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M8 ST JAMES INTERCHANGE

DESIGN & CONSTRUCT

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1. Introduction

By the late 1980's, it had become clear that traffic congestion caused by the restricted capacity of the overhead roundabout at St James Interchange on the M8 adjacent to Glasgow Airport was so serious that major improvements were required to eliminate the extensive queuing on the A740 (Linwood to Glasgow) at morning peak hour, and on the off ramp (from the M8 to Linwood) at the evening peak hour.

On behalf of the Scottish Office, Strathclyde Regional Council (SRC) studied the problem in detail, recommending, among other improvements, that direct links be constructed from the A740 (Linwood) to and from the M8 over the existing interchange.

In 1989, traffic lights were introduced as a temporary measure to regulate peak hour flows on the overhead roundabout and a decision was made to promote the project as a Fixed Price Design and Construct Competition, the largest roads project to be procured by this method in the UK to date.

2. The Design Construct Competition

The project was advertised in the EC Journal in September 1989. Of the thirteen firms which expressed interest, six provided the required further details and were interviewed in December 1989. From these, three 'consortia' (Balfour Beatty/Scott Wilson Kirkpatrick, Tarmac/Gibb, Norwest Holst/Acer) were invited to tender.

Documents were issued in May 1990 and Tenders were to be returned by November 1990 although this was subsequently changed to January 1991. SRC provided the Specifications and all other documentation including the geometry, a 'MOSS' ground model and photographs for large photomontages.

During the Tender Period, detailed proposals had to be submitted in September 1990; Royal Fine Art Commission for Scotland interviewed the 'consortia' in October 1990 and 'pre-tender' information had to be submitted during November 1990.

The Conditions of Contract were based upon the ICE 5th Edition with the following major differences:-

- Contractor to decide Contract Period
- Fixed Price Lump Sum Contract
- V.O.P. from 42 days before Tender to Commencement of Work
- Contractor to pay all Fees
- Contractor to design and build
- No payments for unforseen conditions
- 20 year guarantee period for settlement of embankments behind abutments etc
- Contractor to pay for all testing
- Quality Assurance system required

The settlement criteria were onerous. All structures were to be piled, all settlement was to be completed before opening the road and there was to be no differential settlement on, or damage to, the existing works or drainage.

Differential settlement behind the new abutments was not to exceed 20mm and any change of gradient up to 100m behind each abutment was not to exceed 0.1%.

Ground investigation information was provided by SRC but Tenderers were invited carry out a joint G.I. managed by SRC's own consultant. The three tenderers shared the total cost but the Joint Promoters reimbursed the winning Tenderer who in turn reimbursed the two losers.

Tenders were assessed by SRC by adding to the Fixed Tender Sums:-

- £43,750 for each week required to completion
- £200,000 for steel composite decks
- £100,000 for partial enclosure
- Zero for complete enclosure and for prestressed or reinforced concrete decks.

Balfour Beatty, having submitted the lowest Fixed Tender Sum and being lowest by the method of assessment, were awarded the Contract in April 1991. Final design commenced immediately followed by construction in September 1991, with completion due in August 1993.

3. Ground Conditions

Ground conditions are poor with varying thicknesses of alluvium and glacial till overlying mudstone or sandstone at between 30 and 40 metres down. Made ground also existed over some parts of the site and the glacial till was much thicker towards the west where, it is of interest to note, the engineers of an earlier age wisely sited the railway line that crosses the site.

It was predicted that settlements of up to 700mm would occur as a result of compression of the alluvium beneath the proposed embankments.

That such settlements had taken place in the past was evident at the approaches to some of the bridges on the existing M8 where there is a noticeable 'ski jump' effect.

4. The Design Construct Process

Balfour Beatty and Scott Wilson Kirkpatrick worked closely together during the tender period to establish all the major requirements for design and construction that would be necessary to meet the clients requirements in the most cost effective way. During this period, sufficient preliminary design was carried out to ensure an adequate level of confidence in cost estimates and technical feasibility.

Following the award, Scott Wilson Kirkpatrick completed the Final Design to a Programme agreed with Balfour Beatty which took account of client approval periods, independent checks and construction periods.

The Contract allowed a period of 5 months for designs to be advanced prior to the date for commencement of the works. Final Design continued through the initial period of construction and refinements and changes were implemented as situations arose during the remaining construction period. Construction commenced in September 1991 and is due for completion in August 1993.

5. The Viaducts

The Viaducts, 740m and 790m respectively, are the most striking feature of the new interchange. Initial investigations established the most economic form of deck construction and the most cost effective span length taking account of the relative costs of deck, substructure and piling.

As it had been decided that embankments approaching the viaducts required to be piled to prevent settlements taking place, the next decisions concerned the cut off points in cost between viaduct and piled embankment. These points, once established, dictated the lengths of the Viaducts and the abutment positions.

The most cost effective scheme utilised precast concrete piles driven to rock or into the boulder clay (except adjacent to the railway where shell auger cast-in-place piles were used); multifaceted pairs of r.c. columns about 1.5m dia supporting r.c. crossheads, and superstructures of steel plate girders acting compositely with r.c. deck slabs.

Span lengths vary from 40m to 67m, piles are up to 43m long and the maximum pier height is 14.5m. The anchor piers are located close to the centre of each viaduct and guided bearings at the other piers allow free movement to expansion joints at the abutments.

6. The Railway Bridge

At first consideration an insignificant structure carrying a slip road over the electrified railway line, this turned out to be a challenging structure to design and one critical in terms of the construction programme.

The design challenge resulted from the very tight headrooms allowed over the electrified railway and between slip road and main viaducts. It is probable that, when establishing the road geometry, the client had in mind a short span structure on closed abutments similar to an adjacent bridge that had been constructed over the railway prior to electrification. As it was not possible to consult with ScotRail prior to Tender, decisions as to the form of construction had to be made based on experience as to that which ScotRail would accept on award and which would cause minimum interference with the railway operations.

It was decided to adopt very shallow plate girders (only 600mm deep) acting compositely with an r.c. deck continuous over three spans of 16, 20 and 16m supported on piled r.c. piers and bank seats. The piles were all shell auger cast-in-place r.c. up to 30m long and the plate girders are in weathering steel in accordance with the client's specification and ScotRails requirements.

7. Geotechnical Works

With such large potential settlements expected beneath embankments, it was necessary to adopt one of two approaches; cause the settlements to take place as quickly as possible or prevent the settlements from taking place at all.

Depending on predicted times for consolidation, estimated costs and the construction programme, decisions were made as to where band drains should be constructed and consolidation accelerated by surcharging embankments and where embankments required to be piled and over what areas and lengths. As a result, the areas behind each abutment were piled using driven precast piles. Granular fill reinforced with several layers of geosynthetics was then constructed as a 'pile cap' on top of the piles to support the overlying embankments and thus eliminate settlements.

Transition zones employing a combination of both techniques were introduced between these conflicting systems to ensure smooth road profiles following construction.

Extensive use of geosynthetics and piles was also adopted where new embankments had to be 'stitched' into existing construction.

8. Conclusions

This has been a challenging project for all concerned and one in which innovative design and construction techniques have been employed in a novel contractual situation.

The client had prepared a detailed specification stating exactly what the technical, aesthetic and contractual requirements were; he has had no significant contractual claims to deal with and the job will be completed on time at a fixed cost with little or no conflict between the parties. Scottish Office and Strathclyde Regional Council have every reason to be satisfied with the outcome.

The Contractor has had to take on very significant risks at a fixed cost but he has had the compensation of being master of his own destiny and he has been able to influence the design to suit his own requirements and to deal with unforseen situations as they arose on site. Like most contractors Balfour Beatty prefer to say little on commercial matters, but they appear to be reasonably happy about how things have turned out.

Scott Wilson Kirkpatrick is, in effect, the Design Subcontractor. This may not be as satisfying or as influential a position as that of the Engineer and it is certainly much more risky, but there has been a harmonious relationship with all parties and, clearly, Design and Construct projects create more roles for consultants to play, so it can be assumed that we are reasonably happy too.

Will this method of procurement result in a blandness in design or a lack of innovation?
Will out-turn costs be higher? Logic dictates that they must be, but of course they can be 'fixed lump sums' which clients seem to find more attractive than shared risk and out-turn costs being higher than tendered sums.
Is this an improved form of procurement?
Is there a catch?
Only time will tell.
In the meantime, we are pleased to be part of a successful team.

Scott Wilson Kirkpatrick

CONSULTING ENGINEERS

CREDITS

Joint Promoters

The Scottish Office, Roads Directorate

The Director of Roads, Strathclyde Regional Council

The Contractor

Balfour Beatty Construction (Scotland) Ltd

The Designer

Scott Wilson Kirkpatrick, Consulting Engineers