Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

DO-NOU TECHNOLOGY IN EARTH ROAD MAINTENANCE

PWODT401

Apply do-nou technology in earth road maintenance

Competence

RQF Level: 4

Learning Hours 40

Credits: 4

Sector: Construction and Building Services

Trade: Public Works

Module Type: Specific

Curriculum: CBSPWO4001-TVET CERTIFICATE IV in Public Works

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Purpose statement	This module describes knowledge, the skills, and attitudes required to apply do-nou technology in earth road maintenance. It is intended for learners pursuing RQF level IV in Public Works. At the end of this module the learners will be able to prepare site, apply foundation layer, establish base layer with Do-nou bags, Establish the wearing course and maintain do-nou roads.

Delivery modality	**Training delivery**		**100%**	**Assessment**		**Total 100%**
	Theoretical content		30%	Formative assessment	30%	50%
	Practical work:		70%		70%	
	• Group project and presentation	20%				
	• Individual project /Work	50%				
				Summative Assessment		50%

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1. Prepare the site	1.1. Data collection in line with the work to be performed is done properly.
	1.2. The damaged area is properly identified with respect to the serviceability of the road.
	1.3. Safety measures are appropriately applied according to safety and health regulations.
	1.4. Grasses and debris are effectively removed as per site clearance conditions.
2. Prepare the foundation layer	2.1. The damaged section is methodically set out in accordance with existing road conditions.
	2.2. Soil excavation in the marked area is effectively carried out according to the soil properties.
	2.3. The damaged area is systematically leveled with respect to surface irregularities.
	2.4. The foundation layer is appropriately fixed in accordance with the expected traffic loads.
3. Establish base	3.1. Tools, equipment, and materials are adequately prepared according to the size of the damaged section.

layer with Do-nou bags	3.2. Tools and equipment are properly fixed according to their standard measurements.
	3.3. The soil is suitably batched to fill in bags based on prepared containers and ties.
	3.4. Do-nou bags are systematically laid depending on the size and condition of the damaged section.
	3.5. Do-nou bags are properly compacted to reach the required bearing capacity.
4. Establish the wearing course	4.1. The wearing course is properly applied in line with camber formation.
	4.2. Watering and compaction of the wearing course are properly performed with regard to camber formation.
	4.3. Neat clean-up is carried out with respect to environmental protection.
5. Maintain Do-nou Road	5.1. Damaged areas are properly identified according to the level of damage.
	5.2. Damaged bags are efficiently removed and replaced with respect to the existing level of do-nou layers.
	5.3. The wearing course is properly applied with respect to thickness layers.
	5.4. Watering and compaction of the wearing course are properly performed with regard to camber formation.
	5.5. Neat clean-up is carried out with respect to environmental protection.

Intended Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
✓ Identify Standards of Do-Nou ✓ Describe Do Nou materials ✓ Classify soil properties	✓ Apply compaction ✓ Fill Do Nou Bags ✓ Arrange Do Nou bag	✓ Communicate actively at workplace ✓ Pay attention in performing Do nou technology

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Prepare the site 2. Prepare the foundation layer 3. Establish base layer with Do-nou bags 4. Establish the wearing course 5. Maintain Do-nou Road
Learning outcome 1: Prepare the site	**Learning hours: 5**
Indicative content	

- **Collect data**
  - ✓ Traffic count
    - Categorize traffic
    - Count traffic accordingly
    - Calculation of Average daily traffic
  - ✓ Slope Gradient
    - Vertical and horizontal dimensions
    - Slope calculation
  - ✓ Availability of local materials
    - Identification of local materials
    - Physical soil tests.

- Cohesive test
- Settlement test
- Particle size
- Distribution

- **Identify damaged area**

  ✓ Identification of extent of damaged area

  - Possible road damages
    - Ruts
    - Potholes
    - Water logging
    - Collapse
    - Settlement
  - Measuring the area to be maintained

- **Apply safety measures**
  ✓ Road safety
  - Safety rules
  - Types of road safety
    - Personal protective equipment
    - Road safety signs
    - Road barriers systems
    - First aid equipment

- **Remove grasses and debris**

  ✓ Unwanted materials at site
  - Grasses
  - Debris
  - Mud soil
  - Trees
  - Crushed stones

  ✓ Unwanted materials at site
  - Grasses
  - Debris
  - Mud soil
  - Dust soil
  - Trees
  - Crushed stones

Resources required for the learning outcome

Equipment	Calculator, Camera, Chainsaw, Computer, first aid equipment, Notebook, Pick up, Road barriers systems, Road safety signs, Square, Stopwatch, String, Wheelbarrow, Workshop
Materials	Timber, Traffic count sheet, Marker pen,
Tools	Axes, Hammer, Hand saw, Hoe, Tape measure
Facilitation techniques	Oral presentation, Group discussion, Practical exercise, Field visit, Brainstorming, Demonstration, Internet Research
Formative assessment methods	Written evidence, Oral evidence, Performance evidence

Learning outcome 2: Prepare the foundation layer	**Learning hours: 5**
Indicative content	
• **Prepare the foundation layer** ✓ Prepare the foundation layer; Fixing pegs Tying string • **Excavate the soil in marked area** ✓ Excavation Vertical excavation Horizontal excavation Removal of excavated soil • **Fix Foundation layer** ✓ Surface irregularity Uneven surface Tools / equipment for checking surface irregularities • **Levelling the excavated portion** ✓ Dump foundation material ✓ Manual compaction	
Resources required for the indicative content	
Equipment	Calculator, Fork jembes, Camera, Chainsaw, Computer, first aid equipment, Notebook, Pick up, Road barriers systems, Road safety signs, Square, Stopwatch, String, Wheelbarrow, Workshop
Materials	Timber, Traffic count sheet, Marker pen,
Tools	Axes, Hammer, Hand saw, Hoe, Tape measure, Sledge /club hammers, Spade, Spirit

	level
Facilitation techniques	Oral presentation, Group discussion, Practical exercise, Field visit, Brainstorming, Demonstration, Internet Research
Formative assessment methods	Performance assessment

Learning outcome 3: Establish base layer with Do-nou bags	Learning hours: 10
Indicative content	

- **Prepare tools, equipment and materials**
  - ✓ Basic estimation of materials
    - Number of bags
    - Lateritic soil
    - Strings
  - ✓ Tools, equipment and materials used in base layer
    - Excavation tools
    - Compaction equipment
    - Levelling tools
    - Do-nou bags materials
      - Bags (types and sizes)
      - Tying strings
      - filling materials
    - Protection materials
- **Fix tools and equipment**
  - ✓ Assembling tools and equipment
    - Excavation tools
    - Excavation equipment,
    - Compaction equipment
    - Levelling tools
  - ✓ Cutting cans and strings
    - Measuring cans
    - Marking cans
    - Cutting cans
    - Sizing tie strings
- **Batch the soil to fill in bags**
  - ✓ Filling soil materials in do-nou bags
    - Loosen the soil
    - Filling soil in the container
    - Levelling soil to container edges
    - Transferring soil into do-nou bags

- ✓ Tying do-nou bags
  - Roll the do-nou bag open end
  - Free space between soil and tie point

- **Lay Do-nou bags**

  - ✓ Placement of do-nou bags.
    - Spacing between bags
    - Putting the open end under tied do-nou bag
    - Systematic arrangement
    - Size of laid do-nou bag
  - ✓ Number of layers
    - Depth of damaged section
    - Empty spaces filling
    - Sequence of layers
  - ✓ Steep slope protection
    - Timber use

- **Compact Do-nou bags**

  - ✓ Blowing laid do-nou bags.
    - Number of blows
    - Standing position
    - Hand compactor holding
  - ✓ Checking degree of compaction
    - Sound of hammer
    - Thickness of do-nou bag
  - ✓ Filling empty space between do-nou bags

Resources required for the indicative content	
Equipment	Chainsaw, Computer, first aid equipment, Notebook, Pick up, Road barriers systems, Road safety signs, Square, Stopwatch, String, Wheelbarrow, Workshop, Fork hoe, Hand compactor Safety gloves
Materials	Timber, Traffic count sheet, Marker pen, Containers, Do-nou bags, Polypropylene bags, Lateritic soil
Tools	Axes, Hammer, Hand saw, Hoe, Tape measure, Sledge /club hammers, Spade, Spirit level, Machette, String, Tie strings
Facilitation techniques	Oral presentation, Group discussion, Practical exercise, Field visit, Brainstorming, Demonstration, Internet Research
Formative assessment methods	Written evidence, Oral evidence, Performance evidence

Learning outcome 4: Establish the wearing course	Learning hours: 10

Indicative content

- **Apply wearing course.**
  - ✓ Selecting proper materials
    - Physical soil test
      - % of Gravel ≥ 50%
      - % of sand ≥ 40%
      - % of Fines (Silt and Clay) ≥ 50%
  - ✓ Road edges protection
    - Road location conditions
    - Stabilization materials
  - ✓ Spreading wearing course materials
    - Setting out camber level
      - 10 cm thickness
      - Camber of 5-8 %
    - Dumping wearing course materials
    - Spreading wearing course materials
- **Perform watering and compaction.**
  - ✓ Watering
    - Watering procedures
    - Tools to be used
  - ✓ Compaction
    - Methods of compaction
    - Physical checking the level of compaction
      - Cohesion
      - Stability
- **Clean working area**
  - ✓ Environment protection.
    - Waste disposal
    - Borrow pits restoring
  - ✓ Manual clearing method
    - Tools and equipment
    - Screening / separation

Resources required for the indicative content

Equipment	Chainsaw, Computer, first aid equipment, Notebook, Pick up, Road barriers systems, Road safety signs, Square, Stopwatch, String, Wheelbarrow, Workshop, Fork hoe, Hand compactor Safety gloves
Materials	Timber, Traffic count sheet, Marker pen, Containers, Do-nou bags, Polypropylene bags, Lateritic soil

Tools	Axes, Hammer, Hand saw, Hoe, Tape measure, Sledge /club hammers, Spade, Spirit level, Machette, String, Tie strings
Facilitation techniques	Oral presentation, Group discussion, Practical exercise, Field visit, Brainstorming, Demonstration, Internet Research
Formative assessment methods	Written evidence , Oral evidence, Performance evidence

Learning outcome 5: Maintain Do-Nou Road	**Learning hours: 10**
Indicative content	

- **Identify damaged area**

  - ✓ Identification criteria of damage
    - Level of Damage
    - Type of damage
    - Cause of damage

- **Remove and replace damaged bags**

  - ✓ Criteria to consider removing and replacing damaged bags**.**
    - Dimensions of damaged area
    - Thickness of layers
    - Filling gap spaces

- **Apply wearing course.**

  - ✓ Selection criteria of proper material
    - Physical soil test
      - % of Gravel ≥ 50%
      - % of sand ≥ 40%
      - % of Fines (Silt and Clay) ≥ 50%
  - ✓ Conditions of application of Wearing course based on types of damage.
    - To the replaced Do-Nou bags
    - To the Exposed stable Do-Nou Bags

- **Perform watering and compaction**

  - ✓ Watering
    - Watering procedures
    - Tools to be used
  - ✓ Compaction

- Methods of compaction
- Physical checking the level of compaction.
  - Cohesion
  - Stability

- **Clean up the working area**

✓ Environment protection.
- Waste disposal
- Borrow pits restoring

✓ Manual clearing method
- Tools and equipment
- Screening / separation

Resources required for the indicative content	
Equipment	blade, Brush grubber, Brush mower, Chainsaw, Computer, Graduated transparent container, Hammer, Hand compactor, Hand saw, Hoe, Marker pen, Measurement tools, Metallic Plate, Mulch, Nails, Pegs, Pen, Pick axe, Picture , Projector, Rake tool, Spade, Spilt levels, Strings, Tape measure, Video, Water container, Water sprayer, Wheelbarrow, Workshop
Materials	Book, Container, Do-Nou bags, Filling soil twines,
Tools	Axes,
Facilitation techniques	Oral presentation, Group discussion, Practical exercise, Field visit, Brainstorming, Demonstration, Internet Research
Formative assessment methods	Written evidence, Performance evidence

Integrated/Summative assessment (For specific module)

The unpaved road from Gishamvu Sector office in Huye District towards Nyanza center of Nyaruguru District is damaged due to heavy rain which caused road sides slope deterioration. Huye District gave tender to ABK ltd to repair the damaged sides slope sections of that road.

You as an assistant road maintainer in ABK Ltd, you have been given a task of repairing a specified section with Do-nou technology within 7 hours. Following are the information about the task:

- Side slope length is 20 m
- Side slope height is 4m
- No waste of materials
- All materials, tools and equipment are available on the site
- Safety precautions are mandatory
- The excavated soil can be used as fill material, if found good

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Prepare the site **(15%)**	Data collection in line with the work to be performed is done properly.	Data are Collected			3
	The damaged area is properly identified with respect to the serviceability of the road.	Damaged area is Identified			4
	Safety measures are appropriately applied according to safety and health regulations.	Safety measures are applied			4
	Grasses and debris are effectively removed as per site clearance conditions.	Grasses and debris are removed			3
2. Prepare the foundation layer **(20 %)**	The damaged section is methodically set out in accordance with existing road conditions.	Foundation layer is Prepared			5
	Soil excavation in the marked area is effectively carried out according to the soil properties.	Marked area is Excavated			5

	The damaged area is systematically leveled with respect to surface irregularities.	Excavated portion is Levelled			5
	The foundation layer is appropriately fixed	Foundation layer is fixed			5
3. Establish base layer with Do-nou bags **(25 %)**	Tools, equipment, and materials are adequately prepared according to the size of the damaged section.	Tools, equipment, and materials are prepared			5
	Tools and equipment are properly fixed according to their standard Measurements.	Tools and equipment are fixed			5
	The soil is suitably batched to fill in bags based on prepared containers and ties.	The soil is batched			5
	Do-nou bags are systematically laid depending on the size and condition of the damaged section.	Do-nou bags are laid			5
	Do-nou bags are properly compacted to reach the required bearing capacity	Do-nou bags are compacted			5
4. Establish the wearing course **(15%)**	The wearing course is properly applied in line with camber formation.	The wearing course is applied			5
	Watering and compaction of the wearing course are properly performed with regard to camber formation.	Watering and compaction of the wearing course are performed			5
	Neat clean-up is carried out with respect to environmental protection.	Neat clean-up is carried out			5
5. Maintain Do-nou Road	Damaged areas are properly identified according to the level of damage	Damaged areas are identified			5

(25%)	Damaged bags are efficiently removed and replaced with respect to the existing level of do-nou layers.	Damaged bags are removed			5
	The wearing course is properly applied with respect to thickness layers.	The wearing course is applied			5
	Watering and compaction of the wearing course are properly performed with regard to camber formation.	Watering and compaction of the wearing course are performed.			5
	Neat clean-up is carried out with respect to environmental protection.	Neat clean-up is carried out			5
Total marks					**100**
Percentage Weightage					**100%**
Minimum Passing line % (Aggregate): 70%					

References:

1. Andreas Beaush and Marie Winshold (2001), Skills course Manual, site Supervisor Course for Labour Based and Community managed upgrading of urban Low income settlement, International Labour Office(ILO),Kenya Water institute(KEWI) and Ministry of Roads-Kisii Training Cebtre (KTC)
2. CORE Rwanda. (2021) Final Report on" Sustainable Youth Employment through Road Improvement taking locally available material-based approach project">.
3. CORE Rwanda. (2020) Simplified Field Training Material "Road Maintenance using Do-nou Technology".
4. Kimura, (2015). Introduction to Global Engineering.
5. Bjorn, J., (2008). Building Rural Roads, International Labour Organization, p. 36.
6. Fannin, R.J., Sigurdsson, O., 1996. Field observation on stabilization of unpaved roads with geosynthetics. J. Geotech. Eng. 122 (7), 544–553.
7. Fukubayashi, Y., Kimura, M., 2011a. Do-Nou technology for rural road maintenance in developing countries. In: Proceedings of the 14th Asian Regional Conference of Soil Mechanics and Geotechnical Engineering, pp. 442–447.
8. Fukubayashi, Y., Kimura, M., 2011b. Change life, motivate people, an approach for poverty reduction by maintaining rural roads in developing countries. Tech. News, ISSMGE Bull. 5 (4), 36–44.
9. Matsuoka, H., Liu, S., (2006). A New Earth Reinforcement Method using Soil bags. Taylor & Francis Group, UK.
10. McCutcheon, R., (1989). Labour-intensive road construction in Africa. Habitat Int. 13 (4), 109–123.
11. Riverson, J., Gaviria, J., Thriscutt, S., (2002). Rural Roads in Sub-Saharan Africa, Lessons from World Bank Experience, World Bank Technical Paper, No. 141.
12. Japan Road Association. (2003).Earth Work for Road–Guide for Construction, Japan Road Association, p. 87.