JACOBS

Aberdeen Western Peripheral Route

Aberdeen Western Peripheral Route

Structures
River Dee Crossing
Noise Barriers

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Contents

1 Executive Summary

1.1 Executive Summary

Following the completion of the noise modelling as part of the specimen design for the Aberdeen Western Peripheral Route (AWPR) 1.2m high noise barriers will be required at the back of both verges over the River Dee crossing.

The main considerations that have been discussed for the noise barriers are the type of materials available and method of attachment to the structure. These have been evaluated in terms of cost, appearance, inspection and maintenance and any other relevant issues. Other items such as colour and shape have been included but are generally considered as more detailed considerations to be developed once a material type and method of attachment is selected.

The materials that have been considered are:

- timber
- concrete
- steel or aluminium (painted)
- clear (methacrylate or glass)

Consideration is given to five means of attaching the noise barrier to the structure. This covers;

- widening of the edge beam
- cantilevered bracket support
- base fixed option (for clear panels only)
- the noise barrier being integrated with the bridge parapet
- a safety barrier in the verge with the noise barrier as a pedestrian restraint

From all of these discussions the main recommendation is for a clear noise barrier at the back of the verge as a pedestrian restraint with a safety barrier in the verge.

2 Introduction

2.1 Introduction

Following the completion of the noise modelling as part of the specimen design for the AWPR it has been found that 1.2m high noise barriers will be required at the back of both verges over the River Dee crossing.

A number of alternative types of barrier system are available and the purpose of this paper is to present and discuss these considering all relevant issues. It is recognised that a number of items of detailing are important for the integration of the selected noise barrier into the design, however it is intended that these items will be addressed once the barrier type and method of attachment has been selected, although some pertinent detailing issues will be discussed where their consideration is believed to be merited at this stage.

Therefore the main aim of this paper is to consider the available options and evaluate them in terms of what are seen as the main issues at this stage which are considered as:

- cost
- appearance (considering views from the road and from adjacent areas)
- inspection and maintenance
- other relevant issues

3 Structure Description

3.1 Structure Description

The specimen design for the River Dee crossing is a 3-span bridge comprising a main span of 120 metres over the river and 2 N° side spans of 75 metres spanning the B9077 on the south side and the footpath and access track on the north side (see Appendix A (A.1 & A.2)). It has a haunched deck which varies in depth from approximately 2.5 metres at abutments and midspan over the river to 5.1 metres over the intermediate supports. Singular 'eye'-shaped columns are proposed as the intermediate supports on each side of the river span.

The deck section comprises a trapezoidal box section with inclined sides to reduce the apparent depth of the structure. Large wide edge cantilevers are also proposed to reduce the apparent structural depth.

4 Noise Barrier Options

4.1 Noise Barrier Options

The options available for noise barriers are numerous and influenced by the following factors:

- material (e.g. timber, steel/aluminium, concrete etc.)
- method of attachment to structure (e.g. independent from the parapet but supported on the structure, independent from the parapet and cantilevered from the structure; integral with parapet etc.)
- colour
- shape (e.g. straight, curved vertically and or horizontally, profiled etc.)

The main factors that will influence the cost and aesthetics at this stage are considered as the material type and method of attachment to the structure. These factors have therefore been considered in detail in an attempt to rationalise the options to be recommended for the River Dee crossing.

4.2 Material

Four basic options are considered to be available for the type of material for the noise barriers.

- timber (see Appendix A (A.3))
- concrete (see Appendix A (A.4))
- steel or aluminium (painted) (see Appendix A (A.5))
- clear (methacrylate or glass) (see Appendix A (A.6))

4.2.1 Costs

The estimated costs for the material options stated above are as follows:

- timber £80,000
- concrete £90,000
- steel or aluminium (painted) £115,000
- clear (methacrylate or glass) £175,000

(These costs exclude the cost for the method of attachment to the structure, which is discussed later.)

4.2.2 Appearance

The appearance of the different materials above have there own advantages and disadvantages.

Considering a timber barrier, perhaps the one advantage that this option has is that the noise barriers required to the north of the River Dee crossing are likely to be timber, mounted on a stone clad steepened slope. If timber barriers were to be adopted over the structure this would provide continuity along the full length of this section of the road.

However there are several disadvantages associated with the appearance of this material. The first is that it blocks driver's views of the River Dee valley, which is a scenic area. Additionally, when viewed from the adjacent B979 and other vantage points it would greatly increase the apparent depth of the structure which has been specifically designed to reduce its apparent depth. Also this material is not considered to harmonise with the surrounding environment which is an open river valley. The new structure will be of concrete construction and the barrier will be located next to a metal parapet.

For a concrete barrier this has the advantage that it would harmonise with the new structure which will be of concrete construction. This system can be fabricated from precast architectural panels which could be patterned to add interest.

However there are several disadvantages associated with the appearance of this material. Similarly to the timber noise barrier it would block driver's views of the River Dee valley and it would greatly increase the apparent depth of the structure.

Metal noise barriers are commonly used on structures and this material has similar characteristics to the concrete option. It harmonises with the metal parapet and can be coloured to add interest. However, again this would block driver's views of the River Dee valley and greatly increase the apparent depth of the structure.

With respect to a clear noise barrier this offers considerable advantages. These advantages are that it would maintain the open views of the River Dee valley and would not increase the apparent depth of the structure. However one disadvantage of this material is the build up of dirt that can accumulate which, if extensive enough, can be unsightly and block views from the bridge.

4.2.3 Maintenance

The four material types have very different durability characteristics and their whole life performance and maintenance should be given important consideration. Timber has the shortest design life with regular maintenance required at intervals of less than 10 years. If maintenance is not carried out then the acoustic performance of this type of barrier can be significantly reduced.

Steel or aluminium systems are currently available with BBA (British Board of Agrément) certification for design lives of 25 years. However for the River Dee crossing a paint system would not be suitable to protect this type of barrier due to the potential to contaminate the river from removal and re-application of the paint system.

Concrete can be designed for a similar design life as the bridge itself which would be 120 years. However one potential maintenance issue would be the durability of the reinforcement. This would normally be high yield steel with the elements being protected with a hydrophobic pore-lining impregnant. Silane, which is now recognised to be a highly toxic material, is the only material approved by Transport Scotland for this purpose. Due to the potential to contaminate the river from the continual application of this material an alternative that could be considered is adopting stainless steel reinforcement. However this is likely to increase the cost of the units by approximately £50,000.

A further maintenance consideration is the replacement of concrete units if they were damaged. Sourcing these components could be problematic and if the panels had architectural features this would also add cost and delay to replacement panels.

The clear materials are considered to offer excellent durability characteristics with slight discolouration over a long period of time being the only real deterioration. They can have a similar design life as the bridge itself which would be 120 years with no protective treatments required. The replacement of the components is also relatively simple with widespread availability of the components. The only disadvantage associated with a clear material is the build up of dirt that can accumulate which, if extensive enough, can be unsightly and block views from the bridge. This is likely to require cleaning by means of a low powered water spray at regular intervals.

4.2.4 Other Relevant Issues

With respect to the choice of material one other relevant issue is the weight of the material. Concrete is considered to be the only one of the materials mentioned that has significant disadvantages due to the heavier sections required.

4.3 Method of Attachment to Structure

The noise barriers are required at the back of the AWPR verge over the structure. The bridge parapets are located at this point and it is usual practice in the UK to locate the noise barrier a working width behind the bridge parapet (see Appendix A (A.7)).

Irrespective of the type of barrier used there are two methods that are usually adopted for fixing the barrier to the structure. The first is to widen the edge beam sufficiently to support the noise barrier in the same manner as it supports a standard parapet. The second method is to provide cantilever bracket supports (usually steel) which cantilever from the edge beam.

Both of the options described above comprise a noise barrier spanning horizontally between vertical supports. A system that is not usually adopted in bridge construction but is frequently used in buildings is to attach glass along its base which cantilevers vertically removing the need for vertical supports and provides a completely clear barrier (see Appendix A (A.8)). This would be an option that could be considered if a clear barrier material was selected.

Due to the similar heights of the noise barrier and bridge parapet the appearance may be improved by integrating the two into one barrier rather than two separate barriers (see Appendix A (A.9)). BS 6779 clause 8.2 e) states that:

'On occasions it will be necessary to combine an environmental barrier with a vehicle parapet with or without pedestrian access. Noise or light attenuation requirements may give variable heights and thicknesses of infill and each case shall be considered on its merits observing the general requirements of this clause.'

It therefore appears that this can be achieved although the method of achieving it is not clear. It is believed that a detail could be developed that would be deemed to comply with BS 6779 and would not require testing. However, if this option is to be taken forward it is recommended that discussions on the technical feasibility of this solution commence at the earliest opportunity in order to confirm this assumption.

A further option that is available is to provide a safety barrier in the verge to act as the vehicle restraint system which would remove the requirement for a vehicle parapet at the back of the verge. The parapet can therefore be replaced with the

noise barrier, provided it is also designed as a pedestrian restraint (see Appendix A (A.9)). It should be noted that pedestrians will be excluded from walking on the verge of the structure due to its Special Road status and the pedestrian restraint is only required for the safety of maintenance operatives and members of the public using the verge in an emergency and is a requirement of TD 19/06.

4.3.1 Costs

The estimated costs for the method of attachment stated above are shown below. These have been compared against the cost of providing a standard bridge parapet on a typical edge beam, which is currently included in the specimen design.

- widened edge beam +£75,000
- cantilever bracket supports +£40,000
- base fix +£75,000
- integrated no significant cost
- safety barrier in verge -£80,000 (saving)

The costs associated with the method of connecting the noise barrier to the structure are influenced by the type of material used, therefore these costs are intended as a guide and are based on a metal barrier, with the exception of the base fix option, which is applicable to a clear barrier only. For the safety barrier located in the verge the saving is realised by the lower cost safety barrier being provided compared to the parapet, which is currently included in the cost of the structure.

4.3.2 Appearance

The appearance of a noise barrier independent from the parapet supported on a widened edge beam is believed to offer a mixture of good and poor visual qualities. A widened edge beam is considered to be a good detail visually which gives the impression that the noise barrier is an integral part of the structure. However the separation between the noise barrier and the parapet is believed to be poor visually as a layperson would see this as unnecessarily complex and cluttered and would not understand the reason for the separation.

The method of supporting the noise barrier with cantilever bracket supports cantilevered from the edge beam is considered to offer the same characteristics as the option above. The gap between the edge beam and the noise barrier would require infilling to prevent leakage of noise and would therefore result in the same visual appearance as above.

Supporting a clear barrier along its base without the need for vertical supports obviously relies upon a clear material being selected. However if this were the case it is believed that this would provide an excellent appearance.

Similarly the integration of the noise barrier with the bridge parapet is believed to offer an excellent appearance as it demonstrates an integrated design approach.

For the option that comprises a safety barrier in the verge with the noise barrier acting as a pedestrian restraint this is believed to offer a good overall appearance. Although the two barriers are separated the separation appears logical as it is wider than the 800mm working width associated with the other options. If this option were to be adopted with a clear noise barrier this is believed to offer an excellent appearance. This would have the least visual impact of all the options discussed,

both from the road and from adjacent areas. It also has the benefit of continuing the line of the safety barriers on the approaches to and departures from the structure.

4.3.3 Maintenance

A widened edge beam to support an independent noise barrier is not considered to add any more significant maintenance to the structure. However bracket supports cantilevered from the edge beam are likely to require significantly more maintenance as they are fabricated from steel components that require a paint system.

A noise barrier that is physically separated from the parapet (or safety barrier) does offer maintenance benefits in the sense that damage caused to the noise barrier from vehicle collisions would be greatly reduced due to the protection offered by the parapet. A system that incorporates the noise barrier into the parapet would require a more complex replacement when the parapet/barrier was damaged. However the frequency of such an occurrence can be very occasional and this should also be borne in mind.

4.4 Colour and Shape

With respect to the colour and shape of the noise barrier, although these can be considerations, it is not believed that they are relevant at this time. For example if a clear material is selected colour and shape would be irrelevant. Therefore these are considered as details that will be given further consideration if necessary following selection of the material.

5 Conclusions & Recommendations

5.1 Conclusions & Recommendations

Although a full conclusion cannot be drawn at this stage it is believed that a number of recommendations can be put forward for consideration.

Of the four material options considered it is believed that a clear noise barrier offers significant benefits (see Appendix A (A.10)). Although it has a high initial cost its long term durability characteristics without any requirement for protective treatment ensures that it is cost effective in whole life terms. It also has superior visual qualities to all of the other materials available.

Summary of material costs (see clause 4.2.1):

- timber £80,000
- concrete £90,000
- steel or aluminium (painted) £115,000
- clear (methacrylate or glass) £175,000 (Recommended)

With respect to the method of attachment of the noise barrier to the structure it is believed that the provision of a safety barrier in the verge with a noise barrier as a pedestrian restraint system offers the best option. Visually it appears logical and if adopted with the clear material offers an excellent open appearance. This option also has the lowest cost.

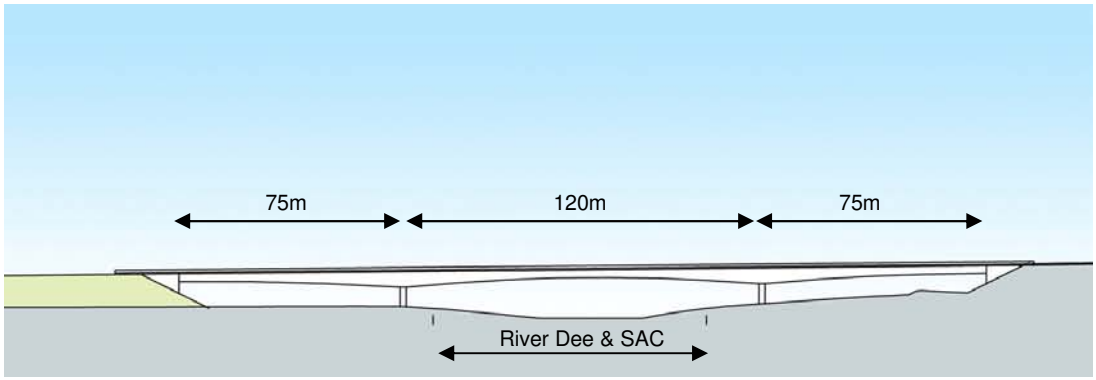
Summary of method of attachment costs (see clause 4.3.1):

- widened edge beam +£75,000
- cantilever bracket supports +£40,000
- base fix +£75,000
- integrated no significant cost
- safety barrier in verge -£80,000 (saving) (Recommended)

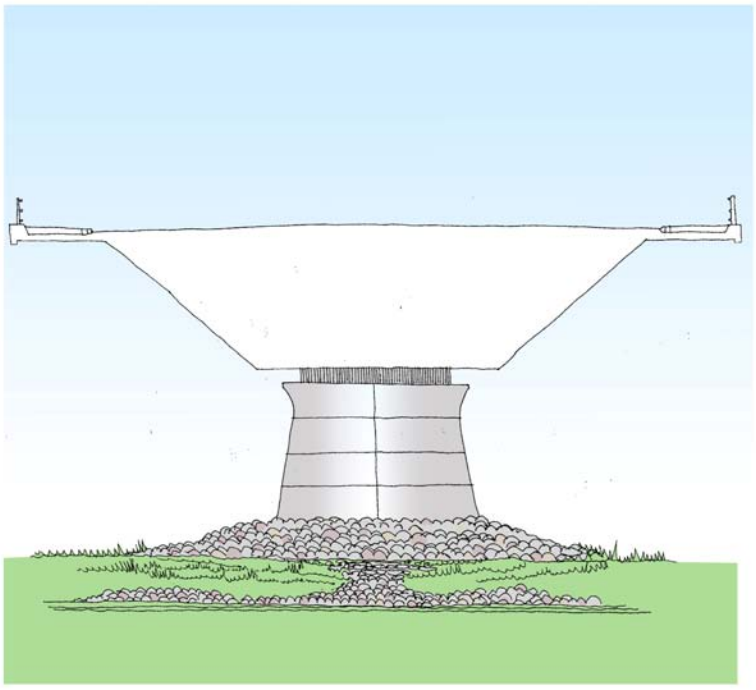
Appendix A: Figures

Appendix A.1: Proposed Structure

Appendix A.2: General Arrangement

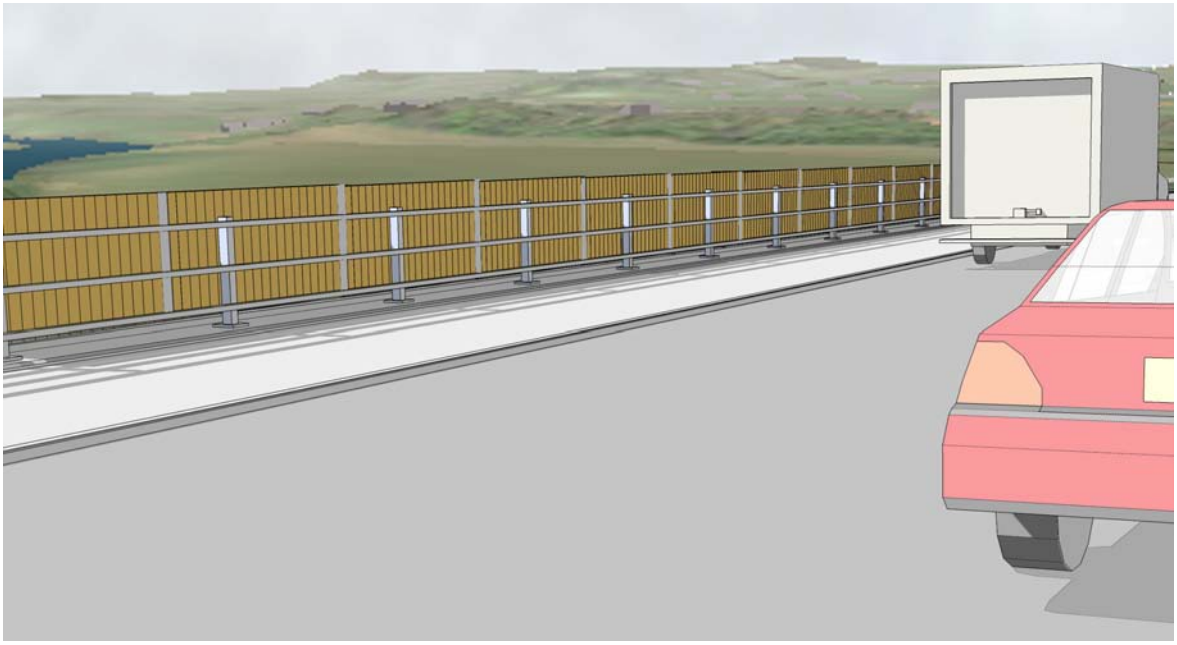


Elevation



Cross Section

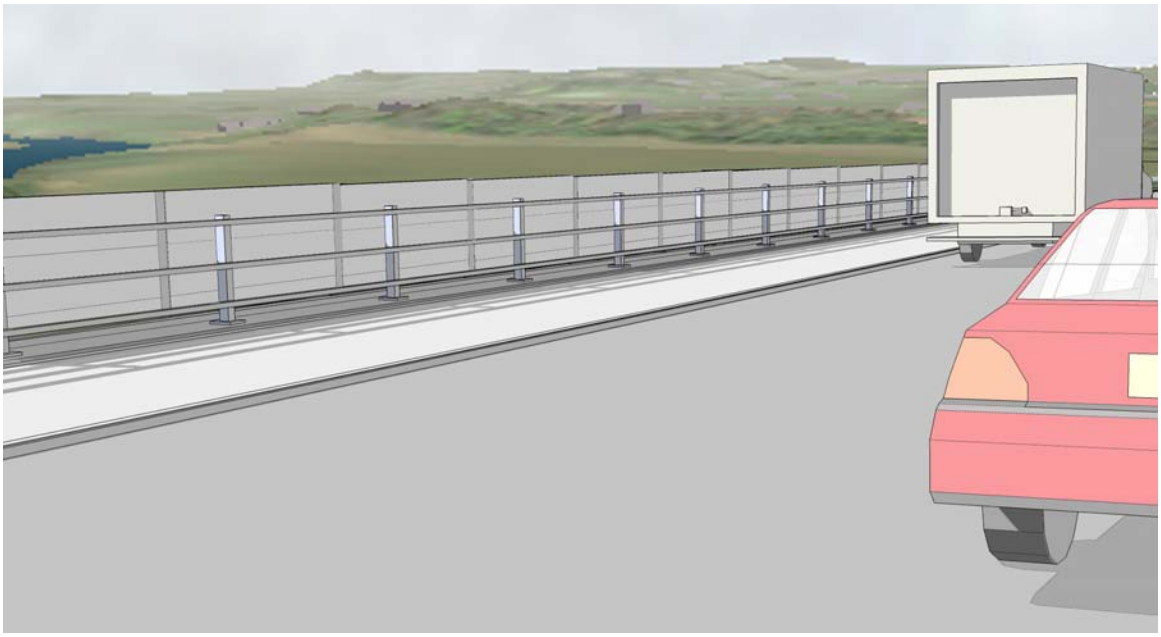
Appendix A.3: Timber Noise Barriers



River Dee Visualisation

Examples of Timber Noise Barriers

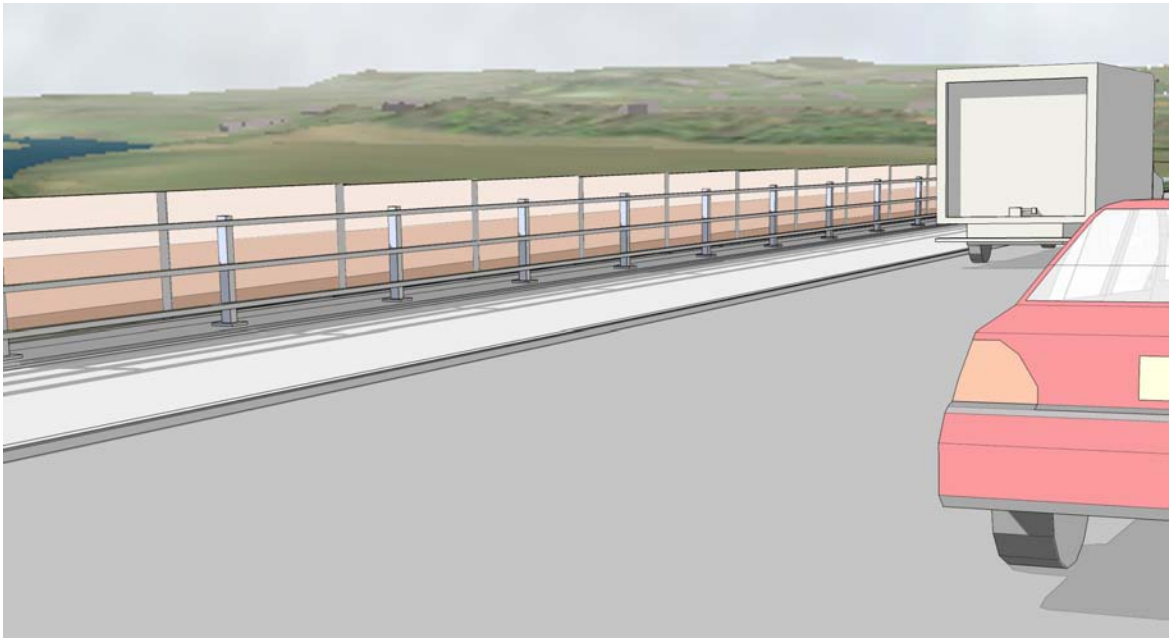
Appendix A.4: Concrete Noise Barriers



River Dee Visualisation

Examples of Concrete Noise Barriers

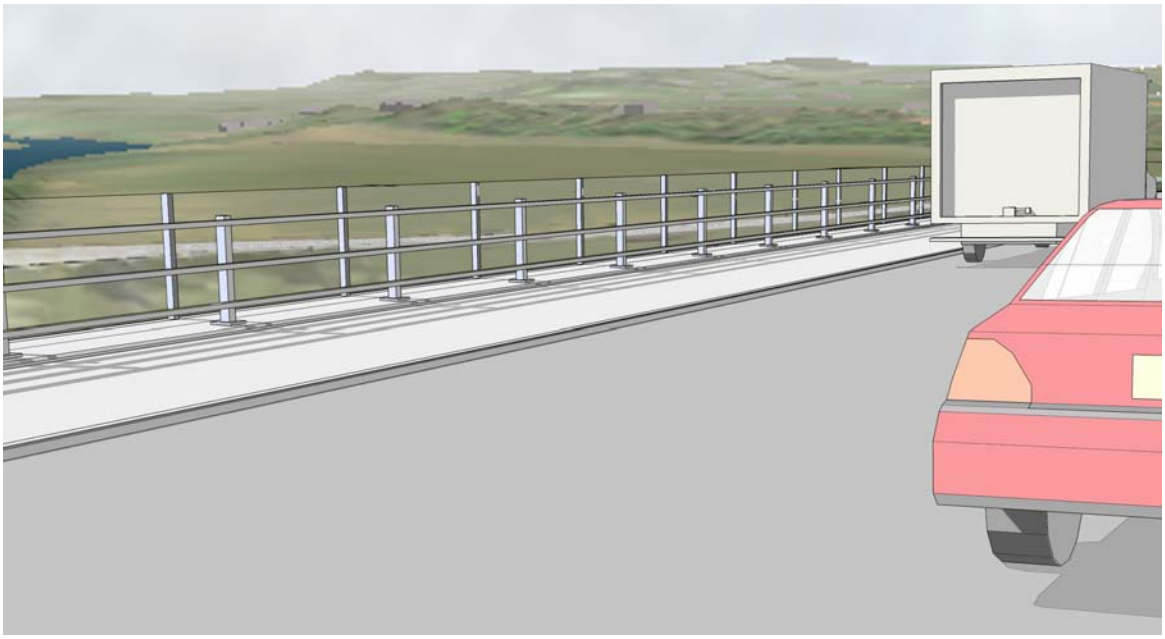
Appendix A.5: Steel or Aluminium (Painted) Noise Barrier



River Dee Visualisation

Examples of Metal Noise Barriers

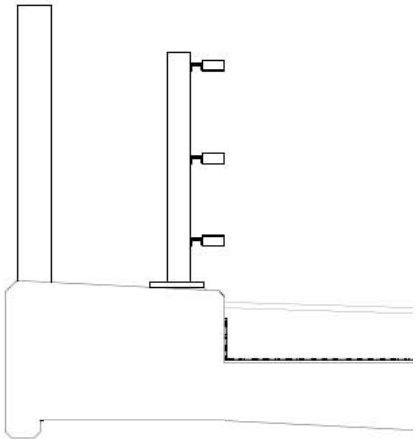
Appendix A.6: Clear (Metacrylate or Glass) Noise Barrier



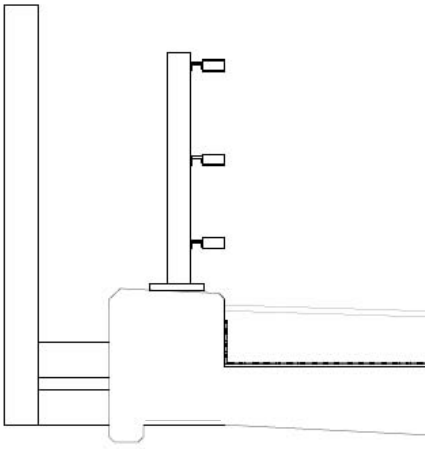
River Dee Visualisation

Examples of Glass Noise Barriers

Appendix A.7: Method of Attachment to Structure

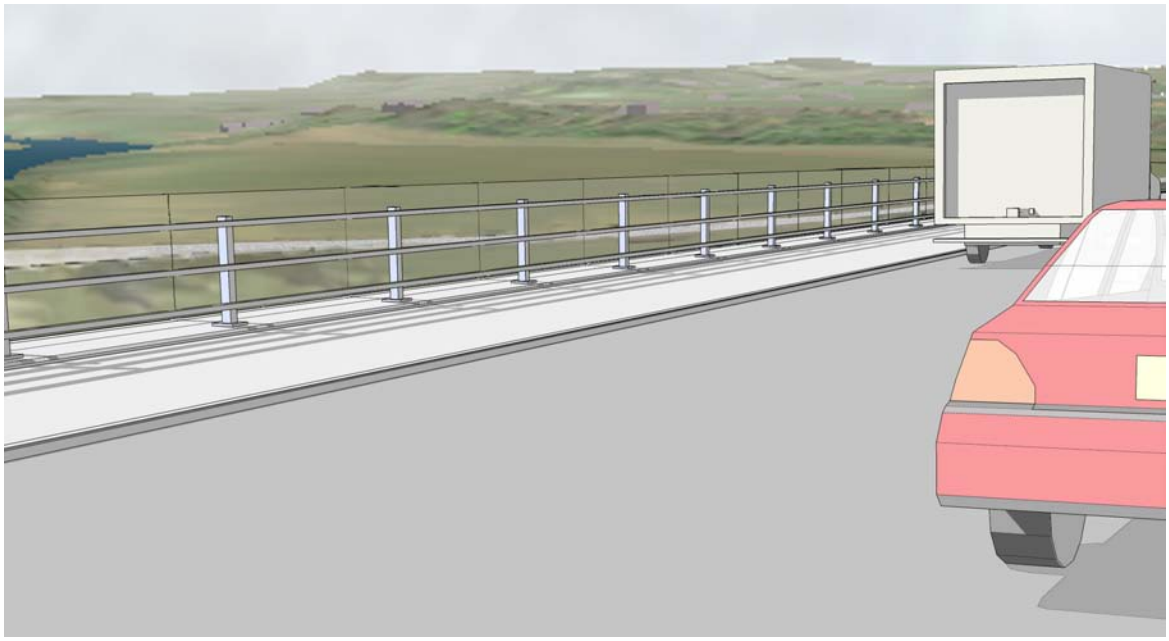


Edge Beam Widened

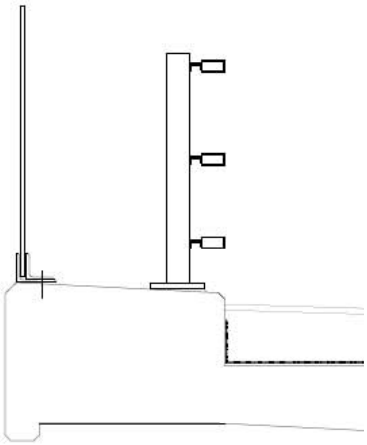


Cantilever Bracket Support

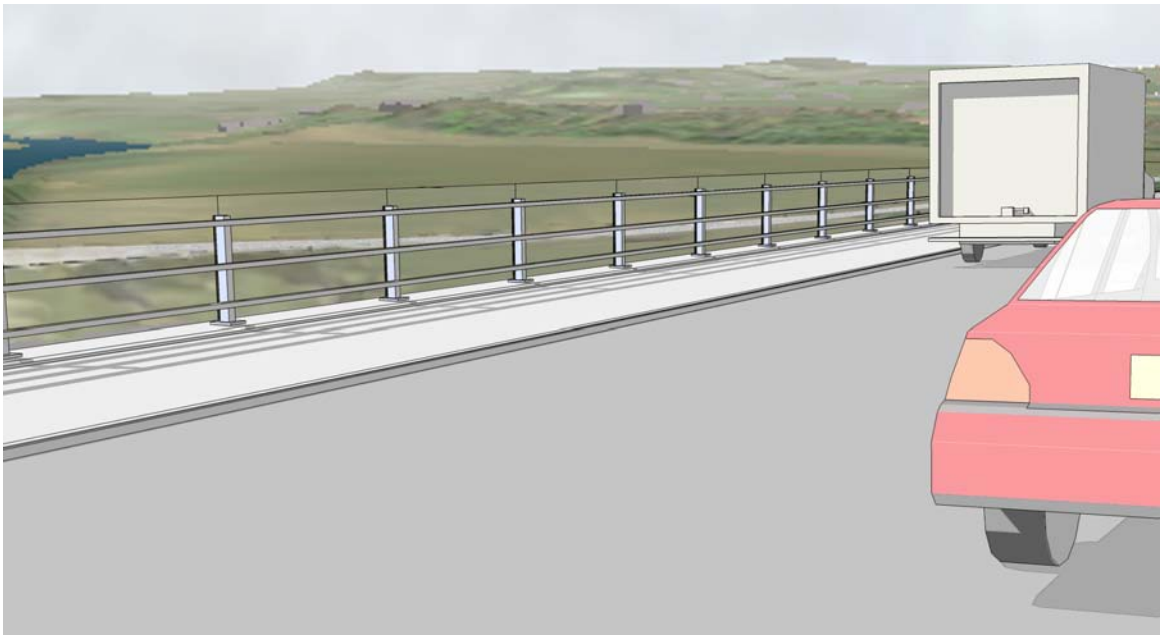
Appendix A.8: Clear (Base Fix) Noise Barrier



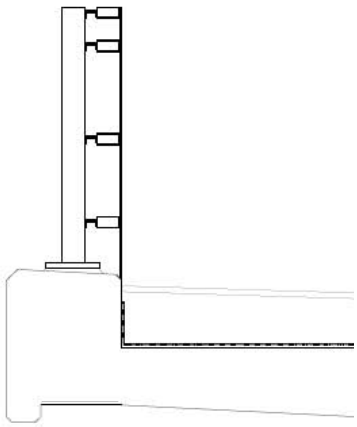
River Dee Visualisation



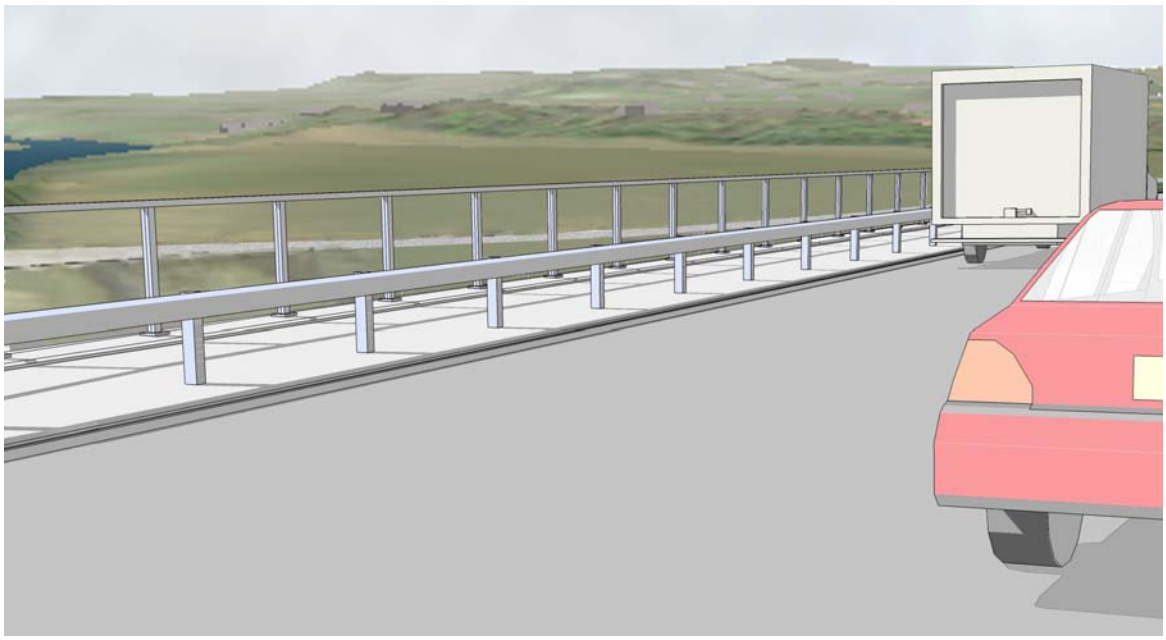
Appendix A.9: Integrated Noise Barrier with Parapet



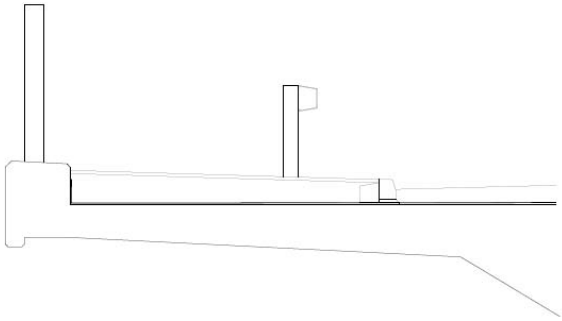
Clear noise barrier integrated with parapet



Appendix A.10: Safety Barrier in Verge and Noise Barrier as Pedestrian Restraint



River Dee Visualisation



Safety barrier in the verge with noise barrier as pedestrian restraint