

# To Study Pipe and Canal Distribution Network of Gunjawani Dam by using Epanet Software

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## CHAPTER 1 INTRODUCTION

### 1.1 General introduction:

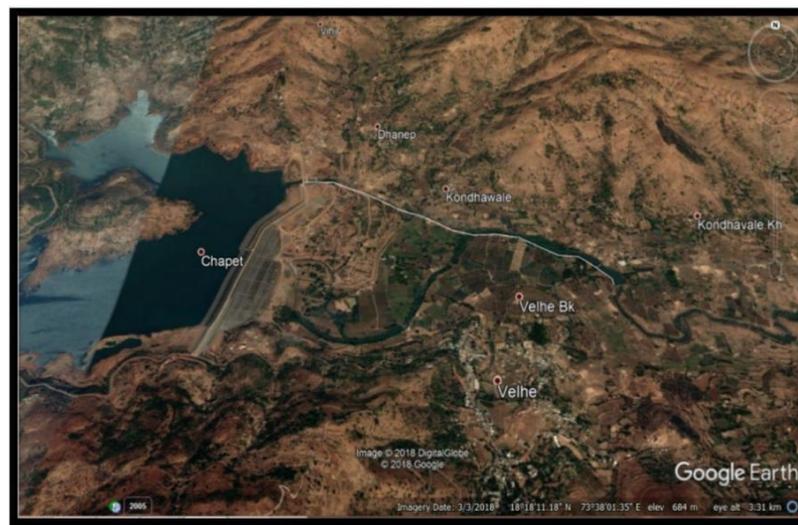
Nature has endowed our country with abundant Water Resources. However, due to limitations of topography, geology, physiographic, dependability, quality and the present state of technology, only a part of available water resources can be utilised. The utilisable water for irrigation is further limited considering other competing demands for domestic, industrial uses, recreational activities etc. It is a matter of great concern that this is happening at a time when there is an increased demand for various agricultural products due to phenomenal growth in the population. The need of the hour is, therefore, to maximize the production per unit of water, besides effecting utmost economy in water use for agriculture.

Water distribution system is hydraulic frameworks consisting of aspect such as are pipes, tanks reservoirs pumps and valves etc. It is necessary to supply water to the public; efficient water supply is of foremost importance in designing a new water distribution network or in spanning the existing one. It is also necessary to investigate and establish a good network ensuring sufficient head. Determination of flows and pressure head in network pipes has been of great amount and concern for those winding with designs, construction and conservation of public water distribution systems. Analysis and design of pipes networks create a relatively complex problem, especially if the network rest of range of pipes as frequently occurs in water distribution systems in agriculture area.

### 1.1.1 Study Area:

The study area, lies in Velhe taluka near Gunjavani dam in Pune district of Maharashtra. The dam is situated on the river Kanand. The area comes under canal command of Kurud irrigation tank. The field lies at  $18.3014285^{\circ}\text{N}$  latitude and  $73.6194598^{\circ}\text{E}$  longitude in Velhetaluka. The Length of the main canal is 1.730 km. The height of dam is 52.82m. Total catchment area of the dam is 104480 sq.km. The height of ogee spillway of Gunjavani dam's 22.76m and width of spillway is 27m. The design discharge of spillway is 1280.03 metre cube/sec. Total existing area under cultivation (irrigable area) is 16500 ha. Total capacity of dam is 25070 cumec.

**Figure .1.1 Topographical view of Gunjavani dam**



### 1.1.2 Canal distribution network (C.D.N):-

A canal is an artificial channel generally trapezoidal in shape constructed on the ground to carry water to field either from the river or a reservoir. Following are the types of canals :-

- 1) According to nature of source of supply :-
  - Permanent canal.
  - Inundation canal.
  
- 2) According to discharge
  - Main canal.

- Branch canal.
- Major distributary.
- Minor distributary.



**Figure.1.2 Earthen Canal**

### **1.1.3 Canal alignment:-**

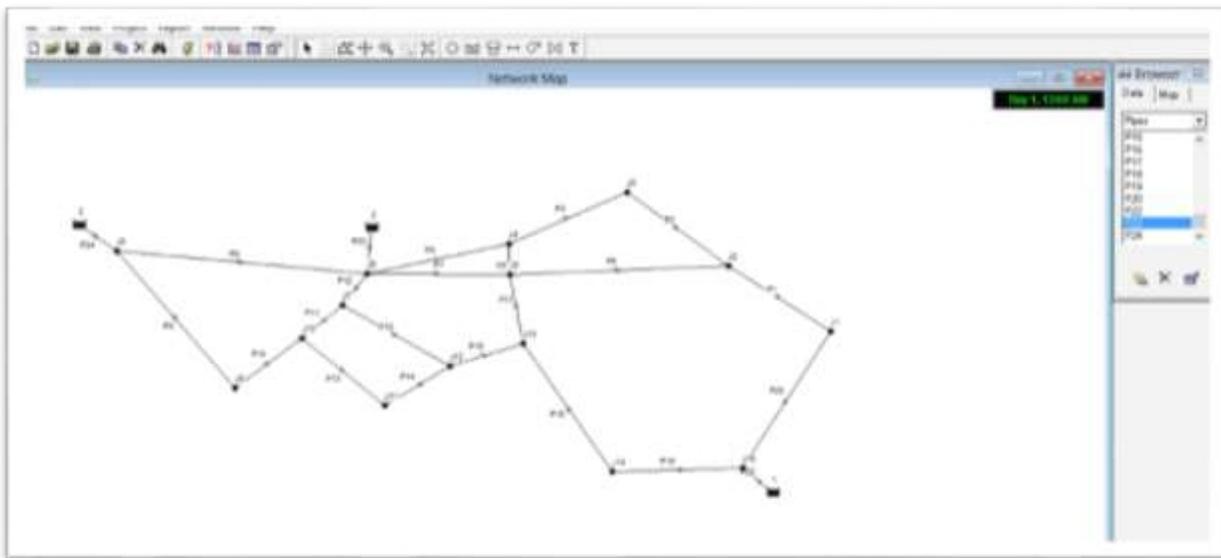
General consideration for the canal alignment:-

1. It should be aligned in such way that maximum area is served with the least length. And its cost including CD work is minimum.
2. A shorter length of canal has less loss of head due to friction and smaller loss of water due to seepage and evaporation, so the additional area can be brought under cultivation.
3. The alignment should be kept straight as far as possible, it will result in minimum losses.

### 1.1.4 EPANET:

EPANET is a public domain, water distribution system modelling software package developed by the United States Environmental Protection Agency's (EPA) Water Supply and Water Resources Division. It performs extended-period simulation of hydraulic and water-quality behaviour within pressurized pipe networks and is designed to be "a research tool that improves our understanding of the movement and fate of drinking-water constituents within distribution systems. EPANET first appeared in 1993.

EPANET provides an integrated environment for editing network input data, running hydraulic and water quality simulations, and viewing the results in a variety of formats. EPANET provides a fully equipped and extended period of hydraulic analysis that can handle systems of any size. The package also supports the simulation of spatially and temporally varying water demand, constant or variable speed pumps, and the minor head losses for bends and fittings. The modelling provides information such as flows in pipes, pressures at junctions, propagation of a contaminant, chlorine concentration, water age, and even alternative scenario analysis. This helps to compute pumping energy and cost and then model various types of valves, including shutoffs, check pressure regulating and flow control.



**Figure.1.6 Introduction of EPANET Software**

A typical usage of the Toolkit functions to analyze a distribution system might look as follows: Step by Step Example Problem

Assume that you need to calculate the diameter of each pipe, the flow and velocity in each pipe, and pressure in each node.

1. To create a new project:

Select **File | New** or click the **New Project** button on the General Toolbar. You will be prompted to save the exiting project (if changes were made to it) before the new project is created.

A new, unnamed project is created with all options set to their default values.

2. To set default values for a project:

Select **Project | Defaults**.

A **Defaults** dialog form will appear with three pages of default categories which you can edit: Default ID Labels; Default Node/Link Properties; Default Hydraulic Options.

Clicking on any box in the right column of any of these menus where choices have been filled in brings up a drop-down menu where you can select from the available choices.

Check the box in the lower right of the dialog form if you want to save your choices for use in all new future projects as well.

Click OK to accept your choice of defaults.

3. To set default preferences for a project:

Select **File | Preferences**.

A **Preferences** dialog will appear. Press **Select** below Temporary Directory. Browse for the c:\temp directory and press OK to accept the default directory

4. Creating the Project Scenario: Working with Objects

a. Select the type of junction (node, reservoir, or tank) to add from the Map toolbar. Move the mouse to the desired location on the map and click.

b. To add a junction to the map: on the toolbar, select the “add junction tool” and then left-click with the mouse on the map at the location where the junction is desired. Repeat for all junctions. Check the problem. The junctions are numbered top to bottom, left to right. Use this order to create the junctions.

5. To add a Link using the Map Toolbar:

Select the type of link to add (pipe, pump, or valve) from the Map Toolbar. Click the mouse over the link's start node. The start node will flash and a pencil will appear on the screen.

Move the pencil between the start and end nodes. Click the mouse again over the link's end node.

6. To select an object on the map:

Select **Edit | Select** or click the **Select Object** button (Arrow) on the Map Toolbar. Click the mouse over the desired object on the map.

7. To select an object using the Browser:

Select the type of object from the Object list box of the Database Browser. Select the desired object from the

Item list box.

## 8. Analysing a Network:

After a network has been suitably described, it's hydraulic and water quality behavior can be analyzed. This section describes how to specify options to use in the analysis, how to start the analysis and how to troubleshoot problems that might have occurred with the analysis.

## 9. Setting Analysis Options –

Select Options from the Object list of the Database Browser.

Select Hydraulics, Quality, Reactions, Times, or Energy from the Item

list. If the Property Editor is not already visible, click the **Edit** button. Edit your option choices in the Property

Editors. 10. Running an Analysis –

To run a hydraulic/water quality analysis:

Select **Project** | **Run Analysis** or click the **Run** button (lightning bolt).

## 1.2 PCHAPTER 2 LITERATURE REVIEW

[2.1] Chandrashkhar Bhagat, Ashwini Mirajkar, 2008, "Optimal designing of piped irrigation network: A case study Bakhari distributary of Pench, India."

In the present study the topology of the irrigation network, water requirement i.e. demand are predefined and the optimization is oriented to find the minimum cost of piped irrigation network. In this paper, the total cost of the irrigation pipe network Bakhari distributaries from EPANET of 2.0 and is calculated and found to be 10.489 crore. Analysis and design by EPANET 2.0 is simple and easy. This work is helpful in deciding the method of designing and optimization in case of irrigation pipe water distribution network.

[2.2] Modesto Pérez-Sánchez 1, Francisco Javier Sánchez-Romero 2, Helena M. Ramos 3 and P. Amparo López-Jiménez 1 Published: 1 June 2016.

In this research, a new methodology is proposed to help water managers quantify the potential energy recovering of an irrigation water network with adequate conditions of topographies distribution. EPANET has been used to create a model based on probabilities of irrigation and flow distribution in real networks. Knowledge of the flows and pressures in the network is necessary to perform an analysis of economic viability. Using the proposed methodology, a case study has been analyzed in a typical Mediterranean region and the potential available energy has been estimated.

**[2.3] Suteja Patode, Kalyani Garad, Published- June 2018 “PDN: an alternative to flow irrigation.”**

The Sonkhas Minor Irrigation Scheme comprises of earth dam across nallah approximately 1.0 km. away from Sonkhas village in Washim Taluka, District Washim

. The Pipe Distribution Network (PDN) is the technique of irrigating the command area through the network of HDPE pipes under gravity flow in place of open channels. This project describes about the need of PDN system, advantage and scope of PDN, essential requirement for PDN implementation, general installation guidelines for PDN, planning and design principles of PDN. The project also discusses about the magnificent improvement in the OPE of an irrigation project by adopting PDN. The project compares the percentage increase in efficiency of the project and other parameters for an illustrated project of Sonkhas in Washim District of Maharashtra.

**[2.4] Kolhe, Published-2012, “Study on optimal utilization of irrigation of pipe distribution network instead of CDN IN command area.”**

The objective of this study is to emphasis on the use of pipe distribution network instead of CDN in command area of irrigation project to improve efficiency of water use. By virtue of OPDN the water efficiency can be improved to 70-80% from existing efficiency of 25-40%. Thus there is about 2-3 times increase in the water use efficiency for irrigation, which means that there will be 55-65% improvement in overall water use efficiency. This study is based on the design of PDN of nagthana - 2. Minor irrigation project, located at Amravati district of Maharashtra state. In this study, focus is placed on the use of PDN instead of CDN in command area of irrigation project to improve efficiency of water use.

**[2.5] Yousuf And Faisal, 2007, “Study on the use of a semi-buried poly-vinyl chloride (PVC) pipeline system in Al-Hassa Oasis, Saudi Arabia.”**

In this paper, the main focus is on improving water conservation. Detoriated concrete canals at AL-Hassa irrigation project, enhanced irrigation water losses, and annual cost of maintenance became uneconomical for the long term. The PVC PIPES easy for maintenance, durability, modification and flexibility give them the potential to be an economical alternative to replace a concrete lateral canal at Al-Hassa irrigation project. PVC pipes were selected to construct a pipeline 360 m in length. An energy head, 2.7m of water was used in determining the pipeline capacity using the continuity equation. The conveyance and the distribution efficiencies increased by 25.3% and 25% respectively due to installation of the pipeline.

## CHAPTER 3

### METHODOLOGY

#### 3.1 Brief description of methodology:

Following is the brief description of the methodology:

##### 3.1.1 Formation of problem statement:

1. To study the canal distribution network (CDN) and pipe distribution network (PDN) over Gunjawani dam for irrigation purpose.
2. From study find out the efficiency of both distribution network.

##### 3.1.2 Literature survey:

Various research papers are studied for the project work.

##### 3.1.3 Deciding the area for the case study:

The study area, lies in Velhe taluka near Gunjavani dam in Pune district of Maharashtra. The dam is situated on the river Kanand. The area comes under canal command of Kurud irrigation tank. The field lies at 18.3014285°N latitude and 73.6194598° E longitude in Velhetaluka.

##### 3.1.4 Collection of data:

Various data is collected regarding the project work.

##### 3.1.5 Collection of soil sample and lab test:

Soil samples are collected from site selected for project and the required soil test are carried out in lab.

##### 3.1.6 Design of PDN by EPANET software:

Pipe distribution network is design for gunjavani dam by using EPANET software.

##### 3.1.7 Result analysis:

The result based on experimental analysis are discussed further. The result based on software work are discussed further.

##### 3.1.8 Conclusion:

To satisfy the better performance of PDN, it should be more efficient than the CDN in various different factors. Further conclusion is discussed in detail.

### **3.2 Detailed description of methodology:**

Following is the detailed description of the methodology.

This chapter describes the materials and methodologies adopted in the study for analyzing the existing irrigation system and design of underground pipe line irrigation system to minimize the losses. The chapter also presents the comprehensive management plan of the existing crop and water resources in order to obtain the sustainable output from the agriculture. This study depends mainly on primary data from the study area, beside secondary data from relevant official sources. The method selected for primary data collection included selection of site, actual site visit to the proposed site, rainfall data, crop type and variety, yield, soil type, method of irrigation. Secondary data consisted of testing of soil sample, preparing of contour maps by using QGIS software. The details of the study area and the sequential methodologies adopted in the present study are described below.

#### **3.2.1 Criteria for Pipe Distribution Network:**

Following is the criteria for Pipe Distribution Network

1. Limited water availability and extensive command.
2. Steep, uneven and undulated topography where canal system is uneconomical.
3. High losses due to evaporation, seepage and water theft.
4. Adoption of advance techniques for future development.
5. Farmer's responses and acceptability.
6. Need for crop diversification.
7. Need of contour irrigation for crops like orchards.
8. Black cotton soil in the reach of canal.
9. Availability of adequate fund.

## CHAPTER 4 EXPERIMENTAL ANALYSIS

### 4.1 Soil sample test:

Soil properties data has been generated through soil survey fieldwork. Soil survey was conducted in the study area. Soil samples were collected in the field and subsequently analyzed in the laboratory to ascertain the various characteristics of soils. The soil test carried on the decided area, to know the nature of the subsoil strata. Following were the test performed on the soil-

#### 4.1.1 Water Content by Oven Drying :

( Referring IS code 2720 part III- 1973 )

Observation Table:  
**Table-4.1- Water content**

Sample	Value
$W_1$ = Weight of empty container	18 gm
$W_2$ = Weight of container + soil	78 gm
$W_3$ = Weight of container + soil after oven drying	65 gm
Water content (w) = $(W_2 - W_3) / (W_3 - W_1)$	0.273

#### Calculations:

1. Empty weight of container ( $W_1$ ) = 18 g
2. Weight of container plus soil ( $W_2$ ) = 78 g
3. Weight of container plus soil after oven drying ( $W_3$ ) = 65 g
4. Water content =  $(w_2 - w_3) / (w_3 - w_1)$   
 $= (78 - 65) / (65 - 18)$   
Water Content = 0.2765.

#### 4.1.2 Specific Gravity By Pycnometer :

( Referring IS code 2720-part III-1980 )Observation Table:

**Table-4.2 Specific Gravity**

Sample	Value
W <sub>1</sub> = Weight of empty container	654 gm
W <sub>2</sub> = Weight of pycnometer + Dry soil	854 gm
W <sub>3</sub> = Weight of pycnometer + Dry soil + Water	1663 gm
W <sub>4</sub> = Weight of Dry soil + Water	1536 gm

**Calculations :**

1. Empty Pycnometer Weight (W<sub>1</sub>) = 654 g
2. Pycnometer + soil (W<sub>2</sub>) = 854 g
3. Pycnometer + soil + water (W<sub>3</sub>) = 1663 g
4. Pycnometer + water (W<sub>4</sub>) = 1536 g
5. Specific Gravity =  $(w_2-w_1) / (w_2-w_1)-(w_3-w_4)$   
=  $(854-654) / (854-654)-(1663-1536)$   
= 2.73



**Figure.4.1 Pycnometer.**

**4.1.3 Field density by core cutter :**

( Referring IS code 2720-part 29-1975)Observation Table:

**Table-4.3 Field density**

Property	Sample 1	Sample 2
W1	946 gm	946 gm
W2	2736 gm	2826 gm
V	1.02 X 10 <sup>-3</sup> m <sup>3</sup>	1.02 X 10 <sup>-3</sup> m <sup>3</sup>
$\gamma = W1-W2/V$	1754.90 gm/m <sup>3</sup>	1878.043 gm/m <sup>3</sup>

Sample 1 :- W1 =946 gm

W2 = 2736 gm

Volume =  $v = \pi/4 * (0.1)^2 * 0.13 = 1.02 * 10^{-3} \text{ m}^3$   
 $\gamma_1 = (w_2 - w_1)/V$

$\gamma_1 = 1754.9 \text{ kg/m}^3$

Sample 2 :- W1 = 946 gm W2 = 2826 gm

Volume =  $1.02 * 10^{-3} \text{ m}^3$   
 $\gamma_2 = (W_2 - W_1)/ V$

$\gamma_2 = 1878.43 \text{ kg/m}^3$

**4.1.4 Liquid limit test :**

( Referring IS code 2720-PART 5- 1985)



**Figure-4.2-Casagrande Apparatus**

**Observation Table :**

**Table-4.4 Liquid Limit**

Properties	Container no. 7	Container no. 9	Container no. 1
No. of blows	7	34	22
W <sub>1</sub> (gm)	18	18	18
W <sub>2</sub> (gm)	32	32	30
W <sub>3</sub> (gm)	28	26	26
$(W_1 - W_2) / (W_3 - W_1)(\%)$	40	75	50
W <sub>L</sub>	56 %		

**Calculations :**

1) Container No.7 No of blows-18 W<sub>1</sub> = 18 gm  
W<sub>2</sub> = 32 gm

W3 = 28 gm

Water content =  $(W2-W1) / (W3-W1) = (32-18) / (28-18) = 40 \%$

**2) Container No. 9**

B] Container No. 9 No. of blows – 34

W1 = 18 gm W2 = 32 gm W3 = 26 gm

Water content =  $(W2-W1) / (W3-W1) = 75\%$

**3) Container No. 1**

No. of blows – 22 W1 = 18 gm W2 = 30 gm W3 = 26 gm

Water content =  $(W2-W1) / (W3-W1) = 50 \%$  Liquid limit of this sample is – 56%

**4.1.5 Plastic Limit Test :**

( Referring IS code 2720-PART-5-1985)

**Observation Table :**

**Table-4.5- Plastic Limit**

Properties	Container no. 7
W <sub>1</sub> (gm)	16
W <sub>2</sub> (gm)	28
W <sub>3</sub> (gm)	26

### Calculations:

Container No. 7W1 = 16 gm W2 = 28 gm W3 = 26 gm

Water content =  $(W2-W1)/(W3-W1) W = 20\%$  WL = Liquid limit= 56%

Wp = Plastic limit= 32 %

IP = WL-WP = 56 – 32 = 24%

From the above results the soil available at the Gunjavani site was brown medium clayey soil.

## CHAPTER 5 RESULTS AND DISCUSSION

### 5.1 Results of test carried on soil samples.

The results of various tests that perform on soil are as follows: A] Type of soil – Brown clayey soil

B] Physical properties of soil :-

1) Texture- Good

2) Colour - Brown

3) Structure- Plate like

4) Density- 1878.43 kg/m<sup>3</sup> C] Water content – 27.65% D] Specific gravity – 2.73

E] Field Density –

$\gamma_1 = 1754.9 \text{ kg/m}^3$

$\gamma_2 = 1878.43 \text{ kg/m}^3 \quad \gamma = 1816.665 \text{ kg/m}^3$

F] Liquid limit – 56% E] Plastic Limit Test – 24 %

### 5.2 Results obtained by using EPANET Software:

Following are the results obtained by using EPANET software:

#### 5.2.1 Reduced level of existing canal:

Following table shows Latitudes, Longitudes and Elevations of nodal points along main line and distributaries which are obtained from QGIS software.

## CHAPTER 6 CONCLUSION

### 6.1 Conclusion:

Considering the scarcity of water, PDN system is recommended for irrigation in command area. PDN system saves water over conventional CDN system and should be preferred where land cost is comparatively high and farmers are unwilling to handover their valuable land. The pipeline distribution system would be more suitable for implementation of modern techniques like sprinkler and drip irrigation etc. The planning and designing of PDN should be carefully done so that maximum benefit of the system can be utilized.

- To improve the overall efficiency of an irrigation project, Pipe Distribution Network (PDN) is one of the best solutions which has great perspective.
- The discharge and the pipe diameters are the main design parameters of PDN which should be carefully calculated so that the maximum advantages of the system can be achieved.
- The pipe distribution network has been developed connecting individual farm covering whole area.
- As per study, discharge of 415 LPS is required throughout the base period for complete growth of crop, which is fulfilled by providing.
- Each farm has got sufficient quantity of water and desired pressure head is maintained.
- After doing the analysis of the water distribution network of the Gunjawani zone, we can conclude that the flow and velocity of water supplied to this zone appropriate and there is no problem in the flow and supply of water.

### References

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