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Design of Water Distribution System of Bharat Housing Society

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A B S T R A C T

In spite of a wide research, design of water distribution networks are not realized using optimization techniques. One reason for this fact is, design of water distribution networks is evaluated, mostly, as a least-cost optimization problem where pipe diameters being the only decision variables. The other motivation for preferring the traditional modeling practice is that, existing optimization algorithms are not presented to the user as friendly as it should be.

In fact, water distribution systems are very complex systems such that it is not easy to obtain least-cost design systems considering other constraints such as reliability, in addition to classical constraints related to hydraulic feasibility, satisfaction of nodal demands and requirement of nodal pressures. t Water distribution system design is inherently associated with hydraulic calculations that require thorough evaluation of obtained results and accuracy of the applied solution. Currently, there are no programs that will replace a designer in these tasks, and there likely will not be such programs. However, some individuals are trying to develop computer programs featuring a certain degree of creativity to facilitate user decision making. In water distribution system design and hydraulic calculations, one should, inter alia, check pressure heads in different parts of the system. It is also important to establish whether the system should contain one or more pressure zones. This determination is connected with the appropriate location of booster and pressure reducing stations

Keywords: *Water distribution network design, water demand, cost analysis.*

1. INTRODUCTION:

A Water distribution system is a hydraulic infrastructure that conveys water from the source to the consumers; it consists of elements such as pipes, valves, pumps, tanks and reservoirs. The most important consideration in designing and operating a water distribution system is to satisfy consumer demands under a range of quantity and quality considerations during the entire lifetime for the expected loading conditions.

Also a water distribution system must be able to accommodate abnormal conditions such as breaks in pipes, mechanical failure of pipes, valves, and control systems, power outages, malfunction of storage facilities and inaccurate demand projections. The possibility of occurrence of each of these deficiencies should be examined to determine the overall performance and thereby the reliability of the system. In general, reliability is defined as the probability that the system performs successfully within specified limits for a given period of time in a specified environment. As it is defined above, reliability is the ability of a system to provide adequate level of service to the consumers, under both normal and abnormal conditions. However, there is still not a convenient evaluation for the reliability of water distribution systems.

Water supply distribution network is a part of town and municipality planning. Hence it's planning and design has to be done by the city planners and Civil Engineers with care, considering the effecting factors like the location of the town or city, its current water demand, the future demand growth, leakages in the conduits, required pressure in pipes, losses in the pipes etc. Water from various ground water and surface water sources is received by the water supply system, where it gets purified, disinfected, chlorinated. This treated water is sent to elevated reservoirs or tanks, from which the water enters the water distribution networks. Water distribution networks serves the purpose of supplying water for drinking, washing, sanitation, irrigation, fire-fighting etc. The objective of the distribution system is to make accessible the water to every house, industrial plants and public places. Every point has to be supplied with optimum quantity of water with 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 activity of taking the water from the treatment plant to the individual homes is done through a well-planned distribution system. A distribution system consists of pressure conduits of different sizes for taking water to the streets, valves to control the flow in pipes, service connections to the individual homes, reservoirs to store the water to be fed into the distribution pipes. The water may be pumped into the pipes, or it may be stored in a reservoir and then led into the distribution pipes. Distribution networks are designed to meet the peak demands, due to which low flow conditions are created in parts of the networks, which leads to the degradation of the chemical and microbial water quality. Therefore the main purpose of the distribution network is to supply water with adequate pressure and flow. There is loss in pressure due to pipe wall friction, water demand, pipe length, pipe diameter and gradient. The traditional, water distribution network follows the street plan and topography. By the usage of soft ware's, the modeler simulates the pressures and flows in the networks. The main elements of a pipe network are pipes, nodes (junctions), pumps, valves and storage tanks or reservoirs. The software notes the flow of water in each pipe, pressure at each node, height of the water in each tank, chemical concentration during its flow through the network during a simulation period, water age, source, and tracing. The main aim of the system is to create enough water pressure at various points i.e., at the consumer's point and to give the choice of the distribution and its elevation with respect to the location of the water treatment plants.

Need of water supply: Human life, as with all animal and plant life on the planet, is dependent upon water. Not

only do we need water to grow our food, generate our power and run our industries, but we need it as a basic part of our daily lives - our bodies need to ingest water every day to continue functioning. "Basic needs of about 135 litres per person per day". It includes the need for water to maintain a basic standard of personal and domestic hygiene sufficient to maintain health. The effects of inadequate water supply causes disease, time and energy expended in daily collection, high unit costs, etc. provision of basic daily water needs is yet to be regarded by many countries as a human right.

Description of study area: The society's name is "Bharat Housing Society" which is located on Pandav Nagari area .The society has 93 Society has different blocks starting from P1 TO P10. The estimated population of the society is 450 persons and We Have to Design it For Next 50 Years.

Location: The Housing Society Situated at padav nagari area , Nashik

Population Determination:

Determination of population is one of the most important factors in planning, if the project has to serve the community for a certain design period. Normally, a design period of 30 to 50 years is selected. What will be the population at the end of design period is the basic question. This can be achieved by using various methods for population.

Problem statement

Due to the insufficient supply of potable water in a locality and the inadequate quality we meant to design a water supply system in Bharat co operative housing society.

Diameters of pipes:

In water distribution system pipes of various diameters are used. The minimum Diameter of the pipe is 80mm.There are no. of pipes of various diameter are also used in this water distribution system i.e.100mm,150mm,200mm,250mm and 300mm.The maximum diameter of pipe is 300mm.

Diameter is increasing with increment of 50mm because pipes are available in market with this increment

. 3.7 Velocity in water supply pipes:

The maximum velocity is in pipe no.20 which is 2.47m/sec and minimum velocity is in pipe no. 29 which is 0.14 m/sec.

3.8 Pressure in pipes:

In water distribution system the minimum pressure in farthest pipe should not be less than 15 m and max pressure should not exceed 20 m.

In this design

Max Pressure = 19.95 m Min Pressure = 14.78 m

3.8 Cover on pipes:

Cover is provided on pipe for the safety of the pipe. For water distribution System the pipes are installed in 1m depth of ground. This 1m depth cover is sufficient for pipes. 3.9 Placing of valves:

Valves are provided to control of pressure and to regulate the flow. Valves are also used to cut off supply for repair purposes. Two valves are provided at each intersection (node) and one valve is for fire hydrant.

3.10 Placing of fire hydrants:

Fire hydrants are used to deliver water from the main for firefighting. Fire hydrants are provided at 1-2m from the edge of road. Outlets of hydrants should be at least 0.5m above the road surface. Fire hydrants are generally painted in red colour for easy identification.

Objective:

1.To supply safe and optimum water to consumers at appropriate pressure.

2. To provide water in appropriate quality and quantity

3. To extend the distribution system to those areas of the plot

Research design:

Generally this study can be seen as a descriptive cross-sectional study with a central task of design of urban water supply system in Bharat Housing Society .The study used a mixed approach with a central premise of; the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. Hence, the mixed approach that is used in this research employs strategies of inquiry that involve collection of qualitative and quantitative data simultaneously to best understand the research problem under investigation. The study was guided by the principles of multiple sources and subsequent crosschecking of information as well as by applying various data collection instrument and analysis techniques- both quantitative and qualitative.

2. LITERATURE REVIEW:

A well planned water distribution network is very essential in the development of an area. The network is built to satisfy various consumer demands while meeting minimum pressure requirements at certain nodes. In the design stage it is of interest to arrive at the least-cost solutions that satisfy a set of constraints including demand and pressure requirements. Often it is also of interest to arrive at less expensive solutions that, however, violate slightly the constraints. Accordingly, research interests have been concentrating on the design of water distribution System to search for the optimal combination of decision variables (e.g. head loss and velocity) from a large number of solutions.

This chapter deals with the theoretical overview of potable water supply and distribution. It assesses the sources of water supply, urban water supply accessibility, major challenges of drinking water supply and distribution, potable water supply problems in developing countries in general and in Ethiopia in particular, benefits of access to safe, reliable, adequate and affordable potable water supply and impacts of inaccessibility of water supply and distribution facilities. In addition to these it assesses the Ethiopian government's water supply and sanitation policy, institutional arrangement and responsibilities at different levels

Water has been an important factor to the development and survival of civilization. The first great civilization arose in the valleys of great rivers, the River Nile, valley of Egypt, the Tigris Euphrates valley of Mesopotamia, the Indus valley of India and Pakistan and Huang He valley of China. Through the ages people have been compelled to settle in region where water is not deficient in quantity, inferior in quality. Only when supplies failed or made useless by unbearable salt or pollution before them were canters of habitation abandoned. So, man's endeavors to achieve a more desirable relationship with the water of the earth have helped them mould his character and his outlook towards the world around him. People have preferred to meet their water troubles head on rather than to quit their places of abode and industry. So people have applied their creative imagination and utilized their skills and released heroic energy. The ancient well aqueducts and reservoirs of the old world, some still serviceable after thousands of years, at least to the capacity for constructive thinking and corporative ventures which had a part in human advancement.

3. METHODOLOGY:

1. Surveys and Maps: The portion of land between the source of water and the area is surveyed to get the levels for the alignment of the main pipe. This pipe carries the treated water to the reservoir(s) located in the distribution area. To prepare the detailed maps with the locations of roads, streets, lanes, residential areas, commercial locality, industrial areas, gardens etc. the distribution area is surveyed. A topographical map of the area is prepared to locate the high and low areas.

2. Tentative Layout: A tentative layout of the distribution line is then marked, the location of the treatment plant(s), distribution mains, distribution and balancing reservoirs, valves, hydrants, etc. The entire area is divided into various distribution districts. The density of population (average number of

people per hectare area) is also marked. The length of pipelines is kept as short as possible.

3. Calculation of Pipe Diameters : When the design discharge is known, diameters of the pipes are assumed in such a way that the velocities of flow lies between 0.6 to 3 m/s. Small velocities are taken for pipes of small diameter and big velocities for large diameter pipes.

4. Design Procedure I. Survey: Survey of the land was done by the remote sensing department noting the elevation of various junctions, length of roads and marking the position of important structures such as religious institutions, academic institutions and water bodies if any. The survey data was converted into an AutoCAD File showing the same.

Population Forecasting:

The economic design period of the components of a water supply depends on their life, initial cost, rate of interest on loan, the ease with which they can be expanded of the likelihood that they will be rendered absolute by technological advances. In order to design the parts of water system, the flow at the end of design period must be estimated.

It is necessary to fix the design period and forecast the population of the area in the design of any water supply scheme. Water supply projects are usually designed for a certain period after the completion of construction works in order to satisfy the population demand.

Design Period:

Design period is the number of years for which the design of water works has been done. Before designing & construction of water supply scheme, it is necessary to assure that the water works have sufficient capacity to meet the future water demand of the town for the fixed design period. Therefore the number of years for which the design of the water works has been done is called design period. The design period, however, should neither too long or too short. Mostly water supply schemes have design period of 30-50years

Population Forecasting Approach:

After the design period has been fixed, the population of the town in various periods has to be determined. As population of the area increases in the future, the correct present and past population data have to be taken form census office to determine design population of the area. The future development of the town mostly depends on trade expansion, development of industries and surrounding country, discoveries of mines, construction of rail way station etc. These elements may produce sharp rises, slow growth, and stationery conditions or even decrease the populations. The populations are increased by births, decreased by deaths, increased or decreased by migration and increased by annexation. These all four factors affect the change in population. The correct present and past population can be obtained from census office.

Layout of Distribution Network:

There are four principal methods of layout for distribution systems: (1) Dead end or tree system (ii) Grid iron system (iii) Circular or ring system (iv)Radial system

Per capita water demand:

The Quantity of Water required by community, Society or Industry is Called Water Demand. & "The Water required for One day is 135 LPCD (lit per person capita demand)". The per capita water demand for various demand categories varies depending on the size of the town, the level of development , the type of water supply schemes, the socio- economic conditions of the town, cost of water, system of sanitation and climatic condition of the area. The per capita water demand for adequate supply level has to be determined based on basic human water requirements of various activity of demand category.

4. DESIGN CRITERIA :

"Hazen William" Equation is used to find out the Head loss. This head loss is used to determine the diameters of water supply pipes.

HL = $C^{1.85}\ D^{4.87}$

Where,

H = Head loss (m/km)

Q = Discharge (m/sec)

C = Roughness Coefficient

L = Length of pipe (m)

D = Diameter of pipe (m)

Height and capacity of over head water reservoir (OHR) :

The height of over head water reservoir is 20 m from the ground surface and the capacity of over head water reservoir is $\mathbf{10}th$ of the average daily water consumption.

Total no. of tube wells installed:

There are two tube wells installed in the central park of the society. The reason of providing two tube wells is that if one is out of operation then other provides water to consumers.

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5. RESULT AND CONCLUSION

Result:

Calculation of required of water according to person

Q =135 LPCD

Number of houses = 93

Average number of person in each houses =5

Then population =93*5=456 persons

For that in 2021 there are 456 persons but we are design it for 50 years.

So by using population forecasting method,

Water demand =921*135=124335Lit/day

As per design criteria consider leakage &losses as 10% and fire 25%

Volume of ESR = 124335/2 =62167.5Lit

(Fill ESR twice a day).

Advantages

Pipes can be easily made in this system. To make design calculations very simple, the pressure and discharge in each pipe can be determined very easily and accurately, based on the required demand of the population, the diameter of pipe of main, sub mains and branches can be designed so the cost can be reduced.

Applications

Lying of water supply system.

Conclusion:

There are many methods of calculation of water distribution systems that enable solving tasks for various structures of pipeline. Computer programs based on the above methods calculate the value required for variables describing the individual elements of the system, but do not have procedures for assessing their accuracy. Due to increasing requirements for quality of the hydraulic system calculation, professionals strive to find new methods to rationalize the calculation process and to introduce intelligent support elements. This paper presents the artificial neural network and its application for the analysis of a pressure head and pressure zones in a water distribution system. To find the most advantageous structure of the multilayer perception, the training of 7 networks with one hidden layer and 9 networks with two hidden layers was carried out. In the case of a single-layer network, the search for an appropriate structure was started on the basis of the Hecht-Nielsen formula, from 17 neurons in the hidden layer, by increasing in each subsequent network from the initial value to 119 neurons. Single-layer networks were characterized by a low capacity of classification of components for the CWDS variable. That is why the training of two-layer networks was initiated. Two-layer networks were trained from a structure of 8-17-17-6, successively increasing the number of neurons in the first hidden layer with the initial value 8-34-17-6, then in the second layer 8-34-34-6 and ending in the structure 8-85-85-6. More complex structures of two-layer networks were very susceptible to the phenomenon of over-fitting. The multiple cross-entropy error function for a subset of validation was used to assess progress of training and select the most favourable structure. To avoid local minima, each structure of the neural network was trained repeatedly, and then, the most favourable option was retained. For the initial two layer network 8-17-17-6, the final value of the error function amounted to 0.6265376 for the training subset and 0.6374514 for the validation subset, while for the adopted structure 0-85-68-6 it amounted to 0.2084361 for the training subset and 0.2408573 for the validation subset. The analysis of sensitivity of the input variables was carried out, but all variables showed a significant impact on the error in teaching the neural network. The resignation of any variable resulted in a significant increase in a teaching error. On the basis of the obtained results, one can conclude that the method presented can complement traditional calculation methods. Using a neural network of a proper structure, the components of the CWDS variable can be classified very precisely. An additional asset is that the Soft max function can be applied in the outlet neural layer allowing for the probability estimation of adopting a given solution. Water distribution systems are often evaluated many times for each variant; as a rule, the calculation does not give a correct solution after the first pass. Therefore, it can be assumed that this is a multi-stage computational process. Further scientific work will attempt to implement elements of the diagnostics of processes in calculations of the water distribution system neutral model. The use of neural modelling techniques in combination with elements of the diagnostics of processes should translate into an improvement in the functioning of water supply systems, reduction in operational costs and improvement in the conditions of service and exploitation

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