Optimal Design of Regional Rural Water Supply Scheme From Pandhari Reservoir For 35 Villages

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Abstract- *Water transmission network is used to convey the water from supply reservoir at water treatment plant to receiving reservoirs..The primary objective of the water transmission scheme's design is to enhance cost-efficiency and performance. The central emphasis of this project lies in achieving an optimal design and cost for the water transmission network, particularly involving a gravity system. The pursuit of an optimal solution for the water transmission system has been a significant focus over the past few decades. .. The search for determining the decision factors, such as pipe diameter and pipe cost, is considered to be a non-linear optimization issue for the water transmission system. In this project, flow path algorithm has been adopted to obtain the optimal design of the basic unit of water transmission system involving gravity i.e. upto six reservoir systems. The effect of frictional losses on the optimal design of water transmission system has been considered in this work. In this project, case study is carried out for optimal design of regional rural water supply scheme from Pandhari reservoir for 35 villages. Diameter of pipeline under different zones are designed and capitalised cost is also calculated.*

Keywords- Water Transmission, Construction, design analysis, reservoir, pipes, pipelines.

I. INTRODUCTION

The watershed region was thoroughly surveyed by the current Groundwater Survey Department in 1990 and 1998. Their analysis indicates that the annual recharge of groundwater is 5546.39 ha-m, whereas the groundwater usage is calculated to be 5847.66 ha-m. This shows that the yearly groundwater use is higher than the yearly groundwater recharge in the area and because of this, the bore wells and open wells have become dry. GSDA declared 48870 ha of land in Warud Taluka as dark watershed. It is suggested that the Shakti River dam be built in order to satisfy the region's severe water scarcity and the growing need for agriculture. The transport of water from Pandhari Dam to 35 village takes place through water transmission pipelines. The pressure is created either through gravity. The water is channeled from the source, such as a reservoir, to water treatment plants and then usually pumped into service reservoirs and distributed to 35 villages of Warud Taluka. For water transmission pipelines, concrete pipes, ductile iron pipes, steel pipes are usually used. For pipelines in smaller dimensions plastic pipes may be used.The optimal design of a regional rural water supply scheme is a critical undertaking for ensuring sustainable and equitable access to clean water in rural areas. This project focuses on developing a comprehensive water supply system utilizing the Pandhari Reservoir to serve 35 villages. By leveraging advanced engineering techniques and strategic planning, the design aims to address the diverse water needs of these communities, enhancing both quality of life and economic development. The scheme will involve meticulous analysis of water resource availability, infrastructure requirements, and distribution logistics, ensuring that the system is both efficient and resilient. This initiative not only seeks to improve water accessibility but also to foster long-term sustainability and self-sufficiency in the region.

Hardy Cross method is most commonly used method for analysis of water transmission networks and was originally intended to use for manual calculations but it requires considerable amount of time to arrive at a desired solution.The design and construction of water transmission system involves huge cost. Therefore, it is necessary to develop a simple analytical procedure for the optimal design of water transmission system. The Lagrangian Multiplier method and Hazen-Williams equation 4 have been adopted in this project work: Transmission network of Amravati is open end system so the flows in the pipes can be found out by applying node flow equation at each node The system was then designed so as to satisfy the nodal head conditions.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The design of transmission mains is carried out using the master plan and the zoning proposed therein as a guide. The designer has a better idea of the spatial and temporal distribution of demand, routes along which the pipes will be actually laid and the field data regarding different lengths and levels; since the pipe sizes are large, fire flows are actually satisfied. However, the effect of the outage of an element during peak flow must be considered. The design and analysis go hand in hand. Generally, a water transmission system is

designed such that it satisfies all the constraints. The diameter of pipes is then rounded off to the next higher available diameter. The analysis of the system after rounding off of diameter is carried out to check whether it is able to carry the design flow. Therefore, the literature review pertains to the analysis as well as the design of water transmission system as well as water distribution system. The literature has been referred from various journals, books and internet. The main objective of the literature review is to explore the related studies on the optimization of water transmission system.

1. To gather information on the water transport system.
2. To compile the network's pipe and junction reports;
3. To comprehend the modeling and analysis of the hydraulic network in flow.
4. To examine the network's pressure head and discharge;
5. To evaluate Warud Taluka

Pipes for Water Transmission System's current water transmission network: The following are pipes that are frequently seen in water transport systems:

1. Steel pipes;
2. Concrete pipes;
3. Polythene, PVC, or plastic pipes; and
4. Cast iron (CI) pipes.

III. WRITEDOWNYOURSTUDIESAND FINDINGS

The cost of a water transmission pipeline's component parts is necessary for optimal design. The cost structure for the water transmission system's component parts has to be looked at in order to build an objective function based on the overall cost of the water transmission system. Pipes and accessories are the main parts of a water transfer system. The main parts that account for a sizable amount of the total cost of the water transmission system are the pipes and accessories.

The current schedule rates (CSR) can be used to determine the cost of pipe. Excel curve fitting may be used to derive the cost function in power form. For a particular pipe diameter, the cost of the pipe may be found using the cost function.

Mathematical Model :

For the purpose of validation of the analytical model, the optimal design will be carried out using the mathematical model based on the dynamic programming approach. The initial solution is the optimal design obtained using analytical model. The option for diameter of each pipe for the main line i.e. for pipes 1, 2, 3 etc. will be taken between 3 to 5 depending on the head constraint at reservoirs and junctions. The dynamic programming approach will be used to find 3 to 5 options for each pipe on the mainline. The mathematical model can be used for the optimal design of water transmission pipelines using the following procedure:

Design Procedure : The design of a water transmission pipeline using mathematical model can be accomplished in the five major steps as follows:

1. Determination of diameter of main pipe;
2. Determination of diameters of branch pipes and rounding off of the diameters to the next higher available diameter;
3. Computation of the head loss and junction head;
4. Generation of different design using various options of diameter at each stage: and
5. Determination of the optimal cost of water transmission system. 55

The cost parameters for the major Component of water transmission system such as pipes and its accessories were obtained using cost data obtained from field. The diameter equation for three reservoir, four reservoir and five reservoir system were developed. The design procedures for three reservoir and four reservoir WTS were developed to obtain the optimal design of Water Transmission system using flow path algorithm so that the various constraints could be satisfied and the calculations could be performed easily in excel sheets.

IV. CONCLUSION

Optimal design of water transmission system involves determination of diameter from various flow paths so as to obtain the least cost design along with the satisfaction of various constraints. Values of junction heads and the diameters of various pipes are calculated using Darcy-weisbach equation. The cost equation is obtained in power form using curve fitting using excel. The cost equation can be used to obtain cost of pipes easily for a given diameter. The cost of the line and thereby the cost of system can be obtained using power cost function. In this dissertation, analytical design procedure has been developed to obtain the optimal design of water transmission pipelines. In this dissertation, a simple design procedure has been developed to obtain the optimal design water transmission pipelines. The design procedure developed has been applied for the optimal design of water transmission system containing three reservoir, four reservoir system, five reservoir and six reservoir system.

From the study of the optimal design of the water transmission systems carried out in this dissertation, the following conclusions can be drawn:

1. The cost function in power form can be used to obtain the cost of pipe.
2. The approach for the calculation of diameter for various flow paths and the selection of optimal diameter is very easy; and the procedure for the optimal design of water transmission system is also very simple.
3. The flow path algorithm, sometimes, gives the solution which is little suboptimal.
4. The method developed here is very easy.
5. The method gives design in a very less time.
6. The method converts the complex system into simple system by breaking down the water transmission networks in flow paths.

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