Innovations in bridge mounted detection: Overcoming challenges in South Wales

The South Wales Trunk Road Agent (SWTRA), working with Atkins, had a requirement to design and install traffic signal upgrades on the A48 in Port Talbot. Two of the sites involved were adjacent to the A48 Briton Ferry Bridge. See Figure 1 below for the general site layout.

The A48, Briton Ferry Bridge is an aged steel and concrete construction bridge, carrying a four lane dual carriageway, currently at the national speed limit. A combined footway/cycleway runs adjacent to the vehicle lanes, separated by safety barrier. The speed limit was due to be reduced to 50mph as part of the scheme. The bridge is highly elevated with considerable changes in elevation along its length. It is in an exposed position close to the coast. The A48 acts as a diversion route should the adjacent M4 be closed, which did happen during the winter storms of 2013/2014.

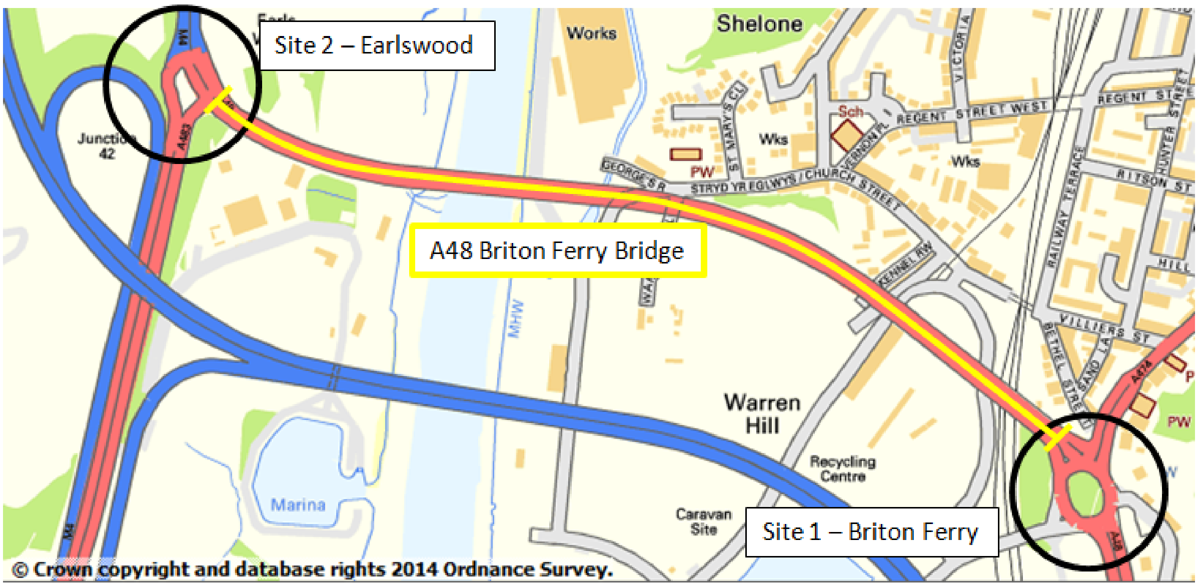

Figure 1 General Layout

Due to the age of the bridge structure, precise construction details were not available. However, it was understood that the road construction above bridge water proofing was approximately 30-40mm deep. No ducting was available in the bridge structure. Lamp columns were present on the bridge, but no access into or out of the lamp columns was possible. Figure 2 shows a general schematic section of the bridge construction, with Figure 4 giving an image of the eastbound approach in to Briton Ferry, site 1.

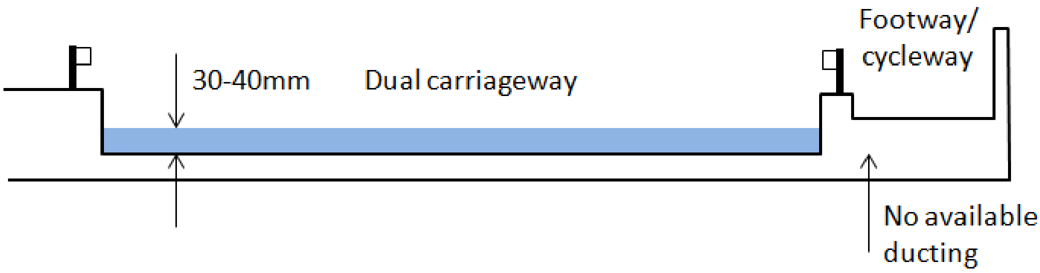

Figure 2 Bridge Construction Schematic

Figure 3 Bridge Eastbound Approach

Site 1, known locally as 'Briton Ferry', was an existing signalised roundabout, operating VA control. The site was due to be upgraded to MOVA control. The bridge deck commences approximately 45m from the eastbound stop line and the site currently operated with loop based system D (X, Y, Z) detection.

The new MOVA design required 'IN' detectors approximately 115m before the stop line. The design also included conventional 'X' loop detection between the stop line and bridge deck. Figure 4 shows the general arrangement of the bridge deck commencement.

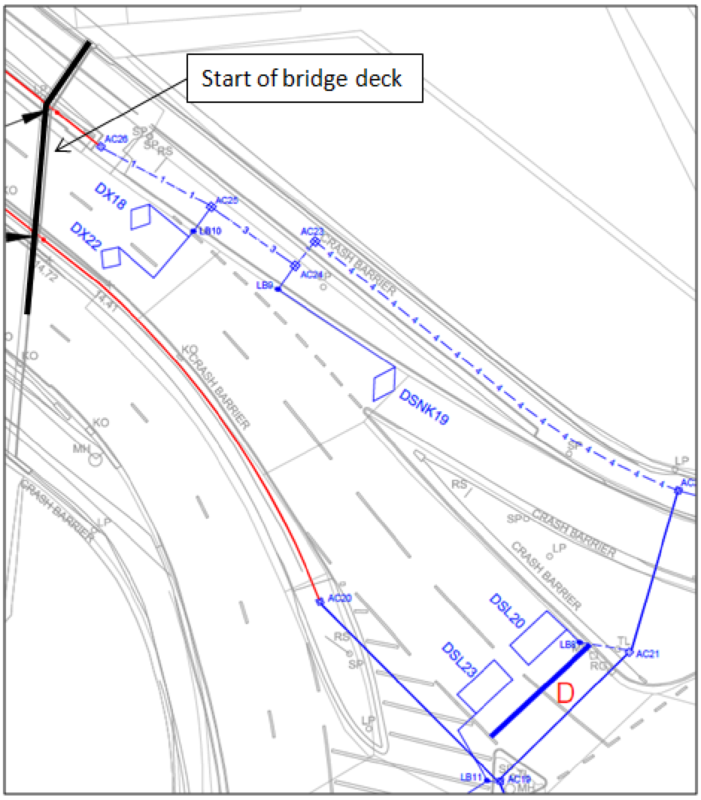

Figure 4 Site 1 - Briton Ferry Arrangement

Site 2, known locally as 'Earlswood', was an existing signalised junction, operating VA control. The site was designed for a full refurbishment, including MOVA control. The bridge deck commences approximately 5m from the westbound stop line and the site currently operates with loop based stop line detection only.

The new MOVA design required 'IN' detectors approximately 100m before the stop line and 'X' detectors approximately 40m before the stop line. Figure 4 shows the general arrangement of the bridge deck commencement.

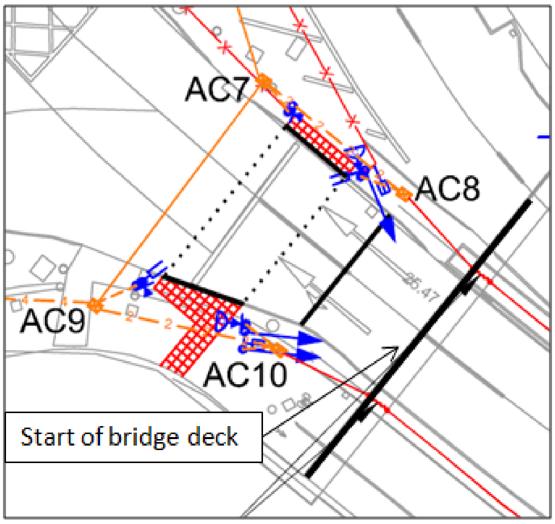

Figure 5 Site 2 - Earlswood Arrangement

As part of the design process, it was known that the Earlswood site was to be installed later than Briton Ferry. In addition, it was known that the closeness of the bridge deck at the Earlswood site would present the most technical challenges in designing and installing detection. It was therefore decided to use the simpler Briton Ferry site as a 'test bed' for any unusual bridge deck detection and that both sites would be planned to use the same detection on the bridge deck.

Challenges

The main challenges faced in the detection design for bridge deck locations were:

1. Very shallow road construction
2. Significant, potentially structural, 'step up' from carriageway level to adjacent footway/reserve
3. No available ducting in bridge
4. No access to lamp columns
5. Change in elevation – bridge climbs away from signals
6. Elevation – Significant drops to side of bridge
7. Weather, exposed location, prone to wind and fog
8. Solution for detection at 100m+ required

A variety of detection technologies were considered for the bridge detection, with all but one eventually discounted. The discounted technologies are given in the table below.

Detector Technology	Reason for being Discounted
Conventional loops	Insufficient carriageway construction depth for slot cutting, no ducting, difficulty of getting loop tails off carriageway
Wireless Magno	Insufficient carriageway construction depth for core drill
'Side fire' radar	Unable to position new poles on bridge deck. Whilst could be lamp column mounted, unable to install cables into lamp

	column. Concerns over mounting height adjacent to significant fall
‘Distant’ radar, pole mounted away from bridge deck	Unable to detect at the 100m required for Earlswood site (but potentially OK for Briton Ferry)
Video detection	Bridge prone to fog. Detection at 100m would require camera mounting at extreme height and unlikely to be viable
Thermal detection	Detection at 100m would require camera mounting at extreme height and unlikely to be viable
Slot cut wired magno	Difficulty of getting detector tails off carriageway. Concerns over depth of slot required if carriageway construction less than expected
Increase in road depth	Would require significant bridge redesign to allow for drainage redesign, potential impacts on barrier design, concerns over additional weight on bridge
Do nothing	MOVA proven to control traffic well and improve safety at many sites across UK and in South Wales. Current operation sub-optimal

Solutions
With all conventional, proven technologies and methodologies unsuitable a new approach was needed. Accepting some form of risk, whether it be cost, time or technology was inevitable.

An initial meeting between the signals design team and client team set out to explore and understand the issue, explore the available options and look as a team for a solution. Subsequently a number of manufacturers were approached to assess whether their existing products may be suitable if used in an unconventional way, or whether new products may be in development that may be suitable.

Radix Traffic stepped forward with their RTM magnetometer detector, as Radix had recently found that it can detect vehicles if installed underground, adjacent to a traffic lane, rather than directly under the lane. However, even with that knowledge, large questions remained over whether the product would be suitable. To help to answer the questions, Radix offered a site trial, which was accepted by both the design team and client.

Figure 6 - Radix Magnetometer Trial Equipment

Figure 7 Trial Equipment

For the trial, Radix were able to bring a battery powered magnetometer and detector card to replicate the operation of an installed detector. A number of different installation positions and orientations were trialled with varying degrees of success.

The main findings of the trial were:

1. When laid above ground, adjacent to traffic lane, in a conventional orientation, detector appears capable of detecting the majority of vehicles passing in adjacent lane
2. Lane discrimination not truly possible, as large vehicles in next lane can be detected (false positive)
3. Some small vehicles not reliably detected and unlikely to detect motorbikes and pedal bikes consistently (false negative)
4. Detector operation can be greatly affected by nearby ferrous objects, such as safety barrier and potentially bridge construction
5. If mounted on narrow central reserve, very likely to detect vehicles approaching and leaving junction (although not specifically trialled due to no access to central reserve)

With a largely successful trial completed an innovative way forward looked likely. However, with no ducting or above or underground access available, the installation of the detectors would still remain challenging. And a list of ‘ifs, buts and maybes’ from Radix highlighted that this would remain a highly unproven and unconventional application.

With a tight construction and ‘switch on’ dead line looming, a flexible and ‘least worst’ (as opposed to ‘best’) design option was taken. An indicative design, using a single above ground mounted magnetometer detector for lane 1 and a similar, but uni-directional detector pair for lane 2 was created. An above ground conduit and cable run was proposed in the design, but the exact mounting and installation method was not determined during the initial design. It was understood by all that there would be an element of risk in the design – Whilst the original on-site trial had been successful, there was no certainty that the design would result in a ‘right first time’ installation – As such the installation at the Briton Ferry site was considered a trial.

Once the main contractor was appointed, a site meeting was held between the entire team involved in the scheme; the client, the structures specialists, the signal designer, main contractor and signal contractor. With a positive approach to ‘how can we make this happen?’ the detector installation method was refined and solutions found to problems such as bridge joints, vandal resistance, transitions between conventional duct, steel conduit and plastic conduit. With the positive ‘we can do this’ attitude across the team, the innovative detection installation began in early August 2014.

Figure 8 Radix Magnetometer Detector

Figure 9 Conduit and IP Rated Joint Box

Figure 10 Uni-Directional Detection Position

Figures 8, 9 and 10 above show some of the installation. The main constituents of the design comprised of:

- Conventional ducting brought as close as possible to bridge deck, with chamber at termination.
- Above ground mounted steel conduit running from chamber to approximately 1m from detector position. Flexible steel conduit used across bridge joints. Secured using short screws into bridge.
- An IP rated joint box mounted at end of steel conduit.
- Plastic conduit from joint box to detector position.
- Waterproof magnetometer detector positioned at end of plastic conduit and secured in position by use of glanded conduit joint.
- Conventional detector feeder cable used between bespoke detector card and joint box.
- Although not installed at time of writing, further vandal proofing to be installed over plastic conduit, potentially a concrete skim.

Success, or not?

The initial installation was completed in early August 2014, with the trial of the equipment on going at time of writing. The initial results have been encouraging:

The single, lane 1 detector is working well, detecting virtually all vehicles passing correctly.

The lane 2 detection has been less successful. When installed, with full lane closures, the system detected all test vehicles perfectly. Unfortunately, with the TM removed and the lane open as normal it was found only a few vehicles were correctly detected. The majority appeared to keep well to the left of the lane and kept outside of the range of the detection. Further refining of the mounting of the detectors has yielded some improvement, but operation is currently not as good as originally anticipated. At the time of writing, further refinements are planned and it is hoped that it will be possible to bring positive results for the lane 2 detection to the Symposium presentation.

With further improvements expected, the installation is being considered successful.

Conclusions

With the challenges of mounting signals detection on bridge deck ruling out all conventional detection options, the SWTRA, Atkins and supplier team took an innovative approach to the technical solution. With risks understood and accepted, a 'least worst' design was proposed and then further refined on site with the contractor and installation team.

The detection operation has been largely successful and it is hoped that the technical concepts that have been developed on the Briton Ferry Bridge will be of relevance to other bridges and potentially other difficult situations elsewhere. But certainly, the positive, 'we can make this happen' attitude of the team can have many applications.