Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Timber Operations, Pricing and First Nations Division

Engineering Branch

Considerations for Use of Ministry Standard Drawings STD-E-010-05 (1999) and STD-EC-010-15 & 16 (2017) Bridge Approach Barriers for FSR Bridges

1.0 Purpose

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (**FLNRORD**) has prepared this document to guide the use of the following ministry standard drawings:

- STD-E-010-05 "**Conceptual Bridge End Guardrail Details**" (June 1999), and
- STD-EC-010-15 & 16 "**Anchored/Connected Bridge Approach Barrier Concepts**" (September 2017).

2.0 Terminology

In this document, the term "bridge approach barrier" or simply "approach barrier" will be used to refer to the concepts shown on STD-E-010-05 and STD-EC-010-15 & 16. The term "bridge end guardrail" from STD-E-010-05 will not be used in this document.

The various approach barrier concepts shown on STD-E-010-05 and STD-EC-010-15 & 16 can be categorized using the following terms, listed in order from the least robust concept to the most robust concept:

- **Unanchored & Unconnected**: Where the approach barriers are not anchored into the ground and not physically connected to the bridge guardrail. (The concrete barrier concept and the guide log concept shown on STD-E-010-05 are Unanchored & Unconnected);
- **Anchored & Unconnected**: Where the approach barriers are anchored into the ground by means of physical connection to concrete blocks buried in the approach fill, and the approach barriers are not physically connected to the bridge guardrail. (This is one of two concepts shown on STD-EC-010-15 & 16);
- **Anchored & Connected**: Where the approach barriers are anchored into the ground by means of physical connection to concrete blocks buried in the approach fill, and the approach barriers are also physically connected to the bridge guardrail with an HSS guardrail transition assembly. (This is one of two concepts shown on STD-EC-010-15 & 16).

3.0 Development of STD-EC-010-15 & 16

3.1 Key Concept Objectives and Features

Some bridge sites may need more robust approach barriers than those shown on STD-E-010-05 to meet the following two key objectives:

- improved safety for errant light vehicles;
- decreased level of maintenance on bridge approach barriers, bridge guardrails, and bridge decks.

To meet the key concept objectives, approach barrier concepts shown on STD-EC-010-15 & 16 incorporate the following features:

- **Approach barriers anchored to buried concrete blocks** for both Anchored & Unconnected and Anchored & Connected concepts: This feature increases resistance to lateral impact, thereby improving safety for light vehicles and decreasing maintenance requirements;
- **Approach barriers connected to bridge guardrails** for the Anchored & Connected concept: This feature provides added stiffness to the ends of the bridge guardrails, thereby improving safety for light vehicles, and decreasing the frequency and severity of damage to: bridge guardrails, their attachments to bridge decks, and the bridge decks themselves;
- **Approach barriers provided with better foundation support** for both Anchored & Unconnected and Anchored & Connected concepts**:** This feature, including provision of a minimum level road base distance behind barriers together with fill placement specifications, helps to keep approach barriers level and immobile in general circumstances, thereby improving safety for light vehicles.

3.2 Operational Objectives for Detailed Design

The design details of the concepts shown on STD-EC-010-15 & 16 were determined considering the following operational objectives:

- Utilize currently available standard and economical precast concrete components with minimal modifications;
- Where modifications to commonly available standard precast components are justified, minimize the variations required from one bridge site to the next;
- Cost and complexity should be appropriate to low cost industrial road bridges, and should consider that standard ministry bridge guardrails for FSRs generally do not meet highway bridge design standards;
- Ensure practicality of field assembly, and allow for simple dis-assembly and re-use at a different site;
- Allow for ease of adaptation (e.g., approach barrier line length and angle) to suit a variety of common bridge site situations.

  Note:

  - For the design, the ministry has not undertaken rigorous theoretical analysis of lateral resistance to vehicle impacts or crash testing.

4.0 Reference Documents

The reference documents listed below provide detailed information for engineering design of bridge approaches and bridge approach barriers. A professional engineer can consider these references when designing approach barriers for specific bridges on Forest Service roads (FSRs).

- FLNRORD "Guidance for Selecting Bridge Guardrail Containment Level and Determining Need for Bridge Approach Barriers on FSRs" https://www2.qa.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/resource-roads/bridge-design-construction/guidance_for_bridge_guardrail_selection__bridge_approach_barriers.docx
- BC Ministry of Transportation and Infrastructure "Supplement to TAC Geometric Design Guide"
- FLNRORD "Bridge Approach Barriers on FSRs" by Gary McClelland, PEng
- FLNRORD "Guideline for Barrier Selection and Design" by Associated Engineering Ltd.

5.0 Considerations for Use of Standard Drawings for Bridge Approach Barriers

5.1 General Considerations

In addition to determining an appropriate standard approach barrier concept for a specific bridge site, a professional engineer should determine the site specific approach road geometry and detailed approach barrier requirements (including lengths and angles).

Approach Roadway Design, Pullout, and Signage Requirements

Approach roadway design, pullout, and signage requirements are not supplied on the ministry standard drawings. A professional engineer should specify these requirements for a specific bridge site.

Length of Approach Barriers

The length of a line of approach barriers at a bridge corner should be determined with consideration of keeping light vehicles from leaving the roadway in high hazard locations, which may not only be at the bridge end, but also along the side of the bridge approach (e.g., where there are high cribs, canyons, steep slopes).

Retrofitting Approach Barriers at an Existing Bridge Site

For existing (rather than new) bridges, approach barriers may be retrofit (i.e., added or improved) without making improvements to bridge guardrails, if improvements to bridge guardrails are either not necessary or would be prohibitively expensive. For some approach barrier retrofit situations, where a bridge guardrail type other than CL-2 or CL-3 is already in place, a professional engineer can develop a unique connection detail between the existing bridge guardrail and the retrofit approach barrier if connection is deemed appropriate.

Adequacy of Bridge Approach fills to Support Approach Barriers

A common problem with approach barriers installed on FSRs has been maintaining their position and stability as required for visual and structural purposes. A professional engineer responsible for design of the approach road geometry and detailed approach barrier requirements, and the related construction, should pay particular attention to site specific general arrangement drawings, contract specifications, and field reviews to ensure approach fills will remain stable and provide adequate foundation support for the approach barriers.

Bridge Ballast Walls

To achieve sufficient level and stable approach fills for placement of approach barriers, a professional engineer responsible for bridge conceptual and approach barrier design may consider lengthening the ballast walls (beyond that specified on ministry standard substructure drawings). In this case, ballast wall structural design and detailing needs to adequately account for increased earth pressures.

Alternatives to Standard Transition and Bull-nose Barriers

The ministry standard approach barrier drawings depict each line of barriers ending (away from the bridge) with two barriers: a standard BC Ministry of Transportation and Infrastructure (**TRAN**) “precast concrete transition barrier 690mm to 460mm - CTB-1E” plus a standard TRAN “precast concrete bull-nose 460mm - CBN-H.”

Alternatively, a professional engineer may choose to specify a one-piece combined transition/bull-nose barrier that is 690mm high at one end, tapering down to a bull-nose shape at the other end. A professional engineer who specifies this alternative component should provide detailed engineering and geometric specifications at the time of ordering, since a standard TRAN drawing for this alternative does not exist. Note that typical one-piece combined transition/bull-nose barriers supplied by BC concrete precasters are shorter in length than the combined length of the standard TRAN transition piece plus the standard TRAN bull-nose piece.

5.2 STD-E-010-05

STD-E-010-05 is conceptual and contains few engineering design details. A professional engineer should provide the necessary specifications when ordering materials or preparing bridge general arrangement drawings based on this conceptual standard drawing. **Note:** Lines of approach barriers longer than those shown on this standard drawing may be required at a specific bridge site.

5.3 STD-EC-010-15 & 16

STD-EC-010-15 & 16 show two possible approach barrier angles (15 and 25 degrees). These are conceptual examples only. For a specific bridge site, a professional engineer can specify appropriate angles, number, layout and type of approach barriers, and whether the approach barriers are to be connected to the bridge guardrail or not. The approach barriers should be drawn to scale on bridge general arrangement drawings.

Options for Concrete Block Layout

STD-EC-010-15 & 16 show two possible concrete block layout options for the mass anchor that is comprised of 3 concrete blocks and one modified Concrete Roadside Barrier-Eye (CRB-E) piece. As shown on these drawings:

- Option 1 consists of a top concrete block with 2 shear keys, 2 base blocks which have a shear key on one half and a flat top on the other half, and a modified CRB-E without shear key voids in its base;
- Option 2 consists of 3 concrete blocks, each with 2 shear keys, and a modified CRB-E that has 2 shear key voids in its base.

A professional engineer may specify one of these two options when ordering, or alternatively may allow a supplier to choose which of the two options it will supply.

Alternate Anchorage Systems

Vertically ducted concrete blocks, vertically ducted concrete roadside barriers and steel rod connections between these ducted components should be as shown on STD-EC-010-15 & 16, unless an alternate anchorage system has been pre-approved by a Ministry Bridge Engineer. Detailed drawings, signed and sealed by a professional engineer, should be submitted to the Ministry Bridge Engineer for any proposed alternate systems. Alternate systems should provide equivalent strength, durability, and functionality to the system specified on STD-EC-010-15 & 16.

Modified CRB-E (Two Longitudinal Steel Reinforcement Bars Typically Required)

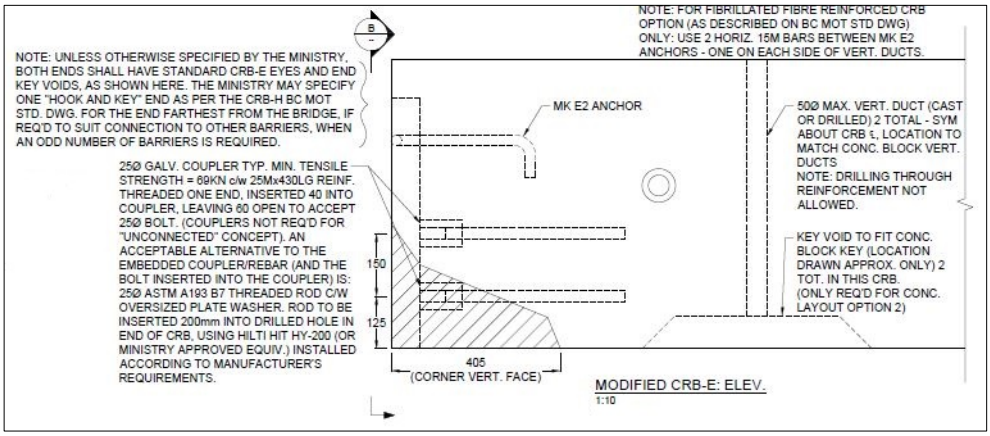
The modified CRB-E barriers shown on STD-EC-010-15 & 16 drawings (partial view shown below in Figure 1) need to be specially cast, since the vast majority of CRB-E barriers currently being produced in BC utilize the fibrillated fibre reinforcement option described on the TRAN standard drawing for this barrier. This TRAN option requires a horizontal rebar to be placed along the longitudinal centreline of the barrier between the steel eyes.

STD-EC-010-15 & 16 specify that two longitudinal bars be used (one on each side of the vertical ducts) rather than one rebar located on the longitudinal centreline which would interfere with the placement of centrally located vertical ducts. This is one reason why it will generally not be possible for a supplier to modify a previously cast standard TRAN CRB-E piece to meet the requirements of these drawings.

Modified CRB-E (Cast or Drilled Vertical Ducts)

Concrete precasters reviewing preliminary versions of STD-EC-010-15 & 16 have indicated that they would typically prefer to cast vertical ducts into the modified CRB-E piece rather than drill them.

Figure 1: Partial Elevation View of Modified CRB-E shown on STD-EC-010-16



Modified CRB-E (Cast or Drilled Horizontal Threaded Connection)

Concrete precasters reviewing preliminary versions of STD-EC-010-15 & 16 have indicated that they would typically prefer to cast horizontal threaded inserts into the end of the modified CRB-E for the connected option rather than attempting to drill horizontal holes to install threaded bars with adhesive.

Modified CRB-E (Eye Details or Hook Details)

TRAN standard precast concrete barriers typically have the same type of end details at each end of a barrier piece. If a professional engineer chooses to use typical barrier line end pieces (at the barrier line end farthest from the bridge), the last two barrier pieces will consist of a standard TRAN "precast concrete transition barrier 690mm to 460mm - CTB-1E" plus a standard TRAN "precast concrete bull-nose 460mm - CBN-H." In order to fit with the TRAN standard transition barrier CTB-1E, the 690mm high barrier that connects to it must have a "hook and shear key " end.

- Even number of approach barriers: For lines of approach barriers that are composed of an even number of total barriers (e.g., 4, 6, 8,…), the modified CRB-E from STD-EC-010-15 & 16 should be produced with an "eye and key void" at each end, so that the remainder of the barriers can be standard TRAN pieces;

- Odd number of approach barriers: If a line of approach barriers has an odd number of total barriers (e.g., 3, 5, 7,…), the modified CRB-E will need to have a "hook and shear key" at the end away from the bridge so that the remainder of the barriers can be standard TRAN pieces.

Steel Guardrail Transition Assembly Shop Drawings

The bridge contractor should prepare shop drawings for the steel guardrail transition assembly, including attachment details to the CRB. The contractor should submit the shop drawings to the Ministry Bridge Engineer for general review (suitability review) to determine their acceptance for the bridge project prior to fabrication, unless approach barriers are specified to be unconnected to the bridge guardrails.