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"The Sidhnai Canal System."

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(*Abstract.*)

ABOUT 15 miles above its junction with the Chenab, the River Ravi flows for 8 miles in a nearly straight channel called the Sidhnai Reach, the width of which is 450 feet at the upper end, and about 1,200 feet at the lower end near the town of Serai Sidhu. The Sidhnai Canal head-works are about 3½ miles above this point, and the canal, which is on the left bank, flows nearly south-west for 37 miles, passing under the North Western Railway near Rashida, 21 miles from Multan. The surveys were made early in 1883, and the excavation was commenced in January 1884, the whole canal, Rajhahas and main water-courses being completed and in operation in June 1887. The area commanded by the Sidhnai Canal is 429 square miles, for which the calculated discharge is 1,072·5 cubic feet per second, at the rate of 2·5 cubic feet per square mile; this land, before the commencement of the works, was nearly all uncultivated. The main canal, where it leaves the Ravi, has a bed 80 feet wide, and is designed for a full supply of 6 feet depth of water, with a bed-slope of 1 in 8,000. The other main channels of the system are from 10 to 20 feet wide, according to the area commanded, and are from 4 to 5 feet deep, the bed-slopes being from 1 in 2,500 to 1 in 5,000.

On account of the small amount of water in the Ravi, at times when it is required for irrigation, it was found advisable to construct a dam, for which purpose the French needle system seemed best suited, and after some trouble from sudden floods this was completed in April 1885. A lock was subsequently provided on the same system to enable boats to pass up or down the river when the water was headed up.

The following details as to the working of the needle dam are given. The needles are made of deodar wood, and are 7 feet 6 inches long by 5 inches by 3½ inches, with a stout handle 18 inches long, ending in a knob; they weigh 36 lbs. dry

and 40 lbs. wet, and can be manipulated by one man. After placing the needles in position at first, they are forced up close together by a man standing on the pitching below the dam, who inserts a crowbar with a wedge-shaped end into the openings, causing the needles to slide along the face of the crest wall, any leakage between them being stopped in the following way. A basket, fixed to a bamboo about 10 feet long and filled with shavings or chopped straw, or some similar substance, is slipped down in front of the leak, so that the light material may be sucked by the current into the opening, which it effectually closes. It was not found that the shock of closing on the crest wall, when first placing the needles in position, ever caused them to break when the wood was sound.

When there is a great difference of level between the water above and below the dam, the rush of water through the interstices makes it very difficult for a man to stand on the pitching below and use a crowbar. This difficulty is overcome in the following way: a piece of tarpaulin or oiled canvas, 8 feet long and 6 broad, is fastened at one end to a wooden bar 6 feet 4 inches long, with handles at each extremity, and at the other end to a bar of round iron, 6 feet 4 inches long and 1 inch in diameter. It is then rolled upon the iron bar, and placed horizontally against the needles, above where the excessive leakage occurs, and the wooden bar, which remains on the outside of the roll, is either tied or held in position by the handles; the roll is then let go, and the weight of the iron bar causes it to unroll itself down the face of the needles, at once closing all the leaks. In order that the screen may be more easily recovered, a cord is attached to a loose collar at each end of the iron bar, and when the needles have been closed up, the screen is pulled up from the bottom by these cords.

For the purpose of regulating the height of water above the dam, it is sufficient in most cases to push some of the needles forward at the top, the water escaping through the open spaces left in this way; but should it be necessary to provide for a greater flow, a sufficient number of them are removed altogether; this can generally be done by hand, but if they have "jammed" from any cause, or if the pressure of the water against them is too great, they are lifted by means of a bent lever.

An eye-bolt is attached to each needle just below the handle; this serves as a fulcrum for the extracting lever, and also to fasten tackle to when the pressure is too great for the needles to be drawn forward by hand. It was found dangerous to work them from the beams, which are only 18 inches wide, and after

one life had been lost, and the Author himself had had a narrow escape, a foot-bridge was added to the dam. This foot-bridge consists of two flat-bottomed rails of 60 lbs. to the yard, 3 feet apart, with 3-inch planking between them, the rails being kept together by tie-bars, and fastened down to the piers at each end by 1-inch iron rods imbedded into the masonry. To lessen the upward shock of the waves during flood-time, the planking is perforated with a large number of 1-inch auger-holes. It is proposed to have two small trollies running on the rails of the foot-bridge, to facilitate the removal and carriage of the needles. The dam is 733 feet long, and the actual cost of it was Rs. 1,01,000, or £7,863 at the current rate of exchange, being about £10 7*s.* per lineal foot.

Arrangements have been made to send warnings by telegraph of any rise of 1 foot in the Ravi at Madhopur and Lahore during twenty-four hours. As floods take a minimum of five days from the former, and two days from the latter place to reach Sidhnai, these warnings have been of the greatest service.

The rules for working the dam, sanctioned by the Chief Engineer, are to the following effect:—

I. The level above the dam at which the water is to be kept by opening or removing needles, is fixed from time to time by the Executive Engineer, the usual height being 6·5 feet above the crest wall of the dam, *i.e.*, 1 foot below the top of the beams, giving 5·5 feet of water in the canal.

II. Anything above 12·5 feet at Bakrola, or 9 feet at Shadera, is to be considered a flood.

III. On a flood being telegraphed, the needles are to be removed one day before it can arrive, so as to reduce the depth of water above the dam to 6 inches above the full supply required in the canal at the time.

IV. As the river begins to rise on the approach of the flood, the needles are to be removed gradually.

V. As soon as the river begins to fall, the needles are to be replaced, so as to raise the water again to 6·5 feet, unless there is intimation of another flood coming, in which case only sufficient needles need be put in to raise the water 6 inches above the supply required in the canal at the time.

VI. When the surface of the river below the dam is at the height fixed in Rule I, all the needles are to be removed.

VII. If it should be necessary for training the river, or removing silt from in front of the canal-regulator and below the lock, to put in needles when the water below the dam is higher than stated in

Rule I, written instructions must be obtained from the Executive Engineer.

VIII. Care must be taken that the dam beldars (native labourers) shall regularly remove floating rubbish from against the needles; and during the flood season, the head-works subdivisional officer must inspect the dam at least once every day.

IX. To prevent deposits in front of the canal-regulator, and above and below the lock, the needles should be distributed so as to force a strong current on to those places; soundings are to be taken every three days along certain lines, and any serious accumulations reported to the Executive Engineer.

X. Soundings are to be taken weekly, and on the subsidence of each flood, along the line of crates at the toe of the pitching of the dam, and any serious scour is to be at once reported. Pitching-blocks should be thrown into the hole scoured out, if the depth continues to increase.

XI. The head-works subdivisional officer will be responsible for maintaining the supply in the canal to the officer in charge of the Sidhnai canal subdivision, and shall not raise the supply without written orders from him or from the Executive Engineer, but may lower the supply on receiving intelligence from any canal servant of an accident having occurred to a canal, or if the state of the head-works requires him to do so. In such cases, however, he is at once to report his reason for so doing to the Executive Engineer and the officer in charge of the Sidhnai canal subdivision.

The success of the scheme has been greater than was anticipated. In the Administration Report of the Canals in the Punjaub for the years 1889–90, it is stated that "the Sidhnai Canal shows a profit of 15·82 per cent., against 12·61 per cent. in 1888–89, and 13·84 per cent. in 1887–88; this canal maintains its character as a highly remunerative work."

The Paper is accompanied by a map and sixteen plates, which have been published in the "Selections from the Records of the Government of India, Public Works Department," No. ccxlviii.