



Ethiopian TVET-System



Irrigation and Drainage Construction

Level II

Based on Feb, 2017 G.C. Occupational Standard

Module Title: Repairing Minor Structure

TTLM Code: EIS IDC2 TTLM 0920v2

This module includes the following Learning Guides

LG 76: Plan and prepare repair work

LG Code: EIS IDC2 M18 LO1-LG-76

LG 77: Repair minor structures

LG Code: EIS IDC2 M18 LO2-LG-77

LG 78: Complete and record work outcomes

LG Code: EIS IDC2 M18 LO3-LG-78

Instruction Sheet	Learning Guide -76: Plan and prepare repair work
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Determining work requirements from plans, specifications and instructions.
- Selecting and checking formwork, materials and equipment
- Selecting , fitting and using personal protective equipment's
- Conducting appropriate utility location activities prior to excavation
- Arranging appropriate site boundary protections

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 –

- Determine work requirements from plans, specifications and instructions.
- Select and check formwork, materials and equipment required to ensure that safety requirements of task and site.
- Select, fit and use Personal protective equipment are.
- Conduct appropriate utility location activities prior to excavation according to legislative and organizational requirements.
- Arrange appropriate site boundary protection according to organizational requirements.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 6”. Try to understand what are being discussed.
4. Accomplish the “Self-checks 1,2,3,4,5 and 6 ” in each information sheets on pages 8, 16, 26, 28, 33 and 36.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to the next LG.

Information Sheet -1	Determining work requirements from plans, specifications and instructions.
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1.1. Determining work requirements from plans

A properly designed and constructed irrigation structure functions well for as long as it is operated well and maintained with care. That means that there is neither leakage nor erosion, that the channels and structures are clean, and that there are no rusty or rotten movable parts in the structures.

- Determining work requirement is a process of identifying and arranging all
- necessary things by reading and interpreting the given design plans, drawings,
- specifications and instructions that can be used to accomplish the specific operated well and maintained with care

1.1.1 Organizational standard requirements

The term standard refers specifically to a specification that has been approved by a standards setting organization.

- The standards most frequently encountered in construction work will now be described under two headings; ‘general-purpose standards’ and ‘nuclear standards’. by regulatory authorities particularly in respect of safety.
- Standards developing organization (SDO) is an organization whose primary activities are developing, coordinating; promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards that are intended to address the needs of a group of affected adopters.
- Federal democratic republic of Ethiopia, ministry of water resources formulate and adopt national standards and criteria for the design, installation, construction, operation, maintenance, inspection and other activities in all water resources management undertakings. Any water work activities should be agreed with the standards.

- ✓ Adopt the water sector as the responsible authority for issuance of the necessary professional certification, professional permits and licenses for consultancy, contracting, as well as manufacturing and importing related to water resources development.

- ✓ Provide the necessary legal framework for penalties commensurate with the violation of legal provisions relating to water resources in order to produce deterrent effects is treated

1.1.2 Environmental requirements

- If so, you may be responsible for ensuring that requirements in federal environmental regulations are met.
- Ethiopia has established the fundamental general policy principles that guide the equitable, sustainable and efficient development, utilization, conservation and protection of water resources in Ethiopia as it is stated in the document of Ethiopian Water Resources Management Policy.
- The policy's stated goal is to "improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic One sectorial policy specifically addresses climate change and atmospheric pollution, through:
 - ✓ promoting a climate monitoring programme
 - ✓ acknowledging a commitment to mitigate emissions, even at low or even insignificant levels of contribution to global emissions
 - ✓ actively participating in protecting the ozone layer, as a means to reduce
 - ✓ vulnerability of the highlands of Ethiopia
 - ✓ encouraging re-vegetation, monitoring grazing and rehabilitating degraded land to compensate for high biomass-fuel consumption

1.1.3 OHS requirements

Provide practical guidance on safe work practices and risk management. While Codes of Practice do not impose mandatory legal obligations, they are admissible in evidence before a court as proof of the standards of health and safety that should be achieved by a duty holder to comply with the relevant legislation and regulations. More importantly, the OHS Code, for example, if relied on as evidence in legal proceedings, reverses the burden of proof to the duty holder. Accordingly, where the Code of Practice has not been followed, the duty holder would be required to prove that they complied with their duties by other means (equivalent to or better than the Code of Practice)

1.1.4 Regulatory requirements:

The role of these regulations is to set out mandatory obligations on specific matters and provide processes or outcomes that duty holders must follow or achieve to meet their general duties under legislation.

Stakeholders such as the Organization suggested that family violence should be within the scope of matters addressed by regulation, and that Codes of Practice and guidance material should provide detail with respect to the duties that arise.

However in light of contrasting stakeholder views, and to the extent that the OHS Regulations set out mandatory obligations and provide detail with respect to meeting general legislative duties, consider it is necessary to amend the OHS Regulations to protect the safety of victims of family violence

1.2. Specifications and organizational requirements.

a. National Standard Construction Specifications:

- Is State the technical and workmanship requirements for the various operations required in the construction of the works,

b. National Standard Material Specifications

- State the quality of materials to be incorporated in the permanent works.

c. Interim Specifications

- Specifications prepared by States for use in contracts that include construction items or materials not covered by national standard specifications.

d. Standard Specifications

- National standard and interim specifications.

e. Unique or One-Time-Use Specifications

- Specifications for construction or material items that are unique to the contract and are not covered by national standard specifications or State interim specifications.
- The specifications are prepared within the State and intended for one-time-use only in a specific contract.

f. Construction Details

- Prepared by the design office and state the special requirements peculiar to a specific work of construction.

- They may take the form of written addenda to the standard construction specifications or notes on the drawings.

g. Contract specifications

- The complete specifications prepared for a specific contract and consist of an assembly of appropriate standard and one-time-use specifications supplemented by lists and descriptions of items of work and construction details.

1.3 Objectives of specifications

The national standard specifications are used to:

- ensure adherence to laws and regulations,
- prevent conflicts within the specifications and between the specifications and other contract requirements,
- prevent omission of essential elements and inclusion of extraneous materials,
- provide a uniform basis for interpretation, and ensure uniform quality of a project works

1.4 Organisational requirements planning tool

Organizational requirements and planning tools Identify organizational requirements and protocols for diaries and staff planning tools .A schedule is a tool for managing time effectively. There are several different types of schedules that can be as simple as a “To do List” or as complex as a plan for a construction project. It involves a reference to a sequence of steps or events and the allotted time for each one.

Refer the following Video from YouTube to get linked video on the information sheet complete.

- <https://www.youtube.com/watch?v=7pTGz7Y31Uk>
- <https://youtu.be/u0MYqIAIJgM>
- <https://youtu.be/u0MYqIAIJgM>
- <https://youtu.be/u0MYqIAIJgM>

Self-Check -1	Written Test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided. (2 pts each)

1. Work requirements are determine from
 - A. Construction plan
 - B. Specification
 - C. Work instruction
 - D. All

2. Work requirements are determine from
 - A. Construction plan
 - B. Specification
 - C. Work instruction
 - D. All

3. Work requirements are determine from
 - A. Construction plan
 - B. Specification
 - C. Work instruction
 - D. All

Note: Satisfactory rating - 5 point Unsatisfactory - below 5 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.

Information sheet - 2

Selecting and checking formwork, materials and equipment

2.1. Introduction to formwork

Formwork (shuttering) in concrete construction is used as a mould for a structure in which fresh concrete is poured only to harden subsequently. Types of concrete formwork construction depend on formwork material and type of structural element. Formworks can also be named based on the type of structural member construction such as slab formwork for use in slab, beam formwork, column formwork for use in beams and columns respectively etc.

The construction of formwork takes time and involves expenditure up to 20 to 25% of the cost of the structure or even more. Design of these temporary structures are made to economic expenditure. The operation of removing the formwork is known as stripping. Stripped formwork can be reused. Reusable forms are known as panel forms and non-usable are called stationary forms.

Timber is the most common material used for formwork. The disadvantage with timber formwork is that it will warp, swell and shrink. Application of water impermeable cost to the surface of wood mitigates these defects.

2.1.1. Formwork requirements

The term “formwork” shall be taken to include centering, formwork, shuttering, bracing and all necessary supports. When the Contractor instructed by the Engineer shall submit formworks Drawings and calculations to the Engineer in advance of the concreting. Formwork shall be of such accuracy, strength and rigidity as to carry the weight and pressure from the concrete to be placed on against it, together with all constructional, wind or other loads likely to be imparted to it, without producing deformation of the finished concrete in excess of the specified tolerances

Formwork shall be sufficiently tight, without plugging, to prevent loss of grout during the vibration of the concrete. When required by the Engineer joints between formwork facing boards shall be sealed with foam rubber, sealing strips or other approved material. Faces of formwork shall be clean, free from projecting nails, adhering grout and other imperfections or defects. Formwork shall be treated with approved mould oil before positioning.

Requirements categories

- A. Rigid –to prevent bulging or movement from pouring wet concrete.
- B. Tight joints –to prevent wet concrete from leaking.
- C. Simplicity –easy erection and dismantling. Bond-breaking agents such as grease is typically applied to the form faces to prevent concrete “sticking.”
- D. Standardized sizes –allowing reuse.
- E. Form finish –to achieve desired texture and appearance of finished product

2.1.2 Types of formwork

There are three main types of formwork that you need to be aware of

- A. Horizontal (Floor/Slab) Formwork
- B. Beam Formwork
- C. Vertical (Column/Wall) Formwork

2.1.3 Types of formwork (Shuttering) for concrete construction

Materials used for the construction of concrete formwork range from traditional materials such as

- Timber,
- steel,
- aluminum, and
- Plywood to non-traditional materials such as fiberglass.

Table 1: Normal sizes of members for timber formwork:

Sheeting for slabs, beam, column side and beam bottom	25 mm to 40mm thick
Joints, ledges	50 x 70 mm to 50 x 150 mm
Posts	75 x 100mm to 100 x 100 mm

2.1.4. Positioning formwork

Considering shapes, formwork types can be classified as:

1. Column Formwork
2. Beam formwork
3. Slab Formwork
4. Wall Formwork

2.2. Types of tools and equipment

Tools are particularly important in construction work. Tools are often classified as

- hand tools and
- power tools.

Hand tools, such as; screwdrivers, brushes, trowels, wrenches, knives, crimpers, clamps, nails, Props, Jacks and so on.

Power tools, which may be powered by electricity, compressed air, liquid fuel, hydraulic power, or powder-actuated and might include; mixers, saws, cutters, drills, grinders, guns, breakers, and so on

- Brick Masonry. Brushes. Chisels. Grouting Guns, Bags and Accessories. Hammers. Masonry Guides. Masonry Trowels. Material Handling. Mortar/Plaster Mixers. Rules, Tapes and Levels..
- Stone Working. Chisels. Splitting Wedges. Stone Handling. Stone Specialty Tools.

2.3. Checking gauging stations

Water metering implies a system of measurements and record of water volume at irrigation & drainage and water management facilities. Water metering allows controlling water resources use and forms the core of the centralized control of water distribution and water supply in irrigation systems.

According to functional features, the inter-farm part of the system includes the site of head water supply, commanding and water distribution nodes, and water delivery points to farms; the on-farm part of the system includes on-farm water distribution nodes, water delivery points to crop-rotation land plots.

The section of head water supply with water intake by pumping includes a pumping station, pressure pipeline, and stilling pool; with gravity water intake – head water intake structure, upstream section of the main canal down to the main gauging station.

In both cases, the head water supply section includes a reach of river or reservoir with special structures (weir, dams, mountings, etc.) and supporting gauging station on the irrigation source for determination and accounting of water resources as well as the main hydrometric post at the head of the main canal for accounting of water intake to the system

The tasks of the irrigation water accounting service are as follows:

- Acquisition of data on system water reserves from a long-term and annual perspective;
- Determination of water discharge and volume for working out and adjustment of water use schedules, estimation of water losses in inter-farm and on-farm irrigation networks;
- Provision of the system with required data for water accounting and control in any water diversion and distribution point; compiling of actual data of operational hydrometer for proper and timely technical maintenance of the irrigation system.

It is required to install an average of 10-12 gauging stations per 1000 ha of irrigated area for ensuring proper water accounting. The equipment of gauging stations is accepted according to their purpose, irrigation network type (open or closed), and size of the water discharge to be measured. Construction of gauging stations and their equipment must meet up-to-date requirements with ensuring operational hydraulic measures (water level, flow velocity and discharge, total runoff volume, etc.)

Requirements for installation of TW and CW weirs:

- the unlined canal section intended for installation of a weir should be rectilinear with a length of no less than $L=10 * b$, with symmetrical cross-section;

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- the unlined canal section (bottom and slopes) should be cleaned from silt, aquatic vegetation, and rubbish keeping symmetric properties;
- a weir should be installed in the middle of the prepared section strictly upright and perpendicularly to the canal axis, cutting into the bottom and slopes of the unlined canal;
- the weir crest should be strictly horizontal; the vertical wall should be perpendicular to the base; the weir axis should coincide with the canal axis;
- the weir crest height P should exceed the maximum canal depth h_{max} downstream the weir;
- the approach section and the end of the tailrace section of the canal should be made in the form of a hydraulic cutoff wall, i.e. of concrete pouring more than twice as wide and thick as the thickness t of the canal bottom concrete casing;
- if flow velocity exceeds $0.5 \text{ m}^3/\text{s}$, the canal approach section upstream the weir should be widened, and the bottom should be deepened to slow down the flow velocity.

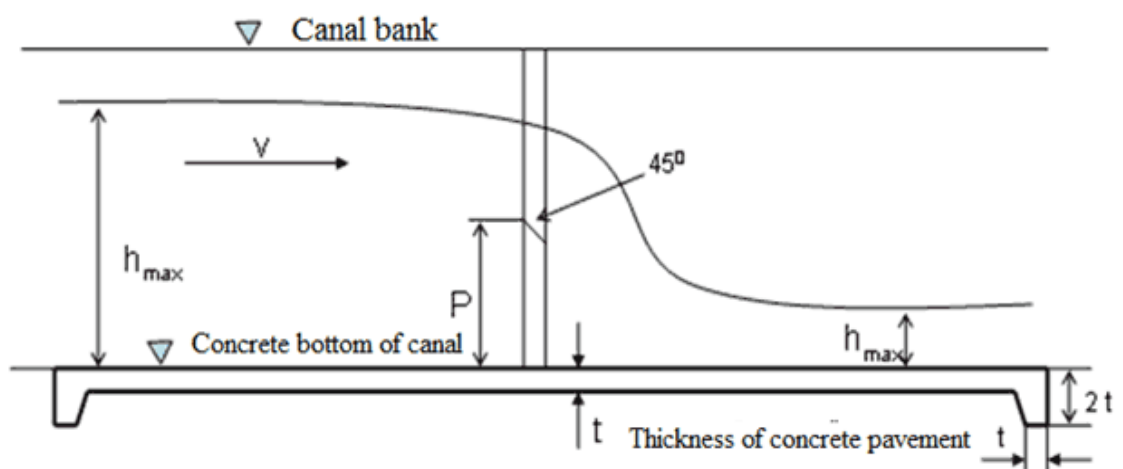


Figure 1. Gauging station with a Cippoletti weir

Note: To mount weir crest strictly in the horizontal position and to bind its crest elevation to the zero point of the gauging rod, it is recommended to use a leveling instrument or a hydraulic level tube using to this effect a long small-diameter transparent hose filled with water (law of communicating vessels).

Measurement of water discharge by means of weirs

Estimation of water discharge (m^3/s) is carried out according to the following working formulae:

For triangular TW weirs

$$Q = 1.4 * H^2 \sqrt{H}$$

For trapezoidal CW weirs

$$Q = 1.9 * b * H \sqrt{H}$$

Where:

b is width of weir crest, m;

H is water head above the weir crest, m.

2.4. Checking small control weirs

Weirs are sharp-crested, overflow structures that are built across open canals. They are easy to construct and can measure the discharge accurately when correctly installed. However, it is important that the water level downstream is always below the weir crest, otherwise the discharge reading will be incorrect.

The water level upstream of the structure is measured using a measuring gauge, as shown in Figure 2, where the difference - the head - between the water level and the crest of the weir is marked 'H'. The discharge corresponding to that water level is then read from a table which is specific for the size and type of weir being used, or the gauge post can show the discharge directly, as will be discussed

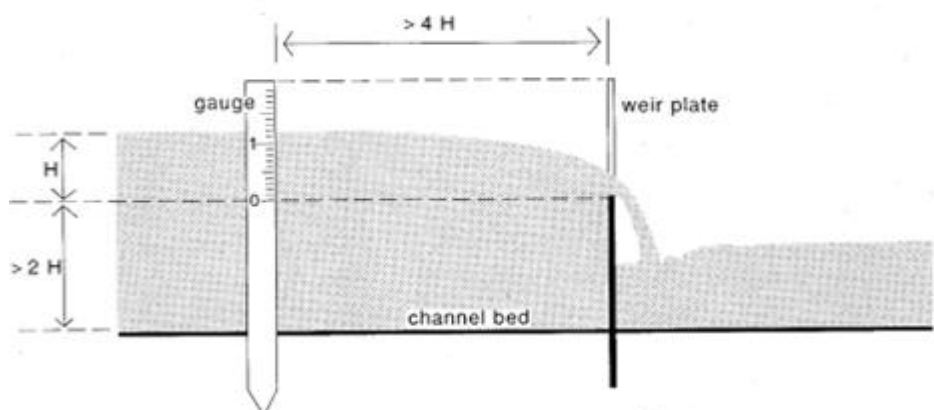


Figure 2. Gauging station to measure water level upstream

2.5. Selecting communication equipment

For practical purposes, a communication system can be considered to be

- “wired” or “wireless”(e.g., conventional telephone, radio communications, etc
- Since the communication equipment available to emergency first responders today does not use optical transmission methods, only radio frequency (RF) equipment will be considered here.

- ✓ Radio Frequency
- ✓ Conventional Radio System
- ✓ Portable Radios
- ✓ Mobile Radios

Self check 2	Written test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided. (2pts each)

1. The following are formwork materials except
 - A. steel
 - B. timber
 - C. gutter
 - D. ply wood
2. The following are formwork equipment
 - A. ties
 - B. Lifting equipment
 - C. winching equipment
 - D. all
3. It is a hand tools
 - A. Hammer
 - B. Grinder
 - C. Mixer
 - D. Cutter
4. One of the following is a communication equipment
 - A. Mobile
 - B. Radio frequency
 - C. Email
 - D. All

Note: Satisfactory rating - 5 point Unsatisfactory - below 5 points

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

Score = _____ Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.
4.

Information sheet -3

Selecting , fitting and using personal protective equipment's

3.1 Personal work site safety procedures

Most accidents can be prevented by taking simple measures or adopting proper working procedures. This information is intended to outline important issues on safety and health that should be paid attention to on construction sites for easy reference by the workers. If we work carefully and take appropriate safety measures, there will definitely be fewer work injury cases, and our sites will become a safe and secure place to work in.

• **Employees' Responsibilities**

Employees should cooperate with their employers and other persons in complying with the safety legislation and guidelines, and should not do anything to endanger themselves and other persons.

• **Tidy up construction sites**

- ✓ Keep passages clear all the time.
- ✓ Sort out materials and pile them up safely. The stacks should not be too high.
- ✓ Beware of floor openings and ensure that they are fenced or covered.
- ✓ Remove refuse as soon as possible.
- ✓ Provide sufficient lighting.
- ✓ Familiarize with the location and the operation of fire-fighting equipment

• **Safety measures**

- ✓ Before you operate a machine, ensure that the dangerous part of the machine has been installed with a guard.
- ✓ Avoid going to any area with insufficient lighting as there may be some dangerous places which have not been provided with fencing.
- ✓ Keep cautious all the time and watch out for moving cranes, hooks or other lifting equipment.
- ✓ Before you use any electrical installation or tool, check the condition of its electric cables.
- ✓ Avoid dragging electric cables on the ground or allowing the cables to come into contact with water.
- ✓ Use electrical tools installed with an earth leakage circuit breaker.

- ✓ Use and handle chemicals with care

You should have a good understanding of your working environment and the instructions given by your supervisor. When evacuation is required in an emergency, you should keep calm and find out

- What dangerous situation the alarm refers to.
- The routes for evacuation.
- The safe place that you should go to as designated by the company.

When someone is found seriously injured, you should:

- Keep calm.
- Seek help immediately.
- Accompany the injured person.
- Assist in the immediate rescue work as far as possible.
- Call the site safety staff.
- Do not try to move the injured person unless it is really necessary to do so.
- Do not tamper with the accident scene while waiting for the arrival of the investigation team.

When a fire breaks out, you should remember:

- Put out the fire with a fire extinguisher if it is a small fire.
- If the blaze is out of control, do not try to extinguish the fire on your own. Call the Fire Services Department right away.

Emergency telephone numbers:

- Always pay attention to the emergency telephone numbers posted on the notice board in the site office.

3.2 Personal Protective Equipment

For your own safety and interest, use the personal protective equipment provided by your employer.

- Wear gloves when handling or contacting chemicals.
- Remember to wear a mask when working in a dusty environment.
- Wear eye and ear protectors whenever necessary.
- Wear a safety harness and secure it to a safe anchorage point when working at height.
- Wear safety shoes to prevent foot injury.

- Consult your supervisor if in doubt.



Figure 3. Wear personal protective equipment

3.2.1 Eye Protection

- A wise worker will certainly take good care of his eyesight.
- A small fragment may cause serious consequences if it enters one's eyes.
- When there is a risk of eye injury, such as in concrete breaking or using abrasive wheels, you should wear suitable eye protectors.
- Take proper care of the eye protectors provided to you.
- Replace damaged or defective eye protectors immediately.
- Ensure that eye protectors are comfortable to wear, and keep clean.
- Use eye protectors for eye protection – do not put it on your head or hang it on your neck.
- Bear in mind that eye protectors are replaceable, but not your eyes.



Figure 4. Wear eye protection

3.2.2 Noise

- Wear ear protectors in areas with high noise levels.
- Properly wear ear protectors according to the manufacturer's instructions.
- Do not reuse disposable ear plugs.
- Clean ear protectors regularly



Figure 5. Safety noise

3.2.3 Safety Helmet

- Wear a safety helmet on a construction site.
- Keep the harness of the helmet clean and make sure that it fits well.
- Do not drill any holes on the helmet or use it for pounding.



Figure 6. Safety helmet

3.2.4 Hand and power tools (from range variable)

• Portable Power Tool

- ✓ Do not use a portable power tool (such as saw, grinder and drill) unless its dangerous parts have been effectively guarded.

- ✓ Place the electric cable and hose of a tool at an appropriate position to avoid tripping hazards.

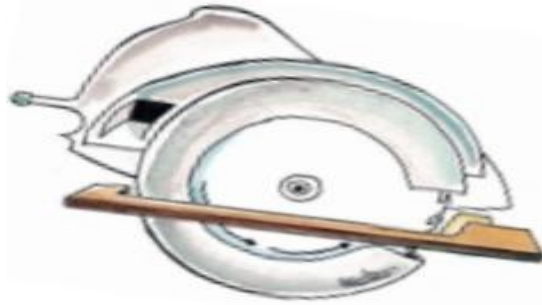


Figure 7. Portable power tool

- **Cartridge-operated Fixing Tool**

- ✓ Do not operate a cartridge operated fixing tool unless you have possessed a valid certificate.
- ✓ Wear suitable eye and ear protectors while operating a cartridge-operated fixing tool.
- ✓ Use a cartridge-operated fixing tool with great care.



Figure 8. Cartridge-operated fixing tool

- **Compressed Air**

- ✓ Use compressed air only for specified purposes.
- ✓ Do not use any compressed air equipment, pipes and relevant devices unless they are of good construction and have been examined and certified safe by a competent examiner before use.
- ✓ Fix the connectors properly.
- ✓ Do not twist the pipes.
- ✓ Do not abuse the use of compressed air for cleaning purpose. Use a brush or a vacuum cleaner to remove dust from clothing and skin.



Figure 9. Compressed air

- **Electric Tool**

- ✓ Before using an electric tool, check the tool and its plug and connecting cable.
- ✓ Do not use a damaged tool.
- ✓ Do not use an electric tool unless its connecting cable is well protected.
- ✓ Do not use an electric tool unless its metal casing is earthed and its power supply is provided with an earth leakage circuit breaker.
- ✓ Do not repair or alter any electrical installation unless competent to do so.
- ✓ If you meet any fault or problem, report it to your supervisor immediately.



Figure 10. Electric tool

- **Lifting Appliance and Gear**

- ✓ Do not operate a lifting appliance unless trained. In the case of a crane, a certificate is required.
- ✓ Before using lifting gear such as hook, shackle or chain sling, check whether there is any wear and tear.
- ✓ Check the weight of the load to be lifted.
- ✓ Do not exceed the safe working load of a lifting appliance or lifting gear.
- ✓ Adopt the correct lifting method.
- ✓ Do not use a lifting appliance or lifting gear unless it has been examined and certified safe by a competent examiner.
- ✓ Do not use a lifting appliance unless it has been regularly repaired and maintained by a competent person. No unauthorized repair is allowed.

- ✓ Follow the safe working instructions of the manufacturer of a lifting appliance.
- ✓ Do not work beneath any suspended load.



Figure 11. Lifting appliance and gear

- **Excavations**

- ✓ Keep the fence on all sides of an excavation intact.
- ✓ Use safe access for ingress and egress.
- ✓ Do not pile soil or any other materials at the edge of an excavation.
- ✓ Make sure that a trench is securely shored before working in it.



Figure 12. Excavations

- **Gas Welding and Flame Cutting**

- ✓ Do not use the equipment for gas welding or flame cutting unless you have attained the age of 18 years and hold a valid certificate.
- ✓ Do not use any gas cylinder unless it has been fitted with flashback arrestors.
- ✓ Wear personal protective equipment.
- ✓ Keep the workplace clean.
- ✓ Place fire extinguishers within reach.
- ✓ Keep gas cylinders in an upright position and secure it properly to avoid overturning.
- ✓ If gas leakage is detected, report it to your supervisor immediately



Figure 13. Gas welding and flame cutting

Self-check-3	Written test
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Directions: Choice the best answer from the given alternative (2 point each)

1. Safety shoes prevent the workers from
 - A. Foot injury
 - B. Hand injury
 - C. Face injury
 - D. Ear injury

2. It is equipment used prevent workers from falling objects
 - A. Goggle
 - B. Glove
 - C. Helmet
 - D. Mask

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

Information sheet - 4

Conducting appropriate utility location activities prior to excavation

1.1 Conducting appropriate utility location activities prior to excavation

Digging, trenching, boring, angering, and blasting are all inherently dangerous to life and property. Even under ideal conditions with a minimum of underground utilities or other obstructions, the risk of potential damage is high.

Unintentional damage to underground facilities during excavation is a significant cause of disruption in

- telecommunications,
- water supply,
- electric power and
- Other vital public services, such as hospitals and air traffic control operations, and are a leading cause of natural gas and hazardous liquid pipeline accidents.
- Coordination, communication and cooperation between excavators, contractors, homeowners, and utility owners can reduce the risk of damage to utility facilities.

When a contractor, excavator or homeowner plans their work, works their plan and calls for underground utility locates in a timely manner, there are many benefits for all to realize

- Reduce the chance of personal injury to employees and citizens
- Maintain uninterrupted utility service to the citizens of Alabama.
- Reduce insurance premium payments.
- Reduce Workers' Compensation payments.
- Reduce non-productive down time.
- Optimize job scheduling activities.
- Reduce overtime payments.
- Reduce damages to expensive excavating equipment.
- Reduce or eliminate the payment of property damage claims.

Self-check 4	Written test
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Directions: Choice the best answer from the given alternative (2 point each)

1. One of the following is underground utility
 - A. Telephone line
 - B. Sewer
 - C. Water pipe line
 - D. All
2. The following can reduce the risk of damage to utility facilities
 - A. Coordination during utility locating
 - B. Communication and cooperative between contractors and owner
 - C. Work site plan for utility service
 - D. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

5.1 Legislative and organizational requirements

A number of stakeholders will have requirements in place that must be taken into account in any risk management process. This is especially so where the environment or human life is at risk. Legislators and regulatory bodies are stakeholders in any risk management process.

Laws have been put in place to ensure that organizations and individuals meet a minimum standard of care to ensure their activities do not result in harm or loss to others. Breaches of these laws can result in fines, jail or both.

Local government will also have a range of requirements that must be met. Councils will control those things that affect the community and which are not covered by broader legislation, such as requirements / restrictions related to construction / building, planning, traffic management, community activities and events.

Councils may also impose further or specific obligations over and above legislative requirements. For example, legislation may require that you manage risks but council may have an added requirement to this legislation requiring that you are able to provide evidence that risk has been managed before it is prepared to issue any necessary permits. Breach of local bylaws can result in fines.

legislative and regulatory requirements may include:

- legislation dealing with
 - ✓ disasters, emergencies
 - ✓ occupational health and safety
 - ✓ the environment
 - ✓ equal employment opportunity
 - ✓ privacy.
- local government requirements dealing with
 - ✓ land use planning
 - ✓ building and planning permits
 - ✓ business permits

- ✓ community interaction
- ✓ noise limits
- ✓ traffic management
- ✓ use of community facilities and event permits.
- safety standards
 - ✓ operating procedures
 - ✓ emergency procedures
 - ✓ Management procedures.

1.5.1. Relevant federal and state or territory legislation and regulations

All people and organizations are required to comply with relevant legislation to which they are subject. This includes prescribed laws, regulations and by-laws. Organizations need to determine their legislative obligations. The following is some of the primary legislation that may need to be considered when applying for a grant.

Some examples of organizational requirements are:

- the organization's vision, goals, objectives and priorities
- business and performance plans
- systems, processes and requirements for quality assurance
- specific change initiatives
- legal requirements, for example, occupational health and safety and anti-discrimination legislation
- standards (such as for ethical behavior) and protocols
- confidentiality and security requirements
- defined resource parameters

1.5.2. Codes of practice, associated standards and guidance material

A code of practice is a practical guide on how to comply with the legal duties under the Work Health and Safety (WHS) Act and Regulations. The WHS Act provides for the approval, variation and revocation of codes of practice by the relevant Minister. The Act also outlines how codes of practice can be used in court proceedings.

Codes of practice have a special status because an approved code is automatically admissible as evidence in court proceedings under the WHS Act and Regulations. Courts may have regard to a code as evidence of what is known about a hazard, risk or control

and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Codes of practice:

- deal with a duty or obligation under the WHS Act or Regulations
- include known information about particular hazards, risks and control measures
- help in determining what is reasonably practicable in the circumstances, and
- can be supplemented with other types of guidance material

Criteria for determining a code of practice

1. Guidance is a necessary part of enabling compliance with the duties contained in the WHS Act and/or Regulations, particularly to support legislative provisions that are outcome focused or do not provide much detail.
2. There is clear evidence of a significant risk or widespread work health and safety problem where evidentiary status of a code will elevate the importance of the issue.
3. There are certain preferred or recommended methods to be used (or standards to be met) to achieve compliance.
4. The information on the hazard, risks and control measures is well-established, reflects the state of knowledge and therefore will not require frequent updating.

1.5.3. Documented organisational policies, manuals and induction programs

This Induction Program provides a mechanism for introducing new staff members to their role and responsibilities and to the organization Mission, culture, ethos, community, organizational structure and the legal requirements associated with employment at the environment. Undertaking and completing the organization Induction Program, including successful completion of essential online learning modules, within the first six months is a condition of employment for all new staff of organization to whom this policy applies.

1.5.4. Relevant community planning and development agreements, such as land care agreements

Development agreements are contracts negotiated between project proponents and public agencies that govern the land uses that may be allowed in a particular project. Although subject to negotiation, allowable land uses must be consistent with the local planning policies formulated by the legislative body through its general plan, and consistent with any applicable specific plan.

This publication provides an overview of development agreement practices and at times provides summaries of the law. Readers should note that attorneys can, and do, disagree about many of the issues addressed in this Development Agreement Manual. Moreover, proposals to change the land use regulatory process are frequently introduced in the state Legislature and new court decisions can alter the practices a public agency should follow. Accordingly:

- Public officials should always consult with agency counsel when confronted with specific situations related to land use laws
- Agency counsel using this publication as a resource should always read and update the authorities cited to ensure that their advice reflects a full examination of the current and relevant authorities; and
- Members of the public and project proponents reading this publication should consult with an attorney knowledgeable in the fields of land use and real property development law

Self check - 5	Written test
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Directions: Choice the best answer from the given alternative (2 point each)

1. Legislative and organizational requirements are
 - A. Code of practice
 - B. Guidance materials
 - C. Standards
 - D. All

2. Some examples of organizational requirements are:
 - A. the organization's vision, goals, objectives and priorities
 - B. systems, processes and requirements for quality assurance
 - C. occupational health and safety and anti-discrimination legislation
 - D. all

Note: Satisfactory rating – 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

6.1 Arranging appropriate site boundary protections

Irrigation Water Management (IWM) is the practice of monitoring and managing the rate, volume, and timing of water application according to the seasonal crop needs, giving consideration to the soil intake and water holding capacities.

Irrigation Water Management (IWM) is the practice of monitoring and managing the rate, volume, and timing of water application according to the seasonal crop needs, giving consideration to the soil intake and water holding capacities. Soil moisture should be managed to obtain optimum yields, without deep percolation losses or runoff.

Irrigation water management will help irrigators determine the effectiveness of irrigation practices, make good water management decisions, and justify making irrigation adjustment in existing systems. Tools are available to assist the irrigator with irrigation water management:

- “Checkbook” method to monitor and balance soil moisture in irrigated cropland.
- Flow meters to record instantaneous flow rates and total volume usage.
- Soil moisture meters and sensors to monitor soil water deficit.
- Soil moisture data loggers to record soil moisture history throughout the growing season.

Self check - 6	Written test
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Directions: choose the best answer from the given alternatives (3 point each)

1. what is Irrigation Water Management?
2. list the types of tools used to assist the irrigator with irrigation water management?

Note: Satisfactory rating – 3 point Unsatisfactory - below 3 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

Instruction sheet	Learning guide #77: Repair minor structures
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Checking equipment, tools and materials,
- maintaining and storing equipment, tools and materials
- Restoring Work site to meet environmental and organisational requirements
- Completing workplace records and process

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

- Check, maintain and store Equipment, tools and materials according to manufacturer guidelines and organizational procedures.
- Restore Work site to meet environmental and organizational requirements.
- Complete Workplace records and process as required.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 4”. Try to understand what are being discussed.
4. Accomplish the “Self-checks 1,2,3 and 4 ” in each information sheets on pages 39, 43, 45 and 49.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1 on pages 50 and do the LAP Test on page 51”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information sheet -1	Checking equipment, tools and materials
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1.1 Checking equipment, tools and materials

Before and after the construction job always take some time to inspect and repair your tools. This will ensure your tools are safe to use and will make them last longer. It also helps to see a sign of damage and any faulty functioning.

In case of damage, it is wise to repair them immediately or take them to a repair shop to avoid last minute hassle. Some of the common features you may focus on while inspecting are explained below:-

- Rust and corrosion: It may be unsafe to use a tool depending on its rust or corrosion level.
- If the damage is great, you might consider replacing the tool.
- to prevent electrical hazards,
- Repair the tool.
- Housing on power tools:
 - Avoid using a power tool whose housing has a crack no matter the size of the crack.
 - Take care of loose, splintered or cracked handles to prevent injuries to you or any other worker.

Material testing is an essential step in the quality control process of virtually any manufacturing cycle. All manufactured components need to be tested for properties such as hardness, structure of the material (e.g. crystalline structure) or the general material composition. Rigorous material testing is especially important for parts that are relevant to security, for example a car's chassis in the automotive industry or turbine components in aviation.

- **Clean your tools**

Cleaning the tools regularly is essential to their proper functioning. After a day of work, your tools will be covered with some amount of dirt. It's important to clean them after you're finished using them. Although a thorough cleaning is not required on a daily basis, make sure you clean your tools regularly. When cleaning your tools, don't use chemicals

that are extremely harsh. Follow the manufacturer’s guidelines for proper cleaning and maintenance.

- **Protect electrical cords**

Airlines and electrical cords are prone to heavy damage since they are generally in the way of construction vehicles, and foot traffic. Other machinery like forklifts, drills, etc. can easily cut through wires. To keep the wires and airlines from getting damaged, it is important to protect them. You can cover the electrical cords with industrial strength casings or purpose-built ramps

- **Lubricate tools**

Whether you work with pneumatic or regular tools, it is important to lubricate them regularly. Lubricating tools helps them to perform better and reduces wear and tear of components.

- ✓ Lubrication is even more important when working with air or pneumatic tools. Pneumatic tools need to be lubricated once a day before use. When moisture or condensation enters the interiors of pneumatic tools, it can cause corrosion. Corrosion can decrease the life of an instrument. Corroded parts are difficult to repair and replace. Hence, the internal components of pneumatic tools should be coated with special air-tool oil. This oil prevents corrosion by displacing any moisture that enters the interior of the equipment.

- **Inspect tools regularly.**

Regularly inspect your tools for signs of damage and faulty functioning. Inspections should take place at the end of each construction job. Ensure that you repair them immediately if there is any damage. This will avoid any last minute hassle.

- **Store tools with care.**

Storing tools properly is of prime importance. Although tools are designed for rough use, it is important to store them properly. Cover up your tools to keep dirt and rain away from the machine. If the tools aren’t used for a long time, inspect them regularly for signs of damage, wear and tear, corrosion, etc

- ✓ When cleaning your tools, ensure that you wear protective gloves.
- ✓ The air tool lubricant should be used as instructed by the tool manufacturer.
- ✓ Handle your tools with care at all times. Maintain safety when you work with or clean your tools.

Self check 1	Written test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided.(2 pts each)

1. Whether you work with pneumatic or regular tools, it is important tools to perform better and reduces wear and tear of components.
 - A. Pneumatic tools
 - B. Lubricate tools
 - C. Inspect tools
 - D. Clean tools
2. Regularly inspect your tools for signs of damage and faulty functioning.
 - A. Pneumatic tools
 - B. Lubricate tools
 - C. Inspect tools
 - D. Clean tools
3. Storing tools properly is of prime importance to private:
 - A. Damage
 - B. Tear
 - C. Corrosion
 - D. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.

2.1 Introduction

All tools are equipped with maintenance guidelines specific to the particular tool. This manual will help provide more details on ways of increasing the life of your tools.

Make sure your tools are sharp and in otherwise perfect condition to function efficiently. Using tools that are worn will stress the rest of the components, reducing their service lives

Guidelines specific to the particular tool

- organize and control the work of the group
- ensure proper standards of workmanship and productivity
- keep records of hours worked and work done
- Maintain an adequate supply of materials and tools.

Tools are designed to make a job easier and enable you to work more efficiently. If they are not properly used and cared for, their advantages are lost to you. Regardless of the type of work to be done, you must have, choose, and use the correct tools in order to do your work quickly, accurately, and safely. Without the proper tools and the knowledge of how to use them, you waste time, reduce your efficiency, and may even injure yourself

2.2 Store tools properly

Proper storage is done to protect them from rain, dust, and rust and also to save your time when you need them in your next task.

- To avoid rust, your tools should always be stored in a dry place.
- In case your garage or storage location has an issue with humidity,
- A dehumidifier may seem expensive but when you compare it with the investment in your tools it will definitely be worth it.
- Utilize the silica gel packs that are usually packaged in various items. The silica gel helps to keep moisture at bay.
- Just throw some in the toolbox to protect your tools from getting rust.
- Rust inhibitors are also useful in preventing rust and you can also use anti-rust liners in your shelves and drawers

2.3 Proper storage of cleaned equipment

- Store all tools and equipment in their designated places. Put frequently used items in conveniently accessible locations.
- Proper Storage and Handling Proper storage and handling of cleaned and sanitized equipment and utensils is very important to prevent recontamination prior to use.
- Cleaned and sanitized equipment and utensils must be: .Stored in clean surface and Handled to minimize contamination.
- Stacking and Storing of spices, herbs and other condiments
- Storage of bottled and canned food or other condiments
- Storage of equipment's, tools, utensils and other implements

2.4 Identify hand and power tools

Power tools Electricity can be dangerous and care should be taken in its use. Even if you have worked in the industry a long time or feel you know about electrical safety, do not take risks with electricity. To prevent accidental electrocution, always use earth leakage circuit breakers (ELCBs) Before power tools are used, operators must be given extensive instruction in the safe use of each power tool to be used Figure



Figure 14. Proper hand tools and equipment's



Figure 15a. Hand tools



Figure 15b. Cleaning equipment

Self-check 2	Written test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided Directions. (2pts each)

1. Guidelines specific to the particular tool
 - A. organize and control the work of the group
 - B. ensure proper standards of workmanship and productivity
 - C. keep records of hours worked and work done
 - D. Maintain an adequate supply of materials and tools.
 - E. All
2. Proper storage of cleaned equipment
 - A. Store all tools and equipment in their designated places
 - B. Proper Storage and Handling Proper storage and handling of cleaned
 - C. Proper stacking of glass ware
 - D. Cleaned and sanitized equipment and utensils must be
 - E. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

Information sheet -3	Restoring work site to meet environmental and organisational requirements
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3.1 Introductions

Cleaners work in all industry sectors and workplaces, from hotels to hospitals and factories to farms. They work inside and outdoors, including in public areas. Often working at night or in the early morning, sometimes alone, cleaners are found in every setting and the work they do is essential

Cleaners may either be employed directly, working in their employer’s premises, or they may work in a location run by a third party. They may be employed by public services, private enterprises, or they may be self-employed. Cleaners may also be employed by a contractor, working at several locations over the course of a week.

Most cleaners are women and work part time.

- I. A significant proportion of workers come from ethnic minorities
- II. Staff turnover is generally high, caused by a high level of temporary work and short fixed-term contracts
- III. Although these employment patterns can cause difficulties, harm to cleaning workers can and must be prevented.

3.2 How and why cleaning workers are injured using their equipment?

Cleaning workers use a wide range of equipment, including brooms, brushes, buckets, dusters, rags, rotary disc machines, steam cleaners, steps, ladders, scrubbers, driers, vacuum cleaners and wet pick-up machines. Once problems emerge, employers have to take measures to prevent further harm to workers, but it is far better if the employer is proactive by identifying and addressing the risks before a worker is harmed.

Where possible, the risks to workers have to be removed; for example, through the replacement of dangerous substances with those that are safer for use. Many of the risks associated with the equipment hazards described above can be minimized by controlling the risks identified during the risk assessment process. Controls may include selecting the right equipment for the cleaning task cleaning

Self-check 3	Written test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided. (2pts each)

1. Cleaning workers use a wide range of equipment, including
 - A. brooms
 - B. brushes
 - C. bucket
 - D. dusters
 - E. All

2. cleaning workers are injured using their equipment
 - A. reduce risk to workers
 - B. safe work area
 - C. minimize hazards
 - D. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.

Information sheet #4	Completing workplace records and process
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4.1. Document and record all processes and activities.

These documents and records should be stored in official files and remain accessible to staff who need them. Base the documents on the prerequisite programs and on the product protection or plan. If documents are already being kept, review them to make sure they are complete and that they follow the necessary standards.

Follow these three general principles to develop records and documents:

- **Keep it short and simple.** Use bullet points and flow diagrams instead of long sentences and lengthy paragraphs
- **Clarity is important.** Step-by-step instructions are easily understood.
- **Use a standardized, consistent format.** Although different programs may need different documents and records, using a similar approach will help staff learn quickly.

Let staff know that attempts to falsify records are easily detected. Auditors are trained to look for signs of fraud that can include records completed in the same increasingly messy handwriting and using the same pen.

Checking records regularly helps ensure that employees are completing their assigned activities. It helps to make sure that records are being filled out honestly and with all the information needed.

4.2 Application of the unit

1. Identify and handle records in accordance with enterprise procedures.
2. Track location of records.
3. Apply security controls to ensure the integrity of records is not compromised.
4. Maintain workplace records systems.
5. Identify problems and take appropriate action.

Some of the most significant record types are

- Property records - title deeds and settlements.
- Accounting papers - including rentals, vouchers, surveys and valuations.
- Legal papers.

- Inventories.
- Correspondence.
- Enclosure papers.
- Manorial papers - court rolls, costumes, terriers, surveys etc.
- Personal and political papers.

Appropriate records should be compiled and maintained throughout the duration of construction project. This creates a contemporaneous history of what happened at what point during the course of the project that can be referred to if necessary.

This not only establishes a ‘memory’ or ‘paper trail’ for the project through which activities and decisions can be reviewed, it allows for the reconstruction, review and analysis of events and timelines should dispute arise. Disputes are often determined by the available records, rather than by the facts, and so it is commercially very important to the parties involved that good records are kept.

There are a number of reasons for record keeping:

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

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

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

For example, under the Construction Industry Scheme (CIS), contractors must keep a record of the gross amount of each payment invoiced by subcontractors, excluding VAT and any deductions made from subcontractor payments. These details must be kept for at least 3 years after the end of the tax year they relate to. Ultimately, when the completed

building is handed over to the client, a set of record information should be passed to them so they are able to operate the building.

It is important that the standard of records kept is high, or they may not provide the expected information when they are actually required. In particular, records should be dated (including incoming records) and where appropriate, signed, and a document management system should be in place to allow efficient storage and retrieval.

Information is now generally managed using specialist software, and apps that make the preparation of records easier and more reliable are also available. This can, for example allow records to be made on site using a mobile phone, which are then automatically uploaded to a project document management system.

Increasingly, project information is prepared in the form of a building information model (BIM), and this may include project records as well as design and specification information. An as-built or as-constructed building information model might be prepared on completion of construction works, consisting of documentation, non- graphical information and graphical information defining the delivered project. During operation, this might be described as an Asset Information Model (AIM), that is, a model that provides all the data and information related to, or required for the operation of the completed built asset.

Self-check 4	Written test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided. (2 pts each)

1. It is general principles to develop records and documents:
 - A. Keep it short and simple.
 - B. Clarity is important. Step-by-step instructions are easily understood.
 - C. Use a standardized, consistent format.
 - D. All

2. Application of the Unit
 - A. Identify and handle records in accordance with enterprise procedures.
 - B. Track location of records..
 - C. Maintain workplace records systems.
 - D. Identify problems and take appropriate action
 - E. All

3. It is a number of reasons for record keeping:
 - A. Legal requirements.
 - B. Contractual requirements.
 - C. To control work.
 - D. To provide data for future work.
 - E. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.
4.

Operation Sheet 1	Techniques of proper storage of cleaned equipment
--------------------------	--

Steps

Step 1: Use properly safety personal protective equipment's

Step 2: Store all tools and equipment in their designated places

Step 3: make proper storage and Handling of cleaned and sanitized equipment.

Step 4: Clean and sanitize equipment and utensils

Step 5: Store tools in clean surface and handle carefully to minimize contamination

LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 6 hours.

Task 1: Properly store cleaned equipment

Instruction Sheet	Learning Guide 78: Complete and record work outcomes
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Inspecting structures and determining appropriate repair techniques
- Applying appropriate repair techniques

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:

- Determine structures are inspected and appropriate repair techniques
- Apply appropriate repair techniques according to manufacturer guidelines and legislative and organizational requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1 and 2”. Try to understand what are being discussed.
4. Accomplish the “Self-checks 1 and 2” in each information sheets on pages 57, and 76.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1-4 on pages 77 and 78. Do the LAP Test on page 79”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1

Inspecting structures and determining appropriate repair techniques

1.1 Inspecting structures

Minor problems in structures, like a leakage or rusty iron parts, may become important if they are neglected. Frequent inspections and regular maintenance will help limit any damage. A canal system, and in particular the structures, can be safeguarded from problems such as leakage, erosion, siltation, rot and rust by regular inspection and immediate repair action. Since the canals are inspected regularly, structures can be inspected at the same time.

This makes it possible quickly to spot the beginning of leakage, erosion or rust. A quickly executed repair will stop the problem while it is still a small one, and before it escalates into serious damage. Inaccessible structures and lots of plant growing on the canal embankments make inspection time-consuming, and it will also be difficult to see water leaking if the walls of a structure are hidden from view.

1.2 Determining appropriate repair techniques

The irrigation system is perhaps the most costly element of an irrigation scheme and is designed to last a long time. However, all too often one finds that irrigation schemes not long constructed bear little resemblance to the original construction and design. Silt deposition, weed infestation, malfunctioning of structures and other undesirable situations make it practically impossible to control the flow in these canals. As a result, the system is unable to deliver the necessary water and distribute it equitably. It is not surprising that farmers working in those irrigation schemes sometimes feel frustrated because they know the potential benefits of irrigation and yet cannot realize their expectations.

Maintenance of the structures is the efforts to secure the conservation of the function of structures in good conditions, including rehabilitation works that recover the structure condition to the required condition in the water resources management scheme.

The maintenance works are classified into three (3) categories, that is,

- the preventive/routine,
- corrective/periodic and
- Emergency maintenance.

Criteria of those maintenance works are as follows:

A. Preventive/Routine Maintenance

The preventive/routine maintenance comprises all activities carried out to maintain optimal functioning of a facility in order to reduce need for corrective/periodical maintenance and prevent high rehabilitation cost. Its components are:

I. Routine Maintenance

All repeated maintenance works, which are performed on a cyclical basis at planned frequencies e.g.:

- Turf/grass cutting of embankment slopes,
- Removal of vegetation from embankments and obstacles from flood plains and watercourses,
- Removal of sedimentation by excavation or dredging,
- Refilling of scour pits, and
- Pointing and lubrication of iron works and devices.

II. Periodical Works

All jobs, which are performed on a cyclical basis at planned period e.g.:

- Regular inspection campaign of water resources management schemes and structures including reporting etc.
- Replenishment of stocking of construction materials
- Survey of riverbed including sounding
- Inspection of the flood plain and inventory of flood plain occupation.

III. Small Repair Works

This includes small-scale activities necessary for the restoration of a facility to a condition equivalent to its design capacity caused by minor failures, damages and defects e.g.:

- Repair of inspection road pavement,
- Repair of cracks within the embankment,
- Repair of seepage through embankment and along the periphery of structures,
- Raising embankment crest due to settlement and subsidence,
- Repair of slope slides and partial failures,
- Repair of toe and blanket drains in embankments, and
- Repair of cracks and damages on aprons, slope protection, etc.

Priorities are normally established in repair works and they fall into several categories, i.e. emergency, rush and non-rush. Emergency repair must be carried out immediately. Rush

within say one (1) month after receipt of notice and non-rush when time is available in the maintenance schedule, but before the next flood.

B. Corrective/Periodic Maintenance

Corrective or periodic maintenance covers large scale non-emergency work requiring greater resources than the preventive/routine maintenance. Generally, corrective maintenance consists of the special maintenance, rehabilitation and rectification works and includes the following works:

- Construction of new structures to enhance water resources management
- Major structure repairs and modifications
- Replacement or major repairs of gates and hoisting mechanisms
- Re-sectioning of flood embankments
- Re-excavation of drainage channels
- Repair of major erosion including slope protection
- Breach closing, construction of retired embankment, etc.
- Bank protection works at the eroded bank to enhance water resources management

C. Emergency Maintenance

Emergency maintenance is concerned with the unexpected damage due to natural calamities that threaten the water resources project. Emergency situation can be reduced if the preventive/routine and corrective/periodic maintenance works are taken up effectively. Emergency maintenance consists of:

- Emergency maintenance during calamities (emergency work), and
- Substantial maintenance after calamities (flood damage repair work).

Corrective/periodic maintenance and emergency maintenance works together are also called asset renewal. This is required to keep the existing water related infrastructure at its intended design and functional use.

The need for an asset renewal program can be reflection neglect, but it can also be a result of normal infrastructure depreciation, even with an adequate O&M back up program. The end of a good preventative maintenance is an aggressive corrective maintenance adopted as part of a formal procedure in an effort to eliminate repressive failure. Review of the failures is required with respect to:

- Redesigning,
- Reconstruction,
- Improving maintenance procedure, and

- Review and changing operational procedure.

To inspect and maintain all parts of water resources management scheme with such regularity in order to eliminate all failures is not practical because the repair cost would not be justified. Rehabilitation works are based on review of the original design or capacity of a system or structure. It may be related to a single structure only, e.g. sluice, regulator groyne, etc., in which case it is indicated as rectification works. Rectification works should be avoided as far as possible by preparing and conducting a proper preventative maintenance program.

Self-Check -1	Written Test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided.(2 pts each)

1. It is a routine maintenance activities
 - A. Removal of sedimentation
 - B. Replacement or major repairs of gates
 - C. flood damage repair work
 - D. none

2. Asset renewal means
 - A. it a combination of corrective and emergency maintenance
 - B. it is a combination of corrective and routine maintenance
 - C. a combination of routine and emergency maintenance
 - D. all

3. Review of the failures is required with respect to:
 - A. Redesigning
 - B. Reconstruction,
 - C. Improving maintenance procedure
 - D. Review and changing operational procedure
 - E. All

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.

Information Sheet-2

Applying Appropriate repair techniques

2.1 Interpret plans, instructions and standard operating procedures

Problems such as the disappearance of movable parts from structures or vandalism and demolition are difficult to prevent, but they can be minimized by involving farmers in canal operation and maintenance, and by cultivating the sentiment that structures are a communal resource and therefore proper maintenance is a responsibility of the community.

2.2 Repair and Maintenance of minor Structures

A. Canal maintenance

Good maintenance program can prolong the life of canals. A routine, thorough programmer should be kept to. Maintenance of an irrigation canal system is usually carried out in between two irrigation seasons, or at times of low water demand. It consists of cleaning, weeding, de-silting, re-shaping, and executing minor repairs

Patrol and Inspection:

(1) Damages/Irregularities of channel/canal:

Maintenance of channel/canal is conducted by visual inspection for sediment deposition, vegetation, riverbed degradation, riverbank erosion, etc.

(a) Sediment deposition

At the selected reaches, fixed-point observation is conducted regularly. Change of channel is grasped comparing the observation result with the past records. Sediment in channel/canal is transported downstream by water flow. Therefore, when the flow velocity gets slow and decreases carrying capacity, sediment is deposited on the riverbed.

The flow velocity generally slows at the following reaches.

- A reach that riverbed gradient changes from steep to gentle toward downstream
- confluence where a main stream with gentle gradient meets a tributary with steep gradient
- backwater reach caused by a crossing structure, e.g. barrage
- tidal reach
- reach where cross-sectional area gets wide -An inside of a curved reach

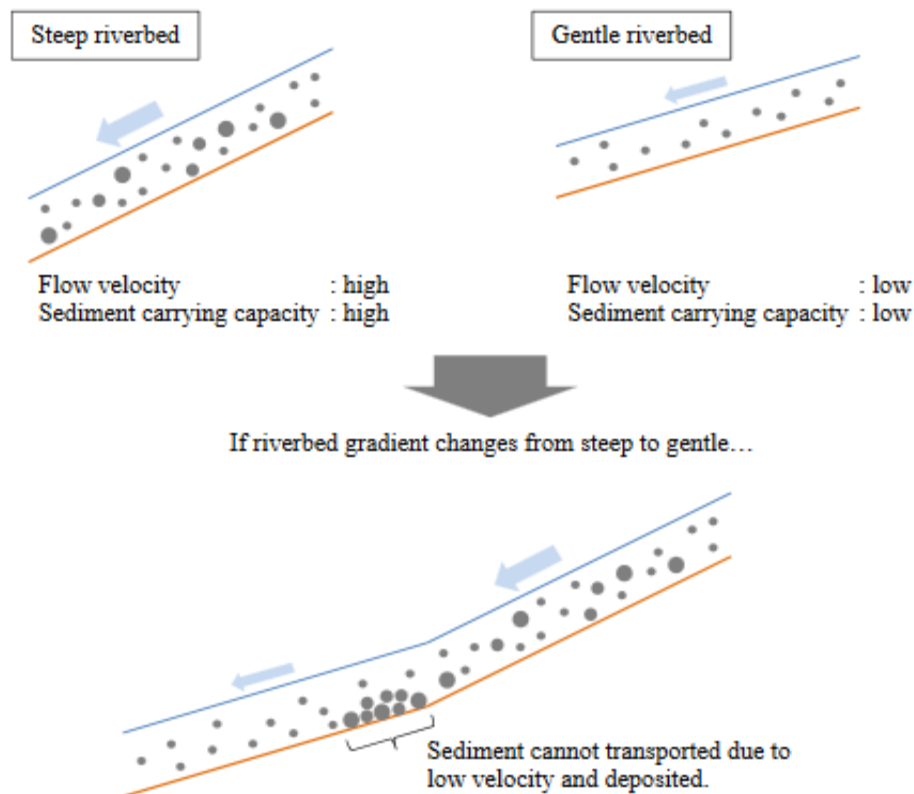


Figure 16. Sediment deposition and riverbed gradient of canal

(b) Riverbed degradation and local scoring

In order to grasp riverbed degradation or local scoring damaging river structures, monitoring the condition of topographical change, displacement of structures, etc.

Viewpoint

If riverbed degradation occurs just downstream of river structures, it might cause them to be deformed or to be washed away. Progress of riverbed degradation can be grasped by observing such deformation of the river structures.



Figure 17. Deformation of river structures due to riverbed degradation/local

(c). Erosion

If river bank erosion progresses, it would cause dike break and land loss along the river. In order to grasp the status of bank erosion and consider the countermeasures, visual inspection is conducted. The places/reaches to be inspected are the following erodible points. The erodible points are generally extracted from planar positional relation. –

- Water colliding front, outside of a curved reach, river bank near water route, etc.
- River bank near a bridge pier, river bank at just downstream of river bank protection works
- A reach that river degradation/local scouring progresses, a reach that cross-sectional area suddenly contracts, etc.



River bank erosion at the curved reach



River bank erosion near a bridge pier

Figure 18. Deformation of river structures due to bank

(2) Illegal/Harmful Acts:

- Construction of illegal structure or earth works (excavation, embankment, etc.) within channel/canal area.
- Illegal land use within the channel/canal area.
- Garbage dumping in channel/canal.

(3) Channel/Canal Water

- Illegal waste water disposal.
- Unusual color or smell of water.
- Many dead fish or aquatic animals floating on water.

B. Embankment structure

Patrol and inspection

a) Damages/Irregularities of Embankment

- Erosion or scouring of embankment due to river flow.
- Settlement, cracks, leakage of water or piping, and other damages on embankment.

- Vegetation on embankment which may damage the embankment.
- Slope failure of embankment and channel bank.
- Cave-in on land side slope.

b) Illegal/Harmful Acts

- Cultivation at the embankment foot.
- Cutting embankment crests and slopes for crossing or water intake.
- Burning trash on the embankment.
- Illegal works on the embankment such as public and private facilities, temporary building, piling, excavation, etc.

Preparation for Repair Works

Repair works of damaged portion of embankment are to be conducted by contract system. Planning, surveying, design, cost estimate, tendering and supervision are to be conducted. Other minor maintenance works (routine maintenance) shall be done by force account

I. Repair of Embankment Crest

After excavation of damaged portion with cutting slope of 60°, high quality soil with appropriate moisture content should be filled. The soil thus filled should be compacted well by using tamper for small scale damage and compacting by vibration roller or bulldozer for large scale damage.

After compaction, sodding should be provided at the shoulder.

II. Repair of Embankment Slope

Slope repair should be carried out with high quality soil and turf in due order of striping, bench cut, finishing stake, embankment, slope tamping, and driving of support skewer.

III. Rehabilitation of Slope Failure

Slope failure due to slide is caused by increase in unit weight of soil saturated mainly due to rain water or rising seepage water and also by decrease of shearing resistance against the weight. For the repair of the slope failure, muddy soil and poor quality soil at the site should be removed and replaced by high quality soil and the replaced soil should be well compacted. Leakage proof works or mitigation of the slope gradient should be carried out, if necessary, depending on the cause of failure and the soil quality.

IV. Repair of Cave-in

The initial cause of cave-in in embankment is an occurrence of voids due to

- (i) Leakage water,
- (ii) Washing away of backfill materials caused by fault of sluice/regulator joint or impervious wall, and
- (iii) Insufficient compaction of refilled soil for built-in facility and backfill sand of retaining wall, etc.

Voids gradually develop into cavities which appear on the embankment crest. Many cases of the cave-in are due to inappropriate construction of structures. In order to repair, a detailed investigation on the cause of cave-in is indispensable prior to filling up the cave. If a fault is found in structure itself, the embankment body concerned should be removed and reconstructed, except for the case that the structure is possible to be mended from its inside.

V. Rehabilitation of Crack

Cracks of embankment are usually caused by,

- a) excessive saturation due to seepage water,
- b) Contraction of embankment using clayey soil and exposure to drought and
- c) Earthquake.

Before the repair, causes of the cracks should be examined and counter measures are to be established. For the repair of such cracks, the embankment body should be excavated in V-shape along the crack with slope of 60°, filled with high quality soil, and compacted well with a thickness of 30 cm.

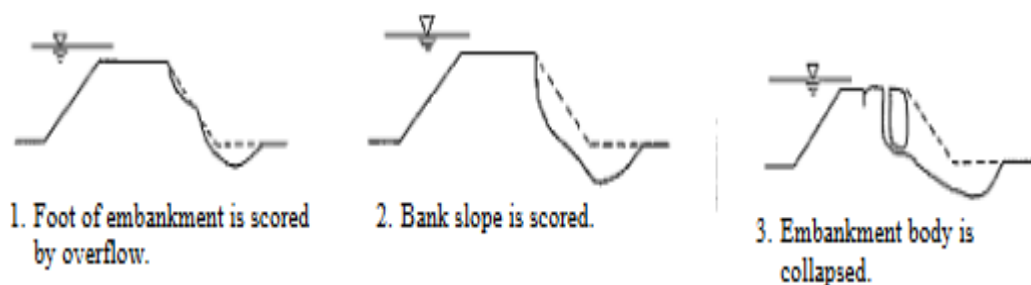


Figure 19. Collapse of embankment

C. Slope (Bank and Foot) Protection Work

Patrol and Inspection

(a) Damages and Irregularities

- Any cracks on slope pavement.

- Condition at the slope protection work especially at foot protection works during low water level.
- Condition of riprap for foot protection at the downstream and upstream site of crossing facilities such as barrage/large scale regulator, etc.
- Condition of construction joint, upper and lower ends of the slope protection work.
- New erosion or scouring in front of the slope protection work.

(b) Illegal/Harmful Acts

- Destroying the slope pavement for crossing or water intake
- Burning trash on the slope protection works.
- Extracting the boulders from the foot protection works.

(c) Repair of Slope Protection work

Damage of slope protection work should be repaired immediately. For planning of the repair, causes of damage should carefully be investigated and reflected to the repair works. If new bank erosion is found, counter measures against erosion should be conducted soon.

In planning of the new protection work, influence of the new work to the adjacent reaches or to the downstream reaches should be taken into consideration. The repair works will be conducted by force account or contract system depending on the quantity of works.

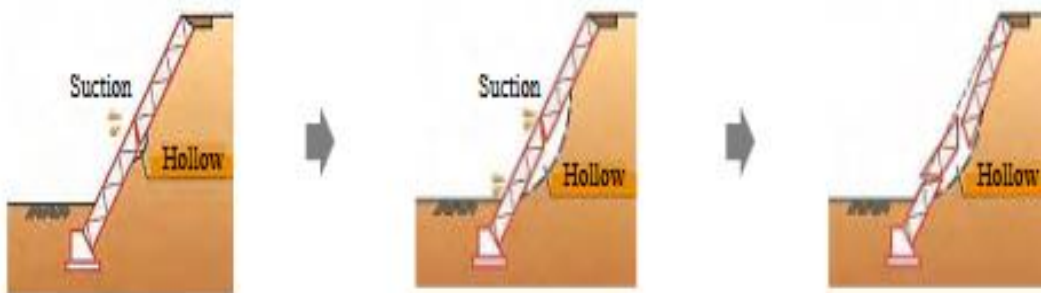


Figure 20a. Damage of slope protection work caused by suction of backfill material

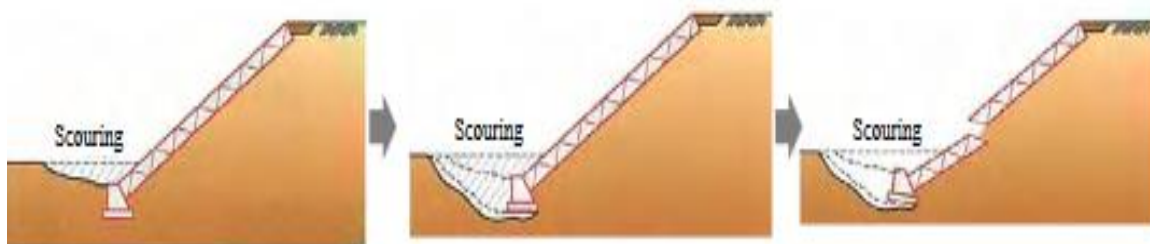


Figure 20b. Damage of Slope Protection Work Caused by Riverbed Degradation

D. Side Drain

Patrol and Inspection

(a) Damage and Irregularities of Side Drain

- Vegetation (Water hyacinth, etc.) which may disturb smooth water flow.
- Severe erosion of drain.

(b) Illegal/Harmful Acts

- Dumping garbage in the drain.
- Barrier put privately in the drain.

(c) Maintenance activities:

- a) Cleaning of drains by neighboring residents (local society oriented), including removal of water hyacinth at least annually. Water hyacinth poses particular problems because of the rate of growth and speed with which they can re-establish after clearance.
- b) Repair or rehabilitation: by force account or contract depending on the quantity of works.

E. Spur Dike

Patrol and Inspection:

(a) Damages and irregularities

In order to grasp the deformation causing functional loss, visual inspection is conducted. Super dike sticks out into water flow and so scoring occurs at the point where flow concentrates at, e.g. the tip. Deformations causing damage are listed as follows.

- Inclination, sliding/overturning, outflow of super dike
- Sliding, outflow of material, e.g. gabion, block and stake
- Erosion at joint between super dike and the bank
- Wear of concrete, decay of timber
- Floating up of a stake

(b) Illegal/Harmful Acts

- Construction of illegal structure on the Spur Dike
- Burning trash on the Spur Dike
- Extracting the material from the Spur Dike

(c) Repair of Spur Dike

Repair works of damaged portion are to be conducted by contract system or force account. For planning of the repair, causes of damaged should be investigated carefully and reflected to the repair works. If new erosion is found near the spur dike, countermeasures against erosion should be conducted soon. In planning of the countermeasures, influence of new works to the adjacent bank/coast should be taken into consideration.



Figure 21. Outflow of concrete block of spur dike

E. Road (inspection/ access road)

Patrol and inspection:

- (a) Damage and irregularities of inspection road.
- (b) Conditions of vegetation and pavement of the road
- (c) Conditions for public use.

Maintenance activities:

Repair or rehabilitation of damaged portions of the road by force account or contract depending on the quantity of works.

F. Bridge/Culvert

Patrol and Inspection

(a) Damage and Irregularities

- Scouring of channel/canal bed around pier and abutment.
- Condition of slope protection works around abutment.
- Gaps or cavities between abutment and embankment.
- Drift wood and garbage around pier.

(b) Illegal/Harmful Acts

- Taking of earth, sand, etc. around pier and abutment.
- Mooring of boats and ships to pier.

(c) Maintenance activities

Requirement of the maintenance activities shall be the same as those stipulated in Embankment and Slope (Bank and Foot) Protection Work”.

G. Barrage/large regulator

Barrage/large regulator is a gated structure constructed across a watercourse to raise and regulate the water level or to divert it into a watercourse for water use or navigation.

Patrol and Inspection

(a) Damage and Irregularities

- Scouring of channel bed around barrage.
- Condition of slope protection works around abutment of the barrage.
- Gaps or cavities between abutment and embankment.
- Drift wood and garbage around barrage.
- Concrete works: any cracks on concrete and wearing out the concrete..
- Channel bed protection works: condition of boulders/concrete blocks.
- Wing wall: any cracks on concrete, and wearing out the concrete.
- Condition of the joints between the abutment and the upstream and downstream channels.
- Gate and gate leaf: In operation/movable conditions, any damage, rusting, greasing and painting.

(b) Illegal/Harmful Acts

- Taking of earth, sand, etc. around the barrage.
- Mooring of boats and ships to pier.
- Any missing of parts of gate for operation.

- Stone or plank put between pier and gate leaf.

(c) Maintenance activities

Requirement of the maintenance activities shall be the same as those stipulated in “**Maintenance of Channel/Canal**”, “**Embankment**”, “**Slope (Bank and Foot) Protection Work and Sluice and Regulator**”

H. Sluice and Regulator

Sluice is a gated structure, which allows water to flow under an embankment, road, or similar obstruction, for draining a surplus water of a watercourse, the polder and the inland.

Patrol and inspection:

(a) Damages and Irregularities:

- Gate and gate leaf: In operation/movable conditions, any damage, rusting, greasing and painting.
- Culvert/conduit: Any cracks on concrete.
- Earth works: Any cracks and cave-in.
- Clogging of conduit with garbage, sand gravel, etc.
- Seepage or local scouring.

(b) Illegal/Harmful Acts

- Any missing of parts of gate for operation,
- Stone or plank put between conduit and gate leaf, and
- Barrier put privately at the inlet of conduit.

(c) Maintenance activities:

- Repair and rehabilitation of damaged portions by force account or contract system depending on the quantity of works,
- Maintenance operation and greasing at four (4) times a year, by caretaker,
- Painting of gate leaf at least once (1) a year,
- Cleaning works are required at least four (4) times annually and coarse rubbish should be swept at need,
- Replacement of gate leaf should be determined considering the damage/rusted condition.



Figure 22a. Sediment deposition from apron Figure 22b. Vegetation in front of gates
To box culvert

I. Aqueduct and Siphon

Aqueduct is a gated structure constructed to convey water over a watercourse.

Siphon is a structure constructed to convey water under a watercourse.

Patrol, Inspection and Maintenance Activities:

Patrol, inspection and maintenance activities of the aqueduct shall be conducted in accordance with “Bridge/Culvert” and “Sluice and Regulator”. Those of the siphon shall be in accordance with 5.5.8 “Sluice and Regulator”.

2.3 Methods of repairing concrete, brick and stone structures

Bricks are the most commonly used construction material. Bricks are prepared by molding clay in rectangular blocks of uniform size and then drying and burning these blocks. In order to get a good quality brick, the brick earth should contain the following constituents.

- Silica
- Alumina
- Lime
- Iron oxide
- Magnesia

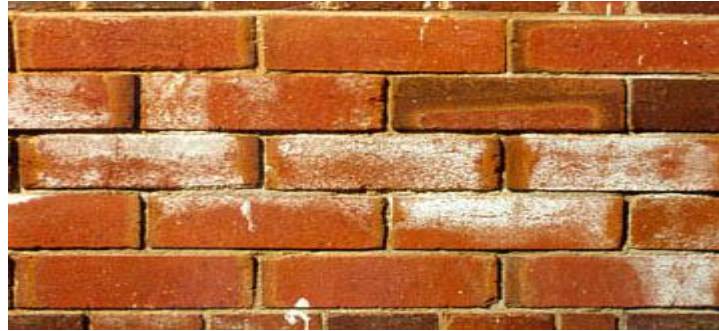


Figure 23. Brick structure

The concrete blocks, bricks or stones are laid flat on the compacted sides and bed of the trapezoidal canal. The joints are filled with cement mortar, which should have a cement-to sand ratio of 1:3 to 1:4 (one part of cement to 3-4 parts sand, by volume).

A rectangular canal can be constructed with a concrete or masonry bed and vertical masonry walls. See Figures 24 shows the destruction of the old unlined canal bed. The foundation for the concrete block lining is in preparation. The block in the foreground will be used as a reference level. The blocks in need to be plastered. Usually the water side of the masonry structure is plastered, particularly if the bricks are not of good quality.



Figure 24. Repairing concrete, brick and stone structures

2.4 Applying appropriate water to cement ratio of concrete

Water/cement-ratio is a main factor which affects the workability of concrete. Generally w/c ratios of 0.45 to 0.6 are used for good workable concrete without any admixture (SP and AEA). Higher the w/c-ratio higher will be the water content per unit volume of concrete, which might cause some problems e.g. bleeding, segregation and losing compressive strength. Slump test is used to determine the workability together with the consistency of fresh concrete. Workability of the concrete is considered as the placement of the concrete without segregation and bleeding. If concrete is segregated, it means that coarse aggregates are separated from the fine aggregates and it settles down at the bottom of the mixer that will be difficult to move and place. Whereas the consistency cannot measure the workability, it gives indication about the workability of the concrete.

2.5 Applying quick-set cement

Quick-Setting Cement is a Portland cement based formula specially formulated for making structural repairs to vertical and horizontal surfaces

Quick-Setting Cement can be used anywhere that rapid setting is necessary, as it sets in approximately 10 minutes. Its unique properties allow the user to actually sculpt the material as it begins to harden. Quick-Setting Cement is used to repair:

- Concrete pipes, sewers and culverts
- Floors, steps and curbs
- Bridges and pavement
- Cold storage vaults and freezers
- Pre-stress panels
- Loading docks and tunnels
- Retaining walls
- Catch basins and septic tanks

2.5.1 Sizes

QUIKRETE Quick-Setting Cement –

- 50 lb (22.7 kg) bags or pails
- 20 lb (9.1 kg) pails
- 10 lb (4.5 kg) pails



Figure 25. Quick –setting cement

2.5.2 Yield

Each 50 lb (22.7 kg) bag of QUIKRETE Quick-Setting Cement will yield 0.45 cu ft (13L) of material.

2.5.3 Physical/chemical properties

Typical results obtained with Quick-Setting Cement when tested in accordance with the applicable ASTM standards are shown in Table 2.

Additionally, Quick-Setting Cement can be built up to a thickness of 1" -2" (25.4 -51 mm) without sag on vertical surfaces.

Table 2: Physical properties

Setting time, ASTM C191	
Initial set	5 - 10 minutes
Final set	10 - 20 minutes
Compressive strength, ASTM C109	
24 hours	3000 psi (20.7 MPa)
7 days	5000 psi (34.5 MPa)
28 days	6000 psi (41.3 MPa)
Post-freeze/thaw Compressive strength	6430 psi (44.3 MPa)
Scaling resistance, ASTM C672	Excellent

2.5.4 Surface preparation

The surface to be repaired should be free of all foreign matter and loose materials. The bond will be enhanced if all smooth surfaces are roughened or etched. The application of QUIKRETE Concrete Bonding Adhesive (#9902) to the area to be patched will further enhance bonding if the application is greater than 1" (25.4 mm) in thickness. QUIKRETE Acrylic Fortifier (#8610) should be used with QUIKRETE Quick- Setting Cement to

enhance bond on applications less than 1"(25.4 mm) in thickness. After initial set, the material may be trimmed and shaped to match the existing contours of the patch area.

2.5.5 Mixing

- One part water to 5 -5 1/2 parts QUIKRETE Quick-Setting Cement by volume. Reducing the water will hasten the set time.
- When using Acrylic Fortifier, replace 1/2 gal (1.9 L) of mixing water with Acrylic Fortifier per 50 lb. (22.7 kg) bag. Add only enough water to get the proper consistency
- Where large quantities of material may be used for deep patching, QUIKRETE Quick-Setting Cement can be extended with up to 25 lb (11.4 kg) of 3/8" (9.5 mm) maximum size aggregate per 50 lb (22.7 kg) bag

2.5.6 CURING

Efficient damp curing is required for at least 48 hours.

Precautions

- Mix no more than can be used in ~5 minutes
- During periods when temperatures are in the area of 40 degrees F (4 degrees C) or lower, precautions must be taken to prevent freezing. Warm water should be used and insulation applied to protect the QUIKRETE Quick- Setting Cement after placing. Hot weather conditions require cool water for mixing and steps to prevent rapid drying.

2.6 Applying cementitious materials and Proprietary equipment

These materials include traditional Portland cement and other cementitious materials, such as fly ash, ground granulated blast furnace slag (GGBS), limestone fines and silica fume.

Cementitious products comprise the glue that holds concrete together. These materials include traditional Portland cement and other cementitious materials, such as fly ash, ground granulated blast furnace slag (GGBS), limestone fines and silica fume. These materials are either combined at the cement works (to produce a composite cement) or at the concrete mixer when the concrete is being produced (the cementitious product is called a combination in this case).

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Fly ash and GGBS are the most commonly used of these materials in the UK. These secondary materials are useful by-products of other industrial processes, which would potentially otherwise be sent to landfill.

GGBS is a useful by-product recovered from the blast-furnaces used in the production of iron. It can be used un-ground as a coarse aggregate or as a supplementary cementitious material (where it can replace up to 70% of cement in a concrete mix). Fly ash is a useful by-product of coal-fired power stations and is environmentally beneficial. If it were not used in composite cements or as an addition at the concrete mixer then the material would be wasted and sent to landfill.

Using GGBS or fly ash in concrete, either as a mixer addition or through a factory made cement, significantly reduces the overall greenhouse gas emissions associated with the production of concrete.

Many countries use cementitious materials (concrete, mortar, etc.) as a containment matrix for immobilization, as well as for engineered structures of disposal facilities. Radionuclide release is dependent on the physicochemical properties of the waste forms and packages, and on environmental conditions.

In the use of cement, the diffusion process and metallic corrosion can induce radionuclide release. The advantage of cementitious materials is the added stability and mechanical support during storage and disposal of waste. Long interim storage is becoming an important issue in countries where it is difficult to implement low level waste and intermediate level waste disposal facilities, and in countries where cement is used in the packaging of waste that is not suitable for shallow land disposal.

The behavior and performance of cementitious materials used in an overall waste conditioning system based on the use of cement including waste packaging (containers), waste immobilization (waste form) and waste backfilling during long term storage and disposal. It also considered the interactions and interdependencies of these individual elements (containers, waste, form, backfill) to understand the processes that may result in degradation of their physical and chemical properties. The main research outcomes of the CRP are summarized in this report under four topical sections:

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- I. Conventional cementitious systems;
- II. Novel cementitious materials and technologies;
- III. Testing and waste acceptance criteria; and
- IV. Modeling long term behavior.

2.7 Concrete placement techniques, including compaction

The work shall consist of removal of unsuitable concrete; surface and face preparation; forming; and furnishing, placing, finishing, and curing concrete repair material as required repairing structures designated in section 18 of this specification.

Compaction is the process which expels entrapped air from freshly placed concrete and packs the aggregate particles together so as to increase the density of concrete. It increases significantly the ultimate strength of concrete and enhances the bond with reinforcement. It also increases the abrasion resistance and general durability of the concrete, decreases the permeability and helps to minimise its shrinkage-and-creep characteristics.

2.8 Perform work-related calculations

Detailed analysis on M20 = 1:1.5:3 (Ratio)

As we know that during concreting when we place wet concrete, it gets harden after certain standard time(30 mins IST & 10hrs FST), considering same it had be decided upon by Civil design Engineers to take a factor of safety ranging from 1.54 to 1.57 to counter that shrinkage. i.e volume of dry Concrete = 1.54 to 1.57 times Volume of wet concrete. Now calculations is as follows for 1cum(assumed) of Concrete work ratio Sum = $1+1.5+3=5.5$

Shrinkage or safety Factor =1.57 (you can take 1.54 also)

So Total volume of wet concrete required is : 1.57cum

Volume of broken stone Require = $(3/5.5) \times 1.57 = 0.856 \text{ m}^3$

Volume of sand Require = $(1.5/5.5) \times 1.57 = 0.471 \text{ m}^3$

Volume of cement = $(1/5.5) \times 1.57 = 0.285 \text{ m}^3$

Volume of cement = $(1/5.5) \times 1.57 = 0.285 \text{ m}^3 = 0.285 \times 1440 = 411 \text{ kg}$

For 1m^3 of M20 (1:1.5:3)

Broken stone = 0.856 m³

Sand = 0.472 m³

Cement = 8.22 bag.

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Some important conclusion from above

8 bag of Cement is required for 1cum of concrete work in M20. 4.4 bag of cement is required for 1cum of concrete work in M10. volume of dry concrete =1.54 times volume of wet concrete.

Self-Check -2	Written Test
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Directions: Choose the best answer for the following questions and write your answer on the answer sheet provided.(2 pts each)

1. It is a Portland cement based formula specially formulated for making structural repairs to vertical and horizontal surfaces
A. Quick –set cement B. Cementious C. Mortar D. None
2. Quick-Setting Cement is used to repair:
A. Concrete pipes, sewers and culverts
B. Cold storage vaults and freezers
C. Pre-stress panels
D. Retaining walls
E. All
3. It is the process which expels entrapped air from freshly placed concrete and packs the aggregate particles together so as to increase the density of concrete.
A. Compacting B. Placing C. Curing D. Mixing

Note: Satisfactory rating - 2 point Unsatisfactory - below 2 points

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

Score = _____
Rating: _____

Answer sheet

Name: _____

Date: _____

Multiple choices

1.
2.
3.
4.

Operation Sheet 1	Techniques of inspection and maintenance of minor structures
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Procedures of inspection and maintenance of minor structures

- Step 1:** use properly personal protective equipment safety
- Step 2:** check structure obstructs the flow in the canal and consequently the water Level will rise
- Step 3** controls the water level for the field intake that is a short distance. Upstream of the check.....?
- Step 4:** show two transportable check structures consists of a wooden board that is Installed in a trapezoidal, lined canal.
- Step 5:** The decision to choose permanent, temporary or transportable check structures depends on local conditions.
- Step 6:** The discharge in the field channel downstream of the check is seriously reduced or may even become zero
- Step 7:** Check structures can be very useful, because the farmer whose turn it is can be given the full channel discharge

Operation Sheet 2	Techniques of repair leakage or crack of minor structure of irrigation
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Operation procedures of repair leakage or crack of minor structure of irrigation

- Step 1-** use properly personal protective equipment safety
- Step 2-** Clean the wall or the floor round the crack. Remove any sand, clay and plant growth
- Step 3-** Make the crack larger and deeper around leakage e and crack structure area etc.
- Step 4-** Fill the hole with a cement-sand mortar and smooth with a trowel.

Operation sheet 3	Techniques of weeding, cleaning and de-silting canal structure
--------------------------	---

Procedures of weeding, cleaning and de-silting canal structure

- Step 1-** wears properly personal protective equipment
- Step 2-** Bushes or trees on canal embankments should be removed
- Step 3-** Plants, silt and debris in the canal should be removed while cleaning the canal bed, care must be taken that the original shape of the cross-section is kept
- Step 4-** Breaches and rat holes in the embankments should be filled with Compacted soil, inside as well as outside of the embankment
- Step 5-** Weak sections and sections of canal embankments where people or animals cross the canal should be strengthened with compacted soil or with bricks.
- Step 6-** Eroded sections of a canal should be rebuilt to the original shape.

Weeding, cleaning and de-silting



Operation sheet 4	Repairing of an undermined structure and the construction minor structure
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A procedure for the repair of an undermined structure and the construction of a screen is given opposite,

- Step 1-** use properly personal protective equipment safety,
- Step 2-** Excavate a trench in the eroded canal bed and sides. The trench should be at least 0m deeper than the eroded bed
- Step 3** Refill the hole under the lining with earth, and compact
- Step 4** Erect a concrete or masonry screen in the canal bed and in the banks of the canal, and connect it correctly to the lining of the canal or structure.
- Step 5** Refill the rest of the hole and firmly compact the backfill

LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 300 hours.

Task 1: Inspect and maintain minor structures

Task 2: Repair leakage or crack of minor irrigation structure

Task 3: Weed, clean and de-silt canal structure

Task 4: Repair of an undermined structure and the construct minor structure

List of reference materials

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