DIRECTIONS for ſecuring and repairing the under-waſhed Piers at Hexham Bridge.

NOTWITHSTANDING the natural hardneſs of the upper cruſt of the gravel bottom, it being now found not capable of reſiſting the action of the water in ſudden and rapid floods, it appears neceſſary to incloſe the ſeveral foundations by a fence, or caſe of ſheet piling, to prevent, at all extremities, the gravel from waſhing from under the baſes of the piers; a plan for the doing whereof accompanies theſe directions.

The work may be begun upon any of the piers that are found convenient, and as ſoon as may be, the bays compoſing the two ſheets that form the ſalient point before the weſt end of each pier ought to be completed, together with one bay of the return upon each ſide of the pier; and as ſoon as this is done the cavity waſhed below the bed of the river ſhould be filled up rather higher than the original bed of the river both inſide and out. The outſide to be filled with rough rubble ſtones from the upper bed of Oakwood Bank quarry, which are exceedingly well adapted for this purpoſe, to be of promiſcuous ſizes, the largeſt not exceeding half a cube foot, or about 70lb. weight. The inſide to be filled with the ſame kind of quarry rubble of promiſcuous ſizes, the largeſt not to exceed that of a large double fiſt, or about 12lb. weight, and for every two buſhels or meaſures of rubble uſed within the caſe one buſhel of clean ſand muſt be thrown upon them.

This done, the deſirable thing would be to proceed thus far with all the four piers that have been laid down in caiſſons, by which means all the piers will be guarded from further damage, after which the completion of the caſing can be done more at leiſure, nor ought this to be omitted with reſpect to the north pier of the center arch, which, though it has ſuffered no material derangement from the late floods, yet experience ſhewing that the gravel bottom ought not to be truſted, the ſame means ſhould be applied as a guard to its ſafety as to the reſt. However, if the piling is found to go on with

with readineſs and facility, and the moving of the tackle from pier to pier a work of labour, then, at the diſcretion of the ſurveyor, the piers may in turn be ſurrounded wholly before the tackle is moved.

As ſoon as the gage piles are driven, the ſcrew clamp may be applied upon the ſurface of the water; or indeed if the piling of each pier be gone on without removal, this clamp may originally be applied as an outward frame for directing the driving of the gage piles, and for retaining them in their places while the ſheet piles are driven; and for greater facility, certainty, and exactneſs, in driving the ſheet piling, ſo as to render them water-tight, I would recommend the long ſides to be divided into four bays, and the ſalient point ſides into three each.

When the caſe is completed, reaching above low water, it may be tried whether the water can eaſily be got out, and if ſo, the under pinning, where wanted round the ſkirts of the caiſſon bottom, may be done by men's hands; but if not, the whole of the interſtice between the caſe and the pier muſt be fitted with rubble and ſand, as before directed for the weſt ends, about ſix or eight inches higher than the bottom of the caiſſon, and afterward driven down by a ſett of about one foot ſquare at the lower end, acted upon by one of the hand-rams: this will cauſe the matter to ſpread under the ſkirts of the caiſſon bottom, and the caſe hindering it from ſpreading outward will render all tight and firm. This done, the interſpace between the caſe and the ſides of the pier muſt be chocked in with blocks of the thickneſs propoſed for the girdle or ſunken courſe, which being ſcappelled to a tolerable ſquare, and adapted to their places, they will not need cramping; but yet, to prevent any violent flood from turning any of them out of their places, it muſt be obſerved to chamfer the upper or leading edge of each croſs joint, as ſhewn in a detached figure, as alſo to pin them faſt with wedges, ſtones, and pebble mortar, or beton, which may be eaſily done if the caſe can be drained, as I expect it may, ſo as to dry the upper ſurface of the ſunken courſe. This being done, the whole of the caſing is to be driven down with ſetts, or otherwiſe cut off to the level of the ſunken courſe, and the ſcrew clamp ultimately fixed, ſo as to be rather below the tops of the piles, which will effectually confine all cloſe home together.

The work being thus fixed, the outſide of the caſe is to be guarded with a ſlope of rubble, which, that it may be the better grounded by a competent body of matter, it will be adviſeable firſt to let the work ſtand the effect of a flood; and then not only filling up the excavation that may be expected on the outſide of the caſes, up to the general level of the bed of the river, but forming a ſlope extending to the diſtance of about ſix feet upon the baſe, at the height of

of the bed of the river, and to reach as high as the clamp. After this, the ſlopes muſt be examined at every flood, and ſupplied where found deficient till the matter appears to be at reſt, which ſooner or later will be the caſe, when the river hath formed itſelf ſuch a channel between the piers as is natural to the new ſett of the ſtream, that the interpoſition of the piers of the bridge muſt neceſſarily occaſion.

In caſe by repeated floods while the work is going on, any of the foundations ſhall appear to underwaſh more than they have done, it will be proper to throw round the weſt end and weſt ſhoulder of ſuch pier a competent body of rubble, the largeſt not weighing more than 25 or 30lb.; for through rubble of this ſize piles may afterwards be driven nearly as well as through large gravel.

The length of the piles ſhould conform to the depth of the water. I would not wiſh the ſheeting piles round the weſt end and firſt bay of the return on each ſide to go into the ground more than about ten feet; and if they do not drive kindly, muſt be contented with leſs; from thence each bay may be gradually leſs depth into the ground, ſo that round the down ſtream pointing ſeven feet will be ſufficient.

If the gage piles drive more kindly, they may be longer by 18 inches or two feet than the ſheeting; but if not, they need not be above one foot longer: and to make them drive kindly, as well as fix faſter, it will be proper to point them longer than heretofore, that is, to about three feet, but not ſhouldering, as with a regular taper, but curved, beginning from nothing at three feet.

The length of the piles covering the weſt end and returns of the fifth pier from the north, being that moſt underwaſhed, the ſheet piles ſhould be at leaſt 15 feet long, and the gage piles in proportion, and the reſt proportionable to the depth of the water; and reſpecting this pier, as the lowering of the water in the caſe will be more neceſſary than in the reſt, it will be proper before any rubble is put in outſide the caſe, to put a layer of earth or loam upon the bottom, amounting to about ſix inches thickneſs, that is, allow a cube yard to ſix yards ſuperficial, this will choak up the pores of the gravel in the deep places, and retard the percolation of the water through the gravel, ſo as to give a better chance of getting out the water, for new founding the weſt end, if deemed neceſſary.

What regards the repairs of the maſonry I ſhall defer to a future opportunity of delivering, in due time.

It

It will be proper, in driving the gage piles, to try to uſe the great ram, fitted with a moveable diſcharger, ſo as not to be lifted above ſix or eight feet above the pile heads; by which means I apprehend it will be found to drive the piles much more kindly than if lifted its full height, and perhaps more kindly than the hand ram.

J. SMEATON.

Hexham,
5th *Auguſt*, 1778.

Additional Inſtructions.

When the caiſſon bottom is fully underpinned, according to the method deſcribed, let the point be taken down one courſe as far as the ſhoulder, ſubſtituting other ſtones of ſuperior thickneſs, ſo as to raiſe the point rather higher than it was originally, by $1\frac{1}{2}$ or 2 inches; reconciling, however, the new with the old work at top, and cramping every ſtone to its neighbour, and to the block ſtones of the old work, with common maſon cramps, run in with lead at each end, to bring them to a bearing, or otherwiſe fixing them faſt with wedges. If you ſhould have any difficulty to get them dry enough to run in the lead, heating the cramp, and putting a little oil into the holes, will render the difficulty leſs.

The taking up one courſe will do for the third and ſeventh piers; but for the fifth you may take down and cramp as before directed, as far as you can.

I have alſo conſidered, that if you can but get large ſtones for the up-ſtream pointings of the girdle courſe, or ſunken courſe, the reſt may be done with aiſler, whoſe breadth and length is ſufficient; and if you can get the water off, as I expect you will, ſo as to point and fill with the very beſt mortar, which when ſtruck to a breadth will make the open joint upward, and more capable of being filled. I would not, however, have any thing pointed from the down ſtream ſhoulders to the down ſtream point; only chocked faſt with ſtones or wedges, leaving interſtices there for what water may get in at the up ſtream part of the pier, to make its eſcape freely below. Such of the old aiſlers as will anſwer to the length and breadth will effectually ſerve the purpoſe without any new dreſſing.

J. SMEATON.

9th *Auguſt* 1779.