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Assessing the Problems of Pumping Stations: A Case Study of Boneh Basht Pumping Station

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***Abstract*—**Establishing pumping stations is one of the most common ways of providing water from rivers. There are many issues involved in the design and operation of pumping stations most important of which is the problem of sedimentation. One of the significant issues which must be taken into consideration in designing pumping stations is the operation method and technical matters related to it. Safety and convenience of operation is one of the issues that must be always considered by the designer. Some of the major issues in making decisions regarding the type of design for the station are geographical condition, the location of the station and availability of experts in maintenance and operation of the station. Dimensions of the station must allow free movement for checking and operating pumps after installation of pumps and plumbing system.

***Keywords*—**Boneh Basht, Iran, pumping station.

I. Introduction

GENERALLY, gravity and pumping methods are used for drawing water from the rivers for various purposes. In different types of drawing water, the rush of sediments towards the mouth of the basin is one of the obstacles in the way of operating pumps. Although some designing standards based on performed studies have partly removed this obstacle, yet many pumping stations and basins are exposed to lateral erosion and their equipments are at risk of destruction and many others are faced with the problem of sedimentation and their suction intakes are rushed by sediments. Sediment control may be performed prior to or after pumping system. In designing the basin all required measures are taken in order to control river sediments. If basin installations are located in an inappropriate part of the river, a great portion of sediments may enter the basin and their evacuation will cost a lot [1]-[3] . Also, if the basin bottom is not at the right height above the river bed, a great deal of river bed sediments may enter the basin or during the arid seasons, drawing water may become impossible. Besides, prior to studying and designing basin installations, various installations such as conducting walls, etc. which are cheaper and simpler must be studied so that in the beginning sediments are prevented from entering the basin and, then, in order to remove the sediments from the intake, all kinds of controlling installations along the river or various basins for absorbing the sediments must be studied and recommended for construction.

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II. Material and Methods

The region being studied, the irrigation network of Boneh Basht, Behbahan, is one of the watering places of Kheir Abad River in Khoozestan province, Iran. Gross and net areas of Boneh Basht pressure irrigation networks are respectively 4248 and 3958 hectares. The water resource for the lands in this plan is the fresh water kheir Abbad River which crosses the south-eastern part of Behbahan. The above-mentioned river originates from the mountains which are located to the east of Behbahan.

The area of Kheir Abbad river basin is 3030 kilometers and its length is 80 kilometers. The average Debbie of Kheir Abbad river flow within the statistical period of 1955-2003 equals 25.14 m^3/sec. With regard to irrigation quality, river water is classified in the C3-S1 group. Thus, this water can be used to irrigate the region in all seasons. Due to the great difference between the lands and water level, water is pumped and transferred through transfer channels.

III. Basin Location

Basin location is the first and most important issue which has a significant role in removing the river sediments especially coarse sediments. Installation of the basin in the outer curve of the river results in entrance of less sediment into the basin. In this section of the river, the spiral flow drives the river bed sediments toward the inner curve. In other words, the curve creates centrifugal and centripetal forces. Centrifugal forces which are created due to the initial speed of the flow are not in equilibrium with the centripetal forces which are created due to the coarseness of the river bed. Therefore, these forces work in a way that in the upper part (above the center of gravity of the flow), due to the fast flow of the water, the water mass is driven towards the outer curve; and in the deeper parts of the river, due to the strength of centripetal forces, the water mass is driven towards the inner curve of the river bed. Since the density of sediments is higher closer to the river bed, therefore, the sediments are drawn towards the inner bed and clear water is drawn toward the outer part of the river. On the other hand, since, in the inner curve, the length of the flow course is shorter, the speed of the flow is reduced and sediments are deposited.

Another significant issue which must be taken into

consideration is that when a basin with an intermediary channel is constructed, even on a straight river course (for example, the basin of the Sebili pumping station on Dez river, Iran), if the front wall of the basin is not stabilized, after a while, on the basin side, gradually, in the course of river sedimentation and erosion occurs and it becomes more difficult to draw water.

Since basin works as Epi, below it the flow speed reduces and sediments of floating particles are diverted towards the mouth of the basin and, eventually, sedimentation becomes possible. According to laboratory experiments, it is better to draw water from the river at the height of 1.5 meters or more from the river bed. Some scientists believe that the minimum height for drawing water from rivers is 0.5 meter.

IV. Sediment control

Since providing agricultural, industrial, and drinking water is important, drawing water from rivers has been performed from ancient times which imposes a lot of expense for transferring water and also related installations including the basin, flow control structures, sediment control structures, canals. Therefore, for the basin installations to have a suitable efficiency we must prevent sediment from entering the installations or control it at the beginning of the basin and remove it from the basin structure. River sediments are of two types; coarse sediments which are on the river bed and the fine sediments which are suspended in the river and their density at the river bed is higher than at the surface of the water. And since sedimentation reduces the basin reservoir and its adjoining canal, both soft and coarse sediments must be removed from the basin and, besides, the cost of controlling and removing the sediment from the basin is considerable. Therefore, less expensive methods must be employed in which sediments are drawn back to the river out by their own weight and water flow and do not require human force to control the sediment. The other issue is the environmental control of the sediment. Whether controlled sediments should return to the river or be used properly so that they won't harm the environment.

Therefore, various methods have been developed with regard to the topography of the basin carriage region and the type of the created basin each of which has its own advantages and disadvantages.

V. Various methods of sediment control at basins

Generally, the aim is to prevent the sediment from entering the basin and, even if sediment enters the basin, to remove it from the basin at the beginning of the basin and return it back to the river or out of the basin. Therefore, one of the most important issues that in hydraulics engineering and design of irrigation plans we have to deal with is controlling the sediment which enters the civil, agricultural, and industrial irrigation channels. Since basins are normally less steep than the main river, the potential for sediment transfer is low and leads to sedimentation in the channel [4]-[6]. Generally, sediment control methods include:

- Sediment basins
- Diverting blades
- Separating the lower and upper water flow by a tunnel
- Washing gates
- Screens
- Stillness pools
- Sediment transfer channels
- Separating walls
- Elevated water base

Each of the abovementioned methods has its own advantages and disadvantages which must be chosen according to place and condition.

VI. Results

Paying attention to technical issues, observing proper designing principles, and employing skillful personnel in designing water structures leads to optimum exploitation of water installations such as pumping stations. Problems about drawing water and sedimentation at Boneh Basht pumping station are due to insufficient attention to the operation method and technical issues at the time of designing some of which will be discussed and logical solutions will be offered.

- The concrete surface and lower bulwark of the stability structure has been destroyed along much of its length and, at the moment, the stability structure (the concrete wall) functions as a vertical slope break and the erosion due to the downfall of the flow has initially led to the destruction of the surface and displacement of concrete blocks and, later, has eroded the river bed. This effect is expanding because a stillness pool has not been anticipated. With the increasing erosion rate, it is probable that the stability structure will collapse following several floods.
- Pumping station's water drawing spot and its related pool are located next to the main course of the river and this has made periodical inspection of hydro mechanical equipments difficult and also maintenance of these equipments has become problematic.
- Lack of anticipation of a discharge duct for the sediments of the deviational dam.
- The entrance of the suction pool in this station lacks a control gate.
- The necessity of the removal of sediments and its resulting economic burden.
- Corrosion of pump blades and blockage of valves and lack of ventilation in some of the suction pipes of the pump.
- Damage to the suction pipe especially valves which have caused an increase in the cost of operation and maintenance.
- Forced stoppage of water supply for the network due to abovementioned reasons.

- in the installations of the current dam, no facilities for the migration of aquatics animals has been anticipated.
- Excessive elevation of the suction pipes center from the water surface in suction pools.
- Unsatisfactory condition of the current electrical equipment.
- Lack of water transfer by two 800 millimeter pipelines uder the present circumstances.

VII. Conclusion

Numerous laboratory studies have been performed on the potential of various basins which shows that drawing water from the outer curve is suitable because the level of sediments in the outer curve is low. Besides, many studies have been performed on the appropriate angle for drawing water in order to correct the flow pattern, reduce turbulence, and prevent sediment from entering the basin. Principles of designing basins and pumping stations are almost clear but various rivers react differently to engineering structures and unexpected changes may occur. Therefore, how to construct these structures and how to operate them is an important issue which has been seldom discussed.

Below are some recommendations for solving the problems at Boneh Basht pumping station and its irrigation system:

- Breaking the floor of the pumping station.
- Increasing the height of the pool wall.
- Floating pumping station.
- Pump series.
- Pump series plus collector.
- Lowering the irrigation pumps.

In order to solve the problem of sedimentation, blade water break (Epi) is recommended as the better option for preventing sedimentation at Boneh Basht pumping station. And also installation of drawer valves is a simple and workable option which can have a higher efficiency especially during the flood season.

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