Minakshi M.Yengale, P. J. Wadhai, Dr. B. V. Khode / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 3, May-Jun 2012, pp.2352-2355

Analysis of Water Distribution Network for Karanja Village -A Case Study

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ABSTRACT:
The objective of study is to minimize the time required for analysis & to make the tedious work to easier by using computer technique. And also the best option in order to optimize the cost of the network. The software program for discharge analysis & cost analysis for network Karanja village is made by using VB language. Water industry due to its unique nature faces many problems. The supply of water from the limited water resources in order to fulfill the ever increasing demand of water. In order to make infrastructure improvement, a water supply system has to handle a large amount of diverse information on continuing basis. The necessary information includes the data about pipelines, valves, pressure, ESR's, Pumps. Most of the required data is generally in the paper format and is not updated regularly. This paper present case study for water distribution network for Karanja village along with performance & comparison of developed computer technique with manual calculation.

Keywords : *Distribution, cost analysis, networks, water supply*

INTRODUCTION :
Water distribution system, a hydraulic infrastructure consisting of elements such as pipes, tanks, reservoirs, pumps and valves etc., is crucial to provide water to the consumers. Effective water supply system is of paramount importance in designing a new water distribution network or in expanding the existing one. Distribution networks are an essential part of all water supply systems. Distribution system costs within any water supply scheme may be equal to or greater than 60 % of the entire cost of the project. A water distribution system is a collection of hydraulic control elements jointly connected to convey quantities of water from sources to consumers. Simulation of water distribution systems using computer technique has reached a mature stage of development. However, the optimal network design is quite complicated due to nonlinear relationship between flow and head loss and the presence of discrete variables.

Water distribution network consists of a planar system of pipes or links (through which the water flow), connected together at nodes which may be at different elevation. In general, the complex will also include pumps, reservoirs and valves. A node usually has one of the two main functions; it either receives a supply for the system or it delivers the demand required by consumers. As a special case, it may satisfy neither of these requirements but merely serve as a junction between two or more pipes. The pressure head at a supply node is established by the presence of a pump or a reservoir. Resistances to flow (friction losses) which are the function of length, diameter, flow rate, and pipe material and roughness occur in the links as the fluid water around the network from supply nodes to demand nodes. The effect of minor losses may be including as equivalent pipe lengths. It is usual to specify a minimum acceptable hydraulic grade lines (e.g. storage reservoirs). Ioan Sarbu(2009) described linear model for optimal design of water distribution system. Shie-Yui Liong & Md. Atiquzzaman(2004) suggested the shuffled complex evolution. In this study comparison of performance of shuffled complex evolution in term of prediction accuracy and computation speed, with GA and other widely used optimization algorithms. A Vason and Slobodan P. Simonovic (2010) presented Development of a DENET computer model that involves the application of an evolutionary optimization technique. This paper present case study for water distribution network for Karanja village along with performance & comparison of developed computer technique with manual calculation

Mathematical Modeling:
To develop the computer technique for Karanja village by using VB (6.0). Initially analysis for small network done manually using Hardy Cross Method. The same problem is solved by using computer technique VB (6.0). The design formulation used for this are

$\triangle Q = \sum H / n \sum H/Q$

Where,
Q = Quantity of flow
H = Head loss
n = Constant , 1.85 for Hazen William's formulae

The assumption made for Balancing of flow are :

1) Assume the suitable flow Q in each pipe line such that the flows coming into each junction of the loop are equal to flows leaving.

2) Assign positive sign to all clockwise flows & negative sign to all anticlockwise flow

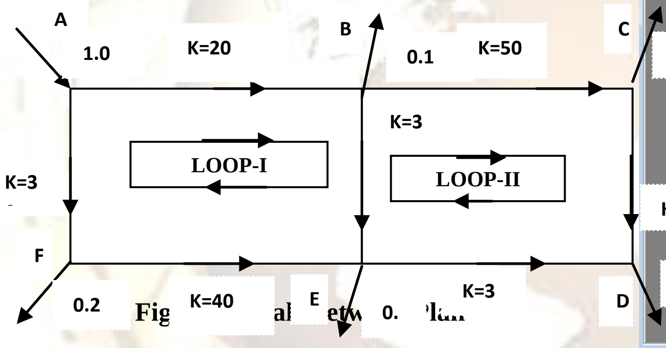
3) Compute the head loss H in each pipe by use of friction formula with the help of chart or monogram giving the same sign as for the flows

4) Compute the $\sum H$ (i.e. algebraic sum of head losses) around each loop and if this is zero in all loop (within allowable limit of ± 0.15m), the assumed flow is correct.

5) otherwise, if $\sum H$ is not equal to 0 for any loop, compute the error in flow.

The solution for the small Network :

The manual calculation are carried out for a network. The manual calculation need time to analysis the network.



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Link	Corrected Flow (m^3/sec)
AB	0.5645
BE	0.2264
EF	0.2355
FA	0.4355
BC	0.2381
CD	0.1381
ED	0.2619

Procedure:
Discharge input format:
Velocity input format:
Cost analysis format:

The limiting condition and the range for variable covered in this study are as follows:

For the analysis of network the page is designed which have following parameters.
Input Value :
Discharge m^3 / s
Diameter : meter
Pipe coefficient : constant
Length : meter

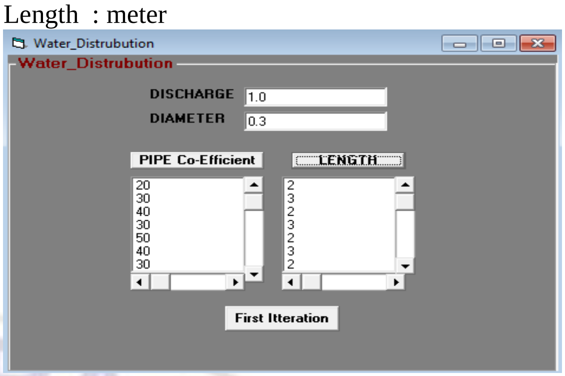


Fig 1: Mathematical Model for Design

The design pages giving the input parameters
The design pages are designed
The Result :
Output Value :
Final discharges in every pipes

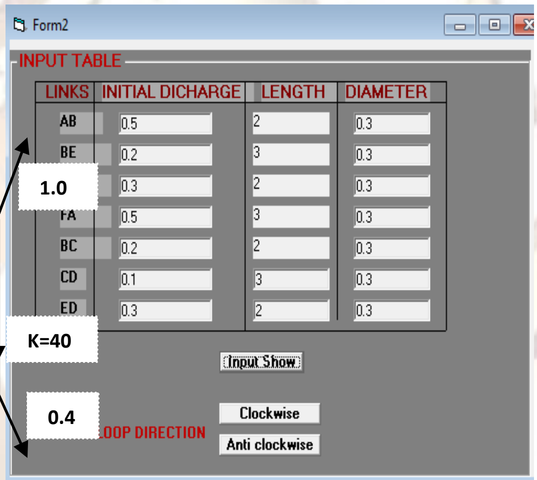


Fig 2: Mathematical Model for Design

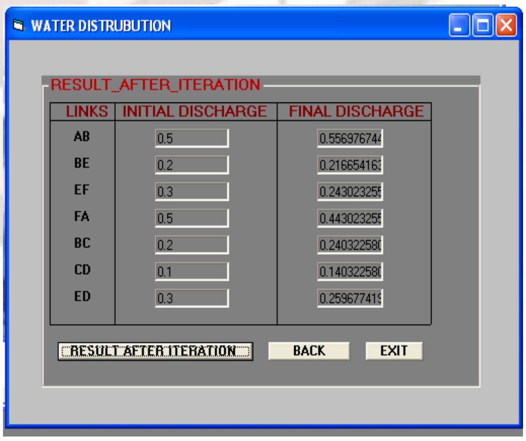


Fig 3: Mathematical Model for Design Comparison of Discharged Manually and by Program

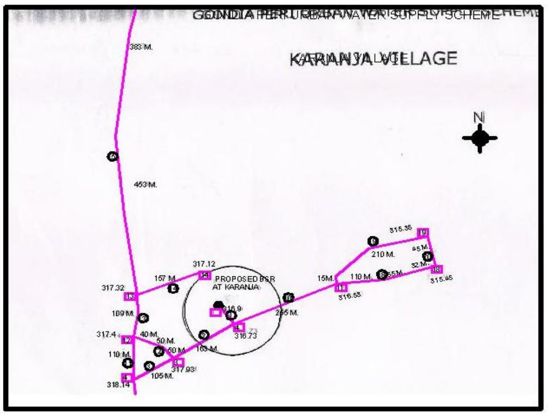


Fig 4 : Map of Karanja Network

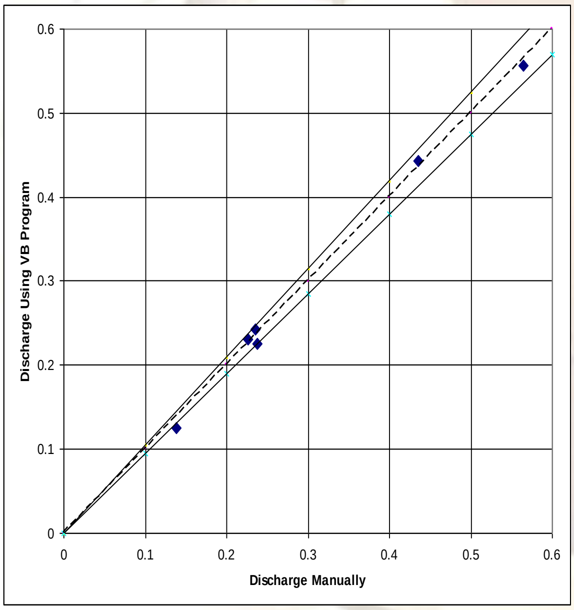


Fig 5: Comparison of Data

Comparison of Discharge by Manual Method & by V.B. Program

Links (loop-I)	Discharge (Manual) m^3/sec	Discharge (Program) m^3/sec	% Error
AB	4.6260	4.56892144177	1.2
AC	4.5680	4.62607078558	1.2
BC	0.72599	0.78256078752	2.79

COST ANALYSIS :

Links	Discharge (Manually) m^3/sec	Discharge (Program) m^3/sec	Percentage Error
AB	0.5645	0.5569	1.30%
BE	0.2264	0.2311	2.07%
EF	0.2355	0.2430	3.18%
FA	0.4355	0.4430	1.72%
BC	0.2381	0.2250	2.80%
CD	0.1381	0.1258	4.90%
ED	0.2619	0.2741	4.60%

The network cost is calculated as the sum of the pipe costs where pipe costs are expressed in terms of cost per unit length.

Total network cost is computed as follows:

$C = \Sigma\, C_k(D_k)L_k$

Where,

C_k = cost per unit length of the kth pipe with diameter D_k

L_k = length of the kth pipe,

N = total number of pipes in the system.

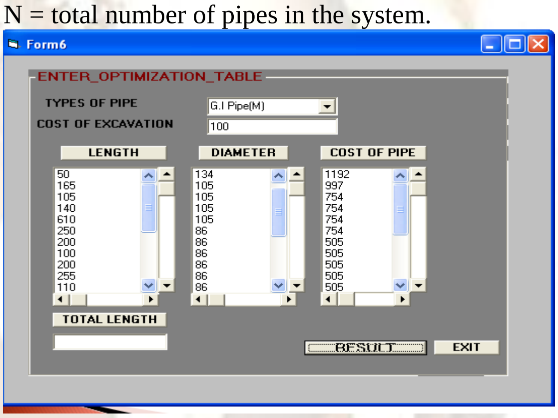
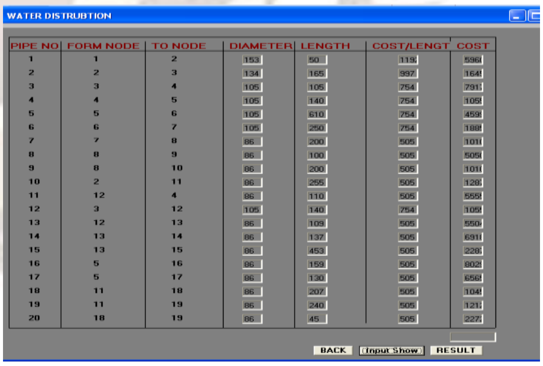


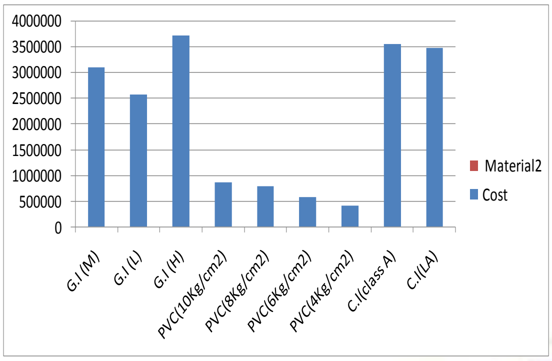
Fig 6: Mathematical Model for Design


WATER DISTRUBTION

PIPE NO	FORM NODE	TO NODE	DIAMETER	LENGTH	COST/LENGT	COST
1	1	2	153	50	119	596
2	2	3	134	165	997	164
3	3	4	105	105	754	791
4	4	5	105	140	754	105
5	5	6	105	610	754	459
6	6	7	105	250	754	188
7	7	8	86	200	505	101
8	8	9	86	100	505	505
9	8	10	86	200	505	101
10	2	11	86	255	505	128
11	12	4	86	110	505	555
12	3	12	105	140	754	105
13	12	13	86	109	505	550
14	13	14	86	137	505	691
15	13	15	86	453	505	228
16	5	16	86	159	505	802
17	5	17	86	130	505	656
18	11	18	86	207	505	104
19	11	19	86	240	505	121
20	18	19	86	45	505	227

BACK Input Show RESULT

Fig 7: Design of Cost Analysis Format



Necessity of project and condition leading to the Analysis of the project

This village is 30 to 35 km from Gondia city, Maharashtra, India. All the newly established educational institutions are within the vicinity of these villages. The development is very fast and hence a new water supply scheme is urgently needed. Hence Water Supply Scheme for Karanja villages with WTP as source is proposed along with water supply rate of 70 lpcd at consumer end for Karanja village.

Elevated Service Reservoirs

1,00,000 Lit cap.12.0 m staging height at ESR, at village Karanja village.

Daily Water Demand

The rate of water supply was 70 lpcd. The daily requirement of water in MLD.

RESULT AND DISCUSSION :

Figure 4, shows that the map of Karanja Village a part of Gondia Water Distribution Network

Figure 5, shows that the manual solution & solution by program are same for network. The average percentage error is within the limit of ±5%.

CONCLUSION :

Using VB (Visual Basic) Technique finds greater application due to it's inherent advantages in connection with analysis of water distribution network if compared with routine manual method. Based on the available data of Karanja network, following conclusion are drawn

1)The VB technique is economical & time saving.

3)Used précisie analysis shows the minimum difference between the manual value generated & technique values varies within permissible range of ±5%.

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NOTATIONS :

Q : Discharge flowing in pipe
V : Velocity of flow in pipe
D : Diameter of pipe
L : Length of pipe
K : Coefficient of roughness
H : Head loss
n : Constant, 1.85 for Hazen William's formulae
C : Cost of pipe