Design of Water Supply Pipe Networks in NIT Srinagar using EPANET Software

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Abstract: - Water is one of the most vital natural resources for all life on Earth. The availability and quality of water always have played an important part in determining not only where people can live, but also their quality of life. Even though there always has been plenty of fresh water on Earth, water has not always been available when and where it is needed, nor is it always of suitable quality for all uses. Water must be considered as a finite resource that has limits and boundaries to its availability and suitability for use. Water is used for various purposes like commercial (hotels, restaurants, office buildings, other commercial facilities), domestic (drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens), industrial (cleaning, transportation, dilution, and cooling in manufacturing facilities), irrigation (freeze protection, chemical application, crop cooling, harvesting, and for the leaching of salt from crop zone). For all this purposes we need to supply water which is done by water distribution system.

INTRODUCTION: -
Water distribution systems connect consumers to sources of water, using hydraulic components, such as pipes, valves, and reservoirs. The engineer faced with the design of such a system, or of additions to an existing system, has to select the sizes of its components. Also, he has to consider the way in which the operational components, pumps and valves, will be used to supply the required demands with adequate pressures. The network has to perform adequately under varying demand loads, and in the design process, one considers several significant loads: maximum hourly, average daily, low-demand periods during which reservoirs are to be filled, etc. Operational decisions for these loads are essentially part of the design process, since one cannot separate the so-called design decisions, the sizing of components, from the operational decisions; they are two inseparable parts of one problem. This paper presents a method for optimizing the design of a water distribution system: sizing its components and setting the operational decisions for pumps and valves under a number of loading conditions, those which are considered 'typical' or 'critical.' EPANET can be used in the planning of pipe network systems to meet forecasted demands of the next 20 years or 30 years. For example, the program can be used to develop long term capital-improvement plans for the existing pipe network system. These plans can include staging, sizing, and locating future pipe network and water chlorination facilities. The software can also be used in the development of a main rehabilitation plan or a system-improvement plan. And, a network analysis can provide suggestions and recommendations to prepare for the occurrence of any unusual events.

EXISTING WORK: -
Pipe network analysis of water distribution systems has evolved from a time-consuming process done infrequently to a quick and easy process done regularly on systems of all sizes. Pipe network analysis initially started early in 1940. Years later, two network analysis programs were introduced by Shamir and Howard (1968) and Epp and Fowler (1970). Both programs used the Newton-Raphson method to linearize the nonlinear mass and energy equations. The major differences between these two programs are:
1. The Shamir-Howard program is based on node-oriented equations, while the Epp-Fowler program is based on loop-oriented equations.
2. The Shamir-Howard program solves for pressure, demand, and the parameters of pipes and nodes, while the Epp-Fowler program solves only for pressures and flow rates.

IMPLEMENTATION: -
Estimation of Water Demand
Assuming consumption of water as per specified by IS Code 1172:1993 as follow:
1. 135 lpcd for hostel
2. 50 lpcd for floating population
3. 150 lpcd for residential buildings
4. 50 lpcd for offices
5. 450 lpcd for medical unit
6. 350 lpcd for medical quarter
7. 2 as peak factor
Table 1: Estimated Future Demand

<table>
<thead>
<tr>
<th>BRANCH</th>
<th>BTech Student</th>
<th>B</th>
<th>MTECH STUDENTS</th>
<th>MTECH STUDENTS</th>
<th>Demand (lpd) @50lpcd</th>
<th>Demand (lps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVIL ENGINEERING</td>
<td>123</td>
<td>185</td>
<td>GE 12</td>
<td>27</td>
<td>970</td>
<td>97000 lpd =1.123 lps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SE 20</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TE 13</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WRE 10</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELECTRICAL ENGINEERING</td>
<td>78</td>
<td>117</td>
<td>EPE 21</td>
<td>36</td>
<td>540</td>
<td>54000 lpd =0.625 lps</td>
</tr>
<tr>
<td>MECHANICAL ENGINEERING</td>
<td>77</td>
<td>116</td>
<td>MSD 20</td>
<td>35</td>
<td>606</td>
<td>60600 lpd =0.701 lps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ITMM 21</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELECTRONICS AND</td>
<td>77</td>
<td>116</td>
<td>ME 11</td>
<td>26</td>
<td>586</td>
<td>58600 lpd =0.678 lps</td>
</tr>
<tr>
<td>COMMUNICATION</td>
<td></td>
<td></td>
<td>C&amp;IT 20</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFORMATION TECHNOLOGY</td>
<td>62</td>
<td>92</td>
<td>NA</td>
<td>20</td>
<td>408</td>
<td>40800 lpd =0.472 lps</td>
</tr>
<tr>
<td>CHEMICAL ENGINEERING</td>
<td>78</td>
<td>117</td>
<td>CHE 15</td>
<td>30</td>
<td>528</td>
<td>52800 lpd =0.61 lps</td>
</tr>
<tr>
<td>COMPUTER SCIENCE</td>
<td>62</td>
<td>7</td>
<td>NA</td>
<td>20</td>
<td>408</td>
<td>40800 lpd =0.472 lps</td>
</tr>
<tr>
<td>METALLURGY ENGINEERING</td>
<td>78</td>
<td>117</td>
<td>NA</td>
<td>20</td>
<td>508</td>
<td>50800 lpd =0.587 lps</td>
</tr>
</tbody>
</table>

NA stands for not available *lpd stands for liters per day *lps stands for liters per second *Seat matrix is taken from CCMT and counselling websites.

For hostels:
As hostels are nearly full up to their capacity so future increment is given to them and assume 135 lpcd as water demand with peak factor of 2 as recommended by code IS: 1172:1993.

Table 2: Water demand for Hostels

<table>
<thead>
<tr>
<th>Name of Hostel</th>
<th>No of rooms</th>
<th>Capacity</th>
<th>Water Demand @135lpcd @ 2 peak factor</th>
<th>Residual Head Required (in m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jhelum</td>
<td>300 in 6 blocks</td>
<td>1 person per room = 300</td>
<td>81000 lpd =0.94 lps</td>
<td>17</td>
</tr>
<tr>
<td>Chenab</td>
<td>99</td>
<td>4 persons per room = 396</td>
<td>106920 lpd =1.24 lps</td>
<td>17</td>
</tr>
<tr>
<td>Indus</td>
<td>123</td>
<td>4 persons per room = 492</td>
<td>132840 lpd = 1.54 lps</td>
<td>17</td>
</tr>
<tr>
<td>Tawi</td>
<td>48</td>
<td>4 persons per room = 192</td>
<td>51840 lpd = 0.6 lps</td>
<td>7</td>
</tr>
<tr>
<td>Dal</td>
<td>48 sets</td>
<td>5 persons per set = 240</td>
<td>64800 lpd = 0.75 lps</td>
<td>17</td>
</tr>
<tr>
<td>S-Hostel</td>
<td>72 sets</td>
<td>5 persons per set = 360</td>
<td>97200 lpd = 1.125 lps</td>
<td>17</td>
</tr>
<tr>
<td>M TECH Hostel</td>
<td>Block 1 26</td>
<td>3 persons per room = 78</td>
<td>21060 lpd = 0.244 lps</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Block 2 4</td>
<td>4 persons per room =16</td>
<td>4320 lpd = 0.05 lps</td>
<td>7</td>
</tr>
<tr>
<td>Mega Hostel</td>
<td>5 storey building with capacity of 1000 persons</td>
<td>270000 lpd = 3.13 lps</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Girls Hostel</td>
<td>12 sets</td>
<td>180</td>
<td>48600 lpd = 0.562 lps</td>
<td>17</td>
</tr>
</tbody>
</table>

Total water demand for Hostels = 878580 lpd =10.169 lps
Also, there are two blocks for Pre-fabricated hostel which is built near jhelum hostel. Assuming 135 lpcd with capacity of 400 persons, then water demand will be equal to 1.25 lps.
### Table 3: Water Demand for new blocks

<table>
<thead>
<tr>
<th>BLOCK NO</th>
<th>Specifications of blocks</th>
<th>Water demand (50 lpcd for Floating population and 150 lpcd for residential with peak factor 2)</th>
<th>HEAD REQUIRED</th>
</tr>
</thead>
</table>
| 1        | 6nos. 100 Capacity Drawing Hall With A2 Size Drawing Board  
25 Nos. 100 Capacity Lecture Theatre With Stepped Seats  
20 Nos. 40 Capacity Classrooms On Level Floor, Computer Centre = 3 floor Electrical Engineering (Ext.)....  
1 Floor  
Academic Section/Examination Halls ---- 1 Floor  
Deans Offices/ Cafeteria ---- 1 Floor | Floor 1 = 0.69 lps  
Floor 2 = 2.89 lps Floor 3 = 0.93 lps Floor 4 = 0.24 lps Floor 5 = 0.02 lps Floor 6 = 0.02 lps Total =4.79 lps | 32 m |
| 2        | IT ----- 1 Floor  
Computer Science And Engineering ------- 1 Floor  
Physics ----- 1 Floor  
Chemistry ------ 1 Floor  
Maths ------ 1/2 Floor  
Humanities ------ 1/2 Floor  
Electronics Comm.Enggdept., CRF Centre ------ 1 Floor | Floor 1 = 0.17 lps  
Floor 2 = 0.175 lps  
Floor 3 = 0.21 lps  
Floor 4 = 0.21 lps  
Floor 5 = 0.21 lps  
Floor 6 = 0.24 lps Total = 1.215 lps | 32m |
| 3        | Workshops ------ 1 Floor  
Mechanical Engineering ------- 2floor  
Chemical Engineering ------ 1 Floor  
Metallurgical Engineering ------ 1 Floor  
Civil Lab /WRMC ------ 1 Floor | Floor 1 = 0.20 lps  
Floor 2-3 = 0.25 lps  
Floor 4 = 0.21 lps  
Floor 5 = 0.21 lps  
Floor 6 = 0.09 lps Total = 0.97 lps | 32m |
| 4        | Hospital  
2 Nos. Banks  
ATMs  
Telephone Exchange  
Shopping Mall  
P&D Stores  
Service Centre | Floor 1 = 0.07 lps  
Floor 2 = 0.12 lps  
Floor 3 = 0.12 lps  
Floor 4 = 0.12 lps  
Floor 5 = 0.12 lps  
Floor 6 = 0.06 lps Total = 0.61 lps | 32m |
| 5        | Girls Hostel With Single Seater / Double Seater Rooms  
Dining Hall & Kitchen  
Multipurpose Rooms  
Activity Rooms | Assuming capacity of new hostel to be of 500 persons consuming water @135 lpcd then demand will be 1.562 lps | 27 m |
| 6        | Badminton Court  
Table Tennis – 2 Tables  
Chess , Carom  
Reading Lounge  
Outdoor Courts for Basket Ball, Volley Ball | Assuming Demand = 0.82 lps | 12m |
| 7        | No. of Flats : 12 to 15  
with Floor area of 120 Sq.m  
Total No. of Flats=70 to85 | Assuming 72 flats with 6 family size consuming water @150 lpcd, Demand = 1.5 lps | 27m |

The above table 3 shows the water demand for new block. Net water demand (including auditorium, hostel, residential and floating water demand and new 7 blocks) = 27.68 lps = 2391552 lpd.

**Validation of results by Hardy Cross Method:**

For approving outcomes given by EPANET, we should discover the release in pipes exclusively utilizing Hardy Cross Method and look at the two outcomes. On the off chance that EPANET results are near Hardy cross outcomes, at that point our product is
getting us results which are legitimate as well. For this reason, we take circle close square 1 which comprises of 5 hubs system as appeared in figure 1.

According to EPANET results, pipes AB, BC, CD, DE and EA convey release of 0.65, 0.25, 10.08, 1.96 and 1.29. Presently will compute deviation (dQ) by strong cross strategy which ought to be exceptionally less, at that point just our results will be right.

\[ \sum R |Q| Q \]

Deviation is given as \( dQ = \sum 2RQ \).

Taking loop direction in anticlockwise direction.

![Figure 1: Hardy Cross Method](image-url)

### Table 4: Calculations for first trial

| Pipe | Radius R (in m) | Discharge Q (in lps) | \( \sum R |Q| Q \) (m³ per sec) |
|------|----------------|----------------------|-------------------------------|
| AB   | 0.0325         | 0.65                 | 1.37 X 10⁻⁸                  |
| BC   | 0.0325         | 0.25                 | 2.03 X 10⁻⁹                  |
| CD   | 0.075          | -10.08               | -7.62 X 10⁻⁶                 |
| DE   | 0.090          | 1.96                 | 1.76 X 10⁻⁷                  |
| EA   | 0.0325         | 1.29                 | 5.4 X 10⁻⁸                   |

dQ = -2.67 X 10⁻⁵ m³ per sec = -2.67 X 10⁻² lps which is very less so discharges flowing in pipes are true. Hence epanet results are valid. The above figure shows the calculation for first trial.

### CONCLUSION:

Subsequently here we are examined plan of water supply pipe networks. The point of the water supply organize framework is to guarantee that water achieves all zones in great quality and amount, with the end goal of investigation and reenactment to acquire least and most extreme power, speed of stream in the pipe arrange framework so as to guarantee the correct working of water pipe organize. Likewise, broke down circles organize as indicated by progression and vitality preservation equations because of the assurance of obscure releases, streams and weight at hubs. Strong Cross technique is utilized due to unravel and break down shut circles organize for stream coherence and head-misfortune so as to adjust the system as the setting of this paper.

### REFERENCES: