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CHIEF RESIDENT ENGINEER (BRIDGES) INFORMAL REPORT
WINDSOR END FOOTBRIDGE – M40. BEACONSFIELD BY PASS

(Report to Geoff Bond, the engineer who designed Windsor End Footbridge.)

The first people who took fright about it were “Kingsbury Concrete", sub-contractors to Leonard Fairclough who decided they could not work to a tolerance of 1/8 inch on length and after seeing their performance en the ordinary beasts I am not surprised. Jim Smith (who did the supervision of Kingsbury), Kingsbury and I all did calculations of anticipated shortening and finally we *agreed* a figure. However these worries did not matter in the end as we had other problems. Fairclough wanted to sub- let the steal work to a firm called Wright-Rain (called hereafter the right shower!) whose main work as large scale green houses although they did do the spans for the Jumbo Jet hanger at Heathrow which was all tubular. When we visited the site it was plain that they had very little experience of full depth butt welds although their welders were all Lloyds men and had been with them a number of years. It was also clear that they had tendered without very much appreciation of the amount of work involved for the steel tonnage and were plainly looking around for some extras if they were going, so this didn't auger very well.

We made one or two small alterations to the weld patterns and also fixed gussets to the angles and Universal Columns where they met. Our main problem during the fabrication was curling of the plates as the heavy welding proceeded. The bottom assembly was fabricated first and then the wide plates with the tee stiffeners. In the first one they hadn't allowed enough precamber and. the poor old plate did this (see diag i). They heated it, they hammered, banged and bullied it but never got it out completely and there are still marks on the out sides to prove it. However they were obviously learning as they went along and subsequent ones improved considerably.

The next bit of finger crossing was the top plates. McCalls said that they wouldn't be happy if there was any buckle in those and if the bearing of the threaded plate wasn’t flat on the underside as the bar would fail. I couldn’t see that a 2" plate would buckle but everyone else said that it had a big hole in it and it might. As it happens they did not, but what did give us trouble were the tapped plates supplied by Lee-McCalls, the hole spacing being very irregular and in one case 3/8 inch out. You may imagine what I began to think. We had a main Contractor impossibly clueless and inept, the steelwork with bowing plates which could throw the bars out of plumb, the holes not in the right place, a beam sub-contractor who could scarcely make a beam to an inch, plus other contractors for the hand-railing and coping. The more I thought about it the more worried I was that they would never be geared up for the pieces to fit.

I did not want to enlarge the duct holes either, for fear of weakening the section or of merely giving Kingsbury an even bigger opportunity of getting it wrong and the only way out seemed to pay as much attention as possible at every stage and try to anticipate the things that slight go wrong.

First of all we took a lot of care with the threaded end plates both in position and verticality. We got the best possible layout and had these checked by John Whale. The best way to see what effect the bars would have seemed to me to have a full set of ten bars actually at works, to offer them up with the plates welded and then make a plot of the final shape of the ten bars at the top as well as the bottom 1 also asked John to see if he could detect whether the bars were bent and if so if they wandered in an arc as they were screwed on, Trying them out also eliminated rough threads.

You may remember that in previous contracts we had an engineer from the office to make regular visits to fabricating or casting works and although this was not done in the Viaduct I did it on Beaconsfield because 1 had plenty to do and I was sure of getting good supervision from John Whale (steelwork) and Jim Smith (Kingsbury). I went up with them for critical things and also found an opportunity for the site Engineer to make one visit for say a beam test. Wright-Rain did find it difficult, in fact impossible, to locate any of the heavy Tee sections specified. I didn't want to accept anything smaller and although at first they proposed fabricating out of plate, when they had done their sums this was plainly so expensive that they asked to reconsider. In the end I made out a list of both Tees and beams (to be cut down) which I could accept and they finally found some heavy joist section.

The welding generally went fairly smoothly, we did some normal plate and weld tests but had no troubles except for a little laminating in one of the side plates. We had to introduce a joint in the main plates and this was tested rigorously. The shop painting was a bit of a panic because fabricating was left to the last minute. One painting sub-contractor backed out and his successors could not get the right grit for the blasting machine. Having got this right Griffiths Bros. suddenly ran out of primer and a special trip had to be arranged for the next batch immediately after testing. Evan then we could only get one colour.

The size of the column bases was a matter of comment from everyone who saw them. I had to assure them that I was responsible and also that whatever happened above they wouldn't collapse by failure of the foundations! We even ran the surface water drainage through them.

The erection (of columns) was fairly straight forward. Two they delivered and erected in one day and the third next day. The levelling devices worked well but there was just enough height in the two centre-line marks at top and bottom of the column to affect the position when the levelling screws were used.

Enough for the steelwork. The concrete beams were a real pantomime. Kingsbury had wanted to change to post-tensioning but this was not on. They procrastinated terribly, perhaps they were a bit afraid of the beams(not the only ones?!) anyway eventually they made up a special bed and started making up the shutter which really looked quite well. We had to add a bit more steel and alter a few things but nothing drastic and all quite normal. I must admit to being somewhat relieved that the first cantilever beam and subsequently the others behaved in a most exemplary fashion. The hog at the ends of the centre cantilever were slightly more than expected but we adjusted this on site. The only other deflection that was noticeable I can only show in an exaggerated diagram, (see diag 2.)

They got the special stainless steel dowels for the pin joint at the abutment all right but couldn't get a die to touch the steel! We had to put a bob on then and dispense with the bar and nuts. The suspended units were no particular trouble. We had a big argument about the method of transporting the cantilever units. They wanted to stick a bogie under the centre support and hold it at the tractor end using the beam as a tow. We eventually told them to do it properly and get on with it. Unfortunately they quoted a. job they had done for Gloucestershire which had been successful but Gloucestershire said they had never approved the method, were just getting round to ask about it only to find one of the beans was cracked on arrival.

There was a lot of talk and I would have liked a bit more action prior to the erection. It was at about this time that we changed agents the second having a lot more push, but his promises in some cases seemed worth little more than the other, we sorted out the staging and finally agreed to combine the jacking method of the staging with that of the crane, we also oscillated between lowering the beams over the bars and putting the bars in first and placing the resin bed first and afterwards. What we finally agreed to do was to arrange the staging so that the beams came down to the calculated thickness of the resin bed. The beam would be adjusted to line and

position with the jacks of the staging and crane and the McCall bars screwed in. The resin would then be pushed in all round.

I had some trials made using glass plates which were covered during packing and we found that this was well compacted and to avoid pushing from one side to the other we laid a little pattern of resin ribs before the beams were landed. You may imagine that this structure was attracting to itself a somewhat disproportionate amount of time and attention and at the start of the erection we had everyone down. It poured with rain nearly all that Friday which thinned the ranks a bit. The first beam landed was the north cantilever. This was lowered to within a few inches of the column and then the bars put in. The kentledge had been placed slightly away which meant that the beam wasn't level'. Rather than level-up the beam they pushed on, making the positioning of the bars very difficult. By early afternoon they thought that the beam was down but unfortunately they had only screwed the bars down about ¾". It took about half an hour to convince the agent that this length of thread would not take 67 tons.

That started a long haul for them because although we got them all in eventually it was difficult and the only way was to lock nut the top and take them down with spanners. The whole operation took about a week. We eventually got the centre cantilever on at about 8:30 at night and the south one on Saturday. The suspended spans were put in ten days later when all the bars had been screwed home. Part of the difficulty with screwing the bolts arose from the ducts in the concrete beams not being quite square or straight. We found it impossible to check the positions once the beams were cast but some were not straight and those in the centre cantilever we actually drilled out. The jacking was straightforward except that they could only get hold of one jack and they had to do the jacking in half bites. Two of the bars failed at 60 tons. We eventually got them out and found that the M.S. thread in the bottom plate had stripped after being screwed too tight. Unfortunately they were both in the South West corner and naturally we found that worst loading induced tension. I don't propose at this stage to try and describe the discussion that went on. It was very lengthy. In the end they accepted our suggestion that we should drill out into the column concrete, offer in a long bolt and grout up with a polyester resin. Fortunately we had had holes drilled in the U.C. members under the column top plate which permitted us to drill so we got a 1¼" dia. bolt down and put on 40 tons.

The copings were a bit of a trial as it was winter when they were done and the railings are not yet to our satisfaction, but the structure now is virtually complete and a subject of admiration from all who see it. The Road Research Laboratory (including Mr Leonard!) took great interest when they heard about it and made dire predictions about its safety. Leonard was particularly scathing about "civil engineering barbarians". His chaps saw the arguments more plainly and told me at the open day that Leonard had seen so much of this bridge he was beginning to appreciate what our problems were. They tested the bridge dynamically at three stages, main structure only (with copings), then with railings and finally with mastic, all these changing the characteristics. The results will not be out till October but what happened was that the railings and mastic dampened the oscillations, particularly the railings so that the natural frequency is out of the critical frequency of 2.7 - 3.2 c.p.s. and up to about 3.8. The bridge is lively but I'm sure that the fixity helps and I wasn't worried as soon as we had the suspended spans on. One characteristic is that the differences in span length improve the damping.

J. B. Powell
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