Executive Summary

The expansion joints on the A702-20 Clydes Rail Bridge, which carries the A702 over the West Coast Mainline, run at a skewed angle across the carriageway. The joints are mechanical BEJ 8 joints, last replaced in 2012.

Recently there have been three instances where cyclists have claimed that the skew of the joints, along with the width and depth of the gap between the rails, has caused them to lose control of their bicycle due to their front wheel becoming trapped in the gap, ultimately resulting in them falling off and sustaining injuries.

In order to mitigate the risk posed to cyclists crossing the bridge a staged approach has been recommended based on the analysis of the options available.

It is recommended that consideration is given to replacing the existing joint rubber seals with new rubber seals currently being developed by USL, the joint manufacturer, once they become available and pending further analysis of the system. The seals being developed reduce the difference in level between the joint rails and the top surface of the seals, removing the risk of a bicycle tyre wedging in the joint even under the worst case scenario considered. The new seal can potentially be installed into the existing joint rails, minimising the amount of disruption from required traffic management as well as minimising the costs involved in the works compared to replacing the full joint. At the same time as replacing the joint seals it is also recommended that Overbanding - high friction surfacing system is applied to the joint rails mitigating the risk of a cyclist slipping on the rails.

In the interim, and while awaiting results from the new rubber seals development analysis, it is recommended that signs are installed on both approaches to the bridge warning cyclists of the skewed expansion joints and risk of wheel entrapment.

Should the findings of USL's investigations determine that the new seal is not suitable then replacing the joints with asphaltic plug joints would be recommended for reducing the risk.

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1 Introduction

The A702-20 Clydes Rail Bridge, where the A702 trunk road passes over the West Coast Main Line route, is located on the A702 just north of the junction between the A702 and A73. This section of the A702 forms the main link between Biggar and the M74, see Figure 1: Location Plan below.

The bridge has two expansion joints, one at either end of the bridge. These joints follow the line of structure below the carriageway and are therefore running at a skewed angle across the carriageway, see Figure 4: Looking North East across the structure, from the western end of the southbound carriageway. and Figure 5 of Appendix A. The joints are mechanical BEJ 8 joints, replaced in 2012, by BEAR Scotland.

Recently there have been three instances where cyclists have claimed that the skew of the joints, along with the width and depth of the gap between the rails, had caused them to lose control of their bicycle, resulting in them falling off and sustaining injuries. These instances are alleged to have taken place on the 06/07/2014, 27/07/2014 and 28/11/2014. One claimant has also alleged that the rails of the joint were slippy when wet.

Transport Scotland has instructed Amey to carry out a risk assessment of the current site.

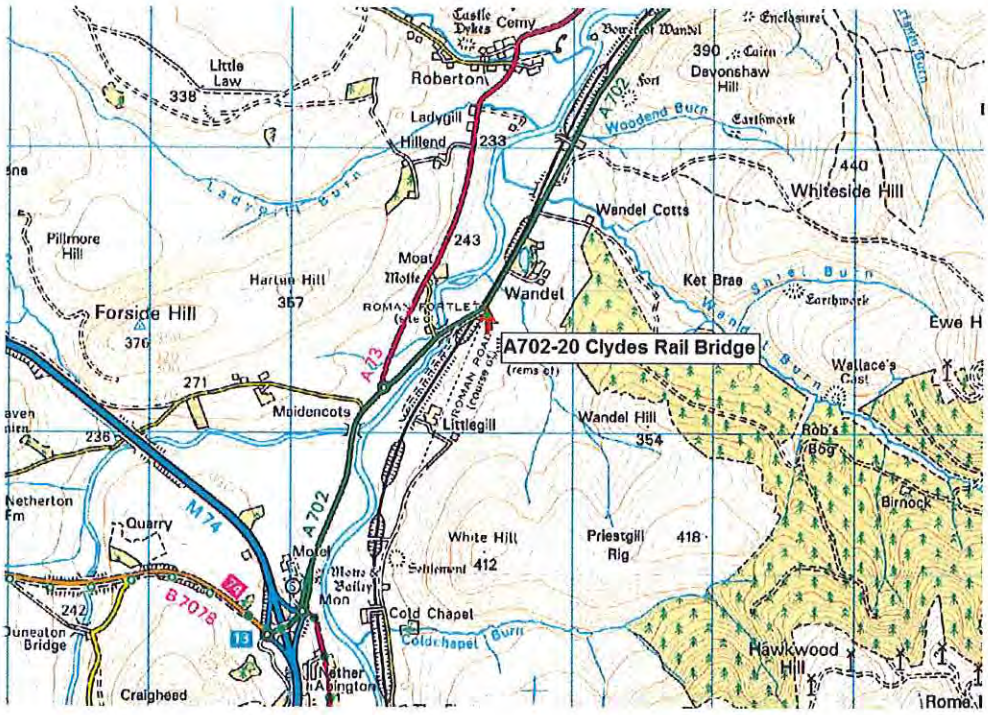

Figure 1: Location Plan

2 Risk Assessment

2.1 Existing conditions

The angle at which the road crosses the train line results in both joints aligning at different skewed angles to the carriageway. The western joint forms an angle of approximately 20° to the edge of the carriageway and is approximately 20.5m in length. The eastern joint forms an angle of approximately 16° and is approximately 27.5m in length, see Figure 2: General Arrangement of site.

At the time of inspection, July 2015, the distance measured between the rails for the western joint was 70mm with a surface profile of 25mm below the carriageway; the distance measured between the rails for the eastern joint was 45mm with a surface profile of 25mm below the carriageway surface.

Generally the joints appear in a good condition. Some wear was noticed on the southbound carriageway eastern joint in the form of a slight tear in the seal; see Figure 6 in Appendix A. However in order to establish the true condition of the joints a full inspection, under traffic management and with access to the underside of the bridge, would be required.

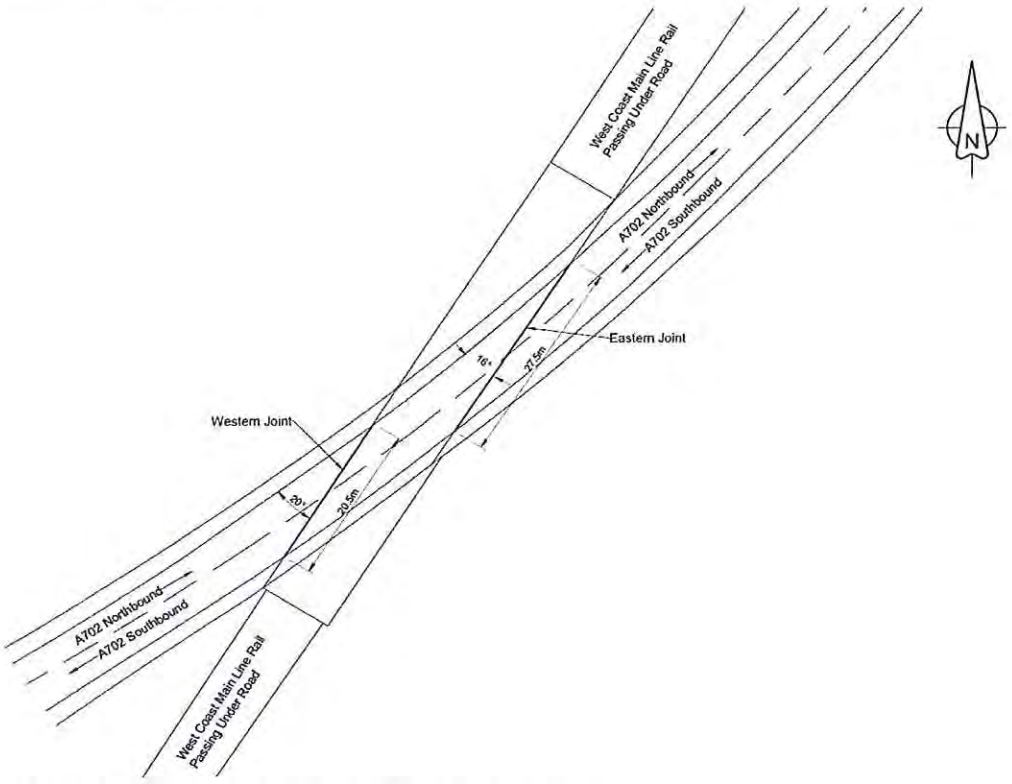

Figure 2: General Arrangement of site

2.2 Assessment of the reported hazard

One of the reported incidences, involving a cyclist, is alleged to have occurred as the cyclist was travelling northbound on the route. While crossing the eastern expansion joint it is alleged that his front wheel got stuck within the joint causing him to fall from his bike.

If this type of accident is possible then travelling northbound over the eastern expansion joint would be considered to be the worst case scenario, on this particular bridge, to enable this type of accident. This is due to two main factors:

- The angle of alignment between this joint and the edge of the carriageway is the smaller of the two joints, 16°, resulting in this joint being the most closely aligned with the direction of travel.
- Travelling northbound over the eastern expansion joint the cyclist would be entering a left hand turn as they left the bridge; this increases the alignment of the direction of travel with the angle of the joint. In comparison, travelling southbound over the same joint the cyclist would be exiting a right hand turn onto the bridge, therefore reducing the alignment of their wheel with the joint as they crossed it, refer to Figure 2: General Arrangement of site.

The cyclist reported that his front wheel dropped into the expansion joint causing the accident. This suggests that, in combination with the skew of the joints, other factors such as the depth of the joints and the possibility of the rails either side of the joint being a slip hazard should also be considered.

The rails were inspected after it had rained, the rails were still wet. They did not appear to be excessively slippy, however it is accepted that the rails will have less friction than the adjacent road surface. The angle of the joint will also increase the trafficked width of the rails. It was not possible to inspect the full length of the rails, in terms of their surface friction, without traffic management. The level of risk for each case considered, as well as design measures considered have been evaluated further in Section 2.3.

2.3 Hazard posed to cyclists by expansion joints on bridge

2.3.1 Northbound Eastern Joint

Hazard: Skew of joints

Evaluation of Risk: Heading northbound over the eastern joint there is an increased risk of a cyclist's bicycle wheel aligning with the line of the joint, compared to the other joints and direction of travel combinations on this bridge. The difference between the alignment of the carriageway and the alignment of the line of the joint is 16°, however due to the cyclist turning into a left hand turn the angle between the direction of travel and the line of the joint will be reduced. The depth and width of the joint does not appear excessive, however it may be enough to channel a narrow road bike wheel if aligned at an appropriate angle.

Risk Rating: Medium/High

Solution A:

Proposed Mitigation:	**Signs** – Located on the approach to the bridge warning cyclists of the skewed expansion joints.
Residual Risk Rating:	Low/Medium
Advantages of Mitigation:	Advanced warning will make cyclists more aware of the joints helping them take adequate care not to align their front wheel with the line of the joint. Low cost solution. Solution can be implemented without the need for traffic management.
Disadvantages of Mitigation:	Only mitigates the risk, it doesn't remove it.

Solution B:

Proposed Mitigation:	**Joint Filler** – This solution was initially proposed by USL in order to prevent a bike wheel being channelled into the joint, even in cases where it aligns with the direction of the joint, by filling the joint with a rubberised type compound which expanded and contracted with the joint.
Residual Risk Rating:	Low/Medium
Advantages of Mitigation:	Cheaper than replacing the joint. Provides adequate initial solution to the risk of channelling a bicycle wheel in the joint. Quick to install and requires minimal disruption to the public through traffic management.
Disadvantages of Mitigation:	Further testing of the product by USL has shown that bonding between filler and joint is not adequate. The results of trials by USL show that the filler de-bonds within two months of install. This de-bonding could result in additional hazards to cyclists in the area if the filler itself comes away from the joint. It would also require continual maintenance and reapplication of the filler.

Solution C:

Proposed Mitigation:	**New Seals** - Replacing the existing joint seal, see Figure 7 of Appendix A, with a new joint seal profile, see Figure 8 of Appendix A, which is currently being developed by USL.
Residual Risk Rating:	Low
Advantages of Mitigation:	This new profile reduces difference in the level of the top of the joint rails and the level of the lowest point on the top of the seal. This would reduce any risk of bike road tyres getting wedged within the

	joint. The new seal profile can be installed into the existing rails, reducing the amount of work and time required to carry out the works, compared to the full replacement of the joints. A cheaper solution compared to replacing the joints. Some wear was noticed on the existing seal of the eastern joint, on the southbound side of the carriageway. While a full investigation would be required in order to fully analyse the condition of the existing joints, the wear on the seal could be an indication of the seal beginning to fail. Replacing the seal of the joint may therefore extend the life cycle of the existing joints.
Disadvantages of Mitigation:	Product still in development. While initial samples have been promising, the product still has to undergo further development and testing in order to ensure it will provide a solution without adversely affection the function of the joint, or the use of the bridge. The next batch of samples is not expected until the end of September and further development is pending the review and analysis of those samples.

Solution D:

Proposed Mitigation:	**New Asphaltic Plug**
Residual Risk Rating:	Low
Advantages of Mitigation:	Completely removes the channelling effect of a joint on a cyclist's wheel by removing the channel.
Disadvantages of Mitigation:	Expensive solution. Requires extensive traffic management and disruption to local traffic. Existing joints are in a reasonable condition and do not currently require replacement, based on condition alone. Asphaltic Plug Joints do not perform well on skewed joints such as

this.

Failing Asphaltic Plug joints can produce hazards to cyclists in the form of asphalt breaking up, resulting in debris and potholing. It is appreciated that these hazards would be more localised and avoidable by a cyclist than the joint rails which cross the entire carriageway.

Hazard: Slipping on Rails

Evaluation of Risk: The rails were inspected after it had rained, the rails were still wet. The rails did not appear to pose a significant slip risk to cyclists; however it is accepted that the rails will have less friction than the adjacent road surface. The angle of the joint will also increase the trafficked width of the rails.

Risk Rating: Low/Medium

Solution A:

Proposed Mitigation:	**Signs** – Located on the approach to the bridge warning cyclists of the skewed expansion joints.
Residual Risk Rating:	Low/Medium
Advantages of Mitigation:	Advanced warning will make cyclists more aware of the joints helping them take adequate care and ensure proper handling of their bicycle when crossing the joint. Low cost solution. Solution can be implemented without the need for traffic management.
Disadvantages of Mitigation:	Only mitigates the risk, it doesn't remove it.

Solution B:

Proposed Mitigation:	**Safetrack Overbanding - Road crack and joint sealing system– a high friction surfacing system - applied to rail.**
Residual Risk Rating:	Low
Advantages of Mitigation:	Reduces the risk of slipping by increasing the friction capabilities of the rails. Low cost solution to improving the condition of the existing rails. Can be applied to the nosing of the joint as well as the rails, this may increase the life of the current joints by sealing any cracks in the asphalt that are present.
Disadvantages of Mitigation:	Requires traffic management to install. Care must be taken to protect the joint seal during application.

Solution C:

Proposed Mitigation:	**New Asphaltic Plug**
Residual Risk Rating:	Low
Advantages of Mitigation:	Removes the risk associated with the joint rails by removing them completely.
Disadvantages of Mitigation:	Expensive solution. Requires extensive traffic management and disruption to local traffic. Existing joints are in good condition and do not currently require replacement, based on condition alone. Asphaltic Plug Joints do not perform well on skewed joints such as this. Failing Asphaltic Plug joints can produce hazards to cyclists in the

form of asphalt breaking up, resulting in debris and potholing. It is appreciated that these hazards would be more localised and avoidable by a cyclist than the joint rails which cross the entire carriageway.

2.3.2 Northbound Western Joint

The angle between the edge of the carriageway and the line of the joint on the western side of the bridge is 20°, which is greater than the angle on the eastern side of the bridge, see Figure 2. The crossing of the western joint heading northbound occurs on a generally straight section of carriageway, maintaining the angle between the direction of travel and the line of the joint at 20°. The overall layout and approach to this joint, compared to that for the Northbound Eastern Joint, either reduces or maintains the risk level posed to the cyclist by the skew of the joint or the possibility of slipping on the rails to a Low/Medium level. Therefore any solution proposed for hazards assessed on the Northbound Eastern Joint would be considered sufficient for the Northbound Western Joint.

2.3.3 Southbound Eastern Joint

Not as critical as the same risks assessed for the Northbound direction since the direction of the road turns against the joint when travelling in this direction, better aligning the path of travel across the joint and reducing the trafficked width of the joint. Any work carried out on the joint in the northbound direction would be carried out in the southbound direction for continuity.

2.3.4 Southbound Western Joint

Similar risk posed to cyclists as that for crossing the western joint in the northbound direction. Any work carried out on the joint in the northbound direction would be carried out in the southbound direction for continuity.

3 Summary and recommendations

The risk posed to cyclists travelling over the joints of the A702-20 Clydes Rail Bridge is dependent on a multitude of factors combining to exacerbate the risk. In the worst case scenario the cyclist must be travelling northbound over the eastern joint, they will be turning into the left hand turn as they leave the bridge further aligning their tyre with the line of the joint, and the joint itself needs to have expanded to a sufficient level as to allow the tyre to wedge within the joint. Other factors, such as the speed of the cyclist and their control of the front wheel of their bicycle, will also play a part in the outcome. Under such conditions it may be possible for the tyre of the bike to wedge between the rails of the joint causing an accident.

An additional concurrent risk, of the cyclist slipping on the joint, has also been highlighted. This may increase the risk of the cyclist losing control of their bike and aligning their tyre with the joint line.

The most cost effective and efficient solution to mitigate the occurrence of such an accident would be to warn cyclists, on their approach to the bridge, that there are skewed expansion joints and to take care when crossing them. Signage could be placed on each approach at low cost and with no traffic management required. This will help mitigate the risk to cyclists using the bridge.

In order to remove the risk to cyclists using the bridge the recommended solution is to replace the existing joint seals with new seals currently being developed by USL. This solution is pending the results of the analysis of the next batch of joint seal samples to be obtained by USL by the end of September. These seals reduce the difference in level between the joint rails and the top surface of the seals. In doing so they remove the risk of a bicycle tyre wedging in the joint even if the tyre aligned with the line of the joint. The new seal can be installed into the existing joint rails, minimising the amount of disruption from required traffic management as well as minimising the costs involved in the works compared to replacing the full joint.

It is also recommended that the Overbanding - high friction surfacing system is applied to the joint rails at the same time as replacing the joint seals. This will remove the risk of a cyclist slipping on the rails and can be carried out under the same traffic management, reducing the disturbance to road users.

In the interim, while awaiting the results of new samples analysis, it is recommended that the proposed warning signs on approach to the bridge are installed.

Should the findings of USL's investigations determine that the new seal is not suitable then replacing the joints with asphaltic plug joints would be recommended for reducing the risk.

Appendix A Photos

Figure 3: Elevation of Structure

Figure 4: Looking North East across the structure, from the western end of the southbound carriageway.

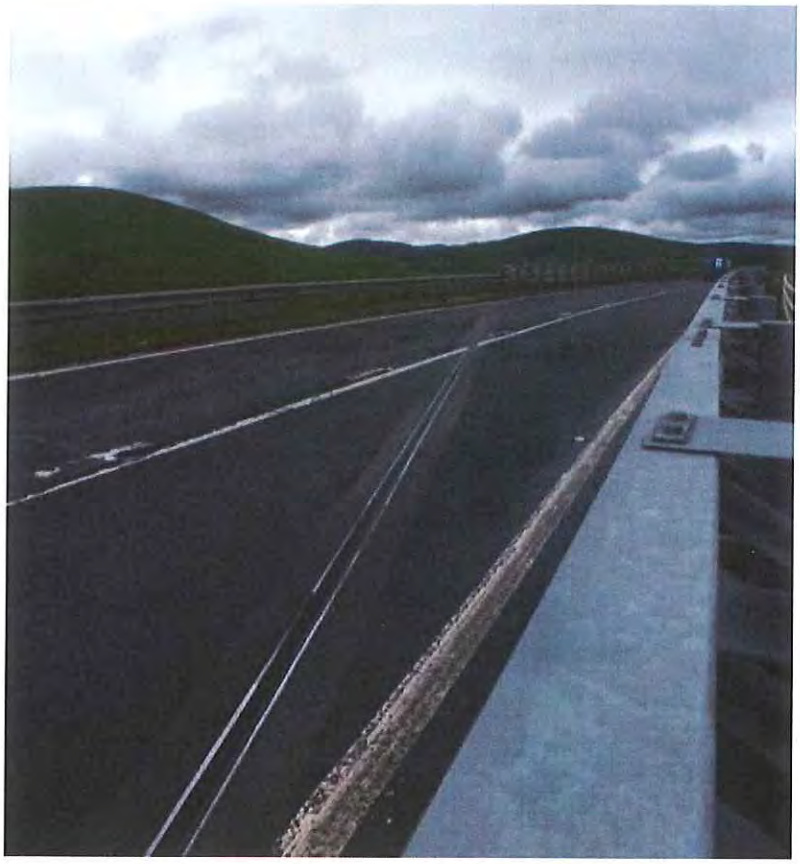

Figure 5: View of Eastern Joint – Taken from edge of Northbound carriageway looking South-West

Figure 6: Tear on Eastern Joint Seal

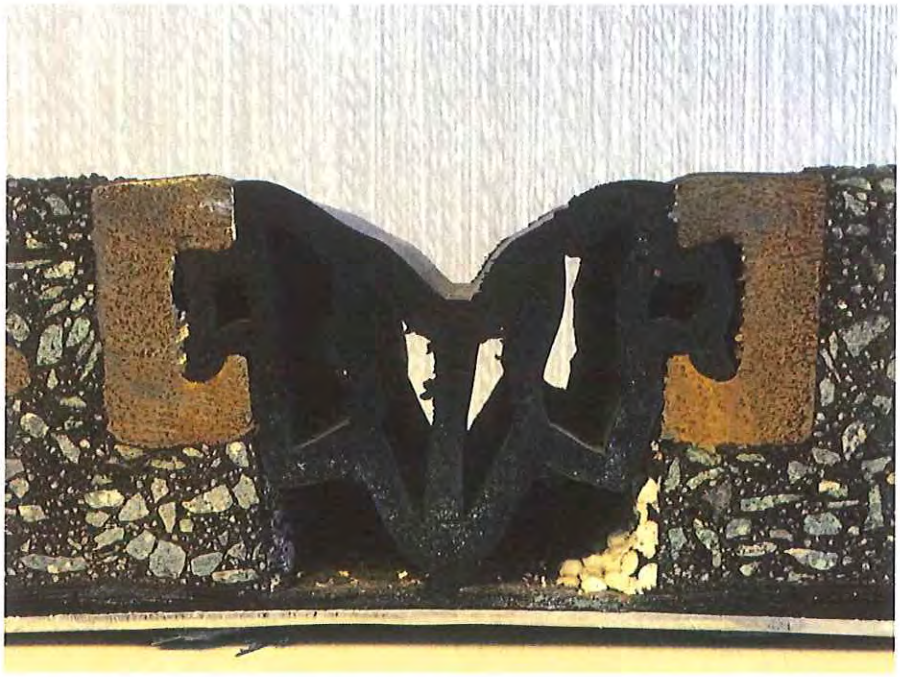

Figure 7: Existing BEJ seal profile

Figure 8: Proposed new BEJ seal profile – under development.