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DATE 7 October 2021

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REF RWW

PROJECT NO A117356 & A235950

Dear Sirs,

Re: 1780 East Broadway Loading and Access Ramps – Preliminary Screening

Background

COWI has been contracted by Westbank to provide a preliminary assessment of the viability of an infill ramp structure between their proposed development at 1780 East Broadway and the Broadway Bridge. This includes the review of modifications to the existing bridge, a conceptual design of the ramp structure, and a review of the interface between the two structures.

The inputs for this screening are the original bridge design drawings, the architectural drawings for the proposed development dated 2021 September 20, the rezoning application amendment dated 2021 September 24, as well as two reports relating to Broadway Bridge that COWI had prepared for the City of Vancouver: a load rating of the bridge (A099052-RPT-001-0) and a seismic assessment (A099052-RPT-003-0).

Modifications to existing bridge

Two access ramps into the 1780 East Broadway development are proposed on the south side of the Broadway Bridge. Access to these ramps will require removal of the sidewalk, curbs and barriers over a significant length of the south side of the west span.

An intersection will also be added at the parkade (western) access ramp. This will require the following modifications:

- › Removal of the median and the addition of a left turning lane.
- › Addition of a pedestrian curb ramp on the sidewalk on the north side of the bridge.
- › New supports for signals at the proposed intersection may be required.
- › There is a streetlight pole on the south sidewalk that will need to be relocated as it conflicts with the parkade access ramp.
- › Replacement of the expansion joint at the west abutment of the bridge is a requirement of the City of Vancouver.

Sidewalk Modifications

On the south side of the bridge the sidewalks and barriers will be removed at the ramp locations. Figure 1 shows the approximate ramp geometry at the parkade ramp. The current depth of the asphalt on the bridge is not known; a depth of 90 mm has been assumed based on the original design drawings.

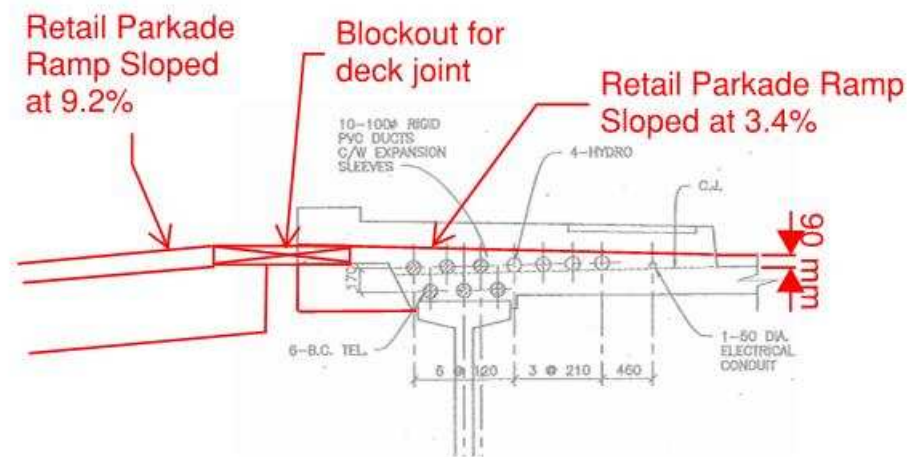


Figure 1: Cross section at retail parkade ramp

The original bridge drawings show a horizontal construction joint at the interface between the bridge deck and the sidewalk. Removal of the majority of the sidewalk concrete will be required at the ramps. Only a limited amount of bridge deck concrete removal is expected to be required.

The design drawings indicate that there are ten 100 mm diameter utility conduits embedded in the south sidewalk: four conduits are for hydro and six conduits are for B.C. Tel. There is also one 50 mm diameter electrical conduit. It is likely that seven of the 100 mm diameter conduits and the 50 mm diameter conduit will need to be removed and the utilities in them will need to be re-routed (possibly under the bridge). Three of the B.C. Tel conduits are at a lower elevation (in the deck slab rather than the sidewalk slab); it is possible that these conduits can remain in place.

The curb ramp on the north side of the bridge will also require removal of sidewalk concrete. The City of Vancouver drawing MF137-L-5 calls for a maximum slope of 8.3 % on curb ramps. In order to achieve this gradient, the full width of the sidewalk will be needed; the proposed change to the concrete outline are shown in Figure 2 below.

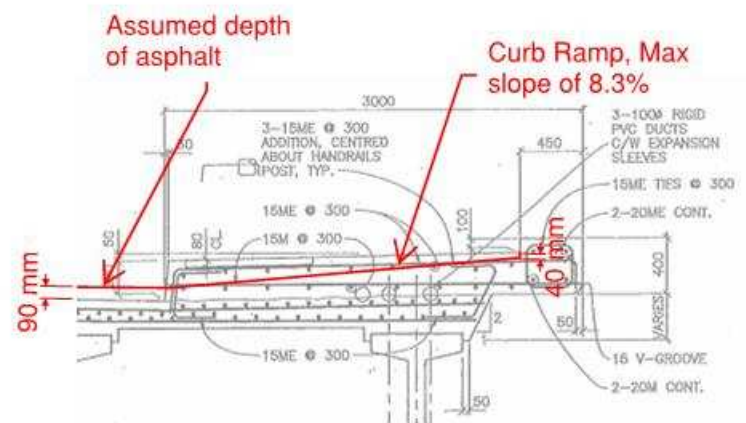


Figure 2: North sidewalk pedestrian ramp

City of Vancouver drawing MF137-L-5 also calls for a flat, 1.2 m wide, 'landing/bypass' area on the sidewalk. The width of the existing Broadway Bridge sidewalk is not sufficient to include this bypass area.

There are three 100 mm diameter ducts embedded in the sidewalk on the north side of the bridge. The original bridge drawings do not identify the purpose of these ducts. It may be possible for these ducts to remain in place.

Existing Bridge Load Rating

The changes to Broadway Bridge that were judged to significantly affect the load rating of the Broadway bridge are the removal of the median and the addition of an additional, seventh, lane (the left hand turning lane at the proposed intersection).

COWI's previous load rating of the bridge has been revised to reflect this proposed condition. We found that these changes did not result in a significant change in the bridge live load capacity. The results showed a small decrease in the governing Live Load Capacity Factors for the girders from 1.08 to 1.06. For the pier caps, the minimum Live Load Capacity Factors were reduced from 1.45 to 1.32.

The alterations to the sidewalks have not been taken into consideration in the preliminary review of the load rating as they will result in a decrease in the bridge dead load. The sidewalks were not considered in the calculations for the capacity of the edge girders in COWI's load rating.

Proposed Ramp Structure

The proposed ramp structure will be a triangular structure that is bounded by the 1780 East Broadway Building on the south side and Broadway Bridge on the north side. A concept design for this structure is provided in the attached sketches A117356-S-SK1 through SK4.

We propose a single precast concrete box girder spanning in the east-west direction along the south side of Broadway Bridge. At the west end this girder will be supported on an abutment seat which will be

supported on piles (and/or possibly tied to the 1780 East Broadway development). At the east end it will be supported on a single column which will align with the adjacent line of columns on Pier 1 of Broadway Bridge.

At the two ramp locations, beams supporting the ramps will span from north to south. At the north end, the east-west girder will support these beams. At the south end, the beams will be supported on abutment seats that are proposed to be incorporated into the 1780 Broadway building. The abutment seats will be skewed at the south end; the lengths of the beams will vary from 7.0 m to 12.5 for the parkade entry ramp and from 18.3 m to 25.0 m for the loading ramp.

Seismic resistance for the ramps will primarily be provided by dowelled connections between the abutment seats and the beams. For the girder parallel to Broadway Bridge, the seismic loads in the east-west direction will be carried back to the abutment seat at the west end. In the north-south direction, the seismic load (resulting from the self-weight of the girder) will be resisted by the abutment seat at the west end and by the single column at the east end.

Rail Constraints

The proposed ramp structure will provide a clear span of approximately 30 m to allow for the possibility of a future rail corridor passing under the west span of Broadway Bridge and the ramp structure.

The vertical clearance under the proposed ramp structure will be approximately 1.0 m less than under the adjacent bridge. Transport Canada requires 7.01 m clearance above top of rail. The future top of rail level is not known.

There is an active rail line operated by BNSF under the middle span of Broadway Bridge. We do not have any survey information on the location of the rail line or the rail boundaries. The existing drawings for Broadway Bridge indicate that the distance between the centerline of the columns on Pier 1 and the centerline of rail (at the time of bridge construction) is approximately 10 m, which is greater than the minimum clearance required by Transport Canada. The location of the rail line and the boundaries of the rail right of way will need to be confirmed to make sure that the column has adequate clearance and does not intrude on the right of way.

A deflection wall will be required to protect the column from the impact of a derailed train. Protection of this column is critical to the performance of the structure as it is a single column with no redundancy. The Guidelines for New Development in Proximity to Railway Operation provide direction on the determination of design loads for deflection walls; this will need to be further investigated at the detail design phase. Also, the American Railway Engineering and Maintenance Way Association (AREMA) provides guidelines on the requirements for crash walls.

Interface between ramp structure and Broadway bridge

The design of the interface between the ramp structure and Broadway Bridge will likely be governed by relative seismic movements of Broadway Bridge and the ramp structure. Future base isolation of Broadway Bridge has been recommended in COWI's seismic assessment; installation of this base

isolation would result in relatively high seismic movements; however these movements may be limited by the clearance limitation at the skewed bridge abutments.

The deck joint between the two structures will be selected to accommodate day to day thermal and live load movements of the two structures and to allow Broadway Bridge to move such that the joint does not adversely affect the current or future seismic performance of the bridge.

Further evaluation will need to be performed to determine the relative movements of the structures and the deck joint type that will best suit this application.

Vehicle Containment Barriers

Vehicle containment barriers will be required on both sides of the two ramps. Concrete barriers have been proposed as shown in the attached drawings.

There are currently steel post and rail type barriers on both sides of Broadway Bridge. On the south side, these will need to be removed where they conflict with the ramp locations. Also, the existing barriers between the ramps will need to be removed and replaced as it is unlikely that the existing post locations will suit the ramp locations. Concrete barriers are proposed to replace the existing steel barriers between the ramps and between the parkade ramp and the west abutment.

The gap between the barriers on the bridge and the ramps will be covered by a steel cover plate. Similar to the deck joints, these cover plates will need to be designed to accommodate day to day thermal and live load movements of the two structures and to allow Broadway Bridge to move such that the joint does not adversely affect the current or future seismic performance of the bridge.

Interface between ramp structure and proposed building

At the south ends of the ramp beams, the beams will be seated on abutments incorporated into the 1780 East Broadway building. At these locations the beams will be fixed against transverse and longitudinal movements.

Yours truly,

COWI North America Ltd.



Rodger Welch, P.Eng.
Vice President, Project Director

