OBSERVATIONS on Two Reports of Robert Mylne Esq. concerning Hexham Bridge, by J. SMEATON, Civil Engineer.

THERE are so many points contained in the two reports of Mr. Mylne, of the 24th April and the 30th September 1783, in which I entirely differ with that gentleman in opinion, that to make the proper observations upon the whole, would draw me out to a length that in the present state of things I would wish to avoid. I shall therefore content myself

myſelf with obſerving upon thoſe that I look upon to be the foundation of that difference of opinion; and upon which the merits of the queſtion ſeem principally to depend. I ſhall therefore paſs over the compliments that Mr. Mylne's politeneſs prompts him to pay me on this occaſion; and particularly as they ſeem to be at my own expenſe. For the greater eaſe of reference, I ſhall apply to the printed copy of Mr. Mylne's reports.

Mr. Mylne ſays, page 5th, (298 of this volume) "The exiſtence of a ſand below, and a "ſuppoſed hardneſs and concretion of five feet, or any ſuch meaſure of the upper parts, "ſeem to have precipitately and fatally determined the plans of operation at firſt ſetting "out; and appear to me to be equally the cauſe of the preſent precipitate opinion for "abandoning the work as impracticable."

He alſo ſays, page 4, (298) "Mr. Smeaton, than whom there is no perſon or artiſt better "inſtructed, more knowing, and of a more penetrating and correct judgment, muſt have "been deceived in the collection of facts and materials, on which he eſtabliſhed his plan "of operations."

Now, if in the following detail it ſhall appear that Mr. Smeaton made a proper collection of facts whereon to judge; and did make a proper judgment thereon, ſo far as at the time he was to form this judgment had come to light; then, Mr. Mylne's reflections on this judgment muſt appear unfounded, and will in courſe fall to the ground.

Mr. Mylne acknowledges himſelf to have been made acquainted with the reaſons and motives of Mr. Smeaton; for page 6th, (298) he ſays, "I have ſeen and examined all Mr. "Smeaton's papers, I have heard all the particulars, and hiſtory of his proceedings and "motives for the method of operations, which he adopted:" and Mr. Mylne knows that this intelligence was from Mr. Smeaton himſelf, before Mr. Mylne went down *to examine the works and perſons concerned, and employed in the detail of its execution:* and that it was in this conference that Mr. Smeaton mentioned to him, that the ground and reaſon which influenced his judgment in not ſinking the piers of the bridge deeper into the bed of the river was an eſtabliſhed opinion that the greateſt part of the river's *bed* conſiſted of a gravel, very hard compacted together and difficult to penetrate at its upper ſurface; but which diminiſhes in compactneſs from the ſurface downwards; ſo that at ſome depth exceeding five feet, it deviated into a ſand, and ultimately into a quickſand or mud. The exiſtence of ſuch a ſand below, as alſo a ſuppoſed hardneſs and concretion of five feet, *or any ſuch meaſure*, of the upper parts, Mr. Mylne explodes in the terms already quoted: but as herein reſides the foundation of that entire difference of opinion that ſtill ſubſiſts

ſubſiſts betwixt Mr. Mylne and Mr. Smeaton, it ſeems proper now to examine the grounds whereon Mr. Smeaton eſtabliſhed this opinion, and alſo the grounds whereon Mr. Mylne explodes it; becauſe, if well founded, from what *appeared at the time*, it muſt be admitted ſufficient in reaſon for Mr. Smeaton's determining his plan of operations according to it, though, ſince the fatal accident, any thing ſhould appear to the contrary; and if on the other hand, from any thing that can be deduced from M. Mylne's operations, Mr. Smeaton's original concluſions ſtand uninvalidated; then it muſt appear, that Mr. Mylne muſt have been drawn into a precipitate opinion, or, as he terms it, *deceived*.

That Sir Walter Blackett built a bridge at Hexham, which not long after it was finiſhed, was thrown down by the great flood in 1771, in one night, and the materials almoſt totally diſperſed, is an event too notorious for Mr. Smeaton to be *deceived* in.

That the foundations of this bridge were let into the bed of the river, well founded upon a great number of piles, and a platform upon the heads of them 12 inches thick, of ſolid balks judiciouſly rabetted together, Mr. Smeaton could not be *deceived* in; having been eye witneſs to many of the operations.

That all the piers, arches, and one of the two abutments were totally deſtroyed, and the whole length of one ſide of one of the platforms raiſed out of the water, half way between the horizontal line and the perpendicular; in this alſo Smeaton could not have been *deceived*, having ſeen it for ſeveral years together; and was expoſed to the full view of every one that paſſed by.

From the above facts, Mr. Smeaton inferred, that though the upper cruſt was hard gravel, yet a much more ſoft and yielding material lay underneath it, otherwiſe the bottom, could not have been turned up in the manner mentioned, and that the foundations would have been more ſecure, had they been laid upon the upper cruſt without its being broken, by excavating or driving piles: and which is evidently proved by the ſubſequent operations that now come in courſe to be mentioned.

That after this accident Sir Walter Blackett, chuſing rather to forfeit the penalty of the bond*, in which he was obliged to uphold the bridge for ſeven years, than to attempt it again, the magiſtrates of the county employed Mr. Wooler, then an eminent engineer, to begin another bridge near the ſame place: and that in conſequence he built a land-

* Penalty 3000l.

breaſt

breaſt on the north ſide; and many preparations being made, and every thing ready for founding a pier, upon the ſame ſide; on digging the foundation put into the bed of the river, the whole work was put a ſtop to for ſome reaſon or other; and in this Mr. Smeaton could not be deceived; becauſe at that time he was often at Hexham, was well acquainted with Mr. Wooler, and ſaw the operations going on, and afterwards diſcontinued: and it will be further proved by living evidence, that the reaſon for diſcontinuing the work, was the *ſoftneſs* of the bottom of the foundation pit; and to aſcertain whether this ſoftneſs was particular to *that place*, a pit within the ſolid bank was dug upon the oppoſite ſide of the river, in the bottom of which the ſame ſoft ſtratum prevailed; and to this ſome of the magiſtrates were themſelves witneſſes, as will alſo be proved: it can alſo be proved from a letter of the ſaid Mr. Wooler, now deceaſed, that in his opinion *a permanent bridge could not be eſtabliſhed here without building a ſolid wall of ſix feet high, and 42 broad, quite acroſs the river;* which he obſerved was an expedient that has ſucceeded where *expenſe was not regarded.* He further ſays, "that the attempting to ſet a bridge "upon ſuch an enormous depth of quickſand, over a river ſo ſubject to floods as the "Tyne, may be deemed ſo hazardous as to be next to imprudence itſelf."

Mr. Smeaton therefore could not be *deceived* as to the exiſtence of a hard ſtratum of gravel at the top, with a quickſand under it, at either of the places juſt deſcribed*: as Mr. Wooler's operations fully prove what was the cauſe of the failure of the firſt bridge.

Mr. Jonathan Pickernell, who was brought from London to be employed in this buſineſs under Mr. Wooler, and recommended by him, will further prove, that he was employed to bore the river, which he did in various places, and verbally reported to Mr. Smeaton, that wherever he had tried the river he conſtantly found a quickſand to take place underneath the upper bed of gravel; and that he had reported the ſame to *the clerk of the peace.*

In this Pickernell might have deceived Mr. Smeaton; in his never having made ſuch borings, nor made ſuch report: but Smeaton did not reſt it here; for in the very place where he built the bridge, he tried the bottom of the river, not by boring, but by driving down a pointed iron bar, in various places acroſs the river, to the depth of nine or ten feet, and conſtantly found, that though the entry of the bar was in all places difficult, yet at every blow it went more and more eaſy; however at this depth the gravel felt ſo tolerably compact as

* N. B. The Dwarf wall, the place recommended by Mr. Mylne, is near the original bridge.

to

to be deemed by him ſufficient for ſupporting a bridge, *provided* the upper cruſt was not *broken by digging or piling;* and provided, the weight upon each pier was not *too great,* which would be the conſequence of *wide arches;* and as was the caſe with Sir Walter Blackett's bridge: the middle arch being 70 feet.

Now, if in the concluſion I drew from thoſe trials of the river's bottom by the bar, I have been deceived; I deceived *myſelf,* as I was not beholden to the *patience and perſeverance* of Mr. Pickernell only, for as I not only directed but aſſiſted in the operation myſelf, I ſaw with my *own eyes,* and felt with my *own hands.*

Theſe are the facts on which Mr. Smeaton built his plan of operations, which facts, if valid, he challenges Mr. Mylne to ſhew, that the methods he grounded them on, were not the moſt likely, *as far as was then known,* to produce a permanent bridge, that if, at all, muſt be erected at ſuch a moderate expenſe as the county of Northumberland was likely to raiſe: for to build a ſolid wall acroſs the river whereon to ſet it, he judged with Mr. Wooler to be improper, except where *expenſe was not to be regarded.*

Let us now ſee what Mr. Mylne has on the other hand eſtabliſhed to invalidate theſe facts. He ſays, page 3d, (297) "I have bored the river at the bridge to the depth of 23 feet "below the latter water level, in a place where I might not be led aſtray by any altera- "tion formed by the ſaid flood in its milder velocity; and I have found under the "teſtimony and perſeverance of Mr. Wake, that the ſoil and texture of the bed of the "river at this place is uniformly a compoſition or congeries of roundiſh and flat ſtones, "gravel and ſand, of equal quality and conſiſtence in the whole of that depth."

Mr. Mylne then cauſed a hole to be bored to the depth of 23 feet into a bed of gravel: but was this the only hole? Mr. Mylne makes no mention of any other. Where did he bore it? Mr. Mylne does not ſay; but contents himſelf with telling us, he did not bore it in a place where the gravel was liable to be diſturbed by the impetuoſity of the river. But does Mr. Mylne think this was ſufficient to determine what the ſoil and texture of that part of the bed of the river was which *was liable* to be ſo diſturbed? Mr. Mylne ſays, page 4th, (297) that the bed of the river "though hard to the touch of boring, and compact "to the eye, and feeling of inſtruments, is wonderfully looſe, and unconnected in its "parts, inſomuch that the bed of the river Tyne ſeems to ſhift and alter its form, extent, "and ſituation with every flood more or leſs; and tearing up at one time to a great "depth that fair moulded and well-laid hollow, which the ſtream had laid for itſelf

"upon

" upon ſome former occaſion." This was not the part, therefore, that Mr. Mylne choſe to examine otherwiſe than in his mind's eye; he choſe a place not ſo liable to alter, although the greateſt part of the bridge, and particularly that part that firſt gave way, was founded, and obliged to be founded, upon *this fair moulded and well laid hollow*, which the ſtream had *laid for itſelf upon ſome former occaſion*. Now Mr. Smeaton cannot be deceived in this, that it was in this very part where he drove down his bar: it was in the deepeſt part of the river; and all his trials were made in a *boat*, though the river was then in its low ſtate. Whereas it will be proved in evidence, that the part where Mr. Wake bored was upon a dry gravel bed, nearly abreaſt of the place where Mr. Smeaton put down his ſecond coffer dam pier: and where the foundation was actually ſunk into the bed of the river, as deep as it poſſibly could be for water *; in confidence that the gravel bed there was quite as deep as Mr. Wake's boring has ſince proved it to be. The fact was, that Mr. Smeaton's original *plan* and propoſition was to build the land-breaſt and one pier, on each ſide, with coffer dams, ſinking the foundation thereof into the bed of gravel, piling underneath and round theſe works, to as great a depth as ſhould appear neceſſary on opening the ground; and which accordingly were done: but finding, on founding the north land-breaſt, and alſo the north pier, that the gravel bed extended ſtill further into the bed of the river than was at firſt expected, he directed the ſecond pier (oppoſite which Mr. Wake bored), to be laid in the ſame way; leaving then only five of the eight piers to be built in the *fair moulded hollow* to be ſubject to the *vaſt powers* of the *floods* of this river; and this he was under a neceſſity of doing, as he found it impracticable to drain off the water ſo as properly to eſtabliſh the piers upon a foundation of piling: judging it, therefore, the ſafeſt expedient to preſerve the upper ſurface whole, which he found by far the hardeſt, and to found the reſt of the piers by caiſſons upon the bottom of the river, defending the baſis thereof by ſuch outworks as then were in contemplation.

How, therefore, it happens that becauſe at the place where Mr. Wake bored " the " ſoil and texture of the bed of the river is uniformly a compoſition or congeries of " roundiſh and flat ſtones, gravel, and ſand, of equal quality and conſiſtency through-out the whole of that depth;" it is and muſt be ſo everywhere elſe, as well where he did *not* bore, as where he did! or how Mr. Mylne becomes entitled to report that Mr. Smeaton's inveſtigation of a ſand (or ſoft matter) below, and a greater hardneſs or concretion of the matter above, as appeared to Mr. Smeaton, from driving the bar as already deſcribed, is an unfounded idea, Mr. Smeaton cannot ſee to ariſe otherwiſe

* It roſe ſo plentifully from the bottom as to employ near 40 men at the pumps.

than

than from an intuitive knowledge in Mr. Mylne that Mr. Smeaton does not pretend to: inaſmuch as that Mr. Mylne does not adduce the trial of any experiment whatever from whence that inference can fairly be made.

Mr. Smeaton, therefore, refers it to any impartial perſon who ſhall peruſe Mr. Mylne's reports referred to, and theſe obſervations upon them, whether it is Mr. Smeaton that has been *deceived* in the collection of facts and materials on which he eſtabliſhed his plan of operations; or that Mr. Mylne, after hearing every thing that Mr. Smeaton had to offer, has undertaken to judge of works in a condition from whence their original ſtate cannot now properly be judged of; and by examining many perſons concerned and employed in the detail of its execution; and relying on thoſe whoſe judgments were incompetent to the buſineſs; that Mr. Mylne himſelf, in the forming of theſe reports, has been *deceived* and drawn into a *precipitate* opinion.

I ſhall now conclude with obſerving, that had Sir Walter Blackett's bridge fallen in the day-time, when it could have been obſerved that the rapidity of the ſtream formed a fall of five feet, or even half of it, I never would have adviſed either Mr. Errington or the county to have ſet about the erection of another bridge at Hexham, either upon piles, or in any other method, unleſs the ſum of money to be expended upon it was unlimited. This ſingle fact would therefore, in the preſent caſe, have deterred Mr. Smeaton from propoſing the building at all, neither was, nor in its own nature could be known, till the flood that proved the ſudden deſtruction of the laſt bridge; though it had, without the leaſt damage, withſtood a flood when the fall was three feet nine inches, in conſequence whereof the water would acquire a velocity of about 900 feet in a minute.

And now, being maſter of theſe facts by the fatal deſtruction of this work alſo, he is unwilling to injure his reputation by the diſappointment of others, in attempting to erect another bridge at Hexham upon a limited ſum: that poſt of honor he leaves to be occupied by ſome more hardy or fortunate adventurer, remembering that a burnt child dreads the fire.

Grays Inn,
28th *June* 1788.

To