Command Area Development with MGNREGS

A Resource Booklet for MGNREGS Functionaries:

Designed and Developed by WASSAN as part of GIZ Project
"Environmental benefits of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA-EB)"

This booklet is a handy reference for use by cutting edge MGNREGA functionaries. It is intended to help and support them to apply the knowledge/ tools/ instruments for the creation of technically sound assets and helps in following all the steps of the process/procedure in their proper sequence, with the recommended precautions.

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FOREWORD

I am happy that GIZ under the MORD-GIZ joint project "Environmental Benefits of MGNREGA" has simplified the SAMARTHYA and has developed four simplified technical resource booklets on themes namely, (a) Watershed Development for Rainfed Areas under MGNREGS (b) Command Area Development with MGNREGS (c) Afforestation and Tree Plantation under MGNREGS (c) Convergence of MGNREGS with Other Schemes and a Simple Mathematics Guide and Measurement.

The primary objective of these resource booklets is to demystify the technical aspects of MGNREGA works for the cutting edge functionaries like Mates. The resource booklets and the mathematics guide will go a long way for the creation of durable and sustainable assets. It will provide necessary support to the MGNREGA functionaries in following required procedures with the recommended precautions.

I am hopeful that the four simplified resource booklets and the Mathematics Guide will act as handy reference for the MGNREGA functionaries and will provide answer for all possible queries to cutting edge MGNREGA functionaries. The illustrations and sketches in the booklets will be helpful for the MGNREGA workers to understand the basics about the works under MGNREGA.

(APARAJITA SARANGI)
Joint Secretary (MGNREGA)

MESSAGE

The project on ` Environmental Benefits of MGNREGA' is a collaboration between GIZ and the Ministry of Rural Development, Government of India. It is operational in the states of Rajasthan (Bhilwara and Chittorgarh districts), Chhattisgarh (Dhamtari and Rajnandgaon districts) and Andhra Pradesh (Anantapur and Vizianagaram districts). This project is technically supporting Gram Panchayats to strengthen the mobilisation, planning processes, implementation capacities, user groups formed under MGNREGS and mechanisms for sustainable use and maintenance of assets.

To strengthen this process, we have supported the development of four booklets based on the "Samarthya" (the technical handbook for MGNREGS developed by MoRD), of which this is one. These booklets provide simplified ways of understanding and designing MGNREGS works related to natural resources management, agriculture and allied activities.

I believe that these booklets will be of immense help for the field level MGNREGA functionaries in creating durable and sustainable assets, thereby helping to mainstream environmental benefits as one of the success indicators of MGNREGA. These booklets will also be useful as resource books for the training of ground level functionaries, thus helping enhance the element of environmental benefits of MGNREGA all over the country.

I would like to express my gratitude to MORD for validating these booklets. I am hopeful that they will be disseminated widely and used across India in its various regional languages.

SABINE PREUSS (Mrs.)
Director
Natural Resource Management Programme
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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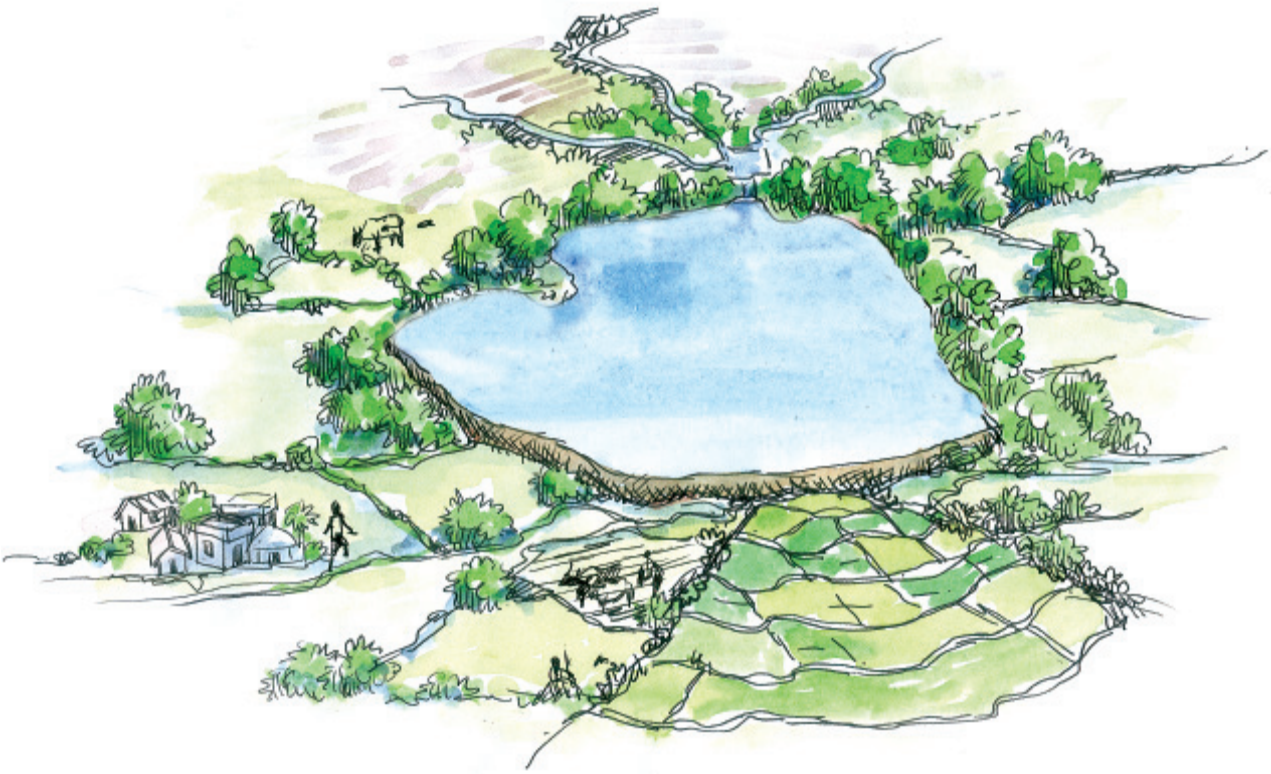
Developing Command Areas under MGNREGA

By and large, irrigation infrastructure is under operation, below their potential due to inadequate maintenance, resulting into the problem of low efficiency of water use and low productivity. There is an immense need for effective micro level infrastructure development and efficient farm water management to enhance agriculture production and productivity. This will inturn improve socio-economic condition of the rural farmers. Command area development works under MGNREGA provide employment to the needy rural masses at one side and better irrigation and drainage facilities at the other end. These works not only save the most valuable irrigation water, but also improve irrigation efficiency of the system. The ultimate aim is to increase optimum crop production per unit of water and per unit of area, which in turn would improve the livelihoods and socio economic conditions of the dependents.



This Booklet covers two types of Irrigation systems:

Part 1: *Tank Water based Irrigation System*

Part 2: *Canal Water based Irrigation System*

Note: *Tank bund is an Earthen bund which is to be convered as part of Resource booklet No. 1 on Watershed Devepement of Rainfed Areas. But, Tank is source of irrigation and deals with several structural elements. Hence, it is covered as part of this booklet.*

Part 1

Tank water based Irrigation System

Introduction

In a watershed area, the catchment area including drainage lines, arable and non-arable lands are being treated by several activities. These activities at one end reduce soil erosion and also build and protect water harvesting structures. Majority of the watershed areas have big water harvesting structures meant for providing irrigation to the lands in command area. Tanks apart, such water harvesting structures are very critical for an agro based rural economy.

Area from where the water flows into a particular water harvesting structure is called catchment area. Area to which the water is provided for irrigation is called as 'Command Area'

Tanks and other irrigation structures should be in 'good working condition' for performing to their full potential. But in many areas, different types of problems are hindering the efficacy and performance of these critical structures; these factors are associated with infrastructure elements like Bund, Sluice, Surplus Weir, Feeder Channel, Supply Channel and Tank Bed etc.

Tank with catchment and command area

Bund is very important to hold and retain the water in the tank. Bund is an earthen structure constructed across a drain or stream. Stone revetment is provided to the bund on side slopes. The revetment is constructed with the support of toe wall.

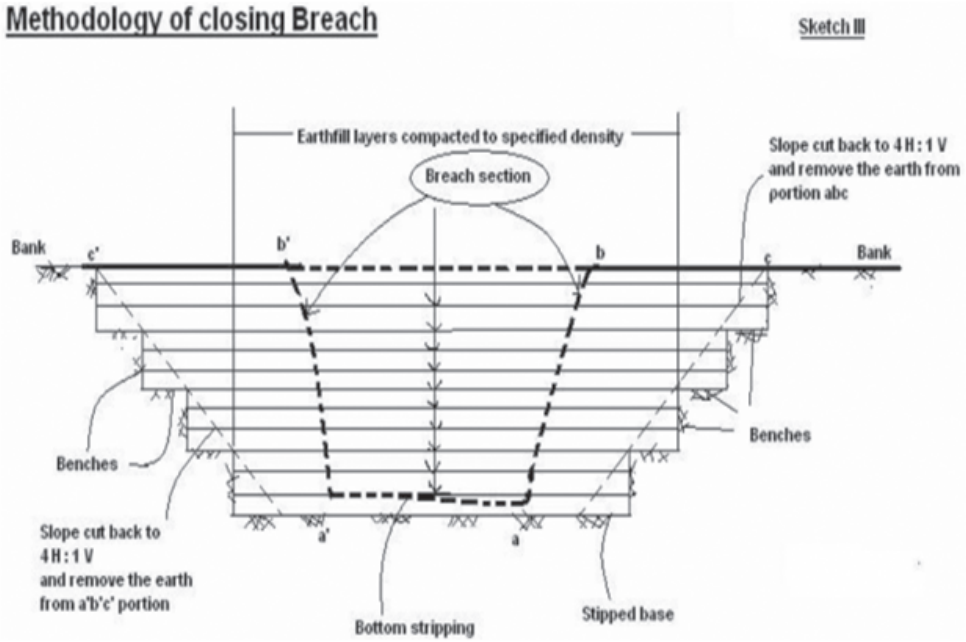
Works for Improving Tank based Irrigation System

1.1 Breach Closing of the Bund

The bund may be breached for various reasons; it may be due to the holes created by iguana or rats/rodents or crabs or borrowing animals, sagging down of revetment stones, voids created by the roots of trees on the bund or continuous seepage of water over a period of time etc. Following key tasks are needed for this activity.

- Removal of bushes
- Removal of stone from the revetment of breached portion
- Removal of earth in the breached portion
- Digging key trench
- Construction of key trench with impervious soil
- Construction of bund
- Compacting with water and roller in layers
- Digging of foundation for toe wall
- Construction of the toe wall

Tech Design



Source: Operational manual on APCBTMP by I&CAD, GoAP

Steps in Marking

- Remove all vegetation, bushes including roots from the site
- Remove the stones from the breached portion and set aside on the bank as they can be used while working.
- Remove the soil exposed from the breached portion
- Remove all loose soil from the ends of the bund, from both sides
- Mark the portion of the bund to cut the earth
- Marking for Earth work for foundation of key trench
- Marking for raising the bund. The slope should be maintained in parity with the remaining portion of bund

Remove weed at breached portion

Steps in Execution

Cut the bund on right and left side in steps

Dig key trench

- Cut the bund on either side of the breach to a flat slope.
- Bench the cut slope in suitable steps of 0.30 m or 0.45 m.
- Slope cut as per design
- If the bund is cut till the bed level, dig the earth for foundation of the bund for 0.50 mtr. Deposit the excavated earth on the banks. This earth should not be used for construction of the bund if the earth is not impervious.
- Earth work for foundation of key/core trench. Dig the earth and deposit the earth on the banks. This earth should not be used for construction of the bund if the earth is not impervious.
- Construct the key/core trench with impervious soil. Compact the earth by adding water in layers of 0.225 m with compactor or earth rammer.
- Once the key trench is raised upto foundation level, simultaneously raise the bund. Compact the earth by ramming it using power operated or fuel operated roller in layers by applying water.
- Tie the rope from bottom to the top of the bund to maintain the required slope.
- For digging foundation of toe wall and construction of the toe wall – (*refer subsequent sections*).

Maintenance

- Observe the seepage of water
- Do not allow plants to grow on the bund
- If the bund becomes prone to breach, form a ring bund in the tank near the bund to protect from force of water

Possible Outcomes

- Tank becomes 'functional'
- Tank retains water to its fullest potential
- Irrigation for fields in the command area

Do's and Don'ts

Do's

- Use impervious soil only for constructing key wall. Do not use the earth dug to construct the key wall.
- Construction of key wall and bund should be by compacting in layers of 9 inches, not just at the end of the work.
- Raise the key wall upto the Full Tank Level (FTL)
- If using roller is not possible, proper ramming must be done using the wooden rammer
- Slopes of embankment should be in conformity of original design. The width of plugged portion of the bund should be extra 0.20 mtr on both sides to ensure effective compaction. The extra width can be trimmed later and earth can be reused

Don'ts

- Do not construct the bund without foundation
- Do not use the excavated earth for foundation to construct the bund
- Do not construct/form the bund without key wall
- Do not construct the key wall and bund without adding water in layers and without ramming and compacting

FAQs

Q: Is it important to clear off the water before treating the breach?

A: Yes, water may damage the bund and deteriorate the quality of the soil. Therefore, water should be completely cleared off from the bottom of the breach section and its close vicinity

Q: Why should the existing earth must be removed from the breached portion of the bund?

A: The earth would have become slushy and muddy and pervious. This may allow the water inside and cause the breach again

Q: What happens if we construct the bund from where the bund is remaining?

A: If we construct bund without removing this upto a particular depth, water may leak out from this portion of exposed earth. Therefore, cut and remove the exposed earth and construct the bund

Q: Why do we need to dig foundation, if the bund is breached till bed level?

A: The portion of the bund is re-constructed. The foundation helps to prevent leakage and retains the bund stronger.

Q: Can we reuse the revetment stone dislodged from the bund?

A: Yes, the stone can be reused

Q: Can the vegetation be removed with roots?

A: Yes, it should be uprooted.

Q: Why do we need the toe wall for revetment?

A: Toe wall functions as base to the revetment wall.

Q: Why should we cut the bund in benches instead vertical straight or in slope?

A: The benches will help the bund with a better bond at junctions/joints.

Q: Why the compacting should be done uniformly?

A: For better compacting and maintaining the bond

Q: Why do we need to raise the key wall upto FTL?

A: FTL means Full Tank Level. If the tank is full, water reaches till this level. The purpose of the key wall constructed with impervious soil is to prevent leakage. Therefore, it should be till the water level.

1.2 Raising Bund Height

The bund is designed considering the capacity of the tank. But, over a period of time, due to siltation in the tank bed, 'angle of repose of soil' on the bund, sagging etc, the height of the bund could have been reduced. To harvest the water to the full capacity of the tank, bund height should be at appropriate level. The issues to be dealt to strengthen the bund are:

- Less height due to erosion of bund on downstream side
- Deterioration of bund section due to erosion
- Breach of the bund due to piping action caused by growth of roots that entrenched into the bund
- Holes dug by rats/rodents, crabs, borrowing animals such as iguana
- Decrease in the height and width of the bund due to soil erosion caused by rain water
- Sweating/ leakage at the bund

Steps in Marking

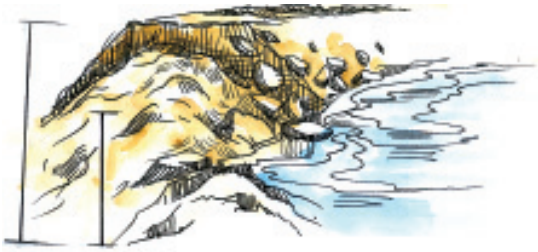
- Measure/calculate the bush to be removed
- Remove the bush
- Give marking for the portion and depth of the earth on the bund to be stripped/ scrapped
- Give marking for raising the bund

Key tasks

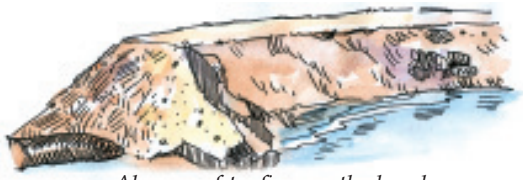
- Removal of bush on the bund
- Raising the bund height by adding additional earth
- Protect the rear section of the bund from scouring action – turfing

Steps in Execution

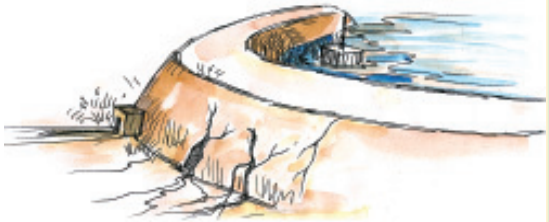
Weed growth on the bund



Collapsed Revetment and bund erosion



Absence of turfing on the bund



Leakages

Rat holes

- Remove the weed/vegetation on the bund
- Strip the exposed and loose soil on the bund
- Tie the rope from bottom to the top of the bund to maintain the required slope
- Divide the total height of the bund to be raised into layers of each 0.225 mtr (9″).
- Construct the bund with the impervious soil in layers.
- Compact the earth with roller (machine operated or manual) by applying the water.
- To prevent the sweating or leakage, construct the key trench with impervious soil before the toe wall on upstream side of the bund.

Maintenance

- Observe the longitudinal and transverse cracks in the embankment. High temperature may crack the clayey soils.
- The cracks may also happen due to differential settlement between adjacent lengths of embankment, at junctions of earth and masonry structures, due to non-uniform compaction in successive layers.
- Remove the ant hills as and when found. Pore sand into holes of ant hills until the holes are filled.
- Grow suitable grass on rear side of the bund to prevent erosion
- Observe the leakage of water
- If the bund becomes prone to breach, form a ring bund in the tank near the bund to protect from force of water

Do's and Don'ts

Do's

- Compact the earth adding water in layers of 9".
- Provide turfing on rear side of the bund
- Extend the bund on the downstream side not on the front side.
- Provide turfing on the rear side of the bund to prevent rain-cut and gullies.
- Use impervious soils such as block soil for constructing key wall. Do not use the earth dug to construct the key wall
- Construction of bund should be by compacting in layers, not just at the end of the work

Don'ts

- Do not use the earth stripped for foundation to construct the bund
- Do not construct/form the bund without key wall
- Do not construct the key wall without adding water in layers of 9 inches and without ramming, compacting
- Do not construct the bund without adding water in layers of 9 inches and without compacting with wooden rammers or machine operated compacters
- Do not remove the grass on the rear side of the bund to prevent exposing of earth to rainfall.
- Do not grow trees on the bund. They enroot into the bund, cause piping action and thereby breaching
- Do not allow the farmers adjacent to the bund to cut the toe of the bund on rear portion
- Do not allow any type of structure on the bund

Possible Outcomes

- Tank becomes 'functional'
- It retains water to its fullest potential
- Fields in the command area gets water for crops

FAQs

- Do not allow any encroachments on the bund.

Q: Why the stripped earth should not be used for foundation
A: This earth is not fit for bund. It does not strengthen the bund.

Q: What happens if the width of the bund is extended on the front side?
A: It reduces the storage capacity of the tank. Generally the revetment is provided on front side, therefore there is no chance to expand the width of the bund on this side.

Q: What happens if the bund is formed without key wall?
A: Key wall prevents seapage/leakage of water. Bund without key wall is prone to leakage/damage

Q: What happens if the bund is constructed without adding water in layers and without compacting with wooden rammers?
A: If the water is not added, the voids in the soil particles will not be reduced. It takes lot of time for the bund for "Settlement". More voids in the soil means bund is prone to breach

Q: What is the harm if there are any structures on the bund?
A: Generally structures and trees weaken the bund.

Q: What happens if the turfing is not provided?
A: Force and speed of rain water flow erodes soil on the sides of the bund. The turfing on the rear side of the bund prevents rain-cut and gullies

Q: Why compacting is needed?
A: Compacting with rollers reduces voids in the soil particles and presses the earth by which bund becomes stronger.

Q: Why the earth must be compacted in 0.225 m layers?
A: If the entire thickness of earth is compacted at the end, the pressure is not sufficient to press the soil till bottom. Therefore, in layers of 0.225 m thickness is appropriate to press and compact the earth to strengthen the bund

Q: Why compacting require water?
A: Adding water will help the soil to get pressed well and fills voids in soil particles

Q: Can we pore water with pipe while compacting bund?
A: No, Water should be sprinkled. If water is pored it becomes more muddy, slurry and will not compact the earth.

Q: Why grass should not be removed on the bund?
A: Grass prevents the soil from the force of rainfall.

1.3 Stone Revetment to Bund

The bund holds huge quantity of water and is prone to breach. Water stored in larger area will have waves and they continuously hit the bund causing erosion and breaches bund. Revetment helps the bund to retain to the water pressure. The problems associated with the revetment are: Non-existence of revetment completely or partly or upto less than the height of the Maximum Flood Level (MFL)/ Maximum Water Level (MWL) or dis-lodged stones.

Steps in Marking

- Removal of bush, weeds, vegetation on the bund and foot of the bund on upstream side
- Give marking to the foundation of toe wall
- If clay blanket is to be provided: Strip the exposed portion of bund and remove the loose soil.
- Tie the rope along the slope, from top of the bund to the base of the bund/toe wall
- Dig trench for toe wall as per the measurements
- Construction of the toe wall with 0.225 mtr stone.
- Construction of Revetment with 0.225 mtr stone
- If required provide blanket with impervious soils
- Provide u/s slope as per the angle of repose of the soil used.

Key tasks

- Earth work for foundation of the toe wall
- Stone work for toe wall
- Revetment upto the MWL/MFL
- Clayey (impervious soil) blanket to the bund before revetment if required

Maintenance

- Observe the dislodging of stone on the revetment
- Do not allow plants to grow on the bund
- Set the dislodged stones proper in regular intervals

Possible outcomes

- The tank becomes 'functional'
- Tank retains water to its fullest potential
- Fields in the command area gets water for crops

Do's and Don'ts

Do's

- Revetment should be aligned to the original design of the bund and it should be upto the MWL/MFL
- Put larger stone on the base of the foundation
- Provide clay blanket before revetment if required.
- For clay blanket or revetment, first strip the exposed earth and maintain the shape with shoulders as per the original design of the bund

Don'ts

- Do not construct the revetment without removing the bushes, weed and vegetation on the bund
- Do not construct the revetment without toe wall

FAQs

Q: Why does the clayey blanket required?
A: To prevent leakage/seapage of water

Q: Whether the clayey blanket is first or revetment is first? Why?
A: First apply clayey blanket to the bund then construct revetment. Clayey blanket is to prevent leakage and revetment is to protect bund from waves of water. If the clayey blanket is exposed to water waves, the clay will not remain, therefore, clayey blanket is in between bund and revetment.

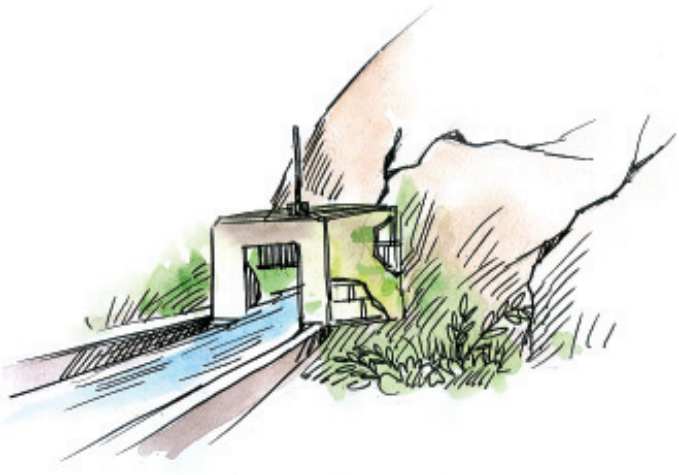
Q: What if the revetment is not aligned to the original design of the bund?
A: The original design of the bund has stone revetment upto MWL. Therefore reconstruction of the revetment should also be raised till the original MWL. Then only it can retain to the pressure of water when it reaches MWL.

Q: Why should the bushes, weed and vegetation etc need to be removed while taking up revetment?
A: If it is not removed, it grows again. The regrowth will damage the revetment stone while it entrenches it roots.

Q: What happens if the revetment is constructed without toe wall?
A: The toe wall is the foundation base for the revetment. This prevents the revetment wall from sagging down

1.4 Strengthening Sluice

Tank sluice is a regulating device and the means of vehicle for providing water to the crops in the command area. This helps the farmers to effectively manage the available water for the crops and also helps in critical irrigation. If this doesn't function properly, it is difficult to draw the required quantum of water from the tank. Either it doesn't give adequate quantity of water or there will be wastage due to leakages. Basically, there are 3 types of sluices.



- Barrel type or pipe type (with Hume pipe)
- Plug and rod system with barrel constructed with stone or brick
- Steel shutter with screw (approached from top of the bund with narrow foot bridge

The **possible issues** associated with the sluice are:

- Damage/issues with Controlling arrangements – plug and rod or shutter with gate
- Leakage of water near the sluice
- Leakage of water along sides of sluice barrel
- Obstacles in the water way
- Rust to plug and rod or gate/shutter
- Siltation inside the channel/water way
- Absence of plug and rod
- Condition of shutters, screw gear

Key tasks

- ❑ Repairs to barrel (stone or brick walls)
- ❑ Fixing of controlling equipment in right condition such as Plug and rod or shutter gate

Steps in Execution

- Remove the obstacles such as stones, weed, silt in the water way
- For repairing barrel
  - Remove the loose earth near the bund
  - Construct the brick/stone masonry
  - Provide lining with cement mortar inside the water way
- For controlling equipment
  - Apply grease to screws and hinges
  - Replacement of existing dysfunctional plug and rod
  - Replacement of existing dysfunctional screw gear operated steel shutters
  - RCC platform
- On rear side
  - Provide stone/brick masonry. This helps in easy removal of siltation if any.
- Excavation of tank bund for Reconstruction of sluice
  - Cut the portion of embankment on either sides (both u/s and d/s) or complete bund of that portion
  - Cut the bund in ratio of 3(h):1(v) ratio benching the slope
- Undertake required repairs to sluice

Maintenance

- Observe the leakages
- Observe turbidity of water leakage

Possible outcomes

- The tank becomes 'functional'
- Tank retains water to its fullest potential
- Irrigation to the fields in the command area

Do's and Don'ts

Do's

- After the repairs, the cement concrete or masonry must be provided with water curing for a minimum of 14 days
- For filling the open-cut bund, construct bund with pervious soil in15 cm layers duly compacting with fuel operated bed compactors
- The bund must be cut in benching the slope

FAQs

Q: Is it compulsory for water curing after the repairs?

A: Yes, it is compulsory. Cement mortar or cement concrete requires curing with water for at least 14 days.

Q: Is there any method to observe the turbidity of the water leakage?

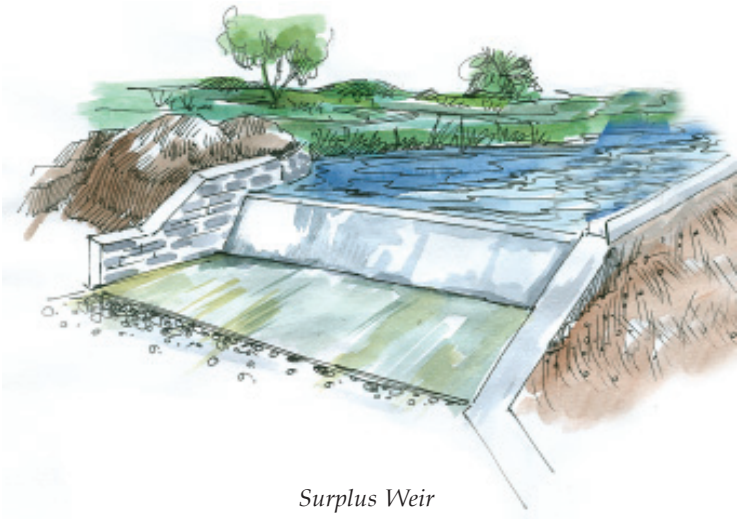
A: If the color of water coming out the sluice is same as the colour of water before entering the sluice. There is no turbidity.

Q: What measures need to be taken to prevent rusting of the sluice parts?

A: Frequently apply grease. Clean with kerosene.

1.5 Strengthening Surplus Weir

Surplus weir safeguards the tank from the excess flood of water by passing it off safely. It is generally located at the ends of the tank bund. If there are leakages in the surplus weir it drains out water which is harvested in the tank for irrigation. Hence, shortage of water for crops under the tank in the command area. Therefore the surplus weir must be in good working condition. The possible issues with the surplus weir could be:



Surplus Weir

- Leakage or any damages in the body wall
- Apron stones are washed away
- Obstacles in the drafting channel such as weed/vegetation growth, siltation, etc
- Damage to the wearing coat with cement mortar
- Damage to the wing walls on upstream and downstream side (nosing) such as missing revetment, dislodging, etc
- Silt near the surplus weir
- Less width of the surplus weir
- Pot holes on solid apron
- Damage of loose apron on downstream side

The surplus weir wall height is equal to FTL water. If tank gets full water, the level of water will be upto this. If tank gets little more, it will spill out from the surplus weir. The wing walls will be raised upto maximum water/flood level (MWL/MFL). This wing wall will be constructed with stone masonry. The tank bund will have revetment upto this level (MWL/ MFL).

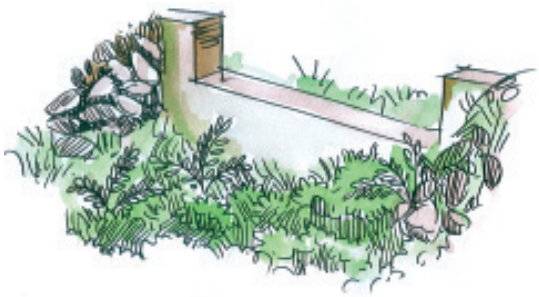
Steps in Execution

- For controlling the leakage or repairing breaches/ damages in the body wall:
  - Remove the stone masonry till that portion
  - Re-construct the portion of the dam to the allowed height
  - Provide wearing coat with cement mortar of 1:3
- For controlling the leakage/seepage
  - Dig the key trench in upstream side parallel to the surplus weir
  - Fill with impervious soil duly compacting with water and ramming with roller
  - Provide skill wall with a thickness of 20 to 30 cm on the upstream side with nominal reinforcement
- Coping slab/ cement plastering: If coping slab/ cement plastering is damaged on the top width portion of the weir
  - Expel the wearing coat of damaged portion
  - Provide cement mortar with permitted thickness. Because the thickness may cause rise in the surplus weir level.
- Reconstructing the apron where stones are washed away
  - Remove the dislodged stone
  - Dig the foundation to the portion of apron
  - Fill the foundation with stones of 0.225 m and above sizes

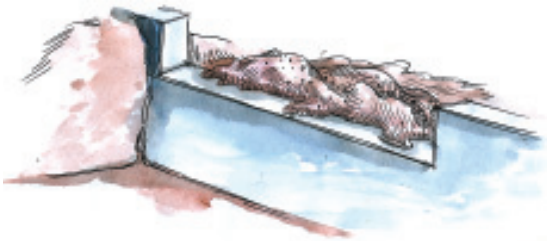
Breached weir

Damaged Cement plastering

Damaged Loose Apron



Weed growth/ obstacles at surplus weir



Silatation near surplus weir

Collapsed side walls

- For removing obstacles in the drafting channel such as weed/vegetation growth, siltation, etc
  - Remove the silt
  - Remove the weed/vegetation
- Removing silt near the surplus weir
  - Remove the silt near the surplus
  - Remove the weed/vegetation near the surplus weir
- Repairing damage to the wing/ side walls on upstream and downstream side (nosing)
  - Construct the protection wall to the sides on upstream and downstream side upto the Maximum flood level
  - Remove the dislodged portion and reconstruct upto the maximum flood level
- Low height/ breach of the surplus weir
  - If the height of the surplus weir is low or breached for any reasons, raise height/ repair surplus weir to the permitted height
- Less width of the surplus weir
  - If the width of the surplus weir is less, increase the width by reconstructing the portion of the weir to the permitted width.
- Closing pot holes on solid apron
  - Cut the pot hole in square/ rectangle.
  - Fill with CC 1 : 3 : 6.
  - Provide proper water curing.

Maintenance

- Observe the weathering coat frequently
- Take up repair works before start of monsoon season

Possible outcomes

- Surplus weir functions properly
- Stores water to the fullest capacity of the tank as per the design
- No more leakages
- Discharges flood water safely

Do's and Don'ts

Do's

- Strengthen the bund at surplus weir by adding impervious soil/gravel
- Before taking up repair work, observe leakages from surplus weir or the bund on downstream side. Accordingly do the repairs

Don'ts

- Do not raise the height of the surplus weir without the permission of appropriate authority. Because the levels are fixed duly surveying the tank bed area (water spread area). If the height is raised, water may submerge the farmers' fields.

FAQs

Q: What is the ground level (GL)?

A: This is the tank bed level.

Q: What is the full tank / reservoir level (FTL/FRL)?

A: This is the level where water gets stopped after the inflow is stopped. If inflow starts into the tank, water starts spilling over the surplus weir.

Q: What is the Maximum Flood/Water Level (MFL/MWL)?

A: This is the level to which water reaches maximum in any situation of maximum inflow to the tank.

Q: What is the Tank Bund Level (TBL)

A: This is the maximum height of the bund. Water should not touch this level even there is maximum inflow to the tank

Q: What if the dislodged stone is not removed before repairs?

A: Removing the dislodged stone allows us to properly repair the damaged portion of the apron. It also helps in placing the stone properly

Q: What if the damaged wearing coat is not expelled before it is replastered?

A: We need to remove the damaged portion and also little more around it in a square or rectangular shape. The structure will easily hold the cement mortar when it is re-plastered

1.6 Strengthening Feeder Channel

Feeder channel is the main source of water to the tank. This channel collects water from its catchment area. Therefore, this feeder channel should have proper access to all small drainages connecting to it. The source of one tank could be, most of the times, rain/flood water from another tank in the upstream side of catchment area. Treatment in the catchment area prevents soil erosion and saves u/s side of the feeder channel and tank from siltation. The length, breadth and depth of the feeder channel depend upon the catchment area and size of the tank. Generally it is a trapezoidal shaped channel.

The issues associated with the feeder channel would be:

- Course diversion
- Leakages to the feeder channel
- Improper shape due to sides erosion
- Siltation
- Obstacles in the channel such as weed/vegetation growth, siltation, etc

Steps in Marking

- Divide the entire supply channel into reaches, walk through along the channel.
- In each reach, identify the portion of channel with vegetation/weed growth. Calculate number of person days required.
- Mark the portion where desilting is required, identify the depth of silt to be removed
- Measure the slope using hydro marker
- Observe the sectioning of the channel. Identify the portion where there is no proper L-section and cross section in Trapezoidal shape

Siltation in Channel

Weed growth in drainage

Steps in Execution

- Remove the weed
- Remove the siltation as per the slope and deposit on the both sides leaving berm as per the design
- For controlling the leakage
  - Cut the suitable earth and fill the sides/flanks at leakages.
  - Stone revetment to the sides to protect the channel banks, where the sides are prone to sagging, weak sides with loose soils and possibility of course diversion
- Strip the sides to maintain the Trapezoidal shape with required slopes

Leakages

Maintenance

- Observe the feeder channel frequently
- Close the holes dug by burrowing animals such as crabs, iguana, etc
- Take up repair works before start of monsoon season

Possible Outcome

- Obstacles in the channel are removed
- Flanks are strengthened to prevent erosion and sagging
- Leakages are controlled
- Tank receives water

Do's and Don'ts

Do's

- Desilting must be done with a non-erosive and non-silting section slope for smooth flow of water.

Don'ts

- Don't remove the silt deeply in the channel. Water should flow smoothly.
- If the source of water to the tank is surplus water from another tank, don't construct check dams across such feeder channels

FAQs

Q: What is Bed Level?
A: This is the bed level in the channel

Q: What is the Ground Level?
A: This is ground level in normal situation, shoulder level of the sides/flanks

Q: What is the Maximum Flood/Water Level (MFL/MWL)?
A: This is the level to which water reaches maximum in highest flood inflow

Q: What are the Flanks?
A: These are the sides of the channel

Q: Why should the slope in the downstream should always be less than the slope in upstream of the channel?
A: For smooth flow of water in the channel.

Q: What happens if the silt is removed deeply?
A: Water becomes stagnant and doesn't move. If you start digging deeper the destination becomes at the higher elevation and water will not reach the destination

Q: What is L-section? Why it must be maintained?
A: It is a longitudinal section in the channel indicating the existing slope & designed slope of the bed of the channel as well as both side bank. It should be properly maintained as per the design, otherwise bed may be either scouring/ siltation

Q: What is Traezoidal section?
A: Trapezoidal section is the shape of the channel

Refer Page No. 115, 116 of Samarthya technical training manual for L-section

1.7 Strengthening Supply Channel/ Minor

Supply channel/ Minor is the means of taking water from tank to the field channels/ water courses. It is the link between tank and field channels/ water courses. In the water distribution network, field channel / water course is the last element of structure. It should function properly to maintain the irrigation efficiency. The supply channel starts from the rear side of sluice. Issues associated with the supply channel could be:

- Absence of Supply/Field channels
- Leakages due to holes dug by crabs, rats, frogs, etc
- Damage to the lining
- Absence of lining
- Damage to the weathering coat
- Damage to the stone masonry
- Absence of stone masonry
- Obstacles in the form of weed/vegetation growth, siltation etc.

Supply channel with stone masonry and plastering

Technical Design

Generally supply/field channels are with or without lining, depends upon the soil/ field types. But, a masonry supply channel with cement mortar lining increases productivity of the water. These are in trapezoidal/rectangular shape.

Steps in Marking

- Detailed survey must be taken up, involving local farmers.
- Identify the locations where the weed, vegetation growth must be removed
- Mark the portion where desilting is required, identify the depth of the silt to be removed
- Measure the slope using hydro marker
- Observe the sectioning of the channel. Identify the portion where there is no proper L-section and cross section in trapezoidal shape.
- Repair/arrange regulatory arrangements (open-close) at field channel connecting to supply channel

Steps in Execution

- Remove the weed
- Remove the siltation as per the slope and deposit on the both sides leaving berm as per the design
- For controlling the leakage of earthen channel:
  - Cut the suitable earth and fill the sides/flanks at leakages.
  - Stone revetment to the sides to protect the channel banks, where the sides are prone to sagging, weak sides with loose soils and possibility of course diversion
- For controlling the leakage of masonry channel
  - Earth work for foundation
  - Bed concrete with 1:3:6
  - Stone masonry with Crushed Rubble/Granite stone
  - Weathering coat on the drain
  - Cement plastering to the bed and both sides in the channel
  - Curing with water for 21 days

Maintenance

- Observe the supply channel frequently
- Close the holes dug by crabs, frogs, etc
- Take up repair works before start of monsoon season
- Encourage farmers to take care of maintenance

Possible outcome

- Obstacles in the channel are removed
- Leakages are controlled
- Water management and water use efficiency would be enhanced.
- Crops receive the water through channel network
- Water wastage is minimized.

Do's and Don'ts

Do's

- The desilting must be done in such a manner that the proper slope as per designed L-section is maintained to allow smooth flow of water.
- The slope in the downstream should always be less than the slope in upstream of the channel
- Masonry with Coursed Rubble Stone (CRS) and cement mortar is the best method

Don'ts

- Do not remove the silt deeply beyond designed bed level in the channel. Water should flow smoothly in the channel.

FAQs

Q: Why the repair works must be taken up before the start of the monsoon?

A: It is easy to take up repair works before monsoon. Once monsoon is started it is very difficult to take up works. Water might be stagnated in the channels.

1.8 Enhancing Storage Capacity of Tank

The ayacut or command area is notified based on the initial capacity of the water harvesting structure/tank. Over a period of time, the capacity of the tank is reduced for several reasons. As a result of this the tail-end farmers do not get water. Siltation in the tank and the growth of vegetation/bushes/weed in the tank bed (juliflora, hypomia etc) are prime reasons for such situation. These need to be addressed to restore the tank to its original capacity.

Removing Vegetation/ bushes in the Tank Bed

For More information, refer Resource Booklet on Horticulture and Plantation

Desilting Tank

Desilting involves removing the silt from the tank bed and applying it to the farmers' fields. It must be associated with transportation and spreading the tank silt in the farmers' fields. This activity not only restores the water retention capacity but also helps the farmers in improving their soil fertility by applying silt in their fields. Desilting in the tank must be done leaving the minimum gap of '5 times to the height of the bund' and upto the designed bed level.

De-silting in the tank

Steps in Marking

- Identify the location which is away from the bund. Minimum distance from the bund to the pit for desiltation must be 5 times of the height of the bund
- If the desilting is to be done in the existing pits, take pre measurements
- Explain to the laborers about the depth of the desilting to be done. It can be doneby making 2-3 pits by excavation or silt up to the designed bed level.

Steps in Execution

- Dig the earth as per the marking
- Additional lead and lift would be provided as per the provisions in the schedule of rates (SoR or SSR). This should be worked out and informed to the labourers before start of the work so that they can work their task aaccordingly.
- Lift the removed silt to "means of conveyance" such as tractor, bullock cart etc.

Maintenance

- Take up treatment structures to control soil erosion in the catchment area (as explained in the resource booklet on "watershed development for rainfed areas")
- A peripheral trench can be dug in the foreshore to prevent siltation in the tank
- Desilting the tanks and transportation of silt to the farmers' fields must be done every year

Possible outcomes

- Desilting improves the storage capacity of the tank
- The fields can be fertile with the application of the silt.

Do's and Don'ts

Do's

- Transport the silt to the farmers' fields.
- Take pre measurements before start of the work
- After completion of work or work period, take the total measurements and deduct from the pre-measurements to calculate the net quantity of the work done.
- The removed silt should not be dumped on bund or within the tank.
- Since it is mostly the fertile top soil received from the catchment area, spread the silt in the fields evenly.

Don'ts

- Do not dig till the sub soil is exposed
- Do not dig near to the bund. Minimum gap between pit and bund should be 5 times of height of the bund
- Do not deposit the removed earth on the bund, since it is useful to the fields
- Do not use the silt to the fields if it is not fertile soil
- Remove silt should not be dumped on the bunds.

Part 2

Canal Water based Irrigation System

Introduction

Irrigation helps in realizing the full potential of the land. It plays an important role in success or failure of crops and also influences yield. Wherever possible, Government has established irrigation infrastructure to harvest water from the rivers, rivulets and streams to provide water to the fields through network of canals. There is a huge supply and distributory network of canals at different levels, with appropriate regulatory mechanisms at each level. These main canals are being maintained by the concerned authorities. Many activities are required for maintaining this huge irrigation infrastructure. Not all, but most of the activities are allowed under MGNREGS. The objectives are: minimizing wastage of water, maximizing the gains through on-farm development works and Equitable distribution of water throughout the command area. This booklet explains the key factors in maintenance of certain infrastructure.

a) **Irrigation Network system in command area:** This network is the conveyance of water from river to field. The system flow is like this;

River/Dam → Main canal → Branch canal → Distributaries → Minors → Hydraulic Irrigation Structures → Watercourses → Structures, turnouts, tail escapes

Design criteria for surface drainage system

- Calculate the Watershed area and the peak run off rain water
- The volume of water to be removed depends on various factors
  - Intensity of rainfall
  - Soil characteristics of catchment
  - Size and topography of the catchment area Vegetative cover

Supply channel

b) **Surface drainage system**: This network functions as a system for removing stagnant water / excess water from the field. If there is heavy rainfall or excess water is not removed from the field for more than 40 hours for wheat and 72 hours for paddy, it will have adverse effect on the crop. The inundation of crop in the water damages it and affects livelihoods of the dependent families. Therefore, drains are constructed to carry the excess water from the fields to natural streams or rivers. In this network following is the system

Field drains → seepage drains → carrier drains/ intermediaries/collectors → sub main drains → main drains → hydraulic structures

c) **Irrigation and drainage structure:** The following hydraulic structures are required in command area, which can reduce the leakages/wastages and increase the water use efficiency

- Outlet from water course or turnouts
- Pipe type outlet from water course
- Three way division box
- Falls on lined water course
- Tail escape
- Inlet to drain

Steps in Identification of Water Course Allignment/ Layouts

- Mark the position of water course on field at every 30 mtr with survey equipment
- Do dag belling. Mark the center line and both bottom width lines of the watercourse
- Take the level of field on both sides of alignment of the water course
- Draw the proposed bed level line keeping the Natural Surface Level (NSL) in view
- Identify 'off taking' point in the parent channel/ minor
- Calculate required Full Supply Level (FSL) in water course – Designed and available
- Identify Working head at 'off taking' point
- Minimum FSL should be designed and drawn in such a way that minimum of 10 cm height of head of flow is available

Measuring the level difference with Dumpy level

Permissible works under MGNREGS for Canal based Irrigation System

- Construction of Minors
- Construction of watercourses
- Construction of field drains and seepage drains
- Construction of farm roads on the both sides of field drains
- Construction of Hydraulic structures such as falls, culverts, tail escape, Inlet to drains turnouts etc.
- Construction of earthen watercourses on ridge lines
- Construction of pucca watercourses
- Construction of field drains on the micro valley lines
- Construction of Collector drain
- Reallignment of field boundary
- Land leveling and land shaping

As the technical aspects of many of the above works are similar, only few works are explained in detail

Issues in supply channel

2.1 Construction of Watercources

Watercourses are designed based upon the area to be irrigated and the topography of the area. As the water is diverted from canal to water course, there is very less possibility of silt. There are two types of water courses; earthen water course and Pucca/Lined water course.

General steps in marking watercourses

- Give alignment in the field with the help of survey instrument.
- Do dag belling, mark the center line and both bottom width lines of the watercourse.
- Scrap top 10 cm. soil from the watercourse alignment for proper bondage/ removal of organic material.
- Mark the height up to which levee is to be constructed on cut stone pillars/ arrows which have been installed to mark the alignment of watercourse.
- Construct well compacted levee in 15 cm. layer by labour from the soil taken from the higher patches.
- Take special care at the outlet point of the canal i.e. off taking from the parent canal / minor. Earth in sufficient should be there to avoid seepage/ leakage at the outlet point in future.
- Construct levee in 15 cm. layers and then do compaction by labour using sheep foot rollers.
- Get the section cutting properly and then mark the bed level and bank level and field level by labouralong with dressing.
- Check it with designed L-section and submit one copy to the Superindent Engineer/Executive Engineer.
- The farm outlets / turn outs should be provided to each individual farmer.
- Get the watercourse connected properly to canal outlet. Must check the levels of outlet pipe and ensure its correct installation.
- Run water into watercourse right up to its tail and irrigate the tail end field too.
- Identify vulnerable reach for lining purpose, prepare estimates there off and get the lining done also.
- If the work of repair of existing watercourse is to be done then do only those steps which are required. In that case the difference between designed and existing watercourse will be measured.

2.1.1 Earthen Water course

The water course is designed for 1 cusec i.e. 28.3 Litre per Sec (LPS) or 40 LPS. Bed slope is generally 1: 1000, but may vary from 1: 500 to 1: 2500 depending upon the topography.

Technical Specifications

- Bottom width of watercourse = 30.0 cm
- Full supply Depth (F.S.D.) = 22.5 cm
- Free board = 15.0 cm
- Total depth of watercourse = 37.5 cm
- Side slope = 1.5: 1
- Top width of the bank of watercourse = 30 cm.
- Total bed width of the levee = 56.25 + 30.0 + 56.25 + 30.0 + 56.25 + 30 + 56.25 = 315.00 cm
- Bottom width of levee of watercourse = 315 cm
- Top width of levee of watercourse = 225 cm

Steps in Execution

Earthen water course

- Scrap grass/bushes where water course is to be constructed
- Scrap the area upto 7.5 cm to 10 cm depth
- Earth work for embankment/ levee of water course
- Break the clods
- Lay the levee in the water course in layers of 15 cm duly compacting manually
- Dress the uneven embankment

2.1.2 Pucca/Lined Water Course

This type of water course is designed for 1 cusec only. The types of lining are mostly

- PCC Water Course
- Stone masonry water course
- Brick masonry water course
- Lining by RCC/Pre cast slabs/Pre cast sections or Semicircular RCC Pipe water course also can be done

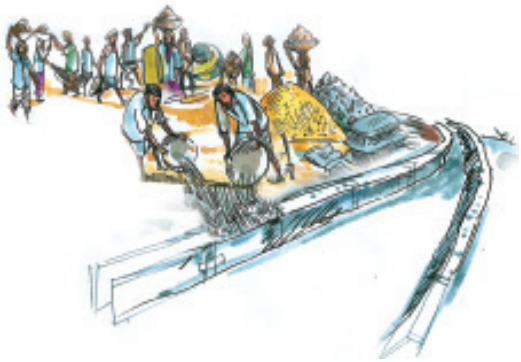
Stone masonry

a) PCC Water Course

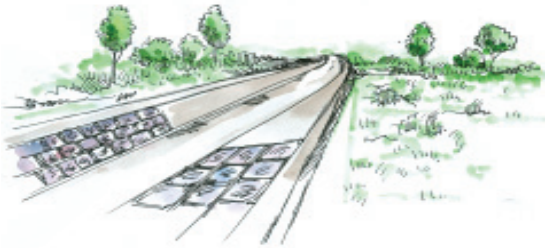
RCC water course

Steps in Execution

- Cut and clear the bushes/weed
- Earth work for embankment
- Break the clods
- Lay the levee in layers of 15 cm duly compacting manually
- Dress the uneven embankment
- Cement concrete (1:3:6) to the bed and sides of the channel
- Curing the concrete with water
- Fixing the wire mesh before plastering
- Plastering in cement sand mortar 1:4
- Rack joints
- Curing with water



Concrete water course

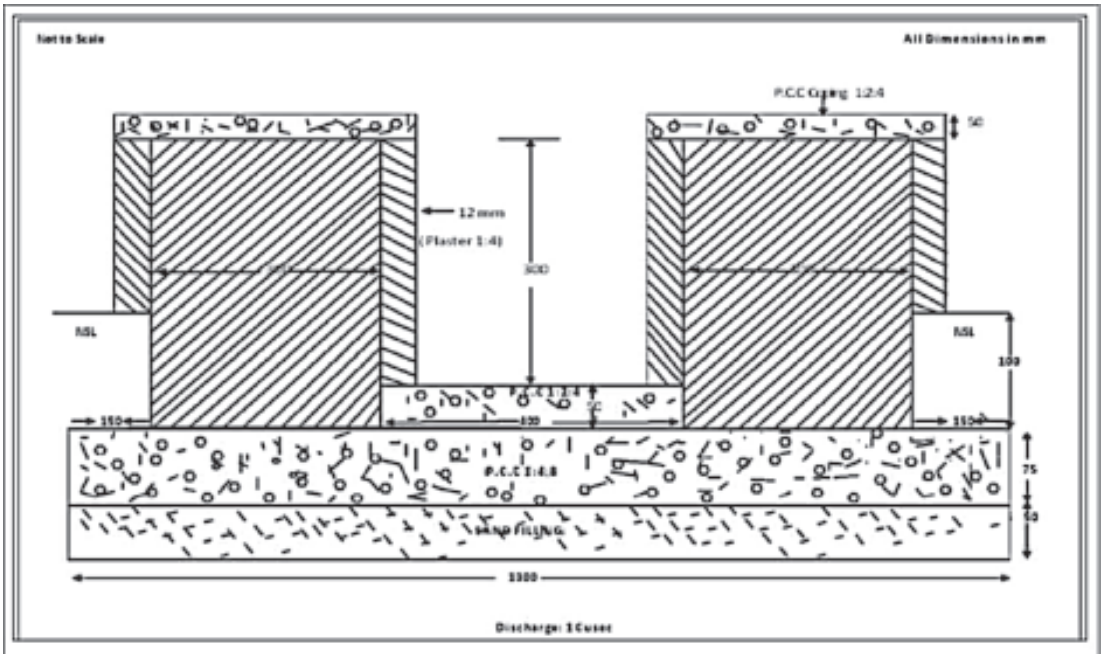


Concrete water course

b) Stone Masonry Water Course

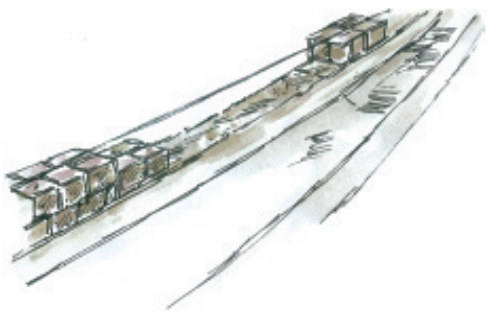
Technical Specifications

- Net water flowing width 37.6 cm
- Height available in the water course for flow of water is 30 cm
- Size of the each RR masonry wall: 30 cm width, 30 cm height
- Size of the foundation: Width 1.30 mtr, depth 22.5 cm



- Sand filling in foundation: upto 5 cm in the trench/foundation
- Concrete to foundation: 1:4:8 mortar, Width – 1.30 mtr (complete) width, height 7.5 cm
- Concrete in water way in the course:1:2:4 mortar, 40 cm width 5 cm height
- Cement plastering (1:4 mortar)inner sides: height 25 cm on both sides with 12 mm thickness
- Cement plastering (1:4 mortar)outer sides: height 20 cm from top on both sides with 1.2 cm thickness
- Coping the walls with cement concrete (1:2:4) on top width of the walls with 5 cm height

Steps in Execution



Stone masonry in progress

- Dag belling
- Cut and clear the bushes/weed/shrubs in atleast 4 mtr width
- Earth work for foundation with 22.5 cm depth and 1.30 m width
- Fill the foundation with sand upto 5cm depth
- Cement concrete (1:4:8) to the bed (complete) 7.5 cm thickness

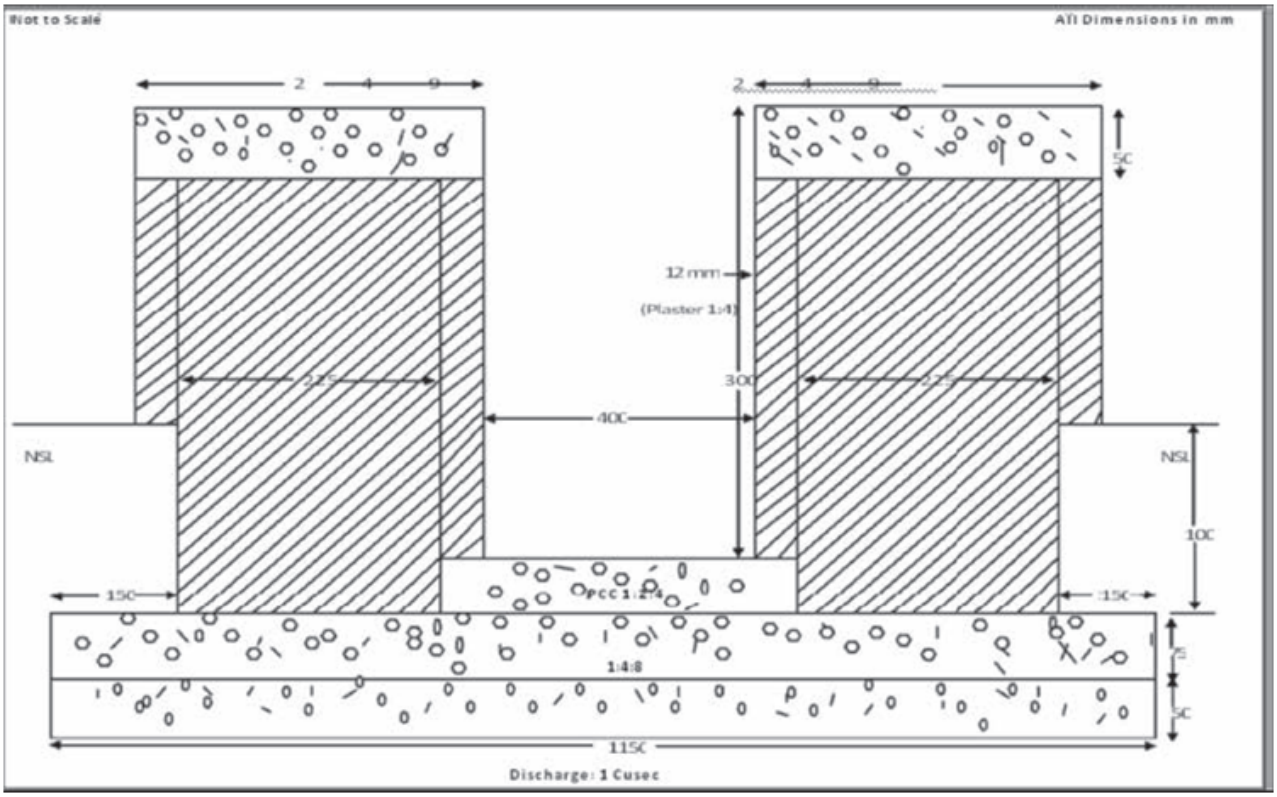
- Curing the concrete with water
- RR stone masonry as per design in 1:6 cement mortar

  (Leave gap of 15 cm on both sides and 40 cm in the middle i.e. water way. Therefore width on both sides (2 walls) is 0.30 mtr. The height of each wall is 0.30 mtr)
- Cement Concrete (1:2:4) on the bed in the channel (water way)with 2cm thickness
- Plastering in cement sand mortar 1:4 upto 1.2 cm thickness on the inner sides and outer sides excluding the portion where concrete of 1:2:4 is applied.
- Cement Concrete (1:2:4) on top width of the walls with 5 cm thickness.
- Rack joints
- Curing with water

c) Brick masonry Water Course

Technical Specifications

- Net water flowing width 37.6 cm
- Height available in the course for flow of water is 30 cm
- Size of the each Brick masonry wall: 22.5 cm width, 30 cm height
- Size of the foundation: Width 1.30 mtr, depth 0.225 mtr
- Sand filling in foundation: upto 5 cm in the trench/foundation



- Concrete to foundation: 1:4:8 mortar, Width – 1.30 mtr (complete) width, height 7.5 cm
- Concrete in bed of the water course is 1:2:4 mortar, 40 cm width 5 cm height
- Cement plastering (1:4 mortar)inner sides: height 25 cm on both sides with 1.2 cm thickness
- Cement plastering (1:4 mortar)outer sides: height 20 cm from top on both sides with 1.2 cm thickness
- Coping the walls of water course with cement concrete (1:2:4) on top width of the walls with 5 cm height

Steps in Execution

Brick masonry

Plastering to Brick masonry

- Dag belling
- Cut and clear the bushes/weed/shrubs in atleast 4 mtr width
- Earth work for foundation with 0.225 m depth and 1.3 m width
- Fill the foundation with sand upto 5cm depth
- Cement concrete (1:4:8) to the bed (complete) 7.5 cm thickness
- Curing the concrete with water
- Brick masonry as per design

  (Leave gap of 15 cm on both sides and 40 cm in the middle i.e. water way. Therefore width on both sides (2 walls) is 22.5cm. The height of each wall is 0.30 mtr)
- Cement Concrete (1:2:4) on the bed in the channel (water way) with 5 cm thickness
- Plastering in cement sand mortar 1:4 upto 1.2 cm thickness on the inner sides and outer sides excluding the portion where concrete of 1:2:4 is applied.
- Coping by Cement Concrete (1:2:4) on top width of the walls of water course with 5 cm thickness.
- Curing with water

Do's and Don'ts

Do's

Design

- Grade can be changed from flatter to steeper. But a grade change structure must be constructed for that purpose.
- If a field starts just after a 'fall structure', its outlet should be fixed at upstream of fall structure.
- Position of fall structure may be changed according to field condition
- The difference of bed level and NSL should be between 0.60 m to 1.5 m. Therefore ensure sufficient soil is available for laying service road along both sides of the field drain
- Bed slope should normally be same as ground slope. However, it should not be flatter than 1:1500 and deeper than 1:500
- Ensure at least 10-20 cm. working head of water on every field, so as to provide easy and quick irrigation by gravity.

Mark out

- The layout should be given on proper micro ridge so that the watercourse can irrigate both sides of the fields.

Water course Execution

- Before starting construction of watercourse levee, throughout its width and length, at least 10 cm. depth should be scraped.
- The level of the surface should be undulated to provide better bonding of the levee with the ground.
- After the excavation of proper section of the watercourse, the bed level (as per designed L-Section) and bank level should be checked properly.
- Some provision for the settlement beyond the TBL (Top Bank Level) should be taken in any type of the earthen embankment.
- While constructing, work should always be started from the head of the watercourse.
- Ensure proper dressing of the watercourse.

- If existing watercourse is damaged 60-70%, it is better to go for new construction at a proper ridge, rather than taking repairs for it.
- Turnout should be given on proper point of watercourse. If there is a fall in the watercourse, then atleast 30-60 meter of the watercourse will be in cutting. In such case take the outlet before the fall in the watercourse.
- After new construction, testing of watercourse should be done properly. Even the tail end fields should be provided proper irrigation. This depends on the design and quality of watercourse.
- For cement concrete, use crusher broker stone of maximum 2 cm size
- Random Rubble (RR) stone size: 75% of RR stone must be of more than 15 cm in size in any direction
- Weight of the RR stone should be more than 23 kg

Drain

- The work of drain should be started from the outlet.
- After the excavation of the drain, bed levels should be marked on the working L-Section. Ensure the designed bed level.
- Proper berm as per the designed X-Section of the drain should be ensured to avoid back filling of the loose soil in the drain.
- Take up grass sodding on the sides of the drain up to the level of the designed Full Supply Depth (FSD).

Outlets

- Turn outs (field inlets) should be provided at a proper naka point on every field to facilitate proper irrigation to the individual farm.
- The junction of minor / distributary from where water will be taken should be properly designed so that the water is available in proper quantity and there is no leakage.
- There should be proper gate so that whenever water supply is not needed the watercourse is closed properly.
- For the drain, ensure sufficient outfall level is available. Otherwise get the outfall level first cleared, then only do the excavation of desired drain.

Other aspects

- L-section must be approved by higher authorities

- The section of the drain may be made higher than the designed to provide earth for the roads on the sides of the drain.
- Ensure proper participation of farmers in design, alignment and construction of watercourse, drains and land leveling etc. Their suggestions are valuable and should be given due consideration.
- The lining should be done with the local material only to minimize the costs. Ensure that the beneficiaries take care of the lining of watercourse, earthen watercourse and drains etc.

Do's and Don'ts

Do's

- Start the drain from outlet
- The slope in the channels should be non-siltation, non-erosive

Don'ts

For Design

- Slope should never be provided steeper than 1:300. In case ground is very steep fall structures should be proposed.
- Grade should not be changed from steep to flatter. If necessary, a fall shall be proposed before changing the grade
- Don't Propose 'fall structure' as far as possible, instead maintain required slope

Execution

- Watercourse should not be constructed in 100% filling, to the extent possible. If done so ensure proper compaction or lining of that reach.
- Earth used for the construction should not be saline, alkaline, pebble or concrete mixed. If so, there is chance for seepage.

Further Learning

- Samarthya Technical Training Manual for MGNREGS
- Maintenance and Technical manual developed by I&CAD, Government of Andhra Pradesh
- Construction manual - Mission Kakatiya – Government of Telangana

Environmental Benefits of Irrigated Command Areas

- Minimises wastage of water and enhance water use efficiency
- Stores and conveys water and brings the water into effective utilisation
- Availability of sufficient water to crops, birds, livestock etc.
- Ensures crop diversity and food security
- Provide home for aquatic life such as fish, crabs, tortoise etc.
- Plays important role in water cycle
- Flow of water regenerates life in soils
- Availability of water helps in retaining the native variety of seed, both for food and vegetable crops
- Opportunity for regeneration of different types of herbs, shrubs, as they grow alongside the water course to the fields
- Contributes in ground water recharge
- Regenerates base flows
- Enables proper functionality of crop seasons
- Enhances the diversity of the flora and fauna as birds migrate to these areas from farthest places including other countries
- Effective water use with the help of irrigation infrastructure reduces climate change impacts
- Development of Minor Irrigation Infrastructure reduces pressure on environment
- It reduces adverse impacts of major irrigation projects
- Minor Irrigation projects do not require land aquisition which displaces and destroys bio diversity.