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16th February, 04

Mr. [REDACTED]
 [REDACTED]

Dear Mr. [REDACTED],

Clifton Suspension Bridge

I apologise for taking four months to reply to your letter of the 17th October last year. [REDACTED]

Thank you for the kind comments on the paper I gave at the Science Museum. I had prepared the paper in full before I delivered it, in anticipation of advanced copies being circulated before the meeting so that a more informed discussion could take place after the presentation. I would now like to address the points you raise in your letter.

The paper describes suspension bridge engineering as it was known and understood in March, 1831 when Isambard Brunel was appointed Engineer to the Clifton Suspension Bridge Trustees. His father, Marc, had made a minor contribution to this corpus of knowledge when he designed two small suspension bridges for the Île de Bourbon, a French island colony now called Réunion in the Indian Ocean. Other than that Isambard was reliant on the work of Samuel Brown, Thomas Telford and William Tierney Clark in particular, all of whom had designed what appeared to be, at the time of their construction, successful bridges. The Brunels, father and son, drew heavily on this technology when designing the bridge for Clifton. I would argue that Marc was the "lead" engineer, not Isambard. The design was refined and improved at the instigation of Davies Gilbert who was one of the two referees acting for the Trustees when evaluating the competing designs in March, 1831. In my judgment, there was only one unique feature in Isambard's design. Each bar of the catenary chain was joined to the next by a single pin. There was no short intermediate link which was a feature of Telford's, Brown's and Clark's designs.

In the lecture I drew the line across the page at March, 1831 as it was not my purpose to follow the development of suspension bridge engineering beyond that date because the 1831 design was seriously flawed. In particular, the deck was not rigid enough to withstand substantial wind loading which would have resulted in it "undulating" in an unacceptable, probably dangerous, way. This phenomenon occurred at Menai and had to be corrected. In fairness to Isambard, he recognised this later, that is after 1831, and produced two stiffened designs. Alfred Pugsley covers this and other weaknesses in

Isambard's Clifton design in *The Works of Isambard Kingdom Brunel, An Engineering Appreciation 1976*, 51 et seq. Incidentally, Marc's two bridges on the Île de Bourbon eventually failed.

John Hawkshaw, 33 Great George Street, was the Engineer to the London Bridge and Charing Cross Railway. This line was sponsored and part financed by the South Eastern to enable its trains to terminate in the West End of London. By this date, London Bridge, which the South Eastern shared with other railways, was overloaded. London Bridge was well sited to service the City but not the West End. Charing Cross was intended to provide a terminus in the West End.

Charing Cross station is on the site of the Hungerford Market. To give trains access Brunel's suspension footbridge had to be removed and replaced by the rail-cum-footbridge which exists today. The Committee, which later became the Board, of the Clifton Suspension Bridge Company, first met on the 22nd May, 1860 at 19 Great George Street, W. H. Barlow's office. Mark Huish was in the chair, also present in addition to Hawkshaw and Barlow were Christopher Claxton, an old friend and colleague of Isambard's, Charles Ward of Osborne Ward, the solicitors to the Clifton Suspension Bridge Trustees, J. R. McClean, an engineer of 17 Great George Street, Charles Waring, a contractor and John Cochrane, also a contractor. The next meeting was held on the 22nd June and, in addition to those at the first meeting, was attended by George Parker Bidder, 24 Great George Street, the incumbent President of the Institution of Civil Engineers, as you point out in your letter, and J. W. Miles, a banker whose firm were bankers to the Clifton Bridge Trustees.

Hawkshaw reported to the second meeting that the Directors of the London Bridge and Charing Cross Railway had agreed to sell the whole of the superstructure of the Hungerford Suspension Bridge for £5,000. This, of course, included the chains. Wythes, the contractor charged with dismantling and removing the old bridge, surrendered his rights for a small shareholding in the new Clifton Suspension Bridge Company.

There were many engineers and engineering contractors amongst the shareholders. The Board was similarly packed with engineers. In addition to Bidder (who purchased 50 shares) there were Hawkshaw (100 shares), John Fowler (50 shares), J. R. McClean (50 shares), George Robert Stephenson (50 shares). Amongst the contractors who bought into the Company was Thomas Brassey (100 shares). One can perhaps summarise the professional support for the Company by noting that, of the 44 people who held 20 or more shares, 17 at least were engineers or contractors. If one strips out Greville Smyth, the local grandee, the Trustees of the old Suspension Bridge and the Merchant Venturers, the figure becomes 17 of 41. The profession and its contractors held 23.6% of the authorised capital of the Company. If the Civils had not moved in, the Bridge would not have been finished. There was no economic case for it, a fact which was recognised at the time.

The Bridge as built was a "cheapie". It differs greatly from Isambard's original design, a point made by Mark Huish, the Chairman of the Company, in

January, 1865 at the first Half-Yearly General Meeting held after the Bridge was opened. Perhaps the best way of visualising what happened is to take the two towers which had been built by Brunel and the Hungerford chains as given: everything else changed. There were three chains, not two, the towers were heightened somewhat. The positions of the chain anchorages were changed, the deck of the bridge was stiffer and narrower. In the original 1861 design, two vehicles could only have passed each other on the bridge deck with difficulty. It was only on Smyth's insistence that the carriageway was widened by five feet, an improvement which he paid £5,000 for, that we have a Bridge today on which cars can pass each other with ease. Smyth's contribution was not charitable, he planned to develop the Somerset side of the river for residential purposes. In this he succeeded when he sold on part of his estate for this purpose. He made a handsome profit and recouped his £5,000 outlay many times over.

The Directors also "skimped" on finishing out the Bridge. The towers were not faced off, the stonework was left as built. Further, the Egyptian embellishments designed by August Pugin in 1831 were dropped. The Directors' decision to complete the Bridge in a minimal way was correct. Until the advent of the motor car, Clifton Suspension Bridge was grossly under utilised. It was only because the Company obtained the Trustees' assets, the land and towers in particular, in exchange for 200 shares i.e. £2,000 of paper, not cash, and the chains were purchased at a knock down price that the project could go ahead. The shareholders of the Company put up, in cash, less than 50% of the total cost of the Bridge.

All this is very different from the popular perception of "Brunel's" Suspension Bridge but it is what the contemporary records say and what was widely known in the early 1860s.

I agree with what you say about wrought iron working. The maximum size of the "lump" increased over time and longer chain bars could be manufactured. This is reflected in the increasing length of the bars for Clifton. As originally designed, they were to be 12 feet long. By 1832 this had become 18 feet and by 1838 20 feet. This last mentioned is the length of the bars as made by Sandys, Carne and Vivian and as eventually used on the Tamar Bridge at Saltash (Pugsley 55).

I hope this covers the various technical points in your letter. The other matters you describe, your relationship with George Parker Bidder and the Fripps are most interesting.

There are far too few good lives of Victorian engineers about, a great gap in our knowledge. Personally, I am very interested in John Hawkshaw but I do not intend to follow this up. I have just finished a biography of Henry Brunel, Isambard's second son. It stands little chance of being published but I have a "taker" for, say, a 15,000 word paper.

As far as a supplement to my paper is concerned, we could possibly do something worthwhile but one has to remember that after Clifton was finished,

there were very few major suspension bridges built in Britain until the late 20th century when the engineering was revived to cross the Severn, Forth and Humber. For the moment I am heavily committed to contributing a paper to a publication which is being prepared on "Engineering Disasters".

Yours sincerely,

Derek Portman

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