International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 03 | Mar 2022 www.irjet.net p-ISSN: 2395-0072

"DESIGN OF WATER DISTRIBUTION NETWORK FOR DARFAL VILLAGE BY EPANET 2.0 SOFTWARE"

Nitin Pawar[1], P.A. Hangargekar[2], S.C.Vadane[3]

[1]P.G. Student, S.T.B.C.E, Tuljapur (M.S.), India
[2]Research Guide & Head, Dept. of Civil Engineering, S.T.B.C.E, Tuljapur (M.S.), India
[3]Associate Professor, Dept. of Civil Engineering S.T.B.C.E, Tuljapur (M.S.), India

---

Abstract – *Currently India has crossed 75 years of Independence. Notable technological development has been taken place in all sectors. The rural development of nation is the key area for progress of country. Because more than 70% population of India is living in village. Water is very essential human need. To fulfill this need is really challenging task for water supply department. It is the duty of local competent authority to fulfill the domestic need of water. A well planned water distribution network is essential helps to satisfy the need of water requirement. In the present study Darphal village's Water Distribution Network (WDN) is designed which is located at district Solapur, State Maharashtra, India. While designing the water distribution network, forecasting of population is for two decades, per capita demand of water and also survey of the village is done. The survey of village used to determine contours, lengths and elevation distribution area. A road map is created. The EPANET 2.0 software is used to design water distribution network. EPANET 2.0 is useful software which is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank etc.*

Keywords: *Pipe network, Flow, Daily demand, Discharge, EPANET 2.0 etc.*

1. INTRODUCTION

Aim of this work is to design and analyze the water distribution network using EPANET Software for village Darfal, District Solapur. Water distribution network consist of elements like pipes, tanks pumps and valves etc. All these components are connected to each other from source to consumer end. The first step of water supply engineer in planning of water distribution systems is to consider many factors like source and location of water, total demand, design period, future growth of population, sizes of pipes, loss of head, firefighting, leakages, etc. It is also important to build a efficient network of water distribution which ensures adequate head at all points. Maintaining design discharge and pressure head in overall network of pipeline is good symbol of design. During the design phase of water distribution system , two important consideration are essential first is to deliver adequate amounts of water to fulfill consumption requirements. Second is, the efficient system of water supply; the desired amount of water has to be made available daily for every individual. Now a day's different modern software's are available for the design purpose. The present work is aimed to design and analyze the water distribution network using EPANET Software for village Darfal, District Solapur.

1.1 Aim of the study

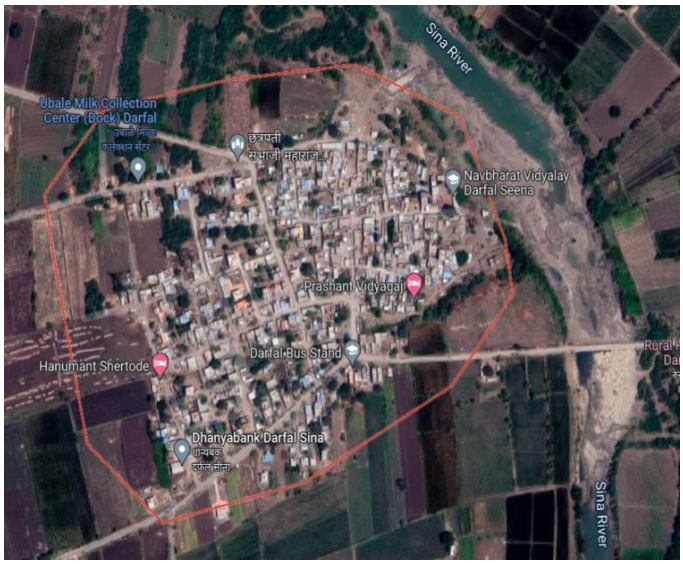
To Design a efficient water supply distribution system for rural area using EPANET 2.0 software.

1.2 Objectives of the study

1. To provide adequate amount of water to the consumers for drinking purpose.

2. To supply water with required discharge and pressure.

2. STUDY AREA



Satellite image of Darfal Village

Darfal Village is located in North Tehsil of Solapur District, Maharashtra, India. It is placed 27 km from Solapur city. As per 2009 statistics, there is Gram Panchayat in Darfal Village. Dafal is located at 17.7965 ° N and 75.7946 ° E. It has an average elevation of 11 metres (36 feet). The climate of the village is tropical. During Summer, the humidity level is very high and in winter the climate is almost always dry. The total geographical area of village is 3439 hectares. Darfal has a total population of 9150 peoples. There are about 1,600 houses in Darfal village. When it comes to administration, Darfal village is administrated by a sarpanch who is elected representative of the village by the local elections. All major economic activities are executed as it is near to the town.

2.1About EPANET 2.0 software:

It was developed by U.S Environmental protection agency's national risk management research laboratory under the water supply and water resources division (formerly the drinking water research division). Due to public domain software it can be freely copied and distributed. Within pressurized pipe networks it performs extended period of simulation of hydraulic and water quality behavior.

2.2 Design Procedure

I. Survey – Initially overall Survey of the distribution area was done. During this R.L of various junctions are taken, length of major and minor roads are measured. The position of important structures are marked. The data of survey was converted into an AutoCAD File showing all the important records.
II. Obtaining Survey data – An AutoCAD file was obtained for the area, showing various features and elevation data.
III. EPACAD – EPACAD software is used to convert AutoCAD files to EPANET files.
IV. EPANET – Once we converted layout in EPANET, all parameters such as units, notations, colors, formulas, scale etc. were selected.
V. Input (Elevation) – The essential data of elevation was entered for each node/ junction from AutoCAD file.
VI. Input (Base Demand) – The base requirement for each node was calculated using the population and assuming a water requirement of 70 liters per day per capita and distributing it between each node depending on the length of pipes connected to each node.
VII. Input (Reservoir) – We have placed a reservoir near the highest node. The reservoir should be located at an altitude of 15-20 m above the node's highest elevation.
VIII. Connection – Pipes are used in network to connect the reservoir .
IX. Running Analysis – Once connections are established and all data has been entered, the network is started for analysis. Warning messages are generated if negative pressures are created in the nodes.
X. Correction – To compensate for the negative pressure, increase the diameter of the pipe connected to the negative pressure node and rerun the analysis. This will continue until the negative pressure is gone and the run analysis shows the message "Run successfully".

3. LITERATURE REVIEW

1) Water Distribution Network using EPANET: A Case Study of Olpad Village,Surat district, Gujarat (Feb 2019)Nisha Patel, Ankita Parmar
In this work, the existing water distribution system is analyzed with the help of EPANET in which the number of nodes, pipes, elevation and demand of Olpad village used. The main focused of this study is to analyzed the water distribution and identify the results in its analysis. The analysis was found that the resulting pressures at all junctions and the flow with their velocities at all pipes are enough to provide the water to the study area. This study would help the water supple engineers in saving the time as it this process is fast and less difficult. To achieve basedemand discharge should be increased.

2) Extending EPANET capabilities with Add-In Tools (2016) P.L. Iglesias, F.J. Martínez, J.V. Ribelles
In this work a new platform for information exchanging between EPANET and third parties' programs have been developed. This new link allows using EPANET's GUI and simultaneously extend its editing capabilities, its computing resources and its processing capabilities. Although EPANET is universally accepted as a reference model in the analysis of water distribution networks, its editing capabilities, information processing and post-processing features have been shown clearly insufficient

3) Water supply network using EPANET through hydraulic modeling (March 2016) Shivalingaswami.S.H., Vijaykumar.H, Nagaraj.S. Patil
In this research the distribution network of Bagalkot (Navanagar) sector was analyzed according to sector 64,65,and 66. The water distribution network has 186 links, 120nodes, and 01 tank. The main aim of this research was to check the water distribution network and find the deficiencies (if any) in the analysis. At the end of the analysis, it was found that the resulting pressures at all the nodes and the links velocities are satisfying enough to provide water to the study area.

4) Gupta I, Dr.R.K. Khitolya, Dr.Shakti Kumar (2013) "Study of water distribution network using EPANET", International journal of computational Engineering Research, Vol.03, Issue 6.
A study was carried out using EPANET for water distribution network of a small area from Punjab city, India by Gupta I et.al. The work basically included the design of water distribution network with help of EPANET software along with the study of hydraulic parameters

required in design and corresponding variations in their functions and values. Design and development of network consisted data collection, building water distribution model and calibration of it with bore-well as source of water supply. Comparison of pressure was also carried out between results obtained from field survey and from the build model. The study showed that results obtained from EPANET based model and actual network are close enough to each other.

4. Materials and Methodology

4.1 Data required

For design a water distribution network of Darphal village, the following data were obtained:

1. Collection of the population of last 6 decades of Darfal village.

2. Collection of the existing work data of head work, ESR and raw water pipeline.

3. Road map of Darfal villages.

4. Data of existing water pipeline.

5. Existing location of Darfal.

6. Capacity of existing source of water.

7.Meteorological data (Rainfall, Temperature, Evaporation, Wind, and Humidity etc.

4.2 Software used:

1) EPANET 2.0
2) AutoCAD 2020
3) EPACAD
4) GOOGLE Earth

4.3 Population Forecasting

ACTUAL POPULATION FORECASTING OF DARFAL VILLEGE :

The following data of population is collected from Darfal grampanchayat office. This population gives record of past 05 decades i.e Year 1982, 1992, 2002, 2012, and 2022. The forecasting of future 02 decades i.e Year 2032, 2042 is done. From geometric method of population forecasting the future 20 years population of Darphal village is calculated and finally according to the 2042 population the total demand is calculated and adopted.

Geometric increase method:

Year	Population	Increase in population	Percentage increase in population
1982	4320	--	
1992	5200	880	880x100/4320= 20.37%
2002	7120	1920	1920x100/5200= 36.92%
2012	8000	880	880 x 100/7120 = 12.36%
2022	9150	1150	1150 x100/8000 = 14.38%
Average per decade			**21.0%**

P2032
$= P[1 + (IG/100)]^n$
$= 9150[1 + (21/100)]^1$
$= 11072$
P2042
$= P[1 + (IG/100)]^n$
$= 9150[1 + (21/100)]^2$
$= 13359$

4.4 Estimation Of Total Water Demand as per IS 1172 : 1993

Water Supply for Residences

A minimum of 70 to 100 litres per head per day may be considered adequate for domestic needs of urban communities, apart from non domestic needs as flushing requirements. As a general rule the following rates per capita per day may be considered minimum for domestic and non domestic needs:

1	For communities with population up to 20 000 and without flushing system	
	a) water supply through stand post	40 lphd (*Min*)
	b) water supply through house service connection	70 to 100 lphd
2	For communities with population 20 000 to 100,000 together with full flushing system	100 to 150 lphd
3	For communities with population above 100 000 together with full flushing system	150 to 200 lphd

Total Daily Demand of water

= Population x demand of water per head per day

=13359 x 70

= 935,130 lit/day.
Add 15 % losses

=935,130 X(15/100)

=9,49,156 say 9.50,000 lit/day.

4.5 Result and Discussion

Area 1								
	NODE			RL				
No.	Node-1	Node-2	LENGTH	Node-1	Node-2	POPULATION	LPCD	LPS
1	1	2	40	100	100.6	0	0	0
2	2	3	12	100.6	100.7	21	1470	0.017
3	3	4	24	100.7	100.8	32	2240	0.026
4	4	5	14	100.8	100.9	24	1680	0.019
5	5	6	32	100.9	101	33	2310	0.027
6	6	7	10	101	101.4	47	3290	0.038
7	7	8	48	101.4	101.6	62	4340	0.05
8	8	9	15	101.6	101.7	22	1540	0.018
9	9	10	35	101.7	101.8	47	3290	0.038
10	10	11	28	101.8	101.9	37	2590	0.03
11	11	12	88	101.9	102	92	6440	0.075
12	2	13	142	102	100.1	132	9240	0.107
13	3	14	88	100.1	100.2	90	6300	0.073
14	4	15	88	100.2	100.4	90	6300	0.073
15	5	16	87	100.4	100.5	91	6370	0.074
16	6	17	88	100.5	100.9	92	6440	0.075
17	7	18	52	100.9	101.1	61	4270	0.049
18	18	19	53	101.1	101.5	59	4130	0.048
19	9	19	51	101.5	101.6	61	4270	0.049
20	18	20	41	101.6	101.8	51	3570	0.041
21	8	21	40	101.8	101.9	46	3220	0.037
22	10	22	33	101.9	102	37	2590	0.03
23	11	23	56	102	102.2	61	4270	0.049

Result of software:

Area1						
Pipe No.	Node		Flow	Length	Dia.	HL
	From	To	(LPS)	(m)	(mm)	(m)
1	1	2	3.01	40	110	0.09
2	2	3	2.68	12	110	0.02
3	3	4	2.41	24	110	0.03
4	4	5	2.11	14	110	0.01
5	5	6	1.74	32	90	0.06
6	6	7	1.47	10	90	0.06
7	7	8	0.91	48	75	0.07
8	8	9	0.751	15	75	0.01
9	9	10	0.512	35	63	0.04
10	10	11	0.334	28	50	0.05
11	11	12	0.191	88	50	0.03
12	2	13	0.316	142	50	0.19
13	3	14	0.221	88	50	0.06
14	4	15	0.221	88	50	0.06
15	5	16	0.221	87	50	0.06
16	6	17	0.223	88	50	0.06
17	7	18	0.423	52	50	0.12
18	18	19	0.145	53	50	0.02
19	18	20	0.144	51	50	0.02
20	8	21	0.121	41	50	0.01
21	9	19	0.141	40	50	0.01
22	10	22	0.068	33	50	0
23	11	23	0.104	56	50	0.02

5. CONCLUSIONS

1. In this work, water distribution network is designed with less error with target discharge and pressure at all ends.

2. EPANET 2.0 software helps to design the water supply system within short time. Number of trials can be taken before finalizing the system.

3. Area developed in haphazard manner with different complexity can be designed with the help of EPANET 2.0 software.

REFERENCES

1. A.N.Alkali, S. G. Yadima, B. Usman, U. A. Ibrahim and A. G. Lawan. "DESIGN OF A WATER SUPPLY DISTRIBUTION NETWORK USING EPANET 2.0: A CASE STUDY OF MAIDUGURI ZONE 3, NIGERIA". (Arid Zone Journal of Engineering, Technology and Environment, June 2013)

2. A.N. Chavan, U.L. Deshpande. "Design of Optimized Water Distribution System for Rural India with Reference To Jambhali, District-Satara, Maharashtra".(Journal of Indian Water Works Association, July-Sept 2020)

3. Arati Shetkar, Nagesh Hanche, Devendra Hanche, Shashishankar A, "Design of Rural Water Supply for Village Navagadi(B) using LOOP Software". (International Journal

of Recent Advances in Engineering and Technology (2016) ISSN 2347-2812, Volume 4, Issue -7)

4. A.R.AYAD, H.A.AWAD, A.A.YASSIN. "GEOGRAPHIC INFORMATION SYSTEMS IN WATER DISTRIBUTION NETWORKS". (Conference Paper, Jan 2012)

5. Arjun Kumar, Kankesh Kumar, Bharanidharan B, Neha Matial, Eshita Dey, Mahan Singh, Vivek Thakur, Sarit Sharma, Neeraj Malhotra. "DESIGN OF WATER DISTRIBUTION SYSTEM USING EPANET". (International Journal of Advanced Research (2015), Volume 3, Issue 9, 789 – 812)

6. Bhagvat Zolapara, Neha Joshipura, Jaydeep Patel.(2015)."Case Study on Designing Water Supply Distribution Network Using EPANET for Zone-I of Village Kherali ";(Indian Journal of Research, PARIPEX Volume 4 Issue 7)

7. Bhavana K. Ajudiya, Dr. S. M. Yadav, Prof. B.H.Pandit. "Water Distribution Network Design and Analysis": A Case Study. (Lakhadhirji Engineering College)

8. Dr. H. Ramesh, L. Santhosh and C. J. Jagadeesh "Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS". (International Conference on Ecological, Environmental and Biological Sciences (ICEEBS'2012) Jan. 7-8, 2012 Dubai)

9. Emengini, Ebele Josephine1, Unigwe, Ozioma2 "DEVELOPMENT OF A GIS-BASED SYSTEM FOR MANAGEMENT OF WATER DISTRIBUTION NETWORK OF ACHARA LAYOUT ENUGU, ENUGU STATE, NIGERIA". (International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 01 | Jan-2016)

10. Manoj Nallanathel, B. Ramesh, A P Santhosh "Water distribution network design using EPANET A case study" (International Journal of Pure and Applied Mathematics Volume 119 No. 17 2018)

11. "Manual on Water Supply and Treatment" Third Edition, the GOI, Ministry of Urban Development, New Delhi, March 1991, pp 319.

12. Nikhil Hooda, Om Damani "Inclusion of Tank Configurations as a Variable in the Cost Optimization of Branched Piped Water Networks" (Copernicus Publications, Delft University of Technology)

13. Nitin P Sonaje, Mandar G Joshi, "A REVIEW OF MODELING AND APPLICATION OF WATER DISTRIBUTION NETWORK (WDN) SOFTWARES" (International Journal of Technical Research and Applications e-ISSN: 2320-8163)

14. Nisha Patel, Ankita Parmar, "Water Distribution Network using EPANET: A Case Study of Olpad Village" (Global Research and Development Journal for Engineering, February 2019 e-ISSN: 2455-5703)

15. Rushikesh Jagtap, Rakesh Gawali, Vinayak Kanade, Sanket Tithe, Prof P R Gayake, "A REVIEW PAPER ON DESIGN AND ANALYSIS OF WATER DISTRIBUTION SYSTEM OF ADYPU CAMPUS" (International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056)

16. Vidhi N Mehta, Dr G. S. Joshi, "DESIGN OF RURAL WATER SUPPLY SYSTEM USING LOOP 4.0" (International Journal of Modern Trends in Engineering and Research, December 2016, Volume 3, Issue -12)

17 Dr. P.R. Bhave and S.D. Shangarpwar from IWWA march 2001 "computer aided analysis and design of water distribution network"

18. Dr. P.R.Bhave and Dr. R.Gupta "Analysis of Water Distribution Network"

19. Eiger G, Shamir U, Ben-Tal A. (1994) "Opatimal Design of Water Distribution Network" Water Resources Research, Vol. 30, No.9, pp- 2637-2638

20. Nemanja Trifunovic (2002) "Water Distribution".

21. Shamir U.(1968) "Water Distribution Systems Analysis", Journal of the Hydraulic Division Proceeding of the ASCE, HY.1, 1968: pp.219-222.

22. Walski, Thomas M., (march 2006) "A History of Water Distribution", Journal AWWA, Vol 98, No.3, pp-110-111.