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Design Water Supply Network Using Epanet Software

Mr. Saurabh Veer[1], Mr. Saurabh Khandve[2], Mr. Yash Pawar[3], Mr. Kushal Marale[4], Prof. Ashwini Waghule[5]
[1, 2, 3, 4]*B.Tech Students,* [5]*Assistant Professor, Department of Civil Engineering, D Y Patil School of Engineering and Technology, Lohegaon, Pune, Maharashtra, India*

***Abstract:** This study represents use of EPANET software in the design of water distribution network. EPANET software is a user friendly software. In order to ensure the availability of sufficient quantity of good quality of water to the various section of community in accordance with the demand, many computer tools were developed, out of all the tools available EPANET become most popular and convenient for the effective design of complex pipe networks. This paper highlights only the effective design and distribution of network of pipes using EPANET tool. The residual head at each and every node was found out by having the elevation as input and thereby the corresponding flow quantities were derived like residual head, velocity and nodal demand etc.*
***Keywords:** Water Distribution, Network Analysis, EPANET, Population forecast, water demand, nodal demand.*

I. INTRODUCTION

Water distribution system is a hydraulic infrastructure consisting of elements such as pipes, tanks reservoirs pumps and valves etc. It is crucial to provide drinking or potable water to the end users; hence, effective water supply is of paramount importance in designing a new water distribution network or in expanding the existing one. Computation of flows and pressures in a complex network has been of great challenge and interest for those involved with designs, construction and maintenance of public water distribution systems. Analysis and design of pipe networks create a relatively complex problem, particularly if the network consists of range of pipes as frequently occurs in water distribution systems of large metropolitan areas. In the absence of significant fluid acceleration, the behaviour of a network can be determined by a sequence of steady state conditions, which form a small but vital component for assessing the adequacy of a network.

A. Background of Water Distribution Network Analysis

One of the earliest theories into inputs and outputs are known, but the flow inside the network is unknown. The Hardy Cross method is an adaptation of the Moment distribution method, which was also developed by Hardy Cross as a way to determine the moments in indeterminate structures.

The method was later made obsolete by computer solving algorithms employing Newton-Raphson method or other solution methods that removed the need to solve nonlinear systems of equations by hand. Solution to water flow and pressure in water distribution network finding includes the popular Hardy Cross method which is an iterative method for determining the flow in pipe network systems where the inputs and outputs are known, but the flow inside the network is unknown.

B. Justification for the use of EPANET

The EPANET software developed by the USA Environmental Protection Agency is adopted because it is for general public and educational use and it is available free online. It has the capacity to analyze unlimited number of pipes and tanks. EPANET has become a popular tool in analyzing complex and simple water distribution networks in both the developed and developing countries of the world. EPANET is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks.

A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network.

EPANET is designed to be a research tool for improving our understanding of the movement and fate of drinking water constituents within distribution systems. It can be used for many different kinds of applications in distribution systems analysis. In this paper it was used to carry out the hydraulic analysis of the distribution network of the study area.

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C. About EPANET

EPANET is a computer program which performs extended period simulation of hydraulic and also water quality behaviour in just pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), most pumps, valves as well as storage tanks or even reservoirs. EPANET tracks the flow of water for every pipe, the pressure in each and every node, the level of water in every tank, so the focus of a substance species through the network throughout a simulation period comprised of multiple time steps. Along with chemical substance species, source and water age tracing may additionally be simulated.

D. Objective

The objective of the distribution system is to supply water to each and every house, industrial plants and public places. Each house must be supplied with sufficient quantity of water at the desired pressure. Therefore, the water has to be taken to the roads and streets in the city and finally to the individual houses. This function of carrying the water from the treatment plant to the individual homes is accomplished through a well-planned distribution system. A distribution system therefore consists of pipe lines of various sizes for carrying water to the streets; valves for controlling the flow, service connections to the individual homes, distribution reservoirs for storing the water to be fed into the distribution pipes. The water may either be pumped directly into the distribution pipes, or it may be first stored in a distribution reservoir and then fed into the distribution pipes.

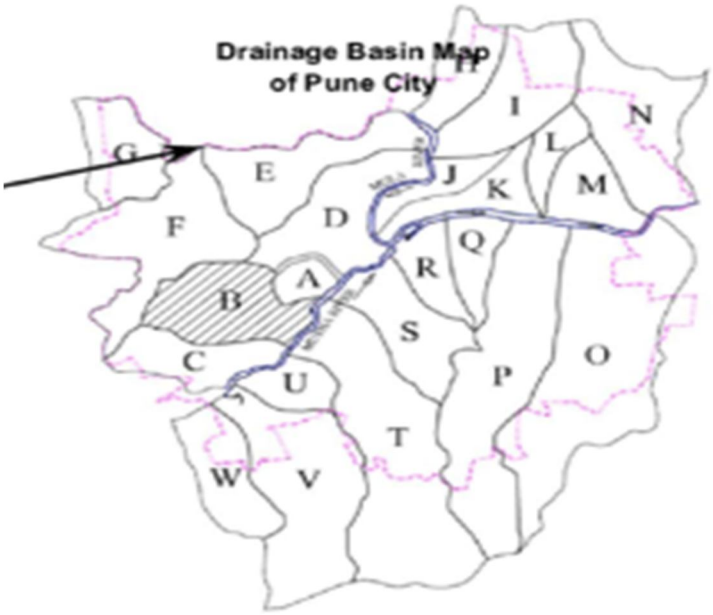


Fig.1 Google image of Charoli, Pune

II. LITERATURE REVIEW

Manoj Nallanathel et.al (2018) Conducted research on “Water distribution network design using EPANET A case study”

The main objective of this project is to study and design the water distribution network of SAVEETHA University using EPANET software. So that we want to check whether the water supplied to the consumers in a reasonable pressure or not. The requirements for this study includes of SAVEETHA University map, demand based on block wise population, elevation of node location, pipe length, roughness coefficient and diameter of the pipe. The SAVEETHA University map was extracted from the google earth that consists of 15 blocks and the elevation of the nodes were determined from the Height and Instrument method of levelling. The water demand was calculated based on number of people in each block. The water distribution network in the SAVEETHA University consists of 14 pipes, 14 nodes and one main overhead tank. The diameter of the pipe is 250mm for the total network.

CALGARY et.al (2019) Conducted research on “investigation into using EPAnet software to design trickle fill water distribution systems”

Small rural drinking water systems in Alberta face financial challenges when supplying potable water via traditional pressurized distribution system. In many rural settings, the costs can be reduced by employing an innovative solution of distributing and delivering water via low-pressure water supply system, often called trickle fill system.

This research develops a modelling approach to design the trickle fill system in Rocky View County, Alberta and investigates into EPAnet software application suggested by US Environmental Protection Agency to study and analyze system hydraulics, water quality, and energy profile. The conducted research concludes the trickle fill system design cannot be performed by EPAnet alone and suggests modeling software applications suitable for rural water development to be used in combination with EPAnet software. The study proposes options for energy optimization for Rocky View County and finds that trickle fill system implementation is the most suitable option.

MONTASIR MARUF et.al (2015) Conducted research on" Water Distribution System Modeling by Using EPANET Software" Sustainable development is a prime concern now a day. A good water infrastructure plays a key role for any kind development for a city. Here in this study, capital city of Bangladesh, Dhaka has been focused for analysis purpose. Although the average condition of the municipals water infrastructure systems is poor and deteriorating fast. Supply water distribution network of Banana area was selected for detail analysis. The area has been modeled using EPA-NET software on the basis of data surveyed by Dhaka WASA. An efficient water distribution system depends on adequate pressure head, velocity and flow rate. Ensuring all of this is a challenging task. Calculation of required pressure head, velocity coverage, flow rate, chlorine dosage has been done. Fire demand coverage has been analyzed for Banani area. Fire demand analysis gives the full overview of the system in the emergency condition. In water supply system chlorine is used for neutralize bacteria and make the water pure.

Bharanidharan B et.al (2015) Conducted research on "DESIGN OF WATER DISTRIBUTION SYSTEM USINGEPANET"

In order to fulfil the water demand of the continuously growing population, it is essential to provide the sufficient and uniform quantity of water through the designed network of pipes. For this purpose, the details provided by the IPH (IRRIGATION AND PUBLIC HEALTHE DEPARTMENT) department, Indore Himachal Pradesh have been followed. The general features of the area like information about the main water source, population of the area, demand of water, requirement of the pumps, distribution network and water tanks are essential for efficient design of water distribution system. According to the government of Himachal Pradesh the per capita consumption of water by an Individual person is 70litres per day and design has been made accordingly. This work highlights the process carried out on design of water supply system for an area named KATHGARH with the help of all this information the design of the water supply scheme for the area with the help of software "EPANET". This design of the water supply scheme for proper supply of water is efficient to meet the daily requirement of water in this area.

G. Anisha et.al (2016) Conducted research on "Analysis and Design of Water Distribution Network Using EPANET for Chirala Municipality in Prakasam District of Andhra Pradesh" The present system of supply adopted in Chirala municipality is an intermittent supply and the network adopted is a dead end system. This system of supply of water in Chirala municipality may or may not be reliable to the upcoming years. Hence the research is all about the analysis of the existing network and concludes about the reliability on the network for the future. The analysis is carried out based on various public demands, quantities of inflows and out flows of the over-head reservoirs. This analysis provides the information about various demands, losses, and uses of the public. The design of a new network of supply will make the municipality be aware of the new demands, rate of increase in the demands. The design is made keeping in view of the population growth rate, and the developing town. The design brings out an improvement in the existing network.

Dr. G. Venkata Ramana et.al (2015) Conducted research on "Network analysis of water distribution system in rural areas using EPANET" In order to ensure the availability of sufficient quantity of good quality of water to the various section of community in accordance with the demand. Many computer tools were developed, out of all the tools available EPANET become most popular and convenient for the effective design of complex pipe networks. This paper highlights only the effective design and distribution of network of pipes using EPANET tool. The residual head at each and every node was found out by having the elevation as input and thereby the corresponding flow quantities were derived like residual head, velocity and nodal demand etc.

Dr. H. Ramesh et.al (2012) Conducted research on "Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS" Water supply system is a system of engineered hydrologic and hydraulic components which provide water supply. The major objective was to generate satellite based thematic layers, town and ward boundary maps and Geospatial Information System based census data and to estimate water demand, design of transmission lines and main pipe lines to meet the requirement of future demand. GIS has been used to integrate and estimate quantity of earth work to be excavated in terms of cutting and filling through Digital Elevation Model (DEM). The pipe network system is simulated to understand its behavior for different inputs using EPANET 2.0. In the present study, both single period and extended period simulation were carried out for distribution network system for one ward. Simulation has been carried out for hydraulic parameters such as head, pressure and flow rate. Total Energy Line and Hydraulic Gradient Line were prepared for the simulated results.

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III. METHODOLOGY

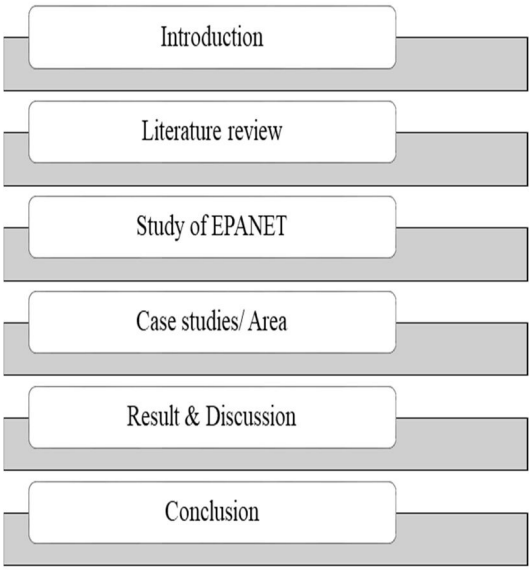


Fig.2 Methodology Flow Chart

Study Area

1) Study location: Pune
2) Data collection on WDN of selected area includes network layout, age of network, supply duration, basic water demand at the nodes, number of pumps, parameters of installed pumps, pipe type, population etc.
3) Water distribution network reconstructed in EPANET.
4) Obtained pump curve by feeding pump parameters in EPANET.
5) Reliability calculation procedure is established for the study with main focus on head and quantity of water satisfaction for the consumer. Population is also assessed based on geometric incremental method for four decades.

IV. POPULATION FORECASTING

Design of water supply and sanitation scheme is based on the projected population of a particular city or town, estimated for the design period. Any underestimated value will make system inadequate for the purpose intended; similarly overestimated value will make it costly. Change in the population of the city over the years occurs, and the system should be designed taking into account of the population at the end of the design period. Factors affecting changes in population are:

1) Increase due to births
2) Decrease due to deaths
3) Increase/ decrease due to migration
4) Increase due to annexation.

The present and past population record for the city can be obtained from the census population records. After collecting these population figures, the population at the end of design period is predicted using various methods as suitable for that city considering the growth pattern followed by the city.

Population forecasting is based on the following methods

a) Arithmetical Increase Method
b) Geometrical Increase Method
c) Incremental Increase Method
d) Graphical Method
e) Comparative Graphical Method
f) Master Plan Method
g) Logistic Curve Method

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V. DISTRIBUTION SYSTEM

Methods of Distribution for efficient distribution it is required that water should reach to every consumer with required rate of flow. Therefore, some pressure in pipe lines is necessary, which should force the water to reach at every place. Depending upon the methods of distribution, the distribution system is classified as follows:

1) Gravity system
2) Pumping system
3) Dual system

LAYOUTS OF DISTRIBUTION SYSTEM

Generally, in practice there are four different systems of distribution system which are used. Depending upon their layout and direction of supply, they are classified as follows:

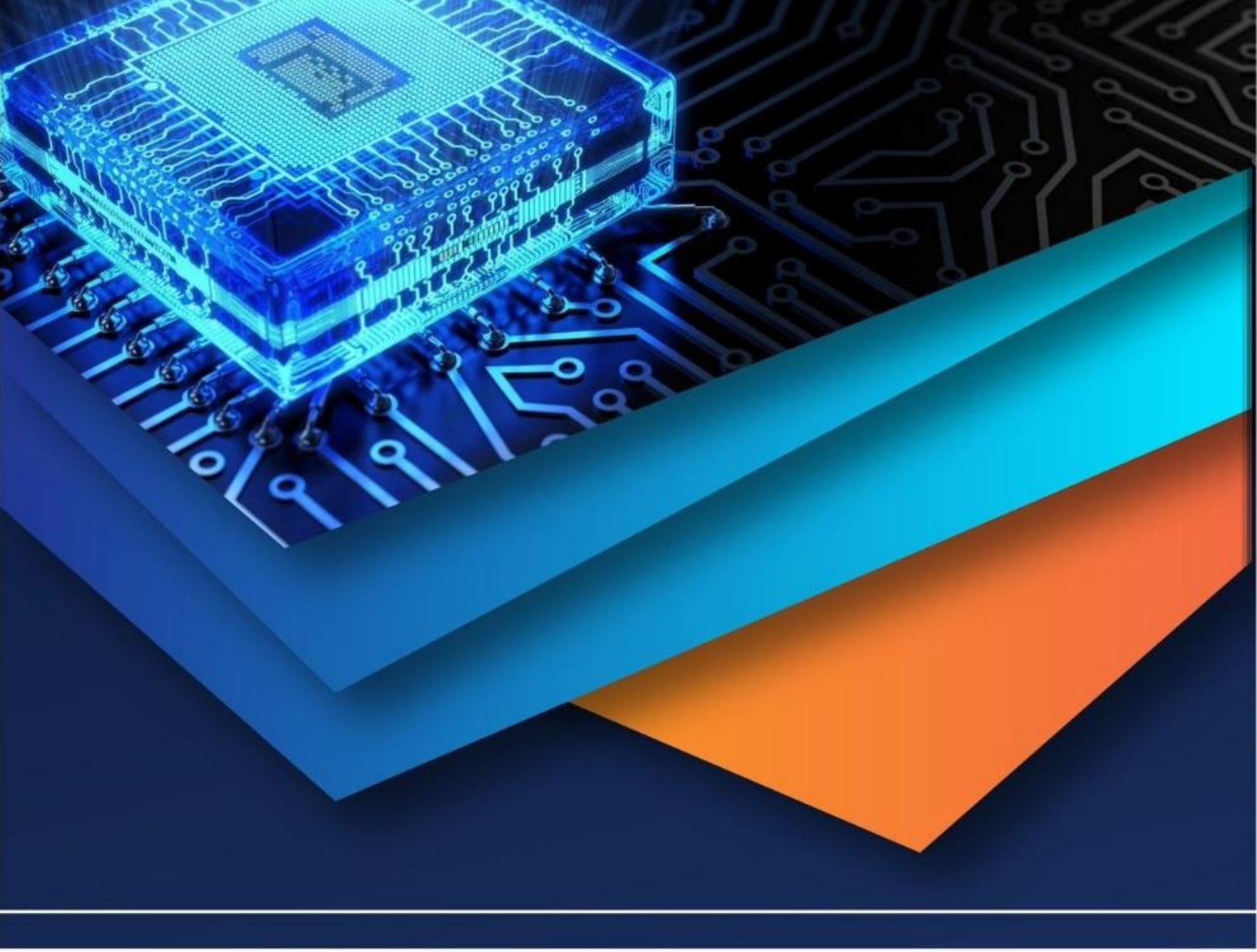
a) Dead end or tree system
b) Grid iron system
c) Circular or ring system
d) Radial system

VI. CONCLUSION

The main focus of this research is to analyses and design the water distribution network and identify deficiencies (if any) in its analysis, implementation and its usage. In this work, the water distribution system has been designed with the help of EPANET in which we use number of nodes, elevation, number of pipes and demands of the study area. The different nodes show different variation of pressure and demand. The method of distribution used in this area is that of gravity type. At the end of the analysis it was found that the resulting pressures at all the junctions and the flows with their velocities at all pipes are adequate enough to provide water to the study area.

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