



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

IRRIGATION ENGINEERING

[BTAI 2201]

Prepared by:

Birabhadra Rout

Assistant Professor

Dept. of Agricultural Engineering
SoABE, CUTM, Paralakhemundi



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

- To install the pump stand a concrete bed is made. The thickness of bed should be about 10 cm for pump stands up to 3m high and 15 cm when the height is more than 3m.
- The diameter of the concrete bed should be at least 30 cm more than the outer diameter of the pipe used as pump stand.
- After laying the concrete and before the bed hardens the pipe is placed vertically in the centre of the bed and a concrete of 1:2:4 mix is added to a thickness of about 5 cm.



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Air Vents:

Air vents are vertical pipe structures to release air entrapped in the pipe line and to prevent vacuum. Entrapped air must be removed to permit an even flow and avoid the danger of water hammer.

They are installed near the pump stand, at all high points in the line, at sharp turns at points where there is a downward deflection of more than 100; directly downstream from any structure that may entrap air, and at the end of the pipeline.



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

End Plug

End plug is provided where the line terminates. The function of the end plug is to close a line and to absorb the pressure developed at the end of the line.

Outlets:

They are necessary to provide controlled delivery of water to the field at any desired location. These should be easy to open and close, be of proper size to provide the flow required, and be so constructed that the water release will not cause soil erosion.



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Riser Valves:

Riser valve is a screw valve installed on the top of riser pipe .A handle and cap plate is attached to a screw type shaft that moves up or down as the handle is turned.

When the plate is lifted by turning the handle, water is released from all sides of the valve .The rate of flow can be controlled by raising or lowering the valve plate.

Other structures used in underground water conveyance are hydrants and Gated Pipes.



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Design of Underground Pipeline Irrigation System

The layout of the underground drainage system should be kept as simple as possible, with the minimum number of changes in direction and gradient.

An underground pipelines irrigation system must be properly designed to handle efficiently the required flow throughout the system.

In designing an underground pipeline system, the head loss due to friction in the pipeline and other factors must be taken into account. Loss of head due to friction in the pipes between two points in a pipe at a distance l apart is given by Darcy's formula as..



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

$$h_f = \frac{f l V^2}{2 g R}$$

f = Darcy's roughness coefficient (dimensionless) which is given in **Table 9.11**; l = length of pipes, m; V = velocity of water in pipe, m/sec; g = acceleration due to gravity (9.81 m/sec²) and R = hydraulic mean radius, m.

Hydraulic mean radius, R is: A/P

where, A = Area of cross-section of pipe, m²
and P = Wetted perimeter, m.



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

$$A = \frac{\pi D^2}{4}, P = \pi D \text{ (where } D \text{ is diameter of pipe),}$$

Hydraulic mean radius, R is $D/4$

Therefore,

$$h_f = \frac{2f l V^2}{g D}$$

Entrance losses in pipelines is calculated as:

- (i) Pipe end flush with the wall of the pump stand

$$h_e = 0.5 \frac{V^2}{2g}$$



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

(ii) Pipe end protruding from wall of pump stand:

$$h_e = 1.0 \frac{V^2}{2g}$$

(iii) Pipe with bell entrance:

$$h_e = 0.10 \frac{V^2}{2g}$$

Where, h_e = Head loss at pipe entrance, m and V and g are same as defined earlier

The other losses which may be significant are the velocity head in the pipe and the head in the pipe and the head loss through riser valves.

The velocity head due to flow in pipe (h_v) is obtained from the formula:

$$h_v = \frac{V^2}{2g}$$



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Table 9.13 Head loss through riser valve

Discharge, lit/sec	Head loss in centimeters of water					
	Diameter of pipe, cm					
	15					
	15	20	25	30	35	40
10	2	1				
20	10	3	1			
30	26	7	3	1		
40	50	13	5	2	1	
50	83	22	8	4	2	1
60	126	34	12	6	3	2
80	250	64	24	11	5	3
100		105	40	18	9	5
125		165	65	29	15	7
150		250	97	44	22	12
175			136	65	30	17
200			185	83	41	22
225			245	100	55	30
250				137	69	37
275				170	83	45
300				210	100	56
350				300	145	77
400					195	103
450					250	135
500						170
550						210



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Sample Calculation:

A concrete pipe line has to carry water across a distance of 1 km from a pump which discharges 100 lit/sec. The field has a down slope of 0.1 percent along the line the pipes are laid. It is required that a maximum pressure in the pipeline should not exceed 4 m of water. What size of a pipe is required? How high the pump stand be to operate the system.

Given that the permissible pressure in the pipeline = 4 m

Gain in pressure head due to downfield gradient = $0.1/100 \times 1000 = 1$ m

The total available pressure head = $4 + 1 = 5$ m over a length of 1000 m i.e. 0.5 m/100 m length.

From Table 5.10, it is observed that a 35 cm diameter pipe will deliver a discharge of 102 lit/sec and the friction loss will be 0.48 m/100 m length of the pipeline. Hence, a 35 cm diameter pipe is selected.



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

The water will rise to a height of $10 \times 0.48 - 1.0 = 3.8$ m.

Allow a free board of 30 cm and entrance head of 50 cm.

The stand pipe will be $3.8 + 0.30 + 0.50 = 4.60$ m.

Hence, the pump stand be 4.6 m to operate the system



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Structures in Conveyance System:

Structures in the irrigation conveyance system are required to control the flow of water and also distribute water.

Sometimes, the irrigation channels are designed on steep slopes and water moving in such steep slopes attains high erosive velocity and cause severe soil erosion in earthen channels.

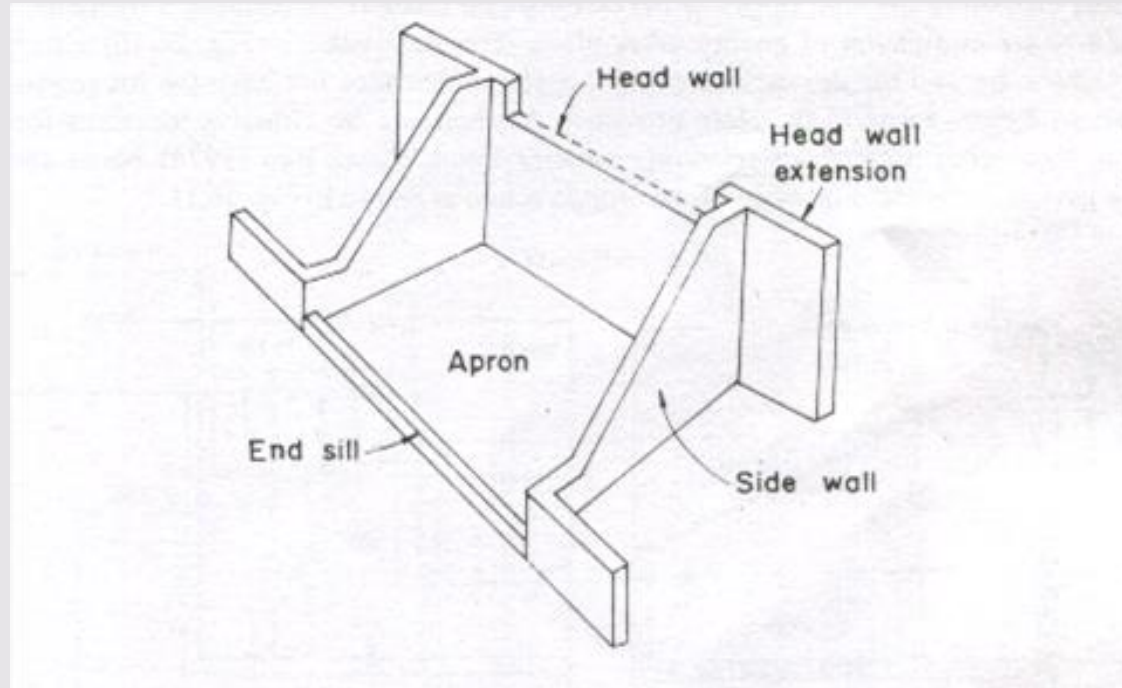
In such a case, structures like drop and chute spillway are required to prevent soil erosion in earthen channels



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Drop Structures:





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

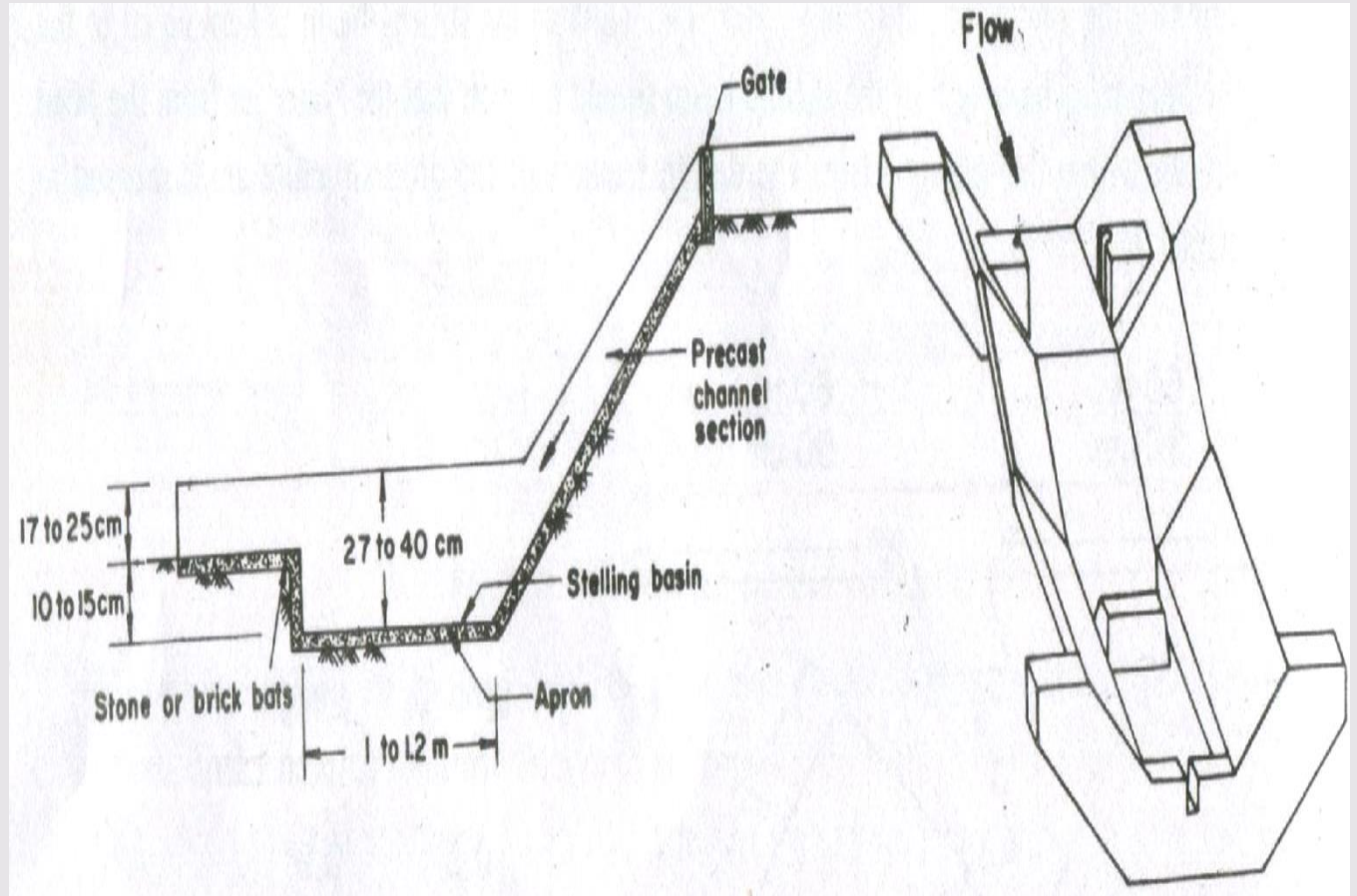
Chute Spillway:

Where the irrigation channel has to pass through steep land slope, chute spillway can be used to convey the water from higher to lower levels. On steep slopes, chute spillway is more economical than a series of drop structures. Chute spillway consists of inlet through which water enters into the structure, conduit to allow water pass through and outlet through which finally water will go out.



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*



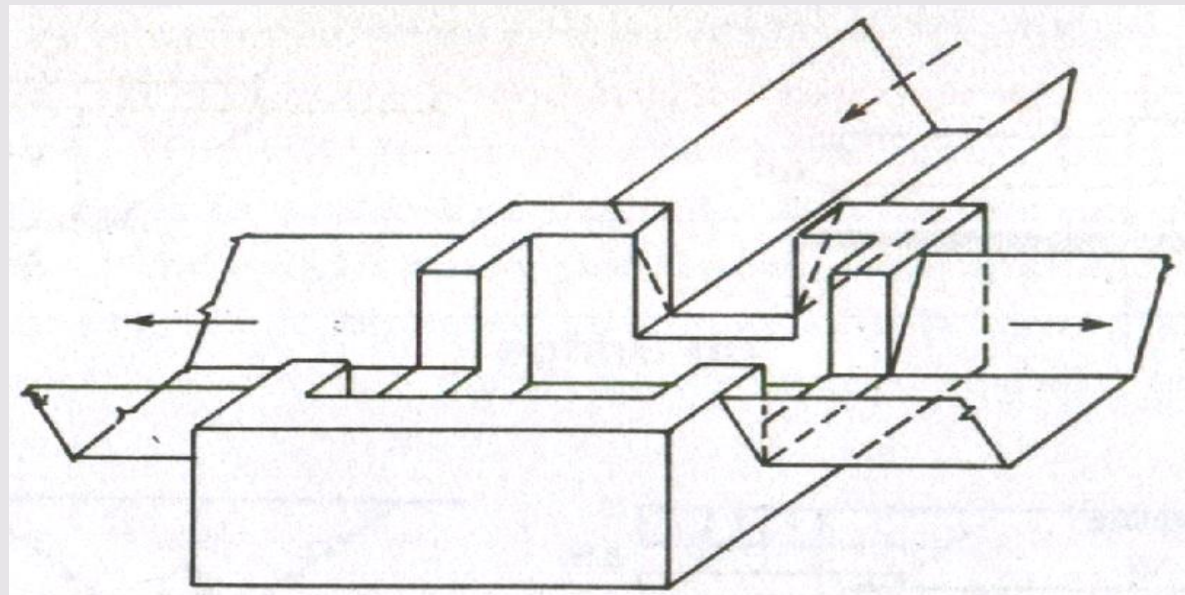


Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Water Diversion and Control Structures

Water from the farm irrigation channels is diverted to branch channels or into fields by means of junction boxes (Fig. below), gates or other forms of outlets.





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Other Water Diversion and Control Structures

Circular Orifice Panel

Portable Check Dams

Diversions

Turnouts

Spiles

Siphon Tubes



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Structures at Channel Crossing:

Flumes

Culverts

Inverted Siphon

Cross-Drainage Structures

(i) *aqueduct*

(ii) *siphon aqueduct*

(iii) *super passage* and

(iv) *siphon super passage*



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

THANK YOU