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GOGAR ROUNDABOUT GRADE SEPARATION

DESIGN & CONSTRUCT

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1. Introduction

In May 1991, Lothian Regional Council (LRC) invited expressions of interest from consortia interested in constructing grade separation at Gogar Roundabout on a Design and Construct basis. This permitted Scott Wilson Kirkpatrick together with Balfour Beatty Construction (Scotland) Ltd to capitalise on their experience developed on the M8 St James Interchange Project.

Gogar Roundabout lies on the western approaches to Edinburgh at the junction of the A8 Glasgow-Edinburgh Road, the A720 City Bypass and South Gyle Broadway. The roundabout, reputedly Scotland's busiest junction, carries more than 100,000 vehicles per day. Although congestion on the western outskirts of Edinburgh is well known, the promotion of road improvements has suffered delays and this has had a restraining effect on development. As part of a planning agreement, Marks & Spencer with ASDA agreed to finance capacity improvements at Gogar Roundabout. A study had indicated that the construction of a flyover on the line of the A8 would free capacity on the roundabout (already signal controlled) and permit easier access to the development sites. The infrastructure improvement had to be completed before the superstores could open and LRC considered that the tight timescale required the use of design and construct procedures.

2. The Tender Process

The competition followed what is now a fairly standard process. Consortia expressed interest and were interviewed on their capability, experience and approach to the project. Three were selected to proceed to the formal tender stage. Following tender, the contract was awarded to Balfour Beatty Construction (Scotland) Ltd with Scott Wilson Kirkpatrick as their Designer. During the tender period, LRC processed outstanding planning issues, land acquisition and accommodation works. Topographic and subsoil surveys commissioned earlier were made available to tenderers.

The ICE Fifth Edition formed the basis of the Conditions of Contract with the following significant differences:-

- Fixed Price Lump Sum Contract
- Contractor to design and build
- No payments for unforeseen conditions
- Contractor to arrange for diversion of services
- 20 year guarantee period for settlement of embankments behind abutments, concrete and steelwork maintenance, bridge bearings, movement joints and waterproofing
- Quality Assurance system required
- Contractor to pay for all testing detailed in the Quality Plan

As the various statutory authorities would not enter into contract with the main contractor, alternative arrangements had to be made.

3. Preliminary Design

The time allowed for design and construct was particularly short (c. 15 months) and it was evident that design decisions taken pre tender would have to be robust to permit the final design stage to proceed expeditiously; of course, this had to be balanced by economy of design to ensure the lowest tender cost. The first task was to review the clients requirement for increased capacity at the junction. At-grade options were developed ranging from complex signal controlled channelisations to multiple gyratories and squareabouts. They could all be shown to work (and indeed be expanded to cope with future requirements) but there were doubts concerning signing, safety and operational aspects. It was concluded that grade separation would provide the optimum solution.

It was clear that a flyover solution could be developed although there were interesting constraints; a height restriction imposed by the CAA due to the proximity of the secondary runway at Edinburgh Airport and the requirement that provision should be made for extending the City Bypass north towards the Forth Road Bridge. Would a north-south flyover be required? Possibly, but CAA restrictions would preclude it. Was it possible to flyunder? Yes, but not in the north-south direction due to the presence of a major sewer and other constraints. It became clear that the best solution would be to take the A8 beneath the roundabout in the east - west direction leaving flexibility for future links to the Forth Bridge. Tender procedures required submission of a complying flyover scheme, but permitted alternatives. The Balfour Beatty/Scott Wilson Kirkpatrick alternative was an east-west 'flyunder'.

In terms of traffic operation, overall geometric layout and services problems the complying and alternative schemes were essentially the same. The form and scale of the structures provided the main differences between the schemes. LRC were convinced of the flexibility afforded by the flyunder proposal and accepted Balfour Beatty's alternative tender in March 1992.

4. Roadworks

Preliminary design concentrated on the two main issues affecting the layout:-

. Maintenance of existing traffic flows through the junction at all times.

. Minimising the time and cost implications of service diversions.

A scheme was developed to cater for the traffic flows. Essentially the approach ramps were widened out to allow the underpass to be threaded beneath the junction. To achieve the space for widening, the roundabout was extended slightly to the north. The construction of the new bridges over the underpass required the provision of two temporary links across the roundabout but these presented little problem.

It was then necessary to fine tune the design to minimise service diversions. The roundabout contained the usual plethora of underground services including an 1850mm diameter sewer, a 200mm gas supergrid, 33kv cables, BT fibre optic and trunk cables together with a range of distribution pipes, ducts and cables.

It was considered essential to avoid interference with the BT fibre optic trunk cables which followed the A8 east-west through the junction. This required the introduction of reverse curves along the line of the underpass but these will be scarcely discernable to road users.

5. Geotechnics

The site investigation data issued by LRC confirmed that subsoil conditions were generally good and that further site investigation (which would have been at the tenderer's own expense) was not warranted.

The sub soil comprises thin layers of made ground and alluvium overlying glacial till and sandstone or mudstone. The alluvium deposits are medium dense silty gravelly sand about 2 to 3 m thick. The underlying glacial till is more than 20m thick, heavily over-consolidated and very hard. It was concluded that while ground conditions were generally favourable, areas of wet alluvium might present some local problems and the presence of boulders might affect piling operations.

6. Structures

There are two main structural elements in the scheme: the retaining walls forming the underpass, and link bridges carrying the roundabout over the underpass. The underpass could not be constructed in open cut due to the presence of services and other restrictions; major retaining walls were necessary. However, through the central portion of the roundabout it was possible to dispense with the wall on one side and form a batter slope which minimised any 'canyon' effect. Due to site constraints, it was not possible to construct conventional walls and hence, some form of piled solution was required. Tied back sheet pile, bored pile and diaphragm walls were all considered but rejected in favour of more cost effective bored cast-in-place piles designed to cantilever out of the glacial till. At the link bridge abutments, further economies were achieved by using the decks as props. Pile diameters varied depending on the retained height and an in-situ reinforced concrete facing provides a pleasing and conventional finish.

The 23m span link bridges are designed to carry 14m wide carriageways together with verges/footways. An M-beam form of construction was proposed with an in-situ concrete deck slab. Both decks were slightly skewed to accommodate the curved carriageway of the roundabout.

7. Final Design

Roadworks design was relatively straightforward but there was a need for many meetings with the service authorities to ensure adherence to the programme and to avoid possible areas of conflict. Substantial effort was also needed on drainage design to ensure that adequate outfalls were available to new sections of road as they were constructed in stages.

Detailed structural design focussed on the possibilities of effecting savings on the outline tender proposals. Finite element analyses of the retaining walls were carried out to rationalise the pile diameters with respect to exposed height of wall. Pile diameters varied from 600mm for an exposed height of 2.8m to 1050mm for an exposed height of 6.7m. Detailed consideration was given to the design of the in situ facing to ensure that account could be taken of out of tolerance piles. The bridge decks were purposely designed to be symmetrical. The choice of a propped structure permitted a simple articulation detail to be developed which avoided the need for extensive inspection galleries. LRC required two sign gantries to be incorporated within the scheme. Rather than develop a site specific solution, approval was obtained for the use of a standard precast concrete gantry that had been developed for the Scottish Office. It is to be hoped that this gantry will be adopted as the standard for future roads contracts in the region.

8. Construction

From the Designer's viewpoint the construction phase has been relatively straightforward with few problems. Any difficulties that did occur, or indeed client variations that were ordered, were expeditiously dealt with by constant dialogue between the design and construction teams. Given the tight construction programme, speedy reactions were essential. For example, following completion of the roadworks and wall geometry design it was discovered that BT cables were not at the depth expected which resulted in a significant redesign effort. In terms of the piling the positional accuracy was excellent and caused no difficulties, however significant boulders were encountered and wet alluvium proved locally problematical as expected. Despite the care taken in the pile facing design this operation was not without its difficulties. The effort put into services design was well directed as many of the delays typically encountered in a roadworks project were avoided.

9. Conclusion

The project is on schedule and due to be opened to traffic in July 1993.

The client received the full benefits of design and construct in that his initial ideas for the project were widened to his advantage and delivered within the required timescale. The Designer and Contractor built upon their previous experience to work within a particularly demanding programme. However, to achieve this they were exposed to considerable cost and risk as a result of the effort required pre-tender. As winners we continue to be part of a successful team but it must be noted that there were no prizes for the losers who also expended considerable effort. It is interesting to speculate as to whether or not a design competition followed by a fixed price tender might provide an acceptable alternative method of procurement. Perhaps, as is often suggested, the need to address ongoing problems as quickly as possible would not be properly fostered under that arrangement.

The completion of grade separation at Gogar will indeed permit easier access to the new superstores in South Gyle, but in terms of the traffic congestion in the west of Edinburgh it is only one link in a complex chain. Any improvement at Gogar will be constrained by lack of capacity on the adjacent sections of the A8 in the short term. It is to be hoped that in the longer term a Gogar 'Flyover' will have a part to play in future links to a new Forth Road Bridge.

CREDITS

Client

Lothian Regional Council, Department of Highways

The Contractor

Balfour Beatty Construction (Scotland) Ltd

The Designer

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