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# DESIGN OF WATER DISTRIBUTION NETWORK FOR JANWAD VILLAGE USING EPANET 2.0 SOFTWARE

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***Abstract:*** ***The present study includes the use of EPANET software for the design of water distribution network for Janwad village. 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, 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 also the concentration of a chemical species in the network can also be analyzed, 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 design of the distribution network in the study area. The results obtained verified that the pressures at all junctions and the flows with their velocities at all pipes are feasible enough to provide adequate water to the network of the study area.***

*Keywords:* **EPANET, Janwad, water distribution network, water supply design.**

## I. INTRODUCTION

**Water is one of the most important factors for the sustainability of life. Water covers about 70% of earth's surface and the fresh water available is about 1.7% as surface and ground water sources. It is important to monitor the adequate supply of potable water for specific area not only in terms of quantity but also the quality [01]. Alvin Flower and a graduate student named Robert Epp developed a new approach to network analysis at the University of British Columbia that applied the Newton-Raphson method to simultaneously solve for the flow adjustment factors associated with the original "loop" method of Cross (1936). This had the net benefit of significantly improving the convergence characteristics of the original algorithm. Water distribution system is a hydraulic infrastructure consisting of elements such as pipes, tanks pumps and valves etc which are designed for the supply of water [02]. Hardy cross was the first to suggest a systematic iterative procedure for network analysis [03]. EPANET 2.0 is a computer program that performs hydraulic simulation and water quality assessment within pressurized pipe networks. EPANET is designed to be a research tool for improving 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. EPANET also performs tasks such as sampling program**

 

**design, hydraulic model calibration, and chlorine residual analysis. 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 [04].**

## II. OBJECTIVES

To carry out detailed topographical and geographical survey of the Janwad village and to design water distribution system for the village using EPANET 2.0

## III. STUDY AREA

The Janwad village situated in chikkodi taluka, Belagavi, Karnataka, India was the area taken up for the study. The area is about 0.087sq.km. The latitude and longitude of the place is $16^0$34'3" and $74^0$34'21" respectively. The Fig 1.1 shows the map of the study area.

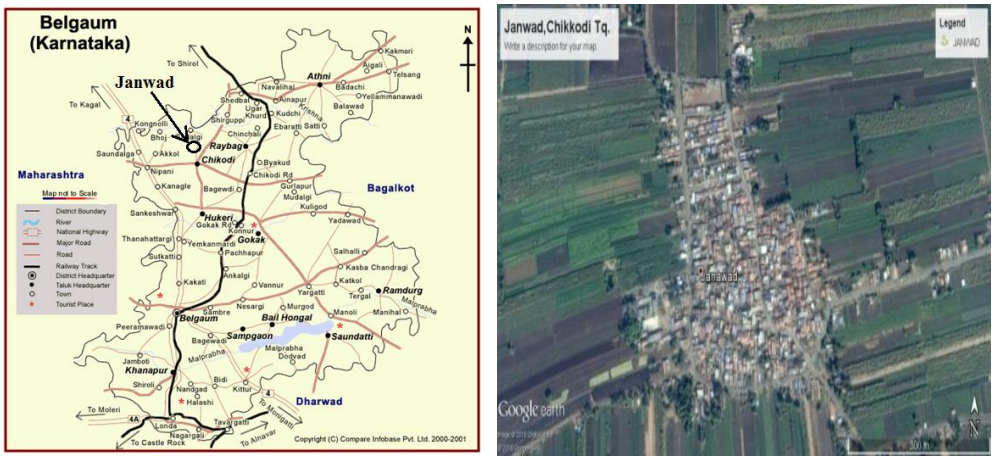


**Figure 1: Google earth map of Janwad village, Belagavi, Karnataka**

The existing water supply system does not cater to the entire village and also it is an outdated design and is in need of up gradation. The existing system is less efficient in providing proper velocity and head for the flow of water. The water has to be supplied to the whole village from the water treatment plant which is situated at the centre of the village.

## IV. METHODS AND METHODOLOGY

### 1. Population Projection

The number of people occupying a given area (i.e., the population) was obtained by official survey conducted by the government agencies at intervals of 10 years which is known as 'decennial censuses'. Village planning authorities and other appropriate authorities will have the records of population development rates which can be incorporated for the design purposes, thus obtained data was useful for projecting the population for the village towards the end of the design period. The population was forecasted using arithmetic progression method [05].

### 2. Survey

As the first step of data collection, survey was conducted on February 2016 in Janwad village, Belagavi, Karnataka. The latitude and longitude of the place is $16^o$ 34'3" and $74^o$ 34'21" respectively and having an area of around 0.087 sq. km. The survey provided the data regarding the ground levels, road alignment and the location of the houses in the village. The simple chain survey and plain table provided detailed information of the terrain and road alignments along with dumpy level was used to get the elevations and terrain details. Detailed

study of topography, future extensions, location of treatment plants were carried out. The following data were collected.

a) Details about contour, land use, population, source of water, sewage generation and population variation were collected.

b) Data of existing water treatment plants were collected.

c) Location of roads and adjacent areas were recorded.

d) Problems regarding existing water distribution system were determined.

**3. EPANET**

EPANET is computer aided design software developed by the Water Supply and Water Resources Division (formerly the Drinking Water Research Division) of U.S Environmental protection agency's National risk management research laboratory. It is public domain software that may be freely copied and distributed. It can perform extended hydraulic simulations and water quality analysis. It helps to quantify the alternative management plans which include altering the sources utilization within the multiple source system, modifying pumping and tank filling and emptying cycles, use of satellite treatment, such as re-chlorination at storage tanks and Targeted pipe cleaning and replacement [06].

## V. RESULTS AND DISCUSSIONS

**1. Population forecasting**

For the present work, arithmetic progression method was adopted for the forecast of the population of the village, since; the exponential growth rate was not available from the collected data. The population was forecasted and a population of 4436 was forecasted at the end of 3 decades.

**2. Survey**

The detailed topographical survey was carried out for the village using dumpy level. The roads were identified and represented in AutoCAD.

**3. Water supply designs using EPANET 2.0**

The Figure 2 shows the pictorial representation of the pipe network designed to provide the water supply to the village using EPANET 2.0.the arrows in the figure shows the direction of flow of water from the source to different parts of the village.

**Figure 2: Complete water supply network designed for Janwad village.**

The Table 1 represents the head and pressure at different nodes for the corresponding base demand and the elevations.

**Table 1: Heads and pressure values for different nodes**

| Node ID | Demand in LPS | Head in m | Pressure in m |
|---|---|---|---|
| J68 | 0.11 | 118.06 | 15.53 |
| J69 | 0.12 | 118.08 | 15.48 |
| J70 | 0.11 | 118.13 | 15.76 |
| J71 | 0.13 | 118.16 | 15.79 |
| J72 | 0.13 | 118.17 | 15.58 |
| J73 | 0.19 | 118.17 | 15.69 |
| J74 | 0.2 | 117.58 | 14.97 |
| J75 | 0.02 | 118.13 | 16.43 |
| J76 | 0.15 | 118.13 | 16.48 |
| J77 | 0.15 | 118.14 | 17.93 |
| J78 | 0.04 | 118.15 | 18.5 |
| J79 | 0.16 | 118.18 | 19.1 |
| J80 | 0.13 | 118.24 | 18.48 |
| J81 | 0.09 | 118.05 | 17.65 |
| J82 | 0.09 | 118.16 | 16.2 |
| J83 | 0.1 | 118.17 | 16.21 |
| J85 | 0.21 | 117.62 | 18.87 |
| J86 | 0.02 | 117.34 | 17.08 |
| J87 | 0.09 | 117.34 | 16.64 |
| J88 | 0.07 | 117.34 | 16.62 |
| J89 | 0.03 | 117.35 | 16.79 |
| J90 | 0.05 | 117.35 | 16.75 |
| J93 | 0.07 | 117.53 | 20.2 |
| J94 | 0.05 | 117.52 | 20.2 |
| J95 | 0.11 | 117.38 | 20.13 |
| J96 | 0.07 | 117.37 | 20.05 |
| J97 | 0.05 | 117.36 | 16.56 |
| J98 | 0.04 | 117.37 | 16.56 |
| J99 | 0.09 | 117.25 | 19.11 |
| J100 | 0.12 | 117.29 | 19.43 |
| J101 | 0.22 | 117.26 | 19.57 |
| J102 | 0.12 | 117.12 | 17.13 |
| J103 | 0.12 | 117.22 | 19.37 |
| J104 | 0.14 | 117.21 | 19.22 |
| J105 | 0.08 | 117.21 | 19.16 |
| J106 | 0.02 | 117.11 | 20.31 |
| J107 | 0.15 | 117.25 | 20.33 |
| J108 | 0.11 | 117.57 | 10.97 |
| J109 | 0.06 | 117.38 | 14.5 |
| J110 | 0.07 | 117.3 | 14.57 |
| J111 | 0.15 | 117.19 | 15.19 |
| J113 | 0.09 | 117.17 | 15.57 |
| J114 | 0.16 | 117.17 | 15.62 |
| J115 | 0.09 | 117.17 | 15.77 |
| J116 | 0.04 | 117.19 | 16.54 |
| J117 | 0.17 | 117.09 | 16.34 |
| J118 | 0.14 | 117.12 | 17.02 |
| J119 | 0.24 | 117.13 | 15.23 |
| J120 | 0.06 | 117.11 | 17.33 |
| J121 | 0.11 | 117.11 | 19.01 |
| J122 | 0.08 | 117.11 | 20.17 |
| J123 | 0.1 | 117.04 | 19.19 |
| J124 | 0.16 | 117.01 | 19.11 |
| J125 | 0.24 | 116.98 | 18.78 |
| J126 | 0.1 | 117.09 | 16.49 |
| J127 | 0.14 | 118.33 | 17.07 |
| J128 | 0.07 | 117.29 | 15.93 |
| J129 | 0.06 | 117.53 | 19.2 |
| J130 | 0.02 | 117.53 | 19.23 |
| J131 | 0.03 | 117.38 | 20.1 |
| J132 | 0.1 | 117.62 | 18.9 |
| J133 | 0.03 | 117.29 | 20.04 |

The values obtained for the design represented in Table 4.2 are well within the prescribed limits of 7 to 22 m and hence the results are acceptable. The Table 2 represents the length, flow, velocity and friction factors associated with different pipes in the network.

**Table 2: Velocity and Flow associated with different pipes.**

| Link ID | Flow in LPS | Velocity in m/s | Unit Head loss in m/km | Friction Factor |
|---|---|---|---|---|
| p7 | -0.09 | 0.04 | 0.04 | 0.035 |
| p8 | 0.2 | 0.08 | 0.18 | 0.031 |
| p9 | 0.32 | 0.13 | 0.43 | 0.029 |
| p10 | 0.02 | 0.01 | 0 | 0.046 |
| p11 | 0.11 | 0.05 | 0.06 | 0.034 |
| p12 | 0.5 | 0.14 | 0.41 | 0.028 |
| p13 | 0.76 | 0.21 | 0.9 | 0.026 |
| p14 | 0.8 | 0.22 | 0.99 | 0.026 |
| p19 | 1.06 | 0.3 | 1.66 | 0.025 |
| p24 | 1.43 | 0.4 | 2.9 | 0.024 |
| p25 | 1.29 | 0.36 | 2.39 | 0.024 |
| p27 | 0.41 | 0.11 | 0.28 | 0.029 |
| p28 | 0.78 | 0.31 | 2.18 | 0.026 |
| p29 | 0.1 | 0.04 | 0.05 | 0.034 |
| p30 | 0.5 | 0.2 | 0.97 | 0.027 |
| p31 | 0.4 | 0.16 | 0.65 | 0.028 |
| p32 | 0.24 | 0.1 | 0.25 | 0.03 |
| p33 | 0.11 | 0.04 | 0.06 | 0.034 |
| p34 | -0.02 | 0.01 | 0 | 0.045 |
| p36 | 0.07 | 0.03 | 0.02 | 0.037 |
| p37 | 0.76 | 0.21 | 0.91 | 0.026 |
| p38 | -0.12 | 0.05 | 0.07 | 0.034 |
| p39 | 0.1 | 0.04 | 0.05 | 0.035 |
| p40 | 0.04 | 0.02 | 0.01 | 0.04 |
| p41 | 0.34 | 0.13 | 0.46 | 0.029 |
| p42 | 0.09 | 0.03 | 0.04 | 0.035 |
| p43 | 0.16 | 0.06 | 0.12 | 0.032 |
| p44 | 0.07 | 0.03 | 0.02 | 0.037 |
| p45 | 0.26 | 0.07 | 0.13 | 0.031 |
| p46 | 0.21 | 0.06 | 0.08 | 0.032 |
| p47 | 0.08 | 0.03 | 0.03 | 0.036 |
| p48 | 2 | 0.56 | 5.38 | 0.023 |
| p49 | 1.69 | 0.47 | 3.96 | 0.023 |
| p50 | 1.55 | 0.43 | 3.35 | 0.024 |
| p51 | 1.5 | 0.42 | 3.17 | 0.024 |
| p52 | 1 | 0.28 | 1.51 | 0.025 |
| p53 | 0.94 | 0.26 | 1.33 | 0.025 |
| p54 | 0.79 | 0.22 | 0.97 | 0.026 |
| p55 | 0.08 | 0.03 | 0.03 | 0.036 |
| p56 | 0.02 | 0.01 | 0 | 0.045 |
| p57 | 0.03 | 0.01 | 0.01 | 0.041 |
| p58 | 0.1 | 0.04 | 0.05 | 0.035 |
| p59 | 0.03 | 0.01 | 0 | 0.039 |
| p61 | 0.18 | 0.07 | 0.14 | 0.032 |
| p62 | 0.26 | 0.1 | 0.28 | 0.03 |
| p63 | 0.21 | 0.08 | 0.19 | 0.031 |
| p64 | 0.35 | 0.14 | 0.51 | 0.029 |
| p65 | 0.31 | 0.12 | 0.4 | 0.029 |
| p66 | 0.42 | 0.12 | 0.3 | 0.029 |
| p67 | 0.33 | 0.13 | 0.45 | 0.029 |
| p68 | 0.22 | 0.09 | 0.21 | 0.031 |
| p69 | 0.08 | 0.03 | 0.03 | 0.036 |
| p71 | 0.02 | 0.01 | 0 | 0.046 |
| p1 | 0.35 | 0.1 | 0.21 | 0.029 |
| p4 | 0.22 | 0.06 | 0.09 | 0.032 |
| p5 | 2.27 | 0.63 | 6.8 | 0.022 |
| p6 | 2.58 | 0.72 | 8.63 | 0.022 |
| p16 | -0.15 | 0.04 | 0.05 | 0.033 |
| p18 | 0.09 | 0.04 | 0.04 | 0.035 |
| p15 | 6.43 | 0.39 | 1.15 | 0.021 |
| p2 | 3.11 | 0.4 | 1.85 | 0.022 |
| p3 | 3.18 | 0.41 | 1.93 | 0.022 |

The values obtained from the design represented in Table 4.3 where velocity ranges from 0.1 m/s to 0.72 m/s and the flow varied form 0.2 lps to 3.18 lps which are acceptable. In this analysis the Hazen-Williams roughness coefficient was assumed for all pipes as 145 mm and diameters of 160, 110, 75 and 65 mm were assumed.

The flow velocity in the pipes ranges from 0 to 0.72 m/s. the pressure head at each node obtained from the network analysis with its distribution is shown in fig. it is observed that the pressure head at every node of the network lies in the range of 7 to 22m. The

minimum pressure head at the node is 7m which satisfies the condition prescribed by central public health and environmental engineering organization (CPHEEO) manual [07].

## CONCLUSIONS

The following conclusions were drawn based on the work carried out on network design for water supply for Janwad village.

- The computer software's are useful in avoiding the iterative process for determining the friction factor and discharge from the hydraulic heads.
- The pressure and flow obtained from the analysis are found to be adequate for the water supply systems.
- Pressure lies between 7 m and 22 m and no point experiences pressure below 7 m which is the minimum requirement.
- The flow variations are in the range of 0.2 lps to 3.18 lps which are generally adequate in a primary residential system.
- The results reveal that the software used for the design has the capability to handle various pipe networks problems without changing in model of or mathematical formulation.
- The software used was viable alternative to other methods particularly in view of accuracy and it results in a simpler algorithm, without any iterative process.

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