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Storage height optimization of Chamravattom regulator-cum-bridge, Kerala

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■ **ABSTRACT :** Water scarcity is an alarming problem that we face now-a-days. Even though we have abundant sources of water, good quality water is not available when most needed. There comes the relevance of water conservation structures. Allocation of water in case of multipurpose projects among various competing needs such as drinking water, irrigation, industrial demands, downstream release, pisciculture etc. is a matter of great concern. Hence reservoirs must be subjected to thorough analysis to see that each drop of water impounded is utilized in the best possible manner. So a study was undertaken for the proposed Regulator-Cum-Bridge (RCB) on Bharathapuzha River at Chamravattom in Malappuram district of Kerala, with the specific objective of determining the optimum storage height of the regulator. The storage height was optimized by considering the inflow and demands on the reservoir for 18 years data. The height was decided as six meters as it gave least deficit when compared to four and five meters.

■ **KEY WORDS :** Optimization, Storage height, Regulator-Cum-Bridge

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Water is a very scarce commodity which one cannot afford to waste. We have to make it sure that we do not fritter away a single drop of this immeasurable wealth, and use it for the best developmental purposes, for sustaining human life and culture. Agricultural sector has been playing a major role in the development of our country. Water is vital for agriculture.

Bharathapuzha River, the second longest river of the state (Kerala) takes its origin at an elevation of +1964 m above M.S.L. from Anamalai hills and flows through the districts of Coimbatore, Palakkad, Malappuram and Thrissur, and joins the Arabian Sea near the Ponnani town, where it is known as Ponnanipuzha. The length of the Bharathapuzha River is 209 km with a catchment area of 6186 sq. km. The catchment area spread over 11 taluks from the Western Ghats to the Arabian Sea. About 2/3rd of the drainage area of the basin *i.e.*, 4400 sq. km. lies in Kerala State and the balance in Tamil Nadu.

Reservoirs are the most important elements of complex water resources development system. They are used for spatial and temporal redistribution of water in quantity and quality and for enhancing the ability of water to generate hydro power. The most important characteristic of reservoir is its potential to cater to multipurpose demand. The multipurpose concept in reservoir system is a sound one and its use is increasing day by day due to the maximum use of a river valley in a unified and a co-ordinated manner and also in many cases, a mono- purpose reservoir project proves uneconomical. Therefore, the multipurpose concept has been found necessary in order to provide the much needed economic justification.

The main objectives while operating multipurpose reservoirs include the determination of optimum water storage for meeting drinking and irrigation purposes and also preventing the saline water intrusion. Hence the storage height becomes a critical deciding factor for which the reservoir operation plan has to be formulated properly. Irrigation consumes a huge quantity of water and quite naturally the major allocation from a reservoir system goes for irrigation. Hence, our aim should be to increase the effectiveness of every drop of water used for irrigation in terms of economy.

This study was undertaken to optimize the storage height of the regulator cum bridge (RCB) which was proposed at Chamravattom across Bharathapuzha envisages the construction of a Regulator-cum-bridge across Bharathapuzha at a place locally known as Chamravattom.

■ METHODOLOGY

The Bharathapuzha locally known as Ponnanipuzha joins the Arabian Sea at Ponnani. Thirunavaya, the historically important place for the only Brahma temple in South India which is situated on the right bank of this proposed RCB. The proposed site of project is about 6 km upstream of the confluence point of the river and sea. The latitude and longitude of proposed project site are 10º 51' North and 75º 57' East. As far as the catchment area is concerned, the average altitude varies from 1964 m in the east to 1m in the west. The gross catchment area is 6186 sq.km. The project area falls in the low land and sea board. The long and narrow stretch of sandy sea board is low and is in several parts liable to be flooded during the monsoon inundation. Topography of the area of the reservoir is fairly even without many undulations. No canal system is envisaged in the project as the ayacut area is to be fed by the already existing lift irrigation systems. The command area is quite suitable for irrigated agriculture.

Fig. A : Location map of proposed RCB and Bharathapuza River basin, Kerala

The area benefited due to proposed RCB falls in Ponnani and Tirur taluks in Malappuram district and Thalapilly taluk in Thrissur district. An ayacut of 9659 ha in Ponnani and Tirur taluks of Malappuram district will be very well benefited by proper irrigation and drinking water supplies. The bridge will be an important link between Ponnani and Tirur town reducing 20 km distance between Cochin and Kozhikode.

Reservoir operation plan:

The reservoir operation plan was prepared based on the obtained details about rainfall, evaporation, stage level, and water demand. The working table was prepared using 18 years data for every year starting from 1987 January till December 2004. The optimal storage height was decided based on these working tables. The tables for a water storage depth of 4, 5 and 6 m were prepared. It was assumed that on January 1, the reservoir is at full storage level. Then based on the inflow in to the reservoir and the demand, the water that will be remaining for the next day was calculated. Instead of finding water use for each day, a month is divided in to three segments each with ten days. Jan-01 means the first 10 days of January and so on.

Along the course of Bharathapuzha River, the site for the proposed regulator-cum-bridge comes after the RCB at Thrithala. When the stage levels were recorded (1987-2004), the RCB at Thrithala was not in an operating condition. Thus the stage level measured at Kuttipuram included the flow at Thrithala also. So in order to get the actual flow reaching the proposed RCB at Chamravattom, the stage level at Thrithala was deducted from that at Kuttipuram. The assumption was that if the Thrithala RCB is in working condition, then the flow coming at the Thrithala RCB will be stored fully. Hence the river inflow at proposed RCB is calculated by using following formula:

River inflow on each day = Stage level at Kuttipuram - Stage level at Thrithala

The surface area corresponding to various storage levels were determined by using the survey details of the site. Evaporation recorded in terms of depth was converted to volume terms. Then net total available water is calculated by using fallowing formula :

Net total available water = Initial storage + Inflow - Evaporation loss

Now the demand on the reservoir including the drinking water and the irrigation requirement were subtracted from the obtained net total availability of water. Then the deficit was determined if any. The remaining volume of water was taken as the initial storage of the next ten days. This was done for the whole year. The same procedure was repeated for 4, 5 and 6 meters of water storage heights of the proposed RCB for a period of 18 years from 1987 to 2004.

■ Results and Discussion

The mean monthly river inflow, Mean monthly net storage volume, Mean monthly net demand and Mean monthly deficit data of 18 years (1987 to 2004) was prepared and presented here in the following graphs. The mean of monthly river discharge reveals that maximum flow occurs during the month of August, followed by July and June. Minimum flow occurs during March, followed by April and February. The mean monthly maximum flow is 393.23 Mm^3 and the mean minimum flow is 20.83 Mm^3. About 90 per cent of the river flow occurs during June to December.

The reservoir operation plan was prepared for each year starting from 1987 to 2004. The data was worked out on the basis of calendar year. It was found that there is not much difference in the results when taken as water year and calendar year. Usually the Irrigation Department follows the calendar year.

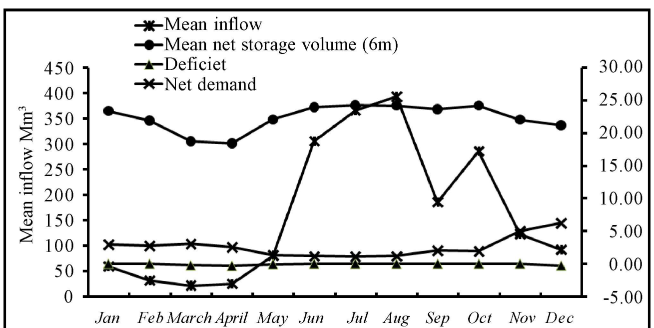

Fig. 1 : Mean monthly inflow vs. Mean monthly net storage volume, Mean monthly demand and Mean monthly deficit for 6 m of storage height

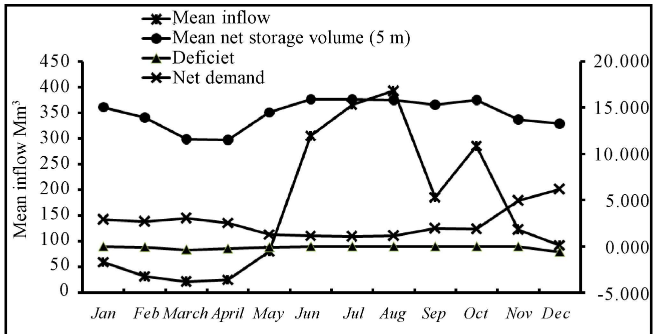

Fig. 2 : Mean monthly inflow vs. Mean monthly net storage volume, Mean monthly demand and Mean monthly deficit for 5 m of storage height

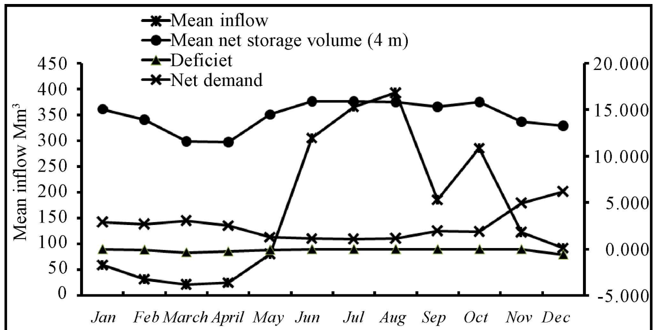

Fig. 3 : Mean monthly inflow vs. Mean monthly net storage volume, Mean monthly demand and Mean monthly deficit for 4 m of storage height

Since the regulator site lies at the mouth of an estuary, a large storage structure cannot be constructed. A small structure of storage height ranging from four to six metres is the only option. Thus the working plan was prepared for storage heights of 4 m, 5 m and 6 m. By analyzing the working schedule of 18 years, it was found that there was deficit during the months of February-May and November-December. The optimum storage level which gives minimum deficit should be selected. Therefore a shutter height of 4.0 m was decided, provided a dead storage of +2.00 m, thus optimized the net water storage height as 6 m.

Conclusion:

Water resources projects involving reservoirs are very expensive and interlinked with many social issues. Hence they must be subjected to thorough analysis to see that each drop of water impounded is utilized in the best possible manner and in a socially acceptable way. The construction and operation of a reservoir is justified only when it produces maximum net benefit. Keeping this idea in mind, a study was conducted to optimize storage height for the proposed regulator-cum-bridge at Chamravattom in Malappuram district of Kerala.

Based on the river inflow data the reservoir working schedule was prepared for 18 years starting from 1987 to 2004 for the storage heights of 4, 5 and 6 meters. The storage height was fixed as 6 meters as it gave the least deficit. The prepared working schedule and optimized storage height of RCB is submitted to the Irrigation Department and NABARD for the funding of the proposed RCB. Based on the recommendations of this study, the structure was constructed with optimized storage height of 6 m and was inaugurated in 2012.

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