Forth Road Bridge
Replacement of Nosing Joints from North and South Side Towers

Forth Estuary Transport Authority

August 2014

ATKINS

Plan Design Enable

Notice

This document and its contents have been prepared and are intended solely for Forth Estuary Transport Authority's information and use in relation to options for replacement of nosing joints from north and south side towers.

Atkins Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 30 pages including front and back covers.

Document history

Job number: 5127603			**Document ref: 5127603/006**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Draft For Comment					
Rev 2.0	First Issue					08/14

Client signoff

Client	Forth Estuary Transport Authority
Project	Forth Road Bridge
Document title	Options Report for Replacement of nosing joints at north and south side towers
Job no.	5127603
Copy no.	
Document reference	5127603/006

Table of contents

Executive summary

The nosing joints on the Forth Road Bridge are located on both north and south side towers and on abutments. The purpose of this report is to investigate the options for repair/replacement of nosing joints at the side towers that are showing signs of distress. The existing nosing joints are equivalent to DMRB Type 3 joint that comprises of two fabricated steel edgings that form the nosings of the joint and filled with poured sealant called “polycast”.

During the visual inspection carried out by Atkins in March 2014, distresses in the form of reduction in plate thickness and loosening of the anchorage to the steel edgings at the side towers were observed. The sealant material between the edgings was also found to have disintegrated with time and only traces of the polycast was seen in the joint. The loss of sealant has left the bearings below the joints vulnerable to corrosion from seeping water. Bearing shelf and concrete corbels are also affected from chloride contamination. Both knuckle and lateral bearings comprise of steel components and need to be protected from seeping water from the deck above. Repair/refurbishment of the existing nosing joint is therefore essential to return the joint watertight as in existing as-built condition. Some concerns have also been raised at the reduction of plate thickness of the angle section that forms the nosing. It has been repaired at least at one location in the past. Its sudden failure may lead to hazardous condition for the traversing vehicle.

In this report various options for repair/replacement of nosing joints have been discussed looking at both the merits and weaknesses. Use of both bespoke and catalogue products have also been reviewed. From the study it is identified that there is no standard off the shelf product that could be adopted in this case without making some modification to the existing detail. A modified nosing joint, discussed in section 3.4.3 is considered to be the most suitable option for replacement of existing nosing joints and hence has been recommended in this report.

The replacement of the nosing joints is not expected to be undertaken immediately, but will be aligned with Roller Shutter joint replacement on main towers after the commissioning of Queensferry Crossing. In this way inconvenience to the existing vehicular traffic on the bridge will be minimised, however it is anticipated that some repairs to the nosing joints may be required in the period from now until the opening of the new bridge.

1. Introduction

1.1. Brief

Atkins has been commissioned by the Forth Estuary Transport Authority (FETA) to investigate the options for repair/ replacement of existing bridge deck expansion joints on the Forth road bridge (FRB). This commission is in response to increasing maintenance work on the joints and inspections of the expansion joints by FETA which revealed areas of local distress and excessive wear in the joints.

1.2. Scope of Report

This report considers the options for refurbishment/ replacement of existing nosing joints on both north and south side towers. Options considered for the joints include minimal repairs, refurbishment, and complete replacement of the joint with a bespoke or off the shelf products. The report also discusses factors and site constraints which may affect the choice of the option. Finally the report provides recommendations for the preferred option for the replacement of existing nosing joints.

2. Site Considerations

2.1. Programme

2.1.1. Programme Constraints

FETA has proposed that the construction work for the repair or replacement of bridge deck joints commence after the opening of the Queensferry Crossing. After opening, the volume of traffic currently on the Forth Road Bridge will be re-routed onto the Queensferry Crossing. Therefore the impact of traffic management for the remaining traffic (currently proposed to be public buses and taxis only) in the form of a carriageway closure on the FRB to carry out the works will be reduced. The replacement of nosing joints discussed in this report will be part of larger scheme of replacement of existing roller shutter and comb joints on the bridge deck. The programme for nosing joints replacement will be aligned with parallel working to minimise the duration for carriageway closure.

Weather is another constraint that must be allowed for on the Forth Road Bridge. Although it cannot be controlled, careful programming of the works can be planned so that the construction coincides with milder weather. Currently the bridge is closed for safety for all high sided vehicles and motorbikes once the wind gust exceeds 65 mph (104 km/h). Working on the structure during high windy condition is not advisable especially when scaffold access is being used. For maintaining safety of the workforce and to minimise disruption to the work it is suggested that the construction works be programmed in the spring/summer months when the weather is more likely to be favourable.

2.1.2. Programme Risks

Risks identified at this stage of the project include:

- Delays due to unfavourable weather conditions
- Traffic incidents on the bridge preventing traffic management being set out
- Availability of resources
- Lead-in times for plant, materials and fabrication
- Lack of access
- Difficulty in dismantling and installing joint components
- Actual built being different from as-built drawings.

The majority of these risks can be reduced or controlled through careful monitoring and advanced planning of works and resources.

2.2. Traffic Management

Traffic management in the form of full carriageway closures will be necessary to gain access to nosing joints. The duration of the traffic management is dependent on the duration of the works and whether the works would be local repairs or a full joint replacement. Although the majority of the traffic volume is to be re-routed onto the new crossing there will be a lower volume of traffic remaining in the form of public buses and taxis which would have to be managed through a contra flow onto a single carriageway for the duration of the works.

The current traffic flow data based on information from 2012 states that the average weekday traffic flow on the bridge is between 30,000 to 40,000 vehicles per day, Monday to Friday. At weekend the traffic flows are lower with a range of 25,000 to 32,000 vehicles per day on Saturdays and between 22,000 to 30,000 vehicles per day on Sundays. These figures are compared to a theoretical daily capacity of just under 30,000 vehicles per day. The number of days the theoretical capacity was exceeded in the year was about 280. Traffic flows vary throughout the year due to seasonal variations for example tourism with the highest traffic flows recorded in August and September and the lowest in January and February. From these figures the benefit to traffic flow from undertaking the works after the opening of the Queensferry crossing can be seen.
.

2.3. Access

Access to the nosing joints will be via the carriageway when the carriageway is closed to traffic. Access to the joints is also available below the joints via the side towers. A temporary means of access (scaffolding or working platform) will be required for the duration of the works to access the joint from under the carriageway. As work requires to be carried out on other joints on the bridge it would be advantageous to carry out the works at the same time to minimise the requirement for additional carriageway closures.

A provision for temporary steel bridging plate shall be made available at the site at all times to provide access to maintenance vehicle over the bridge as and when required.

2.4. Resources

The types of resources that would be required for the repairs or replacement of the joints include:

- Workforce
- Plant and materials
- Specialist personnel for hydro-demolition
- Steel fabricators
- Site welders

Plant will include lifting equipment for moving joint sections and steelwork.

2.5. Temporary Works

Temporary works will be required at the side towers to set up full containment below the joints for hydro-demolition of existing concrete to remove the existing steel edging from the carriageways.

Workshops with FRB staff will be significant in understanding the methods and control measures that were used in the past when carrying out local repairs to the joints. Such information will be central to developing a safe and clear method for carrying out the works.

2.6. Procurement

If the use of bespoke joint is determined to be the preferred solution for replacing the existing joints then tender drawings and specification must be developed to a suitable level of detail to allow a competent contractor to price the joints and allow its fabrication. Similarly, if a catalogue product is recommended then the drawing and specification should be sufficient detailed to allow joint manufacturer to quote the price for the replacement joint.

2.7. Future Maintenance and Repairs

Any new joints will be designed with a design working life category 2 for the working life up to 50 years with replaceable structural parts as specified in *DMRB IAN 124 Annex A Table A.1-Design working life* and *BS EN 1990:2002 Basis of structural design*.

If repair or remediation to the existing joint was determined as the preferred option then there is likely that there may be a need for more frequent maintenance and repair as the joint may not have the same working life as a new joint.

2.8. Listed Building Consent

The Forth Road Bridge is a category A listed structure. Any alterations to the structure would require prior Listed Building Consent from both the local planning authorities, the City of Edinburgh Council, Fife Councils and Historic Scotland. The councils have a statutory duty to determine valid applications within two months. Work on the nosing joints is considered as minor works which do not affect the character of the structure therefore they are unlikely to require consent. It is however recommended that early consultation with the councils is undertaken to determine if the nosing joint replacement does require prior consent.

2.9. Health and Safety

A number of health and safety factors will need to be considered during the design and construction of the nosing joints works. The following may be considered as health and safety risks that need to be considered through the full phase of the project:

- Hydro-demolition of the concrete deck elements
- Working adjacent to live traffic
- Working at height
- Site welding, cutting, drilling and grinding materials (hot works)
- Manual handling
- Removing and applying protective coatings
- Use of cementitious and bituminous materials
- Adverse weather conditions

3. Nosing Joint Repair/Replacement

3.1. Description of Existing Nosing Joints

The nosing joints on the Forth Road Bridge are located at the side towers towards the suspended side span. The existing nosing joints are not a catalogue product from a standard joints manufacturer as steel edgings that form the nosings are now largely replaced by cementitious, polyurethane or ploureide binders. Available as built information shows two different details for the nosing joints. Figure 3-1 shows the detail that currently exists on the bridge and seems to be an improvement on the detail shown in Figure 3-2.

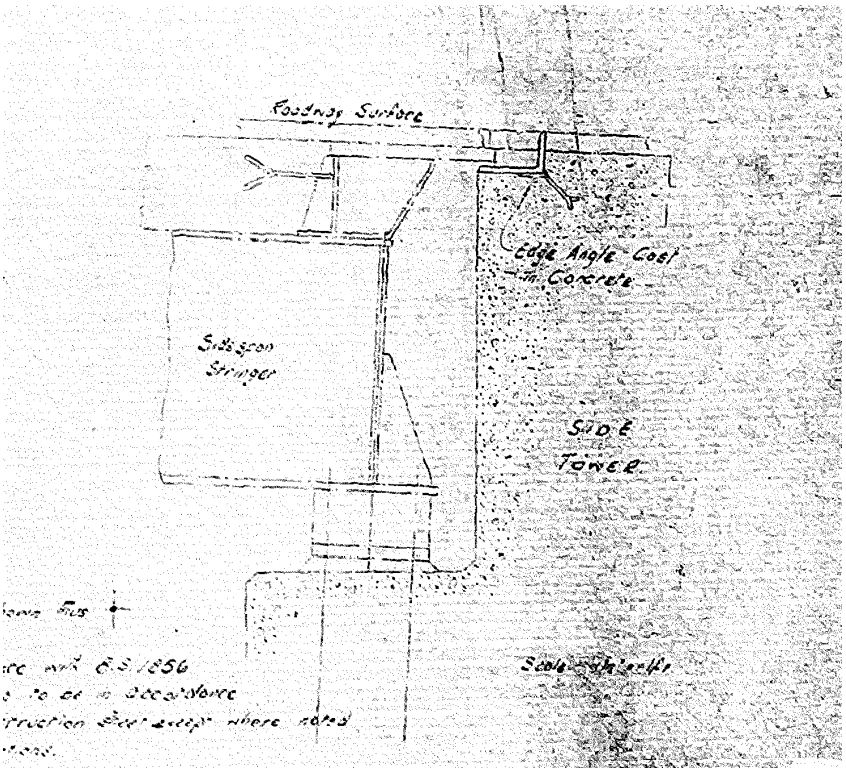


Figure 3-1 As built Nosing Joint Detail 1

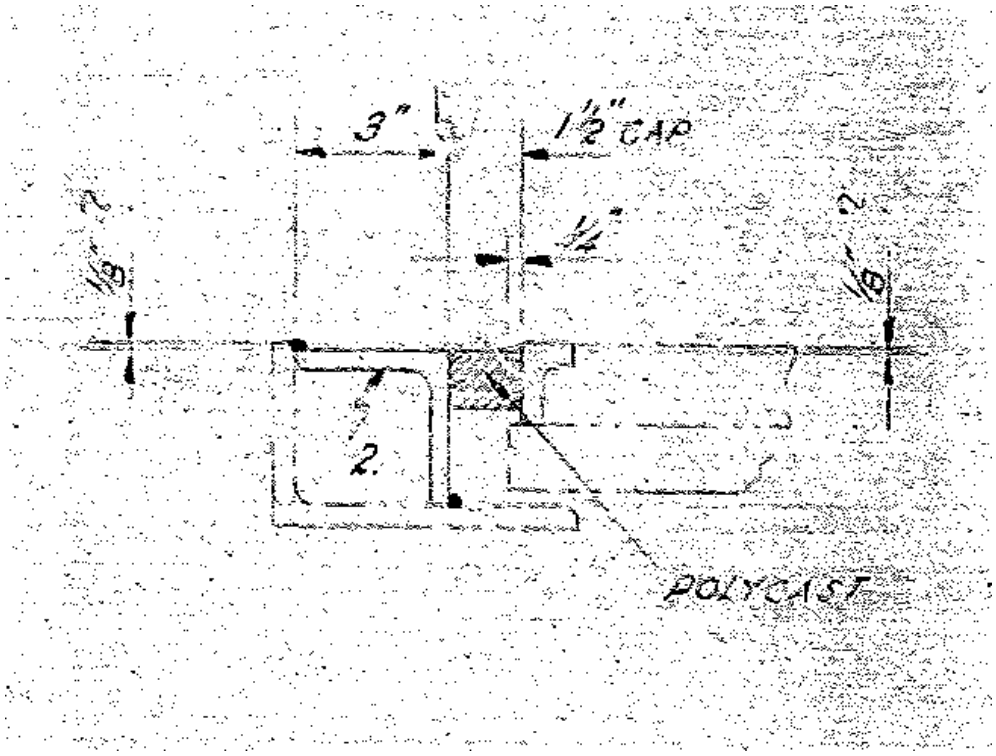


Figure 3-2 As built Nosing Joint Detail 2

From the as-built details, the clear gap between the steel edgings is determined to be 38mm. This seems to be sufficient to accommodate the movement range required at the interface between the suspended span and the side tower. It is also noted that the articulation of the suspended span deck at the side towers is such that all lateral and longitudinal movements are restrained at the truss level but the deck has some capacity to rotate in-plan about the central lateral bearing due to wind or other lateral actions. The purpose of the existing nosing joints is to accommodate this in-plan rotation of the deck.

3.2. Maintenance History

There is limited information on the early maintenance work carried out on the nosing joints. However, FRB has confirmed that local repairs were carried out on the nosing joints in the past. Evidence of local repair to steel edging plate/angle at the side towers is seen in the photograph below.

Figure 3-3 Local Repair to Steel Edging on North Side Tower

Figure 3-4 Additional Anchoring to the Steel Edging on the North Side Tower

3.3. Causes of Deterioration

Visual inspections of the nosing joints in March 2014 indicate that nosing joints are still functional, though loss of sealant in the gap may cause long term durability issues for the bearings below.

Two major types of distresses that were observed during the visual inspection are as follows-

1. Fracture in the steel edging plates causing the running angle to be unsupported and becoming distorted under loading.
2. Loosening of anchorage to steel edgings towards the side tower.

The fracture in the steel plates is believed to be due to gradual wear and reduction in plate thickness from normal traffic loading, whilst the separation of nosing plates from backing concrete is likely to be due to inadequate anchorage or loosening/ delamination of the backing concrete.

3.4. Options for the joints

Four options for repair/refurbishment of the nosing joints have been considered and these have been discussed in detail below. In summary the options are:

a) Option 1: Continue with current maintenance regime;

b) Option 2: Completely refurbish the existing joint;

c) Option 3: Completely replace the existing joint with a nosing joint with elastomeric insert;

d) Option 4: Completely replace the existing joint with single-element EMR joint.

3.4.1. Option 1: Continue with current maintenance regime

This option would result in keeping the current joints as they are and undertaking essential repairs as and when necessary as is the currently practice. This may result in minimum traffic disruption in the short run, but ultimately repairing the existing steel edging would become difficult requiring more frequent interventions and full replacement of the steel edgings would be imminent.

The main advantage of this option is that previous knowledge of repairs could be taken forward to undertake any reactive work on the joint that may be needed from time to time. Such repairs can be carried out quickly by the available workforce on the bridge.

However, there are significant disadvantages associated with this option as well. One of the main disadvantages is that existing seal cannot be reinstated in the current form and the bearings below the joints would be vulnerable to contaminated water (salt laden) and corrosion in the bearings would exacerbate with time. Further, the top plate in the edging is showing increased signs of wear and it is likely that any further wear may lead to a progressive increase in the number of interventions required to repair the joint. The types of failure that may be seen as increasing occurrences are- fracture or deformation in the top angle plates and loosening of anchor ties in the steel edgings.

A summary of advantages and disadvantages of this option is provided in Table 3.1 below.

Table 3-1 Advantages and Disadvantages for Option 1

Option 1: Continue with current maintenance regime	
Advantages	**Disadvantages**
1. Minimum traffic disruption in the short term.	1. Risk from local failure of steel edging may lead to hazardous situation for the vehicles.
2. Retains existing joint with maintenance requirements known from previous repairs and learning taken forward to extend the existing life of the joint.	2. Joint will result in an increasing financial liability as more section of steel edgings wears off requiring frequent maintenance interventions
3. Minimum initial cost.	3. Reinstatement of elastomeric seal or pourable sealant cannot be undertaken in the present

Option 1: Continue with current maintenance regime	
Advantages	**Disadvantages**
	condition.
	4. Risk of sharp edges forming due to wear.
	5. Vulnerability of existing bearings to seeping water from the joint is not addressed.
	6. Weather conditions may not be suitable for emergency repairs, increasing the time taken to complete the works.
	7. Cannot plan to undertake work at same time as other work due to urgent nature of repairs.

The costs of this option would be difficult to evaluate as it would be dependent on the extent of repairs and period of carriageway closures. It is anticipated that traffic management and traffic delay costs will be relatively higher for this option compared to other options as works will be done over a number of short periods.

3.4.2. Option 2: Refurbish Existing Joints

Refurbishing the existing nosing joint would aim to retain the same joint detail and return it to as new condition. Complete refurbishment of the nosing joints would include replacing the worn nosing plates, the anchor ties, backing concrete and the sealant material between the edgings. The replacement components will be bespoke and would require precise measurement to maintain a like for like refurbishment.

The advantages of this option include a complete replacement of the backing concrete in the anchorage zone, replacement of the worn edging angles and reinstatement of pourable sealant in the joint gap. Refurbishment would not require any modifications in the steelwork in the suspended span.

The main disadvantage of this option is that the refurbishment would require replacing the edging angles like for like thereby reducing the scope for improvements for future maintenance. The work to refurbish the joints would also require Oxyacetylene flame or saw cutting of the existing edging angles and re-welding (in-situ) into the supporting steelwork.

The capital works cost of this option is likely to be higher than the previous option as refurbishment would involve large amount of in-situ work compared to local repairs. However, the costs of future maintenance interventions would be significantly lower for this option compared to continuing with the current maintenance regime. It is anticipated that refurbished joint would have a service life of at least 10-15 years before next major intervention will be required.

Traffic management on the bridge would be required during the refurbishment works. This would be in the form of a carriageway closure for a period of 3 to 4 weeks.

Main advantages and disadvantages of this option have been summarised in the Table 3.2 below.

Table 3-2 Advantages and Disadvantages for Option 2

Option 2: Refurbish Existing Joint	
Advantages	**Disadvantages**
1. The existing nosing joints are returned to an as new condition	1. Refurbishment works would be extensive with limited scope for improvement for future maintenance.
2. The existing detail of the joints is retained that is familiar to the maintenance team therefore no	2. Concrete breakout, in-situ cutting, welding of steel plates and other hot works may be

Option 2: Refurbish Existing Joint	
Advantages	**Disadvantages**
additional training required.	unavoidable
3. Modification in the existing sealing material is possible which may improve the general maintenance of the joint.	3. There would be difficulties to gain certification from the contractor/supplier on the performance of the refurbished joints.
4. Existing steelwork on the suspended span is retained.	4. For similar cost new improved joint system could be installed.

Full refurbishment of all the nosing joints including the replacement of the nosing plates and filler material on both carriageways and two side towers is estimated to be in the order of £200,000 (excluding traffic delay management). The duration required for the refurbishment of one joint is likely to be two to three weeks although this may be reduced from learning of refurbishing multiple joints. Consideration on working on multiple joints in one carriageway at a time may save significant time and cost.

3.4.3. Option 3: Replace with Similar Nosing Joint

Refurbishing the existing nosing joints may address the current issues and return the existing joint to as-built condition, but it could not accommodate any advancement in the design and performance of more recent joint types. This option considers improvements in the existing joint detail encompassing improvements in material and edging details that should increase the service life and future intervention period compared for similar joint type.

A typical standard nosing joint requires fixing an elastomeric insert between the nosings on either side built in resin/epoxy mortar. In this case, adopting standard nosing detail in epoxy mortar may not be possible without significant modification in structural steelwork in the suspended span deck. However, utilising the existing detail, edgings fabricated in steel could be installed to form nosing with standard elastomeric insert glued (to the edgings) in the gap. From the feedback received from Forth Road Bridge, the projection in the existing edging on the suspended span side has the tendency to bend upon impact load and therefore there is an opportunity to rectify the edging detail for the replacement joint. A typical detail for the replacement joint is shown below.

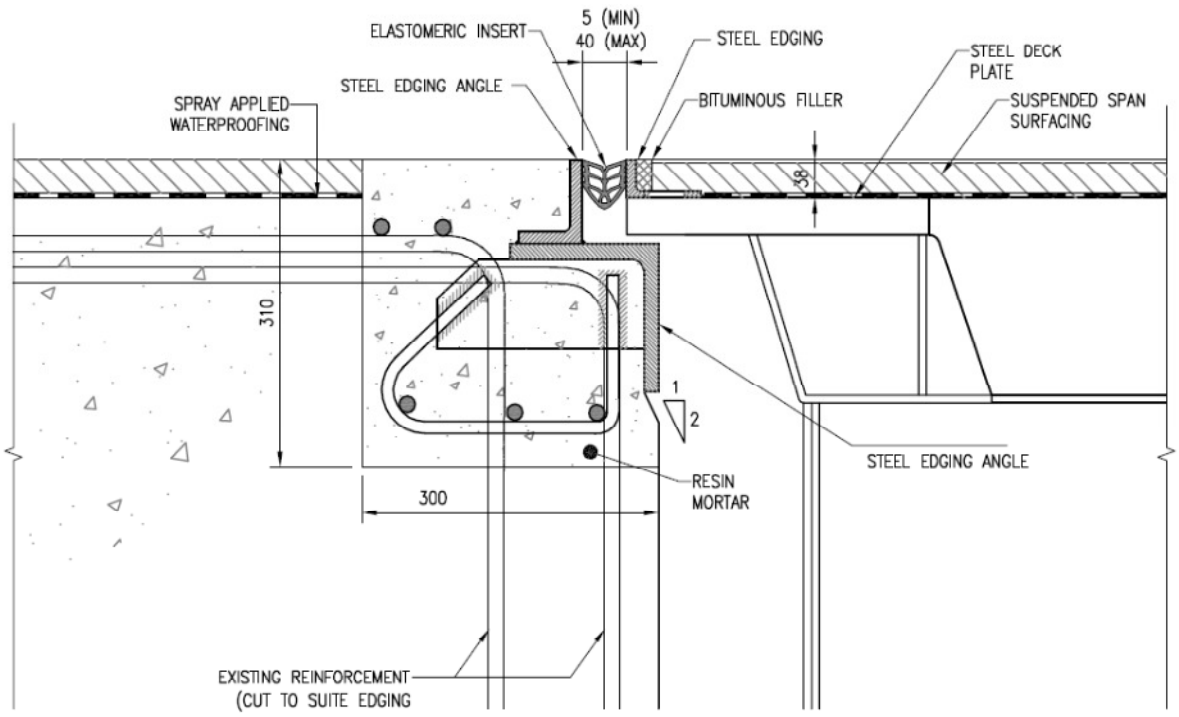


Figure 3-5: Nosing joint with pre-formed compressible seal

The maintenance intervention for nosing joints (as per suppliers) is typically 8 years under high traffic and 10 years under moderate to low traffic. A number of manufactures that produce nosing joints should be able to supply the extruded EPDM insert for use in this case e.g. Mageba, Ekspan, Freyssinet, URS and Stirling Lloyd.

The cost for this option is estimated to be £200,000 (excluding delay costs). The higher initial capital cost can be outweighed by assumed lower costs for increased intervention periods as the whole joint will be new.

Traffic management similar to previous option will be required to complete the work. The duration of the works is likely to be three to four weeks per carriageway although learning and experience from installing each joint is likely to decrease the duration

A summary of relative advantages and disadvantages of this option is detailed in Table 3.3 below.

Table 3-3 Advantages and Disadvantages for Option 3

Option 3: Replace with similar nosing joint	
Advantages	**Disadvantages**
1. Provides an improvement over an existing detail with increased service life.	1. Concrete breakout, in-situ cutting, welding of steel plates and other hot works will be required.
2. No major refurbishments should be required for up to 10 years	2. Cost of this option is likely to be higher compared to standard off the self products as edging detail will be bespoke and require in-situ welding to connect to the existing steelworks.
3. New joint likely to perform better than any refurbished or locally repaired option	3. Lead time for procurement of replacement component will be more than standard off the shelf products.
4. Joint will be fabricated and installed by manufacture who will be able to provide certification of the joint performance	

3.4.4. Option 4: Replace the existing joint with a single element elastomeric in metal runners (EMR)

An alternative joint type that could be considered in place of the noising joint is a single element elastomeric joint with metal runners. This type of joint incorporates a central elastomeric seal inserted between two steel carrier rails which are anchored to the bridge deck either in a preformed boxed out section with a fast setting high performance resin mortar or welded to permanent steelwork. The joints are manufactured in one unit so in the case of the Forth Road Bridge the joint will cover the entire carriageway width of 7.3 m.

This type of joint is available from a number of joint manufacturers including Ekspan, Maurer and Pitchmastic PmB. However, in order to install a standard EMR joint a minimum recess depth of 70 mm (with a clear width of 145 mm) is required. This would not be easily achieved on the Forth Road Bridge without significant break out of concrete from both the deck slab and the side tower in addition to adaptations to the steel fixing plate on the suspended span deck. To overcome the depth restriction, some of the manufacturer's provide metal runners that could be welded directly to the steel plate. From the available standard products the minimum depth that these edging could be welded into is about 40mm. This type of edging could be used on the suspended span side while on the side tower, standard boxed out section of 175mm (deep) x 300mm (wide) option can be formed to fix the other edge beam. Elastomeric insert can then be pushed into position to form the joint.

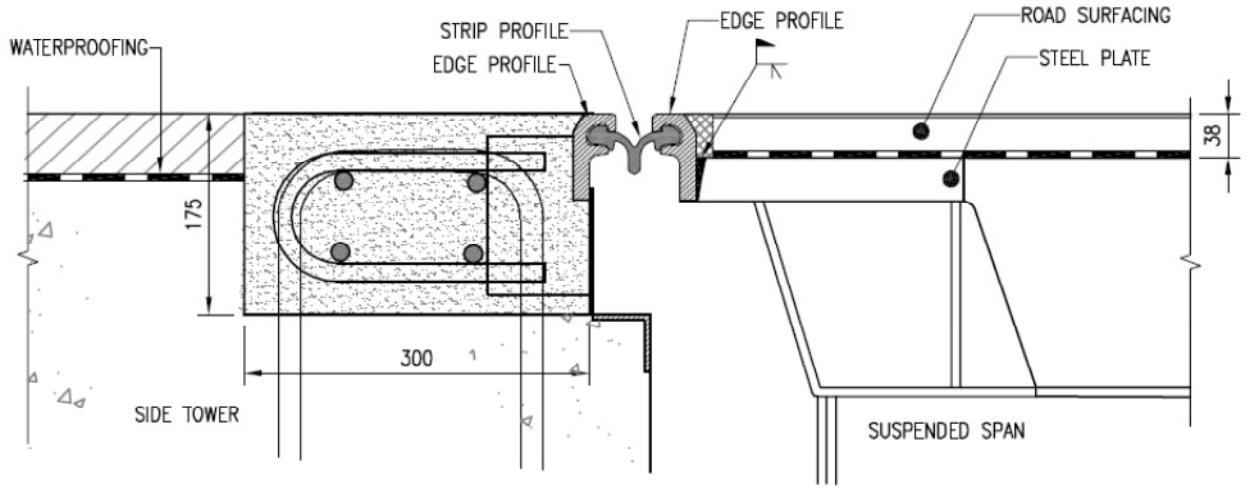


Figure 3-6: Elastomeric in metal runners

One of the key advantages of this type of joint is that they perform well under varying movement range and in this case the movement range of the joint will be well within the design range. However, this option would require welding smallest possible edging profile on the suspended span, which is not easily available with all the suppliers. Further the limitation in surfacing thickness would mean welding the steel edging profile to deck plate on its side than its base. As these joints will be subjected to varying impact load during their service life, the edging connection to the deck plate will be susceptible to fatigue and being an untested detail, adopting this joint type on the bridge would involve significant risk. In addition there will be buildability concerns in forming a butt weld with limited access below the deck plate.

The initial cost of installing this type of joint would be slightly less than the nosing joints (potentially due to use of standard edging profiles than bespoke edging) however the whole life cost would be much higher due to more frequent intervention period.

A summary of relative advantages and disadvantages of this option is detailed in Table 3.4 below.

Table 3-4 Advantages and Disadvantages for Option 4

Option 4: Replace existing joint with single element EMR joint	
Advantages	**Disadvantages**
1. The required movement range will be well within the capacity of EMR joint type.	1. Adaptation to current steel fixing plates may be required to provide vertical clearance for elastomeric elements
2. Lead time for procurement of replacement component will be sort.	2. Hot works would be required for installation of the joints and for removing of existing joint elements
3. Proven joint type with design service life of over 10 years.	3. Procurement of edging profile may be limited from selective suppliers only.
	4. Potential fatigue issue at weld connection between steel edging profile and deck plate on suspended side span.
	5. Use of practically untested detail.

4. Conclusions & Recommendations

4.1. Conclusions

The existing nosing joints have generally served the purpose for the last 50 years with some repairs. However, the reported issues of wear and fracture on the nosing plates including loss of anchorage to the steel edgings requires existing joint be replaced with improved design that remediates the current defects and increase the intervention period.

It is believed that existing nosing joints have long reached their service life and any further repairs could only delay its replacement. Refurbishment of the joints with new edging plates and poured sealant could restore the joint to its original as-built condition, but it is unlikely to mitigate the persistent maintenance issues. The time and cost required to be invested in this type of refurbishment would have little merit compared to similar effort and resource required to install a new joint system.

Use of standard EMR (Elastomeric in metal runners) joint was considered but due to the restricted surfacing thickness of 38 mm on the suspended span, forming any form of connection between the edging profile and existing steel deck was considered tricky and even if butt weld is to be formed (as shown in Figure 3.4) it will be susceptible to fatigue due to variable impact load. Standard EMR joint requires minimum 70mm recess depth to form suitable anchorage into the deck and as this would not be feasible without significant alterations this option is not considered viable.

Replacing the existing nosing joint (i.e. nosing joint with poured sealant) with similar joint type but with preformed compressible seal and bespoke steel edgings was also considered and it was found this type of joint would have some advantages over the existing detail with minimum modification to the existing steelwork. With use of compressible seal, the maintenance of the joint seal would be much easier and with improved edging detail most of the current known issues could be mitigated. It is believed that this option would provide an acceptable alternative with maintenance and durability benefits that otherwise could not be achieved by other options.

4.2. Recommendation

Based on the discussions in this report and consideration of the time for carrying out the works, capital cost, intervention periods and likely delays to traffic from maintenance works the following are recommended:

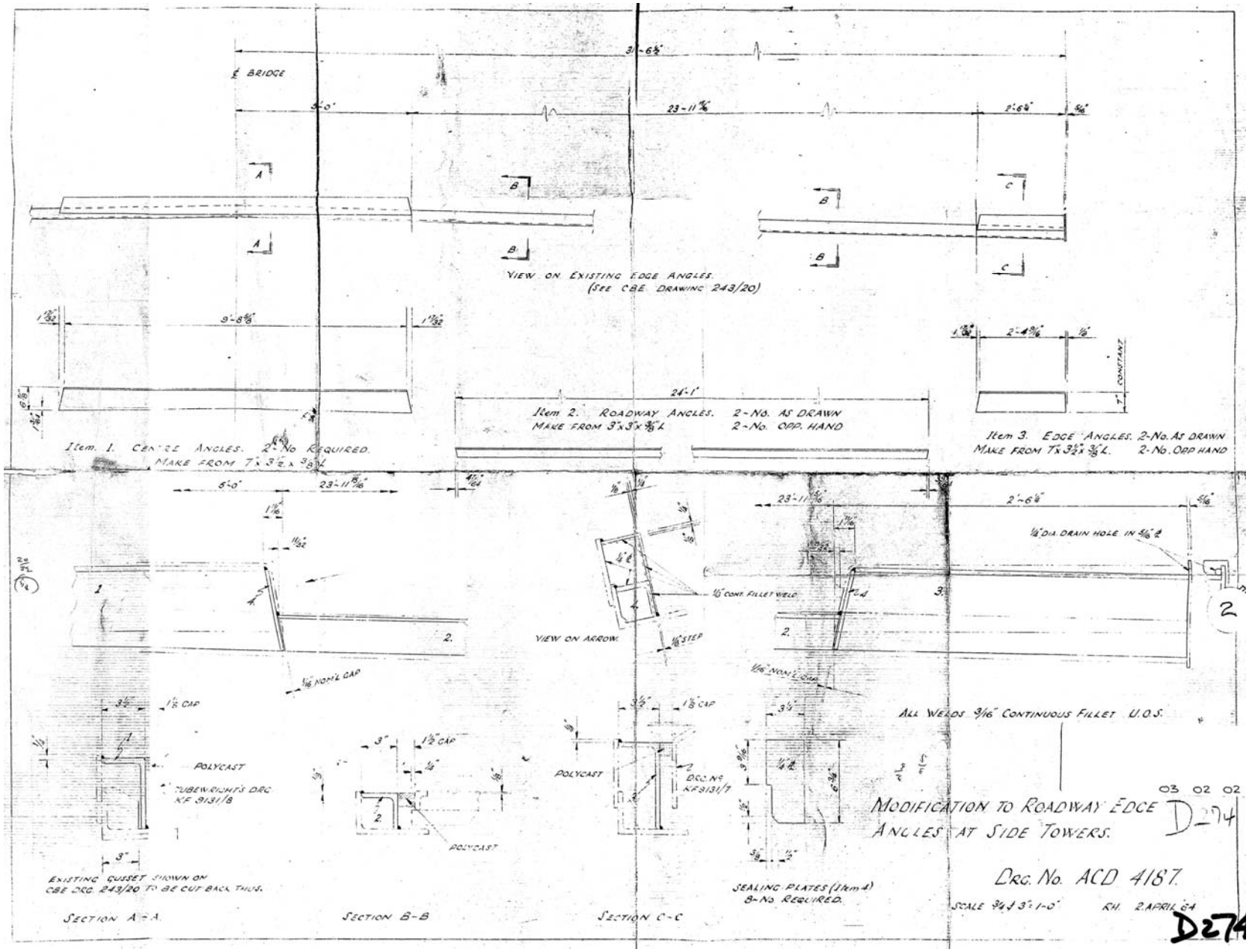
1. Continue with the existing nosing joints with inspection and maintenance regime in place until the traffic from the existing A90 is shifted to Queensferry crossing on its commencement in 2016-17. This will minimise the inconvenience to the travelling public, but the potential for emergency repairs will remain which should be accounted for in the strategic planning for maintenance of the bridge.
2. Once the motorway traffic is shifted to Queensferry crossing, works to replace the existing nosing joints on the side towers shall be aligned with similar joints replacement works on the main towers.
3. The existing nosing joints shall be replaced with modified nosing joints with steel edgings forming the nosings (DMRB BD 33, Type 4). The new joint will consist of three key components; two steel edgings and one compressible seal. If either of these is damaged over the period of usage, they could be individually replaced without damaging the other elements.
4. Based on the preliminary details, the cost of replacing the joints is estimated to be around £ 200,000 excluding any traffic management of traffic delay costs.
5. To progress the work on the nosing joints, it will be necessary to further develop the preferred option into detailed designs, specifications and works contract.

5. References

1. As built Construction drawings
2. Options Report for Bridge Deck Joints Rev B, Atkins Report No. 5032119/125/002, date issued Nov 2007

Appendices

Appendix A. General Arrangement Drawing of Existing Nosing Joint


℄ BRIDGE
VIEW ON EXISTING EDGE ANGLES.
(SEE CBE DRAWING 243/20)
Item 1. CENTRE ANGLES. 2-No REQUIRED.
MAKE FROM 7"x3½"x⅜"L
Item 2. ROADWAY ANGLES. 2-No. AS DRAWN
MAKE FROM 3"x3"x⅜"L 2-No. OPP. HAND
Item 3. EDGE ANGLES. 2-No. AS DRAWN
MAKE FROM 7"x3½"x⅜"L. 2-No. OPP HAND
CONSTANT
VIEW ON ARROW.
½" DIA. DRAIN HOLE IN ⅝" ℄
⅛" CONT. FILLET WELD.
⅛" STEP
⅛" NOM'L GAP
⅛" CAP
POLYCAST
TUBEWRIGHT'S DRG KF 9131/8
DRG. No KF 9131/7
EXISTING GUSSET SHOWN ON CBE DRG. 243/20 TO BE CUT BACK THUS.
SEALING PLATES (Item 4) 8-No. REQUIRED.
ALL WELDS 3/16" CONTINUOUS FILLET U.O.S.
MODIFICATION TO ROADWAY EDGE ANGLES AT SIDE TOWERS.
03 02 02
D274
DRG. No. ACD 4187.
SCALE ¾" & 3" = 1'-0" R.H. 2 APRIL '64
SECTION A-A
SECTION B-B
SECTION C-C
D274

Appendix B. Photographs of Existing Nosing Joints

Figure B-1 View of Nosing Joint (North Side Tower, Northbound Carriageway)

Figure B-2 View of Nosing Joint (South Side Tower, Southbound Carriageway)

Figure B-3 View of Nosing Joint (Local Strengthening of North Side Tower)

Figure B-4 View of Nosing Joint (Local Repair of Steel Edging Plate)

Atkins
Highways & Transportation
Canning Exchange
10 Canning Street
Edinburgh
EH3 8EG

www.atkinsglobal.com
Telephone 0131 221 5700
Fax 0131 221 5751