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DESIGN AND ESTIMATION OF CANAL AND OUTLETS

A Project Report

Submitted in partial fulfillment of the Requirements for the award of

B.Tech Degree

In

Civil Engineering

Submitted by

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ABSTRACT

Apart from many other factors, the design of Irrigation channels and control structures plays very important role in the successful performance of an irrigation system. Irrigation projects are launched for equitable distribution of water among the shareholders and its efficient use at the farms, for which design of diversions and control structures provide basic framework. Both the service providers and users of water desire that the system should be free of problems and minimum loss of efficiencies

Canal cross-section designs for uniform flows are contrasted and compared by using non-dimensional shape parameters. The basic relations among the cross-section shapes and design variables (the wetted perimeter, the water depth, the water surface width, the cross-sectional area, the lining volume, the excavation volume, etc.) are exposed. These relations are used to uncover robust rules that can determine optimal canal designs for elementary problems, directly from flow information such as capacity, velocity, slope, and roughness. For problems involving complex limits and economics, the relations are combined with optimization methods to solve for the economically optimal cross sections. The possible cross sections are parameterized by at most two variables, so the calculations do not require the use of sophisticated optimization methods or large computers..

CHAPTER-1

INTRODUCTION

1.1 CANAL

Canal is an artificial channel generally trapezoidal in shape. It is constructed to carry water to the field either from river, dam or a reservoir and for navigation purpose.

1.2 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:

1. Main Canal: The main canal is the largest canal in the system. It takes off directly from the canal headwork 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.

2. Branch Canal: A branch canal takes off from the main canal or 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.

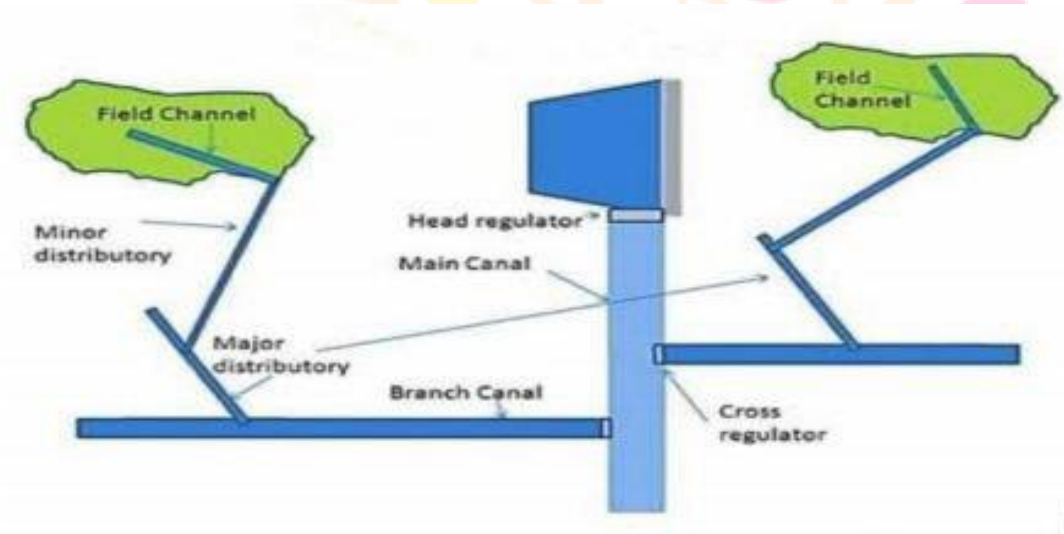
3. Major Distributary: A major distributary takes off from a main canal, a branch canal or another distributary and supplies water to minor distributaries and water courses. The discharge capacity is usually between 0.25 to 5 cumec and these channels are generally used for direct irrigation

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 CANAL SURFACE

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



Fi

g 1.2.1- Different Canal Based on Size

1. Lined Canal: A lined canal is the one which has its surface lined with 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.

Figure 1.2.2- Lined Canal

2. Unlined Canal: An unlined canal is the one which has the surface of 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.

FIG.1.2.3 UNLINED CANAL

● CLASSIFICATION BASED ON PURPOSE

Based on the purpose served, canals are classified into following types

1. Irrigation Canals: An irrigation canal is the one which is constructed for carrying the water for irrigation

2. Power Canals: A power canal is the one which is constructed for carrying the water for hydropower generation. It is also called a hydel canal.

3. Navigation Canals: A navigation canal is constructed to provide inland navigation. Small ships and steamers can apply in these canals.

4. Water Supply Canal: A water supply canal provides water for drinking purposes and industrial use.

5. Feeder Canals: A feeder canal is constructed to feed water to another canal. It is located outside the commanded area of the canal system.

6. Carrier Canals: A carrier canal carries water for another canal and is also used for irrigation.

7. Multipurpose Canal: A multipurpose canal serves two or more purposes, such as irrigation, water supply, hydropower and navigation.

1.3 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

1. Conveyance Structures: A canal conveying water from the source 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. Depending upon the relative positions of the canal and the drainage, the cross-drainage works may be broadly classified into 3 categories:

a) CANAL OVER THE DRAINAGE:

 Aqueduct: It is a structure in which the canal flows over the drainage and the flow of the drainage below is open channel flow. It is provided when the canal bed level is higher than the HFL of the drainage

 Syphon Aqueduct: In a siphon aqueduct also, the canal is taken over the drainage, but the flow in the drainage is under pressure. It is constructed when the HFL of the drainage is higher than the canal bed level.

Fig 1.3.1:- Aqueduct

b) Canal Below The Drainage

 Super Passage: It is a structure in which the canal is taken below the drainage and flow in the canal is open channel flow. It is required when the canal FSL is below the drainage bed level.

 Canal Syphon: A canal syphon is a structure in which the canal is taken below the drainage and flow in the canal is pipe flow (i.e. under pressure). It is constructed when the canal FSL is above the drainage bed level.

c) CANAL AT THE SAME LEVEL AS DRAINAGE:

 Level Crossing: A level crossing is provided when the canal and the drainage are practically at the same level. In this case, the drainage water is admitted into the canal at one bank and is taken out at the opposite bank.

 Inlet And Outlet: An inlet-outlet structure is provided when the drainage and the canal are almost at the same level, and the discharge in the drainage is small. The drainage water is admitted into the canal at a suitable site and the excess water is discharged out through an outlet provided on the canal at some distance downstream of the junction

2. REGULATORY STRUCTURES: Different types of structures are constructed on the canal into regulate.

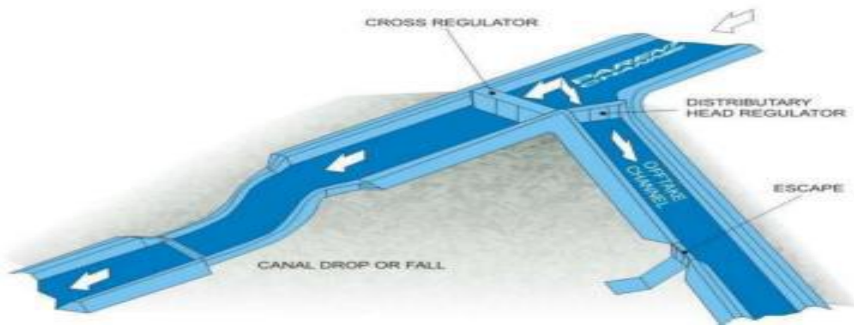


Fig .1.3.2 Canal Regulator

a) Distributary Head Regulator:

It is provided at the head of each distributary and branch canal. It controls the entry of water into the offtaking channels.

b) Cross Regulator:

It is provided on the parent channel just downstream of the offtake point of the offtaking channel to raise water level in the parent channel, so that the full supply can be taken into the offtaking 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 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.

1.4 CANAL ALIGNMENT

The alignment is the feasible path or route from a source location to the desired destination. A canal has to be aligned in such a way that it covers the entire area proposed to be irrigated with the shortest possible length, and at the same time, its cost including the cost of cross drainage works is minimum. While aligning a canal, following points should be considered:

1. A canal should be aligned on a watershed (or ridge) as far as possible because it ensures irrigation on both sides of the canal and it avoids cross drainage works.

2. Attempts should be made such that the main canal mounts the ridge in as small length as possible from the point of offtake.

3. The canal should run straight even when the watershed makes a sharp loop.

4. The alignment should be such that the number of cross drainage works is minimum.

5. The length of the canal should be as small as possible. The smaller the canal, the less are the absorption and seepage losses and the lower is the maintenance cost.

6. The canal alignment should avoid inhabitated areas, religious places, valuable property and other important monuments.

7. As far as possible, the canal should run through the heart of the commanded area to keep the cost of distribution system to a minimum.

8. As far as possible, curves in the canals should be avoided.

9. The canal should avoid sandy or alkaline or waterlogged areas and also the soil should not be hard to excavate.

10. The canal should be aligned such that its crossings with the road, railway lines and drainages are at right angles.

11. The canal should have a balanced depth of cutting as far as possible so that the soil excavated from the cutting is used for filling. This ensures the minimum cost of earthwork.

12. The canal should not be in heavy cutting as it would be uneconomical and the flow irrigation would not be possible.

1.5 OBJECTIVE OF CANAL

Canals are designed for uniform flow considering economy and reliability. Uniform flow is described by a resistance equation. Whereas the economy is achieved by minimization of cost, maximum reliability is realized by delivery of discharge with the least frequency of failures.

- **Following are the objective of canal**

1. Water Supply

2. Flood Control

3. Navigation

4. Water Management

5. Hydro Power Generation

6. Nature Restoration

CHAPTER -2

LITERATURE REVIEW

2.1 PRABHATA K. SWAMEE, GOVINDA C. MISHRA, AND BHAGU R. CHAHAR (2001)

Design of a minimum cost canal section involves minimization of the sum of costs per unit length of the canal, subject to uniform flow condition in the canal. The objective function has been expressed as the cost per unit length of the canal for lining, the depth-dependent unit volume earthwork cost, and the cost of water lost as seepage and evaporation losses. A general resistance equation has been used as an equality constraint. Using a nonlinear optimization technique on an augmented function, generalized empirical equations and section shape coefficients have been obtained for the design of minimum cost irrigation canals of triangular, rectangular, and trapezoidal shapes. The optimal dimensions for any shape can be obtained from the proposed equations along with tabulated section shape coefficients. The equation for optimal cost along with the corresponding section shape coefficients is useful during the planning of a canal project. A design example with sensitivity analysis has been included to demonstrate the simplicity of the present method.

2.2 ABDULMOHSIN ALSHAIKH (2009)

Irrigation-water-delivery systems are designed and managed to receive water from a source and to distribute it among farmers in order to meet their agricultural requirements. High system performance can be achieved through rehabilitation of deteriorating and inadequate physical facilities and through improved system management. Various design decisions must be made in order to rehabilitate or develop irrigation-water-delivery systems, including those related to specification of the characteristics of hydraulic structures used to convey regulate, or divert waterThis study develops and applies a response surface methodology (RSM) for achieving optimal design for hydraulic structures in irrigation-water-delivery systems in canal networks. This approach provides a means of understanding system behavior through developing a response surface in terms of a mathematical expression representing system performance as affected by design decisions. Design decisions include pipe diameters for diversion and regulating structures. Simulation of steady spatially varied flow was incorporated into the response surface methodology to determine high-performance low-cost solutions. Objectives of adequacy, efficiency dependability, and equity of water delivery were considered in defining water delivery performance. Fuzzy membership functions were used to address subjectivity associated with interpreting expected values of performance measures associated with each of the prescribed objectives.

2.3 HISHAM EZZAT (2009)

Apart from many other factors, the design of Irrigation channels and control structures plays very important role in the successful performance of an irrigation system. Irrigation projects are launched for equitable distribution of water among the shareholders and its efficient use at the farms, for which design of diversions and control structures provide basic framework. Both the service providers and users of water desire that the system should be free of problems and minimum loss of efficiencies. Therefore, all the stake holders need to update their knowledge about the design parameters, principles of design, construction and the properly measured deliveries by the system to the users. This chapter has thus, been designed to include basic concepts, design terminology and principles of design based on Lacey's Theory proposed for the lined and unlined canals.

2.4 KALPESH KUMAR A. PARMAR, PATEL NIMISHA G. (2013)

Water is becoming a scarce resource as a result of the growing demand in various purposes such as hydropower, irrigation, and water supply etc. Canal irrigation scheduling is an important activity that significantly influences production of crops compared to other aspects of agriculture. Irrigation canal scheduling is the activity of preparing an optimal schedule of outlets on supply canal as per need of user, subject to canal system constraints.

2.5 A KENTLI (2014)

Today the increased world population and therefore the growth demand has forced the researchers to investigate better water canal networks distributing much more water while at least keeping its quality. Canal design formulas are explicitly obtained for different cross-sections considering minimum area but optimal design of canal sections considering seepage and evaporation losses are still an open area to study. In this study, two different algorithms are applied to this problem and results are compared with the one in literature. Genetic algorithm and sequential quadratic programming technique are used in optimization. Triangular, rectangular and trapezoidal cross-sections are optimized. It is seen that both algorithms are giving more accurate results than in literature.

2.6 MAHENDRA UMARE (2014)

India is basically an agrarian country and crop-water is supplied through the system of canals from either dams or distribution chambers. Conventionally, canals are designed, constructed & maintained by the Water Resource Department of an Indian State following a conventional design philosophy given by Kennedy, Lacey, Manning's in which the seepage losses are a big concern for the engineer. An approximate estimation of seepage under the un-lined canal is 7 Cumec per Million Square Meter & that of Lined Canal is 2.5 Cumec per Million Square Meter. To address the problem, Prof. P K Swamee has suggested an alternate design philosophy based on minimum seepage loss. Swamee presented simplified algebraic equations for computation of seepage loss for triangular, rectangular, and trapezoidal sectioned canals, which accurately replace the cumbersome evaluation of complex integrals. Swamee concluded that using these seepage loss equations and the general uniform flow equation canal can be designed for minimum seepage under the canal system. But, while designing the canal system for distributing water to the farms, a typical design approach issued by the central design office of the Government agency is adopted all over the state. The calculation of seepage is based on the thumb rule or the field observations done in the past for similar structures; and to reduce the seepage losses, canal lining is adopted which involves the heavy cost of construction & maintenance as well. This approach does not suits to the present environmental conditions where scarcity of water, due to irregular or deficit rainfall & depletion of ground water due to over exploitation, is being felt by the entire world. In such situation, adaptability of Swami's approach needs to be examined. This paper studies the comparison of the design philosophy suggested by Prof. P K Swamee with conventional design philosophy adopted by government agencies in tropical country like India.

2.7 VIKAS WAYAL (2014)

A canal aligned up along the boundaries of tillable areas to supply water for the purpose of land farm or agriculture is said to be an irrigation canal. Irrigation canals are an important source of irrigation for supplying water to agriculture development. These canals supply water to agriculture through rivers or dams. For the sustainable development of agriculture needs abundant water. Through this channel, complementary businesses like poultry farming, animal husbandry industries, polyhouses, green houses also get priority. Proper design of canals is necessary keeping in mind the water requirement of crops or orchards and water availability. Through this canal, the farmer is well suited to harvest Kharif and Rabi season crops and also help in production of orchads. Irrigation canal design has brought about a great revolution in agriculture and new business opportunities are opening up on a large scale.

2.8 YOUSRY MAHMAUD (2015)

Seepage and evaporation are the most serious forms of water loss in an irrigation canal network. Seepage loss depends on the channel geometry, while evaporation loss is proportional to the area of free surface. In this paper, a methodology to determine the optimal canal dimensions for a particular discharge is developed. The nonlinear water loss function, for the canal, which comprises seepage and evaporation loss, was derived. Two constraints (minimum permissible velocity as a limit for sedimentation and maximum permissible velocity as a limit for erosion of canal) have been taken into consideration in the canal design procedure. Using Lagrange's method of undetermined multipliers, the optimal canal dimensions were obtained for minimum water loss. A computer program was developed to carry out design calculation for the optimal canal dimensions. The results are plotted in form of a set of design charts. The proposed charts facilitate easy design of the optimal canal dimensions guaranteeing minimum water loss. Water loss from the canal section can be estimated from these charts without going through the conventional and cumbersome trial and error method. Sensitivity analysis had been included to demonstrate the impact of important parameters.

2.9 KRISHNA P PAUDEL (2016)

The design of irrigation canals with sediment-laden water is generally below expectation and potential as in most cases the aspects of sediment transport and in some cases the proposed management plans were not included in the design process. The sediment transport process is affected by the flow conditions in the canals, and the latter are affected by the existing water delivery mode. Hence, the design is one of the important aspects that determines the sediment transport process and sedimentation or erosion. A design that reflects the energy considerations (rational method) will lead to less sediment problems for the design discharge. However, changes in the discharge and the connected sediment behavior are not covered by this design and mathematical modelling of the sediment transport offers the possibility to investigate the distribution of sediment deposition or entrainment for a particular flow and a specific situation in time and place. The mathematical model SETRIC has been used to evaluate an existing design and its effect on the sediment transport process. The modelling results show that it is possible to reduce sedimentation problems by improving the existing design approach

2.10 ABID SARWAR (2017)

Apart from many other factors, the design of Irrigation channels and control structures plays very important role in the successful performance of an irrigation system. Irrigation projects are launched for equitable distribution of water among the shareholders and its efficient use at the farms, for which design of diversions and control structures provide basic framework. Both the service providers and users of water desire that the system should be free of problems and minimum loss of efficiencies. Therefore, all the stake holders need to update their knowledge about the design parameters, principles of design, construction and the properly measured deliveries by the system to the users. This chapter has thus, been designed to include basic concepts, design terminology and principles of design based on various regime theories including Kennedy's Theory, Lindley's Theory and Lacey's Theory proposed for the lined and unlined canals. The chapter further presents the design specifications of control structures, farm outlets and types of intake structures for small canals. It also provides opportunity to the readers for learning from relevant practical examples and multiple choice questions relevant to the subject.

2.11 R.J. RAUT (2018)

India is basically an agrarian country and crop water is supplied through the system of canals from either dams or distribution chambers. Canal irrigation networks provide water supplies for agriculture and food products. The purpose of irrigation is to achieve an efficient and effective use of available Water sources. To address these problems Prof P.K. Swamee has suggested an alternate design philosophy based on minimum seepage loss. Swami presented an equation for computation or seepage losses for triangular, rectangular and trapezoidal sections of canal. In the design of canals both lined and unlined canals systems are generally used. An approximate estimate of seepage under the unlined canal is 7 cusec per meter

2.12 PARAG KOCHE (2020)

As global population increasing, the gap between demand and supply of water also widening. Leads to threat for human existence. Many scientists finding way to water conservation. While municipal waste water and industrial effluents cause major environmental engineers. Recycling waste water for irrigation is seems to be solution. The paper mill effluent for irrigation offers many benefits such as conservation of water resources, conversion of barren land into irrigated area. Addition of nutrition to the soil. All this reduce the pollution of inland water bodies. The extent to which effluent irrigation responsible for problem such as water logging. Salting of soil, deterioration of surface and ground water are not estimated in holistic manner. The fact effluent irrigation become necessity in arid and semi-arid region demonstrate to need the impact assessment. the evaluation of effluent irrigation system for long term sustainability and monitoring major to sustain effluent irrigation is of prime importance to effluent user and public. The impact of the period of irrigation can also be assessed more precisely as the four schemes have been introduced at different periods of time viz.

2.13 MRUDULA S KULKARNI (2021)

Design of canals are plays the important role, to water flowing seepage loss, over tapping, stability of embankment, erosion, maintenance of canals and overall cost economy of Irrigation Project. Water resources department of Government of Maharashtra gives the design procedures of canals by Government circular No. MIS-2015. Design of open canals and distribution and network is done in accordance with this Government circular for lined and unlined canal. This procedure includes discharge carrying capacity of canal on the basis of crop water requirement of the planned ICA of the canal shall be calculated by modified penman method. The ICA of the canal is finalized the fortnightly crop water requirement and net irrigation requirement (NIR) is worked out by modified penman method. The gross irrigation requirement (GIR) of canals shall be calculated by adding the canal conveyance losses up to the crop root zone. The various values of rugosity factor (n), bed gradient (s) as per terrain in command area, calculate area (A) assume breadth (B), depth (D) in the range and calculate breadth and depth, wetted perimeter (P), hydraulic mean depth(R), velocity of assumed section by manning's formula (V). Thus if calculated velocity is less than permissible velocity, repeat the trial and if actual design discharge of assumed cross section matches with design discharge, the canal section adopted is acceptable. Indian standard, IS 10430:2000 criteria for design of lined canals and guidelines for selection of type of lining incorporate the design of lined canals with Capacity-Capacity required for the canal to irrigate the command depends on the crop pattern, irrigation intensity, rotation period, water required during critical period, transmission losses, etc.

2.14 NARSINGH. E. KATK (2021)

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2.15 VINIT JADAUN (2021)

Canals are canals that are frequently referred to as artificial waterways that are used to convey water and water-based vehicles. They may also help with irrigation. It resembles a manmade river in appearance. Under pressure, canals are utilized to convey free-flowing surfaces. This paper covers everything there is to know about water canal architecture and planning, starting with the fundamentals like what a water canal is and which countries built them, such as China, Russia, Brazil, Vietnam, India, and the United States, as well as the various types of canals based on variables like function and border cell. This research also looks at many basic elements of water canal design, such as how natural forces are always at odds with construction

2.16 YOUSRY MAHMAUD GHAZAW (2021)

Seepage and evaporation are the most serious forms of water loss in an irrigation canal network. Seepage loss depends on the channel geometry, while evaporation loss is proportional to the area of free surface. In this paper, a methodology to determine the optimal canal dimensions for a particular discharge is developed. The nonlinear water loss function, for the canal, which comprises seepage and evaporation loss, was derived. Two constraints (minimum permissible velocity as a limit for sedimentation and maximum permissible velocity as a limit for erosion of canal) have been taken into consideration in the canal design procedure. Using Lagrange's method of undetermined multipliers, the optimal canal dimensions were obtained for minimum water loss. A computer program was developed to carry out design calculation for the optimal canal dimensions.

2.17. KUMAIL AHMAD (2022)

Apart from many other factors, the design of Irrigation channels and control structures plays very important role in the successful performance of an irrigation system. Irrigation projects are launched for equitable distribution of water among the shareholders and its efficient use at the farms, for which design of diversions and control structures provide basic framework. Both the service providers and users of water desire that the system should be free of problems and minimum loss of efficiencies. Therefore, all the stake holders need to update their knowledge about the design parameters, principles of design, construction and the properly measured deliveries by the system to the users. This chapter has thus, been designed to include basic concepts, design terminology and principles of design based on Lacy's Theory proposed for the lined and unlined canals.

2.18 ABDUREHMAN (2023)

A canal is frequently used to convey water for farmland irrigation. In addition transporting irrigation water, a canal may also transport water to meet requirements for municipal, industrial, and outdoor recreational uses. The conveyance canal and its related structures should perform their functions efficiently and competently with minimum maintenance, ease of operation, and minimum water loss

A direct irrigation scheme which makes use of weir or a barrage, as well as a storage irrigation scheme, necessitates the construction of a network of canals. A canal is an artificial channel, generally trapezoidal in shape constructed on the ground to carry water to the fields either from the river or reservoir

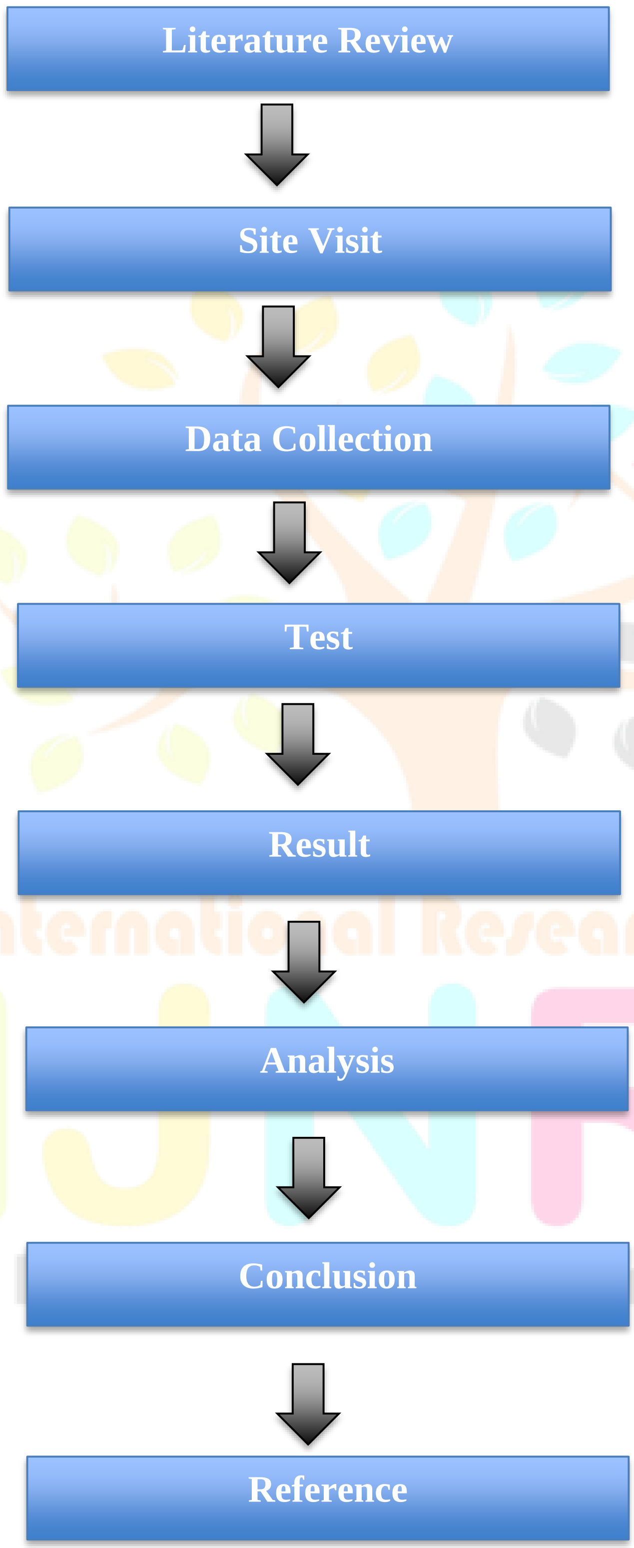
OUTCOME OF LITERATURE REVIEW

The outcome of a literature review focusing on canal design would provide valuable insights into various aspects related to the planning, design, construction, and management of canals. After studying all the factors in the canal system used for irrigation, We concludes that it is the main source to get the water for irrigation purposes and meet the requirements of the farmers. The economic impact of inaction versus some combination of the above alternatives will need to be studied more intensively.

Canal should be designed for Ridge which is generally known as Ridge canal .which can irrigate water in both the direction of canal.

CHAPTER -3

METHODOLOG



3.1 Site Visit

Fig 3.1.1 Site Visit at Indira Canal

The Indira Canal is a significant waterway that serves various purposes, including irrigation and water supply. It is located in the state of Uttar Pradesh, in the city of Lucknow. The canal stretches across various parts of Lucknow and its vicinity, providing water to agricultural lands and also serving as a source of drinking water for the city. The precise location may vary depending on which part of the canal you're referring to, but it generally runs through the outskirts and rural areas surrounding Lucknow.

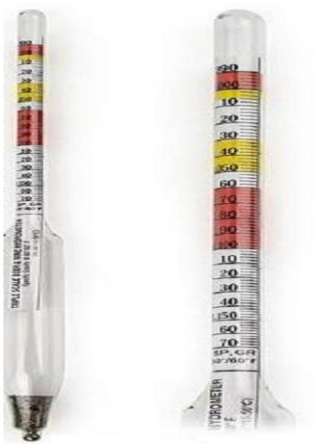
3.2 Data Collection

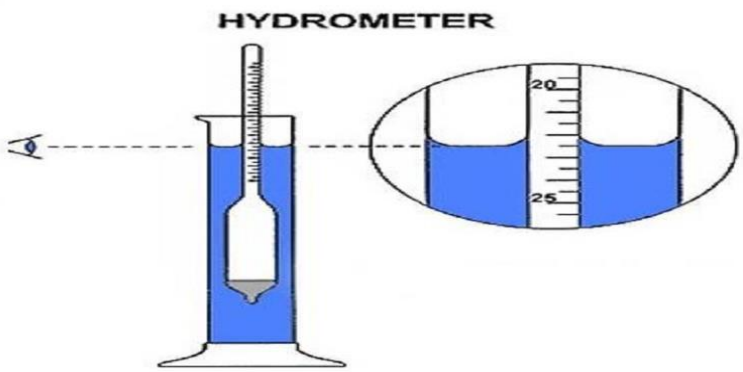
We collect the sample of particles from bed of Indira canal to know the size of particles that are stored at the bottom of canal

Fig 3.2.1 SAMPLING AT INDIRA CANAL

3.3 Testing

Hydrometer Test





- **THEORY**

The hydrometer method is one commonly used method to accurately determine particle size distribution in a soil sample. As the name implies, a hydrometer is used; a hydrometer is an instrument used to measure the specific gravity of a fluid. The basis for this test is Stoke's Law for falling spheres in a viscous fluid in which the terminal velocity of fall depends on the grain diameter and the densities of the grains in suspension and of the fluid. The grain diameter thus can be calculated from knowledge of the distance and time of fall. The hydrometer also determines the specific gravity (or density) of the suspension, and this enables the percentage of particles of a certain equivalent particle diameter to be calculated.

Fig 3.3.1 Hydrometer Test in Lab

- ## NEED

The results of testing will reflect the condition and characteristics of the aggregate from which the sample is obtained. Therefore, when sampling, it is important to obtain a disturbed representative sample that is representative of the source being tested because the distribution of different grain sizes affects the engineering properties of soil

APPARATUS REQUIRED:

1. Glass cylinders of 1000-ml capacity
2. Thermometer
3. Hydrometer
4. Electric mixer with dispersing cup
5. Balance sensitive to ± 0.01g
6. Stop watch & Beaker

- ## Re-Agents Required:

Dispersing solution-4% (Dissolve 5 g of sodium hexa - metaphosphate in de-ionized water of 125 ml)

- ## Procedure:

Soil passing 4.75mm I.S. Sieve and retained on 75micron I.S. Sieve contains no fines. Those soils can be directly dry sieved rather than wet sieving.

- **Wet Sieving**:

If the soil contains a substantial quantity (say more than 5%) of fine particles, a wet sieve analysis is required. All lumps are broken into individual particles.

1. Take 200gm of oven dried soil sample and soaked with water.
2. If de-flocculation is required, 2% Calgon solution is used instead of water.
3. The sample is stirred and left for soaking period of at least 1 hour
4. The slurry is then sieved through 4.75 mm sieve and washed with a jet of water.
5. The material retained on the sieve is the gravel fraction, which should be dried in oven and weighed.
6. The material passing through 4.75 mm sieve is sieved through 75-micron sieve.
7. The material is washed until the water filtered becomes clear.
8. The soil passed through 75-micron sieve is collected and dried in oven.
9. Take 40 gram of the oven dry soil sample after removing soluble salts and organic matter if any.
10. It is then mixed with 4% solution of dispersing agent in water to get a known amount of suspension by volume and stirred well.
11. This suspension should be made 24 hours before testing.
12. After 24 hours, the suspension is again mixed using Electric mixer with dispersing cup and
13. Following stirring with mixer, the suspension which is made up to 1000 ml in the measuring cylinder is turned end to end for even distribution of particles before the time 't' begins to be measured.
14. The hydrometer readings are recorded at regular intervals as indicated in the data sheet. From the data obtained the particle size distribution curve is plotted in the semi-logarithmic graph sheet along with the dry sieve analysis results.

➢ CORRECTIONS (INDIVIDUAL):

- **Meniscus Correction (Cm):**

Since the suspension is opaque, the readings will be taken at the top of the meniscus while the actual should be from the bottom of the meniscus. It is constant for a hydrometer (Always positive).

- **Temperature Correction (Ct):**

If the temperature is less than 27^0C, the correction is negative and vice-versa. Temperature should be measured from starting till end of the tests at regular intervals and are averaged. Then it is compared with the standard temperature (27^oC).

- **Dispersion Agent Correction (Cd):**

Addition of calgon always increases the specific gravity of the specimen. Hence, this correction is always negative

3.4 RESULT

From the above test we determined the size of particles present in sample

Size of particles = 0.004mm

3.5 ANALYSIS

The analysis of a hydrometer test involves careful consideration of the data collected, interpretation of results in the context of the test's purpose.

CHAPTER -4

DESIGNING METHOD

4.1 Design of Alluvial Channel

ln the case of alluvial channels, the channel surface consists of alluvial soil which can be easily scoured. Moreover, the velocity is low which encourages silting. Therefore, in an alluvial channel, scouring and silting may occur if the channel is not properly designed. The quantity of silt transported by water in an alluvial channel varies from section to section due to scouring of bed and sides as well as due to Silting (or deposition). If the velocity is too high, scouring may occur. On the other hand, if the velocity is too low, silting may occur.

The command of an irrigation channel decreases if the scouring occurs because the fall supply level falls. The discharge capacity is decreased if the silting occurs because the cross-section is reduced. Therefore the alluvial channel should be designed such that neither scouring nor silting occurs.

1 .Kennedy's silt theory

2. Lacey's silt theory.

KENNEDY'S THEORY

R.G Kennedy, an executive engineer of Punjab PWD, carried out extensive investigations on some of the canal reaches in the Upper Bari Doab canal system. He selected some straight reaches of the canal section which had not posed any silting and scouring problems during the previous 30 years. He considered the canal in those reaches as stable. Kennedy gave his theory, in 1895, based on the investigations carried out on those reaches of the canal. The vertical component of these eddies try to move the sediment up while weight of the sediment tries to bring it down. So if the velocity is sufficient to generate eddies so as to keep the sediment just in suspension, silting will be avoided based on the concept critical velocity. Eddies generated at the sides were neglected by Kennedy because such eddies are horizontal for the greater part and therefore have very little silt supporting power. Therefore, the eddies generated only at the bed of the channel are effective for transportation of the silt.

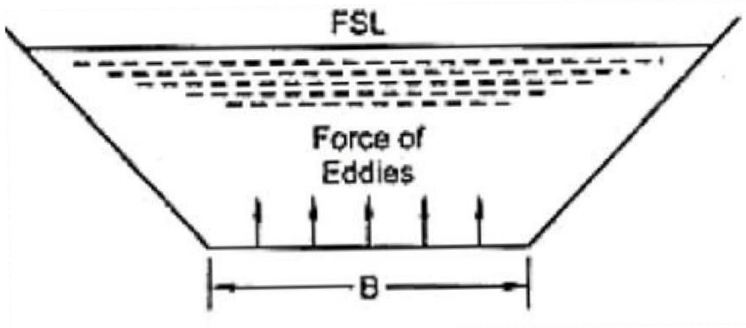


Figure: -4.1.1 Generation of Eddies (According to Kennedy)

According to Kennedy, the critical velocity Vc in a channel may be defined as the mean velocity of flow which will just keep the channel free from silting or scouring.

He gave his equation as: $\mathbf{V_o = 0.55\ D^{0.64}}$

Later he recognized that the grade (or size) of silt played an important role in the silt-carrying capacity of the channel and introduced another factor, called the critical velocity ratio (m). the equation was thus modified as:

$$\mathbf{V_o = 0.55\ m\ D^{0.64}}$$

m = critical velocity ratio = 1.1 to 1.2 for coarse sand
= 0.8 to 0.9 for fine sand

Kennedy's method of design:

Kennedy used 3 basic equations, namely:

1. Continuity equation:

$$\mathbf{Q = A\ V}$$

2. Flow equation (Kutter's equation):

$$C = \frac{23 + \frac{0.00155}{i} + \frac{1}{N}}{1 + \left(23 + \frac{0.00155}{i}\right)\frac{N}{\sqrt{m}}}$$

3. Kennedy's critical velocity equation:

$$\mathbf{V_o = 0.55\ m\ D^{0.64}}$$

Generally, discharge Q, Manning's coefficient N and the C.V.R (m) are given or assumed. Still there are 4 unknowns, namely A, V, R and S. Since there are only 3 equations and 4 unknowns, the complete solution is not possible. To obtain the complete solution, either bed slope or B/D ratio is assumed.

DRAWBACKS OF KENNEDY'S THEORY:

i) In the absence of B/D relation the Kennedy theory do not provide easy basis for fixing channel dimensions uniquely.

ii) Perfect definitions of silt grade and silt charge are not given.

ii) Complex phenomenon of silt transportation is not fully accounted and only critical velocity ratio (m) concept is considered sufficient.

iv) There is no provision to decide longitudinal slope under the scope of the theory.

v) By use of Kutter's formula inherent limitations therein remain applicable in Kennedy's channel design procedure.

LACEY'S REGIME THEORY

Lacey, an eminent engineer of U.P irrigation department carried out extensive investigations on the design of stable channel in alluviums. On the basis of his research work he found many drawbacks in Kennedy's theory and he put forward his new theory .He differentiated between three regime conditions:

1. True regime

2. Initial regime

3. Final regime

- **TRUE REGIME:** A channel will be in true regime if these conditions are satisfied:

1. Discharge is constant

2. Flow is uniform

3. Silt charge is constant

4. Silt grade is constant

- **INITIAL REGIME:** It is the first stage of regime attained by an artificial channel. The channel when excavated has somewhat a smaller width and a flatter slope. As the channel comes in operation and flow takes place, the bed slope of the channel is increased due to deposition of silt on the bed of the channel when the channel throws down its incoherent silt on the bed. It increases the velocity of flow in the channel which allows the given discharge to flow through the channel of the smaller width. With an increase of bed slope, the depth of channel may also change. However, the width of the channel does not change because the sides of the channel are usually cohesive and they resist erosion. If the soil in banks is clay, the sides may resist erosion almost indefinitely.

- **FINAL REGIME:** It is the ultimate regime attained by an alluvial channel when in addition to bed slope and depth, the width of the channel has also been adjusted. After a long time, because of continuous action of water, the resistance of the sides of the channel is overcome and finally gets adjusted according to discharge and silt grade, then the channel is said to have permanent stability called final regime.

- **LACEY'S BASIC REGIME EQUATIONS:**

Lacey found that the silt is kept in suspension by the vertical component of eddies, but he also considered the eddies generated at the sides of the channel which have vertical components and hence support the silt. Lacey, therefore, considered the hydraulic radius R as the characteristic parameter rather than the depth of flow D considered by Kennedy.

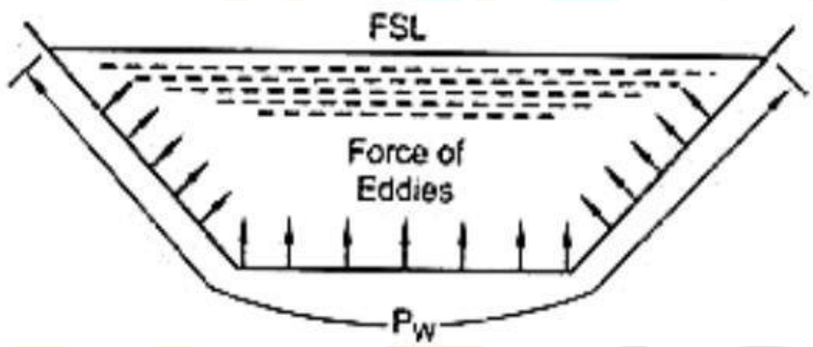


Figure: -4.1.2 Generation of Eddies (According to Lacey)

➢ Lacey's fundamental equations:

Lacey gave four basic equations:

1. **Silt Factor**: This is similar to C.V.R (m) as introduced by Kennedy. The silt factor was related to the average particle size of the silt. The silt factor depends upon the average size of the channel boundary material and its density. Since the specific gravity of all the transported material is same (about 2.65), the difference in density is ignored, hence the silt factor is related only to the particle size. Lacey gave the following equation for silt factor:

$$f = 1.76\sqrt{m}$$

2. m is the average particle size in mm.

3. Relation between mean velocity (V) and hydraulic radius (R):

R=5/2V^2/f

4. Relation between cross-sectional area (A) and mean velocity (V):

$$A f^2 = 140 V^5$$

5. Flow equation:

i. $$V = 10.8 R^{2/3} S^{1/3}$$

➢ DESIGN OF CHANNELS BY LACEY'S EQUATION:

Given: Discharge Q and silt factor f.

STEPS-

1. Determine the velocity. $V = (Q f^2/140)^{1/6}$

2. Calculate the area of flow. $A = Q/V$

3. Compute the wetted perimeter. $P = 4.75 \sqrt{Q}$

4. Knowing the area of flow and wetted perimeter, determine the depth D and width B from the geometrical relations given below, using a side slope of 0.5:1.

$$A = BD + 0.5 D^2$$

$$P = B + D\sqrt{5}$$

4.2 CANAL LINING

Canal Lining is an impermeable layer provided for the bed and sides of canal to improve the life and discharge capacity of canal. 60 to 80% of water lost through seepage in an unlined canal can be saved by construction canal lining**.**

Canal lining refers to the process of adding a protective layer to the inner surface of a canal to prevent water seepage and erosion, thereby improving water conveyance efficiency. Canal lining is commonly employed in irrigation, drainage, and water supply systems to minimize water loss and maximize water delivery to end-users. Several materials and methods are used for canal lining, each offering different benefits and suitability depending on factors such as soil conditions, water quality, and budget constraints.

Types of Canal Lining

1. Concrete (in-situ construction)

2. Precast concrete (tiles)

3. Lime concrete

4. Shotcrete

5. Brick tiles

6. Asphalt

a. Buried asphalt membrane

b. Asphaltic concrete

7. Stone blocks, concrete blocks undressed stones.

8. Earth materials –

a. Compacted earth

b. Soil cement

9. Prefabricated light-weight membranes

10. Bentonite - soil and clay membranes

11. PVC films

- **CONCRETE LINING**

Concrete lining involves pouring or spraying concrete onto the canal bed and sides to form a durable and impermeable layer. Concrete linings provide excellent protection against water seepage and erosion and have a long service life. They are suitable for large canals and high-flow applications but may be relatively expensive to install.

Cement Concrete linings are widely used, with benefits justifying their relatively high cost. They are tough, durable, relatively impermeable and hydraulically efficient. Concrete linings are suitable for both small and large channels and both high and low flow velocities. They fulfill every purpose of lining. There are several procedures of lining using cement concrete

Fig 4.2.1 CONCRETE LINING

- **BRICK LINING**

Brick lining entails laying bricks on the canal bed and sides, typically using mortar to form a smooth and watertight surface. Brick linings offer good resistance to erosion and are relatively cost-effective compared to concrete linings. However, they may require more maintenance and can be susceptible to damage from freezing and thawing.

In case of brick lining, bricks are laid using cement mortar on the sides and bed of the canal. After laying bricks, smooth finish is provided on the surface using cement mortar

Fig 4.2.2 Brick Lining

- **GEOMEMBRANES**

Geomembranes are synthetic liners made of materials such as high-density polyethylene (HDPE) or reinforced polyethylene (RPE). Geomembrane linings are lightweight, flexible, and resistant to chemicals and UV degradation. They provide an effective barrier against water seepage and are easy to install, making them suitable for both new construction and rehabilitation of existing canals.

- **ASPHALT LINING**

Asphalt lining involves applying a layer of asphalt concrete to the canal surface to create a waterproof barrier. Asphalt linings are durable, cost-effective, and relatively easy to install. They offer good resistance to abrasion and can accommodate minor movements in the underlying soil

Fig 4.2.3 Asphalt Lining

- **CLAY LINING**

Clay lining involves compacting natural clay or clayey soils onto the canal bed and sides to form a low-permeability barrier. Clay linings are inexpensive and environmentally friendly but may require careful compaction and maintenance to prevent cracking and erosion.

Earthen Type lings are again classified into two types and they are as follows:

- Compacted Earth Lining
- Soil Cement Lining

Compacted earth linings are preferred for the canals when the earth is available near the site of construction or In-situ. If the earth is not available near the site then it becomes costlier to construct compacted earth lining. Compaction reduces soil pore sizes by displacing air and water.

Reduction in void size increases the density, compressive strength and shear strength of the soil and reduces permeability. This is accompanied by a reduction in volume and settlement of the surface. Proper compaction is essential to increase the stability and frost resistance (where required) and to decrease erosion and seepage losses.

Fig 4.2.4 Compacted Earth Lining

- **PLASTIC LINING**

Plastic liners, such as polyvinyl chloride (PVC) or polyethylene (PE) sheets, are used to create impermeable barriers in canals. Plastic linings are lightweight, flexible, and resistant to chemical and biological degradation. They are relatively easy to install and suitable for small to medium-sized canals

Plastic lining of canal is newly developed technique and holds good promise. There are three types of plastic membranes which are used for canal lining, namely:

- Low density poly ethylene
- High molecular high density polythene
- Polyvinyl chloride

. The advantages of providing plastic lining to the canal are many as plastic is negligible in weight, easy for handling, spreading and transport, immune to chemical action and speedy construction. The plastic film is spread on the prepared sub-grade of the canal. To anchor the membrane on the banks ‘V trenches are provided. The film is then covered with protective soil cover.

Fig 4.2.5 Plastic Lining

- **PRECAST CONCRETE LINING**

Precast concrete slabs laid properly on carefully prepared subgrades, and with joints effectively sealed, provide a lining. These slabs are 5 - 8 cm thick with suitable width and length to suit channel dimensions and they result in a convenient weight to handle. This type of lining is most convenient to repair as it can be placed rapidly without having to shut down the canal for long period.

- **BOULDER LINING**

This type of lining is constructed with dressed stone blocks laid in mortar. Properly dressed stones are not available in nature. Irregular stone blocks are dressed and chipped off as per requirement. When roughly dressed stones are used for lining, the surface is rendered rough which may put lot of resistance to flow. Technically the coefficient of rugosity will be higher. Thus the stone lining is limited to the situation where loss of head is not an important consideration and where stones are available at moderate cost.

Fig 4.2.6 Boulder Lining

➢ ADVANTAGES OF CANAL LINING

1. Seepage Reduction
2. Prevention of Water Logging
3. Increase in Commanded Area
4. Increase in Channel Capacity
5. Less Maintenance
6. Safety Against Floods

1. SEEPAGE REDUCTION

The main purpose behind the lining of canal is to reduce the seepage losses. In some soils, the seepage loss of water in unlined canals is about 25 to 50% of total water supplied. The cost of canal lining is high but it is justifiable for its efforts in saving of most of the water from seepage losses. Canal lining is not necessary if seepage losses are very small.

2. PREVENTION OF WATER LOGGING

Water logging is caused due to phenomenal rise in water table due to uncontrolled seepage in an unlined canal. This seepage effects the surrounding ground water table and makes the land unsuitable for irrigation. So, this problem of water logging can be surely prevented by providing proper lining to the canal sides.

3. INCREASE IN COMMANDED AREA

Commanded area is the area which is suitable for irrigation purpose. The water carrying capacity of lined canal is much higher than the unlined canal and hence more area can be irrigated using lined canals.

4. INCREASE IN CHANNEL CAPACITY

Canal lining can also increase the channel capacity. The lined canal surface is generally smooth and allows water to flow with high velocity compared to unlined channel. Higher the velocity of flow greater is the capacity of channel and hence channel capacity will increase by providing lining. On the other side with this increase in capacity, channel dimensions can also be reduce to maintain the previous capacity of unlined canal which saves the cost of the project.

5. LESS MAINTENANCE

Maintenance of lined canal is easier than unlined canals. Generally there is a problem of silting in unlined canal which removal requires huge expenditure but in case of lined canals, because of high velocity of flow, the silt is easily carried away by the water. In case of unlined canals, there is a chance of growth of vegetation on the canal surface but not in case of lined canals. The vegetation affects the velocity of flow and water carrying capacity of channel. Lined canal also prevents damage of canal surface due to rats or insects.

6. SAFETY AGAINST FLOODS

A line canal always withstand against floods while unlined canal may not resists and also there is chance of occurring of breach which damages the whole canal as well as surrounding areas or fields. But among the all-concrete canal linings are good against floods or high velocity flow.

4.3 CANAL LOSSESS

Water enters the main canal at the head works through the head regulator and flows through the branches, distributaries and the water courses and finally reaches the field. Throughout its journey, there are continuous water losses which have to be accounted for the design of channels. These losses are considerable, especially in unlined canals. The losses in irrigation in irrigation channels are mainly of the following types:

➢ **ABSORPTION LOSSES:** Absorption losses occur because of absorption of water by the soil surface at the canal wetted perimeter. When the water table is at a considerable depth below the canal bed, the water infiltrating the soil below the canal bed is unable to reach the ground water reservoir below the water table. The soil layer which is in immediate contact with the channel section is completely saturated due to the absorbed water. It forms a bulb of saturated soil below the channel. The soil layer below the saturated bulb is not fully saturated. Thus the extent of saturation goes on reducing with from the ground level. Above the water table, there is also a small zone of saturation due to capillary action. Above that zone, there is also a zone of partial saturation in which the degree of saturation decreases as the distance from the water table increases. Thus there exists a zone of unsaturation between the soil saturated by canal water and that by the capillary action from the water table. Therefore there is no chance of continued and constant flow from the canal to the groundwater reservoir. Absorption losses are independent of the seepage head (difference of water level of the canal and the level of ground water table). These losses depend upon the water head from the water level of the canal to the bottom of the saturated zone and the capillary head for the soil at the boundary of the saturated zone. In general, Absorption losses depend upon the depth of water in the canal and the type of soil.

➢ **PERCOLATION (OR SEEPAGE) LOSSES**: When the water table is close to the canal bed, Percolation (or seepage) occurs from the canal to the water table. There is a direct flow from the canal to the ground water reservoir. Almost all the water which seeps from the channel joins the ground water reservoir. The seepage losses mainly depend upon the total seepage head (difference between canal water level and water table level) and the type of soil and are independent of the depth of water in the channel. Percolation losses are generally much greater than absorption losses. They may be as high as 3 times or more of the absorption losses.

➢ **Absorption and percolation losses from the canal mainly depend upon the following factors**:

✓ **Permeability of Soil:** Greater is the Permeability of soil in the bed and banks of the cannel, greater are the losses.

✓ **Depth of Water:** Greater is the depth of water in the canal, greater is the losses.

✓ **Velocity of Water:** The losses decrease with an increase in the velocity of flow in the channel.

✓ **Amount of Silt:** The losses decrease with an increase in the amount of silt carried by the canal water.

✓ **Temperature of Water:** The losses increase with an increase in temperature of water because viscosity decreases and the permeability of soil is increased.

✓ **Age of the Channel:** The losses are large in newly constructed channels and they reduce as silt gets deposited with the passage of time and a relatively impervious silt layer is formed.

✓ **Level of the Channel Bed:** The losses are more when the canal is in heavy filling than when in cutting.

✓ **Position of the Water Table:** The losses depend upon the Position of the water table with respect to the canal bed. The losses are more when the water table is high.

➢ **TRANSPIRATION LOSSES**: Transpiration losses occur through the vegetation and weeds in the canal. These losses are usually a small percentage of the total losses in an unlined channel. These losses can be considerably decreased by keeping the canal banks free of vegetation

➢ **EVAPORATION LOSSES**: As canal water is exposed to the atmosphere at the surface, loss due to evaporation is obvious. Evaporation losses depend upon the water surface area of the canal, relative humidity, wind velocity, temperature and various other factors. Generally, evaporation losses are less than 1% of the total water entering the canal head.

- **EMPIRICAL FORMULAE:**

- In U.P. the following empirical formula is used for the determination of canal losses:

$$Q=1/200(B+D)^{2/3}$$

Where-

Q is total loss in cumecs per km length of channel

B is bed width of the channel (m)

D is the depth of water (m)

- In Punjab, the following empirical formula is used.

$$K = 1.6\, Q^{0.0625}$$

Where-

Q is the discharge in cumecs.

K is total loss of water in cumec per million square km of perimeter.

CHAPTER -5

DESIGNING OF CANAL

- **DATA**

Diameter of particles =.004mm

CCA =234000hectare

Intensity of irrigation for Kharif season =85% and duty is1020 h/cumec

Intensity of irrigation for Rabi season = 60% and duty is 1700 h/cumec

- **CALCULATION: -**

Area under Kharif season = 0.85x234000

1989000

Discharge for Kharif season = area/duty

Q =1989000/1020

Q =195m^3/s

Area under Rabi season = 0.60x1989000

= 119340 hectare

Discharge for Rabi season =area/duty

Q=119340/1700

Q=.72m^3/s

Design discharge =largest discharge either of Rabi season or Kharif season

So, we take design discharge as **195m^3/s**

Now we have,

Q=195m^3/s

Diameter of particle (d) = 0.004mm

- **AS PER LACEY THEORY-**

$F= 1.76\sqrt{d_{mn}}$

Where d_{mn}= mean particle size of silt in mm

1. SILT FACTOR

Particle	**Particle size (in mm)**	**Silt Factor**
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**

Table No -5.1.1 Silt Factor as per diameter of particles

$f = 1.76\sqrt{d}$

$f = 1.76\sqrt{.004}$

$f = 0.12$

But we know that for very fine silt, silt factor is 0.4 so we take

$f = 0.40$

2. VELOCITY

$V = (Qf^2/140)^{1/6}$

$V = (19.5x0.40^2/140)^{1/6}$

$V = 0.80m/s$

3. PERIMETER

$P = 4.75\sqrt{Q}$

$P = 4.75\sqrt{195}$

$P = 66.33m$

4. AREA

$A = Q/V$

$A = 195/0.80$

$A = 243.75m^2$

5. DEPTH

$D = P-\sqrt{(P^2-6.994A)}/3.472$

$D = [66.33-\sqrt{(66.3^2-6.994x243.75)}]/3.472$

$D = 4.1m$

6. WIDTH

$B = P-2.236D$

B = 66.3-2.236x4.1

B = 57.0m

7. HYDRAULIC MEAN RADIUS

$R= 5/2 (v^2/f)$

$R = 5/2x0.8^2/0.4$

R = 4.0m

8. SLOPE

$S = (f^{5/3})/(3340Q^{1/6})$

$S = (0.40^{5/3})/(3340x195^{1/6})$

S = 1/37038

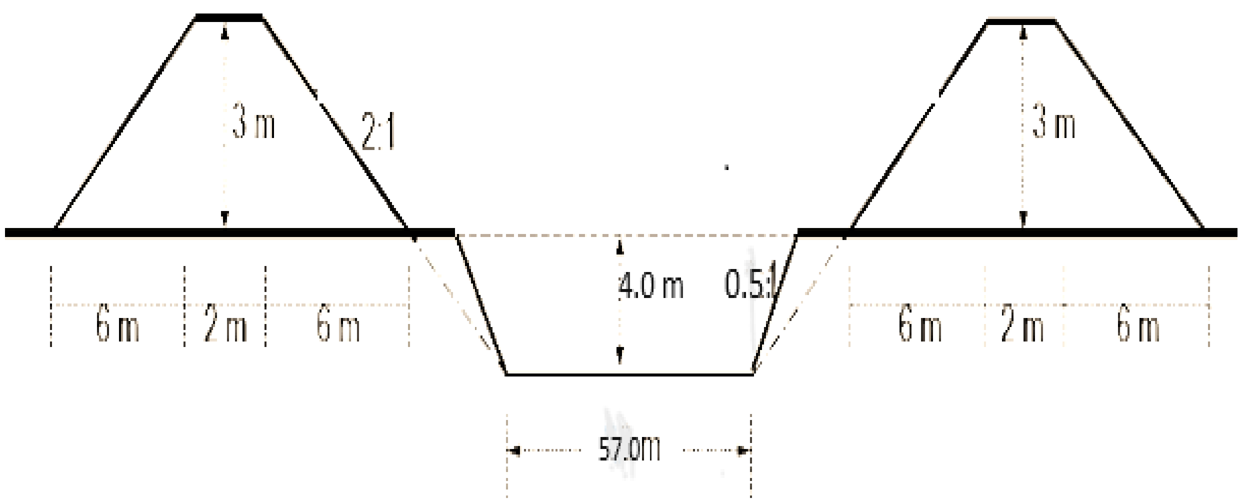


Fig: -5.1.1 C/S OF CANAL

Location of Site -Kala Gaon, near Outer Ring Road Lucknow.

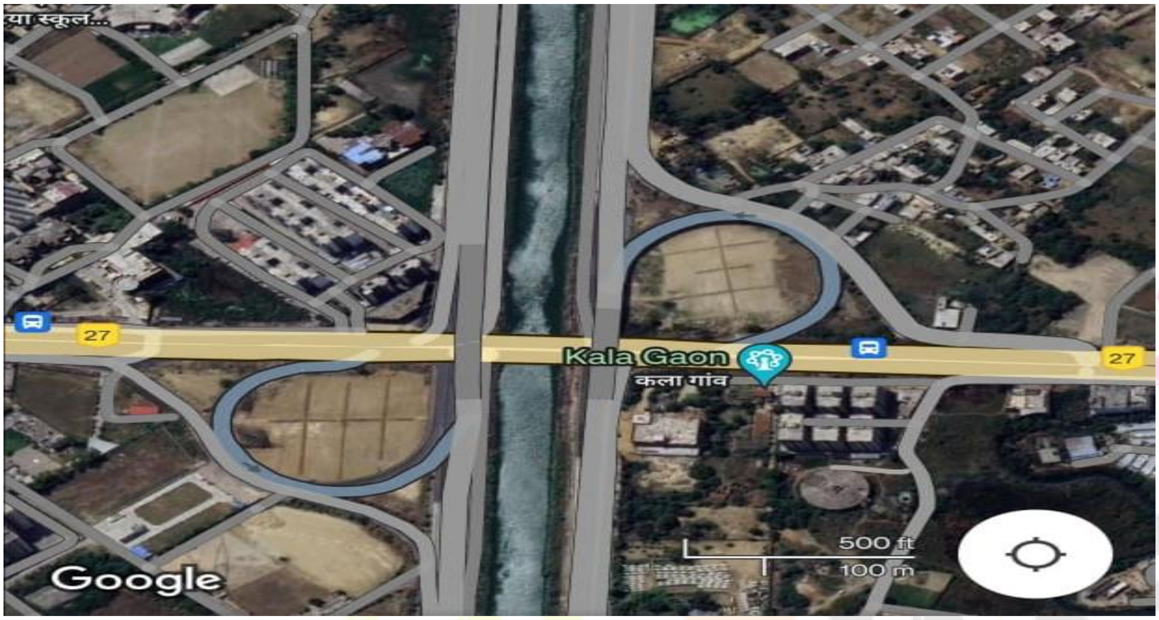


Fig -5.1.2 SITE LOCATION

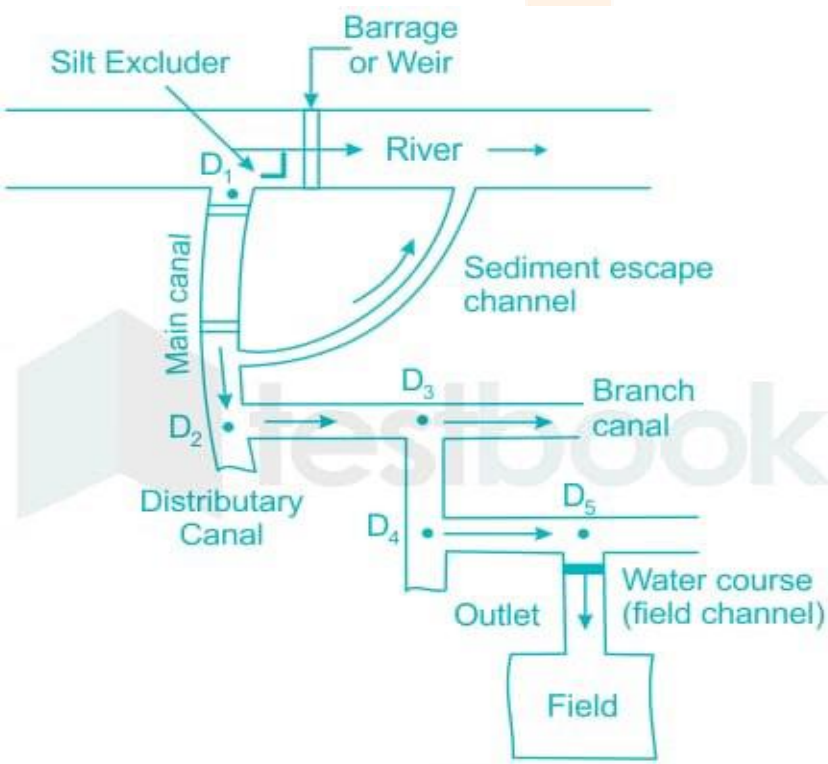


Fig-5.1.3 CANAL SYSTEM

CHAPTER 6

ESTIMATION

6.1 DETAIL OF MEASUREMENT

- **Given Data**

Width =57m

Depth =4.1 m

Length =1000m

- **VOLUME OF EARTHWORK**

= [Bd+sd^2]x length

= [57x4.1 +0.5x4.1^2] x1000

= 242105 m^3

- **LENGTH OF SIDE SLOPE**

=y[$\sqrt{1} + m2$]

=4.1[$\sqrt{1} + .5$^2]

=4.58m

Lining of canal is done by brick

Thickness of brick lining =0.075 m

Standard brick size 250x115x75mm

- **SURFACE AREA OF CANAL**

=57x1000+ 2(4.58x1000)

= 66160m^2

- **VOLUME OF BRICK WORK**

= 66160x0.0750m

= 4962m^3

BILL OF QUANTITY (AS PER DELHI SCHEDULE OF RATE)

Sr.No	Description	Quantity (cum)	Rate (Rs./cum)	Total cost (Rs.)
1.	Earthwork			
	Excavation (including removing vegetation from soil, labor cost , material, tools, plants, machinery and all other Charges including compaction.	242105	253.45	6,13,61,512
2.	Lining of canal			
	Brick lining (includes all labour, material ,cement sand aggregate , tools, plants, machinery)	4962	7999.68	3,69,94,435
			Total	**101055947.00**

Table no 6.2.1 –BILL OF QUANTITY

6.3 SUMMARY OF ESTIMATION OF COST

Name of work – Design and Estimation of Canal and outlet

Sr. No.	Item	Amount (Rs.)
1	As per Bill of Quantity	101055947.00
2	Add 1% Contigencies	1010559.47
3	Add 1% Quality Control	1010559.47
4	Add 2.5% Work Charge Establishment	2526398.00
	Total Estimation Cost	**105603463.9**

Table no 6.3.1 SUMMARY OF ESTIMATION

CHAPTER 7

OUTLET

An outlet is a device built at the head of a water course to the flow of water in and into the water course. An outlet connects the water course the distributing channel and provides a measure of discharge passing through it. Outlets are essential for efficient and safe running of a water course. There are various types of outlets commonly provided on any canal. Sluices are outlets provided in dams

A canal outlet typically refers to the point where water is discharged or released from a canal system. Canals are artificial waterways built to transport water for irrigation, drainage, navigation, or other purposes. Canal outlets can take various forms depending on the design and function of the canal system.

7.1 OBJECTIVE OF CANAL OUTLET

The objectives of a canal outlet depend on the overall purpose of the canal system and its specific design considerations. Generally, the objectives of canal outlets include:

(a) WATER DISTRIBUTION

Canal outlets facilitate the controlled release of water from the canal system to distribute it to agricultural fields, urban areas, industrial zones, or other destinations where water is needed for various purposes.

(b) WATER MANAGEMENT

They help in managing the flow of water within the canal system, ensuring that water levels are maintained at optimal levels for irrigation, navigation, flood control, or other functions.

(c) FLOOD CONTROL

Canal outlets may include spillways or other structures designed to release excess water from the canal during periods of heavy rainfall or high flow, thereby preventing flooding downstream.

(d) REGULATION OF WATER SUPPLY

Some canal outlets are equipped with gates, valves, or other regulating structures that allow for precise control of water flow. This regulation ensures that water is delivered as needed to different areas served by the canal system

(e) WATER QUALITY CONTROL

Canal outlets may include features such as filters or screens to remove debris and sediment from the water before it is discharged, improving water quality downstream.

(f) ENVIRONMENTAL CONTROL

Canal outlets can be designed to minimize ecological impacts, such as maintaining fish passage or preserving habitats for wildlife Canal outlets may be designed for ease of maintenance and operation, with features such as access points for inspection and cleaning, and mechanisms for adjusting flow rates as needed.

7.2 COMPONENT OF CANAL OUTLET

A canal outlet typically consists of several components.

(a)MAIN CANAL

This is the primary waterway that carries water from its source (such as a river or reservoir) to the outlet.

Fig 7.2.1 Main Canal

(b) OUTLET STRUCTURE

This is the portion of the canal where water is discharged. Depending on the design and purpose of the outlet, it may include features such as gates, valves, or other regulating mechanisms to control the flow of water.

(c) REGULATING GATES

These are used to control the amount of water released from the canal. They can be manually operated or automated, depending on the complexity of the canal system.

A regulating gate is a mechanical structure or device used to control the flow of water from the canal into another watercourse or irrigation system. These gates are essential for managing water distribution, flow rates, and levels within a canal network.

Overall, regulating gates play a crucial role in efficient water management within canal systems, helping to optimize water distribution, prevent flooding, and ensure that water resources are used effectively for irrigation, municipal supply, or other purposes.

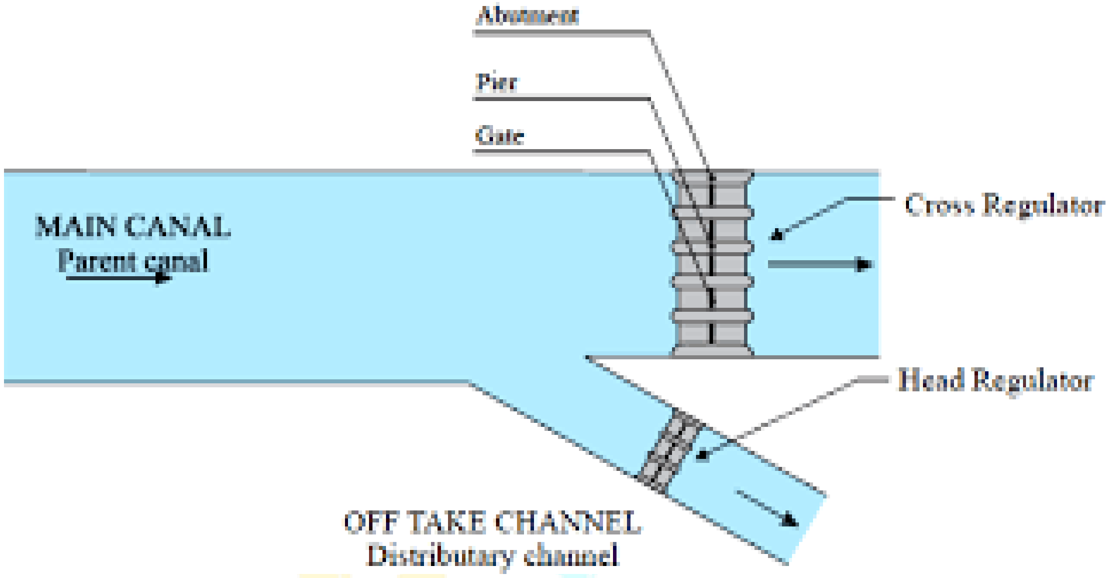


Fig 7.2.2 Regulating Gates

(d) SPILLWAY

In some cases, a spillway may be incorporated into the outlet structure to allow excess water to be safely discharged during periods of high flow

Fig 7.2.3 Spillway

(e)ACCESS ROAD OR PATH

This provides access to the outlet structure for maintenance and operation purposes.

(f) PROTECTION MEASURE

Depending on the location and surrounding environment, the outlet structure may be equipped

With measures such as erosion protection, fencing, or screens to prevent debris from entering the canal

(g)DRAINAGE FEATURES

Some canal outlets may include drainage features to manage excess water or prevent waterlogging in the surrounding area

7.3 CLASSIFICATION OF OUTLET

Canal outlets ate classified into three types, namely

(1) Non-modular outlets

(2) Semi-modular (or flexible) outlets

(3) Modular outlets.

1. NON-MODULAR IRRIGATION OUTLETS:

PIPE OUTLET:

It is provided in the form of a simple opening made in the canal banks which leads water from the parent channel to the field channel. The opening may be circular or rectangular in shape. In the former pipeline may be used. The rectangular tunnel or barrel may be constructed of masonry. Figure 13.1 shows the longitudinal section of a non-modular pipe outlet. The diameter of the pipe may range from 10 to 30 cm. The pipeline is laid on a light concrete foundation to prevent possibility of settlement.

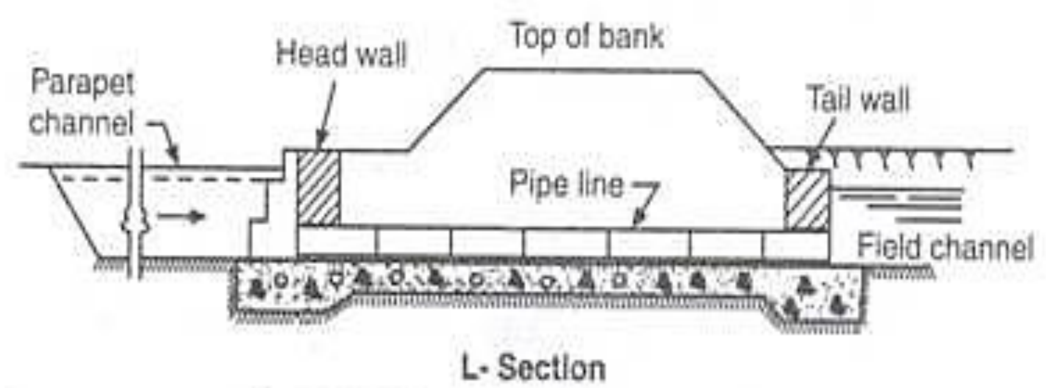


Fig 7.3.1 Pipe Outlet

The opening is generally drowned and hence the outlet discharge depends on the difference of water level of parent and field channel. The loss of head through pipe is given by well-known relation

$$H=0.5v^2\left[\frac{v2}{2g}\right]+\left[\frac{4flv2}{2gd}\right]+\left[\frac{v2}{2g}\right]$$

First term gives entry loss, second friction loss and third velocity at exit. Discharge is given by q = KA√H. So, far as possible the pipe line or the rectangular tunnel is constructed at right angles to the parent channel. The pipeline or barrel is generally laid in horizontal position. When the outlet is feared to draw more silt share the pipe line may be laid in inversely inclined position with a rise of 1 in 12 (Vertical: Horizontal)

2. Semi-Modular Outlets:

This category outlet discharge is independent of the water level in the field channel. Hence, this type may be correctly recognized as intermediate type to modular and non-modular outlets. It is designed to utilize the advantages of both the types in a limit.

When the water level in the parent channel is high all outlets derive proportionately more discharge and protect the channel from being damaged. Also when the level in the parent channel is low all the outlets derive correspondingly smaller discharge to maintain equitable distribution even at the tail of the channel. Thus, this is most suitable type of irrigation outlet and hence widely used.

There are various types of semi-modules namely. Free discharging pipe outlet, Kennedy's gauge outlet, scratchily outlet, Harvey Stoddard module, Crump's open flume outlet, Crump's adjustable proportional module, etc. Out of all these types Crump's adjustable proportional module is widely used in Punjab

Some of the semi-modular outlets include following types

(a) Pipe outlet

(b) Kennedy's gauge outlet

(c) Open flume outlet

(d) Orifice semi-module

(a) PIPE OUTLET:

When a pipe outlet discharges freely in the atmosphere the discharge through the outlet is not dependent in any way on the water level in the water course. In such cases pipe outlet can be said to be working as a semi-module.

(b) KENNEDY'S SEMI-MODULE:

It consists of a bell mouth orifice. It is made of cast iron. The orifice abuts against a truncated cone which is slightly bigger in diameter than the orifice. An air vent pipe is fitted at the junction of the cone and the orifice. The air vent pipe is kept sloping and is protected by an angle iron on the outer side. An enameled gauge is fixed on the angle iron

The air vent pipe is fitted to permit the orifice to discharge into free air at atmospheric pressure. The air vent pipe is connected to an air inlet pipe at the top. Air inlet pipe is horizontal perforated pipe laid on dry ballast. It makes the discharge independent of the water level in the field channel so long as the minimum modular head is available Minimum modular head is 0.22 H, where H is the depth of water over the center of the orifice. The water discharges at atmospheric pressure from bell mouth orifice into the truncated cone. The water is led further through cast iron expansion pipe to a concrete pipe and from there to the water course.

The outlet is cast in definite sizes for fixed value of discharges. The intermediate discharges may be obtained by raising or lowering the outlet orifice. This type of outlet is open to tampering easily by closing air vents.

This causes the pressure drop in the chamber because the entering water jet sucks the air of the chamber. This increases the discharge of the outlet. This type of outlet is not therefore very much in use.

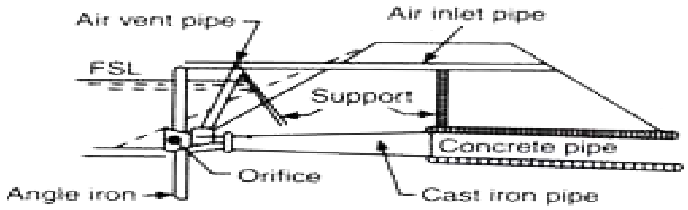


Fig 7.3.2 Kennedy Gauge Outlet

The outlet discharge is given by the following formula

q = A.C.√2gH

Where A is cross sectional area of the pipe at throat

H is depth of water from center of orifice to FSL

C is coefficient of discharge = 0.97

(c) PUNJAB OPEN FLUME OUTLET:

Only differences are that the approaches have been modified to induce more silt into the outlet and the length of the throat is kept equal to 2G.

3. MODULAR IRRIGATION OUTLETS:

As the outlet discharge of this type is independent of the difference of water levels of the parent channel and field channel it is also called rigid module. Modular outlets may be constructed with movable parts. But then the movable parts are liable to be damaged or choked. Hence, this type is not used in practice. As a result modular outlets with immovable parts are evolved. They are Foote module, Spanish module, Khanna's module, Gibb's module, etc.

- **Description of Gibb's module is given below**

(a) GIBB'S MODULE:

It is a modular outlet. Irrigation water is taken through an inlet pipe to a rising pipe. The rising pipe is in the form of a spiral. Generally, it is semi-circular. The water when flows through it are turned through 180°. During the movement in the rising pipe vortex motion is developed. As the flow is continuous angular velocity of the flow is same.

Angular velocity ω = v x r

Where v is tangential velocity,

And r is radius of flow

Obviously, the tangential velocity of flow at inner radius of the rising pipe is greater than that at outer radius. Also there is centrifugal head impressed on the water. As a result depth of water at outer radius is more than that at inner radius of the rising pipe.

The rising spiral pipe is connected to an eddy chamber. Figure 13.2 shows the plan and longitudinal section of Gibb's module. It gives clear idea about the arrangement of the component parts.

The eddy chamber is rectangular in section but semi-circular in plan with horizontal floor. It takes back the water in the original direction of flow. In the eddy chamber the baffles are provided at equal distance to dissipate excess energy of flow and to maintain a constant discharge.

The baffles do not rest on the bottom of the eddy chamber but there is an opening left between the floor of the chamber and the lower end of the baffles. This bottom opening is not rectangular in-shape but the height of opening reduces towards the inner side of the chamber. Thus, the lower end of the baffle is not flat but it is kept sloping.

This arrangement helps in maintaining constant discharge. When the energy of incoming water is more for perfect dissipation of energy the length of eddy chamber and in turn the number of baffles is increased. This is attained by giving one full turn to the eddy chamber in addition to the previous half turn.

Thus, the eddy chamber is given one and a half turn. After the excess energy of flow is destroyed and discharge is made constant the water from eddy chamber is taken into a spout. The spout is connected to a field channel by means of expansion walls. The walls are generally splayed with 1 in 10 (lateral: longitudinal) expansion.

The Gibb's module can be designed to give 0.03 cumec constant discharge for modular range of 0.3 m. The minimum working head required to maintain this discharge is 0.12 m. At this stage it may be recognized that as modular outlets require complicated arrangement of parts it is quite expensive. Secondly, in alluvial tracts the silt trouble is more. Outlet gets choked up with silt. Hence, this type is not much in practice.

(b) KHANNA'S RIGID MODULE

Khanna's module is similar to an orifice semi-module with additional shoots fixed to the roof block. The shoots result in back flow and thus keep the outlet discharge constant. If the water level in the distributary is at or lower than its normal level, the outlet functions like an orifice semi-module. However, when the water level in the parent channels is above its normal level, the water rises in chamber A and enters the first inclined shoot. This results in a back flow and dissipates additional energy. This enables a constant discharge. The number of inclined shoots and their heights above the normal water level can be varied to meet the local requirements. The shoots are housed in a chamber to prevent them from being tampered with. If the shoots are blocked, the outlet continues to operate as a semi-module.

- **DESIGN PARAMETERS**

Some basic parameter that characteristics performances of an outlet are flexibility, sensitivity, proportionality, setting, efficiency, minimum modular loss, modular limits and modular range.

(a) FLEXIBILITY

Flexibility is the ratio of the rate of change of discharge of an outlet (do/Q_o,) to the rate of change of discharge of the distributary channel (dB/Q) due to any change occurring in the water level of the distributary.

Thus, mathematically we can express:

$F = (dQ_0 / Q_0) / (dQ / Q)$

(b) SENSITIVITY

Sensitivity (S) of an outlet is defined as the ratio of the rate of change of discharge of an outlet (dQ_o / Q_o) to the rate of change in the water surface level of the distributary channel with respect to the depth of flow in the channel

(c) PROPORTIONALITY

An outlet is said to be 'proportional' when the rate of change of discharge in the out14 is the same as the rate of change of discharge in the parent channel; in other words, when the flexibility = 1. Therefore,

$$\frac{m}{n} X \frac{A}{H} = 1$$

Or,

$$\frac{H}{h} = \frac{m}{n} = \frac{outlet\ index}{channel\ index}$$

(d) EFFICIENCY

The ratio of the head recovered (i.e. the head remaining after all the losses in the outlet have been accounted for) to the input head of the water flowing through the outlet is known as its "efficiency". In case of weir type outlet, efficiency is the same as drowning ratio.

CHAPTRER 8

CONCLUSION

8. CONCLUION

The conclusion of designing a canal involves summarizing the key aspects of the design process and its implications for the project. Here's a comprehensive conclusion for the design of a canal:

In conclusion, the design of a canal is a complex process that requires careful consideration of various factors such as geography, hydrology, environmental impact, economic viability, and engineering feasibility. Throughout the design process, numerous challenges arise, including ensuring sufficient water supply, managing water quality, mitigating environmental impacts, and accommodating navigation requirements. Effective canal design necessitates a multidisciplinary approach, involving collaboration between engineers, hydrologists, environmental scientists, economists, and stakeholders. By integrating advanced technologies such as Geographic Information Systems (GIS), hydraulic modeling software, and remote sensing, designers can better analyze and optimize the canal alignment, cross-section, and operational parameters .Furthermore, sustainable design principles must be prioritized to minimize adverse environmental effects and promote long-term resilience. This includes implementing measures to prevent erosion, sedimentation, habitat disruption, and water pollution, as well as incorporating features like fish ladders and wildlife corridors to enhance ecological connectivity. Economic feasibility is another critical aspect of canal design, requiring thorough cost-benefit analysis and consideration of long-term maintenance and operation expenses. Additionally, socio-economic factors such as land acquisition, displacement of communities, and socio-cultural impacts must be carefully addressed to ensure equitable outcomes for all affected stakeholders. Ultimately, the successful design of a canal relies on balancing technical requirements with environmental sustainability and socio-economic considerations. By adopting an integrated and holistic approach, canal designers can create infrastructure that not only facilitates water conveyance but also contributes to regional development, environmental conservation, and societal well-being

8.1 FUTURE SCOPE

The future scope of canal design encompasses several emerging trends and opportunities that are likely to shape the development of canal infrastructure in the coming years:

(a). INTEGRATION OF SMART TECHNOLOGIES

Advancements in sensor technology, Internet of Things and automation will enable the implementation of smart canal systems. These systems can monitor water flow, quality, and structural integrity in real-time, allowing for proactive maintenance and efficient water management

(b). CLIMATE RESILLENCE

. With the increasing frequency and intensity of extreme weather events due to climate change, future canal designs will need to prioritize resilience. This may involve incorporating features such as flexible design elements, flood control mechanisms, and adaptive management strategies to withstand changing environmental conditions.

(c). RENEWAL ENERGY INTEGARTION

Canals offer potential opportunities for integrating renewable energy generation technologies such as hydroelectric turbines, solar panels, and floating wind turbines. By harnessing the energy potential of water flows and sunlight along canal corridors, these projects can contribute to sustainable power generation while minimizing land use impacts.

(d). MULTI-FUNCTIONAL DESIGN

Future canal projects may adopt a multi-functional approach, where canals serve purposes beyond water conveyance. These include recreational amenities, green spaces, urban transportation corridors, and ecological habitats. Such integrated designs can maximize the societal and environmental benefits of canal infrastructure.

(e). WATER-ENERGY –FOOD NEXUS

Recognizing the interconnectedness of water, energy, and food systems, future canal designs may emphasize holistic management approaches that optimize resource use and promote synergies between these sectors. Integrated canal projects could facilitate water storage, irrigation, hydropower generation, and aquaculture activities in a coordinated manner.

(f). COMMUNITY ENGAGEMENT AND EQUITY

Increasing emphasis will be placed on inclusive decision-making processes that involve local communities, indigenous peoples, and other stakeholders in the design and planning of canal projects. Ensuring equitable access to benefits and addressing social justice issues such as land tenure, displacement, and cultural heritage preservation will be paramount.

(g). NATURE-BASED SOLUTIONS (NBS)

Nature Based solution offer innovative approaches to canal design that mimic natural processes and enhance ecosystem services. Examples include vegetated buffers, constructed wetlands, and shoreline restoration techniques that improve water quality, biodiversity, and resilience while providing additional co-benefits such as flood protection and carbon sequestration.

(h). CIRCULAR ECONOMY PRINCIPLES

Embracing principles of the circular economy, future canal designs may incorporate strategies to minimize waste, promote resource efficiency, and maximize the reuse and recycling of materials. This could involve sustainable construction practices, water recycling systems, and bio-based materials that reduce environmental impacts over the canal's lifecycle. By embracing these trends and opportunities, the future of canal design holds promise for creating resilient, sustainable, and inclusive infrastructure that addresses the evolving needs of society while safeguarding the environment for future generations.

CHAPTER 9

REFRENCE'S

1. Academic.edu

2. Canal design and construction, a book by V. K. Bharathi Books

3. Comparative Study of Canal Design (2019) by PK Swami

4. Design of canal by R V Yadav

5. Design of canal structure by Bureau of Reclamation

6. Design of a canal section for minimum water loss by YM Ghazal (2011)

7. Irrigation Engineering and Hydraulics Design S K GARG

8. IS 10430: 2000 Criteria for design of lined canal

9. IS: 3370-(part-I)1965 Code of Practice for Concrete Structures for storage of liquids.

10. IS 456 Plain and reinforced Concrete –Code of Practice

11. IS: 4745-1968 Code of practice for Design of Cross Section of Lined Canal

12. IS: 5968-1987 Guide for Planning and layout of canal system for irrigation

13. IS: 7114-1973 Criteria for hydraulic design of Cross Regulators for Canals.

14. Kalpesh Kumar, A Parmar, W R M L D College of engineering Ahmedabad

15. Made easy Publication Irrigation Engineering

16. Mahendra Umar Associate Professor, Civil Engineering Department, Nagpur Institute of Technology, Nagpur, India

17. Mrudula S. Kulkarni Head of school of Civil engineering Dr.Vishwanath Karad MIT World Peace University Pune, India

18. R.J. Raut Professor, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India

19. Sanjeev Gadded Professor at Indian Institute of Technology Bombay

20. S.B Thakore Principal, AISSMS College of Engineering, Pune, India

21. Science Direct - Design and analysis of a canal section for minimum water loss by YM Ghazal (2011).

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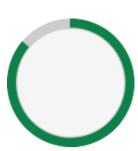

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WEB The quantity of silt transported by water in an alluvial channel varies from section to section due to scouring of bed and sides as well as due to Silting (or deposition). If the velocity is too high, scouring may occur.

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On the other hand, if the velocity is too low, silting may occur. The command of an irrigation channel decreases if the scouring occurs because the full

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