APPENDIX C

BASIS OF DESIGN

1.0 INTRODUCTION

This basis-of-design (BOD) document presents structural design criteria of the preferred alternative of Bellevue Grand Connection: I-405 Crossing – Downtown to Eastrail project.

Preferred alternative consists of plaza extension at the west tie-in. This BOD does not discuss the design criteria of structural retrofit of the plaza extension.

1.1 Bridge summary

Proposed pedestrian bridge structure is divided into five segments:

- West tie-in structure, CIP PT box girder (130’-130’ span arrangement)
- West node structure (210’-0” long structure)
- I-405 crossing structure (830’ total length with 230’-370’-230’ span arrangement)
- East node structure (323’-0” long structure)
- Eastrail tie-in structure (584’-0” long structure)

1.2 Design Codes

The standards to be used in the bridge design are listed below in order of precedence. This encompasses the design of the bridge control line, superstructure, substructure, foundations, abutments, railings, bearings, seismic performance, and vibration criteria.

i. AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, 2009 (AASHTO Ped)

ii. AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd edition, 2011 (AASHTO Seismic)

iii. AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020 (AASHTO LRFD)

iv. AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, First Edition, 2015 (AASHTO Signs)

v. Washington State Department of Transportation Bridge Design Manual (LRFD), 2023 (BDM)

vi. Washington State Department of Transportation Design Manual, 2023 (DM)

vii. American Institute of Steel Construction, Steel Construction Manual, 16th Edition, 2023 (AISC)

viii. American Concrete Institute 318-19, Building Code Requirements for Structural Concrete, 2022 (ACI)

ix. AASHTO Guide for the Development of Bicycle Facilities, 4th Edition, 2012 (AASHTO Bike)

x. 2018 International Building Code (IBC)

xi. 2021 Washington State Building Codes (WSBC)

1.3 Design Life

The design life shall be 75 years, consistent with AASHTO LRFD Section 1.2.

2.0 BRIDGE GEOMETRY

2.1 Deck Width

West Tie-In Structure

30’ wide structure, allowing for dedicated pedestrian and bike lanes.

West Node Structure

Width varies from 30’ to 80, used as geometry transition from West Tie-In to I-405 Crossing Structure, and vertical circulation. Allows for dedicated pedestrian and bike lanes.

I-405 Crossing Structure

40’ wide structure, allowing for dedicated pedestrian and bike lanes with two-six-foot-wide and one-six-foot-wide landscaping area.

East Node Structure

width varies from 30’ to 105’, used as geometry transition from I-405 Crossing Structure to the Eastrail Tie-In, and vertical circulation. Allows for dedicated pedestrian and bike lanes.

Eastrail Tie-In Structure

30’ wide structure, allowing for dedicated pedestrian and bike lanes with 6-foot-wide landscaping area.

2.2 Alignment Geometrics

- Design speed for the Bike path is 20 mph per AASHTO Bike.
- Minimum radius of curvature is 74’.
- The minimum bicycle stopping sight distance is 170’.
- Maximum grade for ramps and the deck shall be 12H:1V per ADA
- Maximum cross slope for pedestrian zones shall be 48H: 1V per ADA.

2.3 Clearance Requirements

Minimum vertical clearance from roadway surface to the constructed structure and bottom of falsework is 17’-6” per DM.

Minimum horizontal clearance to the existing Sound Transit guideway structure is 15’-0”. This is not a published standard; however, Sound Transit has expressed a preference for this minimum horizontal clearance to allow for their overhead catenary power system and for inspection access.

2.4 Railings

Railing height above the walking surface shall be 4'-6" to accommodate cyclists per the DM. If the railing is combined with the raised landscaping feature, 4’-6” railing height must be above the top of landscaping feature.

For access ramps, handrail shall be a maximum of 38” and a minimum of 34” per DM.

2.5 Throw Barrier

Throw barrier will be provided to meet the Sound Transit design criteria. Currently, throw barrier will be placed where proposed structures is above the existing Sound Transit’s guideway structure.

2.6 Vertical Circulation

Vertical circulation structures, such as elevators and stair structures will be designed in accordance with IBC and WSBC.

2.7 Drainage

Allowance for the dead load of drainage pipes will be considered under the utilities section.

2.8 Expansion joints

Expansion joints will be designed to accommodate concrete shrinkage, thermal variation and long-term creep per the BDM.

2.9 Utilities

For the preliminary design, following utilities will be assumed:

- 3-in diameter supply water, 3 sets
- 2-8" diameter drain pipe, 3 sets
- 6" diameter fire pipe, 3 sets

2.10 Lighting

Dead load of lighting poles and concrete pedestal will be considered.

3.0 DESIGN LOADS

3.1 Permanent Loads (DC & DW)

Components and Attached Dead Loads (DC)

- Normal weight concrete (deck and substructures) = 0.155 kcf
- Precast girder concrete = 0.165 kcf
- Structural Steel = 0.490 kcf
- Bridge railing to be determined
- Throw barrier to be determined
- Haunch assumed for dead load for steel and precast girders
- Stay-in-place (SIP) deck forms = 15 psf

Wearing Surface and Utilities (DW)

- Utilities allowance = 0.500 klf
- Permanent loads applied to the composite structure are distributed evenly to all girders for bridges with 6 girders or less per BDM.

3.2 Live Loads (LL)

Pedestrian and cyclist live load = 90 psf, placed with patterns to induce the maximum load effects. No dynamic load allowance is applied per AASHTO Ped.

The bridge deck will also be designed to accommodate an H10 two-axle vehicle in accordance with AASHTO Ped Section 3.2. No dynamic load allowance will be applied, and the H10 load will not be applied concurrently with live pedestrian load. Note that this will allow for maintenance vehicles to be used on the structure.

The design live load for pedestrian railings shall be taken as w = 0.050 klf, applied simultaneously in the lateral and vertical directions, in accordance with Section 13 of AASHTO LRFD. In addition, each longitudinal element shall be designed for a concentrated load of 0.2 kips, acting simultaneously with the linear load at any point and in any direction at the top of the longitudinal element.

3.3 Wind Loads (WS)

Wind loads are calculated in accordance with AASHTO LRFD and modified per AASHTO Ped using AASHTO Signs.

Vertical uplift on the bridge deck of 20 psf is applied over full deck width acting at the windward quarter point of the deck.

3.4 Earthquake Loads (EQ)

Seismic analyses are performed in accordance with AASHTO Seismic, the seismic design approach for all five structure segments will be based on life safety.

The response spectrum will be developed for the site using AASHTO Seismic for the given site class, as determined by the preliminary geotechnical recommendations.

3.5 Temperature (TU & TG)

Uniform temperature loads due to structure temperature rise or fall are defined in accordance with AASHTO LRFD and WSDOT BDM.

3.6 Load Factors and Load Combinations

Load combinations and load factors are in accordance with AASHTO Ped Tables 3.4.1-1 and 3.4.1-2.

3.7 Load modifier

A load modification factor of 1.0 is used.

4.0 DEFLECTION CRITERIA

Deflection of all five segments of the proposed structure will be checked for AASHTO Ped clause 5, under Service I load combination.

For cable supports or atypical structural systems, alternative deflection analysis will be performed, as AAHSTO Ped may be excessively conservative or unachievable for those structures.

5.0 VIBRATION CRITERIA

Vibration analysis will be performed in accordance with AASHTO Ped Section 6 with supplemental publication by SETRA (Service d'Etudes Techniques des Routes et Autoroutes) (2006).

6.0 MATERIALS

6.1 Concrete

For structural design following parameters are assumed:

- F’c = 4.5 ksi, applies to deck and substructure elements
- F’ci=8.5 ksi, F’c= 10 ksi, applies to precast structure
- Γ = 0.150 kcf for normal weight concrete

6.2 Reinforcing steel

Use Grade 60 reinforcing steel conforming to ASTM A706 unless noted otherwise.

Minimum cover is 2” unless otherwise noted.

All bent bar dimensions are taken as out-to-out.

All reinforcing steel bends conform to CRSI Standards or as noted otherwise

Reinforcing splice lengths shall be determined according to AASHTO 5.10.8.2, 5.10.8.4 and BDM 5.1.2.D.

Minimum splice lengths are shown in the plans and/or bar lists.

6.3 Prestressing steel

- F’u = 270 ksi

6.4 Structural steel

All structural steel shall be AASHTO M270, Grade 50 unless noted otherwise on the plans.

Modulus of elasticity, E = 29,000 ksi (AASHTO 6.4.1)

7.0 FOUNDATION DESIGN

Foundation design will be developed in the final type selection report.

8.0 ANALYSIS

Analysis approach to the five structure segments will be developed in the final type selection report.