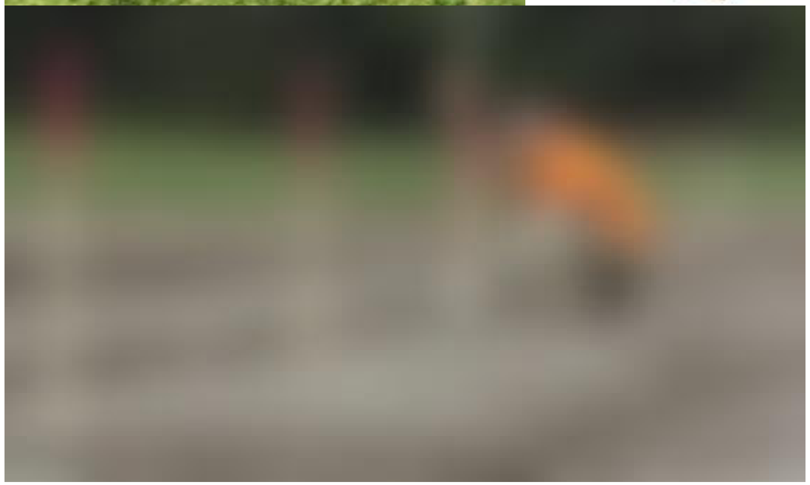
Methods of Survey Stakes:

Control of alignment and grade during construction is established through the use of **survey stakes**. Stakes are generally made of wood in different sizes. Based on the use of the stake they are called *alignment stakes, offset stakes, grade stakes, and slope stakes*.

Survey stakes are markers surveyors use in surveying projects to prepare job sites, mark out property boundaries, and provide information about claims on natural resources like timber and minerals. They can be made from wood, metal, plastic, and other materials and typically come in a range of sizes and colours for different purposes. Sources can include surveying and construction suppliers, and people can also make or order their own for custom applications.

A survey stake is typically small, with a pointed end to make it easy to drive into the earth. It may be color-coded or have a space for people to write information on the stake. Surveyors use stakes when assessing sites to mark out boundaries, record data, and convey information to other people. On a job site, for example, survey stakes indicate where it is necessary to backfill with soil to raise the elevation, or to cut soil away to lower it. Stakes can also provide information about slope and grading for people getting a job site ready for construction.



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Construction Staking, also known as a Site Layout Survey, is the process of interpreting construction plans and marking the location of proposed new structures such as roads or buildings. Construction staking is performed to ensure a project is built according to engineering design plans. The staked reference points guide the construction of proposed improvements on the property, and will help to ensure the construction project is completed on schedule, on budget and as intended.

Accurate construction staking is a critical step in ensuring the success of a construction project. Engaging an experienced and licensed surveyor will guarantee accuracy and reliability of results.

During site development, the land surveyor takes the engineer's or architect's design shown on their plans and places (stakes) their correct location on the ground so the construction sub-contractors can place the buildings, roads, fences, electrical and other underground utilities, etc. in their correct location.

Construction staking may consist of Rough Grade Staking to map the general location on improvements at a site, or precise Site Layout Surveys for actual construction purposes.

Rough Grade Staking Rough Grade Staking defines the location of the site improvements with their respective reference to the location and final grade elevation. This is done for the construction of slopes, building outlines, parking lots and roadways, and enables the contractor to grade and prepare the site for the next sub-contractor to commence his work.

Site Layout Staking Once the site has received inspection and approval from the local agency, the contractor can move right into the various stages of construction of the underground utilities, retaining walls, buildings, site lighting and parking lot or street paving.

This Site Layout Staking phase typically begins with those features that are underground such as sanitary sewer lines, storm drain lines, water lines, electrical lines etc. Once all underground utilities are installed the above ground features are staked for construction. The building corners are staked along with any interior grid lines throughout the building, as well as onsite items such as fire hydrants, curb and gutter, walls/planters, catch basins and area drains.

Grading (Engineering)

Grading in civil engineering and landscape architectural construction is the work of ensuring a level base, or one with a specified slope,[1] for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage. The earthworks created for such a purpose are often called the **sub-grade** or **finished contouring** (see diagram).

Grade level

Grade refers to the construction level relative to the ground around it. Below grade is below ground level, on grade is at ground level, and above grade is above ground level.

Subgrade

In transport engineering, **subgrade** is the native material underneath a constructed road,[1] pavement or railway track (US: railroad track). It is also called **formation level**.

The term can also refer to imported material that has been used to build an embankment.

Construction

Subgrades are commonly compacted before the construction of a road, pavement or railway track, and are sometimes stabilized by the addition of asphalt, lime, portland cement or other modifiers. The subgrade is the foundation of the pavement structure, on which the subbase is laid down.

The load-bearing strength of subgrade is measured by California Bearing Ratio (CBR) test, falling weight deflect to meterback calculations and other methods.

Construction Stakes and how to read them:

https://www.youtube.com/watch?v=1DR2JbueLho
https://www.youtube.com/watch?v=JlLW0TWgj0w
https://www.youtube.com/watch?v=2T2JWvZCF2Y

LU4. Follow survey markers, construction grades, and stakes	• Recognize symbols • Identify markings on job site	• Describe types of survey marker,symbols and their identification	

Describe types of survey marker,symbols and their identification:

The following guide is a simplified description of a variety of markings that are used by land surveyors. Throughout an active shale gas field, the first signs of pending expansions are the simple markings of stakes, flags, and pins. Many months or even years before the chain saw fells the first tree or the first dozer blade cuts the dirt at a well pad location, the surveyors have “marked the target” on behalf of their corporate tactical command staff.

The three most commonly used markings are the simple **stakes**, **flags** and **pins**. These surveyor symbols are common to any construction project and guarantee that everything gets put in the right place. In an active gas field, these marking tools are used for all aspects of exploration and production:

- access roads to well pads,
- widening the traveled portion of the roadway,
- well locations,
- ponds and impoundment locations,
- temporary water pipeline paths,
- surface disturbance limits,
- compressor stations,
- gas processing sites, and
- rights-of-way for roads and pipelines.

Quite frequently these simple markings are undecipherable by themselves, especially by non-professionals. One cannot just know what is happening, what is likely to occur, or how concerned one should be. Context and additional information are usually needed. Sometimes the simple colors and combinations of colored tapes might only make sense in conjunction with similar markings nearby. Sometimes public notices in the newspaper and regulatory permits must be used to decipher what is planned.

For an example, the proposed 30″ diameter EQT pipeline called the Ohio Valley Connector seems to be regularly marked using a combination of blue and white (see figure 10 below) surveyors tape to mark the actual pipeline location, then green and white (see figure 4 below) to mark all the proposed access roads along the routes that will be used to get pipe trucks and excavation equipment into the right of way. These access roads might be public roadways or cut across private leased property.

Common surveyor symbols & signs:

Surveyor flags and tape: Sometime the flags or streamers are just attached to trees, fence posts, or put on a stake to make them visible above the weeds. There might be no markings on the stake, or only simple generic markings. This could just mean that this is the correct road and turn here. It could also signal a proposed or approximate location for some future work.

These are a selection of typical surveyor tapes, also called flags or ribbons. Many other specialty color combinations are available to the professional surveyor.

<u>Stakes with simple markings</u>: Flags with some type of identification (it might be names or numbers). This one was used for a proposed well pad access road location. There are no dimensions given on these.

<u>Stakes with simple flags and basic identification:</u> The stakes shown here all indicate an access route to be used for equipment and trucks to get to a proposed pipeline right of way.

<u>Control points:</u> These three stakes are identifying a control point that is outside the limits of disturbance (LoD). These markings surround a pin to be used for reference.

Control point stakes

Controls points: This stake is also identifying a control point location. All control points will have some type of driven metal rod, usually with a plastic cap identifying the surveyor. Frequently there are three stakes with extra flags or tape. They are always set off to the side of the intended work area. They are not to be disturbed.

Control point stake and pin

Control points: Another set of three stakes marking a Control Point location. It is common to see triple stakes with elaborate, multiple flags. Even if only two stakes are present, there always will be a driven steel pin and identifying cap.

Control points: This shows a close-up of the identifying cap on a metal driven steel pin. Control point locations are not meant to be disturbed as they are for future and repeated reference. They might give the latitude and longitude on the stake plus the altitude above sea level.

Control points: This is another, older control point location. This represents a typical arrangement where the stakes somewhat try to protect the metal pin from a bulldozer blade by warning its operator.

Limit of disturbance: The “L O D” here means the limits of disturbance. Beyond this point there should not be any trees cut or dirt moved. The stakes shown here indicates that this is the outside limit of where the contractor will be disturbing the original contour of the surface soil.

Limit of disturbance stakes

Limit of disturbance: The “L O D” means the limits of disturbance of the proposed pipeline right of way. Beyond this point there should not be any trees cut or dirt moved. This could also be used for the outside edge of well pads or access roads or pond locations.

Limit of disturbance ROW stakes

Pipelines: Stakes with flags and “center line” markings are usually for pipelines. Here you see the symbol for center line: a capital letter “C” imposed on the letter “L”.

Pipelines center line

Pipelines: Again you see the capital letter “C” super imposed on top of the letter “L” used frequently for pipe line center lines, but can also be used for proposed access roads.

Pipelines center line

Pipelines: As shown here, “C” and “L” center line flags can also be used for future well pad access roads.

Road access center line

Precise location markings: Stakes like this will usually have a steel pin also associated with it. This stake gives the latitude, longitude, and elevation of the site.

Precise location stake

Permanent property lines: You may also find markings, like this one inch steel rod with an alum cap, that denote permanent property lines and corners of property.

Permanent property rod

Permanent property lines: Another kind of permanent property line or corner marker is the "boundary survey monument." This is likely an aluminum cap on top of a one inch diameter steel bar.

Construction Stakes and how to read them:

https://www.youtube.com/watch?v=1DR2JbueLho
https://www.youtube.com/watch?v=JlLW0TWgj0w

https://www.youtube.com/watch?v=2T2JWvZCF2Y

LU5. Monitor Drawings and plans	• Perform metric and imperial measurements • Interpret abbreviations and symbols common to civil drawings • Distinguish between plan, side view and section • Determine scale and north orientation	• Describe metric and imperial measurements • Describe symbols used in drawings and plans and their interpretation • Describe difference between plan, elevation and cross section • Describe scale and indication of north on the drawing	

- <u>**Describe metric and imperial measurements:**</u>

<u>Metric Measurements:</u>

The metric system is an internationally recognised decimalised system of measurement. It is in widespread use, and where it is adopted, it is the only or most common system of weights and measures. It is now known as the International System of Units.

In its modern form, it consists of a set of <u>base units</u>: *<u>metre</u>* for length, *<u>kilogram</u>* for mass, *<u>second</u>* for time, *<u>ampere</u>* for electrical current, *<u>kelvin</u>* for temperature, *<u>candela</u>* for luminous intensity and *<u>mole</u>* for quantity. These, together with their derived units, can measure any physical quantity. *Metric system* may also refer to other systems of related base and derived units defined before the middle of the 20th century, some of which are still in limited use today.

The metric system was designed to have properties that make it easy to use and widely applicable, including units based on the natural world, decimal ratios, prefixes for multiples and sub-multiples, and a structure of base and derived units. It is also a <u>coherent system</u>, which means that its units do not introduce conversion factors not already present in equations relating quantities. It has a property called *rationalisation* that eliminates certain <u>constants of proportionality</u> in equations of physics.

The units of the metric system, originally taken from observable features of nature, are now defined by phenomena such as the microwave frequency of a caesium <u>atomic clock</u> which accurately measures seconds. One unit, the <u>kilogram</u>, was defined in terms of a man-made artefact until recently, but its precise definition now depends on a fixed numerical value for <u>Planck's constant</u>. The new definition was formally propagated on 20 May 2019.

While there are numerous named derived units of the metric system, such as the watt and lumen, other common quantities such as velocity and acceleration do not have their own unit, but are defined in terms of existing base and derived units such as metres per second for velocity.

Units of the British imperial system and the related US customary system are officially defined in terms of the metric system. Notably, as per the International Yard and Pound Agreement the base units of the Imperial and Customary system are defined in terms of the metre and kilogram.

The metric system is also extensible, and new derived units are defined as needed in fields such as radiology and chemistry. The most recent derived unit, the katal, for catalytic activity, was added in 1999. Recent changes are directed toward defining base units in terms of invariant constants of physics to provide more precise realisations of units for advances in science and industry.

The metric system is used to measure the length, weight or volume of an object. Length is measured in **millimetres** (mm), **centimetres** (cm), **metres** (m) or **kilometres** (km).

- 1 cm = 10 mm
- 1 m = 100 cm
- 1 km = 1000 m
- 1 cm is about the width of a staple
- 1 m is about the width of a single bed

Weight is measured in **grams** (g) and **kilograms** (kg). Volume is measured in **millilitres** (ml) and **litres** (l).

- 1 kg = 1000 g
- 1 l = 1000 ml
- 1 kg is the weight of seven apples
- 1 l is the volume of a carton of orange juice.

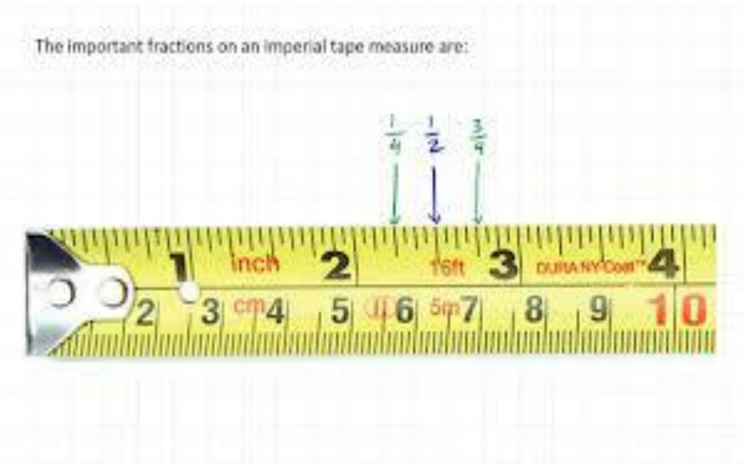
Metric Unit of Measure	
Measures of Length	
1 meter (m)	= 1000 millimeters (mm)
1 meter (m)	= 100 centimeters (cm)
1 Kilometer (km)	= 1000 meters
1 decimeter (dm)	= 1/10 meter
Measure of Weight	
1 gram (g)	= 1000 milligrams (mg)
1 kilogram (kg)	= 1000 grams
Liquid Measures	
1 liter (L)	= 1000 milliliters (mL)
1 deciliter (dL)	= 1/10 liter

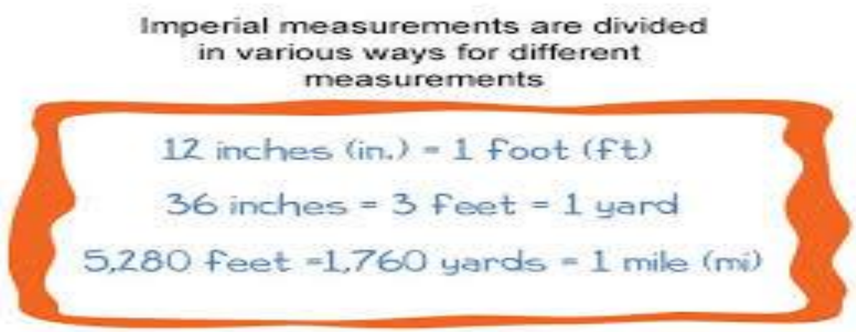
Prefix	Meaning	Length	Mass	Capacity
kilo-	thousand (1,000)	kilometer	kilogram	kiloliter
hecto-	hundred (100)	hectometer	hectogram	hectoliter
deka-	ten (10)	dekameter	dekagram	dekaliter
*base unit	ones (1)	meter	gram	liter
deci-	tenths (0.1)	decimeter	decigram	deciliter
centi-	hundredths (0.01)	centimeter	centigram	centiliter
milli-	thousandths (0.001)	millimeter	milligram	milliliter

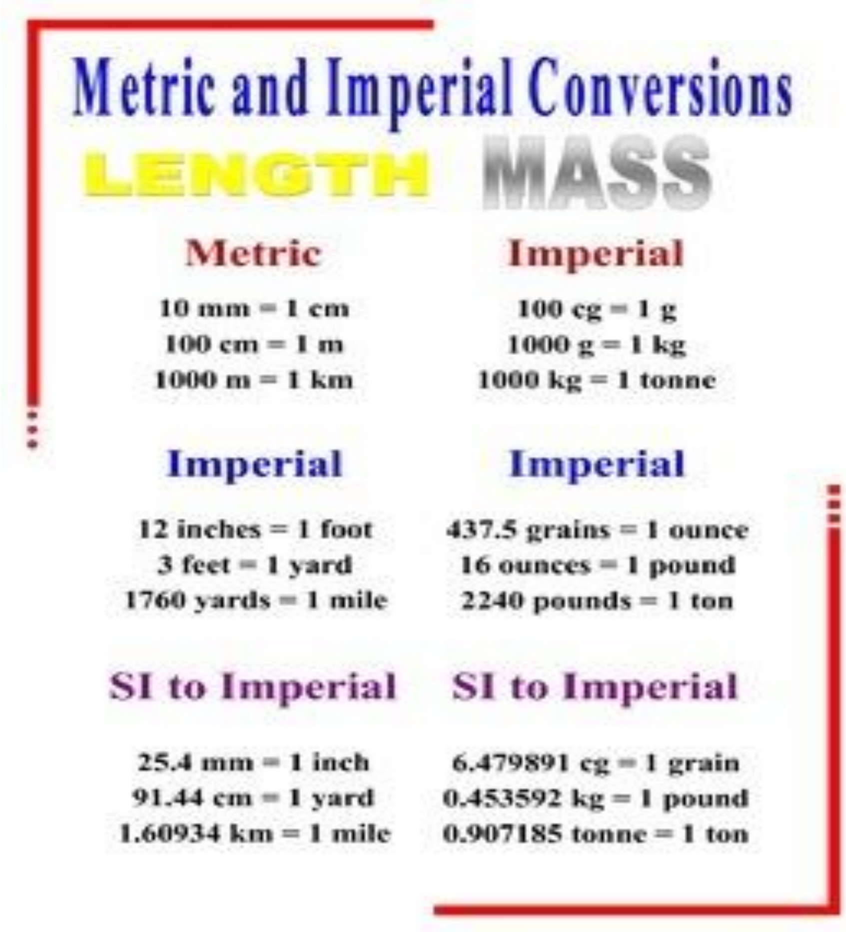
Imperial Measurements:

The system of imperial units or the imperial system is the system of units first defined in the British Weights and Measures Act of 1824, which was later refined and reduced. The imperial units replaced the Winchester Standards, which were in effect from 1588 to 1825. The system came into official use across the British Empire. By the late 20th century, most nations of the former empire had officially adopted the metric system as their main system of measurement and imperial units are still used in the United Kingdom, Canada and other countries formerly part of the British Empire. As part of the UK's metrication programme, most of these imperial units are no longer statute measures. The imperial system developed from what were first known as English units, as did the related system of United States customary units.

unit	abbreviation or symbol	equivalents in other units of same system
		Weight
yard	yd	3 feet, or 36 inches
foot	ft, or '	12 inches, or 0.333 yard
inch	in, or "	0.083 foot, or 0.028 yard







Metric	Imperial
20 - 30cm	8ins - 1ft
30 - 40cm	1ft - 1ft 4in
40 - 60cm	1ft 4ins - 2ft
60 - 90cm	2ft - 3ft
90 - 120cm	3ft - 4ft
120 - 150cm	4ft - 5ft
150 - 180cm	5ft - 6ft
180 - 200cm	6ft - 6ft 7in
200 - 225cm	6ft 7ins - 7ft 5in
225 - 250cm	7ft 5ins - 8ft 2in
250 - 300cm	8ft 2ins - 9ft 10in
300 - 350cm	9ft 10ins - 11ft 6in

Imperial vs. Metric System

There are two main systems for measuring distances and weight, the Imperial System of Measurement and the Metric System of Measurement. Most countries use the Metric System, which uses the measuring units such as meters and grams and adds prefixes like kilo, milli and centi to count orders of magnitude. In the United States, we use the older Imperial system, where things are measured in feet, inches and pounds. It might be confusing if you are living in the U.S for the first time and are not used to this system. If you ask someone for directions, they will probably tell you something is a certain number of miles away. Or you may be told to move a few feet… But, whose feet?

The Imperial System is also called The British Imperial because it came from the British Empire that ruled many parts of the world from the 16th to the 19th century. After the U.S gained independence from Britain, the new American government decided to keep this type of measurement, even though the metric system was gaining in popularity at the time.

We are one of the few countries in the world that still use this system, and first time visitors may find it confusing. Here are a few things to remember that will come in handy day to day:

- 1 mile equals 1.6 Kilometers.
- 1 inch is about 25 millimeters or 2.54 centimeters
- A 3-foot measurement is almost exactly 1 meter
- 1 Kilogram is just over 2 pounds
- 1 pound is about 454 grams
- For British visitors, 100 pounds = 7.14 stone

Complicated measurements, used in the sciences for example, will be in the metric system so no need to worry if you are planning to do an internship in engineering or chemistry.

By the way, the temperature scales are different too. We didn't want to make things too easy for you! Though not technically part of the metric system, Americans measure temperature in Fahrenheit, not Centigrade. You may turn on the television and listen for the weather and hear that it is 70 degrees outside. No, you won't pass out and be vaporized by the sun; 70 degrees Fahrenheit is actually very pleasant, about 21 degrees Centigrade. Centigrade has been used around the world from the mid 20th century but again, Americans held fast to the original Fahrenheit system.

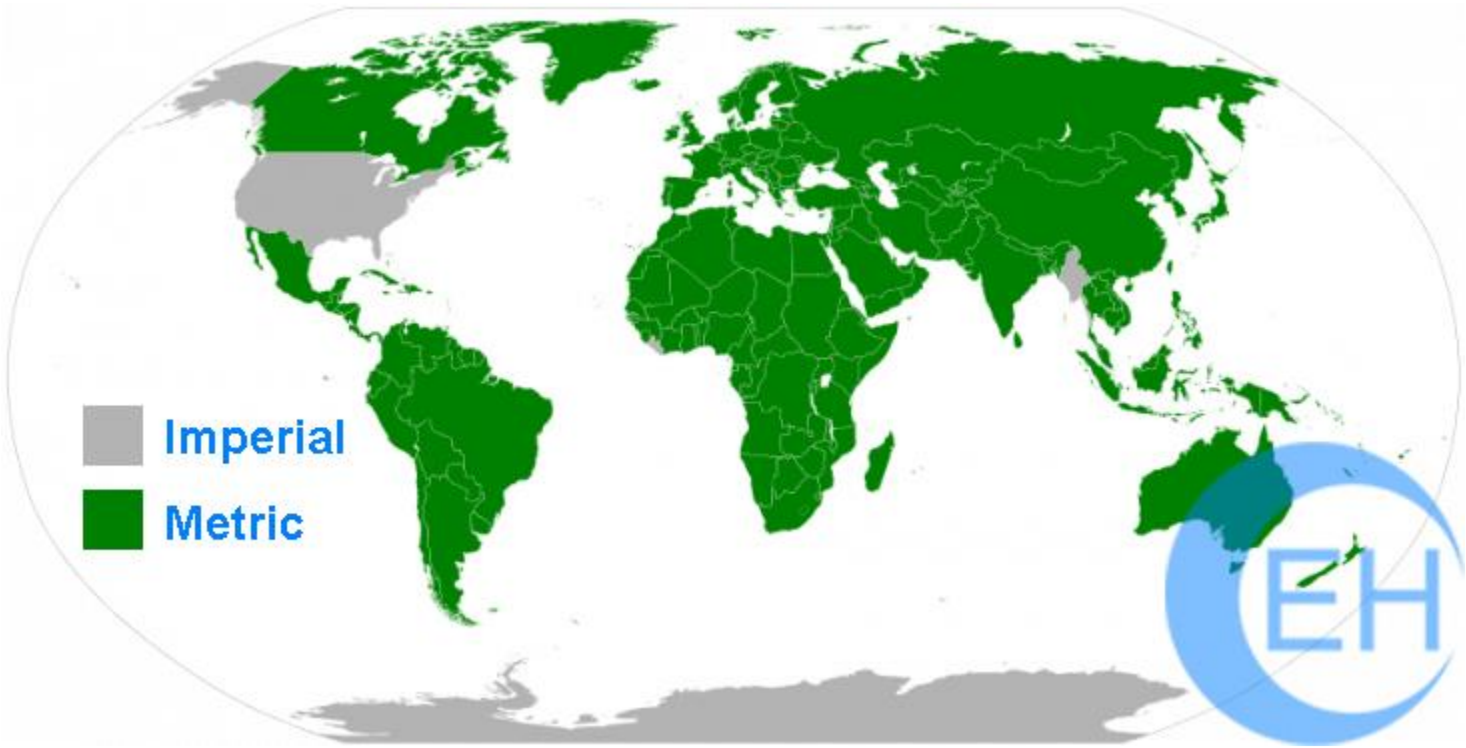
Here are some more handy conversions for temperature:

- 0 degrees Celsius is equal to 32 degrees Fahrenheit. (The freezing point)
- 24 degrees Celsius is equal to 75 degrees Fahrenheit. (A very pleasant day)
- To convert Celcius (c) to Fahrenheit, use the formula (c * 1.8) + 32

There is no reason to expect that we will change over to the Metric System and Centigrade anytime soon. The chances that we will make the switch during your short-term stay in the United States are slim, so your best bet is to try to adjust as much as possible. Or, if you have a smart phone, you can do what I do when I travel-- download a conversion app. The company World Wide Metric has a comprehensive and easy to use conversion webpage.

What Is The Difference Between Imperial And Metric Systems

There are two main systems for measuring distances and weight, the Imperial System of Measurement and the Metric System of Measurement. Most countries use the Metric System, which uses the measuring units such as meters and grams and adds prefixes like kilo, milli and centi to count orders of magnitude. In the United States, people use the older Imperial system, where things are measured in feet, inches and pounds. The picture below is the main use area difference between imperial and metric system.



The Metric and Imperial systems are both systems of measurement. That is, they are not just one unit of measure, but are inter-related systems of many units of measure – measuring length and area, weight and mass, volume, force, energy, power, time, temperature, luminosity, etc.

Metric and Imperial differ in almost all of the particular units used in the two systems (metres vs feet, kilograms vs pounds, etc.). However, they share units measuring time (seconds, minutes, hours) and electricity (volts, amperes, watts, ohms, etc.) — Time, because no one was successful in decimalizing it, and electricity because it is newer than either the Metric or Imperial system.

The Imperial System is also called The British Imperial because it came from the British Empire that ruled many parts of the world from the 16th to the 19th century. After the U.S gained independence from Britain, the new American government decided to keep this type of measurement, even though the metric system was gaining in popularity at the time.

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If you need to convert from Imperial or US Standard units to Metric, or the other way around, one of the tables of difference between imperial and metric below should help.

LENGTH

Metric			**US or Imperial**
1 millimeter [mm]			0.03937 in

1 centimeter [cm]	10 mm		0.3937 in
1 meter [m]	100 cm		1.0936 yd
1 kilometer [km]	1000 m		0.6214 mile

US or Imperial			**Metric**
1 inch [in]			2.54 cm
1 foot [ft]	12 in		0.3048 m
1 yard [yd]	3 ft		0.9144 m
1 mile	1760 yd		1.6093 km
1 int nautical mile	2025.4 yd		1.853 km

AREA

Metric			**US or Imperial**
1 sq cm [cm^2]	100 mm^2		0.1550 in^2
1 sq m [m^2]	10,000 cm^2		1.1960 yd^2
1 hectare [ha]	10,000 m^2		2.4711 acres
1 sq km [km^2]	100 ha		0.3861 $mile^2$

US or Imperial			Metric
1 sq inch [in^2]			6.4516 cm^2

1 sq foot [ft^2]	144 in^2		0.0929 m^2
1 sqyd [yd^2]	9 ft^2		0.8361 m^2
1 acre	4840 yd^2		4046.9 m^2
1 sq mile [$mile^2$]	640 acres		2.59 km^2

VOLUME/CAPACITY

Metric			US Measure	Imperial
1 cu cm [cm^3]			0.0610 in^3	
1 cu decimeter [dm^3]	1,000 cm^3		0.0353 ft^3	
1 cu meter [m^3]	1,000 dm^3		1.3080 yd^3	
1 liter [l]	1 dm^3		2.113 fluid pt	1.7598 pt

US Measure	Imperial		Metric
1 cu inch [in^3]			16.387 cm^3
1 cu foot [ft^3]			0.02832 m^3
1 fluid ounce	1.0408 UK floz		29.574 ml
1 pint (16 floz)	0.8327 UK pt		0.4732 liters
1 gallon (231 in^3)	0.8327 UK gal		3.7854 liters

MASS

Metric		US or Imperial

1 milligram [mg]			0.0154 grain
1 gram [g]	1,000 mg		0.0353 oz
1 kilogram [kg]	1,000 g		2.2046 lb
1 tonne [t]	1,000 kg		1.1023 short ton
1 tonne [t]	1,000 kg		0.9842 long ton

US or Imperial			**Metric**
1 ounce [oz]	437.5 grain		28.35 g
1 pound [lb]	16 oz		0.4536 kg
1 stone	14 lb		6.3503 kg
1 hundredweight [cwt]	112 lb		50.802 kg
1 short ton (US)			0.9072 t
1 long ton (UK)			1.0160 t

https://www.youtube.com/watch?v=pu_illAgCPg
https://www.youtube.com/watch?v=sNn_qsgBuM0

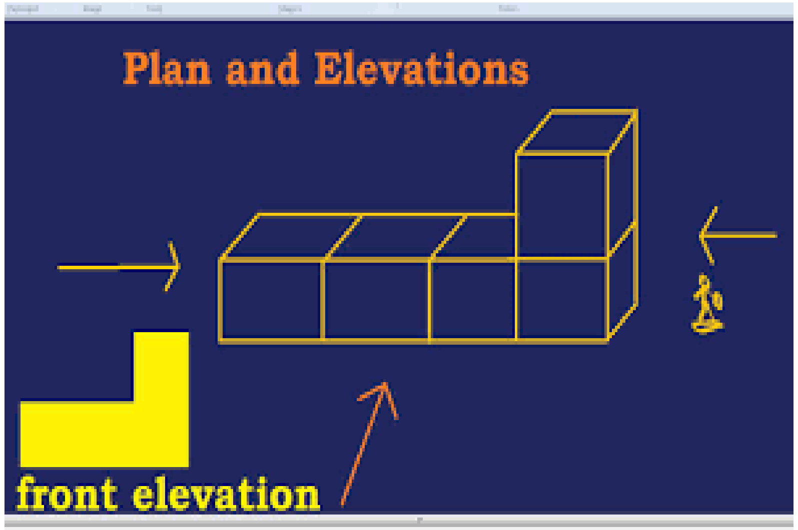
- **Describe difference between plan, elevation and cross section:**

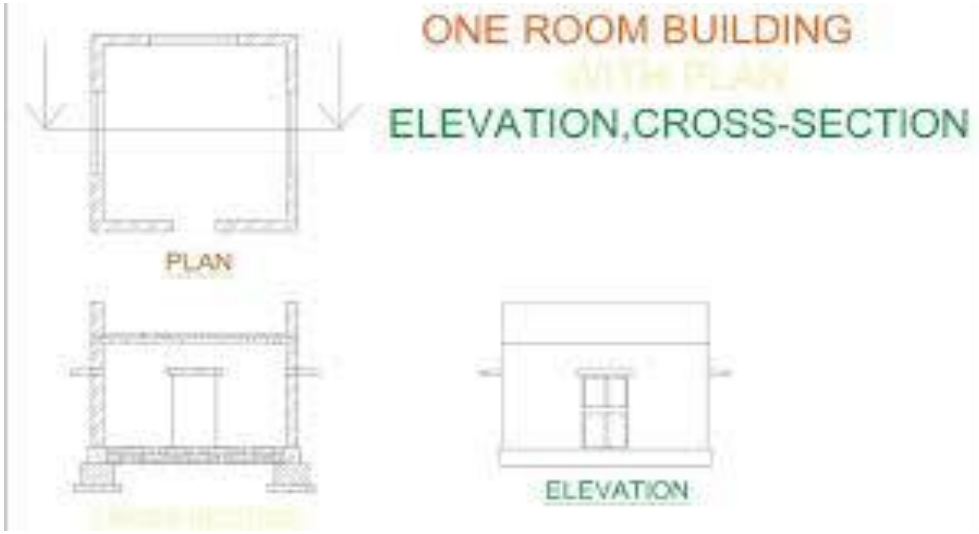
plan is the top view **of** the horizontal **cross section of** any design. **Elevation is** the front/side view **of** vertical **cross section of** any design.

Plans, **elevations and sections** are 2D visuals that represent a 3D object. Combining **different** 2D visuals allows you to create an accurate representation **of** a design. Or **in the** instance **of** interior design, a space. ... A **section** is a cut through **of** a space which will show more **of** the room's features.

<u>Plans</u> <u>and</u> **<u>elevations</u>**

A **plan** is a scale drawing showing a 3D shape when it is looked at from above. An **elevation** is the view of a 3D shape when it is looked at from the side or from the front. When an architect designs a building they will draw the **plans** and **elevation** of a building. Generally, **elevations** are produced for four directional views, for example, north, south, east, west.






YOUR IDEAS
AND SKETCHES
BASIC 3D FLOOR PLAN
DETAIL 3D FLOOR PLAN
bench set
10$
15$
DETAIL 3D MODELING WITH 3D FLOOR PLAN, ELEVATION, CROSS SECTION
30$
ARCHIASSISTANT

Describe scale and indication of north on the drawing:

A drawing that shows a real object with **accurate sizes reduced or enlarged** by a certain amount (called the scale). The scale is shown as the length in the drawing, then a colon (":"), then the matching length on the real thing.

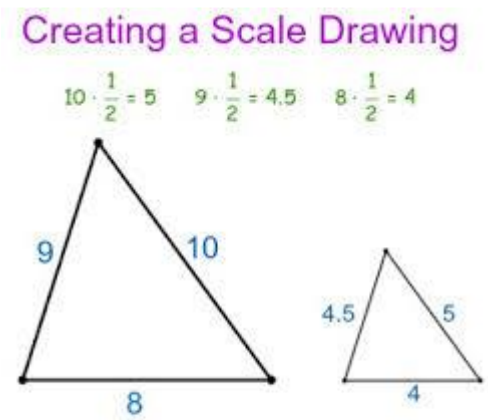
To scale a drawing by hand, start by measuring the width and height of the object you'll be scaling. Next, choose a ratio to resize your drawing, such as 2 to 1 to double the image in size. Then, multiply your measurements by the first number in your ratio to increase the size.

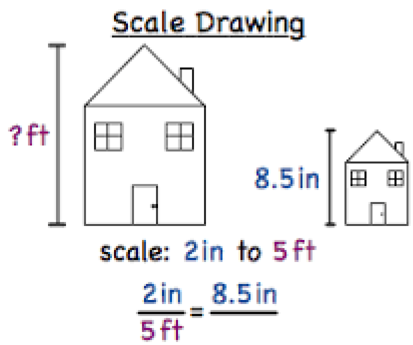
Scale Drawing:

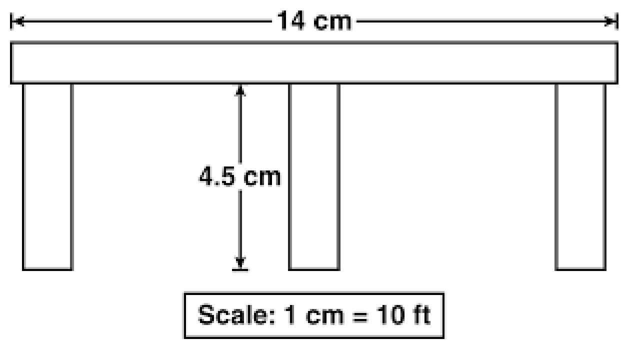
Scale drawings show an image either reduced or enlarged in size. The change between the original and the scaled drawing is generally represented by two numbers separated by a colon, like 10:1 (read as "ten to one"). The difference between the ratio numbers represents the factor by which the scaled image is enlarged or reduced. So for a 10:1 scale ratio, a 1 inch (2.5 cm) drawing will be 10 inches (25 cm) in real life.

Measure the object you'll be scaling. For images that are irregularly shaped, measuring with a ruler or tape measure can be difficult. In these cases, outline the perimeter with a piece of string, then measure the length of the string to find the perimeter.

- For rough scaling of simple 2-D objects, you can probably get by with only measuring the width and height of the object.[1]
- It'll be helpful when you start drawing the scaled image if the perimeter is broken up into segments, like the top, bottom, and sides.[2]
- You may be able to break up the perimeter into small, regular shapes, like squares and triangles. These segments can be added together to find the perimeter.



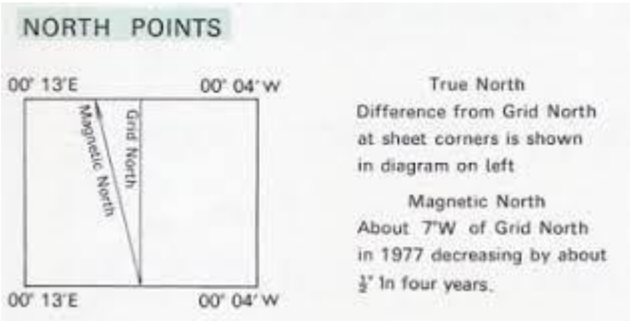


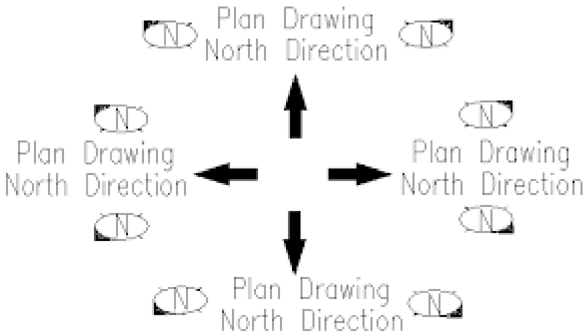


Indication of North on Drawing:

Most early maps, before the wide-spread use of the compass, placed east at the top. This is generally thought to be due to the fact that the sun rises in the east. ... Many early settlers of **North** America created maps with a west-east **orientation** that resulted from the **direction** that they primarily traveled and explored.

Most modern-day maps typically show an orientation with north at the top of the two-dimentional depiction. In other eras, different directions at the top were more prevalent, and all directions have been used by different societies and cultures to depict our world. The biggest factors that contribute to north being commonly placed at the top of a map include the invention of the compass and the understanding of magnetic north and the egocentricity of society, mainly in Europe.





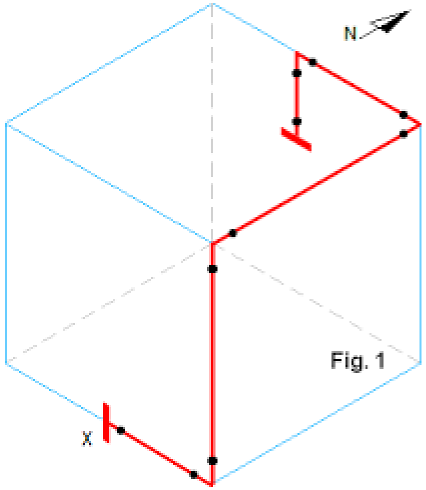


Fig. 1

LU6. Develop environmental concerns with site personnel	• Identify actual and potential environmental concerns, such as proximity to water courses, noise levels, fuel leaks and hazardous materials • Communicate with site supervisor	• Describe environmental concerns, such as proximity to water courses, noise levels, fuel leaks and hazardous materials	

Construction projects have a significant impact on the world's environment. In fact, every aspect of construction has some measurable impact– from mining processes used for materials, to the waste produced by the project and how it is disposed of. It is important to understand and take initiative to decrease the environmental impact of construction projects which harm the water, ground, and air we breath.

Limit the Environmental Impact of Construction

Construction contributes to environmental damage both on a global scale, as well as locally. It is important to learn what impact construction causes in order to scale back damage. Here are five ways to help limit environmental impact during your construction project.

1) Limit Fuel Usage

Construction firm's biggest negative impact on the environment is caused by the burning of fossil fuels, like gas and diesel. Every construction project results in these gas emissions of carbon dioxide, methane and other waste products that pollute the air and are believed to contribute to global warming. In order to limit fuel usage:

- Minimize haul distances
- Reduce vehicle idling time
- Use *greener*, alternative fuel sources
- Use hybrid equipment

By striving to limit your construction project's fuel usage, you can help decrease negative emission and pollutants and improve air quality.

2) Reduce Noise

Construction noise is a major source of noise pollution. Most of this noise is produced by machinery in site preparation, demolition, and landscaping. Many construction sites are located near homes and businesses and can noise complaints might be likely. Be sure, when beginning a construction project, to be considerate and adhere to any local construction time restrictions. Many people might not appreciate work and loud construction noises beginning at six A.M. on a Saturday. Another good idea is to send a letter to neighbors before beginning work to alert them to how long the project will last and what to expect.

3) Properly Dispose of Waste

In 2014, there was over 534 million tons of construction material waste in the United States. Demolition waste makes up 90% of total debris, and much of this waste is disposed of in landfills or through incineration. Both these methods harm the environment. By salvaging, reusing and recycling existing materials, you can cut down on materials harming our precious earth. Hardware, appliances, and fixtures can be recycled or reused. These can be used on future projects or donated to those who need them. Brick and concrete can be recycled and used as fill or driveway bedding, and metals and wood are valuable commodities that can be recycled.

4) Utilize Reusable Technology

There are a lot of *green* building options that help you decrease a negative environmental impact. For example, **inflatable water dams** help combat erosion, water runoff, and prevents sedimentation. While sandbags and traditional dewatering solutions are costly and time-consuming, inflatable water dams are reusable and take up little space. They are easier to install and environmentally friendly by using existing water already on your worksite.

5) Expedite Your Project

By accelerating your construction project, you reduce traffic disturbances and also reduce associated emissions and fuel costs. Establish firm completion goals and implement these measures to stay on track. Expediting the construction process helps reduce noise pollution, as well as cutting back on traffic duration and improves safety zones.

Decrease Your Environmental Impact

There are numerous ways to decrease the negative environmental impact on your construction project. By utilizing green and reusable technology, keeping project length to a minimum, limiting fuel use, along with other suggestions listed, you are sure to make a difference in the impact of the environment.

The global community has grown increasingly more environmentally conscious in every aspect of life. More and more consumers are making green choices and businesses, too, are undergoing efforts to reduce their carbon footprints. Public sentiment and increasing regulations have brought this to the forefront of construction planning and execution as well. The good news is going green can also help increase your productivity, efficiency, and bottom line.

Environmental Considerations in Construction You Need to Know

At the end of the day, construction generates a lot of waste. It's a fact that's hard to get around. While it may be impossible to completely eliminate the environmental impact of your construction projects, you can significantly reduce it. Here's how:

Energy efficiency

During the construction process, it's important to increase your energy efficiency as much as possible. Using old, outdated tools and equipment decreases your productivity and requires more energy consumption to complete the job. One great way to keep your operations as energy efficient as possible is keeping your machines, equipment, and tools repaired and updated. The more productive you are and the faster your projects are completed, the less energy you'll use.

Green materials

There are a number of green materials in research and production that can be used in place of traditional materials. Often, they are reclaimed or recycled from other construction projects which reduce or eliminate a portion of your initial construction costs. Many of these materials are becoming more and cost-effective while the cost of traditional materials is going up. What's more, they typically make it much easier for you to conform to ever-more stringent and numerous building codes and regulations.

Reduced waste

Reducing the waste produced in construction projects begins with your project planning. Establish, track, and document your waste reduction goals. Research and identify materials that can be reused or recycled. Maximize use of your materials and avoid excess materials as much as possible. Choose reusable products as much as you can such as **inflatable bladder dams** in place of traditional cofferdams or sandbags.

Better tools and equipment

When choosing your tools and equipment, look for tools designed to increase productivity, lower energy use, and reduce man-hours. Newer products are typically designed for better productivity and reduced environmental impact. You may pay more upfront for these tools, but they'll save you money in the long run.

Long-term: sustainability

In addition to environmental concerns during construction, builders also need to include a plan for long-term sustainability. In other words, how will the facility continue to be environmentally friendly over the long haul? This includes maximizing overall efficiency with an integrated design, water management, energy efficiency, and building location.

Building the Future

We, as a society, are working hard to create a better future with a lower overall impact on the environment. With each new construction project, builders are becoming more and more environmentally conscious. The good news is, while it used to be more expensive to go green, advancements in technology and product availability have now made it more cost-effective in many cases. Help create a better tomorrow. Use this guide to environmental considerations in construction to get started going green in your company.

LU7. Demonstrate grades and stakes	• Interpret symbols and markings on stakes • Mark stakes/surface with appropriate symbols or markings, such as colored paint and ribbons	• Describe color codes for civil works and their importance	

They have often been referred to as survey color codes, survey flag colors, color codes for underground concrete, utility location pain codes and utility locate color system.

There are 2 additional colors that are not widely used in our line of work, but are used in the construction and survey field. ***White*** is often used by contractors and is a color that we are interested in because that gives us a better idea as to where the proposed digging, cutting, or construction will take place. ***Pink*** is strictly used by land surveying companies to state where the temporary survey markings are.

The color codes for locating utilities, conduit or rebar in concrete can present slightly different colors depending on the surface. Most often used are the colors red, yellow, blue and black. This is because rather than flags or paint, chalk or a wax crayon is often used and the colors these are produced in is limited to these basic 4 colors.

- If you are an **excavator** or an **environmental consultant** about to do soil boring, you are very interested in what is located below the ground you are about to dig into. It could cost you the job or even possibly your life if its not correct.

- If you are an **engineer** or **architect**, maybe the results of these colors on the ground will completely change some of the design you have already done.

LU8. Demonstrate grade checking devices	• Check grades using information on stakes and site plans • Determine laser levels, sight levels and line (also known as string levels)	• Describe grade checking devices and tools • Describe laser levels, sight levels and line	

SURVEYING EQUIPMENT

When your project demands the best high-quality land surveying equipment and tools, we have the top brands of commercial grade surveying equipment sold within the industry. The professional grade tools that we sell will stand up to daily and commercial use. If you're shopping for the best surveying equipment, we carry a wide variety of commercial-grade Surveying Tools. We do discount surveying equipment, but we do not sell cheap surveying equipment, we sell what Professional Land Surveyors and Contractors call "The Good Stuff" which are the top shelf brand names within the industry it include Land Surveying Tripods, Surveying Bipods, Fiberglass Grade Rods, Aluminum Grade Rods, Builders Grade Rods, Story Poles, Laser Levels, Auto-Levels, Transit Levels, Hand Levels, Abney Levels, Surveyors Brush Axes, Land Surveying Markers, Land Surveying Rods, Marking Paint, Surveying Prisms, Prism Poles, GNSS Equipment, Total Stations, GPS Equipment, property corner Pin Finders, Bags and Cases, Surveyors Roll Flagging, Theodolites, Transits, Mag Nails, PK Nails, Magnetic Locators, Tribrachs and Land Surveying Equipment Adapters.

List and images of Surveying Equipment:

https://www.engineersupply.com/surveying-equipment.aspx

LU9. Review job specifications and safety considerations with site personnel	• Communicate with site supervisor to confirm job specifications • Identify safety concerns, such as location of utilities	• Describe duties of site supervisor and job specifications • Describe safety precautions and location of utilities on job site	

Site supervisor

The role of a site supervisor generally involves the management and supervision of a construction site in accordance with health and safety guidelines. It is the responsibility of the site supervisor to assess hazards, determine risks, conduct regular inspections, and maintain a safety programme.

The site supervisor will typically work closely with the site foreman, who is responsible for organising construction works on site, and report to the project manager.

Site supervisors should have relevant experience in construction or civil engineering, as well as appropriate health and safety training.

The responsibilities of a site supervisor may include:

- Supervising workers, subcontractors and work activities.
- Preparing and presenting site inductions, safety briefings and toolbox talks.
- Assessing and managing safety hazards.
- Ensuring appropriate site rules and welfare facilities are in place.
- Carrying out regular inspections.
- Helping project managers to plan the work programme.
- Helping co-ordinate deliveries of materials, plant and equipment.
- Completing records for site reports.
- Attending site management meetings.
- Carrying out regular inspections to ensure compliance with relevant legal requirements, processes and procedures.
- Raising safety concerns at the appropriate level.
- Resolving problems and implementing improvements.
- Organising and overseeing external inspections, such as with a health and safety inspector.
- Providing emergency first aid if required.

Relevant skills of a site supervisor include:

- A positive attitude.
- The ability to communicate with, motivate, and if necessary discipline the workforce.
- The ability to understand drawings and other contract documents.
- A good understanding of safety procedures.
- First aid training.
- Organisational skills.
- The ability to mediate to resolve issues.
- An understanding of legal responsibilities.
- An understanding of welfare and environmental issues.
- An understanding of occupational health and behavioural safety issues

What does a Construction Site Supervisor do?

Construction Workers

As a Construction Site Supervisor, you need to provide a supporting role to workers below you. A good Supervisor will be able to provide guidance to other workers on how to be more competent in their role. Try and be as easy to contact as possible and always know who is on site and where they are working; this will help you to tell the right people about certain hazards on site.

Site Inspections

A big part of your role will be determining the probability of an accident happening on site. To do this you will be required to carry out consistent risk assessments; these risk assessments will allow you to spot any hazards and fix them before they causer an accident. If the hazard isn't fixable it will be your job to report it so that it can be dealt with as quickly as possible.

Health and Safety

As a Supervisor, you need to make sure that all your workers are informed of the health and safety hazards on site and the precautions they need to take. You cannot supervise every worker 24/7; so, you need to inform everyone who will be working onsite before work begins. The Site Supervisor communicates with the Contractor and the crew on a regular basis regarding site rules.

MULTIPLE CHOICE QUESTIONS (MCQs)

Question 11 Is the following statement true or false?

"The planning of work does not include assessing site hazards"

A TRUE

B FALSE

Question 12 Which of the following is a part of planning work?

A Visual inspection

B Communication methods finalization

C Reading of site plan and drawings

D All of the above

Question 13 Which is the best practice to plan work?

A enlist equipment and attachments to perform the job

B Determine the appropriate starting, exit and access points

C Estimate work activities and estimated completion time

D All of the above

Question 14 Which ability is important in planning work?

A Follow symbols and markings

B Follow survey markers, construction grades, and stakes

C Monitor Drawings and plans

D All of the above

Question 15 What is the important task to perform with site work planning?

A Assess site hazards

B Ensure work procedures

C Review job specifications and safety considerations with site personnel

D All of the above

FREQUENTLY ASKED QUESTIONS (FAQs)

1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?	Competency-based training (CBT) is an approach to vocational education and training that places emphasis on what a person can do in the workplace as a result of completing a program of training. Compared to conventional programs, the competency based training is not primarily content based; it rather focuses on the competence requirement of the envisaged job role. The whole qualification refers to certain industry standard criterion and is modularized in nature rather than being course oriented.
2. What is the passing criterion for CBT certificate?	You shall be required to be declared "Competent" in the summative assessment to attain the certificate.
3. What are the entry requirements for this course?	The entry requirement for this course is 8th Grade or equivalent.
4. How can I progress in my educational career after attaining this certificate?	You shall be eligible to take admission in the National Vocational Certificate Level-3 in Leather Products Development Technician (Pattern Maker). You shall be able to progress further to National Vocational Certificate Level-4 in Heavy Construction Machinery Operator Course; and take admission in a level-5, DAE or equivalent course (if applicable). In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).
5. If I have the experience and skills mentioned in the competency standards, do I still need to attend the course to attain this certificate?	You can opt to take part in the Recognition of Prior Learning (RPL) program by contacting the relevant training institute and getting assessed by providing the required evidences.
6. What is the entry requirement for Recognition of Prior Learning program (RPL)?	There is no general entry requirement. The institute shall assess you, identify your competence gaps and offer you courses to cover the gaps; after which you can take up the final assessment.
7. Is there any age restriction for entry in this course or Recognition of Prior Learning program (RPL)?	There are no age restrictions to enter this course or take up the Recognition of Prior Learning program
8. What is the duration of this course?	The duration of the course work is 1,510 hrs. (11 months)
9. What are the class timings?	The classes are normally offered 25 days a month from 08:00am to 01:30pm. These may vary according to the practices of certain institutes.
10. What is equivalence of this certificate with other qualifications?	As per the national vocational qualifications framework, the level-4 certificate is equivalent to Matriculation. The equivalence certificate can be obtained from The Inter Board Committee of Chairmen (IBCC).

11. What is the importance of this certificate in National and International job market?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTC website.
12. Which jobs can I get after attaining this certificate? Are there job for this certificate in public sector as well?	You shall be able to take up jobs in the local or overseas construction companies in heavy machinery operator job profile.
13. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the level of supervisor after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
14. Is this certificate recognized by any competent authority in Pakistan?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). The official certificates shall be awarded by the relevant certificate awarding body.
15. Is on-the-job training mandatory for this certificate? If yes, what is the duration of on-the-job training?	On-the-job training is not a requirement for final / summative assessment of this certificate. However, taking up on-the-job training after or during the course work may add your chances to get a job afterwards.
16. How much salary can I get on job after attaining this certificate?	The minimum wages announced by the Government of Pakistan in 2019 are PKR 17,500. This may vary in subsequent years and different regions of the country. Progressive employers may pay more than the mentioned amount. The heavy Machinery Operator normally earns 20,000 to 25,000 in the start.
17. Are there any alternative certificates which I can take up?	There are some short courses offered by some training institutes on this subject. Some institutes may still be offering conventional certificate courses in the field.
18. What is the teaching language of this course?	The leaching language of this course is Urdu and English.
19. Is it possible to switch to other certificate programs during the course?	There are some short courses offered by some training institutes on this subject. Some institutes may still be offering conventional certificate courses in the field.
20. What is the examination / assessment system in this program?	Competency based assessments are organized by training institutes during the course which serve the purpose of assessing the progress and preparedness of each student. Final / summative assessments are organized by the relevant qualification awarding bodies at the end of the certificate program. You shall be required to be declared “Competent” in the summative assessment to attain the certificate.
21. Does this certificate enable me to work as freelancer?	You can start your small business by purchasing your own heavy construction machine and can start earning 50,000 per month. You may need additional skills on entrepreneurship to support your initiative.

ANSWER Sheet:

Question # 01 = B
Question # 02 = D
Question # 03 = B&C
Question # 04 = D
Question # 05 = C
Question # 06 = D
Question # 07 = D
Question # 08 = B
Question # 09 = B
Question # 10 = D
Question # 11 = B
Question # 12 = D
Question # 13 = D
Question # 14 = D

National Vocational and Technical Training Commission (NAVTTC)

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