

great breadth of piers and sterlings so much contracts the passage of the water, as not only very much incommodes the navigation through the arch, from the fall and quick motion of the water, but from the same cause also the bridge itself is in much danger, especially in time of floods, when the quantity of water is too much for the passage. Add to this, that besides the danger there is of the pier bursting out the sterlings, they are also subject to much decay and damage by the rapidity of the water, and the craft passing through the arches.

**THRUST**, the same as drift, shoot, &c.

**VOUSSOIRS**, the stones which immediately form the arch, their under sides constituting the intrados or soffit. The middle one, or keystone, ought to be, in length, about  $\frac{1}{3}$  or  $\frac{1}{6}$  of the span, as has been observed; and the rest should increase in size all the way down to the impost; the more they increase the better, as they will the better bear the great weight which rests upon them, without being crushed, and also will bind the firmer together. Their joints should also be cut perpendicular to the curve of the intrados.

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## TRACT II.

QUERIES CONCERNING LONDON BRIDGE: WITH THE ANSWERS,  
BY GEORGE DANCE, ESQ.

AS an Appendix to the foregoing Tract, on the Principles of Bridges, a few smaller papers, on kindred subjects, are inserted in this and some of the Tracts immediately following. The present paper is one, among several of a curious nature, which I purchased at the sale of Mr. Robertson's books, in the year 1776, and appears to contain circumstances of too much importance to be kept private. It seems to have ori-



ginated from enquiries formerly made, for improving the bridge and the port of London, in the year 1746. It consists of queries proposed by the magistrates of the city; and answers to those queries, by Mr. George Dance, the Surveyor General of all the works of the city of London, who was the father of that excellent architect the present City Surveyor. It seems also that the queries had been proposed to the public in general, to solicit answers from any ingenious engineers or architects; for the paper remarks that,

“ The persons who are to answer these queries, may add to their answers what further remarks and observations they shall think proper, to the same purpose as these queries.—In the middle of every arch there are driven down piles, called dripshot piles, in order to prevent the waters from gullyng away the ground.—I am of opinion, from the nature of the work, that the bridge was not so wide originally as it now is; and that the points of the piers have been much extended, in order to erect houses thereon.—I observe likewise, that in some of the piers, there are fresh casings of stone, before the original ashler.

“ July the 9th, 1746.

George Dance.”

“ QUERY 1. What are the shapes and dimensions of the stone piers, the sterlings, and the openings at high and low water? N. B. This will be best answered by figured sketches, or plans, correctly laid down from an exact mensuration by a scale, provided that scale be not smaller than 8 or 10 feet to an inch.”

“ *Answer.* I have described the shapes and dimensions of the stone piers, sterlings, and openings at high and low water, in a figured plan, which I delivered to Mr. Comptroller.”

“ QUERY 2. What are the depths of water, just above, under, and just below the arches, or locks, at a common low water? N. B. These depths may be marked on the plans or sketches.”

“ *Answer.* The depth of water, beginning at the south end of the bridge, is as follows: viz.



	On the west side.		Under the arch.		On the east side.	
	ft.	inc.	ft.	inc.	ft.	inc.
1st lock	16	0	5	9	8	10
2d	14	6	9	0	10	4
3d	22	3	3	0	14	0
4th	14	0	7	0	15	7
5th	18	9	10	3	18	7
6th	17	7	8	7	15	11
7th	18	1	8	10	15	11
8th	25	1	9	2	18	3
9th	17	8	5	9	18	6
10th	21	2	5	6	17	8
11th	18	11	3	5	12	8
12th	17	0	2	4	22	0
13th	24	6	8	9	20	0
14th	22	3	9	0	17	4
15th	23	9	6	9	20	7
16th	19	9	6	11	21	10
17th	20	3	4	6	21	10
18th	19	4	7	9	14	1
19th	10	10	4	0	13	10
20th	6	7	6	1	10	10

I have likewise described the dimensions in the plan aforesaid."

"**QUERY 3.** At what height, above low-water mark, and at what depth below the surface of the sterlings, is the underbed, or lower side of the first course of stones?"

"*Answer.* The height of the underbed of the first course of stones, is various: some being 2 feet 4 inches, some 1 ft. 11 inc., some 1 ft. 10 inc., some 1 ft. 3 inc., some 1 ft. 1 inc. above low-water mark; and some are 6 feet, some 5 ft. 8 inc., some 4 ft. 6 inc., some 4 ft. 1 inc., and some 4 feet below the surface of the sterlings. These are the dimensions, as far as I am able to get them: there being no opportunity to make observations but when a breach happens to any of the piers."

"**QUERY 4.** What is there between the stones and the heads of the piles? Is it one row of planks only; or two rows,



crosslaid; or timber: what wood are they made of, and what are their dimensions or scantlings?"

*Answer.* In general I find nothing between the stones and piles, but sometimes pieces of plank, mostly of oak, and a little of elm, some of which is 6 inches and 4 inc. in thickness; which I apprehend were not originally placed there, but only when reparations have been made, on which account they were fixed, in order to wedge up tight to the stonework; it being impossible to make sound work in that case by any other method."

"**QUERY 5.** Are the piles which surrounded the foundations of the piers, before the sterlings were added, square or round, rough or hewn, driven as close as possible, or at a distance? If they touch one another, are they fastened together with a dovetail, or by any other contrivance of the same nature; and if they do not touch, at what distance are they at a mean?"

*Answer.* These piles are round, rough, and unhewn: they are driven close, and touch one another: they do not seem to be fastened together by any contrivance, except that some have planks upon them, and some have none. But these observations I have made where breaches have happened, so that one might get 1, 2, or 3 feet within the surface of the piers: but how they are in the middle of the piers, is impossible to determine."

"**QUERY 6.** Are the heads of those surrounding piles fastened together by any kirb or capcile? If there be any, let it be described, and its dimensions, by a figured sketch."

*Answer.* They are fastened by no kirb or capcile.— There are only planks upon some of them, as I mentioned in the former answer."

"**QUERY 7.** Are the inside piles, on which the foundations of the piers are laid, round or square, hewn or rough, very close, or at what distance at a mean; of what timber, and size; are they shod or not?"

*Answer.* This query is very difficult to answer. I can only say, that I have had an opportunity to examine one



pier, about 7 feet within. It is the south pier of the dam lock; a great part of which was undermined, by some of the sterlings being carried away, and leaving it defenceless there. I observe that the piles are round, rough, unhewn, and driven close together; and they are chiefly elm, of about one foot diameter. Some of these piles, being taken up, were shod with iron; and I think it is reasonable to suppose they are all so."

"**QUERY 8.** Whether the foundations of the piers, before the sterlings were added, extended beyond the naked line of the stone-work: and if so, as it is most likely, describe how much, at a mean, and the manner, by a figured sketch?"

"*Answer.* There is, to every pier, a setoff, or foundation, which extends about 7 inches beyond the naked line of the pier; and that setoff or foundation is of stone. But I am of opinion that sterlings were fixed at the first erecting of the bridge; because I think it impossible for the piers to stand long without some such defence. But whether they were so much extended, or in the same shape they are now, is not easy to determine."

"**QUERY 9.** Are the piles, that are under the foundations of the piers, much decayed and galled by the action of the currents of waters, before the sterlings were added?"

"*Answer.* All those piles under the foundations of the piers, which I ever saw, are very sound at heart. But about one inch of their surface hath been decayed: but these were piles which had been for some time exposed to the violence of the flood, by the breaches made in the sterlings. But I apprehend that cannot be the case with the piles which go farther under, or in the middle of the piers; because water cannot act upon them."

"**QUERY 10.** What is the inside of the stone piers made of? whether of the same sort of stone as the outside; cut and laid regular, or only common rubble stones, laid in very bad mortar, as it is in Rochester-bridge?"

"*Answer.* I have seen, in several breaches, the texture



of the piers: and by them it appears to me, that the insides of the said piers are filled with rubble; and the external faces are formed with ashler laid in courses: but the rubble appears to be laid with good mortar.

“George Dance.”

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### TRACT III.

#### EXPERIMENTS AND OBSERVATIONS TO BE MADE ABOUT LONDON BRIDGE.

THIS is another of the papers, relating to the state of London bridge, bought at the sale of the late Mr. John Robertson's books. It appears to be an answer given to certain queries, addressed to the Royal Society from the Committee of Common Council of the City of London. This answer is signed by the President, the Vice-Presidents, and several other respectable members of the Royal Society; viz. by Martin Folkes, esq. the president, and by Wm. Jones (father of the late Sir Wm. Jones), James Jurin, M. D., Geo. Lewis Scott, esq., Benj. Robins, esq., and John Ellicott, esq., all names highly respectable for their eminent scientific labours.—Their report is in the following words:

“In order to answer the queries proposed by the Committee, with regard to the alterations of London bridge, we apprehend it will be necessary,

“1st. To have an exact level taken, between some fixed point on the west side of London bridge, and another point on the east side of Westminster bridge; as also, to take the like level between some fixed point on the east side of London bridge, and another point at some convenient place about 2 miles below the bridge.

“2. To take the perpendicular height of each of those 4