OPTIMIZATION DIAMETER OF PIPE AT FRESH WATER NETWORK SYSTEM

Chairil Saleh
Department of Civil Engineering
University of Muhammadiyah, Malang
INDONESIA
Chairissy@yahoo.com,

Sulianto
Department of Civil Engineering
University of Muhammadiyah, Malang
INDONESIA

ABSTRACT

This paper studied optimization diameter of pipe. Diameter of pipe was due to fresh water network system. Location of study was at Turen District, Malang Regency, and Indonesia. The methodology consisted of optimization using genetic algorithm so that was got average rest of pressure. Results could be used as consideration to optimize service of fresh water use.

Keywords: optimization, diameter of pipe, rest of pressure

INTRODUCTION

The most common type of coherent structure associated with secondary flow in curved bends was the main cell of cross-stream circulation, or helix, within which the fluid particles follow a helicoidal path (Constantinescu et al., 2011), If the bed was not strongly deformed, the main cell extends over a large part of the cross section. Once the pool-point bar structure developed, this cell generally extended only over the outer, deeper part of the channel (Constantinescu, 2011),

Channel geometry equations which relate discharge to channel width or channel cross section were considered to be the most reliable (Tayfur and Singh, 2011). Some author developed regression equations relating discharge to channel cross section to yield the most satisfactory results. Once hydraulic geometry equations were defined for a stream, the cross-section area measurements was all that was needed for estimating the discharge.

Step-pool geometry, including relationships between step length, step height, grain size, stream gradient, and channel width, and variance in these relationships, had been investigated to seek insights into formative processes, hydraulic controls, and analogies to lower-gradient syatems (Wilcox et al., 2011). Step-pool sequences, in which flow plunges over channel-

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spanning boulder, log, and/or bedrock steps into downstream scour pools, produce stepped longitudinal profiles and dissipate enrgy in high-gradient streams.

Traditionally, the optimal design of water distribution network considered minimization of economic cost. Nowadays, however, minimization of design cost was considered as the objective function of a water distribution network design problem and diameters of the network's pipes as its variables, In a discrete optimization problem with 10 locations for the pipes and 10 commercial diameters available for each pipe, the decision space for such a problem would be 10^{10} different states (Sultanjalili et al., 2011). Design of water distribution networks that do not consider performance criteria would possibly lead to less cost but it could also decrease water pressure reliability in abnormal condition such as a breakage of pipes of the network.

CONTEXT AND REVIEW OF LITERATURE

Flow in element of pipe

Flow in pipe had energy as velocity energy, pressure energy, and head energy. Based on principal of Bernoulli, total energy was described as Figure 1 (Triadmojo, 1995).

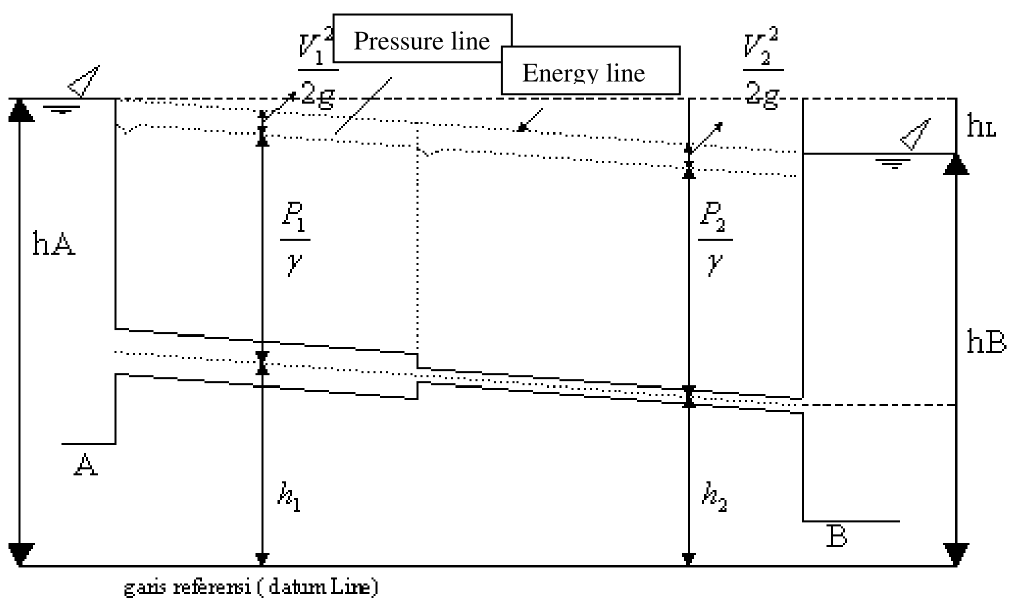

Figure 1 Diagram of energy

Bernoulli equitiom was as follow : (Triadmojo, 1995)

$$E_1 = E_2 = h_1 + \frac{v_1^2}{2g} + \frac{p_1}{\gamma} = h_2 + \frac{v_2^2}{2g} + \frac{p_2}{\gamma} + h_L \quad \text{.......................} (1)$$

Note : $\frac{v_1^2}{2g}$ = velocity head at point-1 (m)

$\frac{v_2^2}{2g}$ = velocity head at point-2 (m)

$\frac{p_1}{\gamma}$ = pressure head at point-1 (m)

$\frac{p_2}{\gamma}$ = pressure head at point-2 (m)

h_1 = elevation head at point-1 (m)

h_2 = elevation head at point-2 (m)

h_L = head loss (m)

Head losses

Reynold number was as follow: (Triadmojo, 1995)

$$\mathrm{Re} = \frac{V\,D}{\nu} \qquad \text{...} \qquad (2)$$

Note :

D = Diameter of pipe (m)

V = velocity in pipe ($m.s^{-1}$)

ν = kinematic viscocity of fluid ($m^2.s^{-1}$)

Re = Reynold number

- Re < 2000, → laminair
- 2000 < Re < 4000 → transition
- Re > 4000 → turbulence

Optimization model

System analysis using mathematical model provides a suitable methodology to analyze various aspect of water resource system planning (Holko and A, Lepsito, 1997). Linear Programming is used for this study. This program would give some advantages for analyzing water resources system planning as follow (Cheng Yun at al., 2008): (1) Constraints and objective function which are used in this program are linear function; (2) This program is quite simple because there are many solver can use to solve this problem; (3) If it can be build the optimization procedure (the objective function with any kinds of constraints), it can be approached the real problem.

The step by step to carry out Linear Programming is as follow (Loucks, 1982): (1) To built optimization models (Figure 2); (2) To determine the resources which would be optimized (for this case study are irrigation and hydro electrical power); (3) To calculate the quantities of input or output for every kind of activity unit; (4) To build the mathematical modeling.

METHODS

Location of study was at Turen District, Malang Regency, East Java Province of Indonesia, it was included 5 villages namely Desa Talok, Desa Pagedangan, Desa gedog wetan, Kelurahan turen, and Desa Sedayu. At this location, supply water was come from Umbul Rejo source. There was used transmition of pipe gravitically to reach the users. Capacity of Umbul Rejo source was 325 l/s. Spesification of existing pipe was as Table 1. Turen District used S 12.5 for tke kind of pipe.

Table 1 Diameter and thickness of pipe

No	Diameter (mm)	Thickness (mm)
1	40	1.6
2	63	2.5
3	90	3.5
4	110	4.2
5	160	6.2
6	200	7.7
7	250	9.6
8	315	12.1
9	355	13.6
10	400	15.3

The steps of research were included

1. To simplify pipe network with lossing the branch of pipe.
2. To analyze hydraulics of branch pipe.
3. To apply genetic algorithm, which included the steps as follow:
    - To determine parameter related to genetic algorithm such as population, probability, mutation, and maximum generation. Mengasumsikan diameter pipa sebagai kromosom.
    - To perform individual population randomly.
    - To evaluate the fitness
    - To select the individual fitted to the best
    - Crossover and Mutation.

FINDINGS AND DISCUSSIONS

Comparison curve rest pressure between due to manual procedure and the sodtware was described as Figure 1 below:

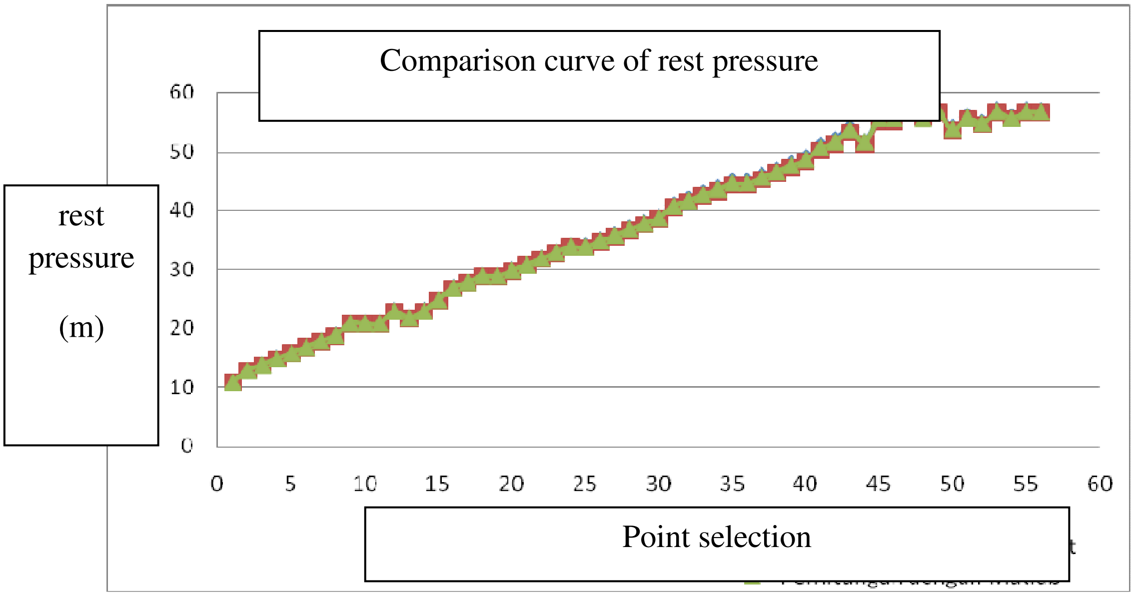

Figure 1 Comparison Curve of rest pressure

Justification of pipe diameter could be carried out due to:

1. Selection of justified diameter was as the comparison between existing and optimized diameter.
2. To select the biggest diameter between existing and optimized diameter using decsrete approaching to the field condition.

Comparison curve of diameter was described as Figure 2.

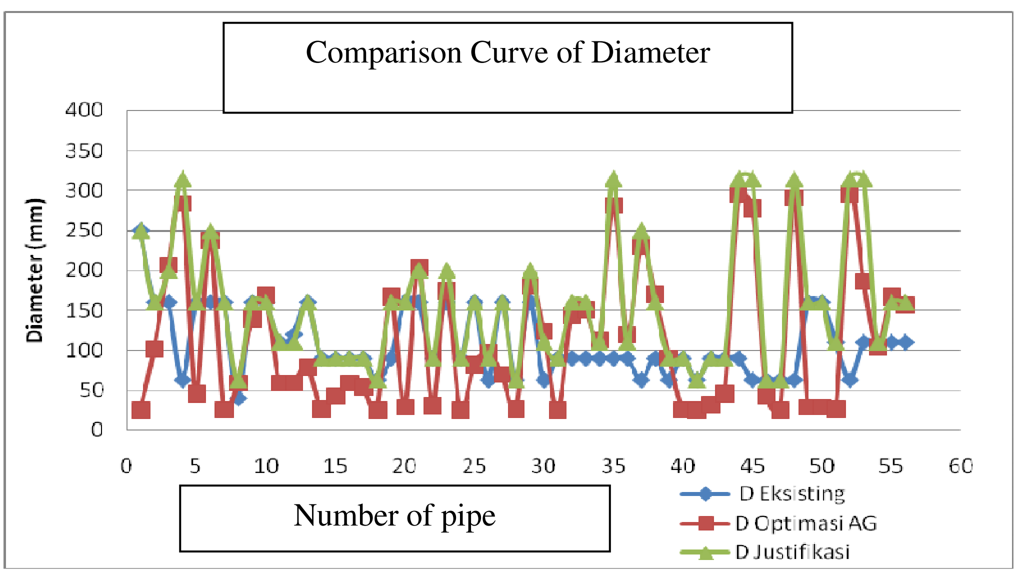

Figure 2 Comparison Curve of diameter

(Note: D Eksisting = D existing, D optimasi AG = D optimized genatic algorithm, D justifikasi = D justification)

Rest pressure were not as well as the result of optimized genetic algorithm. It was shown that rest pressure was 29.49 m, minimum value was 7.93 m and maximum value was 37,42 m. Control result of rest pressure was low enough, it was 27.55 m but at existing condition, it was 43.86 m. This condition was described as Figure 3 below,

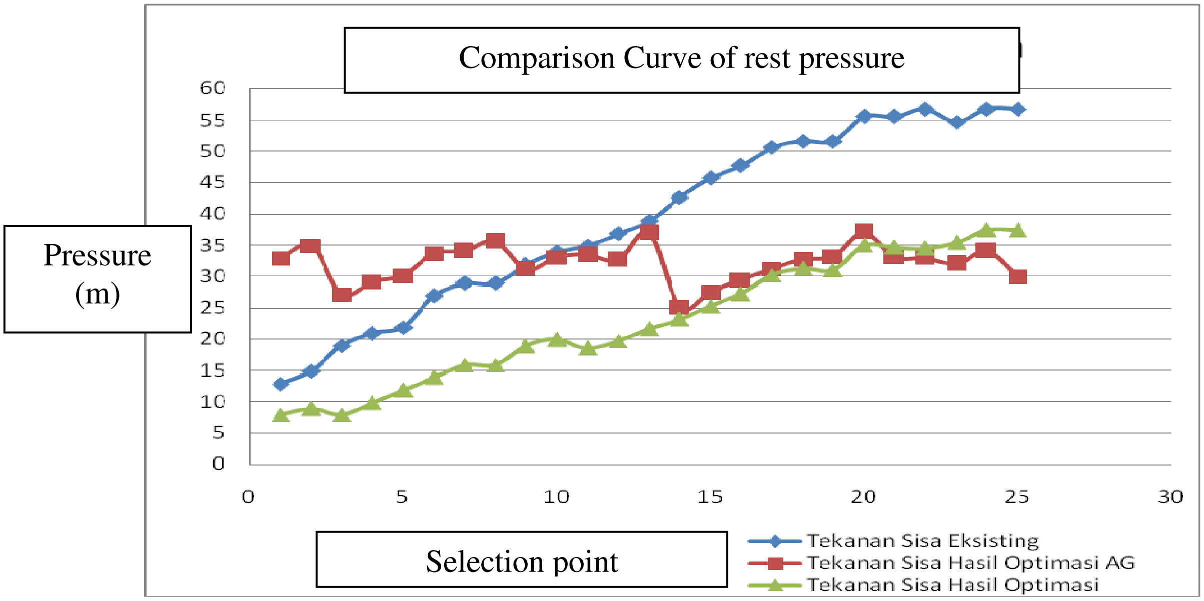

Figure 3 Comparison Curve of rest pressure
(Note: tekanan sisa eksisting = existing rest pressure, tekanan sisa hasil optimasi AG = rest pressure due to genetic algorithm, tekanan sisa hasil optimasi = rest value due to optimization result)

CONCLUSION

Performance of pipe network after optimization due to genetic algorithm showed that the difference rest value with the minimum value was 11.99 m (the minimum value was = 25.19 m and maximum value was 37.09 m). Based on justification of diameter, it showed that the difference rest value with the minimum value was 7.93 m (the minimum value was = 37.42 m and maximum value was 43.86 m).

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