GIRR Woodside 2: Precast Beams and Half Joint Tests

To facilitate tight control over the quality of concrete on Woodside 2, all structural concrete was produced, placed and tested on site under the control of the Contractor, Balfour Beatty and supervision of Scott Wilson Kirkpatrick & Partners.

In addition, all precast, prestressed, post-tensioned beams were constructed on site.

The photograph [left] shows a skewed edge beam, a standard edge beam, a standard internal beam and a skewed internal beam 'curing' and awaiting installation.

The edge beams weighed approx 80t and the internal beams approx 40t.

Beam length was approx 85ft [26m] and depth approx 5.25ft [1.6m].

The photograph below shows an edge beam with reinforcement, prestressing tendons and ducts in position awaiting steel shuttering prior to placing concrete.

A skewed edge beam half joint on completion of test with jack removed and supported from the underlying ground. Note the steel cable rock anchors, the steel jack support block [resting on the underlying rc pile], the DEMEC strain gauge points and, in this case, the unusual main crack running from the bottom of the beam rather than from the 'root' of the half joint.

The design of half joints for the precast, prestressed, post tensioned beams for Bridges 11 and 12 was a matter of considerable discussion. Standard design philosophy [for rc joints] included diagonal reinforcement close to the internal corners of half joints but placing such reinforcement in the congested ends of prestressed concrete beams was seen to be difficult. Alternative design philosophies, with only vertical shear reinforcement, looked like they might produce a more practical solution. In due course, it was decided to test various designs, with and without diagonal reinforcement, for 'right' and 'skewed' edge and internal beams.

Short, lengths of test beams, including sections of top slab 'deck', were constructed with different half joint designs at both ends. A bored, cast-in-place rc pile was driven to rockhead and steel cable rock anchors were constructed adjacent. A pneumatic 'jack' positioned on top of the rc pile provided the upward thrust to the half joints and this was restrained by the rock anchors located an appropriate distance beyond the half joint. The ends of the test beams were painted white and DEMEC strain gauges were used to determine the strains at each increment of test load.

The DEMEC strain gauge consists of a dial gauge attached to an Invar bar. A fixed conical point is mounted at one end of the bar and a moving conical point is mounted on a knife edge pivot at the opposite end. The pivoting movement of this second conical point is measured by the dial gauge. Pre-drilled stainless-steel discs were attached to the test beams using an epoxy adhesive. Following each loading increment, the conical points were inserted into the holes of the discs and the reading on the dial gauge noted. In this way, strain changes in the test beams were converted to readings on the dial gauge. Cracks, which developed as the test loads reached their upper limits, were marked on the white paint using indelible marker pens and photographs taken. The information was then sent back to the Bridges team at Park Circus for analysis and finalisation of the designs.

One of my jobs was to take the DEMEC strain gauge measurements, record the results and mark the developing cracks! This was a trifle unnerving at the start but, fortunately, none of the half joints actually failed during test!

While I was not involved in the analysis of the test results, it is my recollection that no diagonal reinforcement was included in the final design and that only vertical shear reinforcement was required. The tests had proven the design philosophy and the half joints have, as far as I can see, performed satisfactorily in operation for the last 45 years.

It has always seemed to me a great pity that this series of tests [and indeed other unusual and innovatory aspects of bridge and structural design pioneered by Scott Wilson], the results and the subsequent design issues were not written up at the time and published or presented as a paper to the Institution of Civil Engineers or Institution of Structural Engineers!

There will be progress photographs showing these tests more clearly in the Scott Wilson Scotland Archive currently held by Michael MacLean at Aecom, Tyndrum Street, Glasgow.

JP McCafferty June 2015.