Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

RETAINING WALL CONSTRUCTION

PWORW301

CONSTRUCT RETAINING WALL

Competence

RQF Level: 3

Learning Hours 70

Credits: 7

Sector: Construction and Building Services

Trade: Public Works

Module Type: Specific

Curriculum: CBSPWO3001- TVET Certificate III in Public Works

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<table>
<tr><td>Purpose statement</td><td colspan="6">This module describes the skills, knowledge and attitude required to construct retaining walls. It is intended for learners who have successfully completed ordinary level and pursuing level 3 in Public Works or applying for recognition of prior learning or other related qualifications. At the end of this module, learners will be able to plan and prepare the work requirements, prepare workplace, construct stone masonry retaining walls, construct gabions, construct honey combs retaining walls and construct reinforced concrete retaining walls.</td></tr>
<tr><td>Leaning assumed to be in place</td><td colspan="6">Safety, Health and environment at workplace; Basic technical drawing; Public works resources; Set out road alignment; Field excavation works; Masonry works.</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="3">Formative assessment</td><td>30%</td><td rowspan="3">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>• Group project and presentation</td><td>30%</td></tr>
<tr><td>• Individual project /Work</td><td>70%</td></tr>
<tr><td colspan="3"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1. **Plan, and prepare the work requirements**	1.1. Documents related to the task are properly identified according to the type of work to accomplish.
	1.2. Drawings are properly interpreted to ensure the understanding of works to be done
	1.3. Materials, tools and equipment are properly selected in line with the activities to be accomplished
2. Prepare workplace	2.1. Workplace for excavation activities is well prepared based on the working drawings.
	2.2. The required type of retaining wall is identified based on the soil properties, height and slope.
	2.3. Setting out is accurately done according to surveying data
	2.4. Excavation is correctly done based on the provided design.

3. Construct stone masonry retaining walls	3.1. Hardcore stones are appropriately selected according to provided specifications.
	3.2. Mortar for stone masonry retaining wall is properly mixed according to the designed mixing ratio.
	3.3. Stone masonry retaining wall is well erected respecting the designed working drawings.
	3.4. Constructed retaining walls are correctly backfilled in accordance with specifications.
	3.5. Retaining walls are properly cleaned according to the required standards.
4. Construct Gabions	4.1. Base is conveniently prepared according to the nature of the soil or the available design.
	4.2. Gabions baskets are properly assembled according to the design.
	4.3. Gabions Baskets are adequately filled with rocks according to the design.
5. Construct honey combs Retaining walls	5.1. Footings of honey combs are properly installed in accordance with their respective steps
	5.2. Drainage of honey combs are appropriately installed according to their respective steps
	5.3. Honey combs layer are systematically installed according to their respective steps
	5.4. Geosynthetic Reinforcement are Systematically installed (when required by design) as per their steps
	5.5. Grasses and flowers in honey combs are correctly planted according to their respective steps
6. Construct Reinforced concrete retaining walls.	6.1. Material, tools and equipment for RC retaining wall are properly identified and selected.

	6.2. Steel bars are correctly bended and placed according to the reinforcement drawings.
	6.3. Formwork for RC is properly prepared and installed according to working drawings.
	6.4. Concrete is well poured into the formwork respecting casting steps.
	6.5. Concrete curing is properly done according to the curing types and weather conditions.

Course content	
Learning outcomes	**At the end of the module the learner will be able to:** 1. Plan, and prepare the work requirements 2. Prepare workplace 3. Construct stone masonry retaining walls 4. Construct Gabions 5. Construct honey combs retaining walls 6. Construct reinforced concrete retaining walls.
Learning outcome 1: **Plan, and prepare the work requirements**	**Learning hours: 5**
Indicative content	
(Based on the performance criteria and the extent of learning outcome: what, up to, how): • **Identification of work requirements** (Refer to RS ISO 45001; RS EAS 188; RS EAS 1020; RS ISO 20347; RS 177; ISO7010; RS 426-1; RS EAS 18-1; RS 144; RS 175; RS EAS 1021; RS EAS 1020; RS 175; RS ISO 13688; RS ISO 14001; RS EAS 134; RS EAS 132) ✓ Drawings ✓ Materials ✓ Tools ✓ Equipment • **Drawing and other documents interpretation** ✓ Unit of measurement ✓ Scale ✓ Plan ✓ Elevations ✓ Sections ✓ Site plan ✓ Signs and symbols ✓ Perspectives ✓ Bill of quantities • **Determination of required quantities** ✓ Material ✓ Tools ✓ Equipment • **Type of retaining wall**	

✓ Stone masonry retaining walls ✓ Gabion retaining walls ✓ Honey combs retaining walls ✓ Reinforced concrete retaining walls

Resources required for the learning outcome	
Equipment	• Excavator, wheel loader, wheelbarrows, stumper, grinder, vibrator, concrete mixer, backhoe, electric cutting machine, bending machine, compactor
Materials	• Cement, hardcore stones, wood, nails, steel bars, binding wires, murram, water, fuel, honey combs, pipes, hollow tubes, grasses and flowers
Tools	• Trowel, spirit level, building lines, plumb bob, T- square, saw, tape measure, hammers, pick, spade, hoe, wooden float, ladder, pan, Pliers
Facilitation techniques	• Presentations, demonstration and simulation, individual and group work, practical exercise, individualized, trainer guidance, group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product based assessment, project based assessment

Learning outcome 2: **Prepare workplace**	**Learning hours: 10**
Indicative content	
(Based on the performance criteria and the extent of learning outcome: what, up to, how): • **Site preparation** (Refer to RS ISO 45001; RS EAS 188; RS EAS 1020; RS ISO 20347; RS 177; RS 175; RS EAS 1021; RS EAS 1020; RS ISO 13688) ✓ Removal of grasses and top soil ✓ Soil Cutting ✓ Soil evacuation • **Setting out** ✓ 3-4-5 Method ✓ Builder square method ✓ Use of topographic instruments • **Excavation for foundation** ✓ Safety precautions ✓ Excavation of foundation trenches ✓ Removing the excavated soil ✓ Timbering: Supporting the sides of an excavation	

Resources required for the indicative content	
Equipment	• Excavator, wheel loader, wheel borrows, backhoe
Materials	• Timber, Nails
Tools	• Pick, hoe, spade, building lines, spirit level, build square, hammers
Facilitation techniques	• Presentations, demonstration and simulation, individual and group work, practical exercise, trainer guidance, group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product based assessment, project based assessment

Learning outcome 3: **Construct stone masonry retaining walls**	**Learning hours: 10**

Indicative content

(Based on the performance criteria and the extent of learning outcome: what, up to, how):

3.1. Hardcore stones are appropriately selected according to provided specifications.

3.2. Mortar for stone masonry retaining wall is properly mixed according to the designed mixing ratio.

(Refer to RS 108; RS EAS 1020; RS 175; RS 426-1; RS EAS 18-1; RS ISO 1452-2; RS ISO 15874-2; RS ISO 4427-2)

3.3. Stone masonry retaining wall is well erected respecting the designed working drawings.

3.4. Constructed retaining walls are correctly backfilled in accordance with specifications.

3.5. Retaining walls are properly cleaned according to the required standards.

- **Base preparation**
  - ✓ Base compaction
  - ✓ Rockfill
- **Hardcore stones**
  - ✓ Selection of stones
  - ✓ Stone dressing
- **Mortar and concrete**
  - ✓ Cement
  - ✓ Sand
  - ✓ Gravel
  - ✓ Rebars
  - ✓ Water

- ✓ Admixtures
- ✓ Mixing ratio
- ✓ Reinforcement works
- ✓ Cast concrete

- **Erect stone retaining wall**
  - ✓ Mortar preparation
  - ✓ Type of stones bonds
  - ✓ Erect stone masonry wall
  - ✓ Install weep holes
- **Backfilling and compaction**
  - ✓ Selection of appropriate murram
  - ✓ Placement of aggregates
  - ✓ Placement of geotextile membrane
  - ✓ Filling and Compaction of murram layer by layer
- **Finishing work**
  - ✓ Copping
  - ✓ Pointing
  - ✓ Cleaning

Resources required for the indicative content	
Equipment	• Stumper, Compactor, wheelbarrow
Materials	• Cement, sand, hardcore stones, water, murram, pipes, geotextile membrane, Pipes
Tools	• Tape measure, spirit level, sledge hammer, trowel, building line, tubes, pan
Facilitation techniques	• Lectures, demonstration and simulation, individual and group work, practical exercise (individualized, trainer guided), group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product-based assessment, project-based assessment

Learning outcome 4: **Construct Gabions**	**Learning hours: 15**
Indicative content	

Based on the performance criteria and the extent of learning outcome, (what, up to, how):

- **Base preparation** (Refer to RS 107; RS 373; RS 261)
  - ✓ Compaction
  - ✓ Rockfill
  - ✓ Cast blinding concrete

- **Gabion basket**
  - ✓ Select gabion basket
  - ✓ Prepare gabion basket

- ✓ Set the gabion basket
- **Construct gabion**
  - ✓ Pack stones into gabion basket
  - ✓ Covering the gabion basket
  - ✓ Coping the top (If indicated)

Resources required for the indicative content	
Equipment	• Excavator, Stumper, Compactor, wheelbarrow
Materials	• Gabion basket, stones, binding wires, sand, gravel, cement, water
Tools	• pliers, building lines, pan, pick axes, hoe, spade
Facilitation techniques	• Presentation, demonstration and simulation, individual and group work, practical exercise, individualized, trainer guided, group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product based assessment, project based assessment

Learning outcome 5: **Construct honey combs retaining wall**	**Learning hours: 15**

Indicative content

(Based on the performance criteria and the extent of learning outcome: what, up to, how):

- **Base preparation**
  - ✓ Base compaction
  - ✓ Cast blinding Concrete
- **Construction of Foundation (**Refer to RS 107; RS 373; RS 426-1; RS EAS 18-1; RS ISO 6935-1; RS ISO 6935-2)
  - ✓ Stone dressing
  - ✓ Erect foundation
  - ✓ Concrete casting
- **Construction of Drainage**
  - ✓ Describe materials used in drainage
  - ✓ Construct drainage system
- **Laying of Honey comb**
  - ✓ Select honey comb
  - ✓ Laying honey comb
  - ✓ Causes of honey combs failure
- **Grasses planting**
  - ✓ Select grasses and flowers
  - ✓ Plant grass/flowers

Resources required for the indicative content	
Equipment	• Wheelbarrow, backhoe, stumper, compactor, trucks
Materials	• Cement, hardcore, sand, aggregates, honey combs soil, water, flowers, grass, manure, wood, nail, steel bars, binding wires
Tools	Pick axes, hoe, pang, spade/shovel, hammer, tape measure spirit level, hoe, rake, trowel
Facilitation techniques	• Lectures, demonstration and simulation, individual and group work, practical exercise (individualized, trainer guided), group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product based, project based assessment

Learning outcome 6: **Construct reinforced concrete retaining walls**	**Learning hours: 15**

Indicative content

(Based on the performance criteria and the extent of learning outcome: what, up to, how):

- **Formwork making**
  - ✓ Type of formworks
  - ✓ Prepare formworks
  - ✓ Fix formworks
- **Steel work**
  - ✓ Cutting
  - ✓ Bending
  - ✓ Fixing
- **Reinforced Concrete Casting** (Refer to RS 107; RS 373; RS 426-1; RS EAS 18-1; RS ISO 6935-1; RS ISO 6935-2)
  - ✓ Casting
  - ✓ Vibration
  - ✓ Levelling
- **Reinforced Concrete Curing**
  - ✓ Purpose
  - ✓ Technique
  - ✓ Timing

Resources required for the indicative content	
Equipment	• Electric cutting machine, angle grinder, bending machine, concrete mixer, vibrator, stumper, compactor

Materials	• Steel bars, cement, sand, gravel, water, admixtures, murram
Tools	• Building line, pliers, pan, pick axes, hoe, spade
Facilitation techniques	• Lectures, demonstration and simulation, individual and group work, practical exercise (individualized, trainer guided), group discussion
Formative assessment methods	• Written assessment, oral presentation, performance assessment, product-based assessment, project-based assessment

Integrated/Summative assessment (For specific module)

Integrated situation

Muhanga-Ngororero road runs across the country's Southern Province. Due to the high slope alongside the road and presence of landslides. Therefore, Muhanga District has signed the contract with CLEMA Construction Company Ltd to construct retaining walls. Masonry retaining wall is required at PK 17, Gabions are required at PK 53, and honey combs are required at PK 80.

You, as a public work technician from CLEMA Construction Company Ltd, you are required to:

i. Construct 2m long and 0.5m high stone retaining wall within 8hrs
ii. Assembly and install one block of gabions (2m long X 1m wide X 1m high) within 8 hrs
iii. Construct 1m long and 1m high honey comb wall within 8 hours.

Required drawings, materials, tools and equipment will be available on site.

Resources

Tools	Building lines, spade, spit level, trowel, pan, pick axe, builder, square, float, hoe, machete, pliers
Equipment	Wheelbarrow, concrete mixer, excavator, backhoe, compactor stumper
Materials/ Consumables	Dressed stones, sand, cement, gravel, nails, murram water, gabion baskets, timber, binding wires

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	

Learning outcome 1: Plan, and prepare the work requirements **(8%)**	1.1 Documents related to the task are properly identified according to the type of work to accomplish.	Ind.1. Construction drawings related to the work are properly identified.			1
		Ind.2. Material and tools are properly identified.			1
		Ind.3. Required equipment are properly identified.			1
	1.2 Drawings are properly interpreted in accordance with the work activity to be accomplished	Ind.1. Drawings are correctly interpreted			1
		Ind.2. Drawing scale is well converted into real dimensions.			1
		Ind.3. Sign and symbols are well interpreted.			1
	1.3 Materials, tools and equipment are properly selected based on volume of works and the activities to be accomplished	Ind.1. Equipment are well selected			1
		Ind.2. Material are well selected.			0.5
		Ind.3. Tools are well selected			0.5
Learning outcome 2: Prepare workplace **(17%)**	2.1. Workplace for excavation activities is well prepared based on the working drawings.	Ind.1. The removal of grasses and top soil is well done based on the required area size			1
		Ind.2. Cutting is well done according to specifications.			1
		Ind.3. Cut soil is well evacuated to the specified dumping site.			1
	2.2. The required type of retaining wall is identified based on the soil	Ind.1. soil properties are well analyzed.			2
		Ind.2 Height of slope are well measured			1
		Ind.3 Type of retaining wall is appropriately selected according to the soil and slope height.			2

	properties and Hight of slope.				
	2.3 Setting out is accurately done according to surveying data	Ind.1. material and tools for setting out are correctly identified			2
		Ind.2 setting out method is appropriately identified according to available material, tools and instrument.			2
		Ind.3 Profile board is well set according to working drawing.			2
	2.4 Excavation is correctly done based on the required design.	Ind.1 Method of excavation are well chosen.			1
		Ind.2 Material and tools are well chosen			1
		Ind.3 Timbering is well applied.			1
Learning outcome 3: Construct stone masonry retaining walls **(21%)**	3.1. Hardcore stones are appropriately selected according to the designed specifications.	Ind.1 Stone specifications are well checked			1
		Ind.2 stone properties are well checked			1
		Ind.3 hardcore stones are well dressed according to specifications.			1
	3.2 Mortar for stone masonry retaining wall is properly mixed according to the designed mixing ratio	Ind.1 Components of mortar are well selected according to specifications.			1
		Ind.2 Mixing ratio are well respected.			1
		Ind.3 Mortar is well mixed according to drawing specifications.			1
	3.3 Stone masonry retaining wall is well erected respecting the designed working drawings.	Ind.1 Dimensions are well respected.			2
		Ind.2 Construction bonds are respected			2
		Ind.3 The wall is well erected according to the construction drawings			2
	3.4 Constructed retaining walls are correctly backfilled in accordance	Ind.1 Types of murram to backfill are well identified.			2
		Ind.2 Murram layers are well applied.			2
		Ind.3 Compaction is well done according to specifications.			2

	with required degree of compaction.				
	3.5 Retaining walls are properly cleaned according to the required standards	Ind.1 Tools to be used are correctly identified.			1
		Ind.2			1
		Ind.3 Constructed wall is well cleaned.			1
Learning outcome 4: Construct Gabions **(17%)**	4.1. Base is conveniently prepared according to existing soil	Ind.1 Tools to be used are correctly identified.			1
		Ind.2 Equipment to be used are correctly identified.			2
		Ind.3 Base for gabion is conveniently prepared.			2
	4.2. Gabion's baskets are properly assembled to volume designed	Ind.1 Gabion basket is well assembled			2
		Ind.2 Gabion basket is well mounted			2
		Ind.3 gabion basket is well set.			2
	4.3 Gabions Baskets are adequately filled with rocks according to the standard practice	Ind.1 Hardcore stone are properly selected			2
		Ind.2 hardcore stone are well erected into Gabion basket.			3
		Ind.3 Gabion basket is well covered before the next one.			1
Learning outcome 5: Construct honey combs retaining walls **(21%)**	5.1 Footings of honey combs are properly constructed in accordance with their respective steps	Ind.1 Type of foundation is correctly selected according to the soil			1
		Ind.2 Material and tools to be used are well selected.			1
		Ind.3 Foundation is correctly constructed according to the construction drawings.			1
	5.2 Drainage of honey combs are appropriately installed according to	Ind.1 Tools and materials are well selected			1
		Ind.2 Drainage technique are well applied			1
		Ind.3 The drainage system is well constructed.			1

	their respective steps				
	5.3 Honey combs layer are systematically installed according to their respective steps	Ind.1 Tools and materials are well selected			1
		Ind.2 Honey combs are correctly installed according to its steeps			1
		Ind.3 The finishing works is properly done			1
	5.4 Geosynthetic Reinforcement are Systematically installed (when required by design) as per their steps	Ind.1 Types of Geosynthetic are identified			1
		Ind.2 Steeps of installing Geosynthetic are well respected.			1
		Ind.3 the installation of Geosynthetic is properly done.			1
	5.5 Grasses and flowers in honey combs are correctly planted according to their respective steps	Ind.1 Types of grasses and flowers are well selected.			1
		Ind.2 steep of planting grasses are correctly applied.			1
		Ind.3 grasses are well planted.			1
Learning outcome 6: Construct reinforced concrete retaining walls. **(16%)**	6.1 Material, tools and equipment for RC retaining wall are properly identified and selected.	Ind.1 Material to be used are well selected			1
		Ind.2 Tools to be used are well selected			1
		Ind.3 Equipment to be used are well selected			1
	6.2 Steel bars are correctly binded and placed according to the reinforcement	Ind.1 Steel bars are properly cut based on dimensions			1
		Ind.2 Steel bars are properly bended			1
		Ind.3 Steel bars are properly fixed			1

	6.3 Formwork for RC is properly fixed according to the designed working drawings.	Ind.1 Type of formwork is well chosen			1
		Ind.2 Dimension of formwork are correctly respected.			1
		Ind.3 Formwork is correctly erected.			1
	6.4 Concrete are well poured into the formwork according to its steps	Ind.1 components of concrete are well selected according to specifications.			1
		Ind.2 Concrete mix ratio is correctly respected			1
		Ind.3 Concrete is well levelled to the required dimensions			1
	6.5 Concrete curing is properly done according to the curing types and weather conditions.	Ind.1 Types of concrete curing is well selected.			1
		Ind.2 Material to be used are well selected.			1
		Ind.3 Concrete Curing is well done.			1
		Ind.4. Time is well respected			1
Total marks					**100**
Percentage Weightage					**100%**
Minimum Passing line % (Aggregate): 70%					

References:

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2. De Vekey RC (2001). *Bricks blocks and masonry made from aggregate concrete: Part 2 – APPEarance and environmental aspects*, BRE Digest 460, Part 2.
3. M.Rashad Islam & Rafiqul A Tarelder, Pavement Design: Materials, Analysis,2016, McGraw-Hill Education
4. Norbert J. Delatte, *Concrete Pavement Design, Construction, and Performance Second Edition*,2016 Routledge
5. William & Radford, *Cement Houses and How to Build Them ,1996*, McGraw-Hill Education
6. RS ISO 45001: Occupational Health and Safety Management system— Requirements; RS EAS 188: Machete — Specification;
7. RS EAS 1020: Shovels and spades — Specification;
8. RS ISO 20347: Personal protective equipment — Occupational footwear;
9. RS 177: Picks, beater picks and mattocks — Specification;
10. RS 175: wheelbarrow specifications,
11. RS EAS 1021: Steelhead hammer-specifications,
12. RS EAS 1020: Shovels and spades specifications,
13. RS ISO 13688: Protective clothing — General requirements;
14. RS EAS 132: Hoe — Specification
15. RS 108: Mortar for masonry — Specifications;
16. RS EAS 1020: Shovels and spades — Specification;
17. RS 426-1: Masonry Cement — Part 1: Composition, Conformity criteria and Specifications;
18. RS EAS 18-1: Cements — Part 1: Composition, specification and conformity criteria for common cements;
19. RS ISO 1452-2: Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 2: Pipes;
20. RS ISO 15874-2: Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 2: Pipes;
21. RS ISO 4427-2: Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes RS 107: Building sands — Specifications;

22. RS 373: Aggregates for concrete — Specification;
23. RS 261: Granite products — Specification
24. RS 107: Building sands — Specifications;
25. RS ISO 6935-1: Steel for the reinforcement of concrete — Part 1: Plain bars;
26. RS ISO 6935-2: Steel for the reinforcement of concrete — Part 2: Ribbed bars