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RECONDITIONING OF MARALA WEIR

COX AND GANPAT RAI

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By

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Marala weir consists of 8 bays of 500' each with undersluices on the left flank where upper Chenab Canal takes off. The weir was built on sand foundation like similar wide shuttered weirs at Khanki and Rasul, which failed most probably because of piping. This weir is very important because on it depends the water supply to the upper Chenab and Lower Bari Doab canals, the combined net annual revenues from which are about Rs. 1 crore. Therefore its likely failure as per experience of Khanki and Rasul weirs had to be avoided.

Construction of Marala weir started in the end of 1908 and was completed in May 1910. It was designed for a maximum head across of 10, and has three well lines, that is on upstream end of impervious floor (A), half-way down the downstream glacis (B), and at the downstream end of impervious floor (C). Total length of work was 320', out of which impervious floor was 140' and the upstream and downstream base protection 70' and 110' respectively. The hydraulic gradient was 1 in 14 as against 1 in 15 recommended by Bligh. Glacis between B and C line of wells was semipervious. This form of construction was probably adopted to relieve any residual pressure without blowing sand. At the same time, glacis was required to be strong enough to stand upto the dynamic action of water. The structure met more of these design requirements.

Marala weir was also facing problems right from the time of its construction. During the dismantling of the downstream glacis, gaps upto 1' in width were found between the two well lines and the wooden piling. In the glacis above the second line of wells, the bottom layer of

masonry had been laid dry and a weak grout of lime surkhi and sand had been poured over it which did not completely fill the joints between the stone. This was quite evident from the examination during dismantling. The state of these open joints showed that water had been flowing freely through them over the sand below.

In order to keep down the upstream water level and facilitate pumping and subsequent diversion of the river, the glacis in bays 1 to 6 was first built to a reduced section, the crest being kept at R.L 797.5 i.e., 2.5' below the final crest. Later in 1909, while raising the reduced section to full height, existence of transverse cracks in bay No. 3 were noticed. The rubble masonry has also settled 2" to 3" in some places below the crest. The weir was first put into commission in April 1912 and the following October, after a monsoon of moderate floods, the glacis was found to be full of cracks and springs. In the following year fresh cracks and springs appeared and in 1917 after a flood of 550,000 cusecs the stone on edge course (Kharwanga) in bay 6 was found to be uplifted. An area 90 x 15 above B line of wells had bulged. In subsequent years this bulging occurred almost all over the glacis between the crest and the C line of wells. In the record flood of 6,86,000 cusecs on 1.9.1928 and another of 66,000 cusecs the following year on 29.8.29, a good deal of damage was done below the weir.

A detailed examination of weir in October 1934 showed that the condition of weir was far from satisfactory. Model experiments were carried out in the Hydraulic Laboratory Lahore, with the following assumptions (i) The well lines were leaking (ii) the top 1.5 of sand below the wire was coarse (iii) there was a hollow between the Kharwanga and the loose stone below between the B and C lines. Of these (i) and (iii) were subsequently found to be correct. Pressure pipes were installed in the weir and observations were made on a number of occasions. These observations showed that there was either no drop from the crest to B line or that its extent was negligible, and that in bay 2 the drop between the B and C line was small and there was residual pressure of 26% above the third line. It appeared from the results that there were cavities under the floor in many bays. This combined with the high residual pressure above C line and the fact (which was verified during the dismantling of the weir floor in bay 8) that some of the wells in this line were only 4 to 5 feet deep led to the conclusion that the weir was in serious danger.

From the above discussion it is clear that weir was designed on wrong principles due to insufficient knowledge of hydraulics. One bay partially subsided under no head during construction, and since the weir has been brought into operation, it had been maintained intact only at considerable expenses. The whole of the impervious section from the crest to B line was full of cracks and open points through which springs were working. The pressure pipe observations gave every indication that cavities existed below. Below B line which had to stand the pounding action of the standing wave, the glacis was too thick and cavities existed along it almost from end to end.

The main defects in the Marala weir were the flat slope of the downstream glacis and the comparatively high level at which the downstream loose protection was laid. To remedy these defects it was decided to dismantle the existing glacis from a few feet below the crest and rebuild it to a new design so as to give a depth in high flood greater than at Khanki.

The work of reconditioning was to be completed in a single season by early March. Besides the problem of unwatering, winter freshets posed another problem. Another consideration was that not only Upper Chenab Canal should run but some water would have to be escaped below the weir for Khanki. After considering various proposals, it was decided to start work from the left flank of the weir and proceed towards the right. Left flank is subject to direct attack of floods from Jammu Tawi. The more difficult part of the work would thus be taken up and completed earlier before frequent freshets which occur after mid-December. The work consisted principally of the following items :

- (i) Driving 14' deep continuous line of sheet piles above the C line of wells.
- (ii) Replacement of the semi-pervious sloping floor between the B and C lines of wells by a horizontal concrete floor 4 feet thick, the new floor being depressed 4 feet below the original level.

- (iii) Reconstruction of the glacis above B line to a slope 1 in 4 until it met the old glacis about 11 ft below the downstream edge of the crest
- (iv) Lowering of block and loose stone protection below C line by 4 feet and
- (v) Provision of two rows of raised and staggered blocks of size 5' x 2' x 2' on the horizontal floor between B and C lines of wells and three rows of such blocks downstream of C line.
- (vi) Grouting of upstream glacis to increase water tightness.

The procedure followed in carrying out the works was that after the ring bunds, up and downstream had been linked and sufficiently strengthened pumping was started followed by dismantling of the weir floor, excavation of the foundations, pile driving, concreting and stone masonry. Work was done in three stages. Bays 1, 2 and part of 3 were taken up first, the remainder of bay 3, bay 4 and part of bay 5 next, and the remainder of bay 5 and bays 6,7 and 8 last of all. In the construction of ring bunds it was kept in view that the bunds should be strong enough to enable the work to go on under reasonable safety, the bunds in the part of the weir to be next enclosed should be started well in time and that at all times sufficient escape capacity should be available over the weir and through the undersluices for the passing of freshets.

Main pumping units installed for dewatering consisted of centrifugal pumps of 10" to 14" size with portable steam engines. For local pumping, Petter crude oil pumping sets or electric sets were used in open sumps or tubewells., The type of piling generally used was Ransome uniform D but where it was necessary to drive piles through stone, the type known as "Universal" was used. For lowering of block area and stone apron, old concrete blocks weighing 3 to 3.5 tons each were to be removed and relaid. Two old dragline excavators working on caterpillar wheels were used for this purpose. Major plant and machinery was collected from within the department. Advantage was taken of the work of reconditioning of the weir to put in a number of observation pipes under the floor of the weir. Due to non occurrence of

high flood so far, position of standing wave after reconditioning has not been ascertained.

The work was started in end September 1936 and was completed by end March 1937. The sanctioned cost of work was Rs. 15.5 lac. The final expenditure is not yet available. The methodology adopted ensured that a work which would have normally taken two seasons to finish was satisfactorily completed in one season within the project estimate, resulting in a saving of 3 to 4 lac of rupees.

Note :

Paper No.215 appears at pages 153 to 195 of the Proceedings of Punjab Engineering Congress 1938, Vol. XXVI. It has 15 Plates. Discussions are recorded at page 195a to 195s.