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Analyse and design for water distribution network in community water supply using different simulation techniques

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The water supply scheme mainly supplies potable water to houses, commercial and industrial institutions. Supplying water to the consumers at the required quantity with adequate pressure is the prime purpose of any water distribution network (WDN). However, the performance of the WDN may vary from the original design in the long run. In this study, a WDN network model was built using WaterGEMS and WaterCAD computer simulators and hydraulic analyses were conducted to obtain an optimal WDN design for an existing community water supply scheme of a village called Poomalanthan in Sri Lanka. A series of steps such as; models, network representation, verification, problem identification, model application, and results analysis were carried out in developing the WDN simulation model. The demand for domestic, industrial, commercial and unaccounted for water was forecasted for twenty-five years while considering the average per capita daily demand as 100 litres. The analysis was carried out using the Hazen-Williams friction method and the hydraulic parameters such as pressure, flow velocity and flow rate were analysed under extended period simulation. The result revealed that all nodes in WDN operate above the threshold pressure limit of 10 mH_2O pressure throughout the day, including peak hours. The pressure during peak hours is the critical output factor which shall give an idea of ensuring water supply to every consumer at an adequate pressure. The nodal pressure is negatively correlated with the ground elevation. Most pipes have a relatively low velocity than specified in the design guidelines, which may be due to the low daily water demand of the small community. However, the chance of silt deposition in the pipes is the disadvantage of maintaining low velocity in WDN. Hence frequent pipeline line washout is recommended to eliminate the silt deposition in the system. The water flow rate in the pipes depends on the water demand at every node. The same hourly flow rate was not observed since the demand in the system was not constant throughout the day. Instead, it varies with the time of the day, and usually, the peak demand arises in the morning and late evening hours when people consume water for bathing, washing, and cooking. The water tower was optimised at 10m height to supply water at sufficient pressure. The WDN was designed for optimised pipe sizes with pipe availability in the market. Statistical comparison through an ANOVA test reveals that there is no significant difference in the nodal pressure, flow velocity and flow rate results derived from WaterGEMS and WaterCAD simulation techniques. Water network computer simulators used during this design can handle various water supply network problems. Computer-aided WDN simulation techniques provide significant advantages over conservational computations in terms of optimisation, results in accuracy, monitoring of the system during operation, time consumption and room for future modification.

Keywords: Design optimisation, WaterCAD, WaterGEMS, Water network model, Water supply