To Mr. Pickernell.

Sir, London, 1ſt April 1779.

As I look upon it that the judiciouſly ſetting on of the baſe courſes upon the damaged foundations is a very material point of conſideration, it was for this reaſon that I was willing to take the whole of the winter fully to make up my mind about it; and having now ſeen the firſt of April, I ſhall no longer defer ſetting you at liberty.

You will readily comprehend, that if, inſtead of beginning with maſonry from the bottom, two or three large detached pieces of rocks had been depoſited in the river, of a ſufficient ſize to build our piers upon; theſe ſerving as feet to ſtand upon, and each capable of ſupporting a proportion of the weight; thoſe rocks, though unconnected below, yet if they are firmly connected at and above the ſurface of the water, by a cap of ſtone well cramped and united in one; this cap would ſerve as a new baſement that could not ſeparate, whereon to raiſe the reſt of the ſuperſtructure.

Our piers in ſome degree anſwer the above idea; and it will now be our buſineſs to make a cap of the two baſement courſes, bonded together with a degree of firmneſs that would not have been neceſſary, had no derangement ever happened.

I propoſe, therefore, that the two baſement courſes be filled in with block ſtones, gauged to a proper thickneſs in reſpect to their beds; and ſo far ſtruck off upon their ſides, as to give opportunity to cramp them to one another, both inſide and out. The outſide ſtones I would adviſe to be cramped to one another with cramps from $1\frac{3}{4}$ to 2 inches broad, and from $\frac{5}{16}$ to $\frac{3}{8}$ thick, all well leaded in, and of ſufficient length to get at leaſt ſix inches fair hold of each ſtone. The whole to be bedded and worked in with terras mortar, of which I will give you the compoſition.

In the next place, as the ground could not be conſolidated with piles under the firſt foundations, I always expected theſe to ſettle to the value of an inch more than the piers that have piles underneath them; but as in conſequence of our derangements, our bearings will be rendered in ſome degree unequal, a greater ſettlement may be expected to take place at the weſt, than at the eaſt end; for theſe reaſons I would have the baſement courſes ſo ſuited to the preſent work, that the eaſt end of the baſement ſhall finiſh an inch higher than the finiſhed piers; and the weſt end two inches higher; alſo that the weſt point and ſhoulders be carried $1\frac{1}{2}$ inch further weſt than the finiſhed piers, ſo as to make the piers $1\frac{1}{2}$ inch longer than the former. In raiſing the ſhafts, I would gradually loſe this $1\frac{1}{2}$ inch in getting up to the impoſt, by ſetting on about the value of $\frac{1}{8}$ of an inch at each courſe;

courſe; ſo that the impoſt will be of the ſame length as the former, but ſtill finiſhed one inch higher at the eaſt, and two inches higher at the weſt ends. Now if afterwards the weight of the arches and ſuperincumbent matter ſhould not preſs down the piers in the proportion allowed for, this will make no apparent fault; becauſe it will rather give addition of elevation to the middle of the bridge; and if the ſettlement ſhould be double to what is allowed for, which I think is as much as can poſſibly be expected, it will ſtill be ſcarcely viſible. The main thing, therefore, that we have to guard againſt in carrying up our piers, is to do them with that care and ſolidity, that though the bearings may be ſomewhat unequal, yet that the whole may go together, without ſhewing any ſetts or rends in the outſide aiſler; and which, though it may happen without any material detriment to the real ſolidity and duration of the work, yet it will diſgrace our building in the eyes of thoſe very many (in proportion to the whole) who can neither ſee nor reaſon any further; on which account I would conſtantly keep the weſt end ſome courſes higher than the reſt, building up as it were a head, and making off the courſes. I would alſo cramp every courſe in the outſide aiſler, from the weſt point to half way down the long ſides, and every other courſe down to the eaſt ſhoulders, till you come to the next courſe below the impoſt; at which height I would throw three block or chain courſes acroſs, in the manner I formerly ordered; there let the work of each pier ſtand as long as we can, and afterwards finiſh as has been already done. I mean what relates to the cramping above the baſement to regard chiefly the third and ſeventh piers: as to the fourth, after the cap is on, as before, I think it will be ſufficient to cramp every other courſe from the point to half-way down the ſides only; but in regard to the croſs chain courſes at the height above mentioned, no caiſſon pier ſhould want them. In regard to the fifth, I muſt ſuſpend all directions till I ſee how it is likely to turn out.

The place where I am moſt apprehenſive that ſetts may appear, is about a yard below or down ſtream of the weſt ſhoulders. I would therefore have you avoid putting in long ſtones faceways, near thoſe parts; for though this may cauſe a few more cramps, and in common apprehenſion not be ſo ſtrong: yet, as every joint will give way a little, it will prevent the breaking of the ſtones in the middle, nor will the weight above act by ſuch long levers to break them.

Inſtead of our former terras mortar, take as follows:

Common lime 1, barrow lime 1, terras $\frac{1}{2}$, ſand $1\frac{1}{2}$; — this doſe with pebbles what you can, for rough work.

To

To ſet ſtones under water:

Barrow lime 1, terras 1, very ſmall pebbles 1; — this being very well beaten, and let grow rather ſtiff, put it down in lumps about the ſize of a pullett's egg. If you have an opportunity of flat bearings, you may mortar the under ſide of the ſtone to be let down.

Below you have my deſcription and directions concerning the new tackles.

I am, &c.

J. SMEATON.

DESCRIPTION of the Shears and Tackle that were made Uſe of in raiſing the Piers, &c. of the Bridge of Perth, and recommended for Uſe in Hexham Bridge.

(See plate 12. fig. 7.)

AB ſhews one of the ſhear logs, which are framed into a ſoal piece being of nearly the ſame height and ſcantling as the ſhears, that is, about ſix inches, but inſtead of being fixed by back ſtays, they are made to overſet by guide ropes commanded by tackle blocks in the following manner:

The guide rope CD is ſuppoſed to be fixed to a lewis to ſome part of the adjacent pier or arch; the guide rope goes to an adjacent pier if raiſed to its height, or the next but one, if the next is not raiſed much above water. DH are a pair of blocks with two ſheaves each, whoſe fall HIK goes to the jack roll or windleſs L, mounted upon a frame in the uſual manner, and fixed upon ſome convenient part of the adjacent pier or arch: now as the roll drawing by the fall KIH, tends to draw the ſhears towards it, with a power of one excluſive of the purchaſe of the tackle, and as beſides the fall there will be four parts of the rope acting as a purchaſe, the conſequence will be, that the whole purchaſe will be as five to one, and the roll muſt gather up five yards of tackle fall to make the blocks DH advance one yard towards each other.

Again,

Again, the tackle blocks F will tend to draw the ſhears the contrary way to the other, and the tackle fall FMNO being attached to the under ſide of the roll L, this roller will command the ſhears either way by turning it one way or the other; now to keep the two tackle falls thus brought to the roller at any equal tightneſs, or nearly ſo, it is neceſſary that the two purchaſes may be equal; it therefore appears that if the fall ONMF, acting over the ſingle pulley M, which ſerves only as a director, were ſimply attached to the block F, no power this way applied to the roll at L, would produce any action upon the ſhears, but only pull at the fixed part of the guide rope EF without producing any action any where. The blocks FG, therefore, muſt contain a purchaſe of five, and this will be done by making the block F treble, and the block G double, the ſtanding part being fixed to the block G, in like manner as the other ſtanding part will be fixed to the block H. If, therefore, one fall is attached to one end of the roll, and the other to the other, while one is winding off, the other winding on, four feet in length, and ſix inches in diameter will be fully ſufficient; and the handle being of the ſame length as before preſcribed, as one man will generally manage the matter, the handles will beſt be ſet oppoſite that they may ſimply balance each other.

To avoid all confuſion of the figures, I have wholly omitted the main tackle blocks, which are ſuſpended from the top of the ſhears; and to avoid the platform of the work from being crowded, I ſuppoſe the fall for the main tackle to be returned from a ſnatch block fixed to a lewis, next the foot of one of the ſhear logs, and from thence paſſed to a main windlaſs or jack roll, and ſuppoſed to be placed upon the adjacent pier at P, or upon the arch near the other windlaſs. Two men in ordinary caſes being ſuppoſed to manage both windlaſſes, that is to aſſiſt each other in hoiſting the ſtone perpendicularly, and then one of them to go to the guide tackle windlaſs to overſet the ſhears, which done, the firſt can lower it by the main tackle.

The overlaying of the ſhears ſhould be ſufficient to clear the ſtones from rubbing and beating againſt the ſides of the pier, while hoiſting perpendicularly, and the feet of the ſhears may either ſtand upon the aiſler or juſt behind it, ſo as to drop ſuch ſtones into their places as come within their compaſs, and that on either ſide. The fall of the main tackle may be prevented from dipping in the water, in paſſing from pier to pier, by a ſmall block being ſuſpended from the guide rope at I.

The guide tackle blocks may be ſuch as thoſe made for ſhipping, the ſheaves about ſix or ſeven inches.

J. SMEATON.

London,
27th *March* 1779.

To

whenever a top flood came, as before that nothing was ever ſtirred, and therefore the rubble not diſpoſed as laid by the water; but as its effects ſeem to have been principally ſpent upon the fourth pier, I think it will be proper now to do with it what I have all along propoſed in my own mind, in caſe an effect ſhould take place to the degree you have deſcribed of that pier: that is, to drive ſome of the round oak piles about 18 inches diſtant, middle and middle, driving them down by ſetts three feet under the common low water ſurface: the point pile being advanced up ſtream about 15, or, if you pleaſe, 20 feet above the ſalient point of the caſing: the line of the piles to be made a little rounding, I think the upper ſide is the better figure. The internal ſpace between the piles and the caſing to be filled with rubble, as large as you can well get it, and ſome large pieces to be chocked in between the ſhoulders of the caſing and the ſhoulder piles, and then filled up with ſmaller at the top. I would alſo lay a footing ſlope of rubble upon the outſide of the piles, to be reconciled with the footing ſlope on the ſide of the caſes. As it appears from all the arches interſpaces wearing deeper, that it is the natural effect of the waters being more confined than at firſt by the interpoſition of the piers; it therefore indicates, that we ſhould not fill up more than what is abſolutely neceſſary for our ſecurity; for the more we block up the more tendency the water will have to take away the blocking and deepen the interſpaces. You have not given me the ſoundings in the reſpective interſpaces, nor told me where the rubble, &c. is chiefly lodged below the tail of the piers; if I were informed of theſe matters, as alſo whether the deepening of the interſpaces was greater at the eaſt or the weſt ſhoulders, or below the eaſt ſhoulders, I ſhould be able to tell how to direct you. You mention however that your ſoundings by the ſide of the fourth pier were eight feet; now if all lies regular, I ſhall not think eight feet too great a depth in the middle between the piers; and if the rubble ſlopes do not reach within three feet of the top of the caſings, extending above two feet in baſe to one of perpendicular height of the ſlope above the caſings, it will be as ſufficient as if higher and broader.

Nothing will ſo much tend to give an eaſy paſſage to the water through the bridge, as its ſpreading equally through all the arches. The beating jetee on the north ſide, greatly tends to prevent the water paſſing freely through the north arches, at the ſame time that it throws it upon the center one; that therefore ſhould not only be removed, but the ſhore made ſmooth and regular, the ground and all impediments removed from the north elliptical arch, and the riſing ground below it taken away; for if the water is ſtopt below an arch it is an equal impediment to the waters getting through it as if under it or above; and whatever is there ſtopped muſt be thrown upon ſome other, and the water naturally tends to find its paſſage where it finds the leaſt obſtruction;

that

that is, where the channel is the deepeſt. Our buſineſs is therefore as much as poſſible to invite the water through the ſide arches by ſmoothing and clearing all impediments to its paſſage through the ſame.

I am, &c.

J. SMEATON.