Bridge Design Criteria Report

Multnomah County | Earthquake Ready Burnside Bridge

Portland, OR

January 29, 2021

Earthquake Ready Burnside Bridge Design Criteria Report

Prepared for

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HDR Project #10144814

CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

REGISTERED PROFESSIONAL ENGINEER
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OREGON
MAY 10, 2005
STEVEN M. DRAHOTA
EXPIRES: 12/31/2021

______________________________Signature Reserved for Final Version

Prepared by Rebecca Bautista (Consultant Bridge Engineer)

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Checked by Mark Libby (Consultant Bridge Lead)

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Reviewed by Steve Drahota (Consultant Technical Lead)

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Approved by Heather Catron (Consultant Project Manager)

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Acronyms, Initialisms, and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
BES	City of Portland Bureau of Environmental Services
City	City of Portland, Oregon
Couch Extension	Replacement Alternative with Couch Extension
CSO	Combined Sewer Overflow
County	Multnomah County, Oregon
EIS	Environmental Impact Statement
EQRB	Earthquake Ready Burnside Bridge Project
FHWA	Federal Highway Administration
GDM	Geotechnical Design Manual
I 5	Interstate 5
I-84	Interstate 84
Long-span Alternative	Replacement Alternative with Long-span Approach
LRFD	Load and Resistance Factor Design
MLK	Martin Luther King Jr. Boulevard
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act of 1969
ODOT	Oregon Department of Transportation
PE	Preliminary Engineering
Project	Earthquake Ready Burnside Bridge Project
Short-span Alternative	Replacement Alternative with Short-span Approach
Temporary Bridge	Temporary Detour Bridge
UPRR	Union Pacific Railroad

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1 Introduction

The purpose of this document is to summarize relevant design specifications and guidelines that are the basis of bridge alternatives and the specific clearance requirements for the proposed alignments. This report describes the criteria and detailed considerations for the one retrofit bridge alternative and three bridge replacement alternatives being studied for NEPA.

1.1 Project Description

Multnomah County (County) is directing the study and development of an environmental impact statement as part of the NEPA assessment to evaluate and recommend a seismically resilient preferred alternative for the Burnside Bridge river crossing. The following summarizes the Earthquake Ready Burnside Bridge Project (Project) design criteria and guidelines.

1.2 Existing Bridge Description

Originally constructed in 1926, the Burnside Bridge crosses the Willamette River (Figure 1), multiple City of Portland (City) streets, parking lots, parks, TriMet Max lines, and other facilities along Burnside Street. This bridge carries five lanes of vehicle traffic (three eastbound lanes and two westbound lanes) as well as bike lanes and sidewalks in each direction. The total length of the bridge is approximately 2,307 feet and consists of three separate bridges:

- West Approach Bridge (Br. No. 00511A) spans 602 feet
- Main River Bridge (Br. No. 00511) spans 856 feet
- East Approach Bridge (Br. No. 00511B) spans 849 feet

This bridge is also a historically significant structure and is listed in the National Register of Historic Places.

Figure 1. Burnside Bridge Main River Span Bridge over the Willamette River, Portland, Oregon

1.3 Major Transportation Facilities and Critical Infrastructure

The seismic resiliency of the Burnside Bridge is impacted by the adjacent major transportation facilities and buildings (Figure 2). The alternatives considered the following existing facilities as potential constraints during the conceptual design process:

1. TriMet light rail lines run on 5th Avenue and under the west approach of the bridge at 1st Avenue on the west side.
2. The City of Portland roadway facilities: Naito Parkway runs under the west approach of the bridge; 2nd and 3rd avenues run under the east approach spans and Martin Luther King Jr. (MLK) Boulevard and Grand Avenue are adjacent to the east approach.
3. The City of Portland large diameter combined sewer overflow (CSO) pipes run under both the west approach and east approach bridge spans.
4. Interstate 5 (I-5) south and northbound main lines and the ramps to and from Interstate 84 (I-84) run under the east approach of the Bridge.
5. Union Pacific Railroad (UPRR) lines run under the east approach of the bridge.
6. River navigation channel for U.S. Coast Guard and other river users.
7. The Portland Streetcar runs just east of the bridge on MLK Boulevard and Grand Avenue.

8. The west and east approaches of the bridge are within close proximity to adjacent buildings, some having sidewalk access from Burnside Street.

Figure 2. Adjacent Major Transportation Facilities and Buildings of Burnside Bridge

2 Roadway Design Criteria and Considerations

2.1 Burnside Street Lifeline Designation

Burnside Bridge is designated as the only County owned Primary Emergency Transportation Route across the Willamette River in downtown Portland in a 1996 report to Metro's Regional Emergency Management Group. This group was formed by intergovernmental agreement among the region's cities, counties, Metro, and the Red Cross to improve disaster preparedness, response, recovery, and mitigation plans and programs. (Source: Regional Emergency Transportation Routes, Portland Metropolitan Region, 1996).

Through the development of the Multnomah County Willamette River Bridge Capital Improvement Plan (CIP)[1], it was determined that the Burnside Bridge is a top priority for the County due to its designation as the only County owned primary lifeline route across the Willamette River in downtown Portland.

[1] CIP (https://multco.us/bridgeplan)

2.2 Traffic Volumes

The Burnside Bridge carries a total of 35,000 vehicles per day, with 19,000 eastbound and 16,000 westbound vehicles (source: 2019 Traffic Counts).

2.3 Design Vehicles

Turning movements shall accommodate the following vehicles:

- WB-67
- WB-40 (Emergency Vehicle) for turning movements
- Portland Streetcar (for future accommodation)

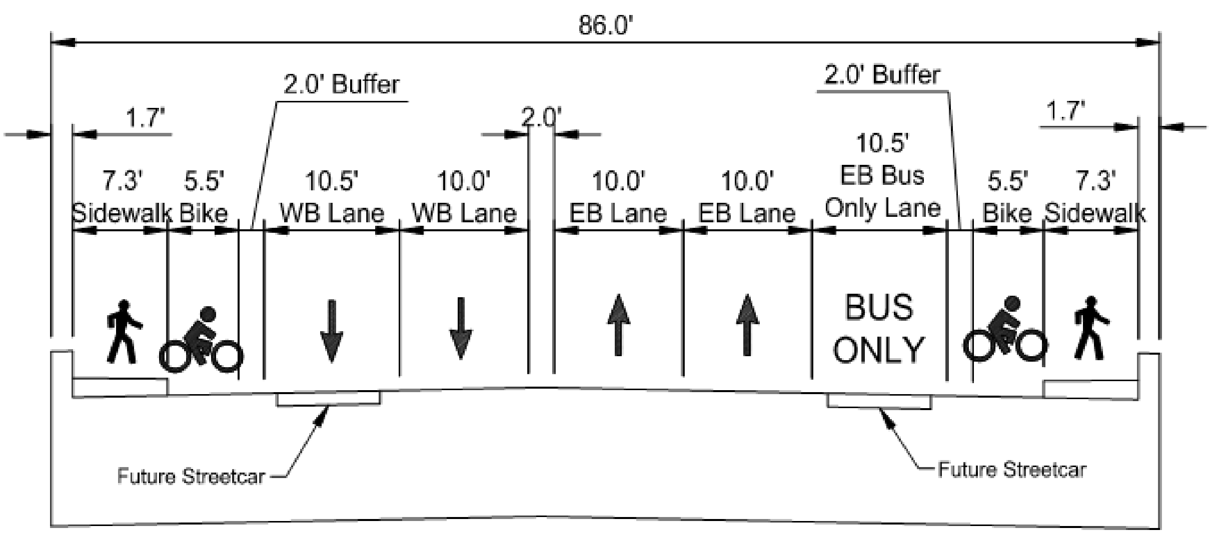
2.4 Vertical Profiles

Profile grades shall be limited to a maximum of 4.75 percent.

2.5 Typical Sections

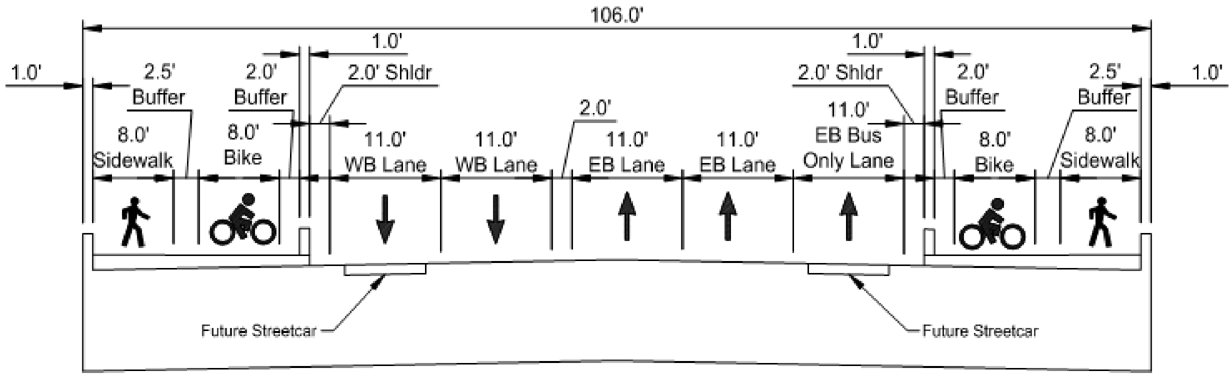
Project working groups are developing the roadway section.

Figure 3. Full Width Typical Section (Retrofit)



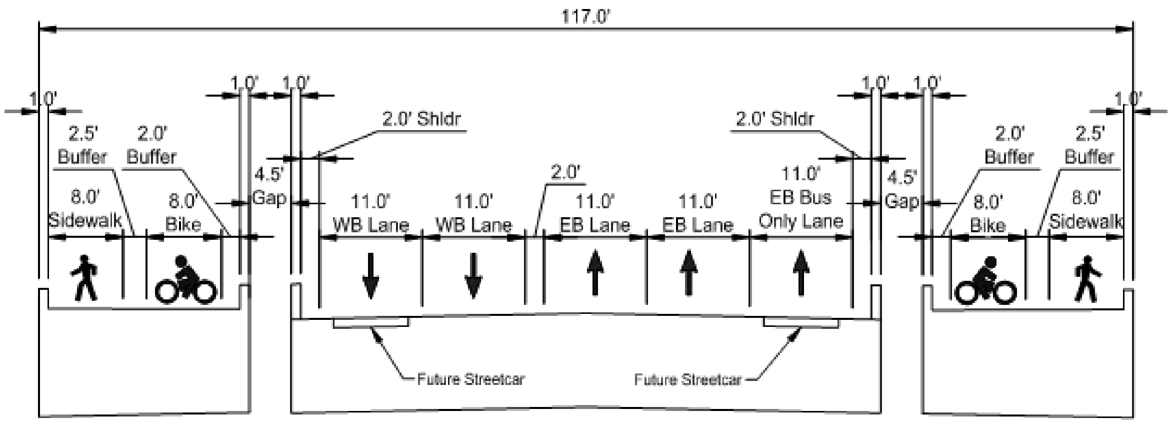
Note: EB (eastbound), WB (westbound)

Figure 4. Full Width Typical Section (Short-span Alternative)



Note: EB (eastbound), WB (westbound)

Figure 5. Full Width Typical Section (Long-span Alternative)



Note: EB (eastbound), WB (westbound)

2.6 Design Speed

- 35 miles per hour (mph)

2.7 Pavement Criteria

- Oregon Department of Transportation (ODOT) Pavement Design Guide

2.8 Americans with Disabilities Act Criteria

Bridge accesses will be ADA compliant.

- Americans with Disabilities Act (ADA)
- Public Rights-of-Way Accessibility Guidelines
- Portland Pedestrian Design Guide

- Portland Bureau of Transportation (PBOT) ADA Curb Ramp Design Report Form
- Oregon Transportation Commission Standards for Accessible Parking Places

2.9 Potential Design Exceptions

None expected at this time.

3 Structures Design Criteria and Considerations

At a minimum, the bridge retrofit and replacement alternatives will be designed to current City, County, State, and national standards as applicable for the features and components of the alternative. Bridges and structures will be designed for a minimum 75-year design life with consideration given to aspects suitable for 100-year design life.

3.1 Bridge Alternatives

Enhanced Seismic Retrofit (Retrofit)

Replacement Fixed Bridge on Existing Alignment (Fixed Bridge)

Replacement Alternative with Short-span Approach (Short-span Alternative)

Replacement Alternative with Long-span Approach (Long-span Alternative)

Replacement Alternative with Couch Extension (Couch Extension)

3.2 Applicable Design Specifications and Guidelines

The bridge alternatives of the Burnside Bridge will conform primarily to the following major design codes (in order of precedence):

- EQRB Project-specific Seismic Design Criteria
- AASHTO *LRFD Bridge Design Specifications* (AASHTO LRFD)
- AASHTO *Guide Specifications for LRFD Seismic Bridge Design* (AASHTO Guide Spec)
- AASHTO *LRFD Movable Highway Bridge Design Specifications* (AASHTO Movable)

Additional design references include, but are not limited to (no order of preference):

- AASHTO *Guide Specifications for Seismic Isolation Design*
- AASHTO *Guide Specifications for Design and Construction of Segmental Concrete Bridges*
- AASHTO *Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges*
- ODOT *Bridge Design Manual* (BDM)

- ODOT *Geotechnical Design Manual* (GDM)
- Oregon Structural Specialty Code
- AASHTO *LRFD Guide Specifications for Design of Pedestrian Bridges*
- ODOT *Bicycle and Pedestrian Design Guide*
- TriMet Design Criteria
- UPRR-BNSF *Guidelines for Railroad Grade Separation Projects*
- FHWA *Steel Bridge Design Handbook*
- AASHTO/NSBA *Steel Bridge Collaboration Standards*
- AASHTO *Guide Design Specifications for Bridge Temporary Works*
- ODOT *Load and Resistance Factor Rating (LRFR) Manual*

3.3 Typical Bridge Section

See section 2.4 above.

3.4 Design Loads

The following Dead Loads will be assumed for general assessments of alternative layouts:

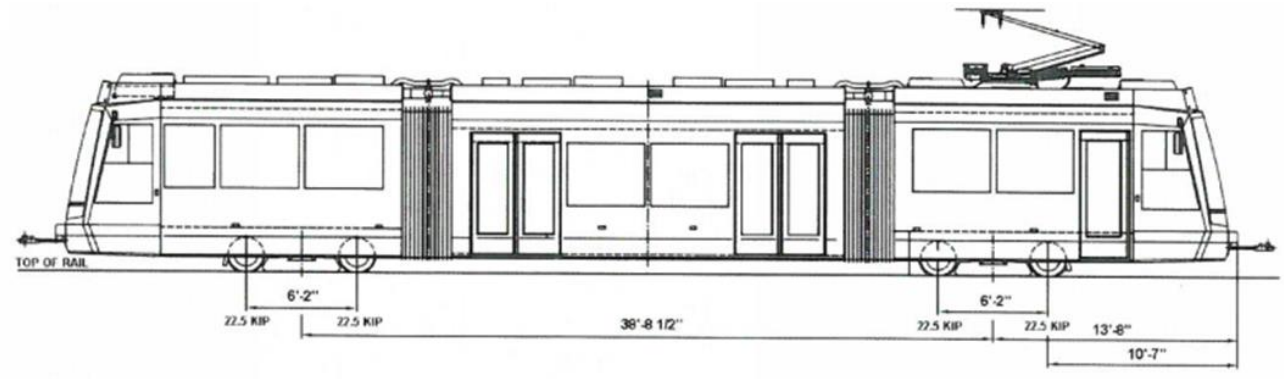
- Use a minimum unit weight of 150 pounds per cubic foot for reinforced concrete
- Use a minimum unit weight of 490 pounds per cubic foot for steel
- Provide a minimum future wearing surface load of 25 pounds per square foot
- Provide a minimum future utilities load of 100 pounds per linear foot per bay, except for movable spans

The following Live Loads will be assumed for general assessment of structure depths for alternative layouts:

- HL-93 design truck or design tandem, and design lane load – for Service I and Strength I Limit States
- ODOT OR-STP-5BW permit truck – Strength II Limit State
- ODOT OR-STP-4E permit truck – Strength II Limit State

Portland Streetcar load configuration as taken from the Sellwood Bridge project information (4 – 22.5K axles spaced as shown in Figure 6):

Figure 6. Portland Streetcar Axle Loads and Spacing



Following a seismic event, it is expected that the Burnside Bridge will be used by heavy emergency vehicles. The EV2 and EV3 trucks may exceed the load effects typically addressed by load rating provisions. A comparative analysis was performed for selected span ranges of the existing bridge spans and for proposed replacement bridge spans to evaluate the load effects of the following live loads:

- HL-93
- OR-STP-5BW
- OR-STP-4E
- OR-STP-4D
- SU7
- EV2
- EV3
- Portland Streetcar

For the selected span ranges, results were evaluated for maximum positive moment, maximum negative moment (for multiple span ranges), maximum shear, and maximum reactions (for multiple span ranges). The results are provide in Appendix A.

The following Sidewalk Loading will be assumed for assessment of alternative layouts:

- Seventy-five pounds per square foot pedestrian load considered simultaneously with vehicular load in adjacent lane.
- HS-20 design truck (no lane load) with wheel line placed 2 feet from the face of rail. Do not consider pedestrian load or adjacent lane vehicle loads at same time. Do apply the multi-presence factor (m = 1.2). Strength I Limit State only.

3.5 Navigation Clearances and Opening

A detailed preliminary navigation study was performed by Glosten to determine the navigational requirements for the Project, both temporary and permanent, for the main span navigation channel. The findings of the study are that the Project shall provide:

Permanent Replacement Bridge:

- Channel navigation clearances will be designed to a minimum 205-foot wide by 167-foot high (above NAVD 88) for the fixed replacement structure or open moveable replacement structure.
- Channel navigation clearances will be designed to a minimum 205-foot wide by 69-foot high (above NAVD 88) for the closed movable replacement structure.

Retrofit Existing Bridge:

- Maintain existing horizontal and vertical clearances.

Temporary Bridge:

- Provide a minimum 165-foot wide by 167-foot high (above NAVD 88) clearance.

The reduced width for a temporary bridge will require tug assistance for some river users. If a temporary bridge is not used then a temporary horizontal clearance may be approved by the U.S. Coast Guard but also expected to require tug assistance for some river users.

3.6 Landside Overcrossing Vertical Clearances

3.6.1 Highway Clearances

I-5 and associated ramps pass under existing Spans 20 to 22. The interstate and ramps are all bridges that were built after the Burnside Bridge with foundations on either side of the existing 86-foot Burnside Bridge width at this location. The structures are within inches of the existing bridge bents including the I-5 southbound bridge and its on-ramp from I-84 to both sides of Bent 21, the I-5 northbound bridge to the west side of Bent 22, and the I-5 northbound off-ramp to I-84 to the west side of Bent 23.

17-foot, 4-inch minimum vertical clearance is the current ODOT criteria for “high routes.” ODOT is evaluating future improvements to the I-5/I-84 interchange and ramps, and has requested that the Project consider an 18-foot, 0-inch vertical clearance over the I-5 northbound and southbound lanes and associated ramps.

3.6.2 City Street and Sidewalk Clearances

Naito Parkway passes under the existing west approach in Spans 14 and 15, and the Tom McCall Waterfront Park trail passes under Span 19. Tom McCall Waterfront Park, which houses many community events, extends under the west approach Spans 17 through 19. Second Avenue passes under the east approach in Span 26, and 3rd Avenue passes under Span 33.

An 18-foot minimum vertical clearance over City streets has been requested by the City of Portland. 18-foot clearance will be provided for new construction where practical. If other criteria conflicts with attaining this clearance, then a reduction of one foot will be evaluated to mitigate the conflict. A maximum reduction of two feet may be considered if significant justification can be provided.

NE 3rd Avenue is the exception, whereas every attempt will made to improve the vertical clearance, the existing 13.7-foot vertical clearance minimum will be maintained.

A 12-foot minimum vertical clearance over sidewalks and other pedestrian facilities will be provided for new construction.

3.6.3 Union Pacific Railroad Clearances

UPRR main lines and a railroad spur line pass under existing Spans 23 and 24. The main lines pass to the west side of Bent 24, while the railroad spur line, which does not appear to be in use any longer, passes to the east side Bent 24.

A 23-foot, 6-inch minimum vertical clearance over the UPRR mainline and siding tracks will be provided for new construction.

3.6.4 TriMet Max Clearances

The Project will maintain the 15-foot, 6-inch minimum vertical clearance over the existing TriMet Max tracks at NW 1st Avenue. At new TriMet Max track crossings, however, an 18-foot minimum vertical clearance will be provided for new construction.

3.6.5 Portland Streetcar Clearances

A 19-foot minimum vertical clearance over the Portland Streetcar tracks will be provided for new construction.

3.7 Landside Horizontal Clearances

A 2-foot offset from existing buildings will be provided for new construction where sidewalk access to buildings is not required. Where existing building access from the sidewalk is maintained, there may be variation from this criteria as needed to provide building access.

For the retrofit alternative, existing conditions and clearances between the existing approach spans and adjacent buildings will remain.

Proposed bent locations in proximity of the I-5 and I-84 structures need to be coordinated with ODOT's future plans in this area.

For more detailed information on property impacts refer to the *EQRB Right-of-Way Technical Report* (Multnomah County 2021).

3.8 Seismic Design Criteria

Seismic criteria will be identified within the *EQRB Seismic Design Criteria Report* (Multnomah County 2021).

3.9 Substructure & Foundation Design

The following parameters shall apply to the design of substructure and foundations:

- Liquefaction, liquefaction-induced settlement, and liquefaction-induced lateral spreading will be investigated.

For more detailed information on ground conditions and parameters refer to the *EQRB Geotechnical Report* (Multnomah County 2021).

3.10 Utilities

Reasonable attempts will be made to avoid significant utility infrastructure with proposed bridge layouts where practical. The large diameter CSO pipes will be avoided. Smaller utilities that are near the surface will be avoided if practical, but some utility relocations will be required. The utilities found underground and on the Burnside Bridge structure are generally described below. For more detailed information on utilities refer to the *EQRB Utilities Technical Report* (Multnomah County 2021).

3.10.1 West Side

The west side utilities include multiple pipes under the streets and in the areas between the streets. The underground pipes accommodate telecommunication, natural gas, electricity, water, sewer, and foul air in structures constructed from clay, ductile iron, PVC, and conduit. Typical pipe sizes range from one to 60 inches in diameter for the City of Portland sewer system. Of particular note, the 168-inch City of Portland CSO pipes located between Bents 17 and 18. The west approach bridge structure carries various conduits and utilities for the TriMet MAX line including the train overhead catenary lines attached to Bent 3.

3.10.2 Bascule Spans

A 6-inch submarine communication conduit crosses the Willamette River between Piers 2 and 3 of the Burnside Bridge. The lines spread into multiple 3-inch and 4-inch conduits on the east and west approach structures.

3.10.3 East Approach

East side underground structures accommodate the similar utilities that are present on the west side, in pipes made of the same types of materials. Of note is a 264-inch City of Portland CSO pipe passing between Bents 28 to 30, a 28-inch City of Portland brick sewer pipe, and a 30-inch City of Portland brick sewer pipe. Conduits are attached to the bridge structure at various locations for electrical, streetlights, and fiber optic. There are also three communication vaults and an electrical transformer on the east approach structure.

3.11 Adjacent Facilities

3.11.1 Water Facility at Pier 1

The Ankeny Pump Station, owned and operated by the City of Portland's Bureau of Environmental Services (BES), is located along the seawall immediately south of the Burnside Bridge. This wastewater and stormwater station serves downtown and southwest Portland. Originally constructed in 1929, the building is listed on the historic register as a significant structure. Improvements or alterations to the building and surrounding site architecture are severely restricted and subject to stringent land use and zoning review.

When initially constructed in 1929, there was an electrical building immediately adjacent to the south side of Pier 1. This building has since been removed, with the motor control centers relocated inside the Pump Station. In its place, there are several above-grade transformers and switch gear. Electrical power to the Pump Station is routed through underground ducts from a PGE vault located between Bent 18 and Bent 19. Design drawings from the electrical remodel show the power supply ducts running west to east over the top of the below-grade pile cap for Bent 19.

On the north side of the bridge, within Tom McCall Waterfront Park adjacent to Bent 19, BES has two below-grade odor-control vaults. The 19-foot-by-19-foot vault contains mechanical equipment and the 25-foot by 26-foot vault contains media for air treatment. Foul air from the Ankeny wet well and Ankeny shaft is piped to the vaults in a 24-inch underground duct that is between Bent 19 and the seawall.

The seawall is recessed into Tom McCall Waterfront Park on the west side of Pier 1. Two sewer force mains running north from the Ankeny Pump Station (one 30-inch and one 42-inch) are attached to the exposed side of the seawall adjacent to Pier 1. The force mains are stacked above each other and follow the seawall recess, turning on the north side of Pier 1, and then following the seawall to the north before crossing under the river to the east.

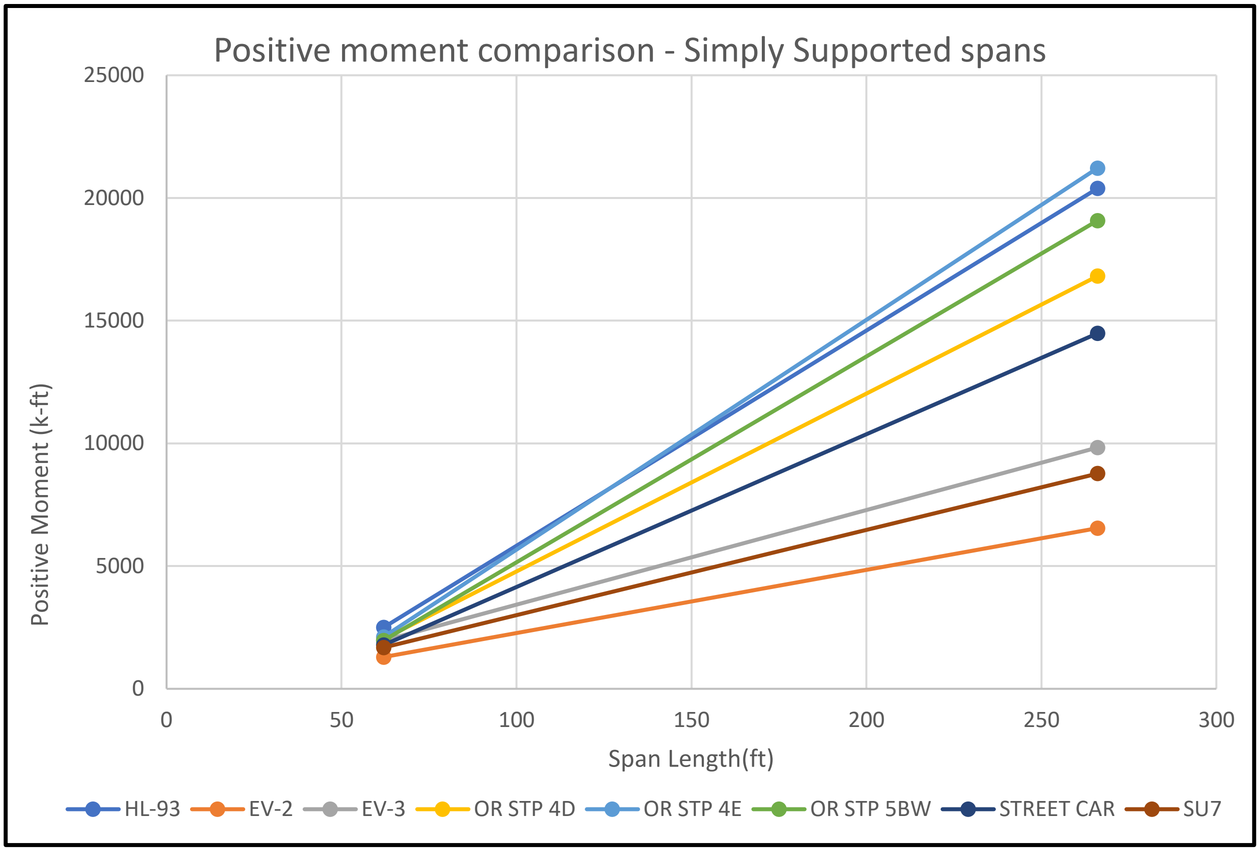
3.11.2 Eastbank Esplanade

A multi-use bicycle / pedestrian access facility connecting the Burnside Bridge to the Eastbank Esplanade is anticipated as part of the EQRB Project. The new connection shall be in compliance with ADA criteria and designed in accordance with the AASHTO Guide Spec and AASHTO *LRFD Guide Specifications for Design of Pedestrian Bridges*. The connecting structure shall be designed to a “Life Safety” performance criteria for the 1000-year earthquake event. Seismically induced liquefaction and lateral spread effects will not be considered as part of the access bridge design, and ground improvements to mitigate those effects will not be provided.

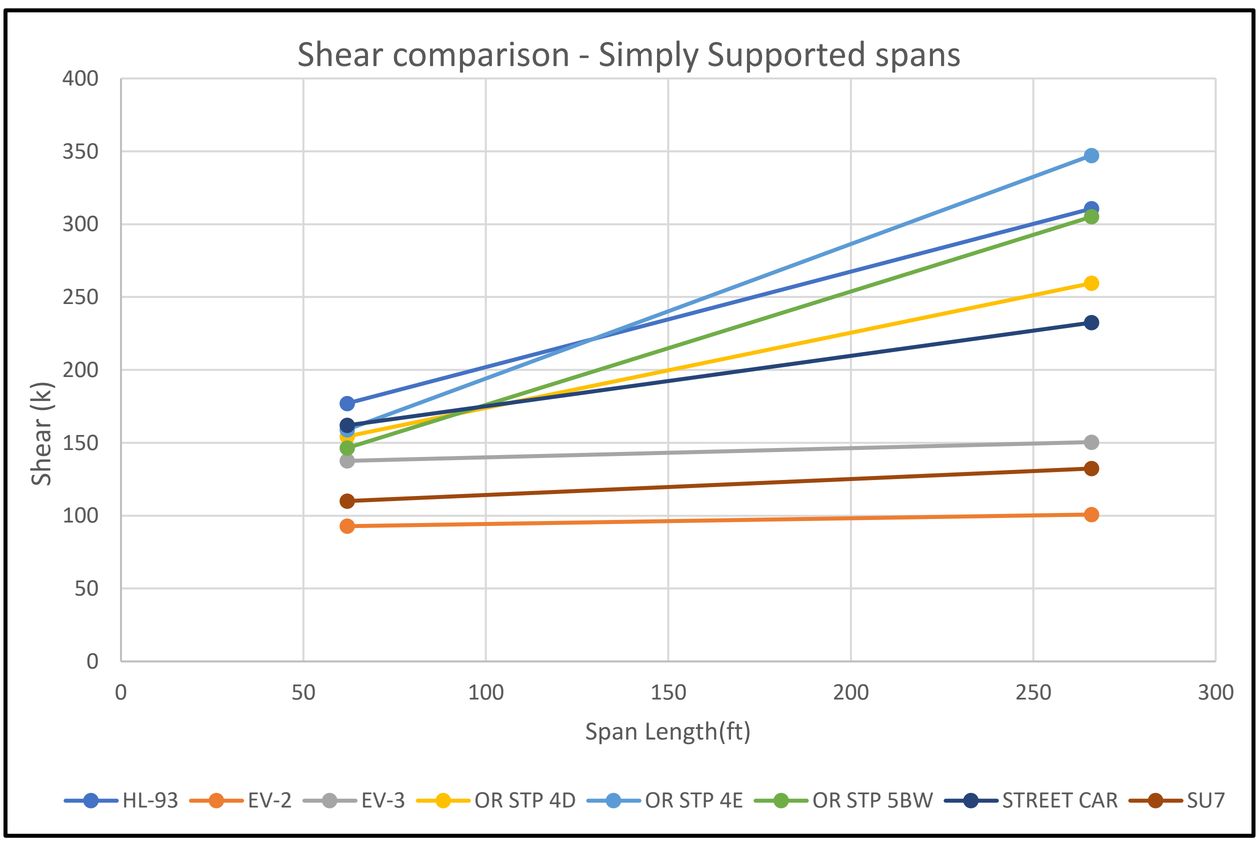
3.12 Temporary Detour Bridges

A temporary detour bridge may be utilized during the construction phase of the EQRB Project. Except for seismic demands, temporary detour bridges shall be designed in accordance with the ODOT BDM Section 1.17.2.1, AASHTO Guide Spec, and AASHTO LRFD. The anticipated service duration of the detour bridge is anticipated to be approximately four and a half years. The temporary detour bridge shall not be designed to resist seismic demands.

Appendix A. Live Load Comparison



Positive moment comparison - Simply Supported spans
Positive Moment (k-ft)
25000
20000
15000
10000
5000
0
0
50
100
150
200
250
300
Span Length(ft)
HL-93
EV-2
EV-3
OR STP 4D
OR STP 4E
OR STP 5BW
STREET CAR
SU7



Shear comparison - Simply Supported spans
Shear (k)
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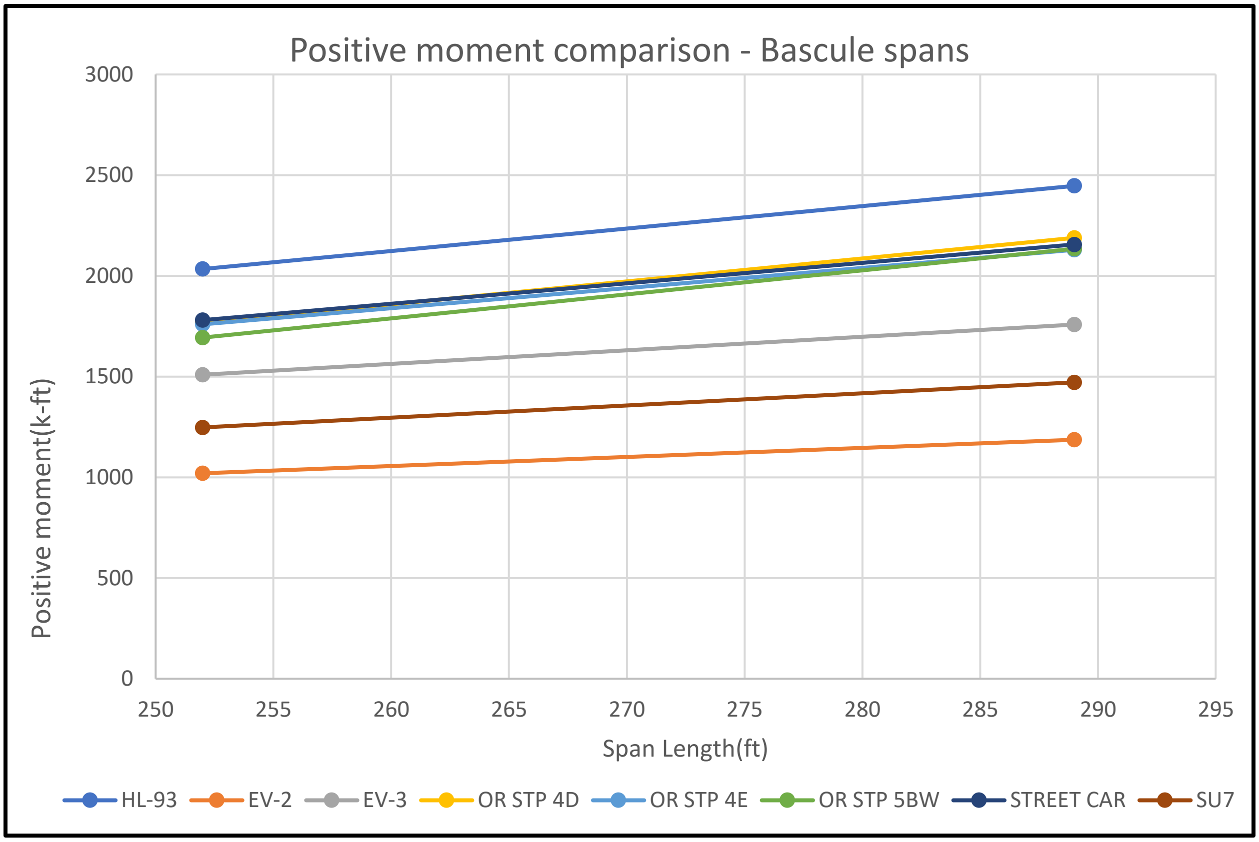
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
Span Length(ft)
HL-93
EV-2
EV-3
OR STP 4D
OR STP 4E
OR STP 5BW
STREET CAR
SU7


Positive moment comparison - Bascule spans
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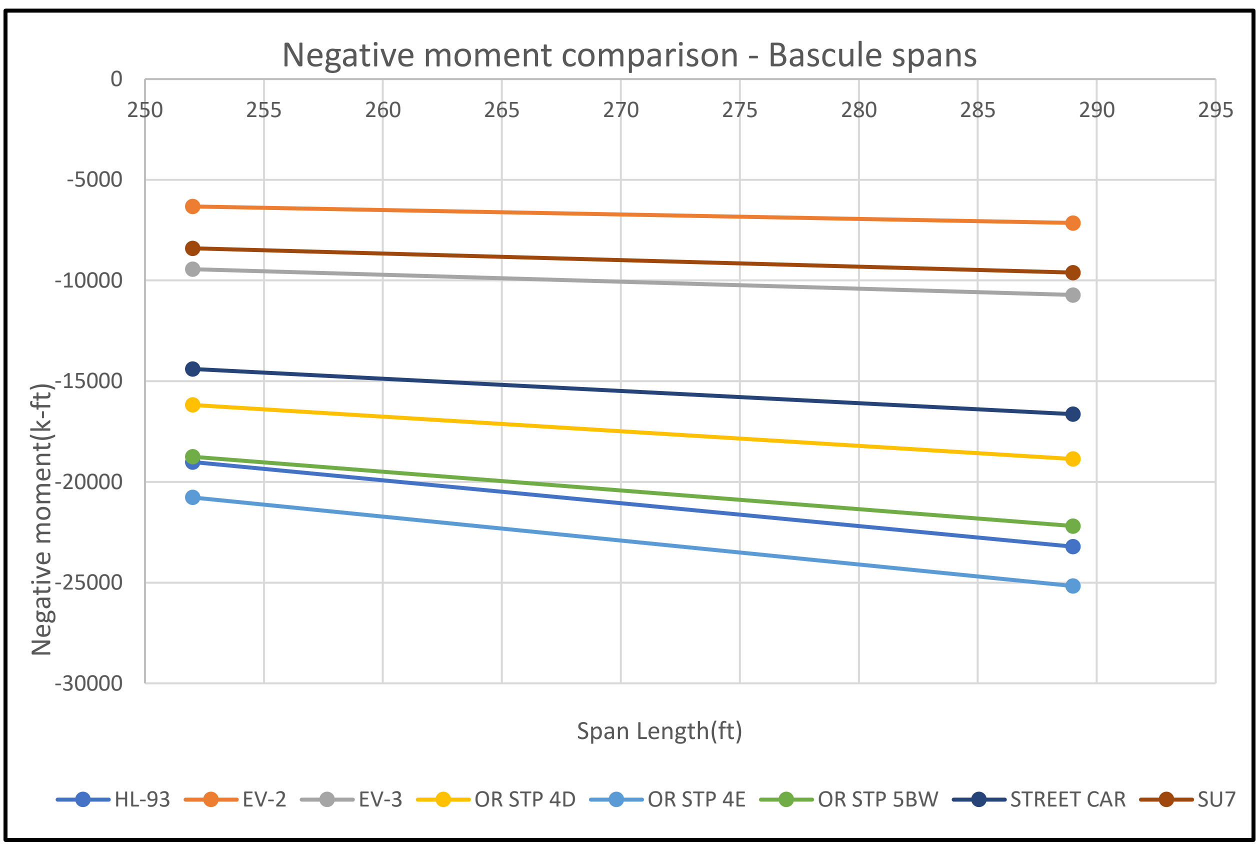
2500
2000
1500
1000
500
0
Positive moment(k-ft)
250
255
260
265
270
275
280
285
290
295
Span Length(ft)
HL-93
EV-2
EV-3
OR STP 4D
OR STP 4E
OR STP 5BW
STREET CAR
SU7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-25000
-30000
Negative moment(k-ft)
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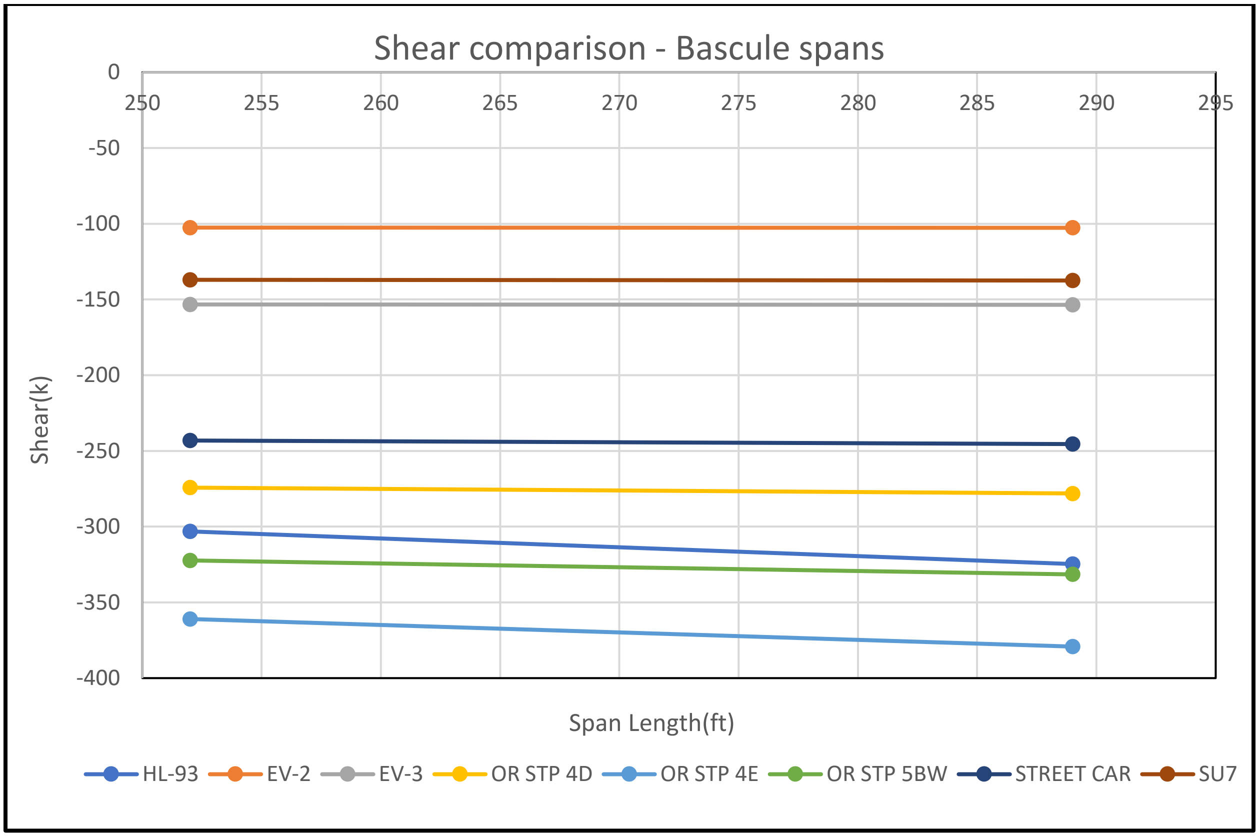
255
260
265
270
275
280
285
290
295
Span Length(ft)
HL-93
EV-2
EV-3
OR STP 4D
OR STP 4E
OR STP 5BW
STREET CAR
SU7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275
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Span Length(ft)
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EV-2
EV-3
OR STP 4D
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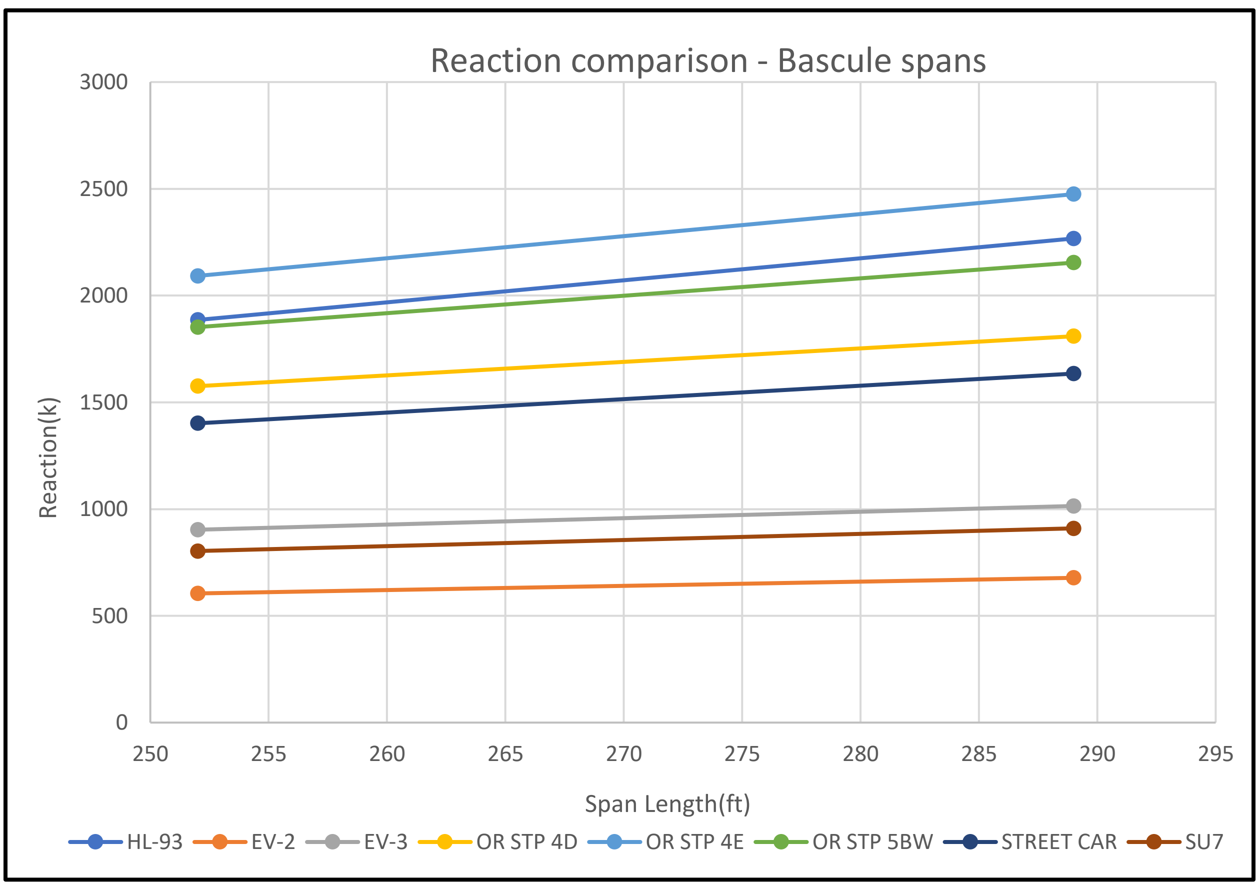
STREET CAR
SU7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STREET CAR
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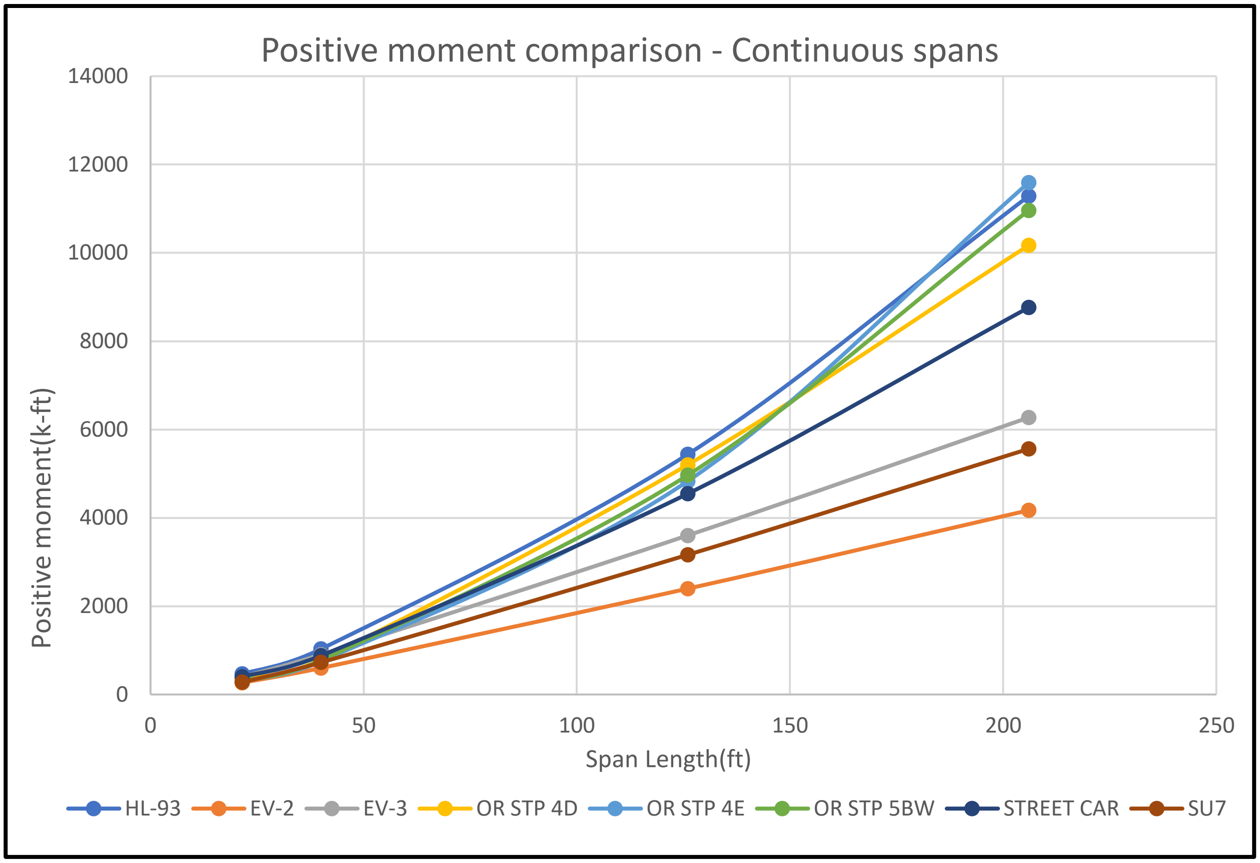
Positive moment comparison - Continuous spans
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Positive moment(k-ft)
Span Length(ft)
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EV-2
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OR STP 4D
OR STP 4E
OR STP 5BW
STREET CAR
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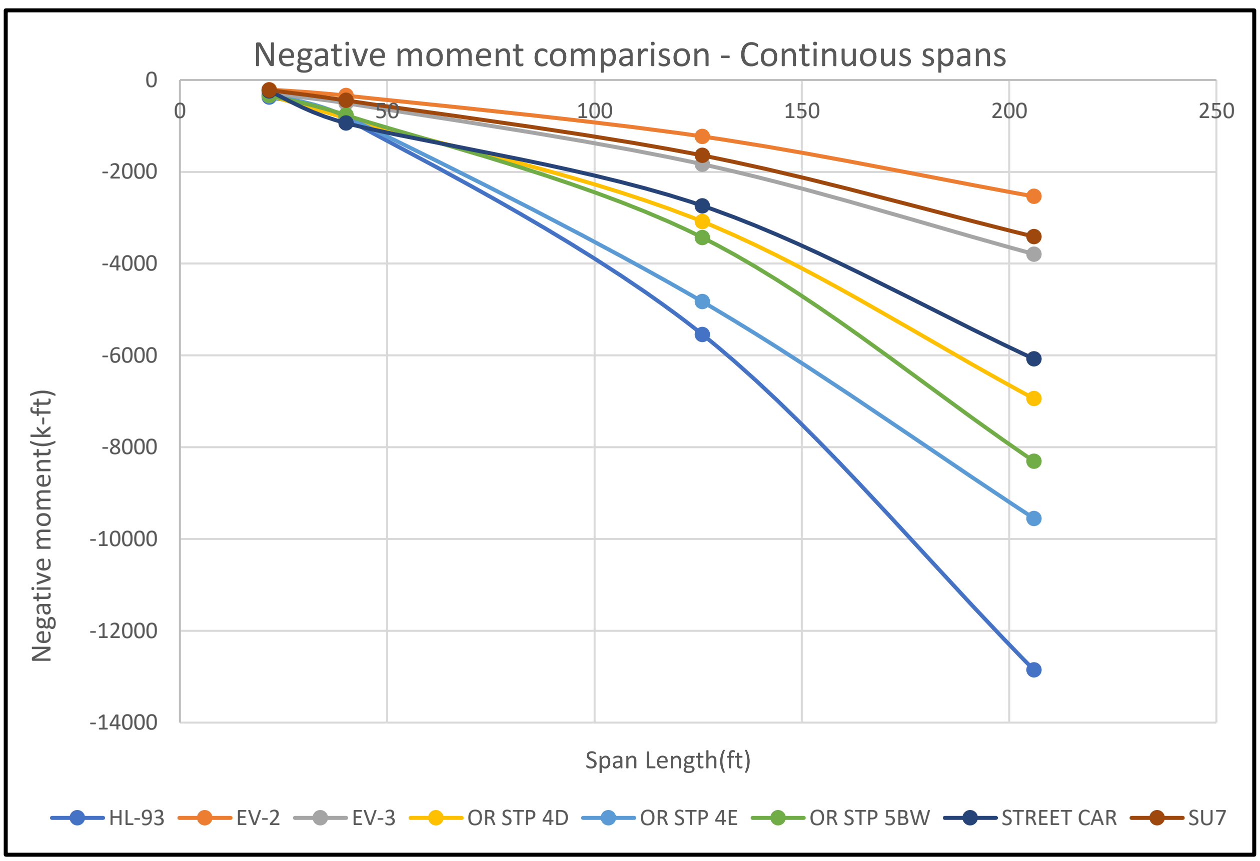
Negative moment comparison - Continuous spans
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Negative moment(k-ft)
Span Length(ft)
HL-93
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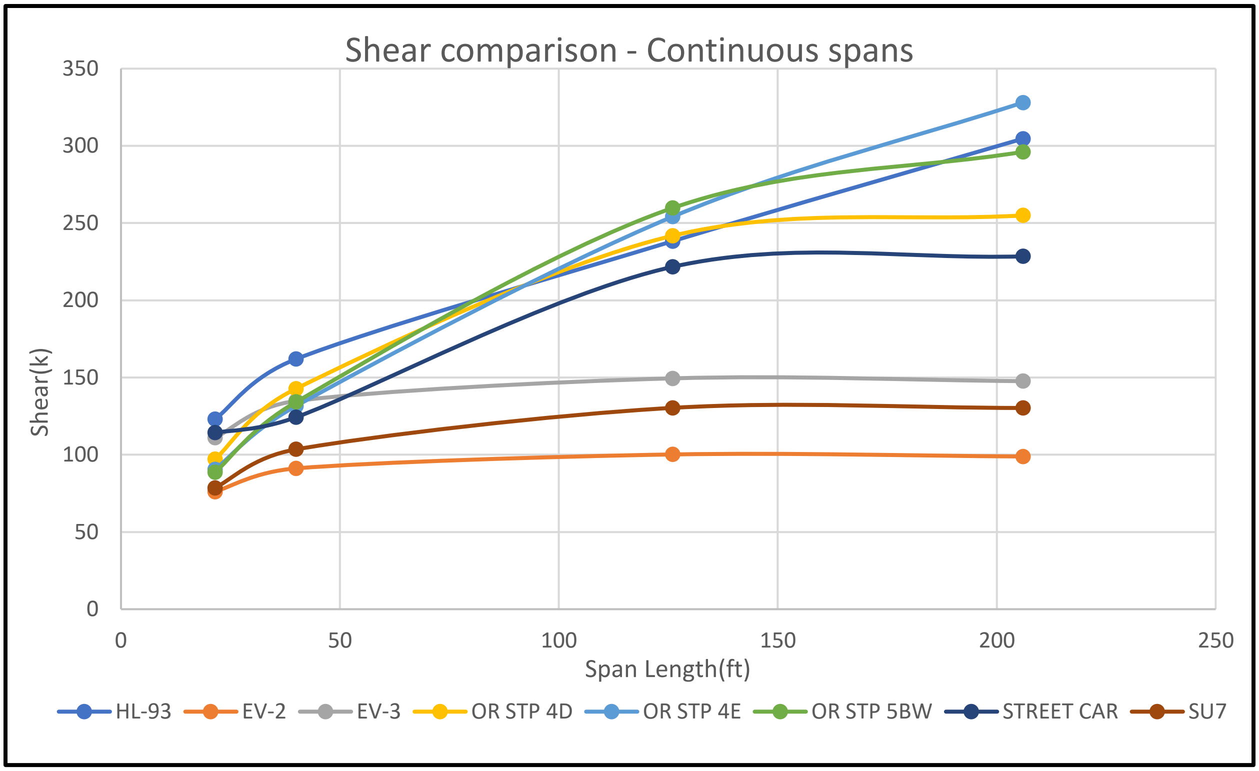
Shear comparison - Continuous spans
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Span Length(ft)
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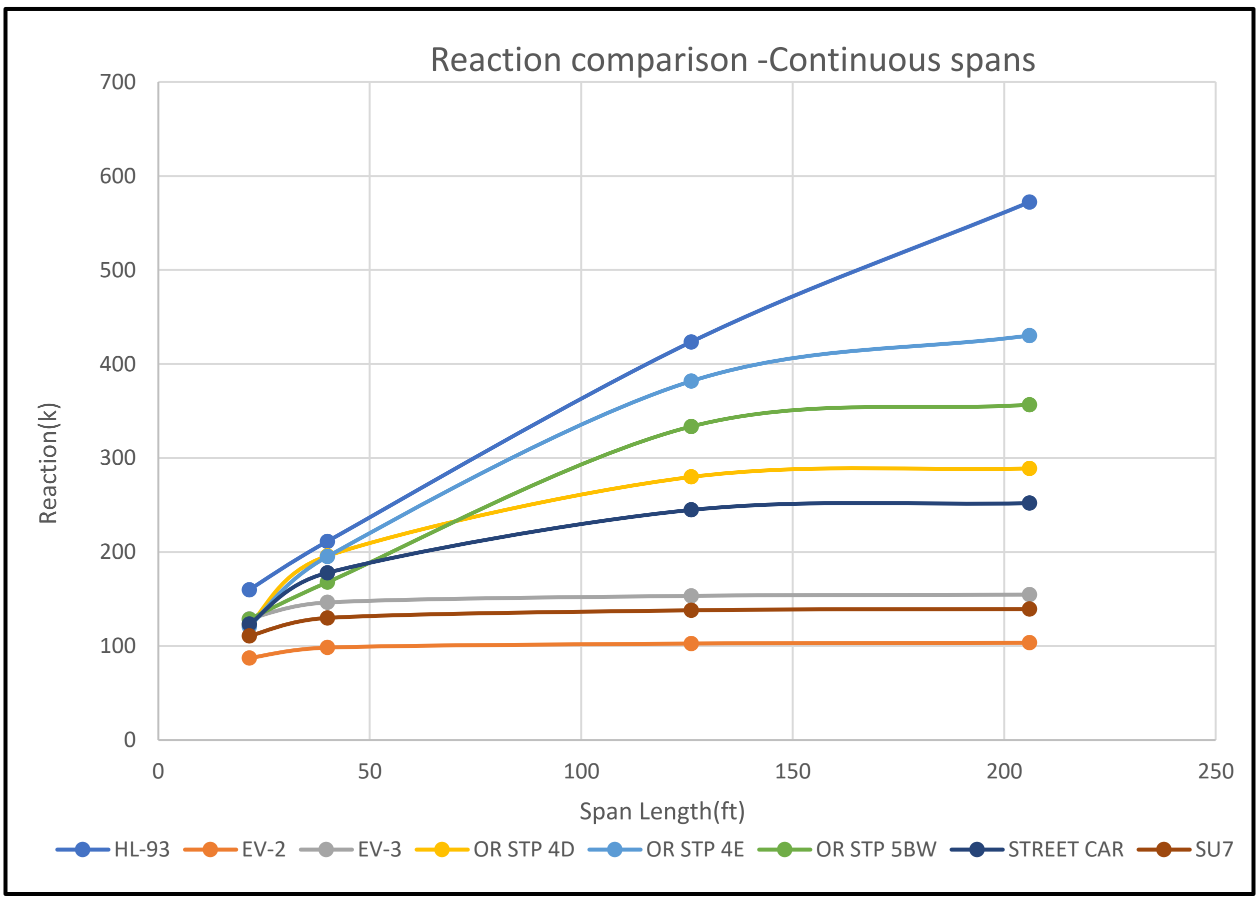
Reaction comparison -Continuous spans
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Span Length(ft)
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