J P M Cafferty.

ST. JAMES INTERCHANGE
Improvement

April 1992

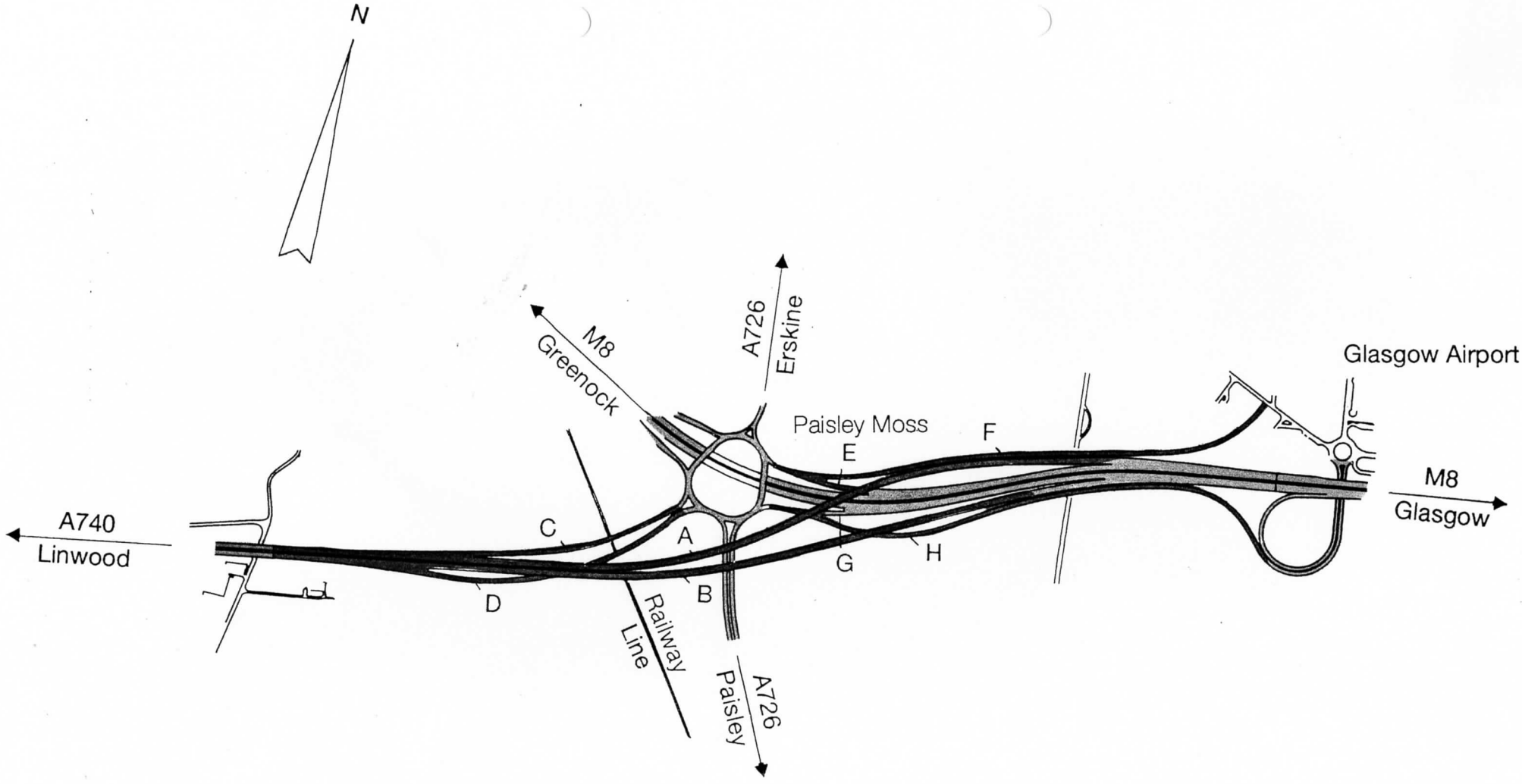
THE SCOTTISH OFFICE

Strathclyde

Balfour Beatty Construction (Scotland) Limited

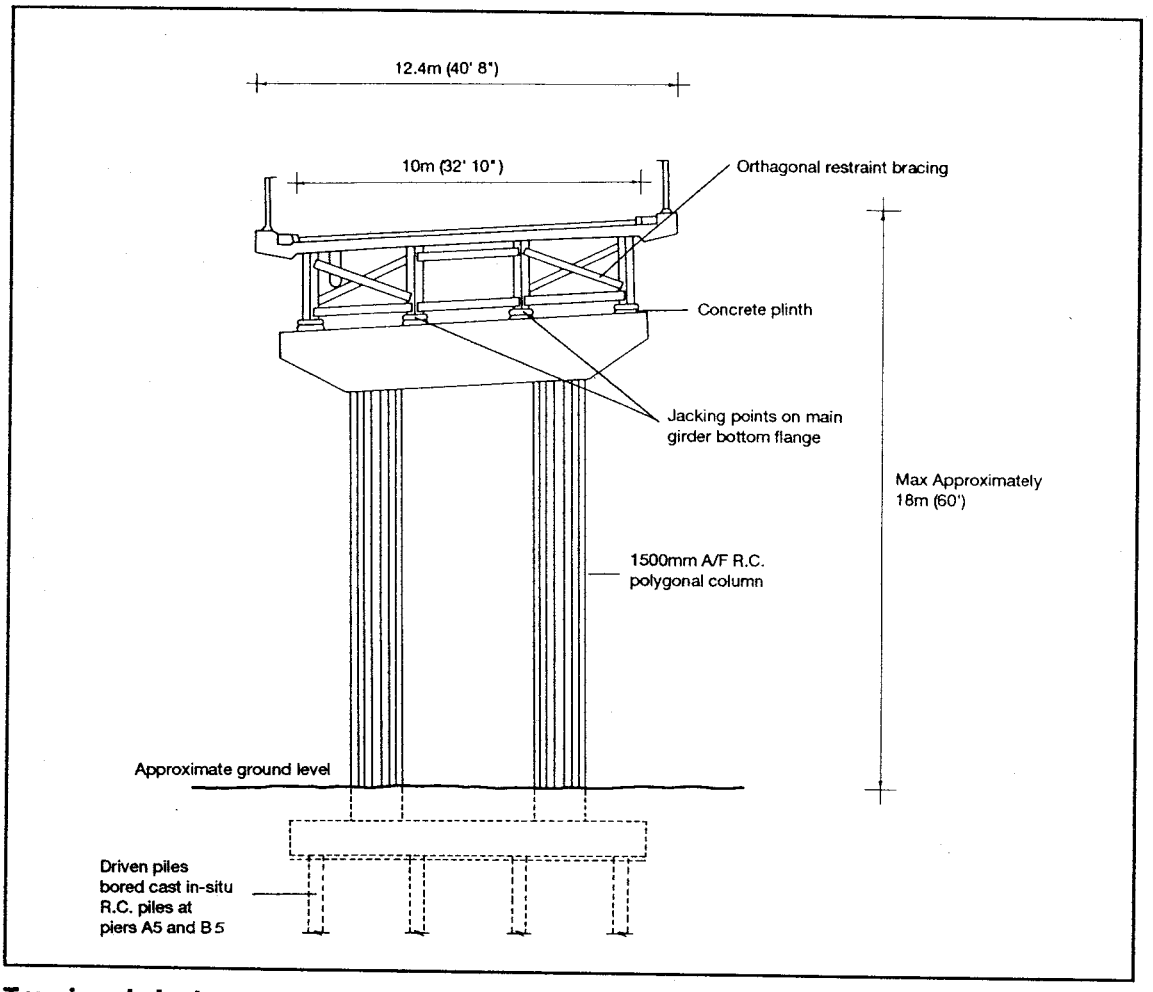
Scott Wilson Kirkpatrick

C O N T E N T S



DIRECTOR OF ROADS DONALD CARRUTHERS, C.Eng., F.I.C.E., F.I.H.T.	ST JAMES INTERCHANGE	DRAWING No. NW/StJ - P140
		SCALES 1:10000
NEW WORKS (PAISLEY) REGIONAL COUNCIL OFFICES COTTON STREET, PAISLEY PA1 1ST	STRATHCLYDE REGIONAL COUNCIL - DEPARTMENT OF ROADS RENFREW DIVISION	FILE No. RI/C158
		DATE ISSUED May 89

F A C T S H E E T



Typical Intermediate Support

Viaduct A:

16 No. Spans Total Length 790 Metres (2,590) width 12.4 metres (40 feet 8"). Span Length 35 - 55m (115ft -180ft) with Max Span of 64m (210ft) over M8 Deck - 4 No. 2.1000 metre (6ft 11") girders cross-braced in pairs with 250mm (10") thick reinforced concrete deck slab.

Total weight of steel in deck is approximately 2,300 tonne (colour - GRAPHITE).
Total weight of concrete in deck is approximately 8,440 tonne.

Viaduct B:

15 No. spans Total length 740 metres (2,340ft) width 12.4 metres (40ft 8")
Span Lengths 40 - 51 metres (131ft - 167ft) with Max Span of 67m (220ft) over A740 Deck details as per A above

Weight of STEEL in deck is approximately 2,100 tonne
Weight of CONCRETE in deck is approximately - 8,330 tonne

Columns - 1.5 metre diameter (5ft) multi facetted.

Foundations - Mainly 285 x 285mm Driven precast concrete
Hercules Piles Bore Insitu Piles adjacent to Railway (to avoid vibration)

4 SUMMARY SHEET DETAILING MAIN CONTRACTUAL DIFFERENCES FROM THE I.C.E. (5TH EDITION)

- Own Time Construction Period.
- Lump Sum Contract.
- Design and Build responsibilities.
- Contractor solely responsible for assessing site conditions.
- No provision for extra payment for unforeseen circumstances.
- Contractor to pay all fees and charges (including railway possessions).
- Contractor to implement a Quality Assurance Plan and pay all testing involved.
- 20 years serviceability maintenance period in respect of settlement.
- Contract price fluctuation provides VOP from 42 days before Tender date to Start of works

5 BACKGROUND

For years traffic congestion at the St James Interchange has increased at peak hours primarily due to the restricted capacity of the existing elevated roundabout. This has caused extensive queuing on the A740 during the morning peak, and on the M8 during the evening peak. The queues on the M8 restrict the opportunity for weaving between the Airport and the interchange itself thus increasing the risk of accidents.

As these problems would be exacerbated once the Johnstone/Howwood Bypass opened, the Scottish Office invited Strathclyde Regional Council to undertake a study to examine the problem in detail and make recommendations.

The report recommended the construction of a grade separated junction with direct links between the A740 and the M8 and direct links between Glasgow Airport and the existing St James Roundabout. The revised layout was designed in accordance with Technical Memorandum TD22/86 to cope with the predicted flows.

As a short term solution, to redistribute congestion on St James Roundabout, peak period traffic signals were installed at each entry and exit in December 1989. Currently, over a 16 hour monitoring period, 60,000 vehicles pass through the Interchange. This flow is increasing at a rate of 4% per annum.

Late in 1989 it was decided to promote this project as a "Fixed Price Design & Construct Competition". The scheme was advertised in the E.C. Journal on 14.9.89 and in the New Civil Engineer on 21.9.89 as a Design & Construct Competition. 13 firms expressed an interest in the competition and were sent a prospectus with five page questionnaire covering design experience, construction experience, financial backing and requesting details of the C.V.s of their senior staff. Six Consortia completed and returned the questionnaires confirming their interest in participating in the Design & Construct Competition.

These six Consortia were interviewed during December 1989, each interview lasting a minimum of two hours.

A short leet of 3 No. Consortia was finalised in April 1990. These were

- Balfour Beatty/Scott Wilson Kirkpatrick
- Tarmac Construction/Sir Alexander Gibb
- Norwest Holst/Acer Scotland

Tenders were issued in May 1990 with a Tender return date in November 1990, subsequently rescheduled to January 1991.

During the tender period , a joint site investigation was arranged by the Tenderers to meet their design needs. The cost of this was reimbursed by the Client to the successful Contractor who repaid to the unsuccessful bidders their share of the costs.

Prior to return of the tenders the Tenderers were required to attend interviews in September 1990 at which they were questioned regarding their draft proposals for the design and the logistics of their construction sequence.
Tenderers were then required to make a presentation to the Royal Fine Arts Commission for Scotland in October 1990 and were required to take cognisance of the points raised by the Commission.

The Tenders were returned on 30th January 1991. In addition to offering to carry out the Works at a fixed price the Consortia were required to specify their construction duration in weeks.

In order to compare and assess the offers made, an additional appendix was included in the Appendix to the Form of Tender which took account of construction duration and the structural form chosen. The sum calculated in this way was used for ranking the tenders.

The Balfour Beatty/Scott Wilson Kirkpatrick Consortium won the tender for a fixed price sum of £27,497,035.49 with a construction duration of 98 weeks. Work commenced on site in September 1991. Construction is programmed to be completed by August 1993.

6 AGENT AUTHORITIES ROLE

[Strathclyde Regional Council]

Project Management

Normally S.R.C. would be commissioned by the Scottish Office to design and supervise the construction of the Works.

In this project, S.R.C. still carried out the geometric design, prepared draft road orders and land plans. The statutory process leading to the orders being made ran in parallel with the tender period.

To reduce the risk to the Contractor the major public utility services were diverted in advance of the works (Value £0.7M). In addition, major accommodation works, including the construction of 21 football pitches, the provision of a drainage outfall and protection works to Paisley Moss were carried out during the tender period (further £0.8M).

The Consortia designed the Works during the tender period with the final design continuing into the construction phase.

During the tender period more than 400 pages of correspondence and 240 pages of questions and answers on the interpretation/clarification of the design brief/specification were compiled into 2 volumes which became contractual.

These volumes covered such diverse topics as:

- Conditions of contract;
- Geometry;
- Drainage
- Geotechnics;
- Structures;
- Accomodation Works;
- Lighting;
- C.I.T.R.A.C.;
- Motorway Telecom System; and Sign Gantries

Site Supervision

The Role of the Purchaser's Resident Representative

Since site supervision is being undertaken to a Quality Assurance Scheme (BS5750) implemented by Balfour Beatty, the traditional role of the Resident Engineer has been replaced by that of a Purchasers Resident Representative.

As part of their Quality Plan, Balfour Beatty have produced Works Procedures which set out how they intend to carry out each site operation, and Inspection Plans which give the status of each operation. The P.R.R.'s staff check Balfour Beatty's compliance with these Procedures, Inspection Plans and of course the Specification and Conditions of Contract.

Two-weekly programmes are produced, updated weekly and, in addition, a daily "Notice of Intent" is supplied which enables the Depute P.R.R. to assign daily monitoring activities to S.R.C. site staff.

If a procedure does not comply the monitoring engineer issues a Departure Report which results in Balfour Beatty raising their own Departure Notice. A discussion with S.R.C. staff may ensue if the Contractor disputes that there is a Departure. The matter is closed out by either (a) the Contractor invoking corrective action or (b) the Client granting a concession. In this way Balfour Beatty take charge of their own affairs ensuring that the standard of workmanship and materials meet specified requirements.

The powers of the Engineer, and those delegated to the P.R.R., are not in any way diminished on the St James Interchange Improvement Contract when compared with a conventional contract. This contract was written in such a way that the P.R.R. retains the authority of the Engineer as per the I.C.E. 5th Edition should the Contractor's compliance with his Quality Plan be found to be lacking.

With regard to measurement this is a fixed price contract. As part of his tender submission the Contractor was required to produce a priced Bill of Quantities with summary sections for each link of the Works. The Contractor submits his measurement using the Bill of Quantities as the basis and an assessment is made by the P.R.R. of the proportion of work carried out in each section prior to sanctioning payment.

7 CONTRACTORS' ROLE

[Messrs Balfour Beatty Construction (Scotland) Ltd.]

The non-conventional role of the Contractor in this type of Contract is a considerable change to the normal custom and practice. The responsibility for risk and uncertainty passes to the Contractor with advantages and disadvantages perceived in this new role.

During the pre-tender stage the Contractor's involvement was more substantial and time consuming. Tenders for design and construct involve the Contractor in a considerable outlay in terms of resources and cost. To minimise this, by agreement prior to tendering, the completion of the detailed design followed award of the Contract. This allowed more time to prepare and plan the Works prior to taking possession of the site. However, it was necessary to progress the design stage quickly since any slippage extended into the construction phase. The various work packages had to be prepared and approved timeously to meet the strict programme requirements set.

The contractor's responsiblities under the contract are mainly:

- 1.The role of leader in the design and construct team.
- 2.Design all aspects of the work and ensure compliance with the brief and statutory requirements.
- 3.Produce all documentation during both design and construction stages, the record drawings for all works, and maintenance manuals for structures.
- 4.Construct, complete and maintain the Works including all remedial works required to be carried out during the guarantee period.
- 5.Cope with design changes resulting from site conditions while still maintaining progress and meeting performance requirements.
- 6.Institute and maintain, for the term of the Contract, a Quality Plan to BS5750 to ensure and demonstrate compliance with the requirements of the Specification.

Advantages perceived by the contractor:

- 1.Contractor as leader can influence the design and buildability and thus effect economic construction.
- 2.Contractor can instigate design amendments which suit his strengths and technical expertise, and introduce innovative methods of construction.
- 3.The Contractor has primary responsibility for the Works. Thus he can exercise more choice, subject to Contract limitations, in selection of materials and construction methods.
- 4.More certainty in final price.
- 5.Adversarial aspects of Contract are less than in a traditional Contract.
- 6.Contractor has more control and influence on work affected by risk.

Obligations:

The responsibility for risk and uncertainty is increased:- i.e.

- 1.Construction related - Design developement, which result in an increase in work content while being bound by a fixed price during construction period.
- 2.Physical - Risks for unforeseen ground conditions are shouldered by the Contractor.
- 3.Contractual - changes to form of contract, amended I.C.E. (5th) Conditions of Contract - Risks for certain delays, etc. are also shouldered by the Contractor.

- 4.Performance and Quality
  -The Contractor's change of role necessitates a reappraisal of the Contractor's responsibilities regarding testing, quality arrangements, performance and productivity. [20 year Guarantee Period for settlement compared to the one year maintenance period required by a traditional contract under the I.C.E. (5th).]

General

Operations on site are not significantly different from a normal contract but the role of each member of the design and construct team has changed.

The Contractor/Consultant team have established a good working relationship which has led to improved buildability on the project, greater control over the events occurring on site and with closer teamwork the partnership have been able to overcome problems that have arisen faster than on a conventional Contract.

The Contract is at present on programme and we anticipate completion by the due date, August 1993.

8 DESIGNERS' ROLE

[Messrs Scott, Wilson Kirkpatrick & Partners]
In a typical major roadworks project, the Consulting Engineer would plan and design the scheme to the Client's brief which typically would consist of published national standards. The detailed design would be based on the Consultant's interpretation of the brief, his aspirations for the finished product and his view on economics of materials and construction methods.

Design and construct is quite different. The Designer has to join a consortium with a Contractor (who will lead the team), convince the Client of the ability of the Consortium to perform, and thereafter produce the most economic design consistent with the brief which permits the Contractor to submit the lowest tender for the project. The cost of tendering is high and there are no prizes for runners up.

In the particular case of this contract the design effort was divided into three main stages:

- i) Initial Submission
- ii) Preliminary Design (pre-tender)
- iii) Final Design (post-tender)

The initial submission detailed the capability of the Contractor and Consultant and was submitted to the Client in December 1989. Even at this early stage it was necessary to present initial thoughts on structural form and traffic management measures to the Client's interviewing panel.

Formal invitations to tender were issued in May 1990. The invitation incorporated Tender Procedures, Design Brief and Specification for the Works. Horizontal and vertical geometry were provided. However only horizontal geometry was considered to be fixed as there was a certain amount of leeway in the vertical alignment. Preliminary design commenced immediately and concentrated on those elements of the job with major design implications: Structural layout and form, geotechnical analysis and foundation design. At two stages during the Preliminary Design it was necessary to submit details of the design to the Client's panel. In September 1990, Outline Proposals were submitted which gave details of the design of the following elements:

- Structures - Foundation Types
- Structural Form
- Articulation Arrangements
- Arrangements for Inspection and Maintenance
- Materials and finishes
- Construction Proposals
- Roadworks - Embankments including control of settlement
- Geometry changes
- Drainage

In December 1990 a further Pre-Tender submission was made giving additional details of Geotechnical and Structural design aspects. Although much of the design effort necessarily concentrated on structural and geotechnical aspects, the design was sufficiently advanced to allow a comprehensive Bill of Quantities to be prepared for tender. Tenders were submitted in January 1991.

Following the award of the Contract to Balfour Beatty, in April 1991, the final design commenced. The Client had properly allowed a reasonable amount of time for design to take place prior to work commencing on site in September 1991.

The design of the interchange was split up into a series of "packages" which reflected different work elements and different lead times necessary prior to work commencing on site. For example 26 weeks lead time was allowed for structural steelwork, whereas only 6 weeks were required for drainage and most roadworks items. Typical design packages were as follows:

- Drainage
- Road Pavement
- Railway Bridge, Substructures
  Viaduct A, Deck Spans 5 - 10

In general the design proceeded to an agreed programme based on the packages. At the time of writing (April 1992) the issue of design packages is substantially complete.

Some of the major features of the design are described below:

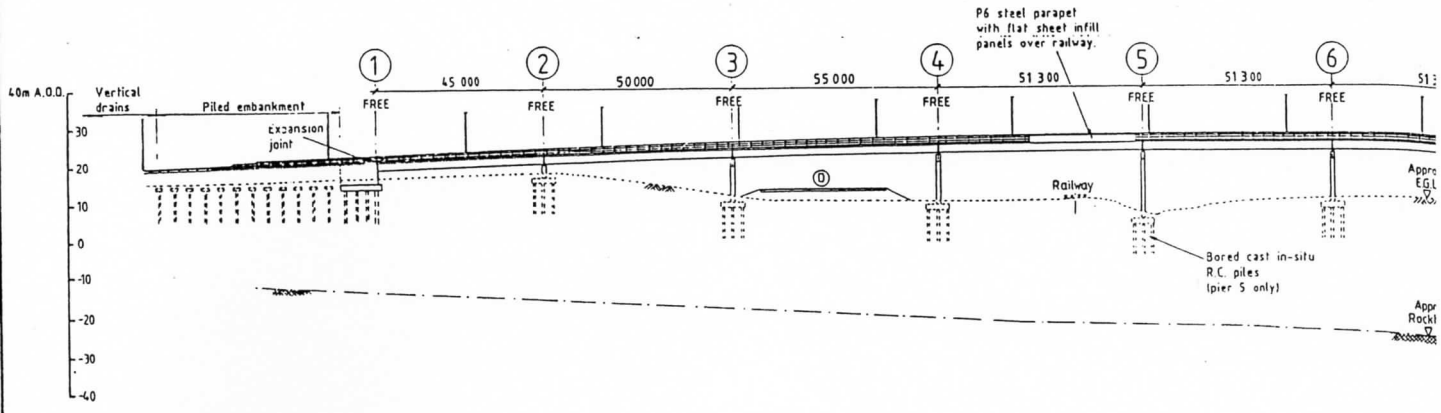
Viaducts A & B - The multi-span decks comprise an in-situ reinforced concrete (RC) slab acting compositely with four steel plate girders. Glass fibre soffit formwork is used for the deck. The substructure consists of an RC crosshead supported on twin RC multifaceted columns which in turn are supported by precast driven piles, except adjacent to the railway where bored piles were required.

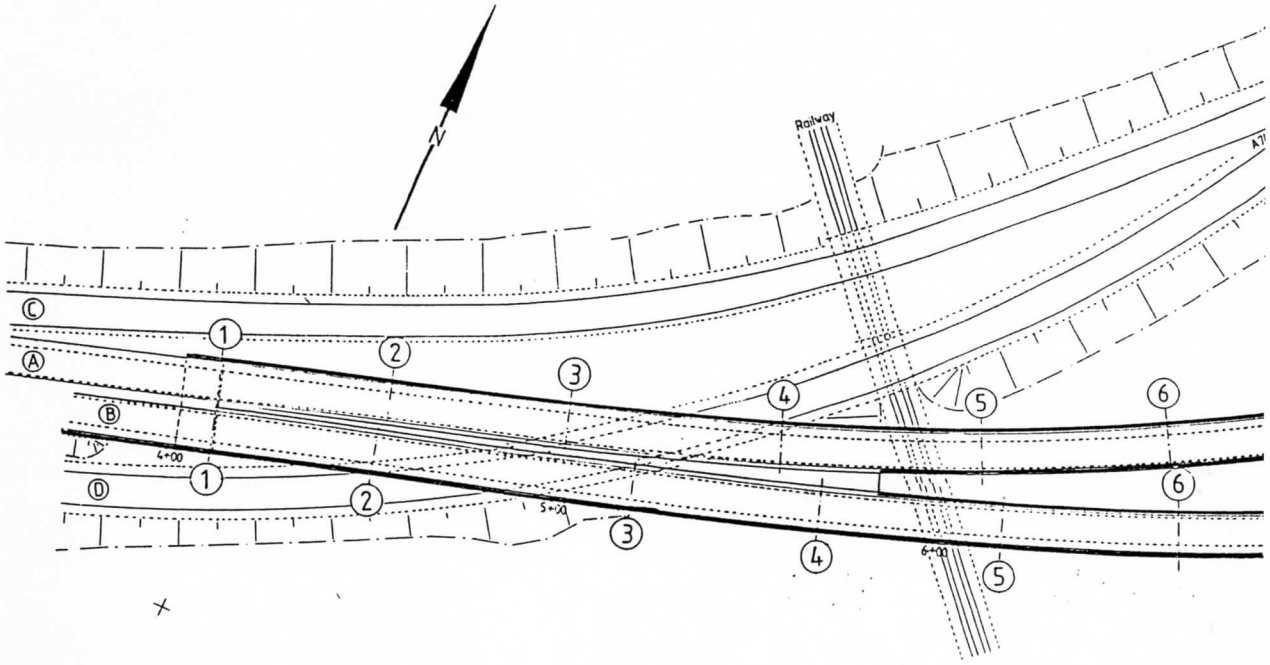
Railway Bridge - Again the three span deck comprises an RC deck slab acting compositely with steel plate girders. In this case, weathering steel is used to minimise maintenance requirements. The intermediate piers and bank seat abutments are carried on bored RC piles.

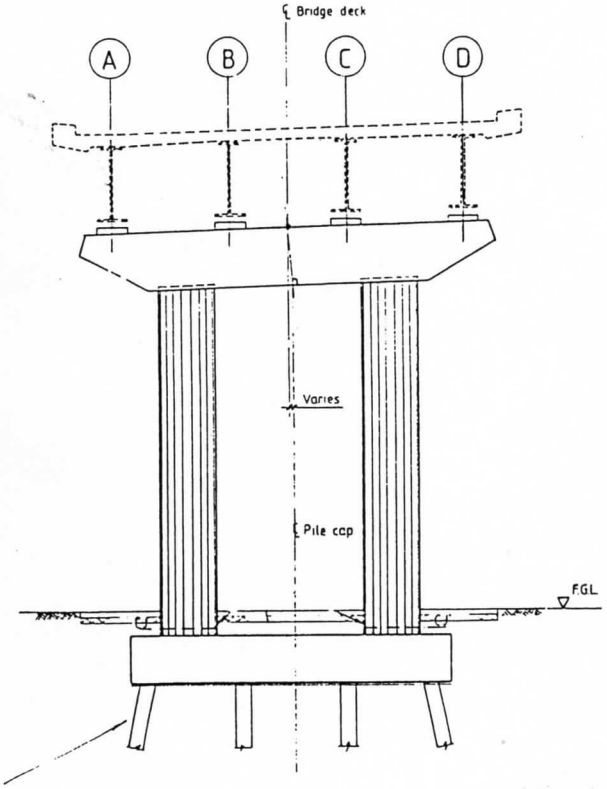
Embankments - Ground conditions are generally poor and the contract contains significant requirements for reducing the effects of settlement, particularly within 100m of structures, over a 20 year period. All structures are piled and, immediately adjacent to abutments, a transition zone is provided where embankments are supported on a geofabric sandwich which spans between discrete pile caps. Outwith this area band drains have been installed beneath embankments and surcharge has been added during construction to reduce any long term settlement effects. Similar measures were taken where new embankments are "stitched on" to existing slopes.

The Designer has a representative on site to act as the focal point for day to day liaison with the Contractor and also, from time to time, to monitor the adequacy of the Contractor's Q.A. System and to inspect the Works and report to the Designer accordingly. Much of the initial work on site concentrated on monitoring pile testing which was intended to verify design assumptions. In the event pile performance was not wholly as expected and an amount of derating has been carried out. Liaison is continually required to ensure that the effects of any altered construction sequence or method on the design are identified at an early stage.

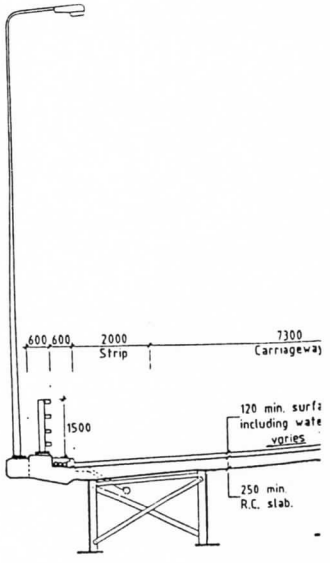
Scott Wilson Kirkpatrick and Company (Scotland) Ltd are responsible for the design of all civil and structural aspects and are assisted by Holford Associates for landscaping works.



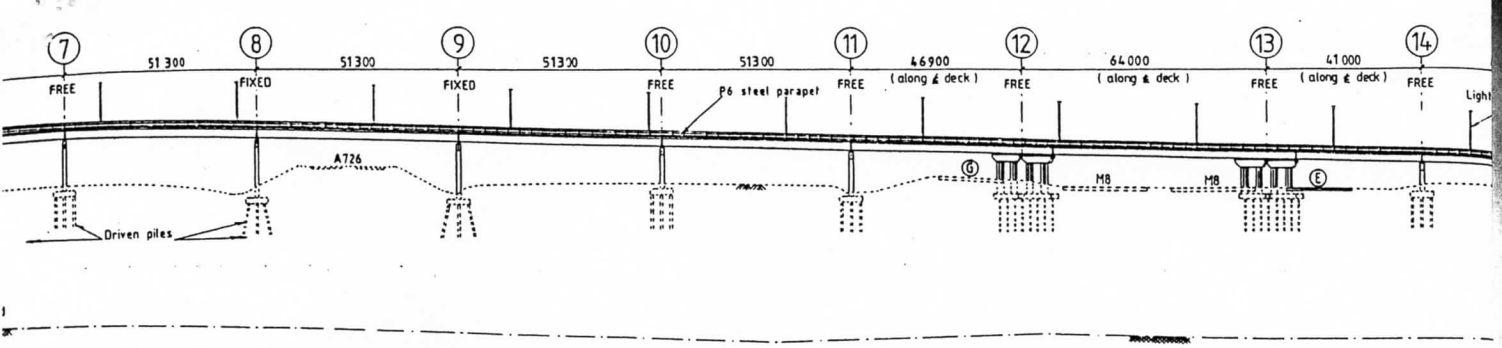




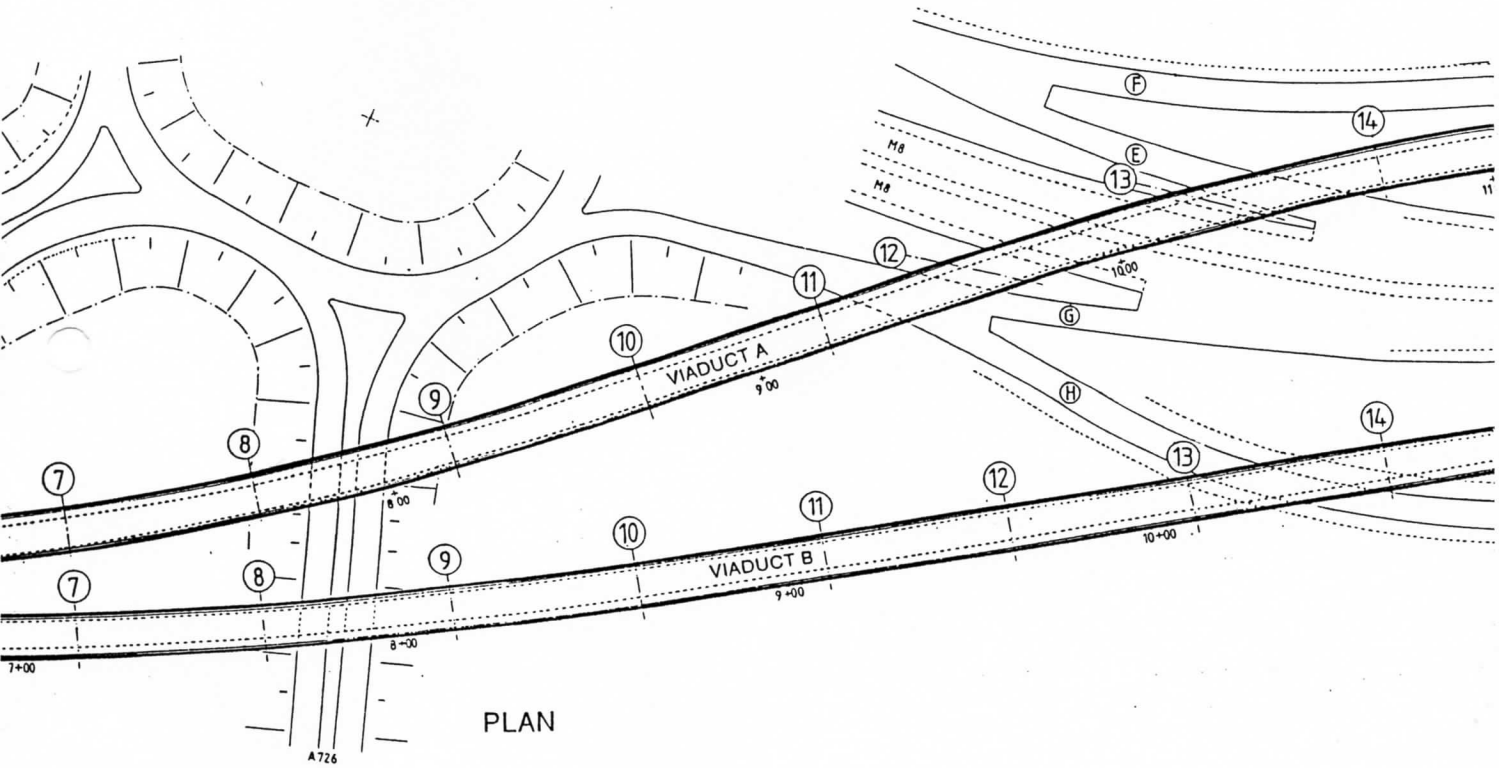
COLUMN AND CROSSHEAD



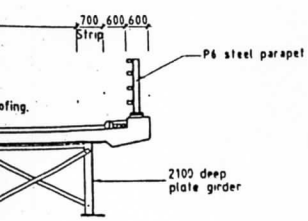
DECK CROSS

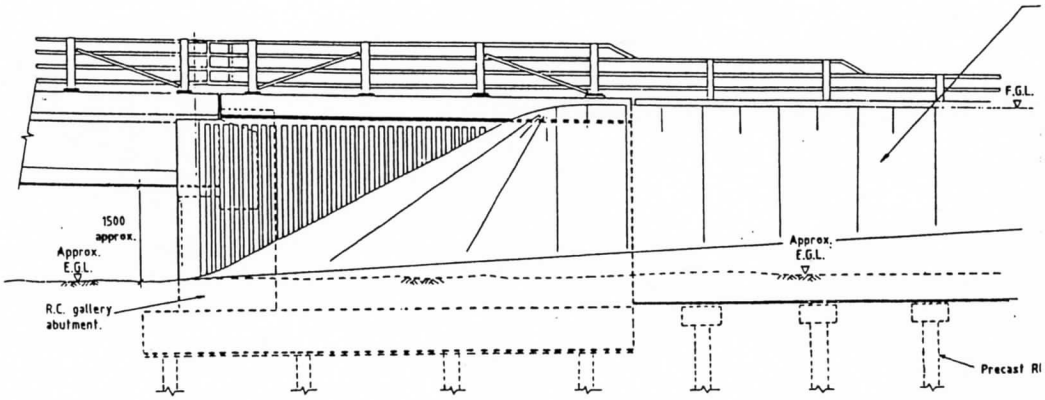


LONGITUDINAL SECTION – VIADUCT A



PLAN

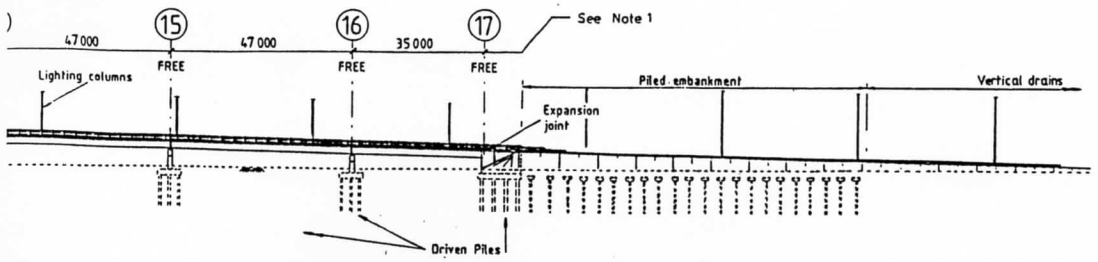


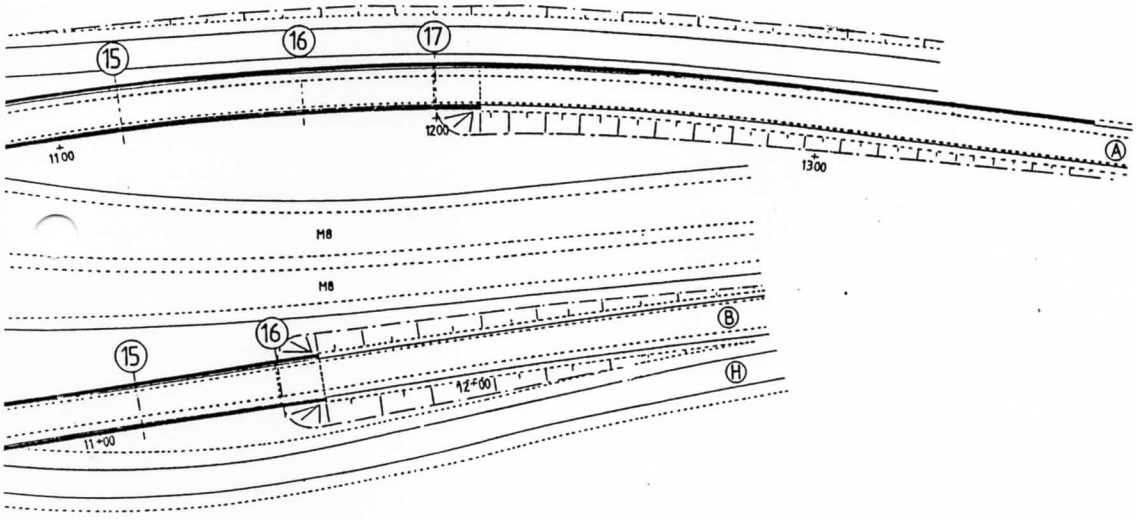


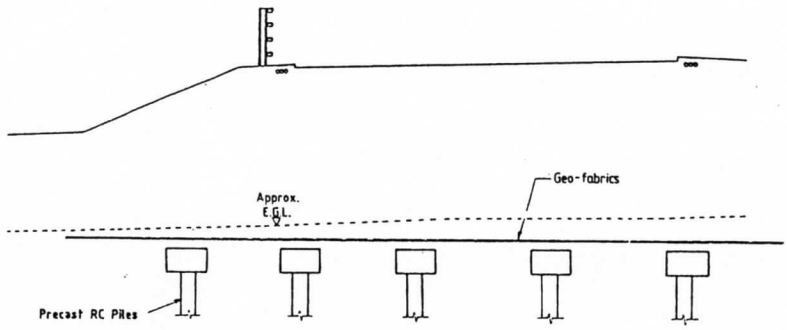
ECTION

TYPICAL ABUTMENT

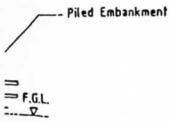
ST JAMES INTERCHANGE - VIADUCTS A AND B

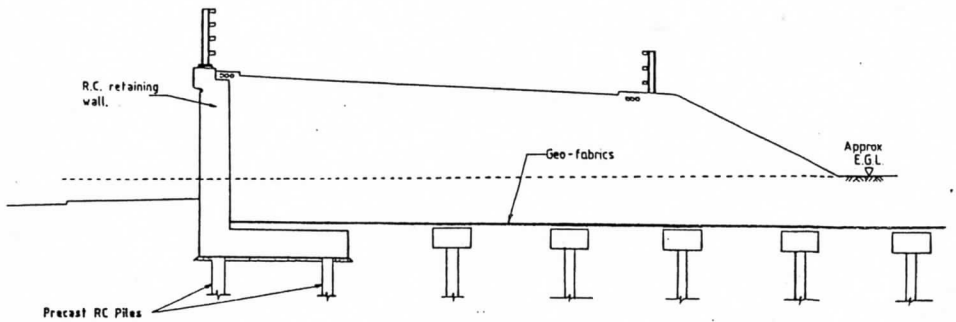






VIADUCT B APPROACH EMBANKMENT





VIADUCT A APPROACH EMBANKMENT