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Some post-war works of the Thames Conservancy†

by

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and

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Discussion

The Chairman (Mr H. J. B. Harding) observed that prestressed piles had been driven with a 4-ton hammer. He knew of a case recently in which they had been driven by a 1-ton hammer and had cracked because the hammer was too light. The makers said that they would remedy this defect by autogenous healing.

60. He had one minor criticism of the Paper. No section drawing should be considered complete unless it showed the nature of the ground in which the structure was built. The cross-sections in the Paper would have been more valuable had they indicated the strata and their levels.

Mr W. E. Doran (Chief Engineer, Great Ouse River Board) remarked that there were thirty-seven small gates at Chertsey Weir. Had the intention been to obtain a light gate which was very easy to work and to control the discharge in thirty-seven steps? Or was there some connexion with the placing of the gangway, built in 1951, which had supports at 15-ft centres? Economically it would seem better to have a gate of 21-ft span rather than three of 7 ft. He believed that Colonel Bowen had used light aluminium-alloy gates on the Thames. For small gates such as those at Chertsey the aluminium-alloy gate had several advantages, principally from the point of view of maintenance.

62. In Fig. 2 the head across the weir was not given, but it seemed to be quite small, the height of the gate being only 2 ft 10 in. There did not appear to be much depth of water over the apron. Was there any danger of a standing wave getting off the apron and causing trouble? Comparison of the two systems of lock construction was interesting. One built in concrete sheet-piling and the other in steel. What were the relative merits of those two forms of construction? There were obvious advantages in using concrete but also obvious disadvantages from the point of view of driving, because the concrete sheet-piles were difficult to drive and to keep in line. There was no key between adjacent piles, and it would have been easier to keep them in line if some form of guide or keying had been provided.

63. The Authors had evidently experienced some difficulty in keeping the piles in line, and also some difficulty with creep. Some years before Mr Doran had used pre-stressed concrete piles for the construction of a new wall in Cambridge, in front of an old one which had collapsed. He had used piles with grooves on both faces alternately with piles having ribs on both faces. Although theoretically ideal for the purpose, the piles, which were 25–30 ft long, had not been made truly straight; the result was that the tolerance allowed between rib and groove had proved to be insufficient. There was clearly a need to establish a standard form of pile which was the most suitable compromise between providing guiding keyways and allowing sufficient tolerance for the imperfections in manufacturing concrete piles.

† Proc. Instn civ. Engrs, vol. 14, p. 255 (Nov. 1959).

64. In any future job he would provide a greater tolerance to allow for the irregularities in precast piles. Apart from that, having some guide was a great advantage and where 12-in. piles were used there was room to provide a guide without danger of the projection spalling off.

65. The Authors' piles apparently had no lead on the bottom; they were straight on the bottom and had no shoe. It was always difficult to decide how much lead, if any, should be given.

66. Mr Doran agreed that considerable economy was achieved in installing the tie-rods by boring beneath the existing cottage.

Mr J. I. Taylor (Engineer to Kent River Board) observed that on the Chertsey Weir there seemed to be no sluices for drawing down the upstream pen level below the depth of 2 ft 6 in. held by the radial gates. Was not this rather a serious drawback in carrying out repairs, or even in inspecting the channel upstream?

68. In §§ 7 and 13 the collapse of the upper portion of the weir was attributed to the fact that it had had to take the whole flow, but it must surely have taken a much greater flow many times in the past and no greater head had been put upon it in the short period between the driving of the cofferdam and the collapse of the weir. Was not it just bad luck that it had collapsed at the very moment the job started? It might have collapsed at that time in any case. The simplicity of the radial gates was very interesting, especially the counterbalancing, and lifting by a simple chain. Had any trouble been experienced with stiffness in lifting or lowering the gates? Fig. 6 showed water spilling over the gates; was that accidental or intentional?

69. With regard to Old Windsor Lock, Fig. 9 might explain part of the cause of the trouble in keeping the piles in line when driving. When using similar sheet-piles he had driven steel tubes to fill the semicircular indentation. He had driven one steel tube with the first pile to form a tongue for the next pile to be married with, and had experienced no trouble in keeping the piles in line. Also, his pile shoes had leads. Would the Authors comment on this?

70. Why were the lock gates sheeted right up to lock side level, 7 ft above M.H.W.S.? Was it to keep the flood water out of the lock? Possibly the lock sides were above the highest flood level, that was not the case with some of Mr Taylor's locks, which sometimes went under water by 10 ft or more. He noted that the Old Windsor Lock gates were sheeted with redwood, whereas on Cookham Lock, constructed later, deal had been used. Had there been any special reasons for the change? Would the Authors give figures for the flood flow at Chertsey Weir, and say what sort of fall there was under that condition?

Mr J. D. Perret (Senior Engineer, Frederick S. Snow & Partners, Consulting Engineers) noted that at Old Windsor Lock prestressed concrete sheet-piles had finally been selected because of the shortage of steel at the time. Was that the only reason for the choice, and would the Authors use it again on future projects?

72. The Thames Conservancy and its predecessors had been concerned with river works for hundreds of years, and in the recent replacement of old structures the Authors must often have formed opinions about the expected life of various types of timber which had been used. Could the Authors give any guidance on the expected life of the various timbers used in river waters?

73. For the sheeting of lock gates certain laminated plastics might be better than either aluminium or timber, and for some of the bearings of those gates which were permanently under water various plastics might be employed. They were long-lasting and reliable and had an extremely low coefficient of friction. Had such materials been considered or was it felt that, on works which were going to be hidden for a very long time after construction, it would be better to rely on materials which had stood the test of time?

Mr N. Jackaman (Managing Director, A. Jackaman & Sons Ltd), whose firm had constructed the Old Windsor Lock, said that the principal difficulty in driving prestressed concrete piles, namely, that they tended to snake round the gate, was in his experience inherent in such piles. At the Old Windsor Lock one factor which had aggravated this difficulty was that the timber sheeting had rotted away, and it had been found afterwards that considerable cavities had been caused by erosion under the main mass wall, so that when the heavy piles were driven they naturally took the line of least resistance and ran forward, or tended to do so, towards the cavities. That had been a very real factor in the difficulty in driving the piles accurately, to which the Author referred.

75. Another interesting feature about the job had been the tying back of the tail dam. That had been very satisfactory and had held very well. There had been no trouble, and in retrospect he was sorry that they had not done the same at the head. There they had strutted against the old structure, and on one occasion, when the water had been very high that winter, there had been movement on the old structure which had caused them considerable trouble. Having freedom at the tail end to construct the dam had been of very great use to them in doing the new work. At the tail end there had been nothing to strut against unless they had used very long struts, which would have been an encumbrance in constructing the new wall.

The Chairman called Mr Jackaman's attention to the Authors' statement in § 27 that: "The contract drawings provided for head and tail dams of steel sheet-piling to keep out the water, but they did not provide for a cofferdam round the whole site. . . . The contractors asked to be allowed to surround the whole site with a steel-piled cofferdam. . . . This modification was accepted and, in view of the amount of pumping that proved necessary, the Authors accept that the contractors were right in their request." He invited Mr Jackaman to give further information about that. In the same paragraph the Authors had said that they had expected that no great quantity of water would be encountered, and that grouting the recesses between the concrete sheet-piles would be sufficient to keep the site reasonably dry. What difficulties had been encountered in grouting those recesses and precisely where had the lock been surrounded by steel piling?

Mr Jackaman replied that, as the Authors had stated, it had been at the request of his firm that the whole site had been put in a box dam. It had not been shown on the drawings, probably because it had been provided after the contract drawings had been prepared. The work had been done some time ago, but his recollection was, looking at the tail dam and the head dam, that it splayed out to 120° for a short distance, perhaps 10 ft, and went just in front of the anchor block which held the tie-bars from the main prestressed piles on the one side. On the other side it was directly in front of the lock-keeper's cottage, so that, looking at Fig. 8, the dam on the lower side was some way back, but on the upper side it was comparatively close, because it had been necessary to keep some distance away from the lock-keeper's cottage. They had asked for this dam because of their knowledge of work in that stretch of the river; they knew that the water level was high and in their opinion they would have, without a box dam, the greatest difficulty in pumping the water level down. The pumps had been situated immediately inside the tail dam, where there was an open area, virtually on the centre-line. The box had been elevated above flood level. They had had two 8-in. pumps, and when excavating they had had to work almost continuously to keep the water level down.

78. For the grouting of the recesses they had poured in very stiff grout and rammed it down with a long rod.

Mr D. A. Brown (Senior Engineer, Sir Murdoch MacDonald & Partners), referring to Fig. 4, asked what were the head- and tail-water levels and the ground levels upstream and downstream of the piling at Chertsey Weir. Since the weir was on a permeable foundation, was there any filter at the downstream side?

80. Regarding the lock, he noted that provision had been made for stoplogs. Presumably they were intended to be inserted in still water. Anyone who had had anything to do with handling stoplogs in running water would realize how difficult it was. Had consideration been given to the use of a horizontal support beam with vertical needles?

Mr R. C. S. Walters (Partner, Herbert Lapworth Partners, Consulting Engineers) observed that locks had been constructed near weirs and asked if they were good points for gauging the river and if, in fact, the river was gauged at these points. Were the gauges incorporated in any way with lock buildings? Cavities had been found underneath the locks; were there similar cavities underneath the weirs?

Mr J. B. Pot (General Manager, The Britannia Dredging Co. Ltd) remarked that in Dutch practice the toes of reinforced concrete sheet-piles would be provided with a lead to ensure the piles "closing up".

83. It would be cheaper to make the grooves triangular instead of semicircular.

Mr S. R. Banks (General Engineering Division, Aluminium Laboratories Ltd) asked if the gear on the old locks, which had lasted for about 100 years, had been mechanical to anything like the extent that the new gear was, and what would be the relative costs of the two kinds of gear over 100 years, taking into account inspections and maintenance.

85. Referring to the up-and-over type of gates, Mr Banks assumed that the side which took the water head was not the side on which the gate tilted back; when the gate was lowered into moving water was there any trouble with vibration?

Mr Robert Freer (Assistant Engineer, Sir Alexander Gibb and Partners, Consulting Engineers) asked about the financial justification for the work. Was there an obligation to control river levels in order to protect the area downstream of the weir? What traffic was there through the new locks, to what extent would it pay for them, and was the traffic expected to increase?

Mr M. J. Kenn (Lecturer in Fluid Mechanics, King's College, London) asked to what extent the Thames Conservancy used hydraulic models for designing and calibrating their river-controlling structures. Would the Authors comment on the agreement found between their models and the full-size structures?

Mr H. H. Miles (Peter Lind & Co. Ltd, Contractors) drew attention to the statement in § 29 that "The accurate driving of the concrete sheet-piling presented the contractor with some difficulty to start with", and asked for some description of these difficulties. In particular, what was the accuracy called for in line and level in the specification, and what had been the accuracy achieved? Accuracy was essential, since a great deal of the piling was exposed.

89. In Table 1 costs were given for direct labour and for contract, and it appeared that costs were very much the same on the basis of, for example, a square yard of lock area. Did the direct labour costs include all the on-costs?

Mr D. H. Hughes (Senior Engineer, Messrs J. D. and D. M. Watson, Consulting Engineers) pointed out that the dimensions given in Table 1 showed that the lock at Old Windsor was 24 ft 2 in. wide, and that at Cookham was 25 ft wide. What was the explanation of that difference, and why was there also a difference in the length?

Mr W. E. Foster, in reply to Mr Doran, explained that a number of small gates had been installed at Chertsey to avoid mechanical means of raising. It had therefore been necessary to keep the gates down to a weight that would enable them to be operated by
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the central hand chain and easily counterbalanced without very cumbersome counter-balance weights.

92. Mr Doran had also referred to the use of aluminium alloy. That had been employed on some of the tributaries to the Thames but had not been used at Chertsey. A question of economics was involved. When they first used aluminium alloy there had been rather a slump in the aluminium industry, which had been looking for new outlets for its material; the steel position had been difficult and aluminium alloy had certain advantages. By the time that Chertsey Weir had been dealt with those economic conditions had changed, steel had been much more easily obtainable and had therefore been used.

93. Replying to Mr Taylor, Mr Foster pointed out that many radial gates were in use on the Thames and on some of the tributaries, and he knew of no case where their operation had caused difficulty. On the contrary, gates of that type were easily operated by the resident lock-keeper, and there was no need to call on the engineering staff to operate them in time of flood. Reference had been made to the fact that Fig. 6 showed water spilling over the gates at Chertsey Weir. For all their locks they had a figure called the Standard Headwater Level, but invariably the level was kept a few inches above that to safeguard against difficulty in the reach below.

94. Mr Taylor had also mentioned the height of the lock-gate sheeting at Old Windsor. The sheeting had been taken up above the highest known flood level and the copings were also above that level. The reason for the difference in the timber used for sheeting at Cookham and Old Windsor was really a matter of the best quality of timber available at the time. Experience on the Thames showed that damage to sheeting was due more often to careless navigation than to deterioration through decay in the course of years, and it had often been necessary to renew damaged sheeting before its natural life had expired. There seemed no reason, therefore, to use expensive or more durable timbers. No reliable figures were available on the life of lock-gate sheeting, but it very rarely remained in place for its natural life. The use of plastics had not been considered.

95. Mr Brown had referred to the question of stoplogs. Provision had been made in the structures by forming grooves in the lock wall. They had not used timber logs for stopping off; they had used steel sheet-piling stood vertically on the floor of the lock, and the grooves housed walings to support the piling.

96. Mr Banks had raised the question of the economics and life of the gear on the old locks compared with the new machines. On the old locks there had been virtually no gear and the gates had been operated by a balance beam and the sluices very often by a simple ratchet mechanism, which was a slow means of lifting the sluices but a very quick way of closing them. They had no figures available of the comparative cost of the old machinery, but the cost of the modern machinery at Cookham, including the provision of all the services, worked out at about £1,300 per gate. Mr Banks had also referred to the "up-and-over" type of gate, which was certainly reminiscent of the garage door worked on the same principle. There had been no trouble with turbulence when the gate was being closed.

Mr H. C. Bowen, in reply to questions concerning the hydraulic conditions at Chertsey, pointed out that the difference in level—4 ft 4 in. from head to tail under standard conditions—was quite small. Under flood conditions the difference was slightly increased but the total level was raised fairly substantially. It was a curious and unusual type of weir, a relic of the past in its way, in that it was so long and so shallow; but, although the tendency since then had been to use deeper gates, if it was properly protected with sheet-piling that form of weir was very satisfactory and was easily regulated by the lock-keeper. Mr Bowen would not consider it as a form of construction if starting *de novo*, but that was never the case on the Thames; it was necessary carefully to maintain the *status quo*, because there were so many interests involved. The gates were easily operated by the lock-keeper and also, unfortunately, by small boys, which was the chief disadvantage of the radial type of gate illustrated in the Paper.

98. The maximum flood flow at Chertsey would be 18,000–20,000 cusecs, but during the work of construction the maximum encountered had been of the order of 4,000–5,000 cusecs.

99. Mr Bowen agreed with Mr Taylor that there had been no way of telling that the upper weir was about to collapse; it had been very carefully examined and had shown no signs of failure, and then suddenly it had collapsed. Probably the defect was due to the absence of any form of sheet-piling cut-off.

100. Several speakers had referred to the concrete piling and the contrast between steel and concrete piling in the two locks. The male-and-female joint had not been used because experience at Newcastle had shown that it had no great advantage; the need to use strong walings to get an accurate line was not avoided, and when walings were used there was no need for that type of interlocking joint. The lock at Old Windsor had to be covered with a Gunitite surface, and to ensure that the Gunitite adhered it was very important that there should be no pressure against it during the process of Guniting. That had been achieved by the grouting. It had been simple, straightforward, and very effective and the expert who had put the Gunitite on had had no difficulty. If Mr Bowen had to do the job again he would use the same arrangement.

101. The question had been asked whether square or round holes should be used. The piles, which had been factory-made, could have been square, but the advantage of square over round was not great. The lead at the foot was an interesting point. The Concrete Development Association had advised that the lead did not confer much advantage. Mr Bowen was inclined to doubt that, but the chief difficulty experienced in the handling of the piling had not been in the line of the piles so much as transversely, i.e. keeping the piles in accurate alignment rather than preventing them from creeping. Precautions had been taken against creep.

102. Mr Jackaman had referred to the tendency of the prestressed piling to snake round the gate, and that had been quite a feature of it. Careful work with the walings had been required. As Mr Jackaman had pointed out, when constructing something like a lock wall, with ground on one side and a void on the other, the difficulties were most serious. The piling, which had been driven with a 4-ton steel monkey, had stood up to the driving remarkably well. The top was about 4 in. and there had been no trouble in the way of shattering of the head. The final set had been of the order of $\frac{1}{2}$ in. on anything from 1 to 5 blows. They had expected a good deal of trouble with the lock house nearby as a result of vibration, but there had been no trouble at all.

103. The Authors had been asked whether they would use steel piling or concrete piling next time they had to build a lock. It was necessary to consider the factors in each case. It was true that work on the steel-pile lock was carried out more quickly, and, since there was always a time factor in lock-reconstruction jobs, that would weigh in favour of steel piling. Mr Bowen believed that alterations to the design of the concrete work as used at Cookham could lead to a quicker job. The piling had been done very quickly, but the subsequent reinforced concrete work had taken most of the time. Both jobs, however, had been done in the 6 months. As for the comparative costs between the two jobs, and between contract work and direct labour, there was not much to choose. The Cookham job had cost rather more, but it had three pairs of gates as against two at Old Windsor, was slightly bigger, and had electrical machinery. Moreover, the site had been more difficult of access; there had been no road access and a good deal of stockpiling had had to be done in the summer, either by road or by water, as a precaution against the cutting-off of communications. The costs had been increased in that way. The cost given for direct labour included all the on-costs and represented the full cost of the job.

104. Reference had been made to the accuracy of the concrete piling. The contractor had certainly achieved a very high degree of accuracy. The lock gates had been built separately and brought to the site and had fitted without any difficulty at all.

105. The difference in length of the two locks was due to the fact that Cookham Lock had an extra pair of gates. There was no standard width for locks, but they were built to about 25 ft because that was a very convenient size for marshalling the launches

and boats. At Old Windsor the width was 24 ft 2 in. because there was rather elaborate fendering at the downstream end, which was not essential; but, so long as there were other locks in existence below of less dimensions, they could afford to reduce the dimensions at Old Windsor in favour of a rather heavier fendering system. They could make the lock wider without much cost should that become necessary.

106. Scouring at Chertsey had been mentioned. The head on Chertsey Weir was not great and although the weir pool had scoured out to a depth of about 24 ft in the middle it was well away from the entrance and trouble from scour was not expected. Hydraulically the new weir was almost the same as the old one, and that had not suffered from scour on the downstream side.

107. The flow of the river was not gauged at the locks under discussion. It was gauged at a number of weirs, but only at those that were properly boxed in with sheet-piling, so that the question of loss of water by leakage could not arise. At all locks head- and tail-water levels were recorded four times a day, and that information was very valuable for investigations of hydraulic gradients.

108. In reply to Mr Kenn, Mr Bowen said that the Conservancy occasionally used hydraulic models, but that use was rather a new development. He did not recall the use of a model on the Thames, but they had recently used one for work on a tributary where a weir had given trouble from erosion, and a member of his staff who had specialized in that work seemed to have obtained a very successful answer in that case. They did not use hydraulic models for the gauging of weirs. When a weir was to be used for gauging it was calibrated by current meter and the curves were worked out from that; that was equivalent to using a full-scale model.

109. That system of building locks on the Thames was something that had grown up in the course of time. Many interests were involved—fishing and navigation, and milling rights of great antiquity; in many cases the original structure had been in private ownership. There had been no uniformity of control until 1866. The programme of work carried out in the latter part of the nineteenth century had been largely concerned with the reconstruction of structures that had been falling down, so that the work had not been done on any plan of central control; it had been largely a question of taking things as they were and reconstructing them as they stood. It was true that the locks referred to in the Paper were on artificial lock cuts, but many more locks had been built more or less in the flow of the river. It was of interest to note, in view of recent advances in machinery, that the last lock to be reconstructed on the Thames prior to the present programme had been at Chertsey not long after the 1914–18 war, and that had been done in about half the time that it had taken to reconstruct the Old Windsor and Cookham locks; but then three shifts a day had been worked with 60–70 men on each shift.

110. Mr Freer had raised the broader question of the economics of the work and the possibility of attracting improved traffic. There did not seem to be good prospects of increasing commercial traffic, but the pleasure traffic on the river, which was quite a lucrative business in its way, was increasing rapidly and steps had had to be taken to cope with it, including keeping the locks in good order in the summer. In the winter they could afford, within reason, to close them for repair as might be necessary. That, however, was not the whole story, because there were many other interests to be considered. There were still certain mills, and there was the question of the conservation of water, which in Mr Bowen's opinion was assisted by maintaining proper water levels. The Conservancy was under a statutory duty to maintain certain water levels and could do so only if their structures were in good order. When Chertsey Weir collapsed they had failed to maintain the water level. That had been a serious case, because, although it had been repaired before there had been any serious trouble, a Metropolitan Water Board intake might have been affected. Basically, therefore, they met the conflicting interests by maintaining standard water levels so far as possible and by trying to get rid of the flood water without exceeding those levels.