OPTIMIZATION WATER DISTRIBUTION NETWORK BY USING SOFTWARE

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Abstract-In India we are facing drinking water problem majority in village areas. So to ensure availability of drinking water effective utilization is prime important. This may be achieved by effective water distribution network with minimum losses. Research is going on to develop better network system and emphasize is given on National water policy for effective water supply system and this depends on proper network system. Water is one of the world's most valuable resources, yet it is under constant threat due to climate change and resulting drought, explosive population growth, and waste. One of the most promising efforts to stem the global water crisis is industrial and municipal water reclamation and reuse. Water distribution network is complex when area to be covered is large and analysis and design need to be done by manual or tradition method, this problem may be overcome by using software for design and analysis. Thus this analysis was taken for research which includes the existing water distribution system network. By using software analysis of existing system have been done .In this analysis it results in material variation, different alternatives, optimization of distribution system,comparision with various hydraulic parameter. This gives the economical alternative solution to the distribution system and payback period of project. After analysis it is found that the existing system may need some modification and therefore software based analysis may be utilized for complex distribution system to achieve economy and time saving.

Keywords: Distribution system, Analysis, material variation, optimization.

I.INTRODUCTION

Water is so important in human life without which he cannot live alive and therefore it plays vital role in human life. In early days human used water from different sources for their purposes & their consumption. So good quantity and quality of water is available for drinking and washing, but as man progressed he is using water from piped system which include the use of water for flushing's, for showering, firefighting and irrigation purposes. In Mohenjo-Daro and Harappa civilization people used water for drinking, irrigation and other purposes. In ancient India people believed that the pure, divine and well provided water conveys offering to god. The well managed and proper operation of water distribution systems plays a critical role in to provide safe drinking water to its consumers. For the last two decades, major efforts have taken place to improve source, water treatment and distribution network . Recently, the research has extended to include not only improvement of water treatment, but also conveying and distributing high quality water to the consumers' taps The distribution system consist of critical component of various appurtenances and drinking water utility. Its primary function is to provide the required water quantity and quality at a suitable pressure, and failure of such system results in serious problem. Water quality may degrade during distribution because of the way water is treated or not treated before it is distributed, reactions between the water and distribution system materials, and contamination from external sources that occurs because of main breaks, leaks coupled with hydraulic transients, and improperly maintained storage facilities. In addition to that special problems are arises by the utility's need to maintain suitable water quality at the consumers tap, and the quality changes that occur in consumers plumbing, which is not owned or controlled by the utility. Water distribution systems carry drinking water from a treatment plant to storage and consumers' taps. These systems consist of pipes, pumps, valves, storage tanks, reservoirs, meters, fittings, and other hydraulic appurtenances. The distribution system is the final barrier before delivery to the consumer's tap. Even when the water leaving the treatment plant is of the highest quality, if precautions are not taken its quality can seriously deteriorate. In extreme cases, dangerous contamination can occur. For the analysis of the distribution system use of new technique gives better results than the traditional method. The later method is common now a days to achieve economy, variation in material, and optimize the system. Former method is limited for simple network and for complex network it is very complicated, any error in analysis causes failure of system. Therefore here this paper consist of analysis of distribution system and optimize the same system by using water gems software

II. STUDY AREA

Thomas m Walski (2006)[1], American water world association had studied that early human has to carry water from source to point of consumption which required more efforts and only minimal water for drinking and washing was available. Piped water system was discovered two millennia before Christ which still functioning today. In 1942 prestressed concrete tank was introduced and then in 1952 to 60 cast in situ concrete were common practice for tank. National research council of National Academy (2001)[2] studied that Water distribution systems carry drinking water from a centralized treat-ment plant or well supplies to consumers' taps. These systems consist of pipes, pumps, valves, storage tanks, reservoirs, meters, fittings, and other hydraulic appurtenances More than 80 percent of the water supplied to residences is used for activities other than human consumption such as sanitary service and landscape irrigation. Most of pipe system having life of pipe almost 30 years although the life of pipe is longer depending on the soil and local condition. Harry E Hickey (2008)[3] US fire administration water supply system and Evaluation method focuses on the municipal water system which provided for the larger area to the consumer at constant rate. Source for the distribution system is underground water tank which is lifted by the pump system. Harry E Hickey (2008)[4] US fire administration water supply system and Evaluation method suggested that the transmission of water system is so important for the success of the constant supply of water without contamination. A. E. Becher Jr., Gerald J. Bizjak, and James W. Schulz(1972)[4] American Water work Association Computer technique for water distribution Analysis paper consist of The problem of accurately analyzing the behavior of distribution networks is common for the analysis but when analysis is carried out manually then it requires number of the alternatives with number of factors skeletonize large systems and make many simplifying assumptions to complete his calculations in a reasonable time. time. These procedures do not always pro- duce a satisfactory design. The search for a better way led inevitably to considering electronic computers. For this results are carried out with different changes and any error in that changes make failure of the analysis. This problem can be solved by using computer for the analysis of complex networks. A system map showing the location, diameter, C (friction factor) number, length, and interconnection of every principal pipe in the system. A list of sources, including their location, input pressure, and flow rate. Generally either the pressure or the flow rate of the source is only an estimated quantity. In addition to the obvious economic disadvantages, manual methods are not good enough to produce the required quality of answers on all but the most elementary systems is quite complicated. Existing Distribution system is required for the analysis by using software.

The distribution system is situated at Indradhanu near,Damani nagar Solapur. By collecting information and input data in the form of drawings, and various design parameters. This information is utilized as input for software and the analysis is carried out to get the output from software. Here different alternatives of analysis for various pipe material (Ductile Iron(DI), Cast Iron(CI), Galvanized Iron(GI) and PVC) is obtained with existing water distribution system. Then this system is optimized with two alternatives and the cost of each alternative is worked out to get best economical alternative.

III.MATERIAL AND METHODOLOGY

Data Required

1. Water Gems software.
2. Drawing of existing distribution system .
3. Length of pipes installed .
4. Diameter of pipes .
5. Pump details.
6. Head at the consumer end..
7. material of pipe

Methodology: The detailed research plan carried out during the study was as per the follows. This shows the step by step procedure carried out during the research study Fig1.

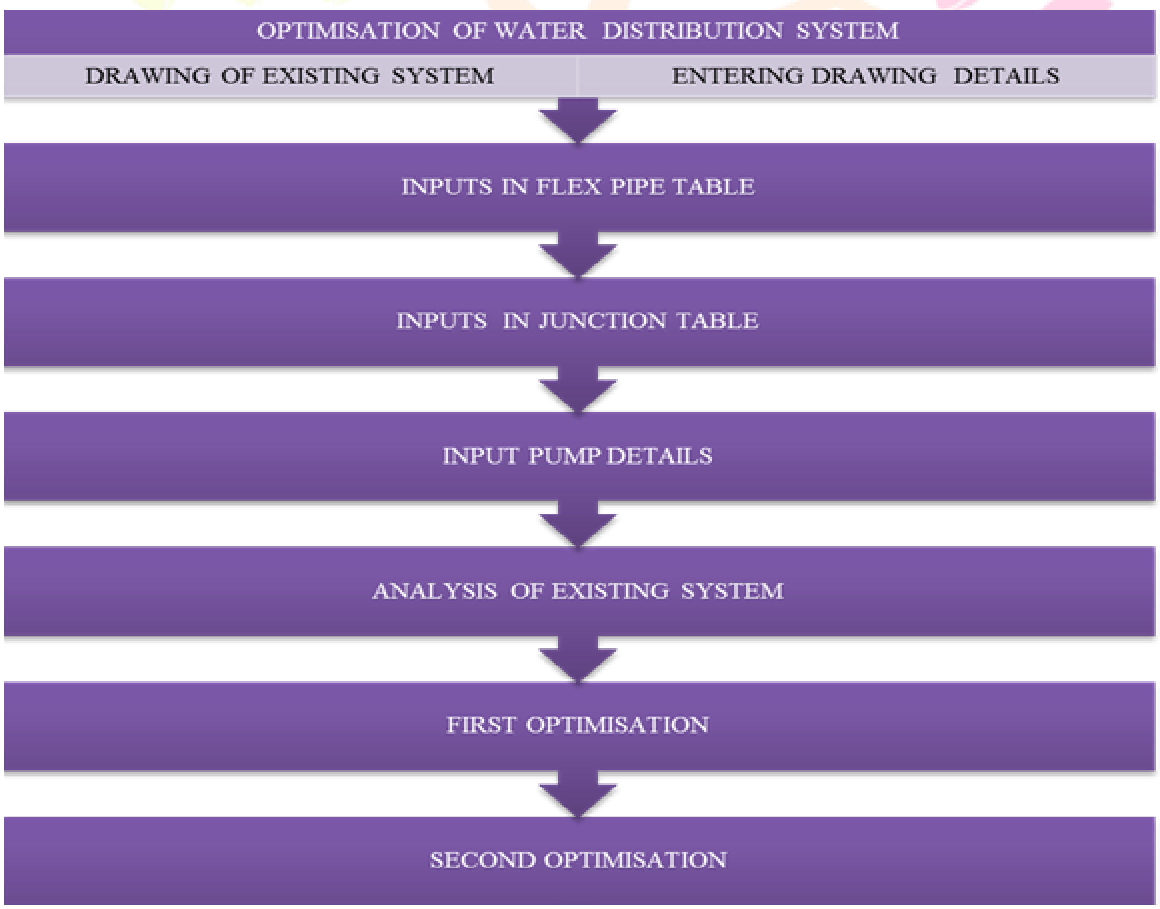


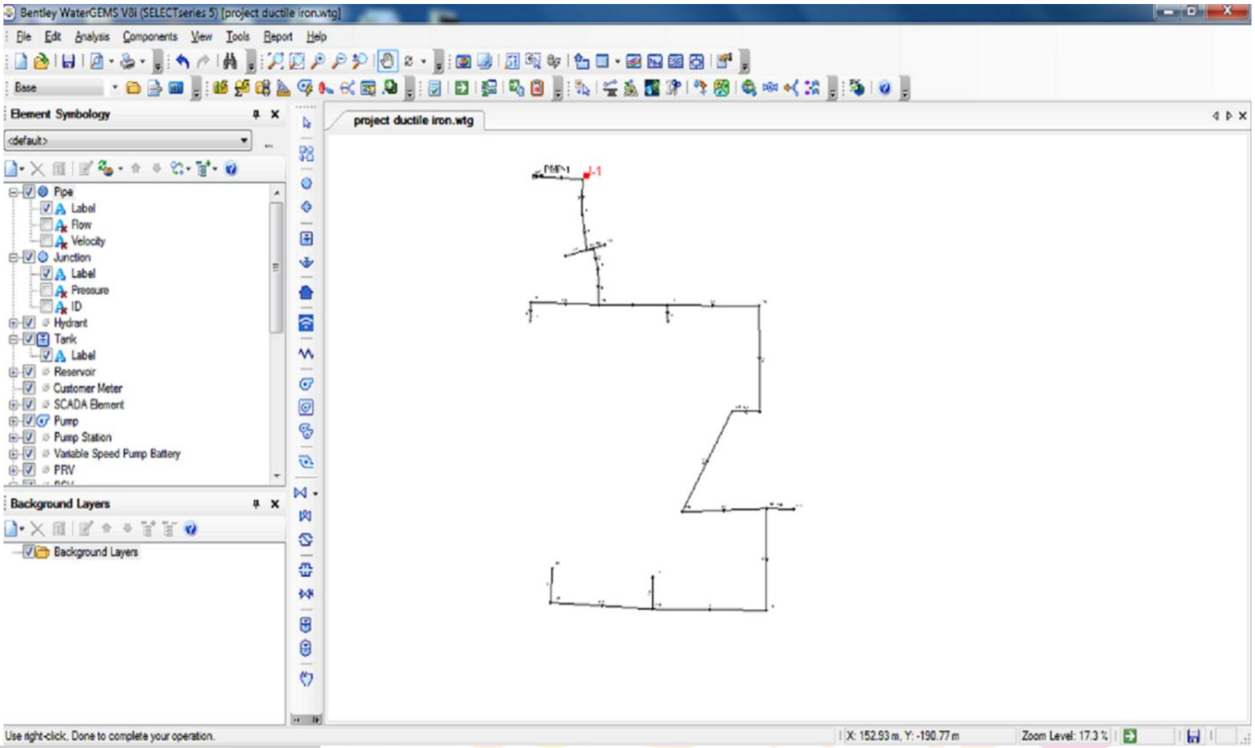
Figure 1. Flow chart in research work

1) Drawing of existing system consist of

1. .Drawing of drinking water
2. Drawing of domestic water

The project is limited to use drawing of drinking water for analysis which can be referred for the domestic purpose**.**

2) Entering details



Source : Use Water gems Software Bentley.

Figure no 2 Existing drawing of damani nagar entered in software

For entering drawing details File- Import-select drawing OR select pipe menu enter drawing details which shown in above image

Above procedure is repeated for various materials such as DI pipe, CI Pipe, GI pipe, PVC pipe and for same existing distribution system and for alternative-1 & alternative-2

3) Input in flex pipe Table

Data can be entered in the flex table in the form of edit in label and length

Select Flex Table-Enter Label-Enter length of pipe-enter diameter of pipe

Alternative method is Select each pipe and Enter Label, Length of pipe- Diameter of pipe

4) Input in flex junction Table

For Junction table Select Flex Junction table-Enter Elevation, Demand, and Zone

Other alternative is use node click on it and enter the details as Elevation, Demand, Zone

5) Input as pump details

Pump details can be entered from pump table

Select-Pump-Pump Definition-Enter Details

Pump details can be entered in the form of elevation or capacity.

6) Analysis of system.

Label	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (mm)
P-2	J-1	J-2	65.0	Cast iron	130.0	False	0.000	7	2.01	0.073	True	14,900
P-3	J-2	J-3	65.0	Cast iron	130.0	False	0.000	7	2.01	0.073	True	21,000
P-4	J-3	J-4	152.4	Cast iron	130.0	False	0.000	0	0.00	0.000	False	0
P-6	J-3	J-6	65.0	Cast iron	130.0	False	0.000	7	2.01	0.073	True	300
P-7	J-6	J-5	152.4	Cast iron	130.0	False	0.000	0	0.00	0.000	False	0
P-8	J-6	J-7	40.0	Cast iron	130.0	False	0.000	7	5.31	0.780	True	9,350
P-9	J-7	J-8	40.0	Cast	130.0	False	0.000	7	5.31	0.780	True	6,800

				iron								
P-10	J-8	J-9	40.0	Cast iron	130.0	False	0.000	2	1.33	0.060	True	14,100
P-11	J-9	C Apt	25.0	Cast iron	130.0	False	0.000	2	3.40	0.591	True	1,350
P-12	J-8	J-11	40.0	Cast iron	130.0	False	0.000	5	3.98	0.458	True	15,800
P-13	J-11	D Apt	25.0	Cast iron	130.0	False	0.000	2	3.40	0.591	True	1,550
P-14	J-11	J-13	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	12,600
P-15	J-13	J-14	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	19,200
P-16	J-14	J-15	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	3,800
P-17	J-15	J-16	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	20,800
P-18	J-16	J-17	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	10,400
P-19	J-17	J-18	40.0	Cast iron	130.0	False	0.000	0	0.00	0.000	False	0
P-20	J-17	J-19	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	19,000
P-21	J-19	A Apt	40.0	Cast iron	130.0	False	0.000	3	2.65	0.216	True	16,500
P-22	A Apt	J-21	40.0	Cast iron	130.0	False	0.000	0	0.00	0.000	True	3,650
P-23	A Apt	B Apt	25.0	Cast iron	130.0	False	0.000	2	3.40	0.591	True	30,000
P-24	B Apt	J-23	40.0	Cast iron	130.0	False	0.000	0	0.00	0.000	True	3,800
P-1A	T-1	PM P-1	152.4	Cast iron	130.0	False	0.000	7	0.37	0.001	False	0
P-1	PM P-1	J-1	65.0	Cast iron	130.0	False	0.000	7	2.01	0.073	True	3,500

Table No.1 Flex pipe table of existing distribution system.

Above table shows the details of flex table for existing distribution system for CI pipe
Above table is repeated for the optimization and comparison is done for the economy. Comparison is as follows for CI pipe

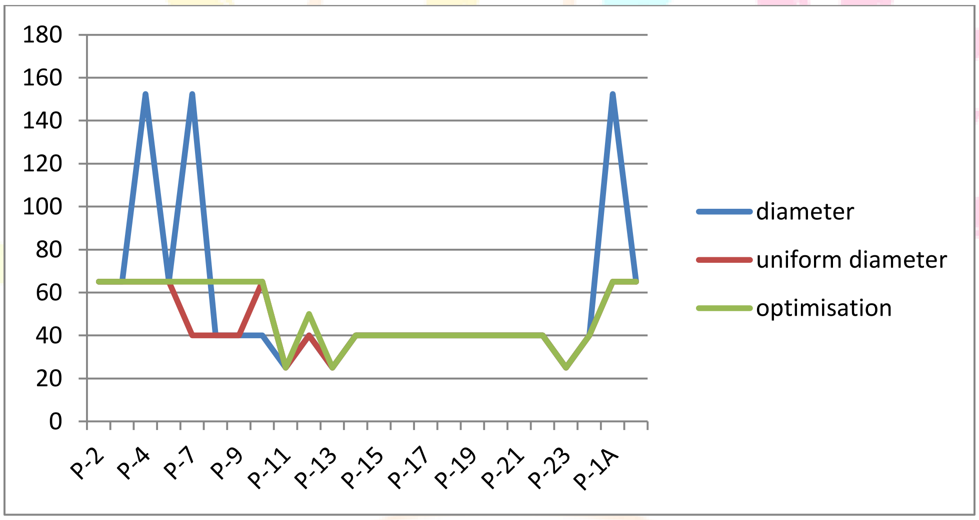
IV. RESULT AND DISCUSSION

This chapter consists of result obtained during the analysis work by using Water Gems Software of Bentley. Study was done for the optimization of distribution system for different material such as DI pipe, CI pipe, GI pipe, PVC pipe and results are represented by graph for comparison. This study may be utilized for the selection of economical alternative on the basis of results.

node	Diameter	First Optimization	Second Optimization
P-2	65	65	65
P-3	65	65	65
P-4	152.4	65	65
P-6	65	65	65
P-7	152.4	40	65
P-8	40	40	65
P-9	40	40	65
P-10	40	65	65
P-11	25	25	25
P-12	40	40	50
P-13	25	25	25

P-14	40	40	40
P-15	40	40	40
P-16	40	40	40
P-17	40	40	40
P-18	40	40	40
P-19	40	40	40
P-20	40	40	40
P-21	40	40	40
P-22	40	40	40
P-23	25	25	25
P-24	40	40	40
P-1A	152.4	65	65
P-1	65	65	65

Table 1 different diameter for CI pipes

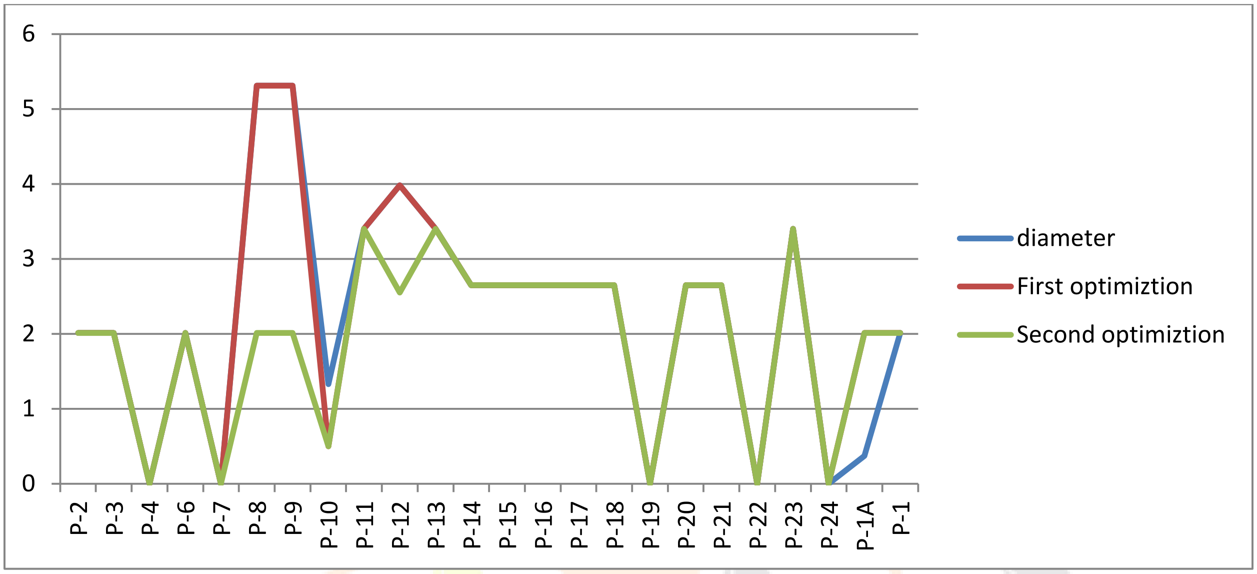


Graph No 1 Variation in Diameter after optimization for CI pipe

node	diameter	First Optimization	Second Optimization
P-2	2.01	2.01	2.01
P-3	2.01	2.01	2.01
P-4	0	0	0
P-6	2.01	2.01	2.01
P-7	0	0	0
P-8	5.31	5.31	2.01
P-9	5.31	5.31	2.01
P-10	1.33	0.5	0.5
P-11	3.4	3.4	3.4
P-12	3.98	3.98	2.55
P-13	3.4	3.4	3.4
P-14	2.65	2.65	2.65
P-15	2.65	2.65	2.65
P-16	2.65	2.65	2.65
P-17	2.65	2.65	2.65
P-18	2.65	2.65	2.65

P-19	0	0	0
P-20	2.65	2.65	2.65
P-21	2.65	2.65	2.65
P-22	0	0	0
P-23	3.4	3.4	3.4
P-24	0	0	0
P-1A	0.37	2.01	2.01
P-1	2.01	2.01	2.01

Table 2 velocity in m/s for CI pipe

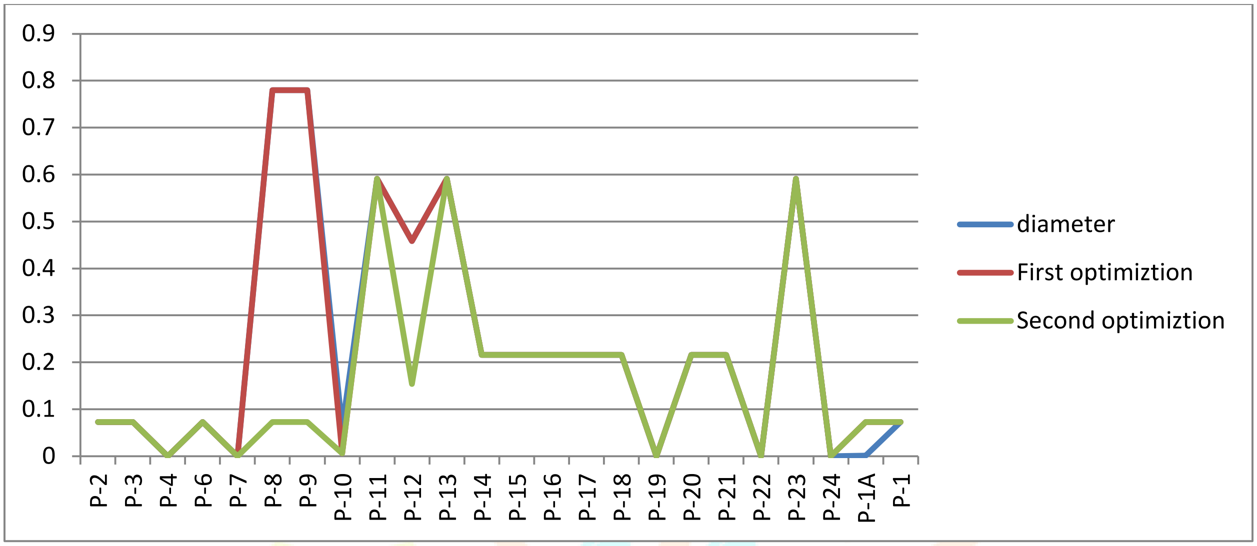


Graph No.2 Velocity in m/s for optimized system for CI pipe

node	diameter	First Optimization	Second Optimization
P-2	0.073	0.073	0.073
P-3	0.073	0.073	0.073
P-4	0	0	0
P-6	0.073	0.073	0.073
P-7	0	0	0
P-8	0.78	0.78	0.073
P-9	0.78	0.78	0.073
P-10	0.06	0.006	0.006
P-11	0.591	0.591	0.591
P-12	0.458	0.458	0.154
P-13	0.591	0.591	0.591
P-14	0.216	0.216	0.216
P-15	0.216	0.216	0.216
P-16	0.216	0.216	0.216
P-17	0.216	0.216	0.216
P-18	0.216	0.216	0.216
P-19	0	0	0
P-20	0.216	0.216	0.216
P-21	0.216	0.216	0.216
P-22	0	0	0

P-23	0.591	0.591	0.591
P-24	0	0	0
P-1A	0.001	0.073	0.073
P-1	0.073	0.073	0.073

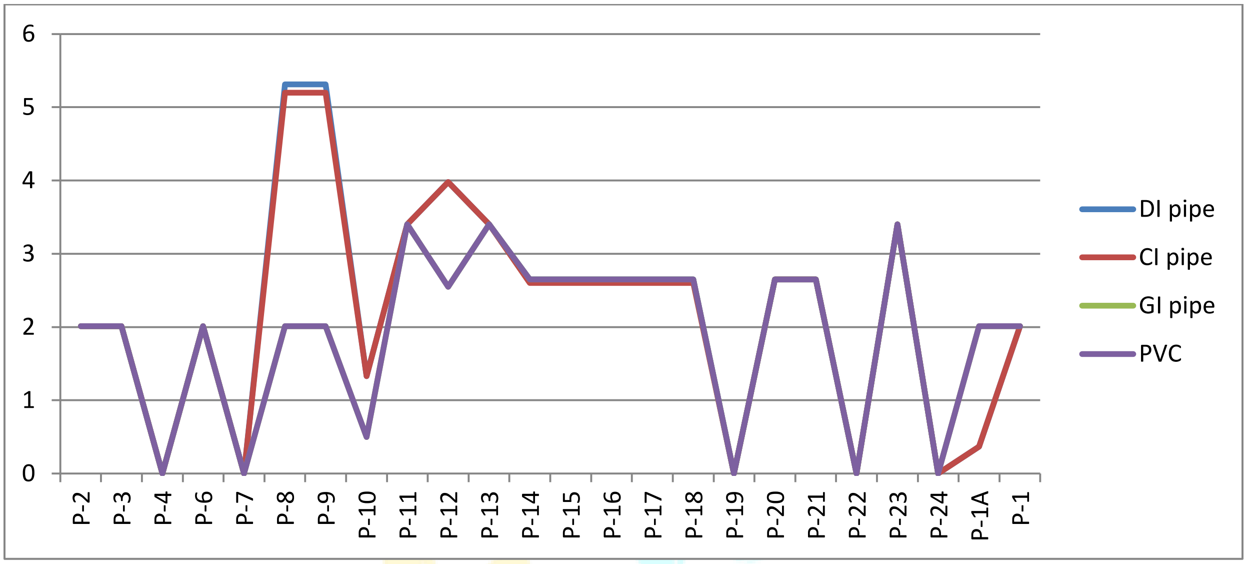
Table 3 Major losses in m/m for CI pipes



Graph No.3 Major Losses in m/m for CI pipe

Velocity variation				
Node	DI pipe	CI pipe	GI pipe	PVC
P-2	2.01	2.01	2.01	2.01
P-3	2.01	2.01	2.01	2.01
P-4	0	0	0	0
P-6	2.01	2.01	2.01	2.01
P-7	0	0	0	0
P-8	5.31	5.2	2.01	2.01
P-9	5.31	5.2	2.01	2.01
P-10	1.33	1.33	0.5	0.5
P-11	3.4	3.4	3.4	3.4
P-12	3.98	3.98	2.55	2.55
P-13	3.4	3.4	3.4	3.4
P-14	2.65	2.6	2.65	2.65
P-15	2.65	2.6	2.65	2.65
P-16	2.65	2.6	2.65	2.65
P-17	2.65	2.6	2.65	2.65
P-18	2.65	2.6	2.65	2.65
P-19	0	0	0	0
P-20	2.65	2.65	2.65	2.65
P-21	2.65	2.65	2.65	2.65
P-22	0	0	0	0
P-23	3.4	3.4	3.4	3.4
P-24	0	0	0	0
P-1A	0.37	0.37	2.01	2.01
P-1	2.01	2.01	2.01	2.01

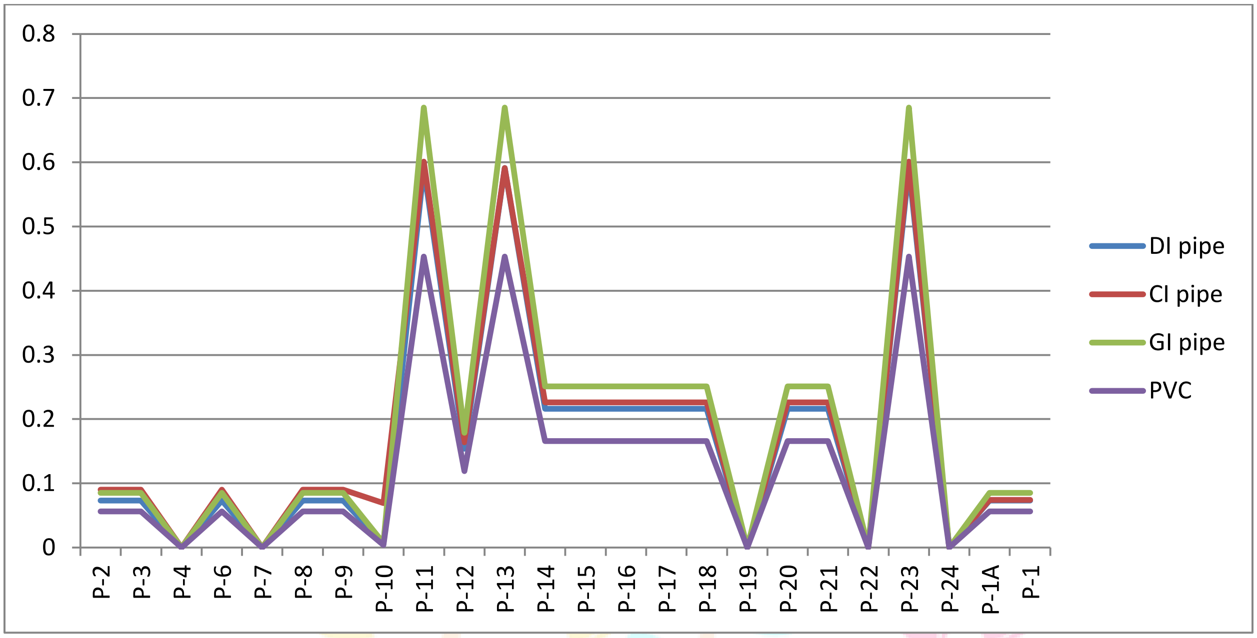
Table 4 velocity for DI, CI, GI, PVC pipes



Graph No.4 Comparison in velocity for optimized system for different pipe material

major losses in pipes				
	DI pipe	CI pipe	GI pipe	PVC
P-2	0.073	0.09	0.085	0.056
P-3	0.073	0.09	0.085	0.056
P-4	0	0	0	0
P-6	0.073	0.09	0.085	0.056
P-7	0	0	0	0
P-8	0.073	0.09	0.085	0.056
P-9	0.073	0.09	0.085	0.056
P-10	0.006	0.069	0.007	0.004
P-11	0.591	0.601	0.685	0.453
P-12	0.154	0.164	0.179	0.119
P-13	0.591	0.591	0.685	0.453
P-14	0.216	0.226	0.251	0.166
P-15	0.216	0.226	0.251	0.166
P-16	0.216	0.226	0.251	0.166
P-17	0.216	0.226	0.251	0.166
P-18	0.216	0.226	0.251	0.166
P-19	0	0	0	0
P-20	0.216	0.226	0.251	0.166
P-21	0.216	0.226	0.251	0.166
P-22	0	0	0	0
P-23	0.591	0.601	0.685	0.453
P-24	0	0	0	0
P-1A	0.073	0.074	0.085	0.056
P-1	0.073	0.074	0.085	0.056

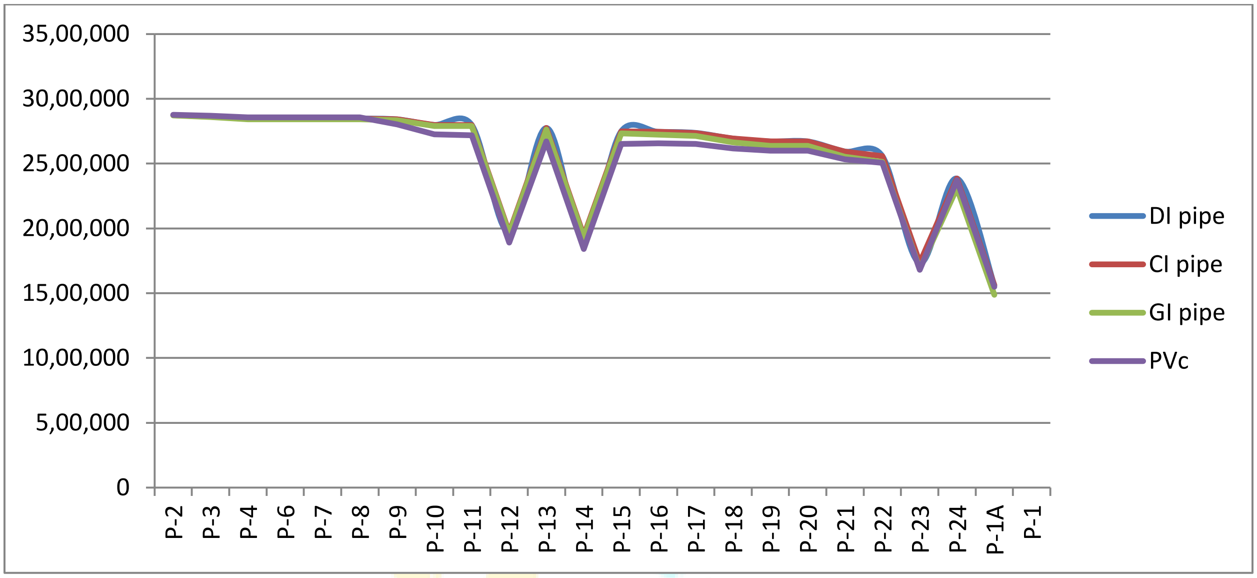
Table 5 Major losses in DI, CI, GI, PVC pipe



Graph No.5 Major losses in pipe m/m for different pipe material

		pressure in N/m2		
	DI pipe	CI pipe	GI pipe	PVC
P-2	2,873,135	2,873,135	2,872,118	2,877,327
P-3	2,862,443	2,862,443	2,859,718	2,869,125
P-4	2,847,375	2,847,375	2,842,241	2,857,564
P-6	2,847,375	2,847,375	2,842,241	2,857,564
P-7	2,847,160	2,847,160	2,841,992	2,857,399
P-8	2,847,160	2,847,160	2,841,992	2,857,399
P-9	2,840,451	2,840,451	2,834,210	2,802,618
P-10	2,797,892	2,797,892	2,790,872	2,725,097
P-11	2,797,116	2,797,116	2,789,972	2,718,759
P-12	1,965,744	1,965,744	1,957,353	1,889,205
P-13	2,774,007	2,774,007	2,763,170	2,670,761
P-14	1,941,478	1,941,478	1,929,209	1,840,320
P-15	2,747,351	2,747,351	2,732,254	2,650,311
P-16	2,744,414	2,744,414	2,722,825	2,656,828
P-17	2,736,375	2,736,375	2,713,501	2,650,660
P-18	2,692,373	2,692,373	2,662,467	2,616,901
P-19	2,670,372	2,670,372	2,636,949	2,600,022
P-20	2,670,372	2,670,372	2,636,949	2,600,022
P-21	2,592,499	2,592,499	2,552,653	2,531,505
P-22	2,557,593	2,557,593	2,512,169	2,504,726
P-23	1,734,029	1,734,029	1,688,605	1,681,162
P-24	2,384,097	2,384,097	2,310,949	2,371,617
P-1A	1,560,533	1,560,533	1,487,385	1,548,053
P-1				

Table 6 Pressure in N/m2 for DI, CI, GI, PVC pipes



Graph No.6 Pressure variation for different material

V. CONCLUSION

By the using software for the analysis of the distribution system it results in ease of selection of material for the distribution system which is shown by the graph. This will be helpful for the analysis of distribution system in future. Here graph shows the various optimized parameter with different material which could be complicated for manual analysis. This comparison also utilized for the economical alternative selection on the basis of material, Cost, Life of pipe, Water quality and various hydraulic parameters. Finally paper conclude that the Water Gems by Bentley will be helpful for the analysis and design of water distribution networks for simple as well as complex network

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