DART+ Coastal North

ANNEX 3.2

Technical Optioneering Report: Electrification of the Northern Line between Malahide and Drogheda

SECTION D

Bridge parapet modifications

ARUP

Contents

			Page
	Abbreviations		1
1	**Introduction**		**2**
	1.1	Packages of work	2
	1.2	References	4
	1.3	Option Assessment Approach	5
2	**Existing Situation**		**6**
	2.1	Overview	6
3	**Requirements**		**11**
4	**Options for modifying parapets**		**13**
	4.1	Road bridges	13
	4.2	Pedestrian Bridges	15
	4.3	Materials	17
5	**Recommendations**		**19**
	5.1	Recommendations for Road Bridges	19
	5.2	Recommendations for Pedestrian Bridges	22
6	**Summary**		**26**

Tables

Table 1-1: List of key documents associated with Electrification of the Northern Line between Malahide and Drogheda

Table 1-2: List of key documents associated with this report

Table 2-1: Parapet Summary for Road Bridges

Table 2-2: Parapet Summary for Pedestrian Bridges

Table 2-3: List of Bridges identified as Protected Structures

Table 5-1: Road bridges with parapet heights between 1.7m – 1.8m

Table 5-2: Road bridges with parapet heights less than 1.7m

Table 5-3: Pedestrian bridges with parapet height less than 1.8m

Table 5-4: Pedestrian bridges with non-compliant screens

Table 6-1: Summary of recommendations for parapet modifications

Figures

Figure 3-1: Extract from the *Electricity Functional Specifications System-Wide*, Clause 5.28.1 Obstacles

Figure 4-1: Reconstruct parapet on a masonry arch bridge (CD376 Unreinforced Masonry Arch Bridges)

Figure 4-2: Raised parapet wall on masonry arch bridge (Borders Railway Project, Newtongrange to Eskbank)
Figure 4-3: Coping extension (GFRP coping – Stockton on Tees Junction (source:www.evergrip.com) and precast concrete – Borders Railway Project, Bonnyrigg Road Bridge)
Figure 4-4: Steel mesh extension (OBB9A – Collins Ave East, Killester and OBB26 – Back Rd, Malahide)
Figure 4-5: Non-transparent parapet extensions (Steel – Bury's Bridge, UK and GFRP example (source www.duracomposites.com)
Figure 4-6: Transparent or opaque parapet extensions (Glass – Dodder Bridge, Ringsend and Polycarbonate or Acrylic – Eastlink, Australia). Note that Section 4.3 of this report discusses relevant materials and recommends against the use of glass.
Figure 4-7: Mesh infill replaced with solid steel panels (Raheny Station footbridge)
Figure 4-8: Steel panels added to outer face of existing mesh screens (Middle Third Bridge, Killester)
Figure 4-9: Solid steel panels on pedestrian bridge (OBR141, Bray)
Figure 4-10: Clear panels on pedestrian bridge (Grand Canal Dock Station)
Figure 4-11: GFRP panels between chords of Vierendeel truss (Vilafant footbridge, Spain)

Abbreviations

Abbreviation	Definition
CAF	Common Assessment Framework
CCE	Chief Civil Engineer's Department
IÉ	Iarnród Éireann / Irish Rail
MCA	Multi-criteria analysis
OBB	Overbridge
OHLE	Overhead line equipment
OLE	Overhead line electrification
TII	Transport Infrastructure Ireland
TSS	Train Service Specification

1 Introduction

The purpose of the report is to provide the technical input into the Preliminary Option Selection Report. This report provides the technical assessment of necessary safety improvement works to bridge parapets as a result of the introduction of overhead line electrification equipment (OHLE) from option selection through to Draft Emerging Preferred Options, including the options considered and how Draft Emerging Preferred Options were chosen.

The report includes:

- An introduction and description of the study;
- A summary of the option assessment approach undertaken;
- A description of the existing situation;
- The requirements;
- The technical options available, along with comparison;
- Recommendations.

1.1 Packages of work

The scope of work for DART+ Coastal North covers a wide range of interventions on the Northern Line needed in order to meet the Train Service Specification (TSS) requirements. To appropriately assess options against each other, the works have been split into separate work packages. Where appropriate, the works have then been further split down into 'sections which define the system which has been subject to the optioneering and design process.

This document is a section of the overarching optioneering report for the electrification of the Northern Line between Malahide and Drogheda. Please refer to Table 1-1 for a list of the different sections which make up the electrification package of work.

Table 1-1: List of key documents associated with Electrification of the Northern Line between Malahide and Drogheda

Section	Title	Longlisting	MCA content
A	OHLE system	No	Not required as the OHLE system type is driven by standards and any options have no material effect on external parties, the public and/or the environment.

Section	Title	Longlisting	MCA content
B	OHLE foundation solution	No	Not required as this has no material effect on external parties, the public and/or the environment.
C	OHLE foundation solution at underbridges	Yes	Assessment of the OHLE solution for underbridges which are of heritage value, visually prominent or over environmentally sensitive areas.
D	Bridge parapet modifications	No	Not required as solution is driven by safety requirements.
E	OHLE Bridge Clearance works	No	Not required as the OHLE solution adopted is driven by standards.
F	Traction Power Supply (will form part of Public Consultation 2)	Yes	Not required for traction power supply strategy which is set by operational requirements and standards, however is required for localised substation locations due to potential impacts on external parties, the public and / or the environment.
G	User worked level crossing south of Donabate	Yes	Assessment of various interventions in response to impact of electrification/service frequency increases.
H	Fencing and lineside safety	No	Not required as the option is driven by safety standards

1.2 References

This report should be read in conjunction with the following related optioneering reports:

Table 1-2: List of key documents associated with this report

Annex	Title	Description
N/A	DART+ Coastal North Preliminary Option Selection Report	This is the main report which summarises the optioneering process and the different packages of proposed works on the DART+ Coastal North project.
N/A	DART+ Coastal North Preliminary Option Selection Report – Executive Summary	This report summarises the main Preliminary Option Selection Report.
1	Emerging Preferred Option Maps	Includes drawings for each Emerging Preferred Option, to support the Preliminary Option Selection Report.
2.1	Policy Context	This presents a detailed review of the European, National, Regional and Local policy context for the DART+ Programme and the DART+ Coastal North Project
2.2	Useful Links	Useful links to documents/websites relating to the DART+ Coastal North project.
3.1	Constraints Report	This report reviews the DART+ Coastal North constraints.
3.2	Technical Optioneering Report: Electrification of the Northern Line between Malahide and Drogheda.	The Technical Optioneering Report for the Electrification of the Northern Line between Malahide and Drogheda. The report is divided into a series of sections, as described in Table 1.
3.3	Technical Optioneering Report: Works around Drogheda MacBride Station	The Technical Optioneering Report for Works around Drogheda MacBride Station. The report addresses track and station modifications to allow for the increased number of DART services.

Annex	Title	Description
3.4	Technical Optioneering Report: Works around Malahide Station	The Technical Optioneering Report for Works around Malahide Station. The report addresses track modifications required to allow trains to be turned back clear of through running services.
3.5	Technical Optioneering Report: Works around Clongriffin Station	The Technical Optioneering Report for Works around Clongriffin Station. The report addresses track modifications required to allow trains to be turned back clear of through running services.
3.6	Technical Optioneering Report: Works around Howth Junction & Donaghmede Station	The Technical Optioneering Report for Works around Howth Junction & Donaghmede Station. The report addresses the addition of tracks to allow a higher frequency shuttle service.
3.7	Technical Optioneering Report: Howth Branch Level Crossings	The Technical Optioneering Report for the Howth Branch Level Crossings. The report addresses the impacts of all proposed increases in train frequency on existing level crossings on the Howth Branch.

1.3 Option Assessment Approach

In line with the Option Selection Process section of the Preliminary Option Selection Report, elements can be scoped out of the Multi-criteria Analysis (MCA) process based on a number of criteria, one of which is as follows:

'If the type of system to be used is solely governed by IÉ standards and specified by technical requirements, then the CAF/MCA process will not be utilised.'

Since this is true for the selection of OHLE parapet modifications, the draft emerging preferred options described in this report are not subject to the MCA process and are instead proposed to be based upon technical requirements as set out within this document.

2 Existing Situation

2.1 Overview

As part of the DART+ Coastal North project, the Northern Line between Malahide and Drogheda is to be electrified. This involves electrifying approximately 38km of track. There are 29 bridges which span over the railway along this length, including 21 road overbridges and 8 pedestrian bridges.

The introduction of OHLE along this length of the railway introduces the risk of electrocution. Current standards and specifications require minimum offset from electrical lines and the need for prescribed parapet heights to reduce this risk.

Parapets

An initial desktop study was undertaken to assess the composition and heights of parapets on the exiting bridges over the railway. This comprised a review of bridge drawings, where available, and a review of inspection reports and photos from various site visits. Publicly available aerial mapping (e.g. Google Maps) and images from Google Street View were also reviewed. Following this initial desktop study, a site visit was conducted on 31 August 2021 to confirm parapet composition and heights for all overbridges between Malahide and Drogheda.

Table 2-1: Parapet Summary for Road Bridges

Bridge No.	Bridge Form	Measured Parapet Height (m)	Parapet Composition
OBB32A	Precast beam	1.75	Reinforced concrete
OBB33	Precast portal units	1.80	Reinforced concrete clad in stone
OBB35	Precast beams	1.75	Reinforced concrete clad in stone (2)
OBB38	Masonry Arch (Protected Structure)	1.15	Stone masonry
OBB39	Precast beams	> 1.80	Reinforced concrete
OBB41	Precast beams	1.55	Reinforced concrete clad in stone (2)
OBB44	Precast beams (Protected Structure)	> 1.80	Concrete blocks (1)
OBB45	Precast beams	1.80	Reinforced concrete clad in stone (2)
OBB46	Precast beams (Protected Structure)	1.70	Reinforced concrete clad in blockwork (2)
OBB47	Masonry Arch	1.25	Stone masonry
OBB49	Precast beams	1.70	Reinforced concrete clad in stone (2)

Bridge No.	Bridge Form	Measured Parapet Height (m)	Parapet Composition
OBB55	Precast portal units	1.55	Reinforced concrete clad in stone (2)
OBB62	Precast beams	> 1.80	Reinforced concrete clad in stone (2)
OBB63 (2)	Precast beams	- (3)	Reinforced concrete clad in stone (3)
OBB66	Precast portal units	1.80	Reinforced concrete clad in stone (2)
OBB68	Precast beams	1.35	Reinforced concrete
OBB77	Precast beams	> 1.80	Reinforced concrete clad in stone (2)
OBB78	Precast portal units	1.70	Reinforced concrete with Reckli cladding
OBB80	Masonry Arch	1.10	Stone masonry
OBB80A	Masonry Arch	1.05	Stone masonry
OBB80B	Precast beams	1.20	Reinforced concrete clad in stone (2)

Table Notes:

1) Orange highlighted cells denote parapets that are marginally lower than 1.80m. Pink highlighted cells denote parapets that are substantially below the 1.80m height requirement.
2) The parapet form appears to comprise a reinforced concrete wall clad in masonry. However, no drawings for this bridge were available to confirm this, nor was it possible to confirm the presence of a reinforced concrete core based on site observations. However, a concrete core is common for this form of parapet and it is a reasonable assumption for the purposes of this assessment.
3) OBB63 is located behind a locked gate (farm access only). Hence, it was not possible to inspect the parapets on this bridge on the day of the site visit. The parapet composition is based on a review of the 2013 IÉ inspection report.

All pedestrian bridges have a parapet height in excess of 1.80m, with the exception of OBB81 which has a 1.1m solid steel plate barrier. The majority of the pedestrian bridges have parapets that comprise of infill panels with mesh or perforated plate. These openings however extend for the full height of the parapet and do not comply with Irish Rail's requirement for the lower 1.2m height of the parapet to comprise of a solid panel and hence will require some form of intervention. Refer to Table 2-2 below or a summary of the pedestrian bridge parapets.

Table 2-2: Parapet Summary for Pedestrian Bridges

Bridge No.	Bridge Form	Measured Parapet Height (m)	Parapet Composition
OBB33A	Steel beams	> 1.80	Full height wire mesh panel. Wire mesh size < 1200mm^2 Compliance with IP2X rating to be confirmed.
OBB38A	Steel beams	> 1.80	Full height wire mesh panel. Wire mesh size < 1200mm2 Compliance with IP2X rating to be confirmed.
OBB51A	Steel beams	> 1.80	Full height wire mesh panel. Wire mesh size < 1200mm2 Compliance with IP2X rating to be confirmed.
OBB54	Precast beams	> 1.80	Full height perforated steel plate. Horizontal gap at base. Perforations < 1200mm2 Compliance with IP2X rating to be confirmed.
OBB57A	Steel beams	> 1.80	Full height wire mesh panel. Wire mesh size < 1200mm2 Compliance with IP2X rating to be confirmed.
OBB66A (TBC)[1]	Concrete	> 1.80[1]	Full height parapet, with lower portion comprising a Vulcalucent GRP panel with stainless steel mesh above[1]
OBB74A	Steel beams	> 1.80	Full height wire mesh panel. Wire mesh size < 1200mm2 Compliance with IP2X rating to be confirmed.
OBB81	Steel girder	1.10	Solid steel plate up to 1.10m. Open above 1.10m.
OBB81C	Steel truss	> 1.80	Solid steel plate up to 1.00m. Wire mesh above. Wire mesh size < 1200mm2 Compliance with IP2X rating to be confirmed.

Table Notes:

1) This is the new pedestrian bridge at Gormanston Station and is under construction at the time of writing. It is assumed that it will be installed with compliant parapets for future electrification. Information shown above is from existing architectural drawings dated May 2021.

Protected Structures

The following bridges are listed as protected structures - recorded on the local Authorities Record of Protected Structures or listed within the NIAH database.

Table 2-3: List of Bridges identified as Protected Structures

Bridge No.	Image of Bridge
OBB38 Rogerstown Lane	
OBB 44 Tyrrelstown	
OBB 46 Bunduncan	

There are a number of bridges which appear to have been constructed in the late 1800's or early 1900's. These bridges have been cross referenced against the local Authority Record of Protected Structures and the NIAH database, but do not appear on them.

OBB47 (disused road bridge adjacent Skerries Golf Club) comprises a masonry arch bridge. It is likely that this bridge will be specified as a structure of Regional Importance following a heritage survey.

OBB80 & OBB80A (McGraths Lane bridges on the approach to Drogheda MacBride Station) comprise masonry arch bridges, while OBB81 (pedestrian bridge within Drogheda MacBride Station) comprises a plated steel girder bridge. It is likely that these bridges will fall under the curtilage of protected structures associated with the station buildings at Drogheda MacBride Station.

In addition to the structures mentioned above, there are a few structures that are referenced in the NIAH database but appear to have been modified since their inclusion. OBB33 (Donabate Station Roadbridge) is noted as a single-arch ashlar limestone road bridge over railway line, c.1860, but has since been modified in the

early-2000s using precast portal units (see NIAH reg no. 11336014). OBB38A (Rush & Lusk Footbridge) is noted as a cast-iron pedestrian bridge but has been replaced with a steel bridge with stairs and lifts. OBB39 (Rush & Lusk Roadbridge) is noted as a stone and cast-iron road bridge but appears to have had a precast beam deck replacement retaining the original stone abutments (see NIAH reg no. 11323018 for both OBB38A and OBB39).

3 Requirements

A number of design standards require a parapet height of 1.8m on bridges that cross the railway. Both TII Publication DN-REQ-03034 and Irish Rail Standard CCE-TMS-410 require a parapet height of 1.8m for bridges over the railway. In addition to these standards, EN 50122-1 specifies requirements for the protective provisions relating to electrical safety in fixed installations associated with electrified tracks.

The DART+ West project developed a functional specification to be used across the DART+ Programme, namely the *Electricity Functional Specification System-Wide* document (MAY-MDC-ELE-DART-SP-E-0002). This document includes requirements for parapets on the scheme, as presented in Figure 3-1 below.

Figure 3-1: Extract from the *Electricity Functional Specifications System-Wide*, Clause 5.28.1 Obstacles

5.28.1. Obstacles

The DART+ network and its structures where design for a non–electrified line. Therefore, when introducing the OHLE, the existing structures might not comply with the requirements set out in EN 50122-1 regarding protection against direct contact.

New OHLE will require safety screens or extending / modifying the fencing to comply with this requirement. Figure 28 shows the three main solutions of obstacles (a, b and c) described in EN 50122-1. Option a) is based on a parapet over the OHLE. b) and c) are based on enlarging the fencing on the structure.

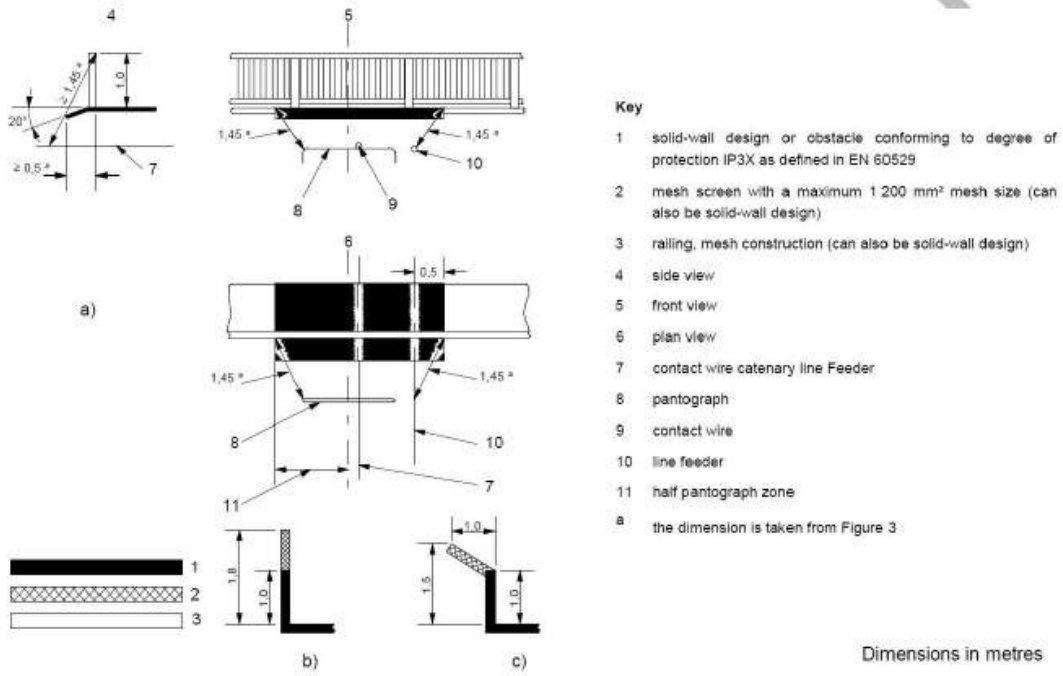


Figure 28. Examples of obstacles along the sides of standing surfaces in public areas for protection against direct contact.

The DART+ programme protection against direct contact shall be provided by **increasing the height of the parapet** up to 1.8m height being the first meter solid wall design (Option b of EN 50122-1). ***[U219]***

Based on the requirements of this document, a 1.8m parapet height conforming to Option (b) is required to provide protection against direct contact with the overhead wires.

Further to the details in the specification outlined above, Irish Rail have requested an enhanced level of protection as outlined in the response to Request for Information (RFI) D+WP56-ARP-P2-AL-RI-KX-000161. This requires the parapet to be solid for at least the lower 1.2m. The remaining 0.6m height can comprise a mesh screen extension with an IP2X rating (12.5mm probe cannot penetrate) or continue as a solid wall.

To avoid the risk of an individual scaling the parapets, no handholds or handrails are permitted. The top of walled parapets are required to have a 45 degree symmetrical steeple coping.

A number of the road bridge parapets will need to be increased in height to meet the minimum 1.8m requirement. Some of these parapets are only marginally lower, measuring less than 0.1m below the required level. Refer to Table 2-1 for a summary of the road bridge parapets.

All pedestrian bridge parapets will need some form of modification to meet these requirements.

4 Options for modifying parapets

4.1 Road bridges

All parapets on the road bridges comprise solid walls greater than 1.2m in height, with the exception of OBB80 and OBB80A (masonry arch bridges at McGrath's Lane). Hence to comply with the project specification requirements, parapets can be increased in height by either a solid extension or mesh extension with apertures smaller than 12.5 mm (IP2X rated).

There are a number of ways in which the bridge parapets can be extended. These are listed below:

- Demolish and reconstruct barrier to correct height;
- Extend parapet height using similar materials (stone, brick, concrete etc);
- Extend parapet height using a lightweight panel (e.g. mesh, steel plate, GFRP, glass, acrylic/polycarbonate);

The images below show examples of potential parapet modifications.

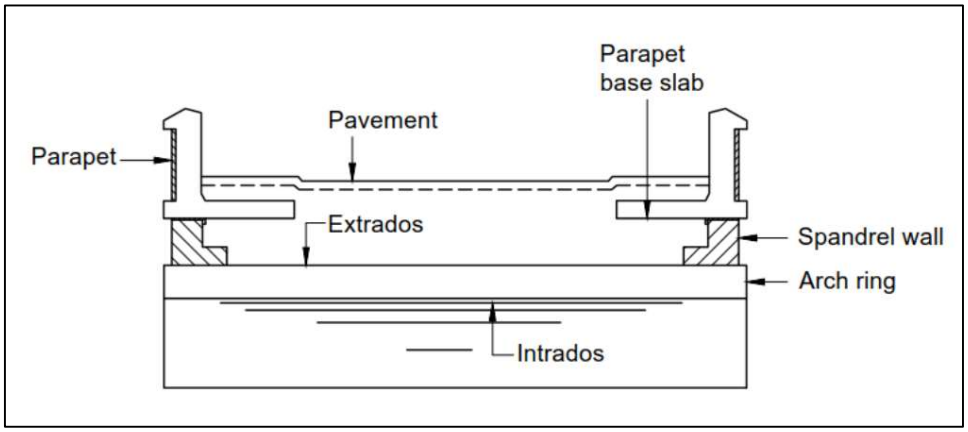


Figure 4-1: Reconstruct parapet on a masonry arch bridge (CD376 Unreinforced Masonry Arch Bridges)

Figure 4-2: Raised parapet wall on masonry arch bridge (Borders Railway Project, Newtongrange to Eskbank)

Figure 4-3: Coping extension (GFRP coping – Stockton on Tees Junction (source:www.evergrip.com) and precast concrete – Borders Railway Project, Bonnyrigg Road Bridge)

Figure 4-4: Steel mesh extension (OBB9A – Collins Ave East, Killester and OBB26 – Back Rd, Malahide)

Figure 4-5: Non-transparent parapet extensions (Steel – Bury's Bridge, UK and GFRP example (source www.duracomposites.com)

Figure 4-6: Transparent or opaque parapet extensions (Glass – Dodder Bridge, Ringsend and Polycarbonate or Acrylic – Eastlink, Australia). Note that Section 4.3 of this report discusses relevant materials and recommends against the use of glass.

4.2 Pedestrian Bridges

All of the pedestrian bridges will require some form of modification to ensure compliance with the specification. This will typically involve providing for a solid panel over the lower 1.2m parapet height. The meshes all have an aperture smaller than 1200 mm^2. Compliance with the latest Irish Rail requirement for the panels to be IP2X rated (12.5mm probe cannot penetrate) will need to be confirmed.

The bridge parapets can be modified in the following ways:

- Install compliant steel mesh above the existing parapet (applicable to solid based parapets);
- Replace existing mesh panels with compliant panels;
- Retain existing mesh panels and install solid panels to the outer face (rail side);

The images below show examples of potential parapet modifications.

Figure 4-7: Mesh infill replaced with solid steel panels (Raheny Station footbridge)

Figure 4-8: Steel panels added to outer face of existing mesh screens (Middle Third Bridge, Killester)

Figure 4-9: Solid steel panels on pedestrian bridge (OBR141, Bray)

Figure 4-10: Clear panels on pedestrian bridge (Grand Canal Dock Station)

Figure 4-11: GFRP panels between chords of Vierendeel truss (Vilafant footbridge, Spain)

4.3 Materials

Parapets could be extended using a number of different materials depending upon the bridge type and environment in which they are used. Below is a summary discussion of potential materials.

- **Steel:** Commonly used. Either stainless steel (grade 316) or hot dip galvanised steel. Where galvanised steel is used, the preference of IÉ is that it is left plain with no additional finish. Alternatively, the galvanised steel could be etched and powder-coated, or painted (including an etch primer specified before painting).

Weathering steel is typically avoided as an add-on due to the unsightly staining it can cause. It can also have issues with forming the protective patina near coastal environments where the airborne chloride content is high.

- **Stone Masonry:** Commonly used as a façade to a concrete wall. Can be sourced in various materials (limestone, sandstone etc) and is typically sourced using local stone where available.
- **Precast Concrete:** Typically used for coping units attached to the top of walls. It can also be used as a façade in the form of Reckli type panels or similar and approved.
- **GFRP:** Can be used in panelled form as an alternative to steel panels, typically to reduce weight. They can also provide a level of colour and transparency. Vulcalucent panel by Vulcan Systems is an example of a GFRP panel using embossed polyester film, light stabilised polyester resins and E-type glass fibre with a resin rich surface.
- **Glass:** Can be used when visibility is required. However, this material is avoided on rail projects due to its vulnerability to breaking and/or shattering. It may also require regular cleaning, increasing its level of maintenance. It is not recommended as a material for use on parapets over the railway line.
- **Polycarbonate:** Typically used on projects where aesthetics plays an important role. However, this material is avoided on rail projects as it does not stand up well to heat. All 'plastic' type materials should be fire/heat tested to ensure physical integrity of the material.

5 Recommendations

5.1 Recommendations for Road Bridges

5.1.1 Parapet heights between 1.7m – 1.8m

There are five road bridges where the parapet height measures between 1.7m and 1.8m. To comply with the specification requirements, the parapets would need to be increased by 50 – 100mm. These bridges are listed in Table 5-1 below.

Table 5-1: Road bridges with parapet heights between 1.7m – 1.8m

Bridge No.	Measured Parapet Height (m)	Parapet Image
OBB32A R126 Donabate Relief Road	1.75	
OBB35 Beaverstown Golf Club	1.75	
OBB46 L1285 Baldongan (Protected Structure)	1.70	
OBB49 Golf Links Rd Skerries	1.70	

Bridge No.	Measured Parapet Height (m)	Parapet Image
OBB78 Colpe Road	1.70	

It is recommended that these parapets be extended in height by adding a steel plate to the top of the parapet to achieve the required 1.8m minimum height. The steel plate would be solid for its full height and sit flush with the top of the existing parapet.

For all implemented solutions there should be no gap between the existing parapet and extended parts, both horizontally and vertically.

5.1.2 Parapet heights less than 1.7m

There are eight road bridges which have parapet heights less than 1.7m in height.

Table 5-2: Road bridges with parapet heights less than 1.7m

Bridge No.	Measured Parapet Height (m)	Parapet Image
OBB38 Rogerstown Lane (Protected Structure)	1.15	
OBB41 Minor road North of Rush & Lusk Station	1.55	
OBB47 Disused road Skerries Golf Club	1.25	

Bridge No.	Measured Parapet Height (m)	Parapet Image
OBB55 R127 Balbriggan	1.55	
OBB68 Gormanston Military	1.35	
OBB80 / 80A / 80B McGraths Lane Drogheda (Curtilage of the Protected Structures at Drogheda MacBride Station)	1.10 / 1.05 / 1.20	

The proposed solution for each of the bridges will depend on their specific circumstances.

OBB38 is a masonry arch bridge and is registered as a protected structure. The existing parapets comprise stone masonry built off the spandrel walls. Two possible options are considered viable for this structure. The first is to extend the parapet height using masonry to match existing, with a suitable coping stone above. The additional load associated with a masonry extension of this height would need to be structurally assessed. The second option is for the parapet height to be increased using a lightweight extension (GFRP or steel mesh). The aesthetics of this bridge would need to be considered in line with its heritage value.

OBB41 appears to comprise a reinforced concrete wall clad in masonry and capped with a steepled coping. It is located in a rural setting and needs to be increased by an additional 250mm. It is recommended that the parapet be extended using a stainless-steel plate attached to the top of the existing coping.

OBB47 comprises an unused masonry arch bridge. This bridge is not currently listed as a protected structure. It is recommended that the height of this parapet be extended in a similar fashion to that proposed for OBB38.

OBB55 is similar in height and form to OBB41. It is recommended that a stainless-steel plate be used to extend the parapet height by an additional 250mm.

OBB68 comprises a reinforced concrete wall with a level top surface. The parapet needs to be extended by approximately 450mm. It is recommended that a steel mesh screen be placed above this parapet to extend its height.

OBB80, 80A & 80B form a 3-span bridge crossing of the railway just south of Drogheda MacBride Station. The end spans (OBB80 and 80A) comprise masonry arch bridges, with the central span (OBB80B) comprising a superstructure with precast concrete beams. The parapets are of masonry construction with slightly rounded capping stones above. These bridges are not on the register of Protected Structures, however they may form part of the curtilage of the Protected Structures at Drogheda MacBride Station. There are currently plans to develop the lands to the east of the railway. Although this bridge currently services only two properties to the east of the railway, there are plans to develop this land for housing. Hence this route may potentially experience significantly higher user volumes than it currently serves. The bridges also comprise a constraint to the electrification of the track at this location due to their height and may need to be substantially modified. However, should these bridges be maintained in their current form, it is recommended that the parapets be extended similarly to OBB38 (either by increasing the masonry wall height or by adopting a suitably designed lightweight extension). The additional load associated with a masonry extension of this height would need to be structurally assessed. Should this load prove to be in excess of what the existing arch bridge can safely carry, then the bridge may either need to be strengthened or a more lightweight parapet solution adopted.

For all implemented solutions there should be no gap between the existing parapet and extended parts, both horizontally and vertically.

5.2 Recommendations for Pedestrian Bridges

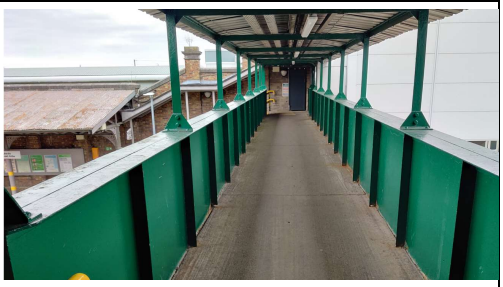
The pedestrian bridge parapets along this route can broadly be separated into three categories.

- Compliant parapets (OBB81C);
- Parapet height less than 1.8m (OBB81);
- Parapet height greater than 1.8m, but with non-compliant mesh screens for an electrified track (all other pedestrian bridges).

5.2.1 Bridges with parapet heights less than 1.8m

OBB81 has been measured as having a parapet height less than 1.8m.

Table 5-3: Pedestrian bridges with parapet height less than 1.8m

Bridge No.	Measured Parapet Height (m)	Parapet Image
OBB81 Drogheda MacBride Station (located within Protected Structure of Drogheda MacBride Station)	1.10	

The superstructure of **OBB81** comprises a steel plated girder with the walkway nested between. The steel webs of the girder form solid plates approximately 1.10 m high. Hence, it is recommended that a steel wire mesh screen be added to the top of the girders to close off the open space above and provide for a compliant parapet system. The extension should be placed flush with the top of the existing girder and not have any horizontal or vertical gaps. This bridge is not specifically identified on the register of Protected Structures, however it will likely form part of the curtilage of the Protected Structures at Drogheda MacBride Station.

5.2.2 Non-compliant parapet screens

A number of the pedestrian bridges have parapet heights in excess of 1.8m, but do not have solid screens or mesh infills which comply with an IPX3 rating (where a 2.5mm probe cannot penetrate). These are listed in the table below.

Table 5-4: Pedestrian bridges with non-compliant screens

Bridge No.	Screen Configuration	Parapet Image
OBB33A Donabate	Wire mesh	
OBB38A Rush & Lusk	Wire mesh	

Bridge No.	Screen Configuration	Parapet Image
OBB51A Skerries	Wire mesh	
OBB54 Ladies Stairs	Perforated plate	
OBB57A Balbriggan	Wire mesh	
OBB74A Laytown	Wire mesh	
OBB81C Drogheda MacBride Station (staff access to depot building)	Solid plate up to 1.0m with wire mesh above.	

OBB33A and **OBB38A** are of similar construction. The superstructure comprises steel beams with the pedestrian parapets supported via vertical steel posts. Woven wire mesh (4mm wire, 12mm mesh, stainless steel) forms infill panels supported by stainless steel restrainer plates on all four sides. The existing mesh complies with the 1200mm^2 opening requirement, but not the IP3X rating requirement for the section below 1.2m.

It is recommended that either the mesh infill be replaced with a solid panel, or that a solid panel be placed hard up against the outer face of the mesh (rail facing side) and attached to the restrainer plates. The solid panels can either be steel plate or a

GFRP panel (non-transparent or opaque). The solid panel can extend for the full height of the parapet or up to a minimum height of 1.2m if the existing mesh is retained.

OBB51A, **OBB57A** and **OBB74A** are all of similar construction. The superstructure comprises a Vierendeel truss with woven wire mesh panels (5mm wire, 12mm mesh, hot dip galvanised and painted) placed between the vertical cords. The mesh infill panels are attached to restrainer plates connected to the truss chords on all four sides. The existing mesh complies with the 1200mm^2 opening requirement, but not the IP3X rating requirement for the section below 1.2m.

Similar to the options above, it is recommended that either the mesh infill is replaced with a solid panel, or that a solid panel be placed hard up against the outer face of the mesh (rail facing side) and attached to the restrainer plates. The solid panels can either be steel plate or GFRP (non-transparent or opaque). The solid panel can extend for the full height of the parapet or up to a minimum height of 1.2m if the existing mesh is retained.

The superstructure of **OBB54** comprises pre-stressed concrete beams and deck slab. Vertical posts are bolted to the concrete upstand and framed at the top and bottom with horizontal steel chords. Perforated steel plate (approx. 15mm dia holes in 4mm thick plate, hot dip galvanised and painted) forms the balustrade panels between supporting members. There is a gap of approximately 50mm between the lower support chord and the concrete upstand. The existing perforated plate complies with the 1200mm^2 opening requirement, but not the IP3X rating requirement for the section below 1.2m.

Given the remote location of this bridge, a full height non-transparent panel is not recommended due to the risk of anti-social behaviour in an unmonitored environment. Hence, recommendations are similar to the proposals for the pedestrian bridges above with mesh infill panels, except that if solid non-transparent panels are used, they should be limited to the lower 1.2m only. An additional plate will be required to seal off the gap between the lower chord and concrete upstand.

OBB81C is a relatively new bridge constructed to provide station staff with access to the depot. The superstructure comprises a warren truss with solid metal infill panels placed between the inclined chords. The panels extend to a height of 1.0 m with a mesh screen fitted above. It is recommended that the solid infill panels be extended to 1.2 m high and the mesh screen above either modified to suit or replaced.

For all implemented solutions there should be no gap between the deck and the parapet, both horizontally and vertically.

6 Summary

The table below summarises the recommendations for the various bridges that require parapet modifications.

Discussions and engagement with the local authority heritage teams will be arranged for protected structures to seek their views on the presented options.

Table 6-1: Summary of recommendations for parapet modifications

Bridge No.	Proposed Solution
Road Bridges	
OBB32A OBB35 OBB46 (Protected) OBB49 OBB78	100mm high stainless-steel plate attached to the top of the existing coping.
OBB41 OBB55	250mm high stainless-steel plate attached to the top of the existing coping.
OBB68	450mm high steel wire mesh in steel frame attached to top of existing wall.
OBB38 (Protected) OBB47 OBB80 / 80A / 80B	These bridges comprise masonry arch construction, with parapet heights no greater than 1.25m. Extend parapet using masonry similar in form to the existing and finished with a suitable stone coping. Alternatively increase parapet height using a lightweight extension (GFRP or steel mesh). The aesthetics of these bridges should be considered in line with their heritage value in consultation with the project Conservation Architect. The bridge will need to be structurally assessed where substantial additional load is being applied. The bridge may either need to be strengthened or alternatively a more lightweight parapet solution adopted.
Pedestrian Bridges	
OBB33A OBB38A OBB51A OBB57A OBB74A	The following options are recommended: - Replace wire mesh panels with compliant panels. These could be solid full height or be a combination of solid and meshed. - Bolt on solid panels to the outside of the existing parapets. These only need to cover the lower 1.2m. The material used for the options above could either be steel or GFRP (non-transparent, opaque or clear).

Bridge No.	Proposed Solution
OBB54	The following options are recommended: - Replace perforated steel panels with compliant panels. These could be solid full height or be a combination of solid and meshed. - Bolt on solid panels to the outside of the existing parapets. These only need to cover the lower 1.2m. Should a solid panel be adopted full height, it is recommended that a clear or semi-transparent material be used for this bridge given its remote location.
OBB81	Install steel wire mesh panels above steel girder.
OBB81C	Extend hight of solid panel and re-install mesh above to suit.