PHILIPPINE NATIONAL STANDARD

Conveyance Systems – Performance Evaluation of Open Channels – Determination of Seepage and Percolation by Ponding Method

DEPARTMENT OF
AGRICULTURE
PHILIPPINES

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancement of Nutrient and Water Use Efficiency Through Standardization of Engineering Support Systems for Precision Farming" funded by the Philippine Council for Agriculture, Aquaculture and Forestry and Natural Resources Research and Development - Department of Science and Technology (PCAARRD - DOST).

As provided by the Republic Act 10601 also known as the Agricultural and Fisheries Mechanization Law (AFMech Law of 2013), the Bureau of Agriculture and Fisheries Standards (BAFS) is mandated to develop standard specifications and test procedures for agricultural and fisheries machinery and equipment. Consistent with its standards development process, BAFS has endorsed this standard for the approval of the DA Secretary through the Bureau of Agricultural and Fisheries Engineering (BAFE) and to the Bureau of Philippine Standards (BPS) for appropriate numbering and inclusion to the Philippine National Standard (PNS) repository.

This standard has been technically prepared in accordance with BPS Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

Conveyance Systems – Performance Evaluation of Open Channels – Determination of Seepage and Percolation by Ponding Method

1   Scope

This standard specifies the method of determination of seepage and percolation in open channels by ponding. The results of this performance evaluation may be used for:
- comparison of the actual losses with the design value
- water balance analysis
- determination of maintenance requirements

2   Definitions

For the purpose of this standard, the following terms shall apply:

2.1
farm ditch
channel which conveys irrigation water from the turnout to the paddy field

2.2
percolation
downward movement of water below ground surface

2.3
pond
sealed section formed between earth embankments where combined seepage and percolation will be measured

2.4
seepage
lateral movement of water below ground surface

3   Principle of Ponding Method

Ponding is one of the methods used to measure the seepage and percolation in open channels where a section of the channel shall be sealed at two ends by earth embankments lined with plastic sheet. This sealed section of the channel shall serve as a pond, in which the amount of water lost for a given time interval shall be measured as shown in Figure 1.

At the start of each measurement period, the depth of water in the pond shall be set at approximately equal to the designed full supply level of the channel. The volume of water lost per unit time in the pond shall be measured as the change in the water surface elevation over an average area of the pond's water surface at a given time interval.
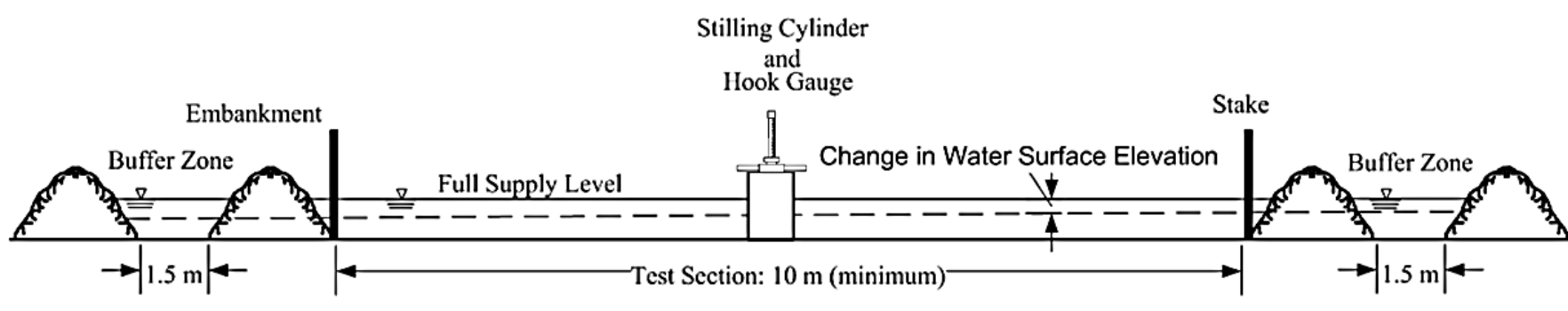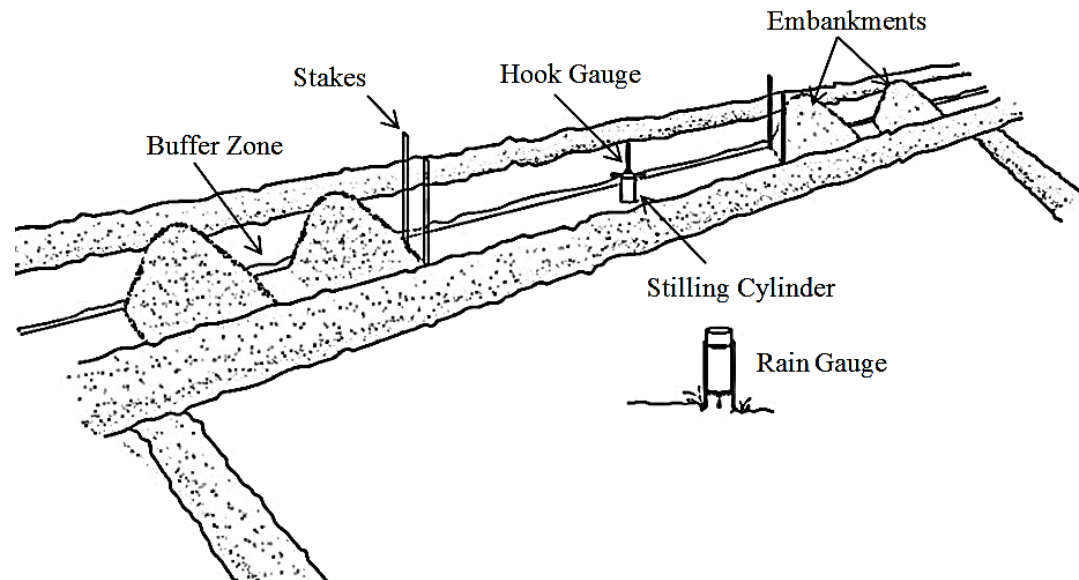
Figure 1. Set-up for Ponding Method

4   Materials and Equipment

List of Materials and Equipment	Minimum Specification
Perforated stilling cylinder without bottom	Material: gage 18 GI sheet Diameter: 20 cm Height: 40 cm Quantity: 1
Hook gauge	Quantity: 1
Rain gauge	Standard 8-inch Quantity: 1
Plastic sheets	
Stakes	Length: 1m
Stopwatch	

5   Site Selection

5.1   The channel sections to be considered shall be at least 10 meters long, straight and with uniform cross sections and slope.

5.2   The channel sections to be considered shall be accessible for ease of pond construction and measurement.

5.3   There shall be no entry and leakage of water from any other sources.

5.4   Bends, steep slopes and segments containing turnouts, valves, gates and other flow control structures shall be avoided.

6   Pond Construction

6.1   The selected channel shall be cleared of debris.

6.2   Compaction of the canal bottom and lower banks shall be avoided.

6.3   The ends of the selected test section shall be sealed with metal plate or earth materials covered with plastic sheet.

6.4   Buffer zones shall be provided with a span of about 1.5 meters on each end of the selected test section as shown in Figure 1. This shall minimize leakage of water across the embankments on both ends.

6.5   The pond and buffer zones shall be filled with water to the normal operating capacity of the channel (80% of the channel depth).

7   Equipment Installation

7.1   One stilling cylinder shall be installed for every 10 m of test section.

7.2   The stilling cylinder shall be installed at the middle of the pond at a stable and level position where hook gauge measurements shall be taken. Installation procedure is shown in Figure 2.

7.3   The middle of the test section shall be located and the bottom of the cylinder shall be laid flat on the channel as shown in Figure 2(a).

7.4   The cylinder shall be driven into the soil using a wood plank and a hammer in order to minimize the disturbance of the soil profile as shown in Figure 2(b). It shall be driven until about 5 cm clearance is achieved between the rim of the cylinder and the normal water level of the channel.

7.5   Level the rim of the cylinder using a carpenter's level as shown in Figure 2(c).

(a)   (b)   (c)
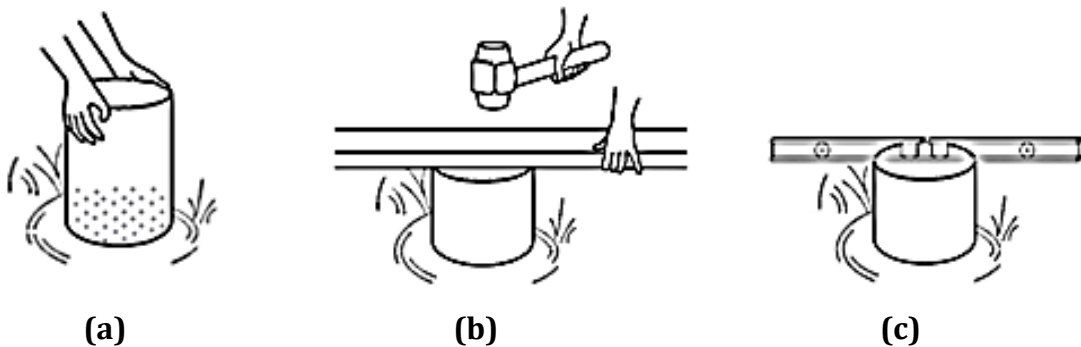
**Figure 2. Installation of stilling cylinder**

7.6   To account for the amount of rain, a rain gauge shall also be installed adjacent the pond as shown in Figure 1.

8   Measurements and Readings

8.1   The length and width of selected channel section shall be determined and recorded immediately after filling with water.

8.2   A minimum of three points along the pond section shall be selected and measured for the wetted top widths. The average top width shall be computed.

8.3   The initial reading on the pond water level shall be determined using the hook gauge. The tip of the hook shall be leveled with the water surface inside the stilling basin as shown in Figure 3.
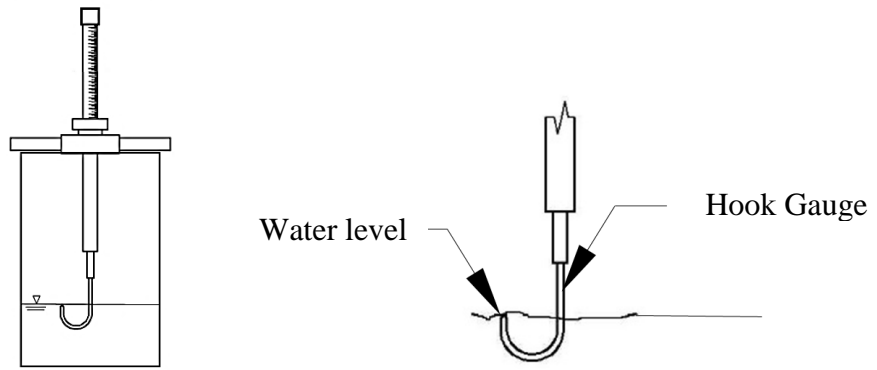
Figure 3. Water Level Reading Using a Hook Gauge

8.4 The water level readings shall always be double checked and the pattern of taking measurements shall be consistent.

8.5 The time of reading shall be recorded as well.

8.6 Readings shall be taken every 15 minutes.

8.7 After the first hour, the time interval between hook gauge readings shall be increased to 30 minutes.

8.8 Readings shall be reset by adding water to the pond before the water level drops below the minimum water depth that the hook gauge can reach from the initial reading. A remark of "RESET" shall be clearly indicated in the record sheet.

8.9 The amount of rain shall be measured using the standard rain gauge as often as water level readings are taken. The measuring cylinder of the rain gauge shall be emptied after each rainfall measurement.

8.10 All measurements and time of readings shall be recorded.

8.11 Measurement shall be terminated until 3 comparable readings are observed.

9 Computation

The following formulae shall be used for the determination of seepage and percolation losses:

9.1 Change in the water depth

$$\Delta H = H_i - H_f$$

where:

ΔH is the change in the water depth in the pond at a given time interval (m)

5

H_i is the initial reading or first reading of water depth in the pond (m)

H_f is the final or second reading of water depth in the pond (m)

9.2   Average pond length

$$L_{ave} = \frac{L_i + L_f}{2}$$

where:

L_{ave} is the average wetted length of the pond (m)

L_i is the pond length during the initial reading (m)

L_f is the pond length during the final reading (m)

9.3   Average pond width

$$W_i = \frac{W_{i1} + W_{i2} + W_{i3}}{3}$$

$$W_f = \frac{W_{f1} + W_{f2} + W_{f3}}{3}$$

$$W_{ave} = \frac{W_i + W_f}{2}$$

where:

W_{i1}, W_{i2}, W_{i3},   is the wetted pond width at three points during the initial reading (m)

W_i is the average pond width during the initial reading (m)

W_{f1}, W_{f2}, W_{f3},   is the wetted pond width at three ponts during the final reading (m)

W_f is the average pond width during the final reading (m)

W_{ave} is the average pond width at a given time interval (m)

9.4   Volume Loss

$$V_{loss} = (\Delta H + R) \times L_{ave} \times W_{ave}$$

where:

V_{loss} is the total volume loss at a given time interval, (m^3)

ΔH is the change in the water depth in the pond at a given time interval (m)

R is the amount of rainfall at a given time interval (m^3/s-m)

L_{ave} is the average wetted length of the pond (m)

W_{ave} is the average pond width at a given time interval (m)

9.5 Seepage and Percolation Loss Rate

$$(S \& P)_{losses} = \left(\frac{V_{loss}}{\Delta T}\right) \bigg/ L_{ave}$$

where:

$(S\&P)_{losses}$	is the seepage and percolation loss rate (m^3/s-m)
V_{loss}	is the total volume loss at a given time interval (m^3)
ΔT	is the time interval between the initial and final reading (s)
L_{ave}	is the average wetted length of the pond (m)

OR

$$(S \& P)_{losses} = \left(\frac{(\Delta H + R) \times W_{ave}}{\Delta T}\right)$$

where:

$(S\&P)_{losses}$	is the seepage and percolation loss rate (m^3/s-m)
ΔH	is the change in the water depth in the pond at a given time interval (m)
R	is the amount of rainfall at a given time Interval (m^3/s-m)
W_{ave}	is the average pond width at a given time interval (m)
ΔT	is the time interval between the initial and final Reading (s)

9.6 Percent of Seepage and Percolation Loss

$$\% (S \& P)_{losses} = \frac{(S \& P)_{losses}}{Q_{design}}$$

where:

$(S\&P)_{losses}$	is the seepage and percolation loss rate, m^3/s-m
Q_{design}	is the design flow in the channel

10 Application of Results

10.1 The computed values of seepage and percolation losses shall be compared with the design seepage and percolation values depending on the soil texture.

Table 1. Seepage and Percolation Values for Various Soil Textures

Soil Texture	Seepage and Percolation (mm/day)
Clay	1.25
Silty Clay	1.5
Clay Loam	1.75
Silty Clay Loam	1.75
Sandy Clay Loam	2
Sandy Loam	4

SOURCE:Design Guides and Criteria for Irrigation Canals, O &M Roads, Drainage Channels and Appurtenant Structures, n.d.

10.2 If the actual seepage and percolation value is greater than the design seepage and percolation value, water duty shall be adjusted.

11   Bibliography

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ANNEX A
(informative)

Test Data Sheet

Set-up Location:	
Latitude:	
Longitude:	
Channel No.:	
Lining Type:	
Test Section Length:	

Date	Time	ΔT (min)	Readings (mm)			Width (m)				Length (m)	Rainfall (mm)	Remark
			Gauge 1	Gauge 2	Gauge 3	1	2	3	Ave			

Sample Calculation

Date	Time	ΔT (min)	Readings (mm)			Width (m)				Length (m)	Rainfall (mm)	Remark
			Gauge 1	Gauge 2	Gauge 3	1	2	3	Ave			
7/8/13	9:39		52.5			0.97	0.95	0.96	0.95	10.900		first reading
7/8/13	12:31	188	14.9			0.91	0.91	0.91	0.91	10.875	0	

B.1 $\Delta H = H_i - H_f$

      $\Delta H = 52.5 - 14.9 = 37.6 \text{ mm}$

      $\Delta H = 0.0376 \text{ m}$

B.2 $L_{ave} = \frac{L_i + L_f}{2}$

      $L_{ave} = \frac{10.9 + 10.875}{2} = 10.8875 \text{ m}$

B.3 $W_{ave} = \frac{W_i + W_f}{2}$

      $W_{ave} = \frac{0.95 + 0.91}{2} = 0.93 \text{ m}$

B.4 $V_{loss} = (\Delta H + R) \times L_{ave} \times W_{ave}$

      $V_{loss} = (0.0376 \text{ m} + 0) \times 10.8875 \text{ m} \times 0.93 \text{ m}$

      $V_{loss} = 0.3807141 \text{ m}^3$

B.5 $(S \& P)_{losses} = \frac{\left(\frac{V_{loss}}{\Delta T}\right)}{L_{ave}}$

      $(S \& P)_{losses} = \frac{\left(\frac{0.3807 \text{ m}^3}{11\,280 \text{ s}}\right)}{10.8875 \text{ m}}$

      $(S \& P)_{losses} = 3.1 \times 10^{-6} \text{ m}^3/\text{s} - \text{m}$

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