

CANAL IRRIGATION

Canal Irrigation

It is one of the types of irrigation where in the reservoir water is carried to the field through channels having specific shape and bed channel slope. The shape is generally trapezoidal or triangular with side slopes based on soil types.

Types of canals

Canals are classified into different types based on different criteria:

Classification based on Size: ❖

Based on size, canals are classified into following types:

Main canal: *The main canal is the largest canal in the system. It .1 takes off directly from the canal headworks. Generally, there are two main canals, each taking off from either side. Sometimes there are two or more main canals on either side. No direct irrigation is normally done from a main canal.*

Branch canal: *A branch canal takes off from the main canal or .2 another branch canal. The discharge capacity of a branch canal is usually more than 5 cumecs. Generally, no direct irrigation is done from a branch canal.*

3. Major distributary: *A major distributary takes off from a main canal, a branch canal or another distributary and supplies water to minor distributaries and water courses. The discharge capacity is usually between 0.25 to 5 cumecs and these channels are generally used for direct irrigation.*

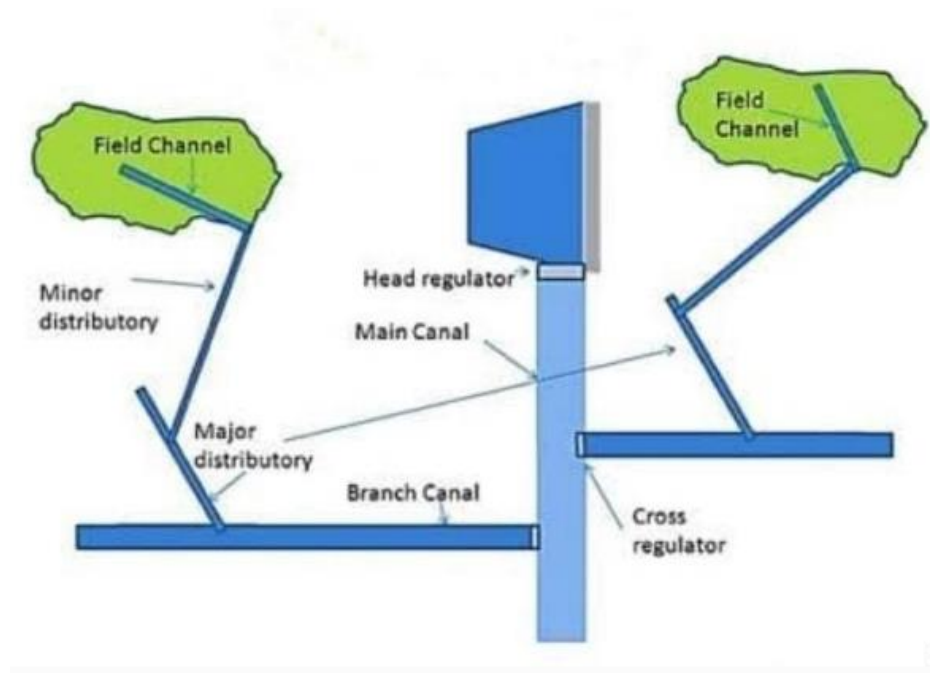


Figure 1 Different canals Based on size

4. Minor distributary: A minor distributary also takes off from a main canal, a branch canal or another distributary and supplies water to water courses, but its discharge capacity is usually less than 0.25 cumecs. The minor distributaries are also used for direct irrigation.

5. Water courses (or field channels): Water courses are small channels which take water from a branch canal, a major distributary or a minor distributary and supply it to the agricultural fields. The water courses are owned, constructed and maintained by cultivators.

Classification based on alignment ❖

Based on alignment, canals are classified into following types:

1. Watershed (or Ridge Canals): The canal which is aligned along a watershed (or ridge) is called a watershed canal. As far as possible, a canal should be aligned on a ridge line so that it can irrigate on both sides of the ridge by gravity, and hence, has a large commanded area.

✓ The dividing line between the catchment areas of two streams is called the watershed or Ridge.

✓ Watershed canals are suitable for plain areas, where slopes are relatively flat and uniform.

✓ Watershed canals have minimum number of cross-drainage works, because most of the drainages originate from the ridge and do not cross the canal.

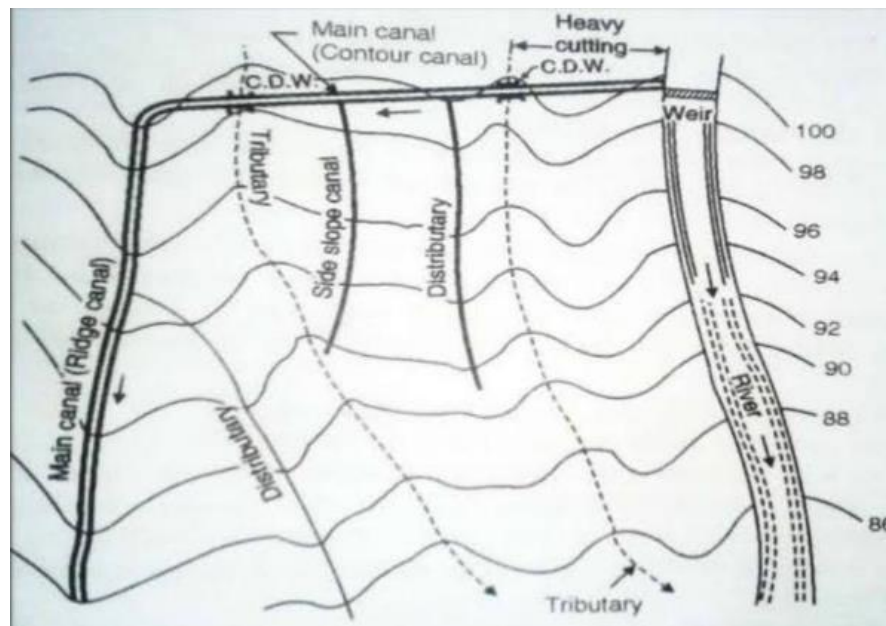


Figure 2 Different canals based on alignment

2. Contour canals: A contour canal is aligned almost parallel to the contours of the terrain.

✓ A contour canal cannot be exactly parallel to the contours because it requires some drop in the bed level to have a longitudinal slope required for the gravity flow.

✓ A contour canal can irrigate only on one side because the land on the other side is higher.

✓ They are aligned generally when canals take off from river.

✓ In a contour canal, there are a large number of cross-drainage works because all the drainages are at right angles to the contours.

3. Side-Slope canal: A side-slope canal is aligned at right angles to the contours.

✓ Because drainages also run at right angles to the contours, a side-slope canal does not normally intercept drainages, and therefore, no cross-drainage work is required.

✓ It can irrigate only on one side.

Classification based on canal surface ❖

Based on the canal surface, canals are classified into following types:

Lined canal: A lined canal is the one which has its surface lined with .1
an impervious material on its bed and sides to prevent seepage of
water. Also, in lined canals, high velocity can be permitted and hence
the cross-sectional area is less.

Unlined canal: An unlined canal is the one which has the surface of .2
the natural material through which it is constructed and it is not
provided with a lining on its surface. These are further of two types:

Alluvial canals: These canals are constructed through the alluvial soils
deposited by rivers. The alluvial soils are incoherent silty soils which can
be easily scoured as well as deposited. These canals are designed so that
there is neither scouring nor silting. The velocity in these canals is quite
low and therefore, the cross-sectional area is large.

Non-alluvial canals: These canals are constructed through hard soils
or disintegrated rocks. Since the canal surface is hard, scouring normally
does not occur, hence, the velocity in these canals is high.

Parts of a Canal Irrigation system

*A large number of structures are constructed on the canals for various
purposes which are classified as:*

- 1. Conveyance structures**
- 2. Regulatory structures**

Conveyance structures: A canal conveying water from the source .1
has to run for large distances and has to maintain the water levels
appropriately. The water which enters the **main canal** is
distributed into **branches** and **distributaries** and ultimately
reaches the agricultural fields through **water courses**. The canal
has to cross terrain of different slopes as well as some obstacles
such as natural water bodies or railway lines, roads, etc. For this
purpose, cross-drainage works are required. The **cross-drainage
work** is required to dispose of the drainage water so that the canal
supply remains uninterrupted. The canal at a cross-drainage work
is generally taken either over or below or at the same level as the
drainage.

Regulatory structures: Different types of structures are constructed on the canal in order to regulate and control the discharge, velocity, etc. in the canal. These structures are called Regulatory structures. These include:

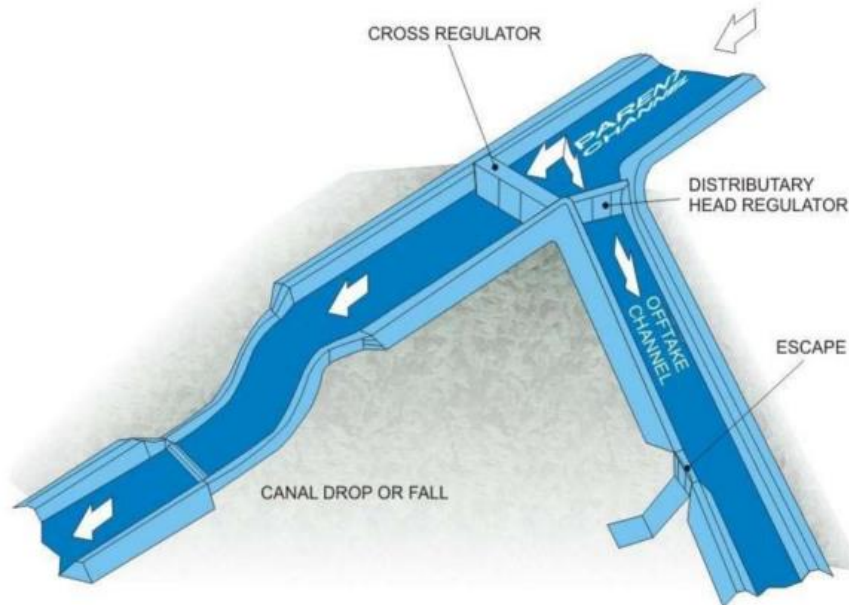


Figure 3 Canal structures for flow regulation and control

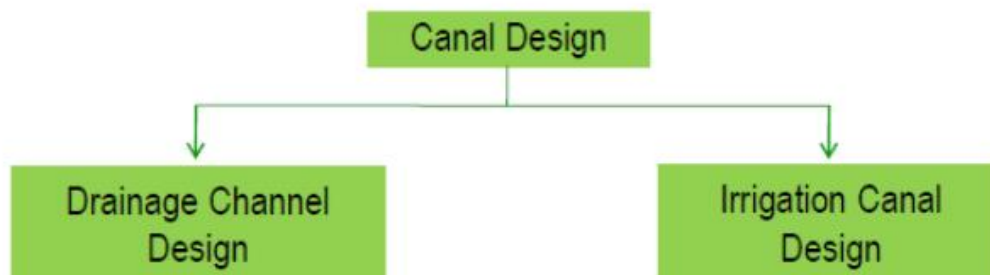
a) Distributary head regulator: It is provided at the head of each distributary and branch canal. It controls the entry of water into the off-taking channels.

b) Cross Regulator: It is provided on the parent channel just downstream of the offtake point of the off-taking channel to raise water level in the parent channel, so that the full supply can be taken into the off-taking channel even when the parent channel is running partly full. Canal regulators are also provided on the downstream of the canal escape and various other locations.

c) Canal falls: When the slope of the natural ground is much steeper than the slope of the canal, a sudden drop in the channel bed is provided. This sudden drop is known as the canal fall. The location of the fall has to be decided judiciously such that there should be a balance between the quantities of excavation and filling.

d) Canal escapes: These are the structures which are designed to remove the water from the canal when excess rainfall occurs or when breaches occur in the canal downstream. They are a sort of safety valves in the canal system to remove the excess water or to empty the canal at the times of emergency or for repair works.

Canal Design Types



Design Parameters

- ❑ The design considerations naturally vary according to the type of soil.
 - ❑ Velocity of flow in the canal should be **critical**.
- ❑ Design of canals which are known as '*Kennedy's theory*' and '*Lacey's theory*' are based on the characteristics of sediment load (i.e. silt) in canal water.

Important Terms Related to Canal Design

- ❑ Alluvial soil
- ❑ Non-alluvial soil
- ❑ Silt factor
- ❑ Co-efficient of rugosity
 - ❑ Mean velocity
 - ❑ Critical velocity
- ❑ Critical velocity ratio (c.v.r), m
 - ❑ Regime channel
 - ❑ Hydraulic mean depth

- ❑ Full supply discharge
- ❑ Economical section .

Alluvial soil.

Is the soil which is formed by the continuous deposition of silt .The river carries heavy charge of silt in rainy season. When the river overflows its banks during the flood, the silt particles get deposited on the adjoining areas. This deposition of silt continues year after year. This type of soil is found in deltaic region of a river. This soil is permeable and soft and very fertile. The river passing through this type of soil has a tendency to change its course.

silt factor

During the investigations works in various canals in alluvial soil, *Gerald Lacey* established the effect of silt on the determination of discharge and the canal section. So, Lacey introduced a factor which is known as '**silt factor**'.

It depends on the mean particle size of silt. It is denoted by 'f'. The silt factor is determined by the expression, $f = 1.76 \sqrt{d}$ where d mm = mean particle size of silt in mm.

Particle	Particle size (mm)	Silt factor (f)
Very fine silt	0.05	0.40
Fine silt	0.12	0.60
Medium silt	0.23	0.85
Coarse silt	0.32	1.00

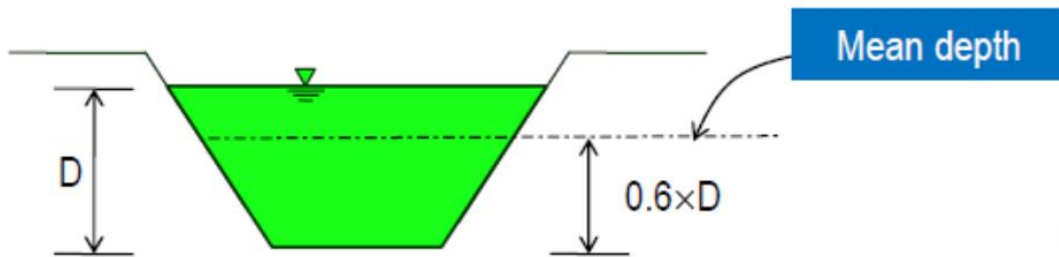
Coefficient of rugosity

The roughness of the canal bed affects the velocity of flow. The roughness is caused due to the ripples formed on the bed of the canal. So, a coefficient was introduced by *R.G Kennedy* for calculating the mean velocity of flow. This coefficient is known as coefficient of rugosity and it is denoted by 'n'. The value of 'n' depends on the type of bed materials of the canal.

Materials	Value of n
Earth	0.0225
Masonry	0.02
Concrete	0.013 to 0.018

Mean velocity

It is found by observations that the velocity at a depth $0.6D$ represents the mean velocity (V), where ' D ' is the depth of water in the canal or river.



(a) Mean Velocity by Chezy's expression:

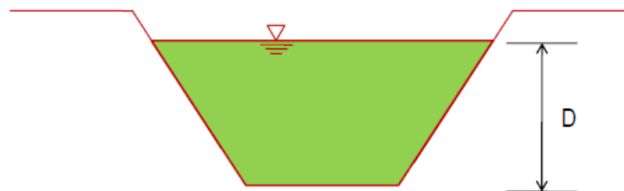
$$V = C \sqrt{RS}$$

(a) Mean Velocity by Manning's expression:

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

Critical velocity

When the velocity of flow is such that there is no silting or scouring action in the canal bed, then that velocity is known as **critical velocity**. It is denoted by ' V_o '. The value of V_o was given by Kennedy according to the following expression, $V_o = 0.546D^{0.64}$; where, D = Depth of water



Critical velocity ratio (CVR)

The ratio of mean velocity ' V ' to the critical velocity ' V_o ' is known as critical velocity ratio (CVR). It is denoted by m .

$$CVR (m) = V/V_o$$

- When $m = 1$, there will be no silting or scouring. ●
- When $m > 1$, scouring will occur ●
- When $m < 1$, silting will occur ●

So, by finding the value of m , the condition of the canal can be predicted whether it will have silting or scouring.

Regime Channel

When the character of the bed and bank materials of the channel are same as that of the transported materials and when the silt charge and silt grade are constant, then the channel is said to be in its regime and the channel is called regime channel. This ideal condition is not practically possible.

Hydraulic mean depth ratio

The ratio of the cross-sectional area of flow to the wetted perimeter of the channel is known as hydraulic mean depth or radius. It is generally denoted by R .

$$R = A/P$$

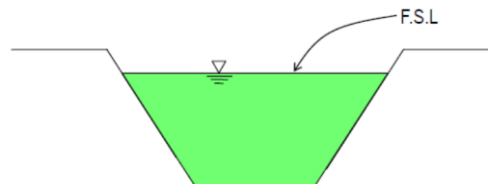
Where,

A = Cross-sectional area

P = Wetted perimeter

Full supply level (F.S.L).

The maximum capacity of the canal for which it is designed, is known as full supply discharge. The water level of the canal corresponding to the full supply discharge is known as **full supply level (F.S.L)**.



Economical Section

If a canal section is such that the earth obtained from cutting (i.e. excavation) can be fully utilized in forming the banks, then that section is known as **economical section**. Again, the discharge will be maximum with minimum cross-section area. Here, no extra earth is required from borrow pit and no earth is in excess to form the spoil bank. This condition can only arise in case of partial cutting and partial banking. Sometimes, this condition is designated as balancing of cutting and banking. Here, the depth of cutting is called **balancing depth**.

