TTLM – How To Construct Water Spreading Weirs

Learning Outcome 1: Introduction to the Water Spreading Weir

Guiding questions for discussion (page 25)

1. Explain the benefit of a WSW to your classmate.
   Answer: Benefits of a WSW can be identified in three areas, (1) production, resilience and livelihood benefits, (2) ecological benefits and (3) socio-economic benefits.
2. What is the basic concept of a WSW?
   Answer: WSWs are low-retention structures designed to reduce runoff and erosion. They consist of a spillway in the actual riverbed and lateral abutments and wings which gradually decrease in size with increasing distance from the main structure.
3. How will a WSW contribute to the rehabilitation of land?
   Answer: A WSW diverts the water to the sides to inundate as much surface area as possible above and below the weir. Water infiltrates and fertile sediments are deposited in the floodplain area.
4. How do WSWs lead to the spread of flood water to the target fields by the sides of the weir?
   Answer: WSWs span the entire width of a valley and consist of a spillway in the actual riverbed and lateral abutments and wings. Floodwater is spread over the land area upstream of the structure, eventually overflows the lateral wings, and then slowly flows back towards the riverbed below the structure. WSWs are effective when built in a series of weirs, where each weir retains some of the water and alluvial deposits (fertile soils) and gradually raises the bed of the valley. WSWs slow the water flow and increase the regularly flooded area.

5. Name the structure parts of the WSW.
   Answer: a spillway in the actual riverbed, lateral abutments and wing walls.

Self-Check Test (page 26 and 27)

Part I: Multiple Choice

1. The structural part of WSW that is constructed at the valley bottom is: (1pt)

1. Counter wall
2. Wing walls
3. **Spill over basin**
4. Micro basin

2. All options below are real benefits/functions of WSWs except: (1pt)

1. **Decrease water infiltration into the soil**
2. Increase water table/ groundwater recharge
3. Trap sediments and organic matter
4. Reduce surface run-off

Part II: Short Answer

3. Write down the special features of WSWs. (4 pts.)
   Possible answers:
   - *They are not dams or barrages*
   - *The function of WSWs is to spread flood water and its sediments, reduce the velocity of flow and enhance infiltration*
   - *The water flows away from the middle of the valley/gulley to the banks.*
   - *The effect on the downstream of the weir is often more important than the upstream.*

- *WSWs are especially well suited for large-scale rehabilitation of degraded wide valley floors*
- *WSWs are designed to stop gully erosion in valley floors*
- *WSWs are easier to manage and maintain than dams, they are also more economical to construct*
- *WSW abutments are designed to protect both the weir and riverbanks below from erosion*
- *The primary uses for WSWs in the Ethiopian Lowland context are agricultural and pastoral use*

4. Describe the basic tip that we consider on the WSWs (3pts.)
   Answer: WSWs are also combined with other soil and water conservation measures such as Dry-Stone Measures (DSM) and biological conservation such as planted sisal, elephant grass or others to achieve the maximum result of the interventions.
5. Explain the special features of the WSWs (3 pts)?
   Answer: as in the above.
6. Write at least three impacts of WSWs? (3 pts)
   Possible answers:
   - *Large-scale rehabilitation of degraded wide-valley floods*
   - *Siltation upstream of the weir*
   - *Stabilisation of the weir and storing of groundwater/soil moisture*
   - *Protecting riverbanks from erosion.*

Learning Outcome 2: Setting out WSWs; measurements and calculations

Guiding questions for discussion (page 57)

1. What is the importance of measurements and calculations?
   Answer: This improves and verifies the right value and allows for the drawing to

be transferred to the ground situation. In the process, the values from the drawings are translated and adapted to the ground situation, whilst maintaining the right proportions and design standards.

2. State all the measurements in WSW.
   Answer:
   - *The height difference between counter wing, high wing and low wing under different conditions*
   - *The maximum height difference between the main weir and low wing*
   - *Reasons to propose counter wing heights and lengths*
   - *Foundation, wall and basin thickness and depth, based on bedrock and soil properties.*
   - *Masonry wall for wings and counter bearing*
3. Define the term horizontal alignment and tell your classmates the purpose of adjusting an alignment.
   Answer: Setting out on uneven ground, and particularly measuring distances, requires you to apply some simple geometry. It means to arrange the values in a straight line or the correct relative position. In the WSWs case, we adjust the horizontal alignment by connecting the structure end to end using the top view of the design and GPS points by putting wood or range pools for each section as markers of the location.
4. Discuss about the meaning, purpose and types of basin
   Answer: The basin structure is an important element of a WSW. The water discharge from the main wall upstream might have a high velocity and, therefore, high erosion potential. The basin will provide a barrier to the area of high-velocity flow that reduces the velocity before the water returns to the natural river channel downstream of the structure. This is important to prevent undercutting of the structure. In the construction of WSW, different basin types depend on the natural ground conditions so we should use the right basin type in each section using cross-sectional design or side view drawing.

Self-Check-Test (page 58 & 59)

Part I: Multiple-choice

1. which part is the first step of the layout? (1pt)

- Basin high
- wing wall high
- **alignment**
- all of the above

2. Which one is the standard basin height of type 250? (1pt)

- 25
- **30**
- 50
- 70

3. Which construction tool is used to check the height of the counter wall? (1pt)

- meters
- survey instrument
- water level
- **all of above**

Part II: Short answer

1. How can we get the main wall height using a survey instrument? (4pts)
   Answer: WSW has different types of walls, so we adjust the height of the wall by putting marks on wood for each section using the design. Steps: (1) setup survey instrument, (2) staff read benchmark (BM) and calculate (3) BM (0,0)-B= F.
2. What is the use of GPS? (3pt)
   Answer: To locate the points during the setting of a WSW a GPS (global

position system) device can be used. The GPS device uses a network of satellites to determine positions on the globe and provides you with a reference coordinate. The GPS can be used to identify important locations and boundaries, as shown in the drawing.

3. List the parts of the WSW structure. (3pt)
   Answer:
   1. *Counter bearing wing*
   2. *High wing*
   3. *Low wing*
   4. *Spillway*
   5. *Counter weir and counter wall.*
4. What is the use of horizontal alignment? (3pt)
   Answer: as explained in the above

Learning Outcome 3: Excavation

Guiding questions for discussion (page 74)

1. Discuss the importance of excavation for WSWs?
   Possible answers:
   - *To bring the sub-grade to the required level, grade and line.*
   - *To remove unsuitable materials from the sub-grade*
   - *To prevent saturation of soil in service or if the water cannot be removed to neutralize any bad effects by the use of appropriate materials that are stable even when saturated.*
   - *Excavation will contribute to assuring the quality of construction work*
   - *To install bedding materials.*
2. What are the major points to check during the excavation work?
   Answer: Mass excavation completion should be checked by measuring the width and depth of the excavation by using the meter and levelling instrument.

3. What does reservoir mean and why do we excavate a reservoir?
   Answer: The reservoir is a tank we use to store water for our construction. We excavate a reservoir during construction time, the length and width equal to 3 m and the depth is 1m. The reservoir is lined with a plastic sheet to avoid the infiltration of the water and also it helps us not to lose the water. We decide the number of our reservoirs based on the length of the structure.
4. Discuss the excavation work and its steps?
   Answer: The steps in excavation work are:
   a. *Site clearance*
   b. *Preparation for excavation*
   c. *Mass excavation*
   d. *Check out mass excavation*
   e. *Trench excavation*
   f. *Check out the depth and width of the trench excavation*
   g. *Excavation water reservoir*
   h. *Cleaning throughout the excavated soil*
5. Why should the excavation depth be adjusted in the case of sandy soils?
   Answer: The soils are less stable, and there is a higher risk of the walls of the trench of the basin collapsing during construction
6. Why should the excavated materials be deposited upstream of the building site?
   Answer: It is kept at the upstream area to avoid downstream erosion and to avoid the material falling back into the excavated area.

Self-Check-Test (page 75 & 76)

Part I: choose the best answer

1. Which part is the first step of Excavation? (1pt)

- trench excavation
- **mass excavation**

- all of the above

2. How much is the standard mass excavation depth of type 250? (1pt)

- A.30
- **B.80**
- C.50
- D.70

3. Which construction material can check excavation depth and width? (1pt)

- **meters**
- **survey instrument**
- water level
- all of above

Part II: short answer

1. Explain the use of Excavation. (3pts)
   Answer:
   - *To bring the sub-grade to the required level, grade and line.*
   - *To remove unsuitable materials from the subgrade*
   - *To prevent saturation of soil in service or if the water cannot be removed to neutralize any bad effects by the use of appropriate materials that are stable even when saturated.*
   - *Excavation will contribute to assuring the quality of construction work*
   - *To install bedding materials.*
2. How can we measure the depth of Excavation? (3pts)
   Answer: Through the use of a measuring tape, and comparing the level of the excavated area with the original level of the field.
3. Why the excavation soil should be filled? (3pts)
   Answer: At the back of the weir wing wall and main wall of the structure the

excavated soil should be backfilled end to end of water spreading weir structure. This will avoid and reduce erosion along the structure.

4. What you will do if the excavated soil type is sandy soil? Write the solution you will do and explain why? (4pts)
   Answer: The soils are less stable, and there is a higher risk of the walls of the trench of the basin collapsing during construction. The solution is to increase the width and depth of the excavation and to make the walls of the excavated basin/trench of a lower angle.

Learning Outcome 4: Constructing Water Spreading Weir

Guiding questions for discussion (page 107)

1. Why is it important to follow construction steps?
   Answer: To construct the WSW, we should follow the sequence to construct the right WSW and make them more durable and effective for their purpose and function.
2. Can you name all structural parts of WSW?
   Answer:
   1. *Counter bearing wing*
   2. *High wing*
   3. *Low wing*
   4. *Spillway*
   5. *Counter weir and counter wall.*
3. What is periodic maintenance? Discuss the purpose of the maintenance.
   Answer: Considering the actual topography or required amount of conservation or depth of the gully, we will have step-by-step construction. After the first construction and rehabilitation, we will continue a second construction or height increment which is initiated by engineers based on the type of damages. Most of the time we maintain every other year, after the rainy season has passed, because there is a chance of a high flood during this season, so most damages

occur during this time interval. That will give a chance for the spreading of the water to continue after the area behind the WSW is silted up. An added advantage is that the flooded area increases the moisture content, creating more space for crop cultivation.

In case of flood damage, we will work on timely follow-up and maintenance work. For height increment and maintenance work, we first observe the site and then take a profile from the structure. After that, we can recommend the type of maintenance based on the damage that occurs in every section and estimate the volume of work in each section.

Self-Check Test (page 108 and 109)

Part I: choose the best answer

1. What is the first step for the construction? (2pts)

- basin
- wing wall
- **wall foundation**

2. What is the use of section division? (2pts)

- To support basin.
- **To support the main wall**
- all

Part II: short answer

1. What is the function of basin structure? (3pts)
   Answer: As explained earlier.

2. Write the sequence of the construction. (3pts)
   Answer:
   a) *Wall trench construction and counter wall trench excavation*
   b) *Triangle support construction: wall construction integrated with a triangle support basin*
   c) *Basin construction, counter wall construction*
   d) *Finalize wall construction*
3. What does quality mean? List the physical tests we take in the field. (3pts)
   Answer:
   - *Material quality such as the quality of:*
     - *Sand- not mixed with soil*
     - *cement- not expired*
     - *water- check if it is clear*
     - *stone- is not smooth, fragile and porous*
   - *check the construction is the same as the design of the drawing.*
4. List down the WSW construction techniques. (3pts)
   Answer:
   - *Lay stone and mortar together at the same time*
   - *Lay stone as closely and tight fitting as possible*
   - *Build a rough surface along the top of the weir*
   - *Fitting the stone and cement together at the same time*
   - *Working with large stones*
   - *Place excavated soil on the upper side of the weir after the construction.*

Learning Outcome 5: Occupation Health, Safety and Environmental Procedures

Guiding questions for discussion (page 139)

1. What does OHS mean?
   Answer: OHS is an abbreviation of Occupational Health and Safety

2. State types of safety?
   Answer: (1) personal Safety, (2) workplace safety, (3) material safety
3. What are environmental policies and procedures?
   Answer: environmental procedures are written statements and principles to manage the environmental effects and aspects of the operation. Every stage of construction work has a measurable impact on the environment.
4. Discuss workplace safety.
   Answer: Workplace procedures and work instructions are followed to ensure safety. The purpose of this procedure is to provide a definitive standard for Health, Safety and Environmental (HSE) incidents
5. What does first aid mean and discuss the use of first aid?
   Answer: Give first aid if any accident is happening which means giving treatment to a person suffering from any injury or illness until professional medical care can be provided.

Self-Check Test (pages 140 and 141)

Part I: Multiple-choice

1. Which one of the following do we apply for environmental protection in WSW? (2pts)

1. Cleaning the place where we mixed the cement
2. Clean the water reservoir, we dug to store water and after we finished the construction
3. Dispersing the soil we dug for the construction
4. **All**

2. Which one is a reason for accident occurrence? (2pts)

1. Not wearing personal protective equipment (PPE) at the work site.
2. No proper handling of materials
3. Not reporting of First Aid injuries.

4. No provision of access/egress.
5. **All the above.**

Part II: short answer

1. What does personal safety mean? (3pts)
   Answer: Various forms of accidents occur at various stages of construction and in various operations. Personal safety means your safety.
2. What does material safety mean? (3pts)
   Answer: Material handling operations to having a productive workplace and completing the job in a timely matter. Keeping the site safe is critical to protect equipment
3. List down the environmental procurers we use in the WSW construction. (3pts)
   Answer: as explained earlier
4. List down reasons for accident occurrence. (3pts)
   Possible answers: as outlined earlier.