Raith Bridge

Inspection, Assessment, Strengthening & Remedial Works

Client
Amey as Maintenance Agent for Transport Scotland
Duration
2000 - 2006
Fees
£700k
Contact
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Raith Bridge, which was constructed in 1971, carries the busy M74 over the River Clyde adjacent to Strathclyde Country Park, near Hamilton.

The bridge comprises two independent decks with a clearance gap along the central reserve. Each superstructure consists of three continuous spans of twin steel box girders acting compositely with a concrete deck slab, supported on reinforced concrete abutments and piers founded on piles.
Scott Wilson undertook the principal inspection and assessment of the bridge, which identified the need for extensive repairs, strengthening and refurbishment works to ensure the structure complied with current standards and was able to function correctly. Of particular concern was the closure of the expansion gap at the north abutment and malfunctioning articulation, which had caused severe cracking of the abutment curtain wall. The findings were summarised in a Draft Strategy Report (DSR), which was presented to the Client. Due to the complexity of the proposed remedial works and the potential for major traffic disruption, the Report recommended that they should be designed and constructed in two separate phases; Phase 1 comprising the strengthening of the steel box girders and diaphragms, and Phase 2 comprising replacement of the abutment curtain walls and bearings.

Phase 1 commenced in 2002 and involved the detailed design of strengthening of the steel boxes, contract documentation and site supervision. Scott Wilson designed additional steel plates to enhance the capacity of the webs and flanges and in-situ concrete diaphragm strengthening. In addition, jacking plinths and internal box strengthening was designed to facilitate future bearing replacement. Throughout the design particular attention was paid to the safety and speed of construction bearing in mind the need for “confined- space” working and the location of the project. The site works commenced in 2004 and were successfully completed in September 2005.

Phase 2 commenced in August 2004 and included the detailed design of replacement abutment curtain walls and wingwalls, replacement of the north abutment bearings, refurbishment of the south abutment bearings, concrete repairs and replacement of the movement

joints, waterproofing and surfacing for both carriageways. During the design phase Scott Wilson were further commissioned by the Client to investigate the capacity of the strengthened Raith Bridge under abnormal SV loading.

Complete carriageway closures were necessary to undertake the Works. Therefore, the design made extensive use of pre-casting to minimise disruption, and ensure the safety of the workforce and the public. Before the work commenced on site, a routine inspection of the structure revealed further serious cracking of the north abutment bearing shelf due to seizure of the bearings and the consequential restraint of thermal contraction of the deck. Scott Wilson was required to act quickly to design emergency jacking plinths to enable the bridge deck to be supported whilst the bearing shelf was quickly repaired.

Scott Wilson assisted with the preparation of the contract documentation and supervised the Works, which were completed satisfactorily in July 2006.

SWSL were then asked to develop and cost a programme for a proposed scheme, which would include both the identified strengthening and remedial measures and the preferred options for the replacement of the existing lighting columns and the upgrading of the bridge parapets. The results of this exercise were included in a Costing Report, which then formed the basis of a presentation to the Scottish Executive Investment Decision Makers, Meeting with a view to acquiring the necessary funding to allow the project to proceed in the near future.

SWSL's work on this project has demonstrated the Company's capability to provide a fully comprehensive range of services associated with the assessment and maintenance of major Highway Structures. Our wide experience in this field, gained over many years of successfully designing all types of highway structures, has provided us with the necessary skills and knowledge to take a project from the first initial inspection, through the structural assessment process and ultimately, if necessary, to the design of any required strengthening or remedial measures.

3. M74 RAITH BRIDGE

Raith Bridge is a three span structure carrying the M74 Glasgow - Carlisle motorway over the River Clyde, adjacent to Strathclyde Country Park in South Lanarkshire. The bridge comprises two independent decks with a clearance gap along the central reserve. Each superstructure consists of three continuous spans of twin steel box girders with composite insitu concrete slab decks. The end spans are both 42.7m between centres of abutment bearings and piers. The main central span measures 51.8m between the centre lines of the piers.

Both decks were designed to be fixed longitudinally with metal rocker bearings at the south abutment, pinned at the intermediate piers and guided longitudinally at the north abutment. The abutments are reinforced concrete cantilever structures on piled foundations. The intermediate piers are reinforced concrete columns with a hinge joint at the connection to their bases. The pier bases are supported on piled foundations.

Scott Wilson Scotland Ltd. (SWSL) was commissioned in 1997 by South Lanarkshire Council to carry out an inspection and Stage 3 Assessment of the M74 Raith Bridge to determine its adequacy to carry the 40 tonne Assessment Live Loading and to consider the HB capacity of the structure.

This initial assessment and inspection identified that the webs and bottom flanges of the steel box girders were overstressed under the 40 tonne Assessment Live Loading in the regions over the intermediate piers and that the abutment and pier diaphragms did not fully comply with the requirements of the current assessment and design standards.

The other principal defect noted at this time was that the expansion gap between the end of the deck and ballast wall had closed. This has resulted in contact between the end of the girders and the north abutment ballast wall at the free end of the structure. The sliding guided bearings on the north abutment were observed to be at, or close to, the full extent of their range of movement. In addition, the ballast walls to both abutments were found to be badly cracked and in generally poor condition.

SWSL monitored the movements of the bridge, due to seasonal changes in temperature, between October 1998 and October 1999 in an attempt to establish the possible reasons and consequences of these articulation defects. A Monitoring Report issued in November 1999 concluded that the most likely reason for the closure of the expansion gap was the forward movement of the bridge abutments shortly after construction, but that the abutments had now apparently stabilised.

In 1999 SWSL also completed a further, highly detailed analysis of the steel diaphragms, using complex finite element methods. This analysis established that all of the diaphragms were significantly over-stressed and required strengthening.

In April 2001 the Scottish Executive appointed Amey Highways Ltd as the Term Operating Contractor for the South West Scotland Trunk Road Unit. AHL commissioned SWSL to consider the possible strengthening options available which would address all the defects identified in the earlier assessment work and to develop the most appropriate scheme to strengthen the bridge whilst minimising any disruption to the Motorway. A Strategy Report produced by SWSL in February 2002 recommended that the required remedial and strengthening work be carried out in two phases. It was proposed that the steel box girders and diaphragms would be strengthened under Phase 1 and that the problems associated with the closure of the expansion gap and the current poor condition of the existing abutments, would be addressed by replacing the existing abutment ballast walls with new precast concrete elements under Phase 2.

The detailed designs for the strengthening to the steel box girders and the new precast concrete abutment ballast walls were both completed in 2004. During inspections carried out by SWSL, during the preparation of these designs, a marked deterioration in the condition of the existing north abutment bearing shelf was noted. The free sliding bearings had apparently locked in place in their fully extended position during the summer and, when the bridge subsequently contracted at the onset of winter, the bearing shelf was then subjected to significant tensile loads for which it had not been designed. This had resulted in major structural cracking to the bearing shelf with a very real danger of the collapse of the concrete section located immediately below the bridge bearing.

Emergency repairs were considered necessary to stabilise the condition of the abutment bearing shelf and SWSL were instructed to quickly design the necessary strengthening measures and to incorporate them into Phase 1 of the strengthening works. This was successfully achieved and the Phase 1 works are currently ongoing on site and are due to be completed in early 2005. The Phase 2 works are scheduled to follow on closely after the completion of Phase 1 in 2005.

SWSL's work on this project has further demonstrated the Company's capability to provide a fully comprehensive range of services associated with the assessment and maintenance of major Highway Structures. Our wide experience in this field, coupled with the considerable resources of our UK wide staff-base, gives us the capacity to respond quickly to changing circumstances, such as those brought about by the sudden deterioration in the Raith Bridge substructure. We were able, at very short notice, to successfully expand the original steel box girder strengthening scheme to include the full detailed design of new reinforced concrete elements to safeguard the structural integrity of the bridge.