Notat: Utredning av høye rekkverk på Askøybrua

Vedlegg 6:

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Erskine Bridge Parapet Replacement.

Erskine Bridge Parapet Replacement

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Abstract

Since its opening in 1971 there have been a steady number of suicides and attempted suicides from the Erskine Bridge. Transport Scotland came under pressure to take action to stop these incidents and a wide range of options were considered. In late 2009, a decision was taken to replace the existing parapets with new "anti-climb" parapets. The new replacement parapets were constructed in 2012.

This paper describes the design development and construction of the new parapets. This included the testing of full-scale prototypes to assess the difficulty of climbing, and wind tunnel tests to investigate the effect on the main cable stayed span. A particular challenge was the need to incorporate gates to preserve safe access to the under-deck maintenance gantries

Keywords
Erskine, Parapets, Barriers, Suicide, Anti-Climb, Cable Stayed

1. Introduction

Erskine Bridge carries the A898 road over the River Clyde, approximately 15km west of Glasgow city centre. The A898 is a dual carriageway with 2 lanes in each direction and forms an important part of Scotland's road network, being the only fixed link across the River Clyde downstream of the Glasgow urban area. The bridge was originally tolled, but tolls were abolished in 2006.

Figure 1: Erskine Bridge with the new parapets installed

The bridge is 1.3km long and has 15 spans., The main span is 305m, with 110m anchor spans either side and 68m approach spans[1]. It is a high level crossing with the deck approximately 60m above the river, see figure 1.

The deck structure is a steel box girder with cantilevers, see figure 2. The main span is cable stayed with the cables and two steel towers in the central reserve. The cantilevers support a cycleway and a footway on each side of the bridge. Under the footway there are water and gas services. Access to these services is from travelling maintenance gantries suspended under each cantilever, although the footway panels are removable for major maintenance.

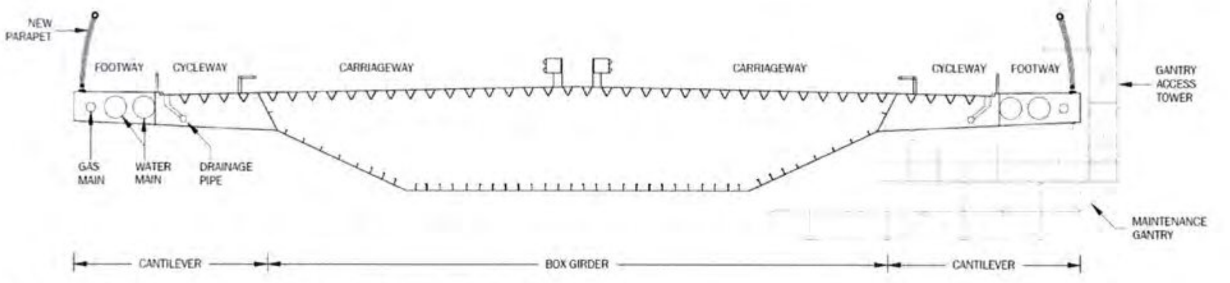

Figure 2: Typical Cross Section of Erskine Bridge

2. The Suicide Problem

Ever since the bridge opened to traffic in 1971 there have been frequent incidents of people jumping or intending to jump from the bridge to commit suicide. The original bridge parapet was 1.2m high with three horizontal rails, see figure 3a, which made it very easy for people to climb up and over the parapet.

Figure 3a: Original Parapet

Figure 3b: Mesh screen over Old Dumbarton Rd

Historically, many of those jumping from the bridge chose to jump onto the Old Dumbarton Road which passes under one of the north approach spans. It was thought that despite the reduced height of the deck at this point, the certainty of instant death through falling onto a hard surface, as opposed to falling into the river, attracted suicide victims. In addition there was a vandalism problem in which objects were kicked, thrown or dropped from the bridge onto nearby properties.

In an attempt to solve both of these issues, a 1.7m high mesh screen was added to the existing parapet in 1983/4 as an anti-climb measure for a 200m length of the bridge. However this was insufficient to prevent all suicides onto the residential area below. The screening was subsequently raised in height in three separate stages, so that by 1994/95 the height was 2.3m high, see figure 3b. This achieved the aim of protecting the road and residents below, although effectively only displacing the suicide problem further along the bridge.

Further anti-suicide methods measures followed in 1999/2000:

- Public telephone booths were installed at the 4 four corners of the bridge, with Samaritan posters displayed inside.
- New frequent 'high visibility' signage was fixed to the existing parapets at closely spaced intervals along the bridge, drawing attention to CCTV cameras and existing bridge SOS telephones (7 each side).

It was also recognised that one suicide could sometimes lead to a series of copy-cat incidents. Therefore an informal agreement was made with the local and national media not to report articles about suicides from the bridge.

However in October 2009 there was a particularly tragic event, in which two vulnerable teenage girls jumped from the bridge in an apparent suicide pact. The initial event and the subsequent Fatal Accident Inquiry both featured prominently in local and national media. Between this event and the construction of the new parapet, there was an increase in the number of suicides and attempted suicides from the bridge.

Transport Scotland came under pressure from local residents and politicians to take action. In late 2009, the decision was taken to replace the existing parapets with new "anti-climb" parapets. However, in the course of the Fatal Accident Inquiry there was no criticism of Transport Scotland. On the contrary, the parapets complied with current standards, and there was evidence that all reasonable precautions had been taken by Transport Scotland to prevent people committing suicide from the Bridge.

3. Finding the Solution

Transport Scotland, through its Term Maintenance Agent, Amey, appointed Flint & Neill Ltd to review the parapet design and propose means of reducing suicides. Initial studies concentrated on options for extending or replacing the parapet, but it was always recognised that there were wider solutions to this problem [2]. Alternative non-construction related options also considered include the following:

- Restrict pedestrian access - it is suggested that suicides are less common from structures without public footpaths. However at the Erskine Bridge, the footpaths and cycleways are well used by the public and with no convenient alternative route, closure would meet with strong opposition. Hence closure was not deemed acceptable.
- Employee training and regular patrols - Although there are maintenance staff frequently working on the structure, there is no round-the-clock staffing of the structure. The costs of introducing a permanent staff presence were prohibitive and there was weak evidence that suicide patrols work.
- CCTV – Further high tech CCTV cameras were considered in detail. However, it was decided that the cost of continuous monitoring was prohibitive, and there was no evidence as to the effectiveness of CCTV Cameras
- Reduce response times of rescuers - Without significant expenditure on a continuous site presence, there will always be a time delay before an emergency crew could arrive on site to intervene. The police and emergency services, including the Clyde Coastguard *(helicopter and rescue boat provision)*, further developed their emergency procedure protocol for efficiently dealing with any suicide or attempted suicide incidents.

Having exhausted other possible courses of action, construction of an anti-climb barrier was the only option left to pursue. The Erskine Bridge Local Group *(which included representatives from Transport Scotland, Local Authorities, Community Councils, Police, NHS, Samaritans and Breathing Space)* were in agreement that an anti-climb barrier was the best solution and there was good evidence as to its effectiveness [2] [3] [4]. However, all parties involved were aware that there would be limits to what could be achieved, as no barrier is impossible to climb.

Solutions at other bridges were considered [5], although due to the unique nature of the existing parapet, there were no off-the-shelf solutions available. In order to develop a workable design it was decided to carry out climbing trials. A length of replica parapet was constructed in the bridge maintenance compound, and a number of prototype extensions and replacement options were erected and tested for climbing resistance, see figures 4a to 4d.

Initially, parapet extensions were developed. These typically comprised some sort of screen in front of the existing parapet to make it more difficult to climb, and raising the height by a series of horizontal wires, supported by brackets that were designed to be uncomfortable to grip. There were two perceived benefits to these forms of extension:

- using the existing parapet and existing fixings would simplify construction and hence minimise costs
- changes to the main span's response to wind would be minimised

For full replacement options three styles were developed. These were:

- a 1.6m high parapet topped with a 0.5m high array of tensioned wires curving inwards
- a 2.4m high parapet curving inwards
- a 2.0m high transparent acrylic screen bent inwards near the top

For the acrylic screen, a sheet of Plexiglas Soundstop® was provided by Evonik Industries. This material has been used on the edges of bridges as a noise barrier. To obtain a wide range of consultation, a number of people were invited to the trials, including rescue teams and maintenance staff from other major bridges. These people were also asked for their opinions on the various options and these were collated. An architectural advisor was also asked to view the prototypes and give an aesthetic opinion on the options.

Figures 4a to 4d: Climbing trials on prototype extensions and replacements

The result of the climbing trials and consultation were:

- Replacement options performed much better than extension options. It was found to be difficult to prevent the climber gaining a foothold on the middle or top rails of the existing parapet. Also the paint system on the existing parapet had come to the end of its useful life and any retention would require full maintenance painting, Extension options were effectively eliminated from further consideration.
- Of the replacement options, the curved parapet was more difficult to climb. Although some of those trying were able to get over eventually it required a lot of effort and determination by the climber. The next best was the wire topped parapet, with the acrylic screen being the easiest of the three
- From the consultation the curved parapet was preferred by most as it looked the most formidable to the climber, and would therefore have the greatest deterrent effect on persons with suicide intent.
- Aesthetically the curved parapet option was considered to be the most acceptable solution.

At the same time as the climbing trials, wind tunnel tests were being carried out on the options to determine the static wind loading on the bridge and the dynamic response of the main span. These wind tunnel tests showed a flutter response for the acrylic screen option and effectively eliminated that option from further consideration. However, all other options provided workable solutions. Hence two main pedestrian parapet styles remained for final appraisal, with a clear preference for the curved parapet. In addition either option could be constructed in aluminium or galvanised steel, giving four options in total. A summary of the appraisal is given in table 1. From this appraisal the curved parapet in galvanised steel became the preferred solution. An enhanced thickness of galvanising was used to maximise the life of the steel option.

Style	Curved parapet		Parapet with tensioned wires	
				
Material	aluminium	galvanised steel	aluminium	galvanised steel
Climbability	Very difficult	Very difficult	Difficult	Difficult
Aerodynamics	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Buildability	Good	Good	Good	Good
Ease of maintenance	Good	Good	Good	Good
Construction cost	Highest	Medium	Lowest	Medium
	Note: little difference between any of the estimated costs			
25 year maintenance cost	Acceptable	Acceptable	Acceptable	Acceptable
Aesthetics	Preferred	Preferred	Not preferred	Not preferred
Resistance to vandalism	Vulnerable to graffiti only	Vulnerable to graffiti only	Wires subject to vandalism	Wires subject to vandalism
Project/safety risks during construction	Low risk	Low risk	Low risk	Low risk
Sustainability	Most environ-mental cost	Low environ-mental cost	High environ-mental cost	Low environ-mental cost

Table 1: Summary of options appraisal

4. Developing the Design

The structure was assessed for the increased wind loading on the parapet. For global load effects it was found that the original design had considered a higher wind speed than would be the case with current design codes and this more than compensated for the additional projected area. However local loading on the deck was a concern owing to the unique form of the bridge cantilevers, and detailed assessment was needed to demonstrate these would not be overloaded. Some minor strengthening works are currently on-going.

Two variations on the parapet design were required. One of the approach spans crosses an electrified railway, and a version of the parapet with solid infill up to 1.5m above deck was developed in order to comply with current UK standards, see figure 5a. Due to the problem of vandalism around the Old Dumbarton Road as noted in section 2 above, a mesh screen version was developed for use over that length of the bridge, see figure 5b. Neither version was deemed suitable for the full length of the bridge owing to the increased wind effects this would put on the main span,

Figure 5a: Parapet over railway

Figure 5b: Parapet over Old Dumbarton Rd

A solution was needed to preserve access to the maintenance gantries. There are four maintenance gantries suspended underneath Erskine Bridge and these are the main means of access to the bridge underdeck cantilever structure and services. The gantries were previously accessed by a drawbridge at the level of the original parapet top rail, and hence access would be greatly affected by the parapet replacement scheme.

Two options were considered. One was to raise the level of gantry access to the top of the new parapet. A major modification to the gantry would be required to get up and over the 2.4m high parapet. Any gantry extension would need to be out of reach to prevent it being used by the public, and the consequent complexity led to this option being discarded. The second option was to introduce gates at regular intervals along the parapet to preserve the existing means of access. A system was developed in which the upper half of a gate folds down leaving a bar at the original parapet top rail level, see figures 6a and 6b. This required very little amendment to the existing gantry. The gate was counterweighted to allow easy operation from either the footway or the gantry. Prototypes were developed and tested to ensure this was no easier to climb than the remainder of the parapet. There are 19 no. lockable gates on each side of the bridge.

Special details were also required to preserve access to navigation lights, the fire hydrants which are situated outside the parapet in the middle of the main span, and the main expansion joint which is situated two thirds of the way along the bridge.

Figures 6a and 6b: Gate for access to maintenance gantry

5. Constructing the Scheme

Highway Barrier Solutions Ltd (HBS) were awarded a £2m contract to fabricate and erect the 2.6km length of new parapet. Works commenced in September 2011. Off-site fabrication was carried out by Varley & Gulliver Ltd and construction on site was spread over twelve months, with progress on site governed by the rate of off-site fabrication.

To simplify construction the parapet was designed to be fabricated in panels 4.2 metres long with spigotted joints to allow for adjustments to line and level. The existing deck plate parapet HD bolt holes were reused with new bolts installed. To ensure the new barrier followed an acceptable alignment, a survey of the existing parapet was undertaken prior to removal.

The parapets were replaced one side at a time. On the side being worked on the footway and cycleway were closed and the public directed to the footway and cycleway on the other side. Occasionally single lane closures were taken during off-peak hours to enable the Contractor to deliver or collect materials from the worksite by lorry, but no road closures were needed for the parapet works. Thus throughout construction the bridge remained open to traffic, pedestrians and cyclists at all times, with little or no inconvenience to the public.

The construction of the bridge means that the footway is not capable of supporting any more than pedestrian loading. The cycleway is capable of supporting some vehicles but not unrestricted traffic. For that reason severe restrictions were imposed on the Contractor for any plant used for the works. The Contractor opted to use a 3-tonne miniature crane, a model CCH30T, see figures 7a and 7b. This crane was positioned in the cycleway and was capable of lifting the 500kg panels without overloading the deck.

There was a concern that during construction, when parts of the existing parapet were being removed, that somebody intending on suicide or vandalism would take advantage of the reduced protection. As well as leading to an individual tragedy this was thought likely to bring the whole scheme into disrepute. To counter this risk it became a contract requirement to erect temporary 'Heras' fencing along both sides of the bridge immediately on possession of the site and provide 24-hour security until the new parapet was completed. As a result of the on-site security a number of interventions were made during the construction period resulting in persons being removed from the bridge by the Police.

The site works went very well and all credit is given to Highway Barrier Solutions for their pro-active approach and quality of construction.

Figures 7a and 7b: Miniature crane operating from cycleway

6. Conclusion

The works were completed in August 2012, see figure 8. Although Transport Scotland wished to avoid publicity of the scheme in order to discourage suicide attempts, completion was greeted with a favourable reaction from the local public, press and politicians.

Figures 8a and 8b: Completed parapet

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