Road civil work Level II

Learning Guide #32

Unit of Competence: Conduct Earthwork

Manual Based

Module Title: ConductingEarthwork

Manual Based

LG Code: CONRCW2M09 LO1-LG 32

TTLM Code:CON RCW2 TTLM 1019 v1

LO 1: Plan and prepare

Instruction Sheet	Learning Guide 32

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

- Application of relevant documents
- Safety Requirement and environmental protection
- Signage Application for traffic management
- Type & Use of Plant, tools and equipment
- Compaction Standards & Testing Requirements

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

- Compliance documentation relevant to the work activity are accessed, interpreted and applied
- Safety requirements are obtained and confirmed from the site safety plan and organizational policies and procedures, and applied to the allotted task
- Signage requirements are identified, obtained and implemented from the project traffic management plan
- Plant, tools and equipment to carry out tasks consistent with the requirements of the job are selected, checked for serviceability and rectified or any faults are reported
- Compaction standards and testing requirements are correctly identified
- Environmental protection requirements are identified from the project environmental management plan, and confirmed and applied to the allotted task

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3,Sheet 4 and Sheet 5” in page 5, 7, 10, 12 and 18 respectively.
4. Accomplish the “self-check 1, self-check 2, self-check 3 and self-check page 6, 9, 11, 17and 22 respectively.

1. Introduction to the Module

Conduct Earth work manual based

In construction terms, Earth work excavation is the process of removing earth to form a cavity in the ground. On small sites or in confined spaces, excavation may be carried out by manual means using tools such as picks, shovels and wheelbarrows.

Setting out or ground tracing is the process of laying down the excavation lines and center lines etc. on the ground before the excavation is started. ... Excavation is done by manual or machine means depending on the availability. The excavated soil is to either removed out the site or stocked around the excavation pit.

Bulk earthworks include the removal, moving or adding of large quantities of soil or rock from a particular area to another. They are done in order to make an area a suitable height and level for a specific construction purpose.

Information Sheet-1	Application of relevant documents

1.1 Introduction to documenting

All daily work activities in the site monitoring and documenting is necessary in order to check ***progress in relation to plans and budgets***.
Work performance is documented in accordance with workplace procedure.

1. Completed work is checked against workplace standards.
2. Errors are identified and corrected.
3. In case of deviations from specific quality standards causes aredocumented in accordance with the workplace's standardoperating procedures

The information which should recorded as document is work place procedure.
Work place procedure – Is helps for performing

- Work activities
- Health & safety requirement
- Environmental requirement
- Quality specifications etc.

Also design of construction should be recorded
Site meetings are usually conducted to review progress of Works in a month
Site meetings & progress reporting monitoring of ***progress and handling of site problems is one of the major responsibilities of the Project Manager and the Supervising*** *Consultant.* Site Meetings and progress meetings provide a formal arrangement for checking contractor's performance against the work programe and providing on spot solutions to site problems. ***Reporting requirements are important as a management tool*** to monitor progress and take corrective action in case deviation from the programe is noticed.
Progress Reports on a ***monthly, quarterly and yearly*** basis, the consultant prepares progress reports to document and record activities, decisions, and any deviations from the original contract. Such information is particularly useful as a monitoring tool as well as settling future legal disputes.

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. The information which should recorded as document is work place procedure?

   A. True B. False

2. Site meetings are usually conducted to review progress of works?

   A. True B. False

Note: **Satisfactory rating - 6 points Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.

Information Sheet 2	Safety Requirement and environmental protection

2.1 Introduction to Safety Requirement

Health and safety of workers The health and safety aspects of the workers are largely governed by the Health and Safety rules and regulation in Compliance with the requirements for the accommodation of traffic, which is not only intended for the wellbeing of the public but also to protect the workers involved on the road. The following minimum practical requirements are, however, drawn to the contractor's attention:-

- The issue of protective clothing, boots, gloves, overalls, etc. to the workers is essential.
- A properly equipped first aid kit must be available at all times.
- Transportation of workers on open trucks/trailers must be controlled e.g. all passengers must be seated with no legs hanging over the side of the truck/trailer.

Type		Use
Hard hat		Protects head of the worker from any falling objects dropping from high level during construction
Over all cloths		Protects the normal clothes from dust, grease and other spilling materials.
Safety shoe (boot		Protects the worker form nail, sharp objects and heavy falling objects by hard-rolled leather shoes with metal toe caps
Dust Mask		Protects nose of the worker from other endangering object and dust during construction.
Goggle		Protects eyes of the workers during welding of metal works and when placing reinforcement in the form work.
Glove		Protects the workers from oils, chemicals, and dust and other dangerous material that affect the skin.
Safety Belt		Secures laborers working in a plane where the construction is done at high level.

Table1. Safety materials

2.2 Introduction to Environmental protection

It is necessary to protect environments. Thenewly formed slopes on fills and embankments can be easily damaged (by run-off surface water, cattle, etc.). It is therefore necessary to protect the slopes as soon as they have been constructed. The erosion protection can be of different types, the most common being planting grass or other types of deep rooted vegetation. A more expensive but fast and effective method is to use stones for protection.

Grass can provide very effective protection against erosion if the right method of planting and the right type of grass is used. The planting can be done either by planting grass runners, or covering the slopes with turf.

The newly planted grass needs to be protected from cattle by a layer of thorny bushes, twigs, branches, etc. and watered when necessary.

- Do not dispose of materials scattered all over the area and on the shoulder. It should be disposed of at safe location or as directed by the Engineer
- If drains are not cleared properly, water can overtop and discharge onto farmland or cause erosion elsewhere.
- The excavated material deposited should not affect the drainage system, vehicle or pedestrian transit, cultivated land, houses, canals or streams. Where necessary, the removed material should be transported to a suitable dumping site.
- Ensure that the working area is fenced off from the children that are coming to play during the off working hours.
- If material was borrowed along the sides of the embankment, make sure it does not become a pond of stagnant water where mosquitos can breed, especially when it is located close to human settlement.
- The activity can generate dust if the road surface is dry
- Avoid using burning (fire) as a method of bush clearing.
- Care must be taken to avoid damage to protected flora, historical monuments and other heritage sites.

Self-Check 2	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Helmet is to protect head of the worker from any falling objects?

   A. True B. False

2. When you used goggle, protects eyes of the workers during welding of metal works?

   A. True B. False

3. Grass can provide very effective protection against erosion?

   A. True B. False

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.

Information Sheet 3	Signage Application for traffic management

1.1 Introduction to Signage for traffic management

When work is being carried out on or close to the carriageway, the Engineer's/technician responsibility to see that adequate measures are taken to warn and protect road users and maintenance workers.

He should instruct all supervisors and foremen in safety measures, including traffic control, and the use of temporary road signs.

In selecting and positioning temporary road signs, the following principles should be applied:-

(i) Only standard signs should be used,

(ii) The signs must be clean and in good condition,

(iii) The standard signs should be displayed in a standard layout

Each Earthwork construction gang should be provided with signs appropriate to the work it is carrying out and all foremen and supervisors should be trained in their use and layout.

All temporary signs must be removed as soon as the work they relate to is complete. If they are not the value of the signing will be reduced.

From the point of view of safety and traffic control, road construction work may be divided into four categories:

(i) work which does not affect the carriageway, such as cleaning out side drains and cutting grass on verges
(ii) work requiring partial closure of the carriageway, such as repair work to surface or base which is restricted to one lane while traffic continues to use the other lane
(iii) Work on the center line, such as white line painting
(iv) Work requiring total closure of the road, with construction of a temporary diversion, such as the reconstruction of a damaged culvert

Whenever possible during construction work, yellow or orange safety vests should be worn by the supervisor and the entire workforce. All vehicles and equipment should be painted yellow or orange and should carry red and white striped marker board's front and rear. All vehicles and equipment should work with headlights switched on and, where possible, should carry yellow flash warn lights. If warning lights are not available, vehicles and equipment should carry a yellow or orange flag.

Self-Check 3	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. The site engineer should instruct all supervisors and foremen in safety measures?
   A. True B. False

2. The traffic signs must not be clean and in good condition?
   A. True B. False

3. All temporary signs must be removed as soon as the work they relate?
   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.
3.

Information Sheet 4	Type & Use of Plant, tools and equipment

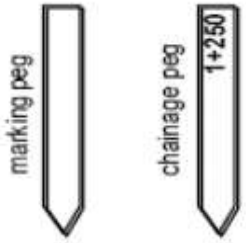
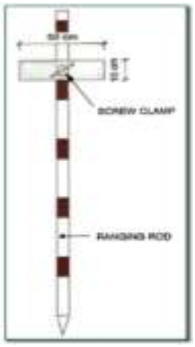
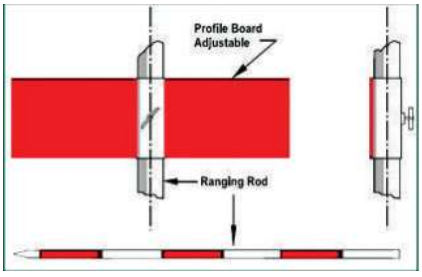
2.1 Type & Use of Plant, tools and equipment

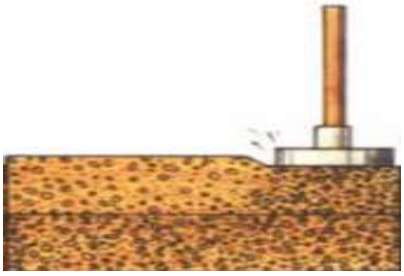
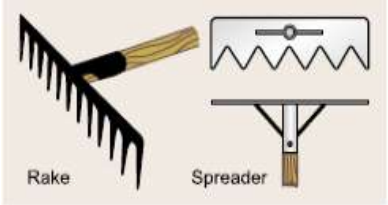
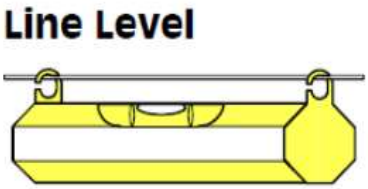
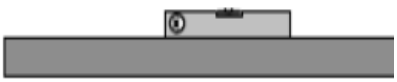
The surveying and setting out requirements for labor-based earth road construction vary with the type of work to be executed. The construction of new roads requires a complete by the surveyor/ Engineer to establish the alignment. The following figures and tables shows the basic surveying tools that are used for setting out in labor based road construction and maintenance technology.

Name of Plant& equipment	Use of Plant and equipment	Type of plant and equipment
Rollers	Roller compactor or roller is compactor type engineering machinery used to compact soil, gravel, concrete, or asphalt in the construction of road and foundations.	
Graders	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.	
Skid-steers	Skid steers is able to manoeuvre in tight spaces and driver through narrow passageways, making it the best choice for interior work.	
Dozers/Bulldozer	Is a crawler equipped with a substantial metal plate used to push large quantities of soil, sand, rubble, or other such material during construction or conversion work and typically equipped at the rear with a claw-like device to loosen densely compacted materials.	
Scrapers	Scraper, in engineering, machine used for moving earth over short distances (up to about 3.2km) over relatively smooth areas.	

Name of Plant & equipment	**Use of Plant and equipment**	**Type of plant and equipment**
Backhoes	Backhoe also called rear & back actor. Is a type of excavating equipment, or digger, consisting of a digging bucket on the end of a two part articulated arm.	
Excavators	Excavators are heavy construction equipment consisting of a boom, dipper, bucket and cab on a rotating platform known as the “house” the house sits atop an undercarriage with tracks or wheels.	
Tip-trucks	A dump truck, known as a dump truck or tipper truck, is used for taking dumps for construction	
Loader	Usually wheeled vehicles with a hydraulically operated scoop in front for excavating and loading loose material Called also front end Loader.	
Water carts	Water cart (Shower truck) for small, medium and large scale water cartage	
Wagon Drill & compressor	Is a mechanical engineering a vertical mounted, pneumatic, percussive-type rock drill supported, on a three- or four-wheeled wagon. A wheel-mounted diamond drill machine	
Blasting machine	A blasting machine is a mechanical method or shoot exploder is a portable source of electric current to reliably fire a blasting cap to trigger a main explosive charge. It is mostly used in	

	mining and demolition at quarry site.	

Name of tools	Use of tools	Type of tools
Pegs	Pegs are used for survey purposes and for setting out all the activities. On labor based sites usually wooden sticks are used of approximately 50 cm length and strings. On one end they are pointed so that they can easily be hammered into the ground. Survey pegs, for example chainage pegs.	
Tape Measure	A great variety of tape measures exist. The most common length of tape measure used for setting out is 30 meters. The tapes are made of steel or linen.	
Ranging Rods	Ranging rods are round sticks usually 2 m long with a diameter of 2.5 cm. They are made of various materials (metal, hard plastic, wood) and are usually provided with a pointed metal end. They are painted red and white with black marking at the 1 meter point. The lengths of the red/white sections are 50 cm.	
Profile Board	A profile board is designed in such a way that it can be attached to a ranging rod. It has a screw mechanism that enables the profile board to slide up and down on the ranging rod and be fixed at any desired point simply by tightening the screw.	
	Hand rammers are used for compacting soil and gravel. It	

Hand Rammers	consists of a weight with a long handle. The effectiveness of a hand rammer depends on its weight and the area that hits the ground.	
Name of tools	**Use of tools**	**Type of tools**
Rakes and Spreaders	Rakes are used in road works for raking out vegetation from loose soil. Spreaders are useful when forming the camber and when spreading gravel.	
Line Level	A line level is a small spirit level of about 80 - 120 mm length. It has a hook on each end of the level which is used for hooking the level onto a smooth line. The level is used together with a line, ranging rods (or profile boards) and a tape measure. The line level requires two people to operate. The line level can be used to: • to transfer levels • to check existing gradients • to set out gradients	
Hoes	The hoe, in addition to being very useful in agriculture, is also a commonly used tool when using labour-based work methods for rural road works. It can be used for excavating soft soils.	
Straight-Edge with Spirit Level	If the spirit level is not long enough, then a Straightedge of 2.50 m to 3.50 m, usually out of wood, can be used. Always ensure that your	

	straightedges on site are actually straight on both sides.	
levelling equipment	Levelling is a branch of surveying, the object of which is to establish or verify measure the height of specified points relevant to a datum.	
Name of tools	**Use of tools**	**Type of tools**
string lines	Is a long flexible structure made with fibers twisted together in to a single. It is used to set out construction activities.	
shovels	Shovel is used to stir the mortar paste, soils prepared in the barrel or drums and keeps the mix to right and uniform consistency.	
hand saws	In wood working and carpentry, hand saws, also known as “panel saws” are used to cut pieces of wood in to different shapes.	
crow bars	A crowbar, also called a wrecking bar, pry bar or pinch-bar. Is used to lever either to force apart two objects or to remove nails. Crowbars are commonly used to open nailed wooden crates.	
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. Drive nails in to wood.	

Table2. Tools, plant and equipment

Self-Check 4	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Pegs are used for survey purposes and for setting out all the activities?

   A. True B. False

2. Ranging Rods are usually provided with a pointed metal end, they are painted red and white?

   A. True B. False

3. Hand rammers aren't used for compacting soil and gravel?

   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.
3.

Information Sheet 5	Compaction Standards & Testing Requirements

5.1 Introduction to compaction

Compaction is defined as the method of mechanically increasing the density of soil.

There are five principle reasons to have compact soil: -

- Increases load-bearing capacity
- Prevents soil settlement and frost damage
- Provides stability
- Reduces water seepage, swelling and contraction
- Reduces settling of soil

5.2 Introduction to testing requirements

Determine the Maximum Dry Density and the Optimum Moisture Content of Soil

This test is done to determine the maximum dry density and the optimum moisture content of soil using heavy compaction

The following three field tests should be carried out on the soil samples obtained from the trial pits when laboratory testing is not possible:

Visual test Take a dry sample of the material and crumble it in your hands. There should be a significant proportion by volume (about half) of particles larger than 2 mm in diameter. Try to crumble the large particles in your hand or by tapping LIGHTLY with a hammer. If the lumps disintegrate completely into sand size particles it will not be suitable for gravelling as the same disintegration will occur under traffic.

Cohesion test Take a handful of damp sample and mould it into a ball to check for the presence of cohesive fine material, which is required to bind the larger gravel particles together. If cohesive fines are present the material will stick together when gently placed on a flat surface. Silts and clays will also stain the hands.

Figure1.simple soil testing in the field

Particle size distribution for this test, two alternatives can be used: the 'settlement test' and the 'vibration test'. Both tests are described and illustrated on the Reference list, and further details can be found in the Technical Manual.

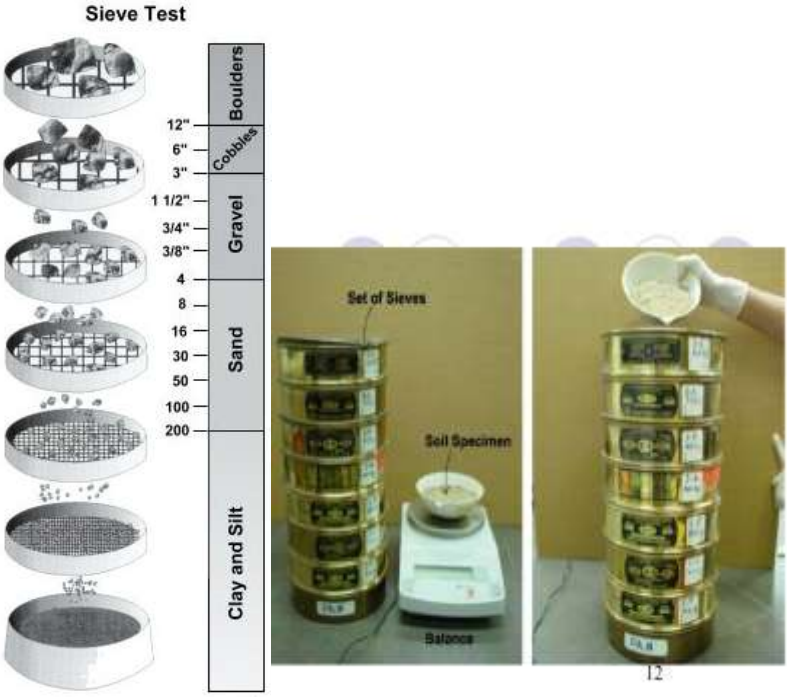


Figure2.Particle size of aggregate distribution

5.3 Compaction Procedures

In order to achieve the high quality outputs relating to this activity, it is useful to assign and train specific workers to operate the compaction equipment. They will eventually build up the experience to efficiently operate in a manner producing uniform and good compaction results. Equally important is that they are trained in how to maintain and service the rollers.

Compaction and watering once the surface material has been spread to the correct thickness and levels, compaction works can commence. Make sure that there is sufficient supply of water so optimal moisture content can be maintained in the gravel during compaction.

Figure3.Watering and compaction procedure

Earth road compaction is best carried out using *steel sheep foot rollers*. Any roller with a minimum weight of one tone, preferably with a vibrating mechanism, will be effective as long as the material is spread in layers not exceeding a thickness of 15cm.

5.4 Factor that affect compaction

Soils to obtain the moisture content – dry density relationship for a soil and hence to determine the optimum moisture content and maximum dry density.

The increase in dry density of the soil achieved as a result of compaction depends upon the following factors.

5.4.1Water content (Moisture content):-

- At water content lower than O. M. C, the soil is stiff and is not workable offering resistance to compaction.
- As the water content increases, the particles become lubricated and are easier to expel air from the voids. Thus the dry density increases till the optimum amount of water is applied.

- With further increase in moisture content the water starts to occupy more pore spaces and results in an increase of the total voids (air and water).
- This results in an increase in the total volume of the soil. Hence this in turn will bring about reduction in the dry density of soil.

5.4.2 Amount of Compaction (No of pass required):-

- At moisture content less than the optimum, increasing the compactive effort brings about an increase in the dry density.
- But at water content more than the optimum, the volume of air voids is almost constant & thus increasing the compactive effort has no effect on the dry density.
- Even at moisture content less than the optimum, the dry density will not go on increasing with an increase in compactive effort.
- With an increase in compaction the increase in ρdry becomes smaller and smaller and finally no change in ρdry will be observed with an increase in compactive effort.

5.4.3 Type of Soil:-

- Generally coarse grained soils can be compacted to a higher dry density than fine gained soils for the same compaction effort.
- When some fines are added to the coarse grained soils to fill the voids, the maximum dry density further increases, But if the amount of fines is too much, more than required to fill the voids, it results in reduction of dry density,
- Well graded soils can attain higher dry density than coarse graded soils.
- High plasticity cays attain much less dry density than low plasticity clays for the some completive effort.

5.4.4 Method of compaction:-

- The increase in dry density for a given compaction effort depends also on method of compaction i-e whether the method of compaction utilizes kneading action static action or dynamic.

5.4.5Thickness of material:-

- The thicker thelayer of loose material that is being compacted, the less the average densitywill be and therefore the stability resulting from a certain compactive effort. As a general rule, the loose layer to be compacted should not be less than 10cm and the maximum thickness may range from 10 cm to 40cm depending on the roller to be used.

Self-Check 5	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Dry sample of the material crack and crumble it in your hands?

   A. True B. False

2. Cohesive fines are present the material will stick together?

   A. True B. False

3. To increase in dry density of the soil achieved as a result of compaction?

   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.
3.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
4. Introductory Training Course in Labour-based Roads Construction for Engineers and Technicians, Marshall, ILO Cambodia, 1993
5. Labor-based Construction Programs: A Practical Guide for Planning and Management, Coukis et al, World Bank, 1983
6. Rehabilitation of Feeder Roads Using Labour-based Methods, Technical Manual, Veselinovic, UNOPS, Afghanistan, 1993
7. Technical Manual, Marshall, District Council Road Unit, Botswana 1987
8. Technical Manual for Low Volume Roads Upgraded and Constructed Using Labour based Methods in Lesotho, Ministry of Works, Lesotho 1992
9. Training Videos for Labour-based Road Construction and Maintenance, ILO 1991
10. Field Manual for Labour-based Road Supervisors, Johannessen, ILO Cambodia, 1994
11. Course Notes, Roads - Labour-based Methods, Strom, Field Training Unit, Botswana 1994
12. Introductory Course in Labour-based Roads Construction for Engineers and Technicians, Roads Training Centre, ILO Laos, 1995
13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

Road civil work Level II

Learning Guide #33

Unit of Competence: Conduct Earthwork Manual Based

Module Title: ConductingEarthwork Manual Based

LG Code: CONRCW2M09 LO2-LG 33

TTLM Code: CON RCW2 TTLM 1019 v1

LO 2: **Carry out Clearing and grubbing operation based on the given tasks**

Instruction Sheet	Learning Guide 33

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

- Workplace Instruction Techniques
- Set-out Clearing & Grubbing Operation
- Disposal of Waste Material

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

- Clearing road width & length is set out as per the work order
- Labor forces and equipment operators are informed of the job requirements
- Bush clearing, stamp, top soil & boulders are removed using equipment and/or labors as appropriate as per the work order.
- Cleared & removed materials are disposed in accordance to the work order.

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3 in page 26, 28 and 33 respectively.
4. Accomplish the “self-check 1, self-check 2, self-check 3 and self-check in page 27, 32and 35 respectively.
5. If you earned a satisfactory evaluation from the “ self-check” proceed to “operation sheet 1 in page 36
6. Do the “LAP test” in page 37

Information Sheet 1	Workplace Instruction Techniques

1.1 Work place instruction

Labour based road construction involves breaking down various components of road construction into small and simple activities that are easily carried out by hand such as vegetation control, earthworks and graveling activities, whereas intermediate equipment, like tractors, light trucks and compaction rollers are used for haulage and compaction activities. The separate operations or activities follow each other in a logical sequence.

Labour forces and equipment operators are informedto the job requirements

Investigate any technical possible solution in order to avoid cutting of a large tree.

Before removal of big trees starts, check and agree on required worker days.

Excavating and loading soils can be carried out using a large variety of work methods and equipment. In all cases, it is important to organize the works in an orderly fashion in which equipment and labour have ample space to operate without being in conflict with each other. The excavation can be carried out with a front-wheel loader, an excavator or using hand tools such as pickaxes, crowbars, hoes and shovels.

Self-Check 1	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Before removal of big trees starts, check and agree on required worker days?

   A. True B. False

2. Labour and equipment operators are should inform the job requirements?

   A. True B. False

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.

Information Sheet 2	Set-out Clearing & Grubbing Operation

2.1 Clearing and grubbing work

Clearing is the first operation to be carried out once the detailed road alignment has been established. It consists of the removal and disposal of all bushes, trees, roots, boulders rubbish, grass and topsoil and other objectionable material from an area marked on the plan or otherwise designated by the engineer. It consists of all preparatory activities before excavation and fill works commence for the road formation and drainage structures.

In labour-based road construction, clearing of vegetation and removal of topsoil is split into 4 sub activities in accordance with the steps used in the execution of the works.

- Bush clearing
- Tree and stump removal
- Grubbing and stripping of soil.
- Boulder removal

Clearing is carried out covering the entire *width* of the road plus the space required for drainage and side slopes. This activity is also required before any borrow pits or quarries can be effectively utilized. Finally, clearing works are necessary when establishing a site camp.

2.1.1 Bush clearing

Bush clearing consists of cutting and removing *bushes and shrubs* within the road reserve. It is carried out as the first work activity when constructing road, normally scheduled to take place just before the earthworks commence.
If it is done too far in advance, the bush grows back and the exercise needs to be repeated. Some bush clearing may also be required during the surveying works in order to provide access and clear sightlines for the surveyors.
Bush clearing is essentially carried out using bow saws, axes and bush knifes. The bush should be disposed of well outside the roadway or stacked in a cleared area for burning. Removed bush and debris should be discarded at locations from where it cannot return to the road reserve and so blocking drains and cross-drainage structures.
Before felling a tree, make sure it is absolutely necessary to cut it down. May be, it is possible to adjust the alignment so that the tree felling can be avoided. If a tree needs to be cut, use experienced workers and keep everyone else

well away. After felling, cut the tree in pieces and remove them from the road side.

Once the tree is cut, dig up and remove the roots. Holes after root extraction need to be filled and compacted properly using hand rammers. Heavy grass cover should be cleared. Light grass cover can be incorporated in the construction earthworks without too much of a problem, and afterwards re-grows, forming protection against erosion on the shoulders. Heavy grass tufts can be used to line side slopes in cross cut conditions or on embankments, and should be separated from the soil to be used for road construction. This work is carried out by task work per area, and the area set will depend on the difficulty of the work.

Figure.4. Labours in Bush clearing

2.1.2 Tree and stump removal

Removing large trees is an expensive operation, especially when it comes to digging out the roots. Trees are often a social amenity providing shade, fodder or firewood for the local community. If large trees stand in the way, realignment should be considered to avoid them. Trees growing near the road can have a good effect on the strength of the road because they can act as a countermeasure to soil erosion.

In hilly terrain, trees protect the exposed faces of cuts against erosion. Equally, trees can stabilize materials on the fill side. Before cutting down trees outside the roadway, it is therefore worthwhile considering letting them remain. For trees within the roadway, an assessment should be made whether it is possible to find technical solutions which still safeguard the performance of the road. For example, instead of cutting down a tree standing in the side drain, a solution may be to install a miter drain (turn-out) in front of the tree and continue the side drains behind the tree.

Deep roots may have to be dug out and then cut using axes; however, it is better if the tree can be pulled down with all the roots coming out. The roots

left in the ground will eventually rot away and leave holes, which can undermine the strength of the road.

Figure.5.Methods of tree removal

Larger sized trees are first cut using an axe or a saw, and thereafter the roots are dug out and removed. Big roots, stumps or pieces of the tree trunks can be burned after grubbing has been done (the risk of bush fires is less when grass and vegetation have been removed).

Felling trees can be dangerous and should preferably be done by experienced workers and always with proper supervision. When the felling takes place, all workers and equipment need to be evacuated to a safe distance away from the area where the tree is expected to fall. Only the workers assigned to the tree felling activity should remain. The site supervisor is responsible for keeping the rest of the workforce and any passersby or traffic at a safe distance.

2.1.3 Grubbing and stripping of topsoil

Grubbing consists of *removing roots of grass* and other light vegetation. It may also include the removal of topsoil containing considerable amounts of organic material. Roots need to be dug out to a depth that ensures that the trees or bushes do not continue growing and reappear in the road reserve.
If the topsoil consists of the same material as the soil below it, there is no reason to remove it. Topsoil should only be removed if it appears to contain organic material and small roots. On most sandy soils the surface can be left undisturbed. This may help to minimize erosion. On the other hand, if the soil underneath is to be excavated and dumped outside the road (spoiled), it is not necessary to carry out any grubbing.

Figure 6.Bush clearing

Following are important issues to remember when checking for this activity.

- Check the width of the stripped and grubbed area
- Check that all grass, upper grass roots and other vegetation remaining after bush clearing within the specified section has been removed (conserve trees where possible)
- Check also for the removal of top soil within the section

Topsoil Removal

Topsoil removal is usually only needed where the topsoil is deep (**10-15cm**), very organic and appears to be inferior in strength than the soil below. If the topsoil layer is very thin, it has very little effect on the compaction and resulting strength of the road. Most agricultural land and open areas are eroded, with a very thin topsoil layer, which can be mixed in with the earthworks for the road construction.

The materials removed need to be discarded at a location where it causes no future damage to the road or surrounding areas. If it is dumped on the high side of the road, it may be washed back into the drainage system of the road during heavy rains. Equally, it may cause damage to farmlands and residential areas. Topsoil can often be reused on the slopes next to the road or spread on adjacent farmlands. Similarly, organic soils can also be used at the end of the project when reinstating borrow pits and gravel quarries.

Topsoil removal is executed using task work on an area basis, determined by the thickness of the topsoil. The best tools to be used in this activity are hoes, mattocks, spades and rakes.

2.1.4 Boulder Removal

Boulder removal can involve hand carrying small boulders, rolling clear, breaking or digging and burying large boulders. This work is often time consuming and expensive and should be avoided if possible when selecting the alignment. Where there is an excessive boulder in the soil, which creates problems for drain excavation, the possibility of lifting the road levels should be considered

Figure 7.Boulder removal

Task work on a group or specific job basis could be used to organize the labor force
A successful and safe method, which requires a lot of patience, is the use of fire and water to quickly cool down the rock. As an effect of this, the rock will crack (see the above picture).

Self-Check 2	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Grubbing in labour-based road construction, clearing of vegetation?
   A. True B. False

2. The cleared areas should be measured at regular intervals of greater than 25 meters?
   A. True B. False

3. All bushes are removed out of the required width?
   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1.
2.
3.

Information Sheet 3	Disposal of Waste Material

3.3 Disposal of waste material

Cut and remove all bushes and shrubs within this area and dispose outside of the cleared area. A panga (bush knife) and stick are required to cut, control and discard the vegetation.

Soilsis a mixture of organic matter, minerals, gasses, liquids, and organisms that together support life. Most soils have a dry bulk density of soil taking in to void when dry.

Granular materials*Granular soils range in particle size from .003" to .08" (sand) and .08" to 1.0" (fine to medium gravel). Granular soils are known for their water-draining properties.*

Geo-fabricsare geo synthetics when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain in civil engineering projects.

Water is a liquid material, water on our planet flows as a liquid in rivers, streams, and oceans; can be used for construction projects like protect dust in work place, mixing of cement, for compaction of pavement material.

If it is necessary to burn the material, do it after stripping and grubbing, and within the same area. The material to be burned in controlled heaps to reduce spreading of fire Remove all grass upper grass roots and other vegetation (except trees) remaining after bush clearing. All topsoil should also be removed from the grubbed width as this would weaken the road if included in its construction.

The vegetation and topsoil should be discarded outside of the grubbed width.

Burning of material to be done outside the cleared area in controlled heaps to reduce spreading of fire.

Excavate around roots, cut stump and roots into pieces and remove. x Dispose cut wood outside the cleared area while timber may be used by villagers. Some timber may also be used for scour checks and setting out pegs or for firewood.

Remove boulders which are not bigger than 0.5m3 and dispose of outside the cleared area.

Bury boulders which are bigger than 0.5m3 well below the formation.

Bigger boulder is split using the fire and water method.

Weathered rock is split using crowbars, chisels, sledgehammers or plugs and feathers.

Larger boulders or rocky sections require blasting. This should only be done by experts and after having attained the necessary license and authority.

Broken stones should be disposed outside the cleared area. Good stones may be selected and retained for structure works and/or scour checks or gabion works. Smaller pieces may also be retained for hardcore beds underneath foundations.

Self-Check 3	Written Test

***Instructions**:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.Write your answers in the sheet provided in the next page.

1. Excavated soil or rock which is either unsuitable for use in the works or is surplus?

   A. True B. False

2. The contractor shall dispose of all trees, stumps, brush, roots removed in the clearing and grubbing process?

   A. True B. False

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.
2.
3.

Operation Sheet 1	Set-out Clearing & Grubbing Operation

Set-out Clearing & Grubbing Operation

Steps 1- Mark up the right of way (Road boundary)

Steps 2- Carry out bush clearing

Steps 3-Carry out tree and stump removal

Steps 4-Carry out top soil removal

Steps 5- Dispose the waste material

Steps 6- Clean-up tools and equipment.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 3 hours.

Practical exercise

Task.1 Perform site clearing and grubbing operation.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
4. Introductory Training Course in Labour-based Roads Construction for Engineers and Technicians, Marshall, ILO Cambodia, 1993
5. Labor-based Construction Programs: A Practical Guide for Planning and Management, Coukis et al, World Bank, 1983
6. Rehabilitation of Feeder Roads Using Labour-based Methods, Technical Manual, Veselinovic, UNOPS, Afghanistan, 1993
7. Technical Manual, Marshall, District Council Road Unit, Botswana 1987
8. Technical Manual for Low Volume Roads Upgraded and Constructed Using Labour based Methods in Lesotho, Ministry of Works, Lesotho 1992
9. Training Videos for Labour-based Road Construction and Maintenance, ILO 1991
10. Field Manual for Labour-based Road Supervisors, Johannessen, ILO Cambodia, 1994
11. Course Notes, Roads - Labour-based Methods, Strom, Field Training Unit, Botswana 1994
12. Introductory Course in Labour-based Roads Construction for Engineers and Technicians, Roads Training Centre, ILO Laos, 1995
13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

Road civil work Level II

Learning Guide #34

Unit of Competence: Conduct Earthwork Manual Based

Module Title: Conducting Earthwork Manual Based

LG Code: CONRCW2M09 LO3-LG 34

TTLM Code: CON RCW2 TTLM 1019 v1

LO 3: Set out sub-grade

Instruction Sheet	Learning Guide 34

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

- Setting out Operation
  - Center line & Grade Establishment
  - Road boundary Setting out

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

- Job is set out to plan from survey controls
- Profiles are established to line and level

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information “Sheet 1in page 41.
4. Accomplish the “self-check 1 in page 46
5. If you earned a satisfactory evaluation from the “ self-check” proceed to “operation sheet 1 in page 47
6. Do the “LAP test” in page 50

Information Sheet-1	Setting out Operation

3.1 Introduction to Setting out

Setting out: – means transferring dimensions from working drawing to the real site. Horizontal and vertical setting out are basic in road construction.

Horizontal setting out: - means fixing width and length of the road.

Road center: - lines are usually marked with pegs at uniform intervals and when the pegs are identified by their distance from the start of the job it is known as through chainage. The uniform interval is a sub – multiple of 100m, commonly 20m. A common convention for expressing a chainage of a peg is to state the number thousands of meters followed by a plus sign and then the remaining distance,
e. g. a peg at 17,120m from the start has a chainage 17 + 120.

Stake: is a timber pointed at one end for driving in to the ground.
Staking out is the driving stakes in to the ground to indicate the foundation location of the structure to be built or the center-line of the road etc. The stakes are often connected by a string, wire or cord in order to secure a clean edge in the excavation

Sub-grade is a natural surface which is ready to receive pavement loads and upcoming load.

3.1.1 Center line & Grade Establishment

Setting out the center line of the road, to ensure that the alignment, as it was designed by the design engineer, will be followed. The design engineer left center pegs behind at 20 meters interval, which should be used by the supervisor to reestablish the center line. After reestablishment of center line, ranging rods or strings must be used to check for the straightness and smoothness of curves.

Figure 8.Center line establishment

Setting out of chainage pegs: The design features of the road are described in the Detailed Improvement Plan (DIP) at intervals of 25 meters. It is very important that an accurate correlation is established and maintained between the design in the contract document and the actual site in the field. This can only be established by placement of permanent chainage pegs along the road at the same intervals as used in the document.

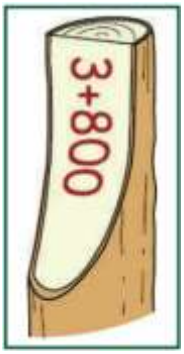


Figure9.Chainage peg

With the position and levels of the center line already established, it is possible to set out the camber and side drains. The road camber is usually constructed at the same time as the side drains. The cross section is set out at a right angle to the center line.

When designing the camber and side drains, it is important once again to keep the excavation works to a minimum by following the existing level of the terrain along the road line. By carefully assessing the road levels along the center line, the resulting quantities of earthworks can be kept at a minimum. The procedure described below is an efficient way of setting out the road levels, achieving a well-placed road with good drainage and which does not involve extensive excavation or fill works.

For the purposes of setting out, it is sufficient to know that certain quantities of work will have to be set out before the work is started. This should be done to show the individual worker (or groups of workers in some cases) how much work he will have to carry out as his daily task.

SETTING OUT HORIZONTAL CURVES There are four basic methods of setting out curves that road construction: Curves Setting out methods:

METHOD	APPLICATION
String method	Suitable only for curves with a radius of less than 30m. The area must be flat and free from obstructions. Mo and hairpin bends.
Quarter method	Suitable for short curves where a string can be stretched unobstructed between the ends of the two straight lines
Tangent method	Suitable for any curves where the alignment 90°. The intersection point for the two between it and the road must be flat
Offset method	Suitable for any curve. However, it requires a trial-and-error approach when applied to an existing alignment.

Table3. Methods of labour based horizontal curve

3.1.2 Elements of Road boundary

Cross-sections show, when drawn on a drawing board, what the final shape of the road will be and how much and which type of work has to be carried out to construct the road.

When set out in the field, the various cross-section pegs give all the necessary information in respect of the location and the level of the road.

The cross-section shows where the different parts of the road are located and how much and which type of work has to be carried out to construct the road.

Cross-sections are set out at right angles to the center-line of the road.Place multi-purpose pegs showing

(i) The edges of the road formation,

(ii) The location of the ditches, and

(iii) The center-line of the road. In the case of cuts and fills you can only place the multi-purpose pegs mentioned under

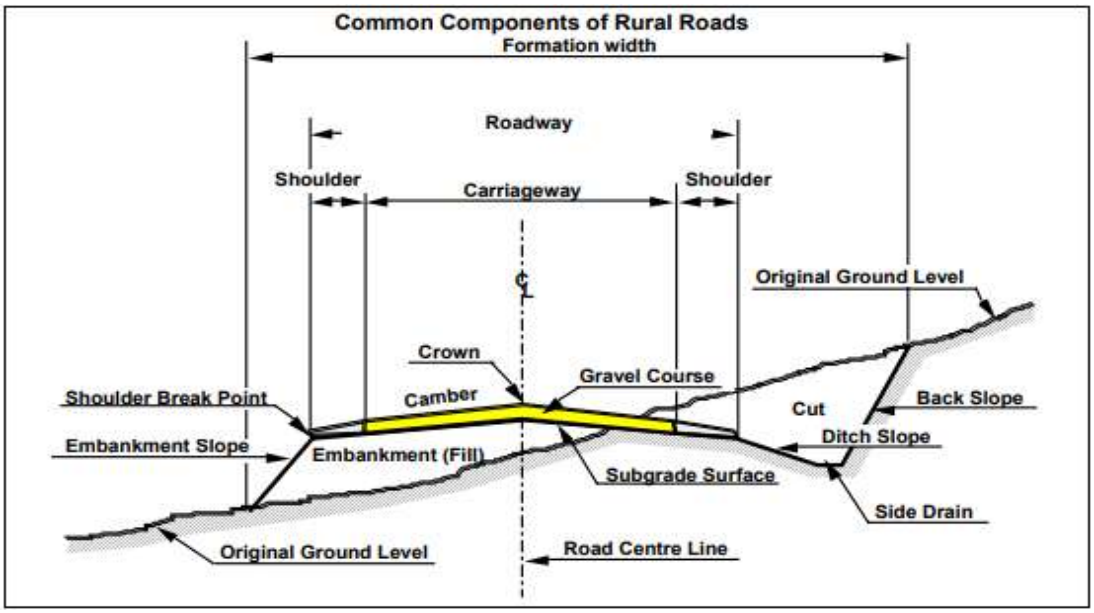


Figure.10.Boundary of rural road

Basic Elements of Road boundary

Carriageway (Width of travel lanes)

- Usually vary from 3 to 3.65 m, but occasionally 2.7 m lane width is used in urban areas where the traffic volume is low and there is extreme right-of-way constraints
- On two way two lane rural roads, accident rate for large trucks increases as the traveled way decreases from 6.5 m

Shoulders

- Serves for an emergency stop of vehicles
- Used to laterally support the pavement structure

Shoulder width

- Recommended shoulder width is in the range of 1.8 to 2.4 m
- for highways serving large number of trucks and on highways with high traffic volumes and high speeds, shoulder width of 3.0 to 3.5 m is preferable
- Minimum shoulder width 0.6 m on the lowest type of roads

- Shoulders should be flush with the edge of the traveled lane and be sloped to facilitate drainage (2-4 % if paved, 4-6 % if not paved)

Median barrier

- a longitudinal structure used to prevent an errant vehicle from crossing the portion of a divided highway separating the traveled way for traffic in the opposite directions
- Roadside barrier –protect vehicles from causing hazards onto roadside and shield pedestrians

Gutters

- drainage ditches located on the pavement side of a curb to provide the principal drainage facility for the highway
- Guard rails –longitudinal barriers on the outside of sharp curves at sections with high fills (greater than 2.5 m)

Sidewalks

- provided on urban or rural roads
- When pedestrian traffic is high along main or high speed roads
- When shoulders are not provided on arterials even when pedestrian traffic is low
- In urban areas, sidewalks are provided along both sides of streets to serve pedestrians access to schools, parks, shopping centers, and transit stops.

Cross-slopes

- to enhance the flow of surface water
- High type pavement –1.5 –2 %
- Intermediate type of pavement –1.5-3%
- Side slopes provided for stability of earthworks; the slope varies depending on the material type

Right-of-way

- the total land area required for the construction of the roadway
- To accommodate all the elements of the road cross-section

- Planned widening of the road

Public utility facilities that will be installed along the highway

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Setting out means transferring dimensions from working drawing to the real site?

   A. True B. False

2. Horizontal setting out means fixing width and length of the road?

   A. True B. False

3. Road centerlines are usually marked with pegs at uniform intervals?

   A. True B. False

4. Stake: is a timber pointed at one end for driving in to the ground?

   A. True B. False

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

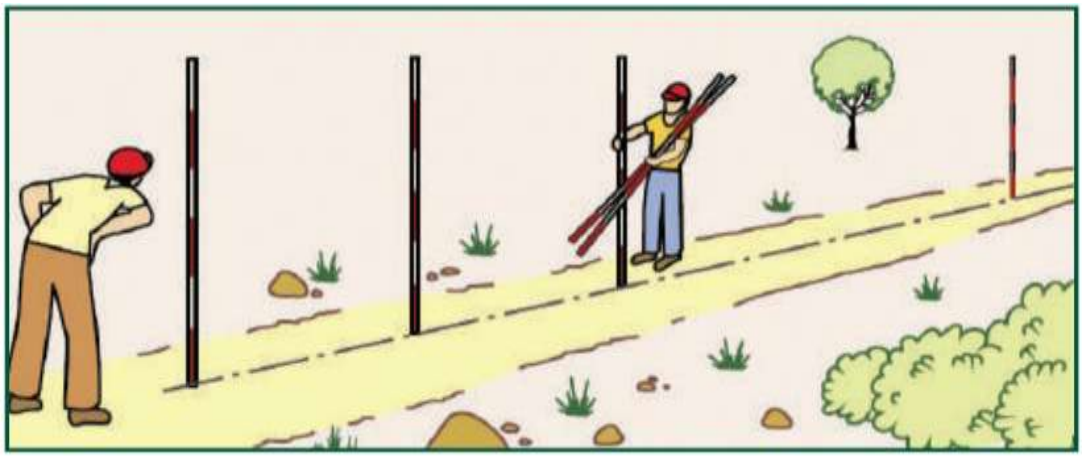
1.
2.
3.
4.

Operation Sheet 1	Setting out operation

Perform the setting out operation

Steps 1- Set out center line, set out ranging rods at intervals along the center line for a section of 50 to 100 meters. At the start of the section, measure out the position of the road shoulders and the outer end of the side drains from the center line. Repeat this exercise at the other end of the section.

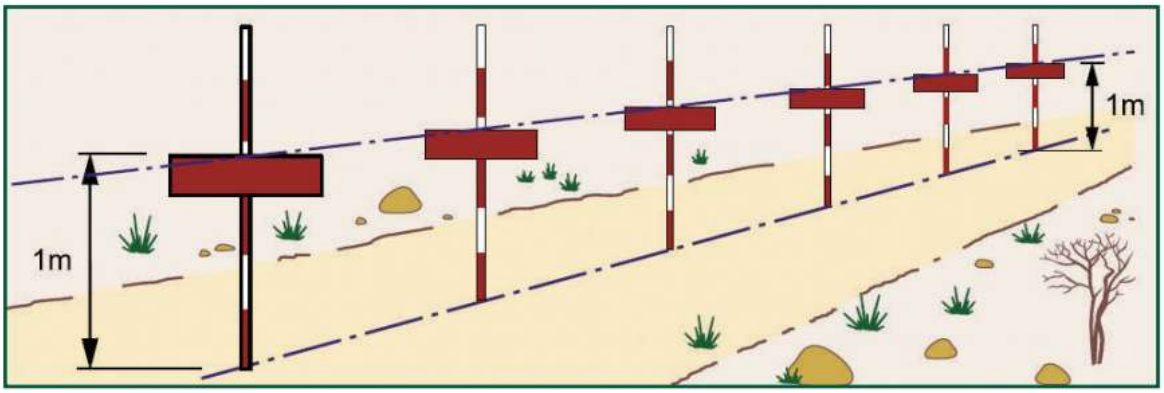
Steps 2- Once the key positions of the road has been set out at the start and the end of the road section, sight in intermediate ranging rods at every 10m along the road shoulders and side drains. Place wooden pegs next to each of the intermediate ranging rods.



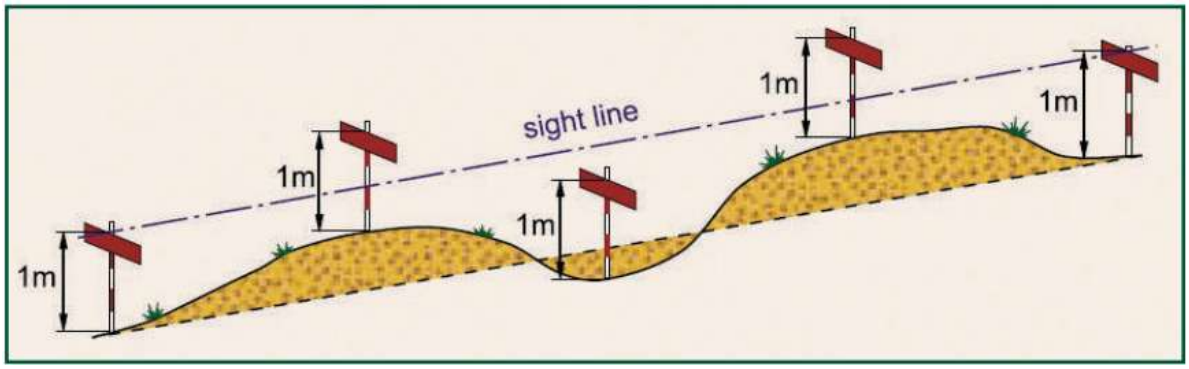
Steps 3- On the center line of the road, fix the first profile board. This profile may be already in position as the last profile from the previous setting out. If not, measure 1m up from the existing ground level, and mark this level on the ranging rod. Fix a profile board to the ranging rod so that the top edge of the profile board is at the mark made on the rod.

Steps 4- Go to the center line ranging rod at the other end of the road section and repeat the procedure, measuring up 1m from the ground level.

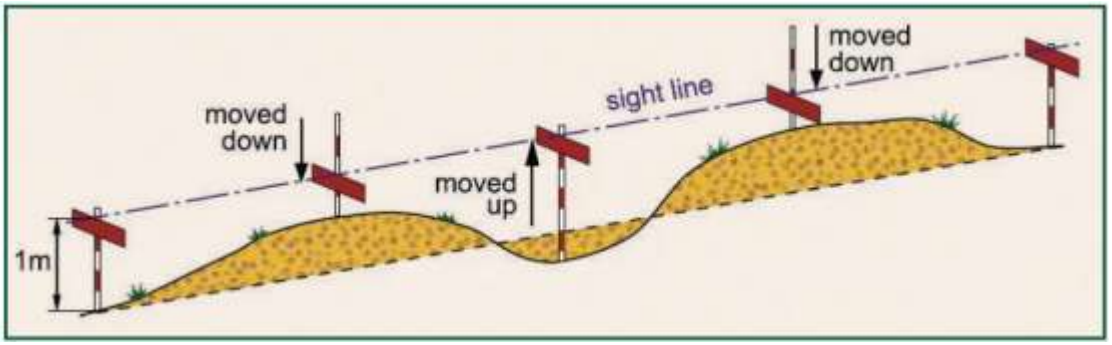
Steps 5- By sighting in the intermediate profiles from one end, fix profile boards on the intermediate ranging rods along the center line so that they are all at the same level.



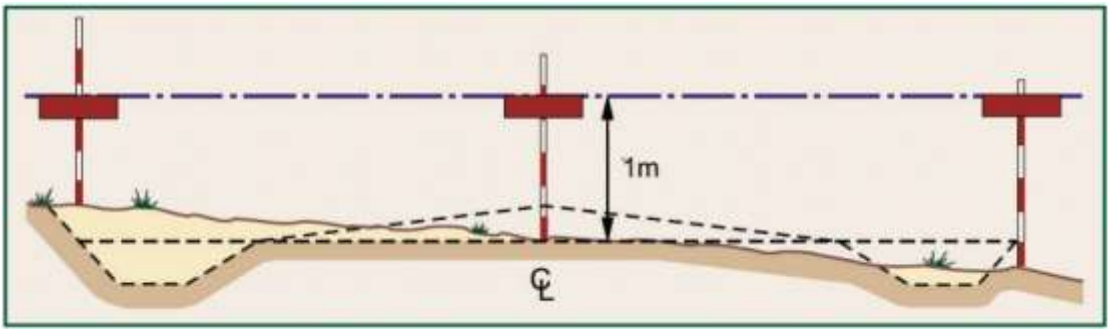
Steps 6- Check the height of each profile board above the ground level. If the height is approximately 1m, there is no need to adjust them and you can use the level of the profile as it is.



Steps 7- Adjust the profile at position move up so that it is 1m above the ground (Fill) and move down so that it is 1m below the ground (Cut) do excavate to level operations, This exercise will reduce the amount of disposed material.



Steps 8- Transfer the levels to the ranging rods at the outer end of the side drains. Start with the beginning of your road section. Using a string and a line level, transfer the level of the profile board at the center line to the ditches on the both sides of the road. Once the levels are set out with profile boards, mark the levels on pegs next to each ranging rod.



LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 4 hours.

Task 1. Perform and establishcenter line setting out operations.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
4. Introductory Training Course in Labour-based Roads Construction for Engineers and Technicians, Marshall, ILO Cambodia, 1993
5. Labor-based Construction Programs: A Practical Guide for Planning and Management, Coukis et al, World Bank, 1983
6. Rehabilitation of Feeder Roads Using Labour-based Methods, Technical Manual, Veselinovic, UNOPS, Afghanistan, 1993
7. Technical Manual, Marshall, District Council Road Unit, Botswana 1987
8. Technical Manual for Low Volume Roads Upgraded and Constructed Using Labour based Methods in Lesotho, Ministry of Works, Lesotho 1992
9. Training Videos for Labour-based Road Construction and Maintenance, ILO 1991
10. Field Manual for Labour-based Road Supervisors, Johannessen, ILO Cambodia, 1994
11. Course Notes, Roads - Labour-based Methods, Strom, Field Training Unit, Botswana 1994
12. Introductory Course in Labour-based Roads Construction for Engineers and Technicians, Roads Training Centre, ILO Laos, 1995
13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

Road civil work Level II

Learning Guide # 35

Unit of Competence: Conduct Earthwork Manual Based

Module Title: Conducting Earthwork Manual Based

LG Code: CONRCW2M09 LO4- LG 35

TTLM Code: CON RCW2 TTLM 1019 v1

LO 4: Form earthworks

Instruction Sheet	Learning Guide 35

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

- Earthwork Operations
- Techniques and methods of compaction operation
- Techniques and methods of material Stabilization operation
- Types and Application of geo-synthetic material

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

- Plant (equipment) operators are informed of job requirements
- ***Earthworks*** are assessed to ensure that the specified height is achieved, with allowances for the pavement courses and the overall dimensions
- Uniform layer thickness and moisture content are monitored to ensure consistency with specifications
- Stabilization of existing ***material*** is monitored
- Surface area protrusions are removed to prevent damage to geo-synthetic material
- Geo-synthetic material is place to manufacturer's specifications

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4" in page 54, 61, 66, and 72 respectively.
4. Accomplish the "self-check 1, self-check 2, self-check 3 and self-check page 60, 65, 71 and 74 respectively.
5. If you earned a satisfactory evaluation from the "self-check" proceed to "operation sheet 1 and operation sheet 2 in page 75 and 76 respectively.

6. Do the “LAP test” in page 77

Information Sheet 1	Earthwork Operations

4.1 Introduction to Earthwork operation

The term earth road is often used for any road without a bound surface layer, i.e. a road without a bituminous or cement based surface treatment.

Cutting and filling material (Cut and Fill) operations

- RES = Reshaping
- ETL = Excavation to Level
- SBO = Side Borrow

Reshaping is used on sections of road, where the road embankment has a reasonable shape and where side drains exist, but need to be desilted.

Excavation to Levela level platform is created from left to right over the entire grubbed width. If the ETL is not done correctly, e.g. there are differences in level from left to right, it will be very difficult, to construct a correct final cross-section.ETL is the most common method in road rehabilitation and requires the contractor to build the road embankment from a level platform, which first has to be prepared by balancing cut and fill over the cross section of the road.

Figure.11.Excavation to level operation

Side Borrow is used where the road needs to be raised, and where the material from the side drains will not be sufficient to establish this. In this case, material needs to be borrowed from further distance.

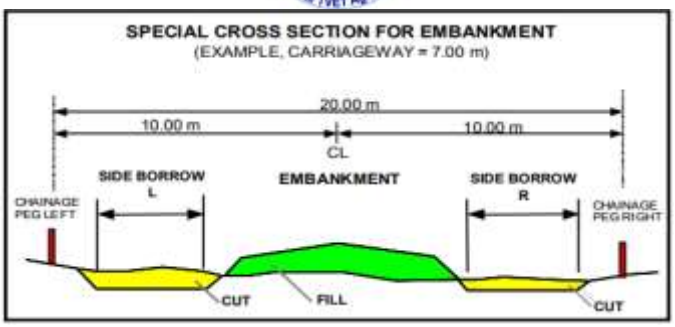


Figure.12.Embankment construction

Cut to Level operation

The problems start when the road is built on cross sloping ground. The steeper the cross slope, the more excavation is needed to build the road. Always avoid steep cross slopes where possible. Locate the road on ridges where possible - this will reduce earthworks as well as reducing drainage works.

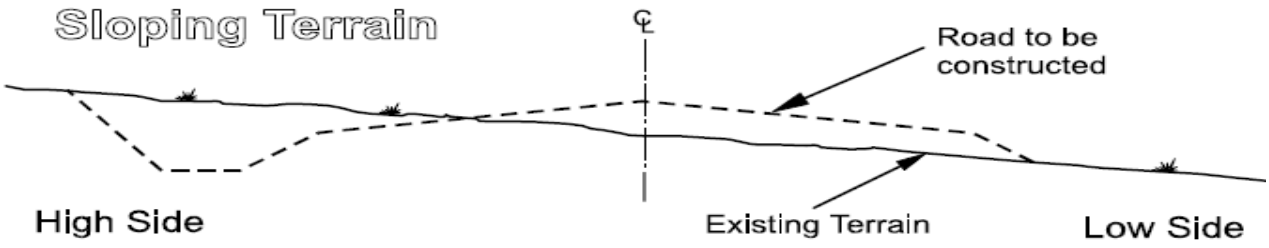


Figure.13.Ground level and proposed road

Road construction in cross sloping terrain has the following features:

- The high side drain will have to be dug deep,
- The low side drain is normally not needed, and
- The road will have to be built on a fill on the low side.

The best way to do this is to split the work into two separate stages.

Excavate the high side and build up the low side and form the side slope on the low side.

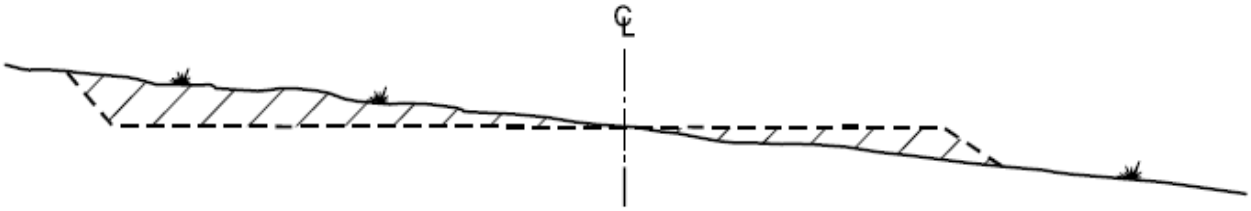


Figure.14.Excavation and filling section of road

Excavate the high side drain and form the camber.

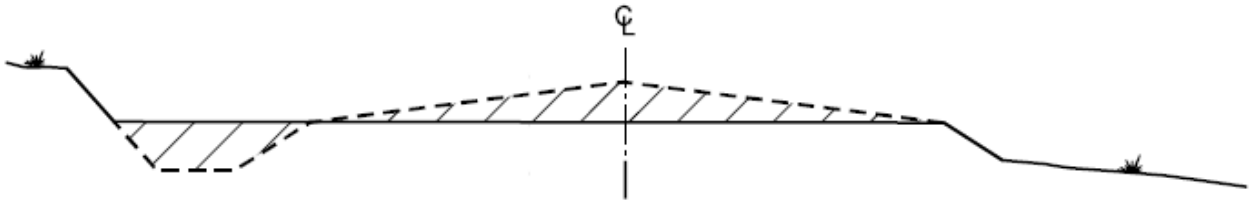


Figure.15.Embankment construction of cambering

The advantages of this method of working in stages are:

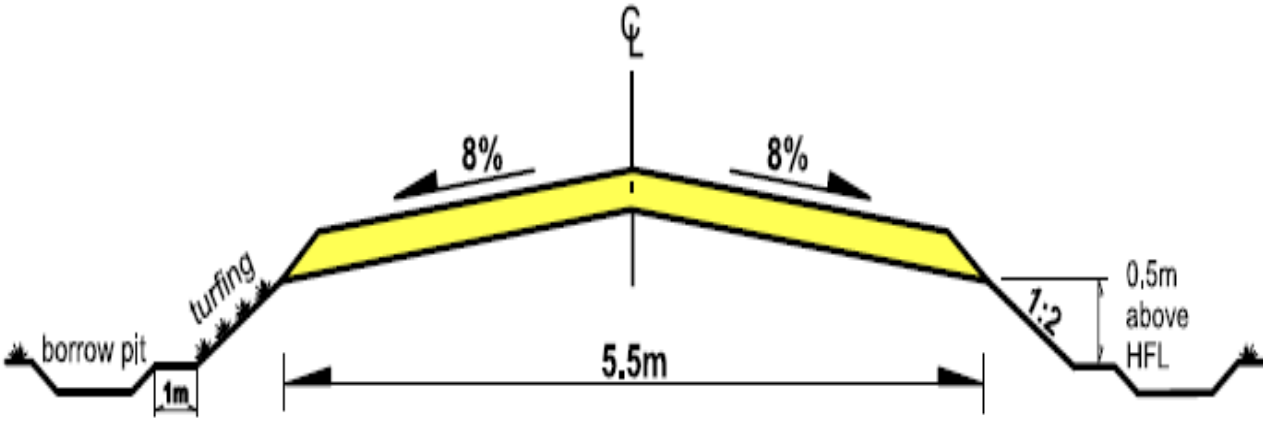
- The excavation approximately balances the amount of fill needed,
- The fill material can be obtained as close as possible to where it is needed - reducing the need for longitudinal haulage,
- By leveling the formation only as far as the edge of the road and then sloping down to the natural ground, reduce the excavation and, in most cases avoid the need for a side drain on the low side.

Embankment Operation

Embankments require large amounts of fill material and are expensive to construct. They should be avoided when possible by selecting a longer route on higher ground. However, this is sometimes not possible in low, flat, agricultural land, where often no alternative route exists. Wherever possible, material should be excavated alongside the

road and carried to the road by baskets or wheelbarrows. If land is not available for roadside borrow pits, or if the material is not suitable, then earth will have to be brought in from the nearest source by appropriate haulage transport. The type of the borrowed soils should be of good quality. Organic soils, and if possible, sand and silt should be avoided. If sand or silt is the prevalent materials in the area, side slopes should be protected with at least a 15cm layer of clayey soils and vegetation to prevent erosion.

It is important to keep the height of the embankment to the least requirement. This is considered to be 0.5m above normal flood levels. Highest annual flood levels are used to determine the embankment height. This information should be available from local inhabitants and should be marked on pegs along the center line when choosing the alignment. Center line alignment should be carefully selected to avoid low areas requiring extra fills and areas where suitable material is not available from the roadside. The below figure summarizes the key dimensions of the cross-section of embankments utilized in the labor-based road project



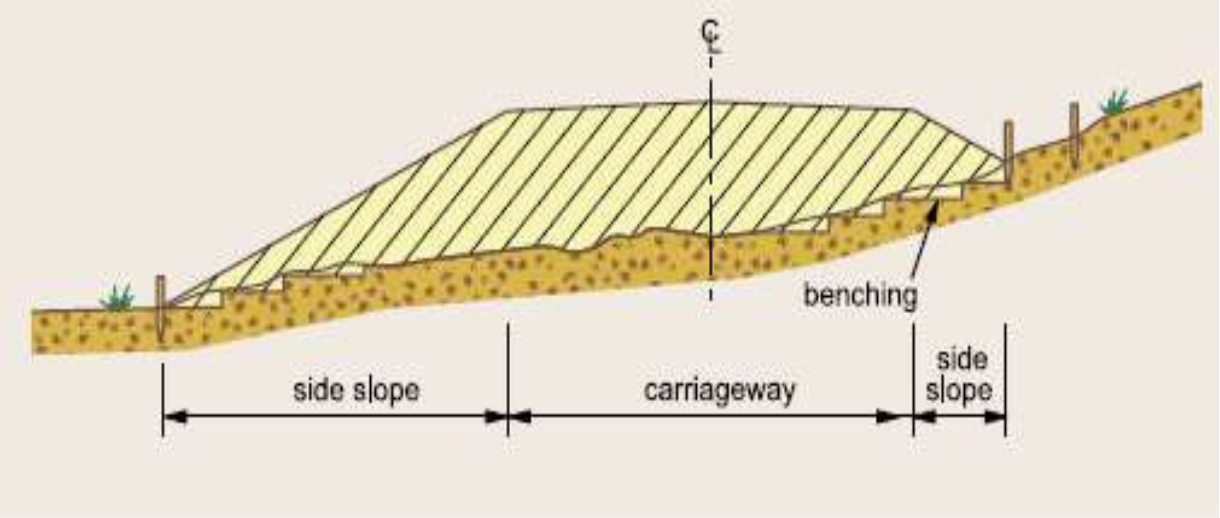


Figure.16.large amount of embankment construction

Cambering

Once the excavation and fill have been completed, the road camber is constructed using soils from the side drains and back slope. Excavated soils from the drains should first be thrown to the center of the road, from where it is leveled out towards each road shoulder to form the camber.

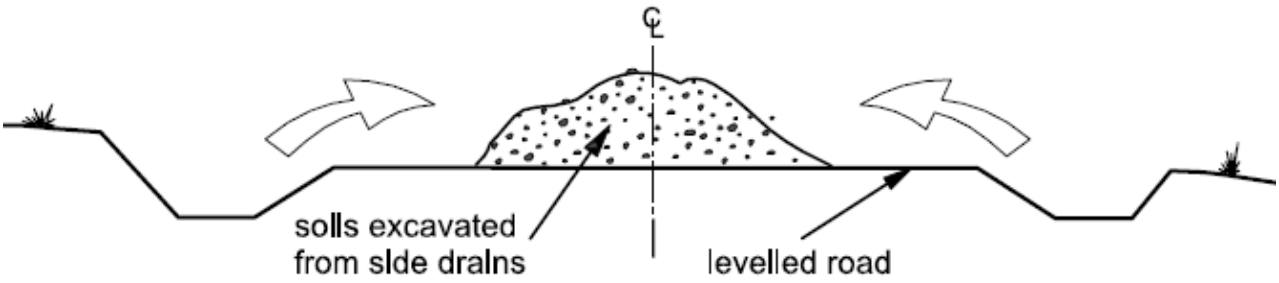


Figure.17.Side borrow operation

The soils excavated from the side drains are used to construct the road camber. To achieve an exact and properly leveled camber, the work is set out using pegs and strings.

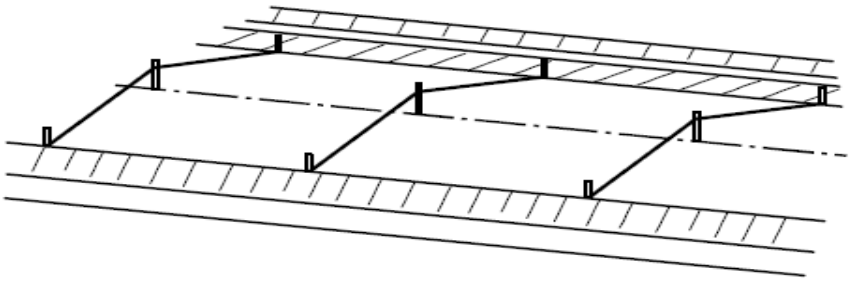


Figure.18.Cambering

Once the soils for the camber have been leveled, the camber is properly compacted. Make sure that the soils contain optimal moisture content.

After compaction has been completed, it is important to check that the final levels of the road camber is exact and to the prescribed standard and quality. This can either be done by setting out the profile boards again and controlling the level between the profiles with a traveller. A quicker method, however less accurate, is to use string lines to check the level of the completed surface.

- ✓ The camber is checked with a 'Camber-board'
- ✓ Check that the material is spread uniformly to specified width
- ✓ forms a cross fall from the centerline to the edge of both sides of the road (camber) by the specified percentage

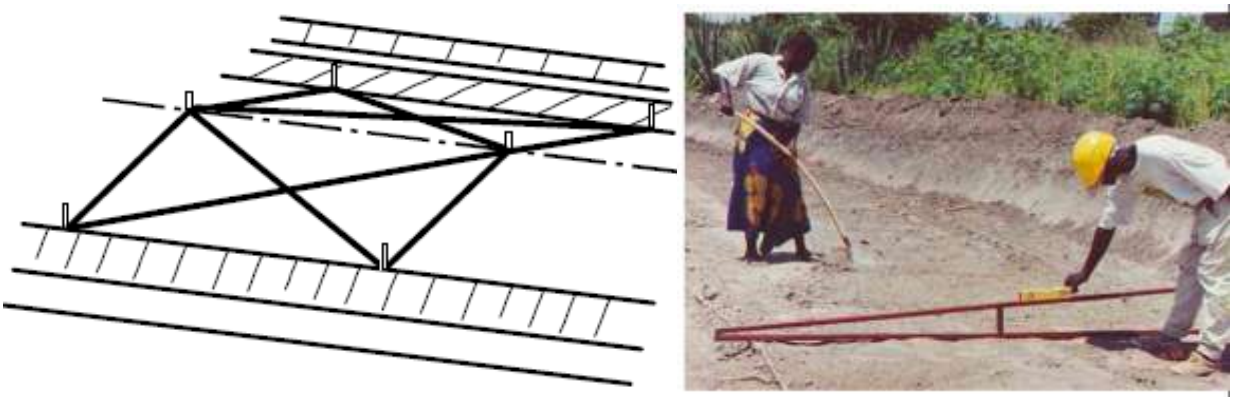


Figure.19.Check camber slope with camber board

If the levels are in-accurate, the irregularities should be removed or filled in. If further filling is required, make sure that this patching is also properly compacted. Finally, repeat once again the checking of the levels to ensure that the earthworks are completed to the correct standards.

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Once the soils for the camber have been leveled, the camber is properly compacted.

   A. True B. False

2. Embankments require large amounts of fill material and are expensive to construct.

   A. True B. False

3. Excavated soils from the drains should first be thrown to the center of the road.

   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet 2	Techniques and methods of compaction operation

2.1 Introduction to compaction

Compaction of a soil is the pressing of the soil close to each other by mechanical means. During compaction air is expelled from the void spaces. Thus compaction results in an increase in the density of the soil. Compaction improves the engineering properties of soils. It increases the shear strength of the soil & consequently the bearing capacity. It also reduces the compressibility & permeability of soil.

Optimum Moisture Content

Soil and gravel in its natural state consists of solid particles, water and air. Air does not contribute to the strength and stability of the soil - on the contrary, it reduces the stability of a soil. A certain optimum quantity of water (usually between 8 to 20%, depending on the soil type) facilitates compaction and contributes to the soil's strength and stability, because it lubricates the particles and allows them to settle in a dense mass. If the soil contains too much moisture and is too wet, the soil particles are kept apart by the water. When the soil is too moist and you try to compact it, it will simply not compress, but flow out sideways. Experience shows that if soil is taken from the ditches or a side borrows, and spread and compacted immediately, the natural moisture content is usually sufficient for good compaction. Sometimes, however, the soil comes from a dry stockpile and then needs to be watered.

It makes sense to check this so-called `optimum moisture content', between too wet and too dry.

This is especially important for gravel layers. A simple way to check moisture content by approximation is to take some of the material you are to compact in your hand.

Squeeze it into a ball. If the ball cannot be formed, the material is too dry. The correct moisture content is reached when you can form the ball and the material packs well together. When you apply pressure, the ball should retain its shape. When you form the ball and flatten it easily when you put pressure on the ball, the sample has a moisture

content which is too high. When the water oozes out of the sample without even applying pressure it obviously is too wet.

Compaction Methods

There are basically four methods of compaction:

- Manually or mechanically operated tampers or rammers,
- Deadweight rollers,
- vibrating compaction, or
- Natural compaction.

Tampers and Rammers

Tampers and rammers compact the soils by impact. Hand rammers are cheap to produce, and consist of a long wooden handle with a cast iron or concrete weight at the end. It is lifted and dropped on the surface repeatedly to produce compaction. The weight is usually 6 to 8 kilograms.

Using hand rammers is expensive and difficult to apply evenly over large areas. A lot of manpower and direct supervision is needed to produce a steady output of reasonable quality. Hand rammers are most useful in small and confined areas such as around culverts, pot-holes and other places where it is impractical or difficult access for rollers.

Deadweight Rollers

There are several types of deadweight rollers, ranging from single or double steel drums, towed or self-propelled or with a load container to hold the deadweight. A major concern when choosing the appropriate type of compaction equipment is:

- Its availability in the region of your road works activities,
- How to deliver it to the construction site,
- How easy is it to operate and how easily can it be reversed, and
- Its cost and reliability.

Large and heavy towed rollers may have good compaction qualities but may prove difficult to turn and operate in hilly or steep terrain. Self-propelled rollers can normally be operated in both directions; however, they are more prone to breakdowns. Some rollers can be ballasted with weights up to 1 tons or more, using water sand or stones. When

using this type of roller, the first passes can be done with relatively light ballast in order to avoid traction problems. After the first few passes the ballast can be increased.

Vibrating Rollers

A vibrating roller will generally compact to a greater depth than a deadweight roller.

The effect of the vibrating motion will depend on the intensity of the vibrations and the type of material on which it is used. They also require lower moisture content than deadweight rollers.

However, it is important to maintain an even speed to achieve even compaction. With deadweight rollers this is less important.

The first passes, should be done without vibration, to avoid that the roller gets "bogged down" into the soil. The speed should be around 3 kilometers per hour or slow walking speed. Instruct your operators to run the engine at a slow and constant speed.

Natural Compaction

The simplest method of compaction is by leaving soil to settle naturally by just leaving it for a period of time. The soil by its own weight, rainfall and people, animals and vehicles travelling on it will eventually consolidate enough to carry traffic loads.

This so-called `indirect compaction' method or natural consolidation is a slow process.

It is normally only used on very low fills, and is most effective if the fill material is very moist and must dry out. Given sufficient time, it has been found that roads compacted by natural consolidation can achieve similar densities as roads compacted by equipment. The main disadvantage is that while the soil is not consolidated, it is prone to erode more easily. Normally, it would be necessary to leave the fill for a period six months to achieve an effective degree of compaction.

Compaction Procedure

To gain even compaction, assign and train specific workers to operate the compaction equipment. They will become experienced at running the rollers at a constant speed for good compaction and will also maintain the rollers.

To produce a good quality road, it is important that all soils are properly compacted. Compaction should be carried out along the road line starting at the shoulder of the road and gradually working towards the center line. Compaction of the road shoulders should be done using hand rammers.

Make sure that the camber of the road is always maintained at 2.5% for both the base layers as well as the gravel layer. After compaction, it is important to check that all levels are correct and that the surface is smooth and does not contain any uneven spots. This check is carried out by using profile boards and a traveler.

Make sure that you have sufficient supply of water, in order to maintain optimal moisture content in the soils which are being compacted

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Soil and gravel in its natural state consists of solid particles, water and air.

   A. True B. False

2. Tampers and rammers compact the soils by impact?

   A. True B. False

3. Large and heavy towed rollers may have good compaction?

   A. True B. False

4. To produce a good quality road, it is important that all soils are properly compacted?

   A. True B. False

Note: **Satisfactory rating - 20 points** **Unsatisfactory - below 20 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.
2.
3.
4.

Information Sheet 3	Techniques and methods of material Stabilization operation

3.1 Introduction to material Stabilization

Soil Stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties.
Soft subgrade that cannot support the weight of equipment constructing the roadbed, is usually removed, a fabric placed and covered with backfill. This allows a stable enough surface to continue construction. Here the fabric not only separates the two materials but also adds strength to the roadbed.
Improving an on-site (in situ) soil's engineering properties is referred to as either "soil modification" or "soil stabilization." The term "modification" implies a minor change in the properties of a soil, while stabilization means that the engineering properties of the soil have been changed enough to allow field construction to take place.

Soil stabilization is a collective term for any physical, chemical, or biological method or any combination of such methods employed to improve certain properties of natural soil to make it serve adequately an intended engineering purpose.

Soil is one of nature's most abundant construction materials. Almost all construction is built with or upon soil. When unsuitable construction conditions are encountered, a contractor has four options:

(1) Find a new construction site
(2) Redesign the structure so it can be constructed on the poor soil
(3) Remove the poor soil and replace it with good soil
(4) Improve the engineering properties of the site soils

In general, Options 1 and 2 tend to be impractical today, while in the past; Option 3 has been the most commonly used method. However, due to improvement in technology coupled with increased transportation costs, Option 4 is being used more often today and is expected to dramatically increase in the future.

A land-based structure of any type is only as strong as its foundation. For that reason, soil is a critical element influencing the success of a construction project. Soil is either part of the foundation or one of the raw materials used in the construction process. Understanding the engineering properties of soil is crucial to obtain strength and

economic permanence. Soil stabilization is the process of maximizing the suitability of soil for a given construction purpose.

The necessity of improving the engineering properties of soil has been recognized for as long as construction has existed. Many ancient cultures including the Chinese, Romans, and Incas utilized various techniques to improve soil stability, some of which were so effective that many of the buildings and roadways they constructed still exist today. Some are still in use.

In the United States, the modern era of soil stabilization began during the 1960s and '70s, when general shortages of aggregates and petroleum resources forced engineers to consider alternatives to the conventional technique of replacing poor soils at building sites with shipped-in aggregates that possessed more favorable engineering characteristics. Soil stabilization then fell out of favor, mainly due to faulty application techniques and misunderstanding. More recently, soil stabilization has once again become a popular trend as global demand for raw materials, fuel and infrastructure has increased. This time however, soil stabilization is benefiting from better research, materials and equipment.

3.2 Why soil stabilization is needed?

- To increase strength, bearing capacity and resistance to deteriorative forces of nature and man-made environment.
- To decrease the volume change tendency, settlement and to control permeability.

Traditionally stable sub-grades, sub-bases and/or bases have been constructed by using selected, well-graded aggregates, making it fairly easy to predict the load-bearing capacity of the constructed layers. By using select material, the engineer knows that the foundation will be able to support the design loading.

Gradation is an important soil characteristic to understand. A soil is considered either "well-graded" or "uniformly-graded" (also referred to as "poorly-graded"). This is a reference to the sizes of the particles in the materials. Uniformly-graded materials are

made up of individual particles of roughly the same size. Well-graded materials are made up of an optimal range of different sized particles.

It is desirable from an engineering standpoint to build upon a foundation of ideal and consistent density. Thus, the goal of soil stabilization is to provide a solid, stable foundation. “Density” is the measure of weight by volume of a material, and is one of the relied-upon measures of the suitability of a material for construction purposes. The more density a material possesses, the fewer voids are present. Voids are the enemy of road construction; voids provide a place for moisture to go, and make the material less stable by allowing it to shift under changing pressure, temperature and moisture conditions.

Uniformly-graded materials, because of their uniform size, are much less dense than well-graded materials. The high proportion of voids per volume of uniformly-graded material makes it unsuitable for construction purposes. In well-graded materials, smaller particles pack in to the voids between the larger particles, enabling the material to achieve high degrees of density. Therefore, well-graded materials offer higher stability, and are in high demand for construction.

3.3 When soil stabilization

With the increased global demand for energy and increasing local demand for aggregates, it has become expensive from a material cost and energy use standpoint to remove inferior soils and replace them with choice, well-graded aggregates. One way to reduce the amount of select material needed for base construction is to improve the existing soil enough to provide strength and conform to engineering standards. This is where soil stabilization has become a cost-effective alternative.

Method of soil stabilization: - There are mainly two types of stabilization. They are Chemical stabilization and Mechanical stabilization.

3.3.1 Chemical soil stabilization:-

One method of improving the engineering properties of soil is by adding chemicals or other materials to improve the existing soil. This technique is generally cost effective: for example, the cost, transportation and processing of a stabilizing agent such as soil cement or lime to treat an in place soil material is

probably more economical than importing aggregate for the same thickness of the base course.

Additives can be mechanical that is their load bearing properties bolster the engineering properties of the soil. They can also be chemical that is they react with or change the chemical properties of the soil thereby changing the properties of the soil.

Combining the additives with the soil is done using various machines. The method to be used depends on three factors

1. What machines are available?
2. The location (urban or rural).
3. The additives that are used.

The following are the machines used to combine the additives with the soil:

i) **Rotary Mixer:** The most economic and time efficient method is to use a rotary mixer, a large machine that incorporates additives with the soil by tumbling them in a large mixing chamber that is equipped with a rotor designed to break up and mix the materials. It is capable of introducing the additives and water very uniformly into the soil and hence the rotary mixer is unrivaled in production by other methods.

ii) **Pugmill:** For some of the applications which require a lot of precision, a pugmill is used. A pugmill is a large mixing chamber that resembles a cement mixer. Measured pre-graded aggregates, additives and usually water are usually mixed in the pugmill and applied in uniform thickness. Pugmills produce high quality soil stabilization but at higher costs and lower production speeds.

iii) **Motor grader:**Blade mixing is usually done using a motor grader. This type of mixing is not as efficient as the other mentioned systems but is far less complex than the other systems. Essentially the additives are placed in flat windows and the blade of the grader mixes the additives with the soil in a series of turning and tumbling actions. It is very difficult to uniformly control mixing percentages and mixing depths using this technique.

iv) **Additives used:** There are many kinds of additives available. Not all kinds of additives work for all soil types and a single additive will perform differently with different soil types. Generally an additive may be used to act as a binder, alter the effect of moisture, increase the soil density or neutralize the harmful effects of a substance in the soil. Following are some of the most widely used additives:

- Portland cement
- Quick lime/hydrated lime
- Fly ash
- Calcium chloride
- Bitumen
- Chemical or bio remediation

3.3.2Mechanical soil stabilization:-

This refers to either compaction or the introduction of fibrous and other non-biodegradable reinforcements to the soil. This practice does not require chemical change of the soil. There are several methods used to achieve mechanical stabilization.

(i) Compaction: - Compaction typically employs a heavy weight to increase the soil density by applying pressure from above. Machines such as large soil compactors with vibrating steel drums are often used for this purpose. Here over compaction of the soil should be avoided and given great consideration because in the case of over compaction, the aggregates get crushed and the soil loses its engineering properties.

(ii) Soil Reinforcement: - Soil problems are sometimes remedied by engineered or non-engineered mechanical solutions. Geo-textiles and engineered plastic mesh are designed to trap soils and help control erosion, moisture conditions and soil permeability. Larger aggregates such as gravel, stones and boulders are often employed where additional mass and rigidity can prevent soil migration or improve load-bearing properties.

(iii) Addition of graded aggregate materials: - A common method of improving the engineered characteristics of a soil is to add certain aggregates that lend desirable attributes to the soil such as increased strength or decreased plasticity. This method provides material economy, improves support capabilities of the subgrade and furnishes a working platform for the remaining structure.

(iv) Mechanical Remediation: - Traditionally this has been the accepted practice to deal with soil contamination. This is a technique where contaminated soil is physically removed and relocated to a designated hazardous waste facility far from centers of human population. In recent times however, chemical and bioremediation have proven to be a better solution both economically and environmentally.

Self-Check 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Stabilization is to improve strength, bearing capacity and resistance?

   A. True B. False

2. Uniformly-graded materials, because of their uniform size, are much less dense than well-graded?

   A. True B. False

3. Chemical soil stabilization technique is generally cost effective?

   A. True B. False

4. Mechanical soil stabilization practice requires chemical change of the soil?

   A. True B. False

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Answer Sheet

1.

2.

3.

4.

Information Sheet 4	Types and Application of geo-synthetic material

4.1 Introduction to Construction of Geotextile

Gabions are wire mesh boxes filled with stones and tied together to form basic structures. They are used principally for retaining walls, drifts and erosion protection. The standard size of gabion boxes is: 2m length, 1m width and 1m height.

- Gabion boxes may be made from purpose made gabion cages, welded steel mesh sheets or galvanized chain link fencing.

- Foundations must be excavated level. Unsuitable material has to be removed and replaced with good soil, stone or gravel and compacted.

- Cages have to be woven together using 3 mm galvanized binding wires, securing all edges every 0.15m with a double loop. Tighten the binding wire with a pair of heavy-duty pliers and secure with multiple twists.

- Stretch and stake the connected baskets with wires and pegs to achieve the required shape (all sides rectangular).

- Fill baskets by hand using hard durable stones not larger than 250 mm and not smaller than the size of the mesh. The best size range is 125 - 200 mm. Place the stones as if for dry stone masonry.
- Fill the boxes to 1/3 of the height. Fit horizontal bracing wires and tension with a windlass to keep the vertical faces even and free of bulges. Further bracings should be fixed after filling to 1/3 of the height.
- Lids are closed and stretched tightly over the stones, (carefully) using crowbars if necessary. The lid is securely woven to the tops of the walls using galvanized wire.

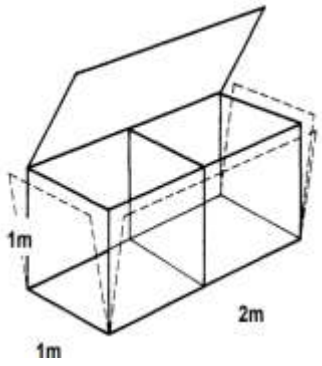
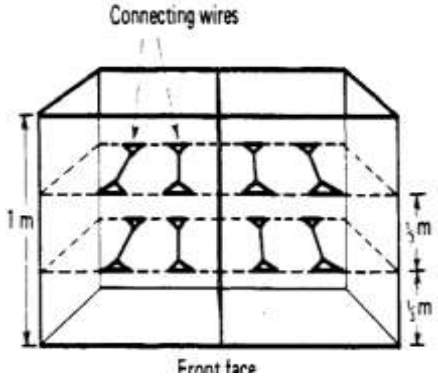
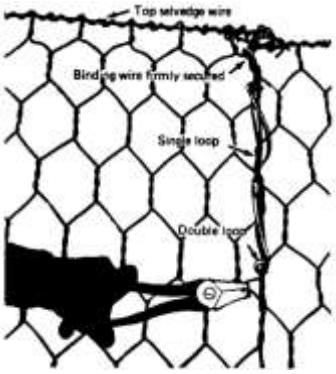
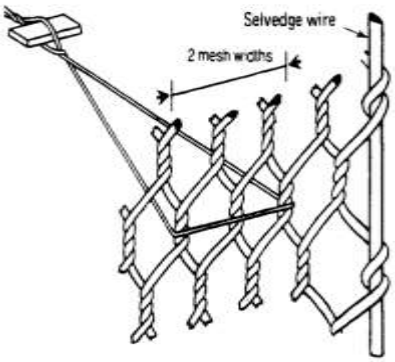
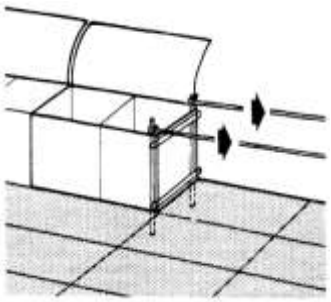
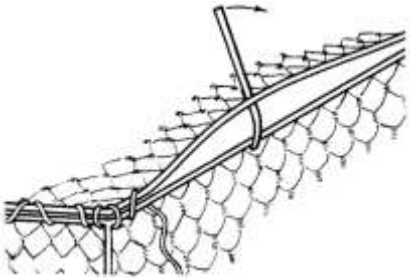
1.Assembly cage		4.Intermediate bracing	
2.Weave boxes securely together		5.Windlass bracing	
3.Stake and stretch cages to required shape		6. Close and secure lid	

Table.4.Geotextile gabion mesh

Self-Check 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:-

1. Gabions are wire mesh boxes filled with stones?

   A. True B. False

2. The standard size of gabion boxes is: 2m length, 1m width and 1m height?

   A. True B. False

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

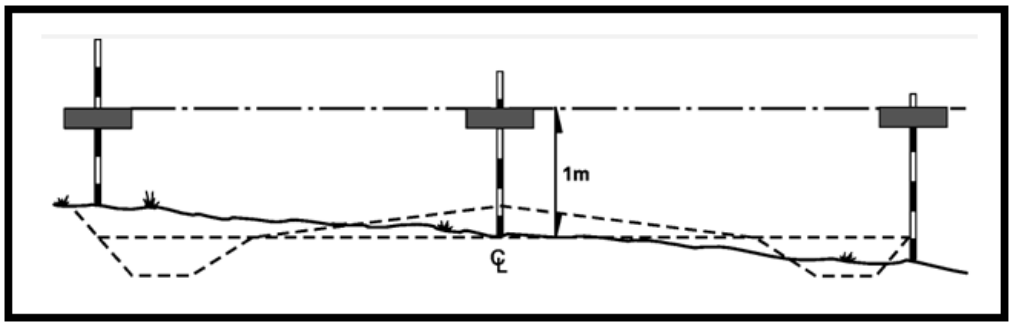
Rating: _____

Name: _____ Date: _____

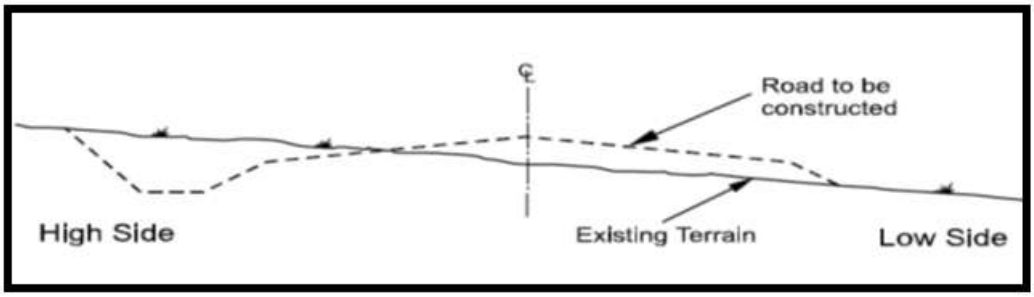
1.
2.

Operation Sheet 1	Earthwork Operations

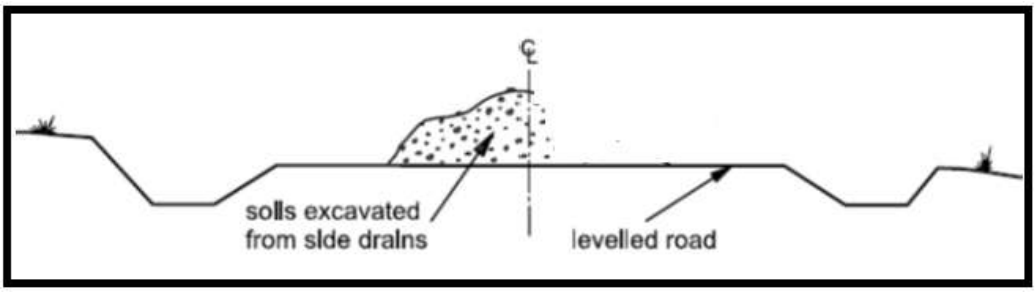
Steps 1-The profile method of Setting out the road boundary with specified width.



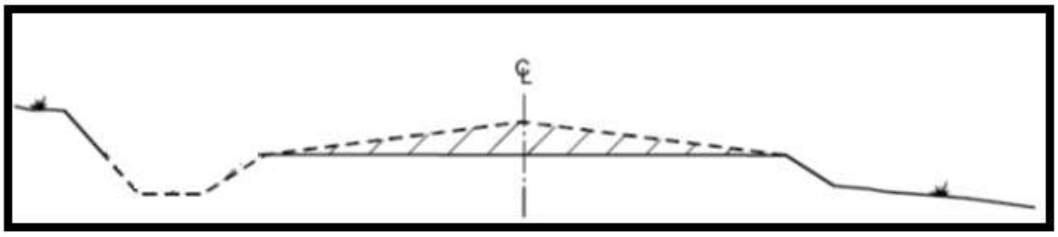
Steps 2-Excavate the high side and storeto the center line.



Steps 3- Spreading is best carried out from the center line towards the shoulders. Check that the material is spread uniformly to specified width.



Steps 4- Camber formation is the final touch to the formation of the road embankment.The camber is checked with a 'Camber-board'



Operation Sheet 2	Techniques and methods of compaction operation

Steps 1- check optimum moisture content of placed material

Steps 2- compaction is carried out edge to center longitudinally.

Steps 3- Check final levels of the road camber.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 3 hours.

Task 1. Perform earth road works manual based.

Task 2. Apply principles of compaction procedure on earth road construction.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
4. Introductory Training Course in Labour-based Roads Construction for Engineers and Technicians, Marshall, ILO Cambodia, 1993
5. Labor-based Construction Programs: A Practical Guide for Planning and Management, Coukis et al, World Bank, 1983
6. Rehabilitation of Feeder Roads Using Labour-based Methods, Technical Manual, Veselinovic, UNOPS, Afghanistan, 1993
7. Technical Manual, Marshall, District Council Road Unit, Botswana 1987
8. Technical Manual for Low Volume Roads Upgraded and Constructed Using Labour based Methods in Lesotho, Ministry of Works, Lesotho 1992
9. Training Videos for Labour-based Road Construction and Maintenance, ILO 1991
10. Field Manual for Labour-based Road Supervisors, Johannessen, ILO Cambodia, 1994
11. Course Notes, Roads - Labour-based Methods, Strom, Field Training Unit, Botswana 1994
12. Introductory Course in Labour-based Roads Construction for Engineers and Technicians, Roads Training Centre, ILO Laos, 1995
13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

Road civil work Level II

Learning Guide # 36

Unit of Competence: **Conduct Earthwork**

Manual Based

Module Title: **Conducting Earthwork**

Manual Based

LG Code: **CONRCW2M09 LO5- LG 36**

TTLM Code: **CON RCW2 TTLM 1019 v1**

LO 5: Place and compact sub-grade replacement materials

Instruction Sheet	Learning Guide 36

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

- Removal of Unsuitable material
- Replacement of suitable material

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

- Unsuitable material is identified, removed and stored separately
- Imported replacement/stabilized material is placed as specified
- Roller operators are informed of the required number of passes
- Compaction process is assessed to ensure nominated number of passes are made to achieve uniform compaction across the sub grade

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information “Sheet 1 and Sheet 2” in page 81 and 84 respectively.
4. Accomplish the “self-check 1 and self-check 2 in page 82 and 85 respectively.

Information Sheet 1	Removal of Unsuitable material

1.1 Introduction to Removal of Unsuitable material

Unsuitable ground such as peat, soft organic clay, and silts must be removed or otherwise stabilized to prevent unequal or excessive roadway settlement or embankment failure.

Unsuitable material may include:-

- Cohesive soils having a liquid limit in excess of 90% or plasticity index in excess of 65%; any material containing topsoil, wood, peat or waterlogged substances
- Any material containing biodegradable or organic material (more than 5%); any material containing scrap metal
- Material from contaminated sites
- Material which by virtue of its particle size or shape cannot be properly and effectively compacted e.g. sand
- Large rocks.

All excess or unsuitable excavated material that cannot be used in embankments may be placed on the side slopes of the nearest fill in a satisfactory manner and shall be placed so as to maintain a distinct shoulder line by generally keeping all such material at least 24" (0.6 m) below the subgrade elevation.

Unsuitable material should be excavated and disposed of as directed to spoil or as fill in areas in which it would be deemed suitable. The unsuitable material which has been removed must be replaced with suitable material from cuttings, or with material borrowed from elsewhere on or off the site.

Selection and procurement of sites for the disposal of material removed from the project shall be the responsibility of the Contractor. Sites used for the disposal of unused material shall be left in a neat and presentable condition.

Excavated soil or rock which is either unsuitable for use in the works or is surplus to requirements, shall be disposed of in specially designated areas

1.2 Removal and Disposal of Material The contractor shall dispose of all trees, stumps, brush, roots and all other objectionable matter removed in the clearing and grubbing process.

Any material, occurring below the existing ground surface in fill areas or roadbed material in cut areas, which is considered by the Engineer to be of a quality that would be detrimental to the performance of the completed road, shall be removed to such widths and depths as ordered by the Engineer and disposed of as directed. Unsuitable Material Excavation shall consist of the excavation and disposal of trash, rubble, Wood, debris, and other miscellaneous materials including Soil or rock cover and intermingled soil or rock materials, which is unsuitable. Soil is having a liquid limit exceeding 60% or a plasticity index exceeding 30.

1.3 Disposal of Scalping The products of scalping shall be deposited at the toe of embankments where such areas are available within the limits of the roadway balance affected. If such areas are not available, the products shall be neatly and uniformly deposited on the right of way in such a manner that no drainage will be blocked.

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Unsuitable ground such as peat, soft organic clay, and silts must be removed?

   A. True B. False
2. Cohesive soils are not suitable for construction?

   A. True B. False
3. All excess or unsuitable excavated material that can be used in embankments?

   A. True B. False
4. Unsuitable material should be excavated and disposed?

   A. True B. False

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.
2.
3.

Information Sheet 2	Replacement of suitable material

1.1 Replacement of suitable material

All suitable material removed from the excavation ***shall be used***, as far as practicable, in the formation of the embankment, in the subgrade, slopes, and shoulders, and at such other places as directed.

Topsoil should be stockpiled separately clear of the work area with care taken to avoid contamination by other materials. The topsoil stockpile should also be accessible for later use for covering finished embankments and re-establishment of site vegetation once works have been completed.

The depth of topsoil to be removed will be indicated on the engineering plans. Typically the depth of topsoil removed is not less than 150 mm. However, the actual depth is usually assessed on site during excavation.

Topsoil should be stockpiled in dedicated stockpile sites. These sites are usually nominated on the approved design drawings. Stockpile sites are located to minimize damage to natural vegetation, and maintain the existing surface drainage such that material from the stockpiles does not enter drainage lines or watercourses. They are located so that the stockpiled material is accessible for carting away at any time.

Filling must be carried out to the lines, levels and grades required to complete the design surface. Filling or embankment construction includes

- All operations associated with the preparation of the foundation areas on which fill material is to be placed
- The placing and compacting of approved material within areas from which unsuitable material has been removed
- The placing and compacting of fill material and of materials of specified quality in nominated zones throughout the works
- All other activities required to produce embankments as specified to the alignment, grading and dimensions shown on the drawings.
- Any pre-treatment such as breaking down or blending material, wetting or drying out material containing excess moisture.

The material must be free of tree stumps and roots and be capable of being compacted in accordance with the earthworks specification.

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. All suitable material removed from the excavation, do not used?

   A. True B. False

2. The depth of topsoil to be removed will be indicated on the engineering plans?

   A. True B. False

3. Filling must be carried out to the lines, levels and grades required to complete the design surface?

   A. True B. False

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.
2.
3.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
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5. Labor-based Construction Programs: A Practical Guide for Planning and Management, Coukis et al, World Bank, 1983
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7. Technical Manual, Marshall, District Council Road Unit, Botswana 1987
8. Technical Manual for Low Volume Roads Upgraded and Constructed Using Labour based Methods in Lesotho, Ministry of Works, Lesotho 1992
9. Training Videos for Labour-based Road Construction and Maintenance, ILO 1991
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13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

Road civil work Level II

Learning Guide #37

Unit of Competence: **Conduct Earthwork**

Manual Based

Module Title: **Conducting Earthwork**

Manual Based

LG Code: **CONRCW2M09 LO6- LG 37**

TTLM Code: **CON RCW2 TTLM 1019 v1**

LO 6: Clean up

Instruction Sheet	Learning Guide 37

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

- Clear work area
- Safe-keeping of plant, equipment and tools

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

- Clear work area
- Safe-keeping of plant, equipment and tools

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described below 3to 6
3. Read the information written in the information “Sheet 1and Sheet 2 in page 89 and 91 respectively.
4. Accomplish the “self-check 1and self-check 2in page 90 and 92 respectively.

Information Sheet 1	Clear work area

1.1 Introduction to Clear work area

Construction regulations require inspections of vehicles, tools, machines and equipment before use. Preventive maintenance is the systematic care and protection of tools, equipment, machines and vehicles in order to keep them in a safe, usable condition limit downtime and extend productivity.

Start by removing all unwanted earth road materials away from the work area. Place them in a secure area where they won't get damaged.

Dispose of rubbish in the following way.
Place metal, recyclable plastic, paper and cardboard in the appropriate recycling location near on the site.

Provide safe access to the job site.
Keep walking and working surfaces clean.
Keep stairways, passageways, and gangways free of material, supplies, and obstructions.
Pick-up and place all debris or trash in its proper container.
Hammer in, bend, or remove any nails protruding from scrap lumber. Cap or bend all exposed steel rebar ends.
Remove any items that aren't being used from the work area and store them in their proper place.
Keep lavatory and toilet facilities (stationary or portable) clean and sanitary.

Waste
Place trash and recycling containers throughout the job site.
Keep waste in metal cans or bins with self-closing covers and remove debris regularly.
Never allow rubbish to fall freely from any level of the project. Use chutes or other approved waste-removal devices.
Seal waste and product drums and containers tightly to reduce evaporation, spillage, and contamination.
Ensure the disposal of scrap, waste, recyclables and surplus materials is in accordance with Federal regulations and local codes.
Never dispose of any waste into storm or sanitary sewers.
Frequently schedule the safe collection and removal of combustible waste.
Lock and secure used oil containers and dumpsters.

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:-

1. Cleaning of tools and equipment is performed _____?
   A. Before use
   B. After use
   C. Not important
   D. All

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

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.

Information Sheet 2	Safe-keeping of plant, equipment and tools

1.1 Safe-keeping of plant, equipment and tools

Workers should be trained on safe procedures for working with tools. However, safe practices when carrying or storing those tools may not be thoroughly covered. Tools can pose a safety risk when they are misplaced or improperly handled by workers. The National Safety Council offers the following tips for safe handling of tools when they are not in use:

Tools should always be carefully handed from one employee to another – never tossed. Pointed tools should be passed either in their carrier or with the handles toward the receiver.

Tools should be issued every morning to the labor force by the storekeeper and record must be kept of the tools issued in the site issue book. Tools should be returned at the end of the day and signed off by the storekeeper. Equipment (shutters, screeds, gauges, etc.) should be issued every morning to the labor force by the storekeeper and record kept of the equipment issued in the site issue book. Also, equipment must be kept clean as the work progresses as well as at the end of the day, when it should be returned and signed off by the storekeeper





Figure.20 Safe keeping of tools and equipment

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:-

1. Tools should be issued every morning to the labor force?

A. True B. False

2. Every day the equipment must be kept clean?

A. True B. False

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.

2.

List of Reference Materials

1. Guide to the Training of Supervisors for Labour-based Road Construction and Maintenance, Karlsson and de Veen, ILO, 1981
2. Building Roads by Hand, Antoniou, Guthrie and de Veen, ILO 1990
3. Design Guidelines for Low Volume Roads Suitable for Labour-based Construction Methods, Ministry of Works, Lesotho 1991
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13. Road Maintenance and Re-gravelling (ROMAR) using Labour-based Methods, Andersson, Beusch and Miles, ILO 1996

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Road civil work

Level-II

Self- check answers

TTLM Code: CON RCW2 TTLM 1019 v1

Learning Guide # 32

Answers for self-check 1

1. A. True
2. A. True

Answers for self-check 2

1. A. True
2. A. True
3. A. True

Answers for self-check 3

1. A. True
2. A. False
3. A. True

Answers for self-check 4

1. A. True
2. A. True
3. A. True

Answers for self-check 5

1. A. True
2. A. True
3. A. True

Learning Guide #33

Answers for self-check 1

1. A. **True**

2. A. **True**

Answers for self-check 2

1. A. **True**

2. A. **True**

3. A. **True**

Answers for self-check 3

1. A. **True**

2. A. **True**

Learning Guide #34

Answers for self-check 1

1. A. True
2. A. True
3. A. True
4. A. True

Learning Guide #35

Answers for self-check 1

1. A. True
2. A. True
3. A. True

Answers for self-check 2

1. A. True
2. A. True
3. A. True
4. A. True

Answers for self-check 3

1. A. True
2. A. True
3. A. True
4. B. False

Answers for self-check 4

1. A. True
2. A. True

Learning Guide #36

Answers for self-check 1

1. A. True
2. B. False
3. A. True
4. A. True

Answers for self-check 2

1. B. False
2. A. True
3. A. True

Learning Guide #37

Answers for self-check 1

1. B. After use

Answers for self-check 2

1. A. True
2. A. True