# Cladding and Integral Finishes to Structures

**BTN 031**

**Version 1.1** **23 June 2022**

## 1 Scope and Application

Bridge Technical Note (BTN) 031 – Cladding and Integral Finishes to Structures – states the Department of Transports' (DoT) requirements for design, installation and maintenance of cladding and integral finishes over all DoT structures except major tunnels.

Bridge Technical Notes are a Code of Practice. Compliance with Bridge Technical Notes is mandatory. Where compliance with this BTN is not achieved, design departures must be submitted to the DoT Technical Reference Panel (TRP) for approval from the Chief Engineer – Roads prior to works occurring.

Other than as stated in this document and other relevant DoT/VicRoads Standard Specifications and technical documents, the provisions of AS5100:2017 must apply. Where the contents of this document and of DoT's other relevant documents differ from AS5100:2017, their requirements override those of AS5100:2017.

This document is to be read in conjunction with Road Structures Inspection Manual and the relevant DoT/VicRoads Standard Specification Sections.

## 2 Definitions

DoT structures – all bridges (including pedestrian bridges), culverts, underpasses, arch structures, high-mast lighting structures, retaining structures, noise attenuation barriers, major signs and gantries structures, etc. maintained/owned/likely to be maintained by DoT.

Cladding – a covering on a structure, primarily used to improve the appearance of a structure.

Integral / Non-cladded structural solutions* – an element with desired shapes and patterns integral to the structural components that is typically comprised of steel or concrete:

- Steel components must be designed and fabricated as Architectural Exposed Structural Steelwork (AESS).
- Concrete components must be designed to be cast in-situ or precast concrete with desired shapes and patterns integral to the structural component.

** Note:*

*Structures / Structural components (e.g. retaining walls, precast concrete panels, on structure noise walls, balustrades/balusters, privacy screens, protection screens, public safety barriers, etc.) involved in the Integral / Non-cladded structural solutions must comply with relevant structural design requirements.*

*For any component that has both structural and cladding functions, the whole component must comply with this BTN.*

Architectural finishes – surface treatments to complete or enhance the aesthetic experience of the structure.

Three-dimensional architectural finishes – surface treatments that include relief in the shape/geometry and/or textures or patterns that have been raised above the background plane.

Major tunnels – a substantially enclosed or track-way greater than 80 m in length (AS 4825-2011). The extent of the tunnel is considered to be the length of the tunnel where there is a roof over the carriageway(s). The requirements of this BTN only apply beyond the extents of the tunnel.

## 3 General

DoT recognises the importance of integrating engineering principles, urban design and landscape requirements as part of the structures design process. The balance between whole of life cycle costs and aesthetics needs to be considered in the planning, design, construction and maintenance of structures.

The design process must minimise the ongoing costs required to maintain the structure during its design life. Certain cladding solutions impede the inspection and maintenance of those structures in an efficient and effective manner. The use of such treatments creates a significant safety risk and increases maintenance costs for the State (and DoT) over the life of the structure.

# 4 Context Sensitive Design and Visibility Criteria

The design of key structural elements needs to be context sensitive. Structures in areas that have 'low visibility' may not require architectural design of the key structural elements listed in Section 6.

Low and high visibility elements are defined below:

**Visibility criteria***

High visibility areas are any of the following:

- Public realm interfaces.
- Visible from pedestrian paths or Shared User Paths.
- High volumes of vehicle patronage greater that 10,000 AADT.
- The complete intersection that has at least one leg greater that 10,000 AADT.
- Visible from adjacent residential dwellings.
- Visible from significant historical or cultural sites or tourist locations.

*An Urban Designer must be engaged to ensure context sensitive design response has been developed for high visibility areas.

Low visibility areas are any of the following:

- Sites with no public realm interfaces.
- Not visible from pedestrian paths or Shared User Paths.
- Not adjacent to residential dwellings.
- Railway reserves (away from stations and pedestrian and cyclist activities).

Where urban design and aesthetics are important, architectural design must be made integral with these elements:

- Steel components must be designed and fabricated as Architectural Exposed Structural Steelwork (AESS).
- Concrete components must be designed to be cast in-situ or precast concrete with desired shapes and patterns integral to the structural component.

# 5 Integral / Non-cladded Structural Solutions

Integral / Non-cladded structural solutions are acceptable to DoT, provided they are in accordance with the design intent demonstrated with the examples listed in Appendix A for:

- Pedestrian barriers.
- Precast or cast-in-situ (retaining) walls.
- Soil nail walls or reinforced soil structures.
- Top down construction of bridge piers or columns.

Examples of these solutions are provided in Appendix A.

# 6 Cladding over Structures

Cladding systems are generally not permitted to be used in conjunction with DoT's structures. Cladding over structures must only be used as the last option to achieve aesthetic and urban design requirements, and must meet the design requirements in Appendix B. Where the use of cladding proposed does not align with the examples provided in Appendix C, it will be considered a design departure and will require the approval of the Chief Engineer – Roads via a submission to the DoT TRP.

DoT will not permit any proposals for cladding over these key structural elements:

- **piers or columns**;
- **crossheads**; and
- **spill through batters** or **abutment batters.**

Where aesthetic and urban design context necessitates the use of cladding, it will only be considered for the following key structural elements:

- **girders or beams**;
- **abutment walls**;
- **truss structures**; and
- **major signs** and **gantry structures.**

Refer to Appendix B for design requirements for cladding.

# Contact Details

For further information please contact:

Principal Engineer – Structures (Roads)
Level 3, 60 Denmark Street Kew Victoria 3101
Email: IandDSrequests@roads.vic.gov.au

**Bridge Technical Notes are subject to periodic review and may be superseded.**

# Document Control

This document is subject to periodic review and may be superseded. The revision date is listed in this BTN.

Note that for projects tendered prior to the revision date of this document, there are no retrospective implications of this document unless agreed otherwise with DoT.

| Version | Description | Revision | Approved by |
|---|---|---|---|
| 1.0 | Document Created | November 2021 | Chief Engineer – Roads |
| 1.1 | Revision of Section 2 for additional requirements for integral / non-cladded structural solutions<br><br>Revision of Appendix A and C for examples of non-cladded structural solutions | 23 June 2022 | Chief Engineer – Roads |

# Appendix A: Integral / Non-cladded Structural Solutions

This section describes the structural systems and finishes that do not include cladding and are acceptable for use on road infrastructure projects. Figures referred to below are provided in Appendix C:

- **Pedestrian Barriers** including integrated architectural screening within the balustrade design provide partial screening of the beams and allow for ease of inspections.
- **Precast concrete panels** are integral with the structure with cast in-situ concrete footings (and cast in-situ concrete buttresses as required). Three-dimensional architectural finish is to be integrated into the precast panels (refer to Figures 15 and 16).
- **Cast in-situ** concrete retaining walls with an integrated architectural finish (refer to Figure 17).
- **Reinforced soil structure (RSS) walls*.** The architectural finish is integrated into the fascia panels (refer to Figures 18, 19, 20).
- **Integrated soil nail and precast concrete panel walls*** with high quality architectural finishes. This method consists of precast panels with an integrated three-dimensional architectural finish that are adhered to the soil nail wall with a reinforced concrete layer. This solution is appropriate in areas of high visibility (refer to Figures 21, 22, 23).
- **Soil nail walls*** with low quality finishes. This method consists of a sculpted shotcrete finish. This solution is only appropriate in areas of low visibility or may be considered an appropriate aesthetic treatment in some contexts, including natural areas with rock formations (refer to Figures 24 and 25).
  Note: Soil nail walls with sculpted shotcrete finish may be subject to efflorescence, flaking and staining from underlying hydrostatic pressure or other factors. These issues need to be carefully considered and mitigated in all exposed shotcrete proposals. This type of finish can be adopted on other retaining structures (e.g. retaining walls) where suitable.
- **Post and precast concrete panel walls** with three-dimensional architectural finish, where the posts are concealed by the precast concrete panels. The cladding that extends in front of the steel post flanges must be designed for the design life of the cladding. The post should be designed to allow for corrosion, over its design life, due to inground conditions for the design life of the structure without the need for regular maintenance (refer to Figure 26).
- **Top down construction of bridge piers or columns** must include an integral concrete structure to be formed around the piles which are unacceptable if left exposed and untreated. The pier form and finish must be architecturally designed to deliver a high-quality visual outcome (refer to Figure 15 for an acceptable pier treatment).

** The design of RSS and soil nail walls must consider soft landscaping design requirements, including tree planting adjacent to retaining walls. Where trees are proposed in the vicinity of retaining structures then those structures need to be designed to accommodate tree planting, e.g. tree roots and abnormal soil moisture changes may affect the integrity of RSS walls and soil nail walls. It is noted that it may not be possible to plant large trees within RSS walls. The form/construction type of the retaining wall will need to be adjusted to accommodate tree planting where it may be necessary to:*

- *screen views of walls from local properties*
- *mitigate graffiti*
- *improve amenity of transport corridors*
- *contribute to urban cooling*

*Overall, it should be noted that the use of soil nail walls will limit tree planting and compromise the overall urban design outcome.*

# Appendix B: Design Requirements for Cladding Proposals

In cases where integral solutions cannot be provided, cladding over a structure must meet the requirements in this section. Where the use of cladding over a structure proposed does not align with the examples provided in Appendix C, the proposal must address these minimum requirements as part of any submission to TRP.

Proposals seeking approval to use cladding must outline why non-cladded options are not possible and how the periodic inspection and maintenance could be undertaken for any structural elements behind cladding in an efficient and effective manner. Where additional activities need to be undertaken to facilitate the undertaking of inspections, these tasks are to be costed for the specified design life of the structure. These costs are to be provided to DoT with any such proposal.

Refer to Appendix C for some examples of cladding on structural members which are considered to meet design intent in the case specific locations.

## General

- The structure can be accessible for any required inspections in accordance with DoT's Road Structures Inspection Manual.
- The time and costs to inspect and maintain the structure are efficient. The need for specialised plant, equipment, manual handling, traffic management and processes are minimised, i.e. if the removal and reinstatement of the cladding is required for each inspection or maintenance task, the costs and time required to complete the work would be significantly higher.
- Architectural cladding and associated components must be durable with a minimum design life of 50 years with the exception of plastic materials and must only need to be replaced once over a design life of a 100-year structure thus minimising whole of life costs.
- Cladding must be designed to be easily removed and replaced without permanent damage to the cladding in process i.e. flimsy or brittle.
- All cladding must be non-flammable.
- For cladding in front of bridge beams or girders, a minimum 750 mm clearance between the cladding and the outer face of the web of beams or girders (or outer face of the beam if no flange) must be provided to allow effective closeup inspections. Cladding must not be attached to bridge railings or barriers.
- Timber is not an acceptable material for use as cladding as it does not meet the design life requirements.

Specific requirements for retaining and abutment walls:

- Cladding panels must allow a minimum 125 mm gap between vertical panels. The cladding panels must not be more than 5 m in width. These must be designed to prevent the accumulation of debris (refer to Figures 1 and 2).
- At abutment walls, the cladding areas must have 600 mm W x 2000 mm H lockable hinged doors at 20 m spacings, with doors located at critical inspection points. Doors need to be designed to blend with the surrounding cladding. The design must consider materials, colours and textures (refer to Figure 27 for example of doors on cladding in front of abutment walls).
- For metal cladding (e.g. steel, rusted/weathered steel, aluminium), a minimum of 20% open area within each panel with larger aperture perforations must be located at critical inspection points. Spacing and location of perforations must not constitute a climbing hazard with a maximum perforations size of 30 mm x 30 mm for the first 3 m height of the panel.
- For plastic/recycled plastic cladding, risks of deterioration, rippling, contraction and expansion must be minimised over the 30 years design life of the material.

## Safety

Cladding over structures must be designed to:

- Minimise OH&S risks to workers during inspection and maintenance works that may involve removal or reinstatement of cladding.
- Minimise potential risk of cladding falling on motorists, pedestrians or properties.
- Tek or self-tapping screws must not be used for any cladding solutions.
- Cladding used must be durable and lightweight.
- Cladding must be designed to be easily maintained without significant traffic disruption and exposing workers to risk.
- Cladding must be installed in a manner that eliminates glare and/or reflection from sun and vehicle head lights which may create hazards.

- Bolted connection must have lock nuts to prevent the elements from coming loose under wind or vibration actions.
- Installation details as well as removal and reinstatement methodology for the panels must be included in the design drawings or in a specific maintenance manual for future reference of maintenance teams.

# Appendix C

## Table of Figures

## Examples of cladding

### 1. Cladding in Front of Soil Nail or Bored Pile Retaining Walls

#### 1.1 Panel Spacing


*Figure 1 - M80 Freeway, Retaining walls (Gladstone Park, Melbourne) - Victoria*

*Figures 1,2 - Demonstrate high quality concrete cladding panel with expressed spacing to allow for inspections. The panel also features an extension above the natural ground level which eliminates the need for compliance fencing above. (Note: The M80 example above shows a fully cladded panel over shotcrete, however the architectural intent for panel spacing must be provided to the lower section of the panel)*

*Figure 2 - M80 Freeway, Retaining walls (Gladstone Park, Melbourne) - Victoria*

## 2. Cladding over Truss Structures

### 2.1 Permeable Cladding on Truss Structure


*Figure 3 - M1 Freeway, York Street Bridge (Malvern East, Melbourne) - Victoria*

*Figures 3,4,5 - Demonstrate high quality permeable cladding on truss structures. Perforations in the material allow for passive surveillance and visual amenity.*

*Figure 4 - M1 Freeway, York Street Bridge (Malvern East, Melbourne) - Victoria*

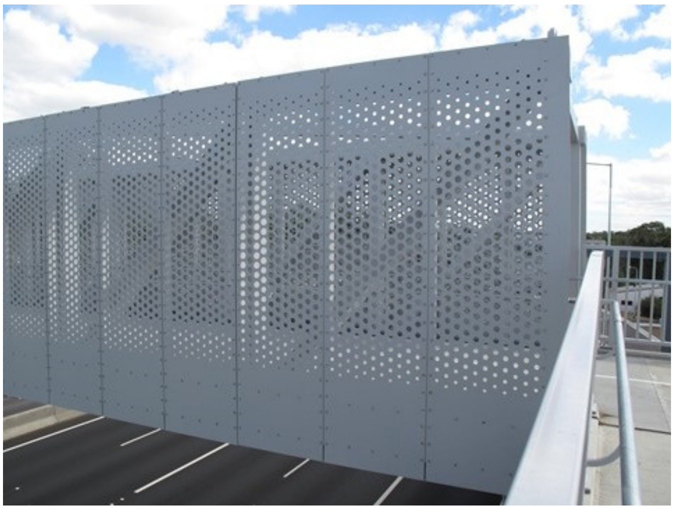

*Figure 5 - M1 Freeway, York Street Bridge (Malvern East, Melbourne) - Victoria*

## 3. Cladding over Beams / Girders

### 3.1 Cladding Offset from Beams / Girders

*Figure 6 - Western Highway (Remembrance Drive - Ballarat) - Victoria*

*Figure 6 demonstrates high quality cladding to beams and girders. The cladding panel is offset from the beam, which allows easy inspections, as the person can safely inspect and access the space.*

### 3.2 Permeable Cladding over Steel Through Girders

*Figure 7 - M2 Tullamarine Freeway, Vaughan Street Bridge (Essendon Fields, Melbourne) - Victoria*

*Figures 7,8,9,10 - Demonstrate creative responses to cladding over steel through girders. Architecturally designed fins provide partial screening of the girders and allow for ease of inspections. Fins allow for the girder to be fully exposed at a perpendicular angle, however when viewed at an oblique angle the fins obscure the visibility of the beam and the bridge under structure.*


*Figure 8 - M2 Tullamarine Freeway, English Street Bridge (Essendon Fields, Melbourne) - Victoria*

*Figure 9 - M2 Tullamarine Freeway, Vaughan Street Bridge (Essendon Fields, Melbourne) - Victoria*

*Figure 10 - M2 Tullamarine Freeway, Bristol Street Bridge (Essendon Fields, Melbourne) - Victoria*

## Examples of Non-cladded Structural Solutions

**4. Pedestrian Barriers** including integrated architectural screening within the balustrade design

*Figure 11 - Barongarook Creek Bridge (Colac) - Victoria*

*Figures 11,12 - Demonstrate architecturally designed pedestrian barriers with fin extensions provide partial screening of the beams and allow for ease of inspections. Fins allow for the beam to be fully exposed at a perpendicular angle, however when viewed at an oblique angle the fins obscure the visibility of the beam.*

*Figure 12 - Barongarook Creek Bridge (Colac) - Victoria*

*Figure 13 - Darebin Yarra trail (Alphington, Melbourne) – Victoria*

*Figures 13,14 - Demonstrate architecturally designed, high quality pedestrian barriers that provide partial screening of the beams to soften the structure within the natural environment and allow for ease of inspections.*

*Figure 14 - Darebin Yarra trail (Alphington, Melbourne) - Victoria*

**5. Precast Concrete Panels** which are integral with the structural wall with cast in-situ concrete footings

*Figure 15 - Calder Highway Interchange (Ravenswood, Melbourne) - Victoria*

*Figure 15 - retaining walls – demonstrates architecturally designed, high quality, curved and heavily textured, full height concrete panel walls that provide good amenity and assist in deterring graffiti.*

*Figure 15 - pier form – A well-defined and smooth pier finish provides a good example of a possible treatment of bored pile piers (this image doesn't display Top-down construction but rather high-quality pier treatment).*

*Figure 16 - Toorak Road Level Crossing (Kooyong, Melbourne) - Victoria*

*Figure 16 demonstrates architecturally designed, high quality and lightly textured, full height concrete panel walls that provide good amenity and assist in deterring graffiti.*

**5. Cast In-situ** concrete retaining walls

*Figure 17 - Chandler Highway (Kew, Melbourne) - Victoria*

*Figure 17 demonstrates good quality, smooth and even finish of cast in-situ abutment and retaining wall. The wall features a well-executed and precise horizontal architectural relief, which breaks up the smooth surface. The transparent noise wall is a good example of a permeable and functional bridge cladding.*

## 6. Reinforced Soil Structures (RSS) Walls

*Figure 18 - Thompsons Road (Lyndhurst, Melbourne) - Victoria*

*Figure 18 demonstrates high quality, textured, and painted full height concrete panel walls. The walls' various textures, colours and configuration reduce the scale of the walls and assist in deterring graffiti.*

*Figure 19 - Western Highway (Remembrance Drive - Ballarat) - Victoria*

*Figure 19 demonstrates high quality, strongly textured and coloured concrete panel walls. The textures, colours and configuration of panels make strong contextual statements and assist with identity and graffiti mitigation.*

*Refer to Figure 6 for example of cladding over bridge beam shown in this image.*

*Figure 20 - Evans Road Level Crossing (Lyndhurst, Melbourne) - Victoria, image source: LXRP*

*Figure 20 demonstrates high quality, heavily textured and coloured concrete panels for improved visual amenity. The clever application of textures hides the joints between panels. The wall reads as one entity, instead of a series of stretcher bond panels. The well-integrated screens overlap the retaining structure and have a clean and consistent horizontal line.*

## 7. Integrated Soil Nail and Precast Panel Wall

*Figure 21 - Texas, USA*

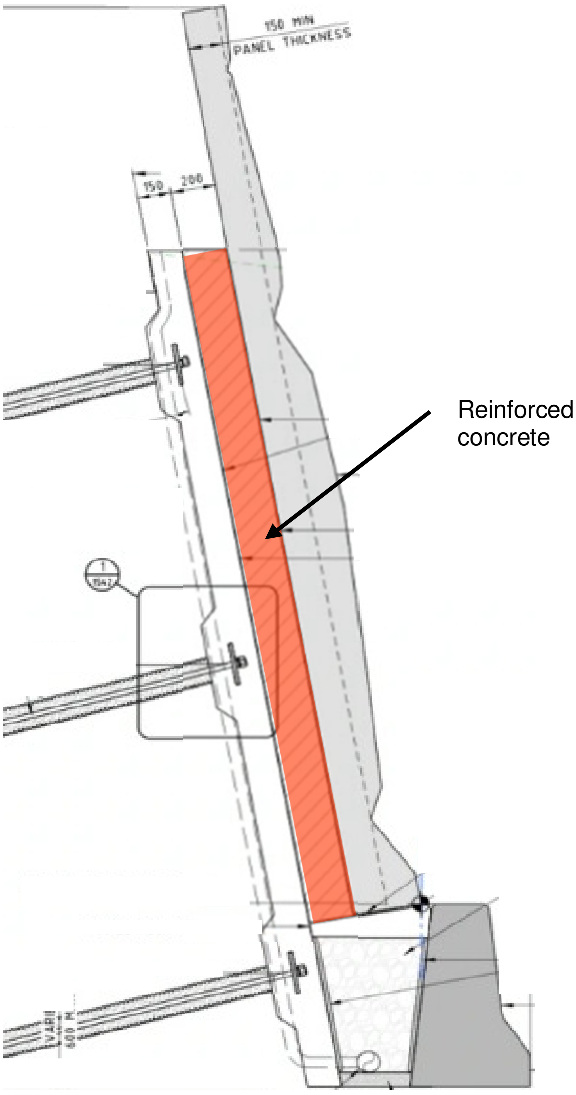


*Figure 23 - MRPV, Schematic Design*

*Figure 22 - Texas, USA*

*Figures 21,22 - Image source: Texas Department of Transportation - Facing Options for Soil Nail Walls.*

*Figures 21,22,23 - Demonstrate precast panels with integrated three-dimensional architectural finish that are adhered to the soil nail walls with a reinforced concrete. The integral panels improve the amenity of shotcrete walls. This is an acceptable solution as any movement failures to the wall behind will be transferred directly to the architectural panel in front which will visible during inspection. Refer to Figures 15,16,18,19,20 for examples of high-quality panel finishes.*

### 8. Soil Nail Walls - Sculpted Shotcrete Finish

*Figure 24 - Geelong Ring Road (Wandana Heights) - Victoria*

*Figure 24 demonstrates the application of sculptured shotcrete in a low visibility, semi-rural context. The neutral wall colours and planting above the wall assist with integrating the wall within the landscape. This type of finish can be adopted on other retaining structures where suitable.*

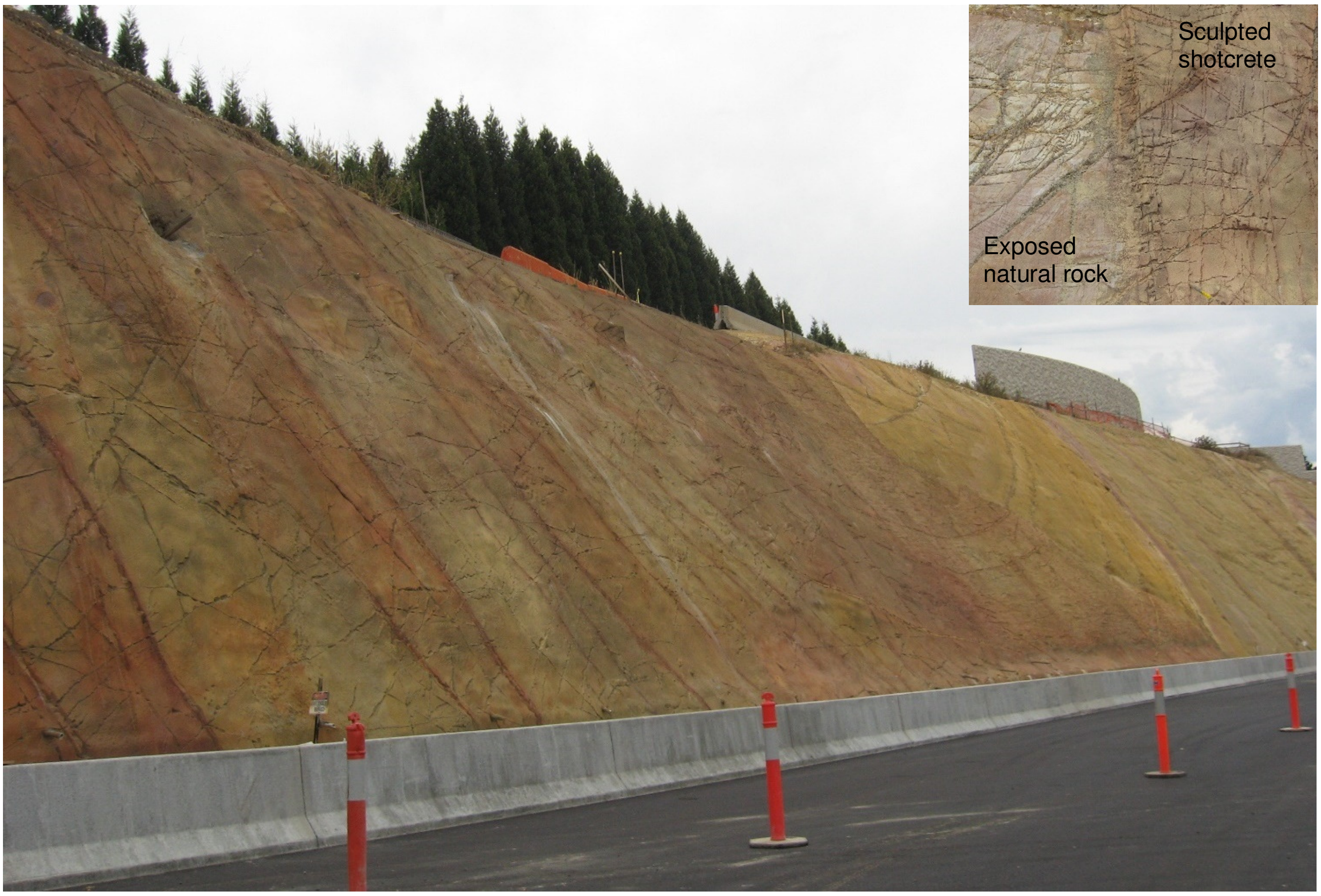


*Figure 25 - Eastlink (Donvale, Melbourne) - Victoria*

*Figure 25 demonstrates a natural rock interface with a shotcrete stabilised embankment. The natural exposed rock cutting and shotcrete surfaces are well integrated and read as one entity. Figure 25 shows a relationship in colour and texture between the two surfaces. This type of finish can be adopted on other retaining structures where suitable.*

## 9. Post and Precast Panel Walls


*Figure 26 - Midland Highway, Anakie Road to Parkland Drive - Kardinia College (Hamlyn Heights) - Victoria*

*Figure 26 demonstrates good quality textured wall, where front flange of the H-beam is hidden. Hidden H-beams and full height panels achieve a clean and simple look with better visual amenity, compared to standard post and panel wall structures.*

### Example of Doors on Cladding in Front of Bridge Abutments

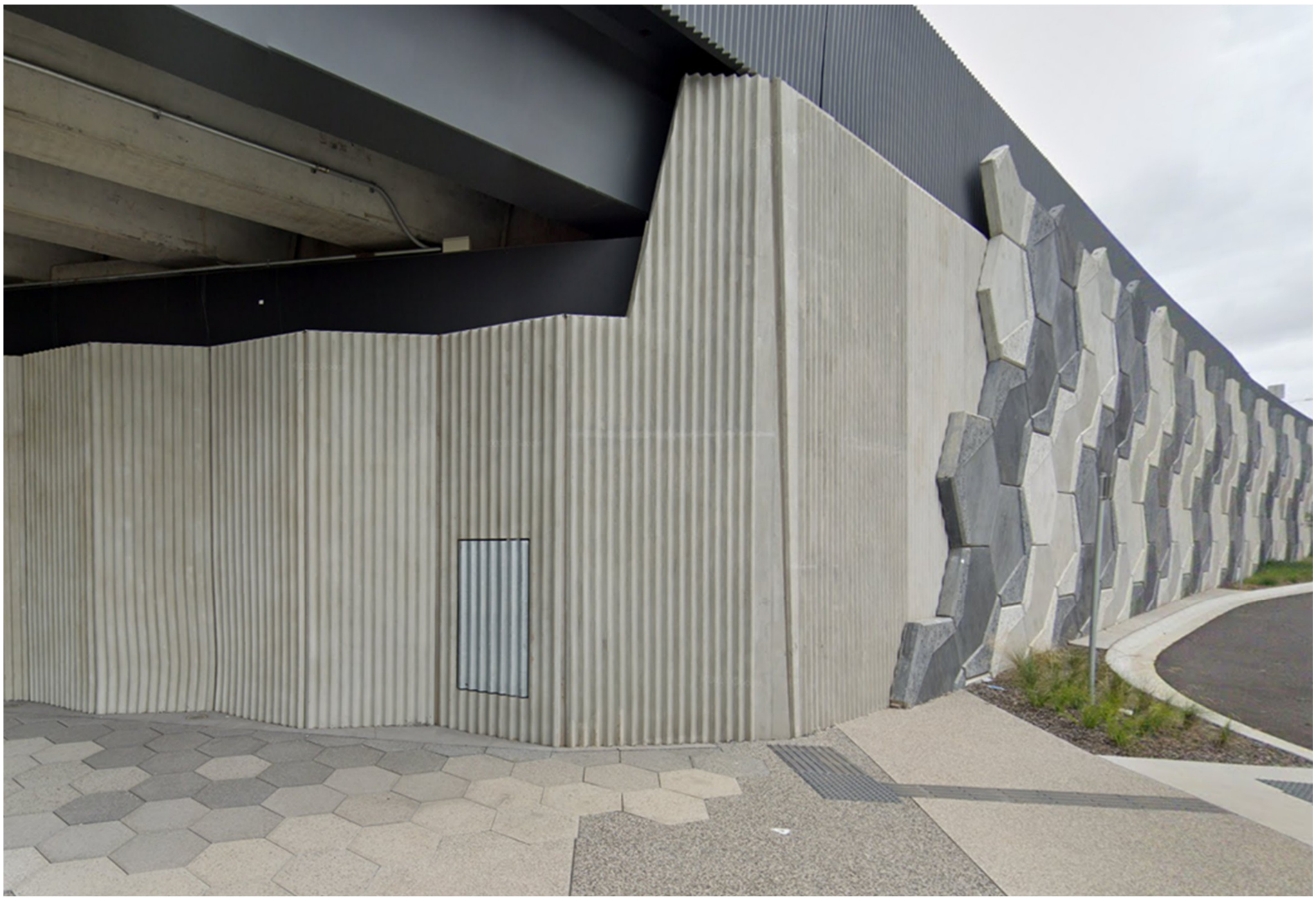

*Figure 27 - Melton Highway Level Crossing (Sydenham, Melbourne) - Victoria, image source: Google Maps*

*Figure 27 demonstrates a well-integrated example of a hinged inspection door at the bridge abutment. This door has a matching architectural form and clean lines, additionally a painted door finish could assist in providing a more visually recessive door.*