Modeling of Water Distribution Network in Kagyi Ward, Mandalay City Using EPANET

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1. Introduction

Mandalay city expands in the central part of Myanmar. According to the 2014 census data, the population of Mandalay city is about 1.25 million and the area is 121.5 km^2. It comprises six townships with 96 wards where the city water supply and sanitation department under Mandalay City Development Committee (MCDC) has been in charge of the water supply system. Currently the water supply system has limited capacity to cover about 71% of the total population of four townships. MCDC has a plan to extend the water supply network by a decentralizing method.

This study aims to design the water distribution network in Kagyi ward for a given layout, demand loading conditions and an operation policy. This study employs EPANET[1)] which is an application programming interface for hydraulic and water quality simulation.

2. Study Area

2.1. Location and water demand in 2044

This study focuses on the network design of water distribution in Kagyi ward, Pyigyitakon township, Mandalay city. Fig. 1 shows an overview of the target ward, which is generated using google satellite image and ArcGIS.

The study area had a population of 4,180 as of 2014. By assuming 1% increasing rate of population, the population in the goal year 2044 will be 5,730. This growth will increase water demand per capita in Mandalay city by about 190 lpcd (liters per capita per day). This ward has no water pipe network connected to the city water supply system. Table 1 explains the change in water demand[2)].

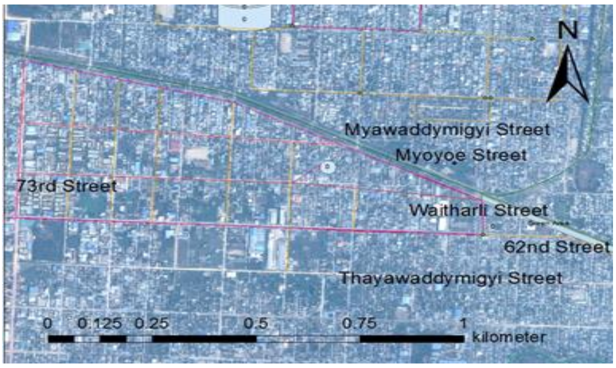

Fig.1 Base map of study area

Table 1 Population and rate of demand for base year and ultimate year

Year	Population	Water demand (lpm)
2014	4180	543.4
2044	5730	744.9

2.2. Water distribution system

Fig.2 shows the water distribution network in Kagyi ward. It has 46 numbers PVC pipes of 100 mm in dimeter, 29 junctions and 1 tank. PVC pipes have the roughness coefficient of 140 in Hazen-Williams equation. Groundwater from a tube well is pumped up and stored in the tank, whose capacity is 6,825 m^3(50 m in diameter and 4 m high) and water level changes between 0.3 m and 3.5 m in the tank. The figures at each nodal point in Fig. 2 represent the water demand at the node. This study intends to supply water to consumers at steady state and at all hours. The diameter of the PVC pipes is so determined as to bear the maximum hydraulic pressure head[1)].

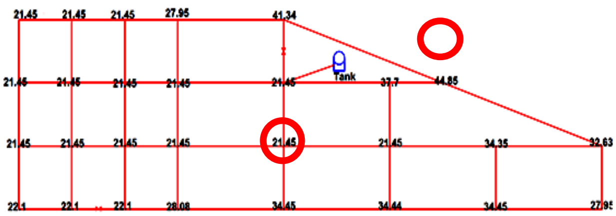

Fig.2 Pipe Network with nodal demand

3. Methodology and Computational Conditions

After preparing the schematic design by AutoCAD as shown

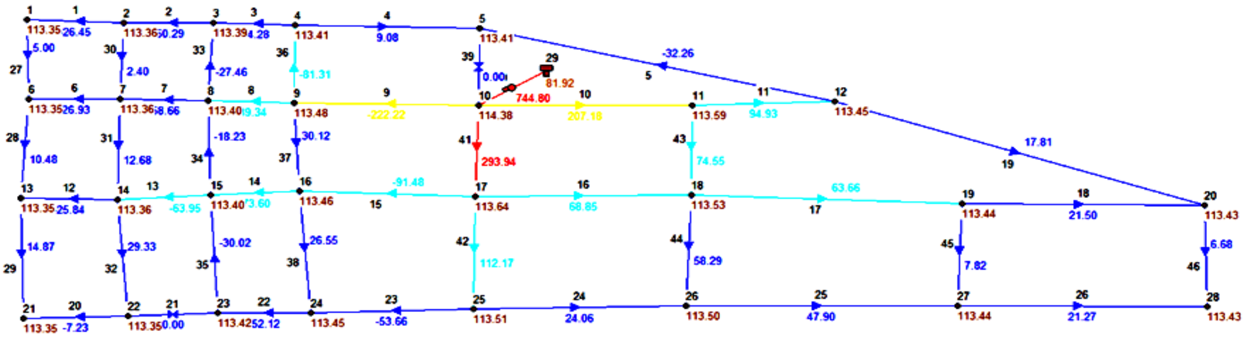

Fig. 3 Total head and discharge in Case-1

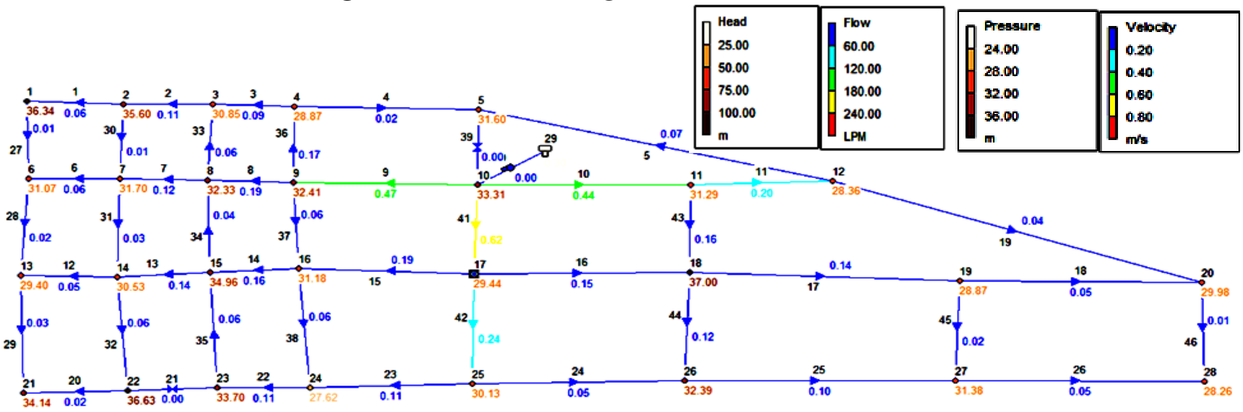

Fig. 4 Pressure head and velocity in Case-1

in Fig.2 with required data and fixing total demand from tank, we carried out hydraulic analysis with EPANET. We have selected Hazen-Williams method and a genetic algorithm to solve the set of nonlinear energy equations[1].

Here we discuss two cases where in Case-1 the discharge of 744.8 liter/min (Q_{25}) is supplied with nodal water demands shown in Fig.2 and in Case-2 Q_{25} is provided with the increased water demand at Node 17 with the water demands at the other nodes being the same as in Fig. 2.

4. Results and Discussion

Fig. 3 represents the distributions of total head and flow rate with flow direction in the network in Case-1.

Fig.4 shows the distributions of pressure head and velocity in links in Case-1. It shows that the pressure head shows little change in the network except at Node 29 (tank), and that Q_{25} can meet the water demands and provide the pressure head exceeding the necessary pressure of 28.0 m for fire-fighting activity at all nodes along the network.

Fig. 5 compares the pressure head distribution in Case-1 and Case-2 where water use at Node 17 is increased by 10 times of the original demand. The decrease in pressure head expands over the network by 1.04 m. The discharge Q_{25} is 10 times larger than the increased demand at Node 17.

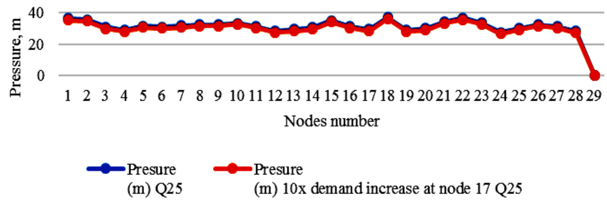

Fig.5 Comparison of pressure head in Case-1 and Case-2

5. Conclusion

Hydraulic analysis of water supply network in Mandalay city has been carried out using EPNEAT. The obtained results are summarized as follows.

1) The residual pressure at all node is found to be greater than the minimum pressure head of 28.0 m for the flow can take easily.
2) The internal diameter of 100 mm is sufficient to resist for the pressure for the entire network.

The pump and tank can supply water up to 2300 liter/min. This flow rate is sufficient larger than the water demands.

References

1) American Water Works Association: Analysis and design of Water Distribution System, 1993.
2) Ramana, G. V.: Network analysis of water distribution system in rural areas using EPANET, 13th Computer Control for Water Industry Conference, 2015.