RTB | RWANDA TVET BOARD

RQF LEVEL 3

BDCSS301

BUILDING CONSTRUCTION

Construction of Stone Structures

TRAINER'S MANUAL

December 2023

CONSTRUCTION OF STONES STRUCTURES

2023

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KIGALI-RWANDA

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ACRONYMS

RQF: Rwanda Qualification Framework

RTB: Rwanda TVET Board

TVET: Technical and Vocational Education and Training

%: Percentages

Kg: Kilograms

Cm: centimeter

Cu. m: Cubic meter

PPE: Personal Protective equipment

HIRA: Hazard identification and risk assessment

GPS: Global Positioning System

INTRODUCTION

This trainer's manual encompasses all methodologies necessary to guide you to properly deliver the module titled Construction of Stone structures. Students undertaking this module shall be exposed with practical activities that will develop and nurture their competencies. The writing process of this training manual embraced competency-based education and training (CBET) philosophy by providing practical opportunities reflecting real life situations.

The trainer manual is subdivided into learning outcomes; each learning outcome has got various topics. You will start guiding a self-assessment exercise to help students rate themselves on their level of skills, knowledge, and attitudes about the learning outcome or unit in their trainee manual.

The trainer manual will give you the information about the objectives, learning hours, didactic materials, and proposed methodologies and crosscutting issues.

A discovery activity is followed to help students discover what they already know about the unit.

This manual will give you tips, methodologies, and techniques about how to facilitate students to undertake different activities as proposed in their trainee manuals. The activities in this training manual are prepared such that they give opportunities to students to work individually and in groups.

After going through all activities, you shall help students to undertake progressive assessments known as formative and finally facilitate them to do their self-reflection to identify strengths, weaknesses, and areas for improvements.

Remind them to read the point to remember section which provides the overall key points and takeaways of the unit.

MODULE CODE AND TITLE: BDCSS301 CONSTRUCTION OF STONE STRUCTURES

Learning outcomes	Learning Hours	Topics
Learning outcome 1: Prepare tools, equipment and materials.	5	**1.1** Identification of Tools and Equipment used to construct stone structures.
		1.2 Identification of materials.
Learning outcome 2: Prepare the construction site	5	**2.1** Cleaning and setting out of the construction site.
		2.2 Excavation and levelling of construction site
Learning outcome 3: Prepare mortar	5	**3.1** Identification of mortar for construction of stone structures.
		3.2 Batching of mortar ingredients.
		3.3 Application of mixing mortar methods.
Learning outcome 4: Erect stone structures	50	**4.1** Shaping and cutting the stone to be used.
		4.2 Construction of stone water reservoirs and open channels structures.
		4.3 Erection of foundation and stairs.
		4.4 Erection of retaining walls structures.
		4.5 Construction of stone water tank structure.
		4.6 Application of finishes on erected stone structure
Learning outcome 5: Conduct Cleanup activities	5	**5.1** Cleaning erected stone structure area.
		5.2. Storage of tools, materials and equipment.

LEARNING OUTCOME 1: PREPARE TOOLS, EQUIPMENT AND MATERIALS.

Self-Assessment

1. Ask trainees to look at the illustration above in their trainee manual and answer the following questions.
2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their trainee manual.
3. Explain that the purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
4. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas to improve and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. List tools and equipment used to construct stone structures.	1. Select tools used to construct stone structures.	1. Safe handling of tools and equipment.
2. Describe the use of tools and equipment used to construct stone structures.	2. Select materials used to construct stone structures.	2. Being attentive while selecting materials.
3. List materials required for construction of stone structures.	3. Select equipment used to construct stone structures	3. Taking care of tools and equipment.

Steps:

Discovery Activity

Task 1:

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to observe the pictures provided under task 1 in their trainee manuals then ask the answer the questions that follow.
2. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are given.
3. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions. Encourage all students to give their views.
4. After the presentations/sharing session, inform students that this activity was not intended for them to give the right answers but to give them a picture of what they will cover in the unit.
5. Introduce **Topic 1.1: Identification of tools and equipment used to construct stone structures.**

Topic 1.1: Identification of Tools and Equipment used to construct stone structures.

Objectives: By the end of the topic, trainees will be able to:

a. Classify correctly the tools used to construct stone structures.
b. Classify correctly equipment used to construct stone structures
c. Describe materials used in construction of stone structures.
d. Explain clearly types of personal protective equipment used in construction of stone structures.

Time Required: 3 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation

Materials, Tools and Equipment needed:

- **Materials:** Water and liquid soap
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, chisels, club hammer, claw hammer, Spirit level, building square, tape measure, decameter.
- **Equipment:**

  Cranes, Hoists, Forklifts, A-Frames and slings, Vacuum Lifters, Lifting clamps and Grabs, PPE(helmet, safety shoes, overalls, gloves, earplugs and safety harness), signposts, angle grinder, laser level and wheelbarrow

Preparation:

❑ *Preparation of workshop/workplace for construction of stone structures.*

❑ *Link with construction site engineers or project managers to organize field site visits related to selection of different tools and equipment to construct stone structures.*

❑ *Organize masonry tools and equipment workshops.*

❑ *Organize transport means (when field visits will be far from the school).*

	❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*
	**Cross Cutting Issues:** ✓ Environment and sustainability. ✓ Gender balance. ✓ Inclusivity.
	**Prerequisites:** ‣ Simple calculations (algebra, geometry). ‣ Safety, Health and environment measures. ‣ Demonstrate the fundamentals of building materials. ‣ Realize construction technical drawing.

Activity 1: Problem Solving

Task 2:

1. Using an appropriate methodology such as pair-share, small groups, large group discussion, or guided discussion, brainstorming, ask trainees to read the statement in their trainee manual and answer questions that follow.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the presentations, ask trainees to refer to Key facts 1.1: Tools and equipment used to construct stone structures in the trainee's manual, and review them together. Answer any questions that trainees might have.

Activity 2: Guided Practice

Task 3:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to perform the tasks provided under task 3 related to the types of tools and equipment used to construct stone structures in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided.
3. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.

Activity 3: Application

Task 4:

1. Explain to trainees that the following task link them to the world of work and giving briefing to trainees, ask them to visit the nearest construction site which constructing any building, infrastructure or any related construction project and perform the following task:
   a. To perform the task in their training manual.
   b. Make a report after the visit.
2. Inform trainees that each one will share his/her experience gained from the workplace with the rest of the class and during the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations.

Topic 2: Identification of materials used to construct stone structures

Objectives: By the end of the topic, trainees will be able to:

a. Describe cement and lime as used in construction of stone structures.

b. Explain types of stones used in construction of stone structures.

c. Describe qualities of a good sand and stones as used in construction of stone structures.

Time Required: 2 hours

Learning methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation

Materials, Tools and Equipment needed:

- **Materials:** Timbers/boards, nails, string line, Sand, Cement, Water ,Stones, lime and liquid soap
- **Tools:** Wheel barrow, Bucket, Pan
- **Equipment:**

  PPE(helmet, safety shoes, overalls, gloves, earplugs and safety harness) and signposts

Preparation*:*

❑ *Preparation of workshop/workplace for construction of stone structures.*

❑ *Link with site engineers or construction project managers to organize field site visits related to selection of different materials to construct stone structures.*

❑ *Avail different masonry materials to be used.*

❑ *Organize transport means (if the field visit is far from the school);*

❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ Environment and sustainability.
- ✓ Gender balance.
- ✓ Inclusivity.

Prerequisites:

- Safety, Health and environment measures.
- Demonstrate the fundamentals of building materials.
- Realize construction technical drawing.

Activity 1: Problem Solving

Task 5:

1. Using an appropriate methodology such as pair-share, small groups, large group discussion, or guided discussion, brainstorming, ask trainees to answer questions that follow:

   a) List down three (3) materials to be used in construction of stone structures.

   b) What are the properties of good sand.

   c) List down types of binding materials used in construction of stone structures.

2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the presentation, ask trainees to refer to Key facts 1.2: Materials used to construct stone structures in the trainee's manual, and review them together.
4. Answer any questions that trainees might have.

Activity 2: Guided Practice

Task 6:

1. Using an appropriate methodology such as pair-share, small groups, large group discussion, or guided discussion, brainstorming, ask trainees to answer questions that follow:
   a. List the types of stones used in construction.
   b. Classify types of cement additives used in construction of stone structures
   c. What are the uses of water in construction of stone structures
   d. Explain the purpose of timber in construction of stone structures.
2. Enough time shall be given to each group. As groups are working, guide them where they find challenges.

Activity 3: Application

Task 7:

1. Organize a visit in the construction site near the school, then ask trainees to go there to observe and perform the following tasks:
   a. List the types of stones.
   b. List types of binding materials available on that construction site.
   c. What are the qualities of sand found on that construction site?
   d. What are the qualities of water used in construction of stone structures?

2 Tell trainees that each one will make a report.

Formative Assessment

1. **Answer the following question by True or False.**
   a. Sledgehammer is used to break big stones into small pieces so that they can be shaped and cut by using a club hammer. **Answer:** True
   b. Club hammer is used for cutting and dressing stones to the required size. **Answer:** True
   c. Vernier caliper is an instrument used for measuring length on a long run. **Answer:** False
   d. Plumb bob is termed as an instrument for checking verticality of stonewall or column. **Answer:** True
   e. Ear proctor is used for protecting our feet against noise. **Answer:** False

2. The following are a list of tools used in construction of stone structures; link every tool with the correct use (function).

List of tools	Use
1) Burnishing tools	a) They are measuring tools used to accurately measure distances (diameter) between two opposite sides of an object.
2) Vernier Calipers	b) They are used for smoothing and polishing stone surfaces.
3) Measuring Wheel	c) It is a tool used for marking straight lines on stone surfaces
4) Mortar pan	d) By rolling the wheel along the ground, it measures the distance covered
5) Chalk Line	e) used for transporting mortar from mixing platform to reach to the mason

3. Give four types of stone used in construction of stone structures.

Answer: These types of stones are: granite, marble, limestone, sandstone, or slate

Self-Reflection

1. Ask learners to retake the self-assessment they had at the beginning of the unit.
2. Then they should fill in the table in the trainee's manual to identify their areas of strength, areas for improvement and actions to take to improve.

   Together with trainees, discuss their findings and identify any areas in which many trainees have difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

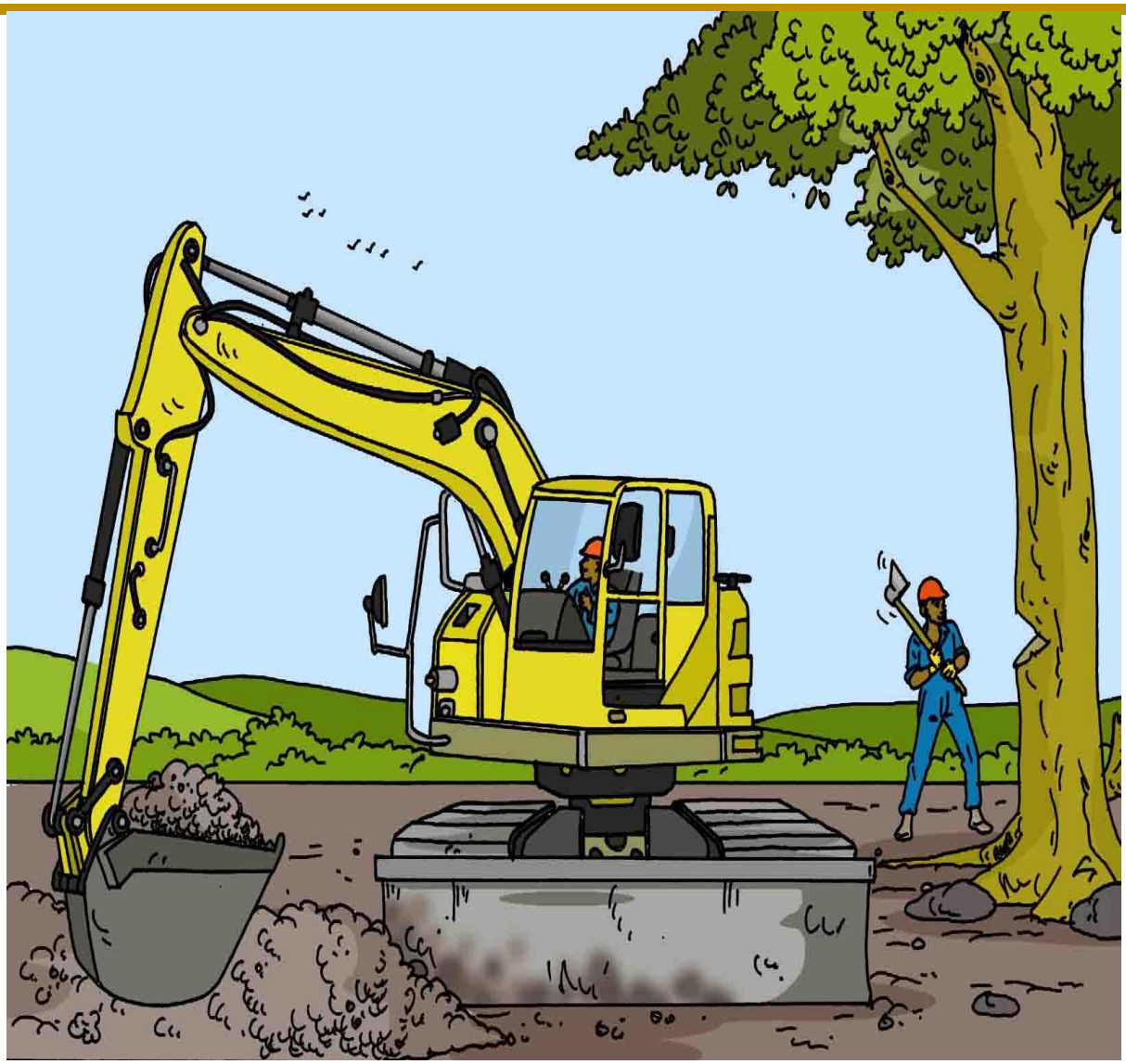
Points to Remember

- **Choose tools that are appropriate for the type of stone structures you are working with.**
- **Make sure your tools are sharp and well-maintained. This will help you to work more efficiently and safely.**
- **Use personal protective equipment (PPE) when using tools, such as safety glasses, gloves, and a dust mask.**
- **Make sure that you have necessary training to operate any equipment safely.**
- **Select stones that are strong and durable and that are correct size and shape for your stone structures.**

Further Information for the Trainer

Look information on:

- Properties of materials used in construction of stone structures
- Safety, health and environment required in construction



Self-Assessment

1. Ask trainees to look at the illustration above in their trainee manual and discuss what they see. What topics do they think this learning outcome will include based on the picture? After some brainstorming, share the main topics.
2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their trainee manual.
3. Explain that the purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
4. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas to improve and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe debris and hazardous objects at the construction site	1.Removal of debris and hazardous objects from the site	1.Teamwork spirit at the site
2.Describe clearing techniques at the construction site	2.Carry out site clearing	2.Effective communication with others at the site
3.List methods of excavation	3.Select the method of excavation to be used depending upon the nature of site	3.Time management skills
4.Differentiate methods of excavation	4.Perform excavation works	4.Compliance with national and international standards during excavation works
5.List steps to be followed in levelling working area	5.Carry out levelling of working area	5.Safety measures to be followed

Steps:

Discovery Activity

Task 8:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to share their prior experience in site construction preparation by answering the questions provided under task 8 in their trainee manuals and make sure that instructions are understood, and all the students are actively participating in in responding the provided questions.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the presentations/sharing session, inform students that this activity was not intended for them to give the right answers but to give them a picture of what they will cover in the unit.
4. Introduce **Topic 2.1: Clean the construction site**.

Topic 2.1: Clean construction site

Objectives: By the end of the topic, trainees will be able to:

a) Explain clearly steps of hazard identification and risk assessment.

b) List and explain methods of control measures of hazard.

c) Outline hazardous materials found at the construction site.

d) Highlight steps used in site clearing.

e) Describe the main techniques of site clearing as used in construction of stone structures.

f) Explain clearly steps to be followed while removing debris and hazardous objects at the workplace.

Time Required: 2 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, lime, Timbers/boards and liquid soap
- **Tools:** Pickaxe, shovel, spade, hoe, machete, Bucket, Pan and jerican
- **Equipment:** Excavator, Bulldozer, Back actor, Damp Truck, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow

Preparation:

❑ *Preparation of learning area (classroom)/workshop/workplace*

❑ *Availability of tools and equipment to be used.*

❑ *Connect with construction site manager or site engineer to organize field site visits related to identifying potential hazards and control measures.*

❑ *Organize transport means (when field visits will be far from the school).*

	❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*
	**Cross Cutting Issues:** ✓ Environment and sustainability ✓ Gender balance ✓ Inclusivity.
	**Prerequisites:** ‣ Safety, Health and environment measures. ‣ Demonstrate the fundamentals of building materials. ‣ Realize construction technical drawing.

Activity 1: Problem Solving

Task 9:

1. Using an appropriate methodology such as pair-share, small groups, large group discussion, or guided discussion, brainstorming, ask trainees to answer questions in their manual on task 9.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the presentations, ask trainees to refer to **Key facts 2.1**: **Clean construction site** in the trainee's manual, and review them together. Answer any questions that trainees might have.

Activity 2: Guided Practice

Task 10:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to read and answer the questions provided under task 2 related to cleaning the construction site in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Write their responses for reference. Encourage all students to give their views.
3. After the sharing session, refer students to **Key facts 2.1**, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that they may have.

Activity 3: Application

Task 11:

1. After giving a briefing to trainees and forming small groups, ask them to read the related scenario provided in their trainee manuals.
2. Guide trainees in that site visit and remind them to perform the task referring to the provided checklist and fill it accordingly.
3. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for doing the assigned task.
4. Remind trainees to make a report.
5. Provide feedback to trainees for further relevant information.

Topic 2.2: Setting out, Excavation and levelling the Construction Site

Objectives: By the end of the topic, trainees will be able to:

a) Clearly explicate methods of excavation as used in construction of stone structures.

b) Highlight the mechanical equipment used in excavation works for construction of stone structures.

c) List down steps of levelling the working area after excavation.

d) Show steps and Methodologies for setting out

e) Clearly understand methods of timbering sides of trenches for construction of stone structures.

Time Required: 3 hours

Learning methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Timber/boards, nails,
- **Tools:** Tape measure, spirit level, Builder's square, hand saw, claw hammer and string lines
- **Equipment:** Lifting Crane, Lifting pulley, Damp Level, Excavator, Total Station, Theodolite, GPS, Tipper truck, dumper truck and PPE(helmet, gloves, earplugs, safety shoes and overall) and optical square.

Preparation:

❑ *Preparation for the workplace.*

❑ *Link with site engineers or construction project managers to organize field site visits related to excavation and levelling the construction site in construction of stone structures.*

❑ *Avail different masonry materials.*

❑ *Avail different construction mechanical equipment*

	❑ *Organize transport means if the site is located far away from the school.* ❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*
	**Cross Cutting Issues:** ▸ Environment and sustainability ▸ Gender balance. ▸ Inclusivity.
	**Prerequisites:** ✓ Safety, Health and environment measures. ✓ Realize construction technical drawing.

Activity 1: Problem Solving

Task 12:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 12 in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used.
2. After the sharing session, refer students to topic 2.2: **Excavation and levelling the Construction Site** and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that they may have.
3. Answer any questions trainees might have.

Activity 2: Guided Practice

Task 13:

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to read the statement and answer the questions provided under task 13 in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the sharing session, refer students to Key Facts 2.2, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 3: Application

Task 14:

1. Using an appropriate methodology such as: small groups, trainees perform tasks based on the scenario provided under task 14 as mentioned in their trainee manuals. Make sure instructions are understood, all the students are actively participating in performing the provided work.
2. Give more guidance or instruction on what they will do. Link what they have done in the classroom to what they should do at the workplace.
3. This activity requires trainees to work independently. During the task, trainees should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for working.
4. After performing the assigned task ask them to make a report shall be submitted to the trainer and feedback is given to trainees for good encouragement.

Formative Assessment

1) **Answer the following questions by True or False:**
   a. Excavation is the term used when digging out or removing earth or soil for trenches or foundations or complete basements. **Answer:** True
   b. When excavating by the machine is handled by an expert. **Answer:** True
   c. Box sheeting is used for supporting the sides or a bench excavated in firm soil, when the depth of excavation does not exceed about 2 metres. **Answer:** False
   d. Vertical sheeting is adopted for deep trenches (up to 10 m depth) in soft ground.
      Answer: True
   e. The sides of some excavations will need support to protect the operatives while working in the excavation.
      Answer: True
2) Explain two methods of site clearing.
   Answer:
   - **Manual method**: It is defined as the method of clearing the site by removing unwanted materials using hand tools like hoes, spades, shovels, machetes and pickaxes.
   - **Mechanical method**: It is defined as the method of removing the unwanted materials such as large trees, vegetables by using mechanical plants (equipment) like bulldozer, excavator, wheel loader, …
3) What is timbering of soil?
   Answer: This is a term used to cover temporary supports to the sides of excavations and is sometimes called **planking and strutting.**
4) What are the methods of side timbering?
   Answer:
   - **Stay bracing:** This method is used for supporting the sides or a bench excavated in firm soil, when the depth of excavation does not exceed about 2 meters.
   - **Box sheeting**: This method is adopted in loose soils, when the depth of excavation does not exceed 4 meters.

- **Vertical sheeting**: This method is adopted for deep trenches (up to 10 m depth) in soft ground. The method is similar to the box sheeting except that the excavation is carried out in stages and at the end of each stage, an offset is provided, so that the width of the trench goes on decreasing as the depth increases.
- **Runner system:** This method is used in extremely loose and soft ground, which needs immediate support as excavation progresses.
- **Sheet piling**: They are designed to resist lateral earth pressure. These are driven in the ground by mechanical means (pile driving equipment). They can be used for excavating to a very large depth.

5) Explain methods used in controlling hazards at the construction site.

Answer:

Methods of control hazards are explained as follow:

a. **Elimination:** Getting rid of a hazardous job, tool, process, machine or substance is perhaps the best way of protecting workers.
b. **Substitution:** For example, a hazardous chemical can be replaced with a less hazardous one.
c. **Engineering control:** Redesign - Jobs and processes can be reworked to make them safer
d. **Administrative controls**: Safe work procedures - Workers can be required to use standardized safety practices.

Self-Reflection

1. Ask learners to retake the self-assessment they had at the beginning of the unit.
2. Then they should fill in the table in the trainee's manual to identify their areas of strength, areas for improvement and actions to take to improve.
3. Together with trainees, discuss their findings and identify any areas in which many trainees have difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- Excavation work must be carefully planned as workers are killed or seriously injured every year while working in and around trenches.
- Thorough risk assessments need to be carried out and method statements produced prior to any excavation work commencing.
- Potential hazards are numerous and include possible collapse of the sides of the trench, hitting hidden services, plant machinery falling into the trench and people falling into the trench.

Further Information for the Trainer

Look information on:

- Properties of materials used in construction of stone structures
- Safety, health and environment required in construction

Self-Assessment

1. Ask trainees to look at the illustration above in their trainee manual and discuss what they see. What topics do they think this learning outcome will include based on the picture? After some brainstorming, share the main topics.
2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their trainee manual.
3. Explain that the purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
4. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas to improve and actions to be taken.

Key Competencies:

Knowledge	Quantify mortar ingredients	Attitudes
1.Define mortar	1.Quantify mortar ingredients	1.Teamwork spirit at the site
2.List types of mortar	2.Select batching equipment	2.Effective communication with others at the site
3.Highlight qualities of mortar	3.Carry out mortar mixing nature of site	3.Time management skills
4.Understand meaning of mixing ratio	4.Carry out mortar mixing	4. Safety measures to be followed
5.List types of mixing ratios		5. Take responsibility
6.Describe uses of mixing ratios		6.Establish resilience in your daily activities
7.Outline method of mortar batching		

Steps:

Discovery Activity

Task 15:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to share their prior experience in building construction by using the questions provided under task 15 in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are given.
2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Encourage all students to give their views.
3. After the presentations/sharing session, inform students that this activity was not intended for them to give the right answers but to give them a picture of what they will cover in the unit.

Topic 3.1: Batching of mortar for construction of stone structures

Objectives: By the end of the topic, trainees will be able to:

a) Explain types of mortar.

b) Describe properties of a good mortar.

c) Define term mixing ratio as used in preparation of mortar.

d) List types of mixing ratio.

e) Describe methods of batching as used in preparation of mortar

f) Carry out the quantification of mortar ingredients

Time Required: 2 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, lime, timber/boards, nails and liquid soap.
- **Tools:** Gauge box, Trowel, Bucket, Pan , Shovel, spade, jerican, string line and hoe
- **Equipment:** Lifting Crane, Lifting pulley ,Concrete/mortar Mixer, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness), wheel barrow

Preparation:

❑ *Preparation of learning area (classroom)/workshop/workplace*

❑ *Availability of materials to be used.*

❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ Gender balance
- ✓ Inclusivity

Prerequisites:

- Safety, Health and environment measures.
- Realize construction technical drawing.

Activity 1: Problem Solving

Task 16:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to read the scenario and answer the questions provided under task 16 in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions. Write their responses for reference.
3. After the sharing session, refer students to Key facts 3.1: Identification of mortar for construction of stone structures and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that they may have.

Activity 2: Guided Practice

Task 17:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees read and answer the questions provided under task 2 related to identification of mortar for construction of stone structures in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. After all the groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions. Write their responses for reference.
3. Tell the trainees to refer to the corrected example for answering the remaining questions
4. After the sharing session, refer students to **Key facts 3.1**, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that they may have.

Activity 3: Application

Task 18:

1. Using an appropriate methodology such as: small groups, trainees perform tasks based on the scenario provided under task 18 as mentioned in their trainee manuals. Explain to trainees that the following task links them to the world of work. Ask them to calculate the quantities of the materials basing on details given in their trainee manual.
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired

to real life situations. Your role is to set clear instructions, methodology and timeframe for performing the provided task.

3. Provide feedback to trainees for further relevant information.

Topic 3.2: Application of mixing mortar methods

Objectives: By the end of the topic, trainees will be able to:

a) Describe mortar mixing tips.

b) Describe methods of mortar mixing as used in construction of stone structures.

c) Explain clearly steps of mortar mixing both manual and machine.

d) Perform hand mixing of mortar to be used in construction of stone structures.

e) Perform machine mixing of mortar to be used in construction of stone structures.

Time Required: 3 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, lime, timber/boards, nails and liquid soap.
- **Tools:** Gauge box, Trowel, Bucket, Pan , Shovel, spade, jerican, string line and hoe
- **Equipment:** Lifting Crane, Lifting pulley ,Scaffoldings Concrete Mixer PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness), wheelbarrow

Preparation:

❑ *Preparation for the workplace.*

❑ *Avail different masonry materials to be batched.*

❑ *Avail different construction tools and mechanical equipment to be used in batching.*

❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ Gender balance.
- ✓ Inclusivity
- ✓ Financial education
- ✓ Standardization culture

Prerequisites:

- Simple calculations such as simple ratios and proportions.
- Knowledge on unit measurement such volume, mass and length.
- Health and safety measures.

Activity 1: Problem Solving

Task 19:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the text and answer the questions provided under task 19 in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions.
3. After the sharing session, refer students to key fact 3.3: Application of mixing mortar methods and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that they may have.

Activity 2: Guided Practice

Task 20:

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to request materials, tools and equipment to perform the task 20 provided in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used.

Activity 3: Application

Task 21:

1. Organize a visit in the construction site near the school, ask them to go there, observe if possible participate in the activities related to the mortar mixture, and remind them to pay attention to the following:
    a. Selected material, tools and equipment
    b. maxing ration
    c. quantity of mortal
    d. method of mixing
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for working.

Formative Assessment

1. The following are mortar mixing tips reply by True or false:

    a. Be sure to use the correct type of mortar mix for the application.
        Answer: True
    b. It is best to use fresh cement (unopened bags) when mixing mortar.
        Answer: True
    c. Always use clean tools to ensure no unexpected (and unwanted) materials end up in the mix
        Answer: False
    d. Use a good grade of fine sand in your mortar mix.
        Answer: True
    e. Do not wear eye protection and waterproof gloves when mixing mortar.
        Answer: False

2. What are the main methods of mortar mixing?
    Answer:
    Machine mixing refers to mixing large quantities of mortar in a drum-type mixer. Hand mixing involves mixing small amounts of mortar by hand in a mortar box or wheelbarrow.

3. Describe procedures for hand mixing of cement mortar.

   Answer: Procedures of hand mixing:

   - Take one bag of cement, which has a volume of nearly 0.035m^3.
   - Then measure the required quantity of dry sand using a box measure. A box has a volume of 0.035m^3. For example, if you are preparing a cement mortar of the ratio 1:3 (i.e. 1-part cement and 3 parts of sand), then for one bag of cement take 3 boxes of sand.
   - First, spread the measured amount of sand on a watertight platform or on a steel trough.
   - Spread the cement over the sand.
   - Then mix them dry by turning over & over, backward & forward several times by a shovel, until the mixture looks uniform in colour.
   - Out of this dry cement & sand mix, take out only that amount of mix which can be used within 30 minutes, and form it into a heap.
   - Make a small depression on top of the heap.
   - Add required amount of water to give it required consistency, to the centre of the heap.
   - Mix the whole mass thoroughly for 5 to 10 minutes by means of a shovel.
   - Water of amount 70% of weight of cement is just sufficient to give it necessary consistency for 1:3 mortar (i.e. Grade M 7.5)

4. What are the quality of good mixed mortar?

   Answer: These qualities of a good mortar are:

   - **The mobility** is used to indicate the consistency of mortar mix, which may range from stiff to fluid
   - **The placeability** or the ease with which the mortar mix can be placed with minimum cost in a thin and uniform layer over the surface depends on the mobility of mortar. The peaceability of mortar mix should be such that a strong bond is developed with the surface of the bed.
   - If **water retention** power of mortar mix is low it separates into layers during transportation and when it comes into contact with the porous bed like brick,

wood, etc, it gives away its water to that surface. Thus, the mortar becomes poor in amount of water and remaining water proves to be insufficient for its hardening.

5. Suppose that we have a stone foundation having the following dimensions: 20 meters in length, 0.4metres in width and 0.6metres in depth. The volume of stone is 80% and volume of mortar is 20% and the coefficient of 10%. Unit weight of cement is 1440 kg/m3 and the mixing ratio is 1:6. Calculate volume of stones required and quantity of other ingredients.

Answer

- Volume of foundation: 20mx0.4mx0.6m=4.8 cu.m
- Volume of stones: 4.8cu.mx0.8=3.84 cu.m
- Volume of mortar: 4.8cu.mx0.2=0.96 cu.m
- Add percentage of wastage: 0.96 cu.m+0.96cu.mx0.1=1.056 cu.m
- Add 25% for dry mortar weight (Dry mortar weight > wet mortar weight):
- 0.96cu.m+0.96cu.mx0.25=1.2 cu.m
- Take 1.2 cu.m as volume of mortar
- Quantity of cement: (1x1.2 cu.mx1440kg/cu.m)/7=246.8kg/50=5 bags of cement
- Quantity of sand: (6x1.2cum)/7=1.028 cu.m

Self-Reflection

1. Ask learners to retake the self-assessment they had at the beginning of the unit.
2. Then they should fill in the table in the trainee's manual to identify their areas of strength, areas for improvement and actions to take to improve.

3. Discuss trainees' findings with them. Identify any areas in which many trainees have difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- Never allow your machine to run dry; dried concrete is incredibly hard and time-consuming to remove from the drum.
- To prevent this, add a small amount of sand into the drum with plenty of water and leave the drum to turn for several minutes and then empty the contents.
- Repeat this process as many times as you need with just water to fully clean the internals of the machine.
- After this, you can switch the machine off and if any of the concrete mixtures remain simply use a stiff brush to clean the drum blades.

Further Information for the Trainer

Look information on:

- Properties of materials used in construction of stone structures
- Safety, health and environment required in construction

Self-Assessment

1. Ask trainees to look at the illustration above in their trainee manual and discuss what they see. What topics do they think this learning outcome will include based on the picture? After some brainstorming, share the main topics.
2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their trainee manual.
3. Explain that the purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
4. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas to improve and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. List types of stone structures	1. Perform dressing of stones	1. Team work spirit at the site
2. Describe shapes of stone structures	2. Select a good stone	2. Effective communication with others at the site
3. Highlight qualities of a good stone	3. Erect open channel	3. Time management skills
4. List various types and sizes of stone	4. Erect foundation	4. Keep workplace clean
5. Highlight various shapes of stones	5. Carry out construction of retaining walls	5. Safety measures to be followed
6. Describe dressing of stones		6. Take responsibility
7. List types of water reservoir		7. Establish resilience in your daily activities
8. Describe foundations		
9. Explain stair		
10. Clarify types of retaining walls		
11. List types of water tank		

Steps:

Discovery Activity

Task 22:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to observe picture provided under task 22 in their trainee manuals and answer the questions that follow. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are given.
2. After the presentations/sharing session, inform students that this activity was not intended for them to give the right answers but to give them a picture of what they will cover in the unit.
3. Introduce **Topic 4.1: Shaping and cutting the stone to be used.**

Topic 4.1: Shaping and cutting the stone to be used

Objectives: By the end of the topic, trainees will be able to:

a) Explain types of stone structures.

b) Describe types of shapes of stone structures.

c) Describe various types and sizes of stone structures.

d) Perform dressing of stones

Time Required: 5 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Stones, timber/boards, water and liquid soap
- **Tools:** Club hammer, sledge hammer, chisel, angle grinders and drills
- **Equipment:** Lifting Crane, Lifting pulley, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, tipper truck and dumper truck.

Preparation:

❑ *Preparation of workplace for shaping and cutting stones.*

❑ *Link with construction site engineers or project managers to organize field site visit related to shaping and cutting of stones.*

❑ *Organize masonry tools and equipment to be used in shaping and cutting stones.*

❑ *Organize transport means (if field visit will be far away from the school).*

❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

✓ Gender balance.

✓ Inclusivity.

	✓ financial education ✓ standardization culture
	**Prerequisites:** ▸ Simple calculations (algebra, geometry) ▸ Safety, Health, and environment measures ▸ Demonstrate fundamental of building materials. ▸ Realize construction technical drawing.

Activity 1: Problem Solving

Task 23:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 23 related to shaping and cutting stones in their trainee manuals. Make sure instructions are understood, all the students are actively participating and necessary are provided and being used.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions. Encourage all students to give their views.
3. After the session of sharing, refer students to Key facts 4.1 and discuss together while harmonizing their responses provided in the sharing session and answer any questions they may have.

Activity 2: Guided Practice

Task 24:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to answer

provided questions under task 24 in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used.

Activity 3: Application

Task 25:

1. Using an appropriate methodology such as individual work, pairs, or small groups, guide trainees to perform the task 25 of dressing stones and refer to related checklist provided in their trainee manuals.
2. Tell to the trainees that this task is individual
3. Inform trainees that each one will share his/her experience gained from workplace with the rest of the class and during the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations.

Topic 4.2: Construction of stone water reservoirs and open channels structures

Objectives: By the end of the topic, trainees will be able to:

a) Describe types of water reservoirs.

b) Describe types of open channel.

c) Calculate side and bottom slope of open channel.

d) Explain steps used in construction of open channel.

e) Construct open channel by using stones.

f) Explain clearly types of stone bonds.

Time Required: 9 hours

Learning methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, Stones, lime and timber/boards
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, tape measure, spirit level, water level, Builder's square, string line, bucket and jerican.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow, concrete/mortar mixer.

Preparation:

- ❑ *Preparation of workshop/workplace for construction of stone structures*
- ❑ *Link with site engineers or construction project managers to organize field site visit related to construction of stone water reservoirs and open channels.*
- ❑ *Avail different masonry materials to be used.*
- ❑ *Avail tools and equipment to be used in construction of open channel.*
- ❑ *Organize transport means (if the field visit is far from the school).*

	❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*
	**Cross Cutting Issues:** ✓ Gender balance. ✓ Inclusivity. ✓ Financial education ✓ Standardization culture
	**Prerequisites:** ▸ Realize construction technical drawing. ▸ Simple calculations (algebra, geometry). ▸ Safety, Health, and environment measures. ▸ Demonstrate fundamental of building materials.

Activity 1: Problem Solving

Task 26:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 26 related to construction of water reservoirs and open channel in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. Depending on methodology, used students share their answers to the class. Write their responses for reference. Encourage all students to give their views.
3. After the presentation, ask trainees to refer to Key facts 4.2: Materials used to construct stone structures in the trainee's manual, and review them together and answer any questions trainees might have.

Activity 2: Guided Practice

Task 27:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to perform the task provided under task 27 in their trainee manuals and answer the related questions. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. Encourage all trainees to give their views.
3. Review them together and provide clarifications where necessary.

Activity 3: Application

Task 28:

1. You have organise the visit in construction site, where open channel are made, tell them to observe and fill the checklist in their manual
2. Explain to trainees that this statement link trainee to the world of construction. Ask trainees to erect trapezoidal open channel by referring to related task 28 provided in their trainee manuals.
3. This activity requires trainees to work independently. During the task, should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for performing that activity.

Topic 4.3: Erection of foundation and stairs

Objectives: By the end of the topic, trainees will be able to:

a) Explain functions of foundation.

b) Explain types of foundation.

c) Identify types of stairs.

d) Perform stair calculations.

e) Erect foundation and stairs

Time Required: 9 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, Stones, lime and timber/boards
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, tape measure, spirit level, water level, Builder's square, string line, bucket and jerican.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow, concrete/mortar mixer.

Preparation:

❑ Preparation of learning area (classroom)/workshop/workplace

❑ *Availability of tools and equipment to be used.*

❑ *Connect with construction site manager or site engineer to organize field site visit related to foundation and stairs.*

❑ *Avail materials to be used in construction of foundation and stairs.*

❑ *Organize transport means (when field visit will be far from the school).*

❑ *Prepare* the required PPE for all trainees and other safety tools and equipment.

Cross Cutting Issues:

- ✓ Gender balance;
- ✓ Inclusivity
- ✓ financial education
- ✓ Standardization

Prerequisites:

- Simple calculations (algebra, geometry).
- Safety, Health, and environment measures.
- Demonstrate fundamental of building materials.
- Realize construction technical drawing.

Activity 1: Problem Solving

Task 29:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to read and answer the questions provided under task 29 related to construction of foundation and stair in their trainee manuals. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.
2. After all groups have finished discussing, ask some group representatives to present to the rest of the class and encourage other groups to give their contributions. Write their responses for reference.
3. After the presentations, ask trainees to refer to **Key facts 4.3**: **Construction of foundation and stairs** in the trainee's manual, and review them together. Answer any questions trainees might have.

Activity 2: Guided Practice

Task 30:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees read and answer the questions provided under task 30 related to construction of foundation and stairs in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being used

Activity 3: Application

Task 31:

1. Using an appropriate methodology such as individual work, pairs, or small groups explain to trainees that the task link them to the world of work. Ask trainees to perform the task 31 related to construction of stone foundation as detailed in the trainee's manual.
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe of the activity.
3. Provide feedback to trainees for further relevant information.

Topic 4.4: Erection of retaining walls structures

Objectives: By the end of the topic, trainees will be able to:

a) Describe clearly types of retaining walls.

b) Explain clearly types of drainage provision for retaining walls.

c) Explain clearly steps used in construction of retaining walls.

d) Perform construction of retaining walls

Time Required: 9 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, Stones, lime and timber/boards
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, tape measure, spirit level, water level, Builder's square, string line, bucket and jerican.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow, concrete/mortar mixer.

Preparation:

- ❑ *Preparation of learning area (classroom)/workshop/workplace*
- ❑ *Availability of tools and equipment to be used.*
- ❑ *Connect with construction site manager or site engineer to organize field site visit related to erection of retaining walls.*
- ❑ *Avail materials to be used in erection of retaining walls.*
- ❑ *Organize transport means (when field visit will be far from the school).*
- ❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ financial education
- ✓ standardization culture
- ✓ Gender balance
- ✓ Inclusivity.

Prerequisites:

- Safety, Health, and environment measures.
- Simple calculations (algebra, geometry).
- Demonstrate fundamental of building materials.
- Realize construction technical drawing

Activity 1: Problem Solving

Task 32:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 32 related to proper erection of retaining walls in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and necessary all are provided and being used
3. After the sharing session, refer student's manual **Key fact 4.4**, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have and answer any questions trainees might have.

Activity 2: Guided Practice

Task 33:

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees answer the questions provided under task 33 in their trainee manuals. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used

Activity 3: Application

Task 34:

1. Using an appropriate methodology such as: small groups, trainees perform tasks based on the scenario provided under task 3 as mentioned in their trainee manuals.
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for performing that activity.

Topic 4.5: Construction of stone water tank structure

Objectives: By the end of the topic, trainees will be able to:

a) Describe types of water storage tanks.

b) Calculate water holding capacity of water tank.

c) Explain clearly steps used in construction of stone water tank

d) Construct stone water storage tank

Time Required: 9 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, Stones, lime and timber/boards
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, tape measure, spirit level, water level, Builder's square, string line, bucket and jerican.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow, concrete/mortar mixer.

Preparation:

- ❑ *Preparation of learning area (classroom)/workshop/workplace*
- ❑ *Availability of tools and equipment to be used.*
- ❑ *Connect with construction site manager or site engineer to organize field site visit related to construction of water storage tank.*
- ❑ *Avail materials to be used in construction of water storage tank.*
- ❑ *Organize transport means (when field visit will be far from the school).*
- ❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ financial education
- ✓ standardization culture
- ✓ Gender balance.
- ✓ Inclusivity.

Prerequisites:

- Safety, Health, and environment measures.
- Simple calculations (algebra, geometry).
- Demonstrate fundamental of building materials.
- Realize construction technical drawing

Activity 1: Problem Solving

Task 35:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees answer the questions provided under task 35 related to proper construction of water storage tank in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and necessary all are provided and being used

Activity 2: Guided Practice

Task 36:

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to answer the questions provided under task 36 in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used

Activity 3: Application

Task 37:

1. Instruct trainees to read the statements in their manual, and then ask them to perform the calculation followed.
2. This activity requires trainees to work independently with limited support from the trainer. During the task, trainees should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for calculating that water storage capacity of water tank.

Topic 4.6: Application of finishes on erected stone structure

Objectives: By the end of the topic, trainees will be able to:

a) Describe clearly types of stone structures finishes.

b) Explain methods used to apply finishes to stone structures.

c) Explain steps used to apply finishes to erected stone structures.

d) Explain tips for applying finishes to erected stone structures

Time Required: 9 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Sand, Cement, Water, Stones, lime and timber/boards
- **Tools:** Gauge box, Trowel, Bucket, Pan, shovel, spade, tape measure, spirit level, water level, Builder's square, string line, bucket and jerican.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness) Signposts, wheelbarrow, concrete/mortar mixer.

Preparation:

❑ *Preparation of learning area (classroom)/workshop/workplace*

❑ *Availability of tools and equipment to be used.*

❑ *Connect with construction site manager or site engineer to organize field site visit related to application of finishes on erected stone structures.*

❑ *Avail materials to be used in application of finishes on erected stone structure.*

❑ *Organize transport means (when field visit will be far from the school).*

❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ financial education
- ✓ standardization culture
- ✓ Gender balance.
- ✓ Inclusivity:

Prerequisites:

- *Safety, Health, and environment measures.*
- *Demonstrate fundamental of building materials.*

Activity 1: Problem Solving

Task 38:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, tell trainees to discuss the given themes provided under task 38 related to proper application of finishes to erected stone structures in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and necessary all are provided and being used
3. After the sharing session, refer student's manual Key fact 4.6 and discuss them together while harmonizing their responses provided in the sharing session and answer any questions that trainees might have.

Activity 2: Guided Practice

Task 39

1. By using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to analyze the text and answer the questions provided under task 2 in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used.

Activity 3: Application

Task 40

1. Ask trainees to read and perform these activities of finishes to erected stone structures by referring to the related details given in their trainee's manuals.
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for reapplication of finishes to erected stone structures.

Formative Assessment

1) The following are explanations relating to water tank, reply by True or false:
   a. A water tank is a container for storing water.

Answer: True

   b. The foundation is the base of the tank and it transfers the weight of the tank to the soil.

Answer: True

   c. The walls of the tank are made of stones that are laid in a specific pattern.

Answer: True

   d. The tank should not be designed to drain properly to prevent water from pooling.

Answer: False

   e. Drainage can be done by sloping the ground around the tank and installing a drainage system.

Answer: True

2) Explicit steps to be followed in construction of stone water tank.

Answer

The steps to be followed in construction of stone water tank are:

- ✓ **Planning:** The first step is to plan the design of the tank. This includes determining the size of the tank, the shape of the tank, and the materials that will be used for the

tank. It is also important to consider the location of the tank and the way it will be accessed.

- ✓ **Excavation**: Once the design is finalized, the next step is to excavate the area where the tank will be built. The excavation should be deep enough to accommodate the foundation and the tank itself.
- ✓ **Foundation**: The foundation is the base of the tank and it transfers the weight of the tank to the soil. The foundation should be made of concrete and it should be at least 6 inches below the frost line.
- ✓ **Wall**s: The walls of the tank are made of stones that are laid in a specific pattern. The stones should be strong and durable enough to support the weight of the water.
- ✓ **Floor**: The floor of the tank is made of concrete and it should be sloped to allow water to drain away from the tank.
- ✓ **Lid**: The lid of the tank is made of concrete or stone and it should be strong enough to prevent water from leaking out of the tank.
- ✓ **Drainage**: The tank should be designed to drain properly to prevent water from pooling. This can be done by sloping the ground around the tank and installing a drainage system.

3) Highlight types of stone structures.

Answer: These types of stone structures are:
Stone Masonry, Dry stone Walls, Stone Bridges, Rock Fill Dams, Stone Pillars, Stone Arches, Retaining walls, Water tanks, Foundations, Open channel and Curvets.

4) Explain types of dressing stones.

Answer: These types of stones dressing are:

- ✓ **Pitched Dressing:** The edges of the stone block are levelled with a hammer in pitched dressing.
- ✓ **Hammer Dressing**: In this type of dressing process, the large part of the rocks are levelled with a hammer but due to hammering hammer marks are shown in the rock.
- ✓ **Chisel Drafting**: In the chisel drafting method, drafts and groove are made at all the four edges, and extra stone at the center is also removed by this method.
- ✓ **Rough Tooling:** Rough tooling is the process where the edges are squared by hammer and chisel.

- ✓ **Punched Dressing:** This dressing method of stone 1 cm vertical or horizontal groove is sunk into the stone.
- ✓ **Close Picked and Fine Tooling:** To get a refined surface, a punched stone is again dressed. This method gives you a fine texture and attractive look**.**
- ✓ **Boasted Finish:** In this method stone covered with parallel marks through their direction. These marks may be horizontal or angle.
- ✓ **Scrabbling:** This type of method is done in the query, and irregular edges of the stone are broken by scrabbling.
- ✓ **Reticulated Finish:** This is done with a 2cm wide margin on its side. a 6 mm deep sink is done.
- ✓ **Vermiculated Finish:** In this finish, there is a more curved and worm-eaten type appearance. It is not more popular because it requires a lot of labour.

5) Explicate the steps used in construction of open channels as stone structures.

Answer:

Steps used in construction of open channel

Step 1**: Protection during Site Construction**

Step 2: **Installation.**

Step 3: **Grading.** Grade the grass channel to the final dimensions shown on the plan. Excavators or backhoes should work from the sides to grade and excavate the open channels to the appropriate design dimensions.

Step 4: Placing Stone Layer (for dry swales).

Step 5: Add Amendments (optional, for grass channels). Add soil amendments as needed. Till the bottom of the grass channel to a depth of 1 foot and incorporate compost amendments

Step 6: Install Check Dams. Install check dams, driveway culverts and internal pre-treatment features as shown on the plan. Fill material used to construct check dams should be placed in 8- to 12-inch lifts and compacted to prevent settlement.

Step 7: Hydro-seed. Hydro-seed the bottom and banks of the open channel, and peg in erosion control fabric or blanket where needed. After initial planting, a biodegradable erosion control fabric should be used, conforming to the District of Columbia Soil Erosion and Sediment Control Standards and Specifications.

Step 8: Plant. Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months.

Step 9: Final Inspection. A qualified professional should conduct the final construction inspection and develop a punch list for facility acceptance.

6) Write notes on main functions of foundation and list out the foundation types.

Answer: The main functions of foundation are:

- ✓ **Reduction of load intensity**
- ✓ **Even distribution of load**
- ✓ **Provision of level surface**.
- ✓ **Lateral stability**
- ✓ **Safety against undermining**
- ✓ **Protection against soil movements**

These types of foundation are:

1) **Shallow foundations** composed by: Spread footings, Strap footings, combined footings and Raft foundations (Mat foundation)

2) Deep foundations may be of the following types:

- ✓ Deep strip, rectangular or square footings.
- ✓ Pile foundation
- ✓ Pier foundation or drilled caisson foundation
- ✓ Well foundation or caissons

7) Describe types of retaining walls.

Answer: Types of retaining walls are:

- ✓ **Gravity Retaining Wall:** To resist movement because of their heavy sections.
- ✓ **Semi-gravity retaining wall**: They are not as heavy as gravity walls. A small amount of reinforcement is used for reducing the mass of concrete.
- ✓ **Cantilever retaining walls**: They are thinner in section. The base slab is the cantilever portion.
- ✓ **Counterfort retaining walls**: Are similar to cantilever walls except that the stem of the walls span horizontally between vertical brackets known as counterforts.
- ✓ **Buttressed retaining walls**: Are similar to counterfort walls except the brackets or buttress walls are provided on the opposite side of the backfill.
- ✓ **Gabions walls:** They are multi-celled, welded wire or rectangular wire mesh boxes, which are then rock filled, and used for construction of erosion control structures and to stabilize steep slopes.

Self-Reflection

1. Ask learners to re-take the self-assessment they had at the beginning of the unit.
2. Then they should fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.
3. Together with trainees, discuss the findings and identify any areas in which many trainees have difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- Ensure the safety of workers for fighting against any types of risks and hazard that may occur to the construction site so that the planned works can be accomplished within the desired time without failure due to that kind of hazards.
- Ensure proper excavation and foundation preparation to create a stable base for the structures
- For comfortable ascent and descent, the rise and tread of a step should be well-proportioned.
- The saturation of the backfill of a retaining wall is always accompanied by a substantial hydrostatic pressure on the back of the wall. Saturation of the soil increases the earth pressure by increasing the unit weight. It is therefore essential to eliminate or reduce pore pressure by providing suitable drainage.
- Carefully backfill around the foundation, ensuring proper compaction and drainage to prevent settlement or water-related issues

Self-Assessment

1. Ask trainees to look at the illustration above in their Trainee Manual and discuss what they see. What topics do they think this learning outcome will include based on the picture? After some brainstorming, share the main topics.
2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their Trainee Manual.
3. Explain that the purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
4. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas to improve and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe tools and equipment to be cleaned after construction of stone structures	1. Select tools used to clean erected stone structures area	1.Teamwork spirit at the site
2.Outline methods of cleaning tools and equipment after work	2. Select equipment used to clean erected stone structures area	2. Effective communication with others at the site
3.Explain the steps on how to clean an erected stone structure area	3. Select materials used to clean erected stone structures area	3. Time management skills
4.Highlight tips for cleaning erected stone structures area	4. Select appropriate method used to clean erected stone structures area	4.Keep workplace clean safety measures to followed

Steps:

Discovery Activity

Task 41:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, tell trainees to observe the picture provided under task 5 in their trainee manuals and answer the questions that follow.
2. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are given
3. Introduce **Topic 5.1: Cleaning erected stone structure area.**

Topic 5.1: Cleaning erected stone structure area

Objectives: By the end of the topic, trainees will be able to:

a) Classify tools and equipment to be cleaned after construction of stone structures.

b) Describe methods of cleaning tools and equipment after construction of stone structures.

c) Describe steps used to clean erected stone structure area.

d) Explain clearly tips for cleaning erected stone structure area.

Time Required: 3 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Water, detergents, sponges, abrasive pads and other cleaning chemicals.
- **Tools:** Wheel barrow, Gauge box, PPE, Trowel, Bucket, Pan, steel brushes, cleaning chemicals
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness), Signposts, ladder and wheelbarrow.

Preparation:

❑ *Preparation of workplace for shaping and cutting stones*

❑ *Link with construction site engineers or project managers to organize field site visit related to cleaning erected stone structure area.*

❑ *Organize masonry tools and equipment to be used in shaping and cutting stones.*

❑ *Organize transport means (when field visit will be far from the school).*

	❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*
	**Cross Cutting Issues:** ✓ Gender balance. ✓ Inclusivity. ✓ financial education ✓ Standardization culture.
	**Prerequisites:** ▸ Safety, Health, and environment measures. ▸ Demonstrate fundamental of building materials, tools, and equipment.

Activity 1: Problem Solving

Task 42:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, instruct trainees to answer the questions provided under task 42 related to cleaning erected stone structure area in their trainee manuals.
2. Make sure instructions are understood, all the students are actively participating and all necessary are provided and being used
3. After the sharing session, refer students to Key facts 5.1 and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 2: Guided Practice

Task 43:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to perform the task under task 43 in their trainee manuals.
2. Make sure instructions are understood, all the trainees are actively participating and all necessary are provided and being used.

Activity 3: Application

Task 44:

1. Tell to trainees to go in the site construction near to school and perform the cleaning of erected stones structures
2. This activity requires students to work independently. During the task, students should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for reapplication of finishes to erected stone structures.

Topic 5.2: Storage of tools, materials, and equipment

Objectives: By the end of the topic, trainees will be able to:

a) Describe importance of storage of tools and equipment used in construction of stone structures.

b) Clearly explain the guidelines to be followed while storing tools, materials, equipment, and personal protective equipment after construction of stone structures.

c) Describe things to be kept in mind while storing tools, materials, and equipment after construction of stone structures.

d) Clearly explain checklist for storing tools, materials and equipment after construction of stone structures.

Time Required: 2 hours

Learning Methodology:

Brainstorming, Buzz group, Role plays, Think-pair-square-share, Four corners, Inside – outside circle, Jig saw, Debate, Group discussion and plenary reporting, Case study, Fishbowl, Field visit work, Simulations, video presentation.

Materials, Tools and Equipment needed:

- **Materials:** Pegboards
- **Tools:** Plates, Warehouse shelves, Labels and markers, racks bins and totes.
- **Equipment:** Lifting Crane, Lifting pulley, Scaffolding, ladder, wheel barrow, PPE (helmets, safety shoes, overalls, gloves, earplugs, and safety harness), Signposts.

Preparation:

- ❑ *Preparation of workshop/workplace for storage of tools, materials, and equipment.*
- ❑ *Link with site engineers or construction project managers to organize field site visit related to storage of tools, materials, and equipment.*
- ❑ *Avail different masonry materials to be used.*

- ❑ *Avail tools and equipment to be used in storage of tools, materials, and equipment.*
- ❑ *Organize transport means (if the field visit is far from the school).*
- ❑ *Prepare the required PPE for all trainees and other safety tools and equipment.*

Cross Cutting Issues:

- ✓ Gender balance: Ensure gender is considered while forming the group.
- ✓ Inclusivity: Make sure that people with disability are included in different group.
- ✓ Promote financial education by emphasizing the need/importance of storage of tools, materials, and equipment.
- ✓ Promote standardization culture among students through realizing the need/importance of storage of tools, materials, and equipment.

Prerequisites:

- Safety, Health and Environment measures.
- Demonstrate fundamental of building materials, tools, and equipment.

Activity 1: Problem Solving

Task 45:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 45 related to storage of tools, materials, and equipment in their trainee manuals.
2. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
3. After the presentation, ask trainees to refer to Key facts 5.2: Storage of tools, materials, and equipment in their training manual, and review them together and answer any questions that trainees might have.

Activity 2: Guided Practice

Task 46:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to answer the provided questions under task 46 in their trainee manuals and answer the related questions.
2. Make sure instructions are understood, all the students are actively participating, and necessary materials/tools are provided and being used.

Activity 3: Application

Task 47:

1. Ask trainees to go in the site construction near to school and observe the storage of tools and equipment.

   This activity requires students to work independently. During the task, trainees should be given a high degree of independence to apply the knowledge, skills and attitudes acquired to real life situations. Your role is to set clear instructions, methodology and timeframe for performing that activity.

Formative Assessment

1. The following are explanations relating to water tank, reply by **True** or **false:**

   a) **Basic Cleaning:** Start by adding excess debris and dirt from the tools using a stiff brush or scraper. **Answer:** True

   b) **Power Washing:** For larger tools like saws, grinders, or chisels, you can use a power washer with a moderate pressure setting to remove stubborn dirt and debris. **Answer:** True

c) **Wire Brushing:** Use a wire brush to remove hardened mortar or concrete residue from the tools. **Answer:** True

d) **Solvent Cleaning:** Certain solvents like mineral spirits or acetone cannot be used to dissolve and remove adhesive residues, paint, or other stubborn substances from tools. **Answer:** False

e) **Sandblasting:** Is a more aggressive method used for removing thick layers of stubborn material from tools. **Answer:** True

f) **Rust Removal:** If your tools have not developed rust, use a wire brush or sandpaper to gently remove the rust**. Answer:** False

2. Describe tips for storing tools, materials, and equipment after erecting stone structures.

Answer:

- ✓ **Clean and inspect tools and equipment**. Make sure all tools and equipment are clean and free of dirt, debris, and chemicals. Inspect all tools and equipment for any damage. Repair or replace any damaged tools or equipment.
- ✓ **Store tools and equipment in a safe place**. The storage area should be dry, cool, and well-ventilated. Tools and equipment should be stored in a way that prevents them from getting rusty or corroding.
- ✓ **Label tools and equipment**. Label all tools and equipment with the name of the tool, the type of tool, and the owner of the tool. This will help to prevent tools and equipment from getting mixed up or lost.
- ✓ **Store materials in a dry, cool place**. Materials such as lumber, concrete, and bricks should be stored in a dry, cool place. This will help to prevent them from warping, cracking, or rotting.
- ✓ **Store equipment in a secure place.** Large equipment such as excavators and bulldozers should be stored in a secure place. This will help to prevent them from being stolen or damaged**.**
- ✓ **Document the storage of tools, materials, and equipment.** Keep a record of where all tools, materials, and equipment are stored. This will help to locate them quickly if they are needed.

- ✓ **Inspect the storage of tools, materials, and equipment regularly**. Inspect the storage area regularly to make sure that the tools, materials, and equipment are still in good condition and that they are stored properly.

3. Outline steps of cleaning erected stone structures area.
   Answer:

   The steps on how to clean an erected stone structure area

   - ✓ **Prepare the area**: Remove any debris or vegetation from the area around the stone structure. This will make it easier to clean the stones and prevent dirt and debris **from** being tracked back onto the stones after they have been cleaned.
   - ✓ **Choose the right cleaning method**: The cleaning method you choose will depend on the type of stone and the level of dirt and grime on the stones. For lightly dirty stones, you can use a mild soap and water solution. For more heavily dirty stones, you may need to use a stronger cleaning solution, such as a commercial stone cleaner.
   - ✓ **Apply the cleaning solution**: Use a soft brush or sponge to apply the cleaning solution to the stones. Be sure to work in small sections to avoid over-wetting the stones.
   - ✓ **Rinse the stones**: Once the cleaning solution has been applied, rinse the stones thoroughly with water. Be sure to rinse away all of the cleaning solution, as any residue can damage the stones.
   - ✓ **Dry the stones**: Use a soft cloth to dry the stones completely. This will help to prevent water damage to the stones.
   - ✓ **Inspect the stones**: Once the stones are dry, inspect them to make sure they are clean. If any areas are still dirty, you may need to repeat the cleaning process.

Points to Remember

- Respect safety regulations for fighting against any kind of hazards and hazards that may occur to the workplace.
- There are a few specific things to keep in mind when storing tools, materials, and equipment after the construction of a stone structure:

- Label everything: Make sure that all tools, materials, and equipment are labeled with their names or descriptions so that they can be easily identified when needed.
- Organize everything: Store tools, materials, and equipment in a way that is organized and makes sense. This will make it easier to find what you need when you need it.
- Secure everything: Make sure that all tools, materials, and equipment are secure and cannot be easily accessed by unauthorized people.
- Inspect everything regularly: Inspect tools, materials, and equipment regularly for damage or wear and tear. If any items are damaged, they should be repaired or replaced as soon as possible.

Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in their Trainee Manuals to identify their areas of strength, areas for improvement and actions to take to improve.
2. Together with trainees, discuss the results and identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Summative assessment

Integrated situation

CYOGA is a College Located in Northern Province, Musanze District. It is surrounded by fence of 110 m long, this fence is facing a problem of landside which may later destroy some college buildings. The Management has decided to sign a Contract with SJAP Company Ltd to protect against the above said landslide starting from the front side of Main Public Road by Stepped Stone Retaining wall of 60 m long, 2m height and 0.5 m thick. As a Mason from the Contracted Company, you are requested to erect the foresaid retaining wall of 2.5m long within 7 Hours. The college has requested you to use well Shaped Stone for Ashlar Masonry Bond. Given That:

a. All materials tools and equipment are available on site
b. Drawings are provided
c. Blinding Concrete is Poured and hardened in the bottom base of the trench.
d. The gradient slope to be applied during the Execution of Stepped Stone Retaining Wall is 90% as Shown on the Drawings.

Resources

Tools	Wood floater, Steel floater, Tape measure, Spirit level, Spades, Steel squares, Trowel, Notch trowel, Steel ruler, Hammer, Scraper, Straight edge, Mason's line, Mortar pan, Stones, Dumpy level, Calibrated Gauge Box, Wheelbarrow
Equipment	PPE, concrete mixer
Materials/ Consumables	Sand, Cement, Water, Lime, Lime, Nails

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			YES	NO	
Learning outcome1: Prepare materials, tools and equipment (10%)	1.1. Right PPE is selected according to the safety and security measures	PPE is selected			4
	1.2. Tools and equipment are adequately selected according to the work to be Done	Tools and equipment are selected			3

	1.3. Materials are identified according to the required quality	Materials are selected			3
Learning outcome2: Prepare the construction site (10%)	2.1. Construction site is cleaned by removing trees, bushes and other hazardous objects	Construction site is cleaned			2
	2.2. Map out accurately the foundation in accordance with design dimensions	Foundation is mapped out			3
	2.3 Adequately excavate and level the construction area with respect to the desired structure	Excavation is done			2
	2.4. The trenches are dug efficiently with respect to the marked dimensions	Trenches are dogged with respect to the marked dimensions			3
Learning outcome 3: Mix mortar (10%)	3.1. Ingredients for mortar mix are appropriately selected.	Ingredients are selected			3
	3.2. Mix ratio and method of mixing are correctly applied in accordance with Rwanda Standards requirements and design considerations.	Ingredients for mortar mix are selected			3
	3.3. Mixing mortar is carried out at the convenient place	Mixing mortar is carried out at the convenient place			4
Learning outcome 4: Erect stone	4.1. Types of stone structures are identified properly	Types of stone structures are identified			10

structures (60%)	4.2. Stones are well selected according to their qualities and its use	Stones are selected			10
	4.3. Stones are shaped with respect to standard shapes, size and its use.	Stones are shaped with respect to standard shapes, size and its use			10
	4.4. Foundation is erected efficiently accordance with structure design and applicable standard.	Foundation is erected with respect of structure design and applicable standard			10
	4.5. Retaining walls are erected with respect to the structural design and applicable standard.	Retaining walls are erected with respect to the structural design and applicable standard.			10
	4.6. Stone finishes are applied on erected stone structure.	Stone finishes are applied on erected stone structure			10
Learning outcome 5: Clean the workplace (10%)	5.1 Tools and equipment are correctly cleaned by respecting cleaning method.	Tools and equipment are cleaned			3
	5.2 Adequate cleaning of working area	Working area is cleaned			3
	5.3 Appropriate storage of tools and equipment by respecting storage method	Tools and equipment are stored			4
Total marks					**100**
Percentage Weightage					**100%**
Minimum Passing line % (Aggregate): 70%					

REFERENCES

1) Abolfazl Eslami, .Mohammad M. Eslami,. (2020). *Foundation Engineering.* Retrieved from sciencedirect.com/: https://www.sciencedirect.com/
2) C Brouwer, A. Goffeau,M. Heibloem. (1985). *irrigation system .* Retrieved from FAO.org: https://www.fao.org/3/r4082e/r4082e00.htm#Contents
3) Deloney, M. L. (2019). *civiJungle.* Retrieved from civiJungle.com : https://civiljungle.com/author/krunal/
4) Emma. (2016). *How to calculate stairs .* Retrieved from firstinarchitecture.co.uk: www.firstinarchitecture.co.uk
5) keuka.studio. (2023). *types of stairs .* Retrieved from keuka studio.com: https://www.keuka-studios.com/types-of-stairs-2
6) ReAgg. (2020, july 27). *ReAGG.* Retrieved from ReAGG.com: https://www.reagg.com/
7) World Health Organization. (2020). Personal protective equipment.
8) Gibb, A., Hide, S., Haslam, R., Gyi, D., Pavitt, T., Atkinson, S., & Duff, R. (2005). Construction tools and equipment–their influence on accident causality. *Journal of Engineering, Design and Technology*, *3*(1), 12-23.
9) Powers, T. C. (1960). *Physical properties of cement paste* (No. 154).
10) Doran, D., & Cather, B. (Eds.). (2013). *Construction materials reference book*. Routledge.
11) Pan, N. F. (2009). Selecting an appropriate excavation construction method based on qualitative assessments. *Expert Systems with Applications*, *36*(3), 5481-5490.
12) Balfour, A. J. (1901). *The Foundations of Belief: Being Notes Introductory to the Study of Theology*. Longmans, Green, and Company.
13) Seeley, I. H., & Winfield, R. (1999). Groundwork and foundations. In *Building Quantities Explained* (pp. 51-75). Red Globe Press, London.
14) Bailey, H., Hancock, D., Bailey, H., & Hancock, D. (1990). Excavating and Timbering. *Brickwork 1 and Associated Studies*, 39-49.
15) Vera-Agullo, J., Chozas-Ligero, V., Portillo-Rico, D., García-Casas, M. J., Gutiérrez-Martínez, A., Mieres-Royo, J. M., & Grávalos-Moreno, J. (2009). Mortar and concrete

reinforced with nanomaterials. In *Nanotechnology in Construction 3: Proceedings of the NICOM3* (pp. 383-388). Berlin, Heidelberg: Springer Berlin Heidelberg.

16) Zornoza-Indart, A., & Lopez-Arce, P. (2019). Stone. In *Long-term Performance and Durability of Masonry Structures* (pp. 59-88). Woodhead Publishing.

17) Xu, Y., Zhang, M., Wang, L., Kong, L., & Cai, Q. (2011). Changes in water types under the regulated mode of water level in Three Gorges Reservoir, China. *Quaternary international*, *244*(2), 272-279.

18) Jain, S. C. (2000). *Open-channel flow*. John Wiley & Sons.

19) Hou, J. H. (2005). Dancing Stairs. In *Digital Design: The Quest for New Paradigms, 23rd eCAADe Conference Proceedings, Technical University of Lisbon, Lisbon* (pp. 459-465).

20) Fazio, R. H., & Olson, M. A. (2007). Attitudes: Foundations, functions, and consequences. *The Sage handbook of social psychology*, 123-145.

21) Mitossi, V., & Koutamanis, A. (1996). Parametric design of stairs. In *3rd Design and Decision Support Systems in Architecture and Urban Planning Conference. Part One: Architecture Proceedings*.

22) Yepes, V., Alcala, J., Perea, C., & González-Vidosa, F. (2008). A parametric study of optimum earth-retaining walls by simulated annealing. *Engineering Structures*, *30*(3), 821-830.

23) Nybø, I., & Hartnik, L. O. (2022). *Design of an Underground Water Storage Tank in Coral Stone and Ferrocement at Eco Moyo Education Centre* (Master's thesis, NTNU).

24) Davis, L. D. New York: Van Nostrand Reinhold, 1991. Melanie Mitchell.

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