EARTHQUAKE READY BURNSIDE BRIDGE

Multnomah County is creating an earthquake-ready downtown river crossing.

BETTER – SAFER – CONNECTED

October 28, 2020

Urban Design and Aesthetics Working Group (UDAWG) – Meeting #3 Agenda

Project:	Earthquake Ready Burnside Bridge (EQRB)
Subject:	Urban Design and Aesthetics Working Group
Date:	Wednesday, October 14, 2020
Time:	1:00 PM – 5:00 PM
Location:	WebEx (see email for link)

WORKING GROUP MEMBERS

Randy Gragg, Executive Director, Portland Parks Foundation
Bill Will, Public Works Artist
Paddy Tillett, ZGF
Chris Herring, Artistic Director, Portland Winter Lights Festival
Megan Crosby, Urban Development + Partners
Ian Williams, Deadstock Coffee
Priscilla Macy, Oregon Outdoor Coalition
Izzy Armenta, Oregon Walks
Dave Todd, Portland Rose Festival
Brian Kimura, Japanese American Museum of Oregon

AGENCY GROUP MEMBERS

Patrick Sweeney, PBOT
Teresa Boyle, PBOT
Lora Lillard, BPS
Hillary Adam, BDS
Tate White, PPR
Justin Douglas, Prosper Portland
Bob Hastings, TriMet
Magnus Bernhardt, ODOT

PROJECT TEAM MEMBERS

Megan Neill, Multnomah County
Mike Pullen, Multnomah County
Heather Catron, HDR
Steve Drahota, HDR
Cassie Davis, HDR
Michael Fitzpatrick, HDR
Katy Segura, HDR
Jeff Heilman, Parametrix
Allison Brown, JLA
Carol Mayer-Reed, Mayer/Reed
Jeramie Shane, Mayer/Reed
Josh Carlson, Mayer/Reed
Anne Monnier, KPFF

Multnomah County

Purpose:

The purpose of the UDAWG is to serve as a technical resource body to the CTF for urban design and aesthetics by:

- *Providing informed insights and opinions on the visual features for each type selection option*
- *Recommending measures to enhance aesthetic opportunities or mitigate potential visual impacts*
- *Representing urban design and aesthetic interests*
- *Reflecting the character of Portland by suggesting place-making opportunities*

Outcomes:

The outcomes for the UDAWG group are to:

- *Inform a set of feasible bridge type options for the CTF's consideration*
- *Inform a project-specific Visual Performance Standard for use during the Type Selection and Final Design phases*
- *Recommend visual and aesthetic evaluation criteria for consideration by the CTF*

Agenda:

Time	Session	Lead
12:45 p.m.	**Early Arrivals** • WebEx meeting platform will be available for folks that want to join early and test computer functions before meeting start	Katy Segura
1:00 p.m. (20 min)	**Welcome, Intros, Pre-Meeting Info, and General Comments** • Introductions • Pre-mtg information • Purpose and Outcomes • Meeting Objectives • Project Update • General Comments	Allison Brown
1:20 p.m. (60 min)	**Key Distillations from Mtgs 1 and 2** • Acceptance of UDAWG's Recommended Key Themes: o Portland Values o Characteristics of Portland o Physical Connectivity o Visual and Experiential Connectivity o Relationship to River o Bridge Site & Location	Allison Brown / Carol Mayer-Reed
2:20 p.m. (90 min)	**Menu of Bridge Types** • Type Selection Process • Similar Bridge Type Selection Experiences • Menu of Bridge Types o Site Context o Range of Movable Bridge Types o Range of Fixed Approach Bridge Types	Steve Drahota / Michael Fitzpatrick
3:50 p.m. (10 min)	**Break**	
4:00 p.m. (50 min)	**Burnside Bridge Aspirations and Opportunities** • CTF perspectives • Desired Bridge Experiences • Bridge Design Opportunities • Urban Design Opportunities	Allison Brown / Carol Mayer-Reed
4:50 p.m.	**Next Steps and Closing Remarks** • UDAWG Mtg#4: Menu of Bridge Type (Refinement)	Allison Brown / Steve Drahota

EARTHQUAKE READY BURNSIDE BRIDGE

Urban Design and Aesthetics Working Group Mtg #3

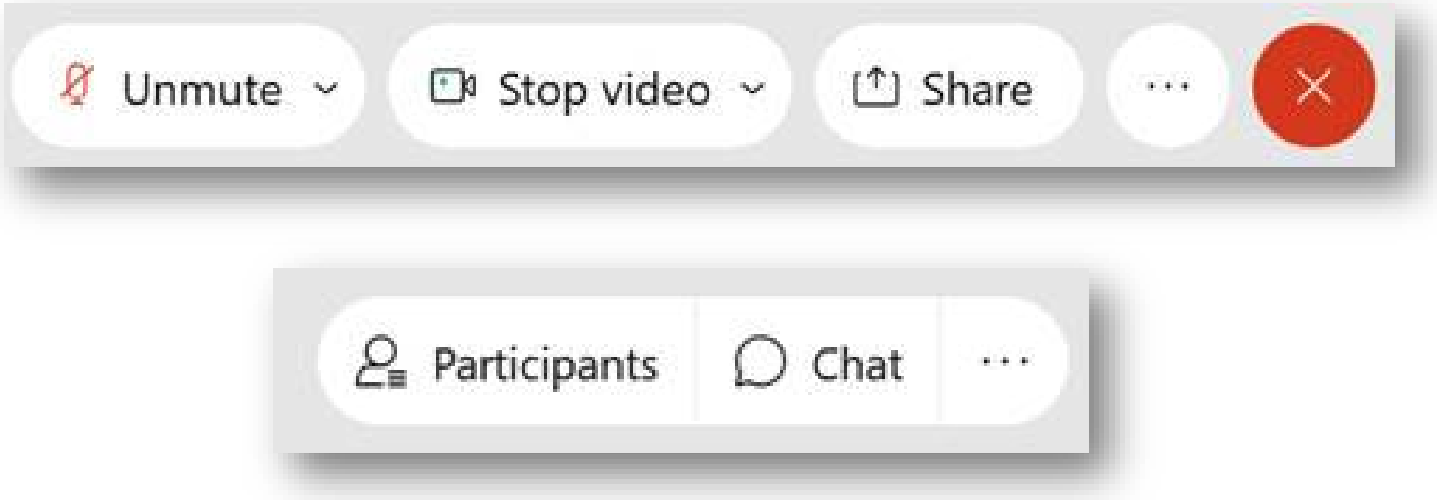
Attendees join meeting via WebEx link in calendar invite

Department of Community Services
Transportation Division

October 28, 2020

Meeting Protocols

Using WebEx participation features



For WebEx tech support call or email Katy Segura:
(503) 423-3709
Katy.Segura@hdrinc.com

Agenda

1. Welcome, Introductions, and Pre-Meeting Info
2. Key Distillations from UDAWG Mtgs #1 and #2
3. Menu of Bridge Types

- Break -

4. Burnside Bridge Aspirations & Opportunities
5. Next Steps and Closing Remarks

Pre-meeting Information Packet

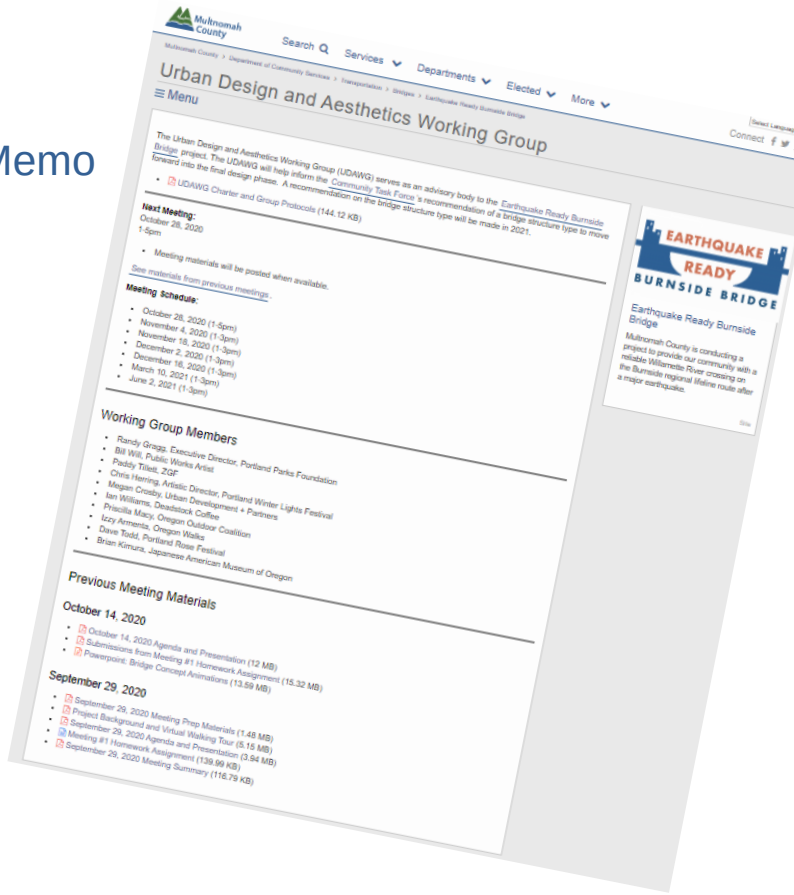
Content

Online UDAWG Library:

https://multco.us/earthquake-ready-burnside-bridge/urban-design-and-aesthetics-working-group

UDAWG Meeting #3 Materials:

- UDAWG Mtgs #1 and 2 “What we Heard” Summary Memo
- UDAWG Mtg #2 Notes
- UDAWG Mtg #3 Agenda
- UDAWG Mtg #3 Presentation



Urban Design & Aesthetics Working Group

UDAWG Purpose and Outcome

Purpose: To serve as a technical resource to the Community Task Force (CTF) for:

- Insights and opinions on the visual features
- Measures to enhance aesthetic enhancing opportunities or mitigate potential visual impacts
- Urban design and aesthetic interests
- Place-making opportunities that reflect character of Portland

Outcomes: To provide input on the following products for the CTF's consideration:

- A set of feasible bridge type options
- A project-specific Visual Design Guidelines
- Recommendations for visual and aesthetic evaluation criteria

UDAWG Meeting Objectives

General Focus

	UDAWG Meeting Number and Date								
	✓ #1 (9/30)	✓ #2 (10/14)	#3 (10/28)	#4 (11/4)	#5 (11/18)	#6 (12/2)	#7 (12/16)	#8 (3/10)	#9 (6/2)
Character of Portland and the Burnside Bridge	———	———	———						
Visual Design Principles			———	———					
Visual Design Guidelines					———	———	1 - - -		
Technical Design Criteria		———	———						
Menu of Bridge Types			———	———					
Range of Feasible Bridge Types					———	2 - - -			
Evaluation Criteria Topic(s)					———				
Evaluation Measures					———	———	3 - - -		
Input on CTF's Eval Criteria								———	
Input on CTF's Rec Bridge Type									———

We are HERE

Project Update

EARTHQUAKE READY BURNSIDE BRIDGE

Key Activities

- Community Task Force (CTF) Meetings
  - Past: Oct 26th (Interests and Values)
  - Future: Nov 9th & 23rd (Selection Criteria Topics; Menu of Bridge Types)
- Working / Focus Groups
  - Bridge and Seismic Working Group Mtg #1 (Oct 23rd)
  - Eastbank Esplanade connection options (ongoing)
- Final Design Request for Proposal (RFP)

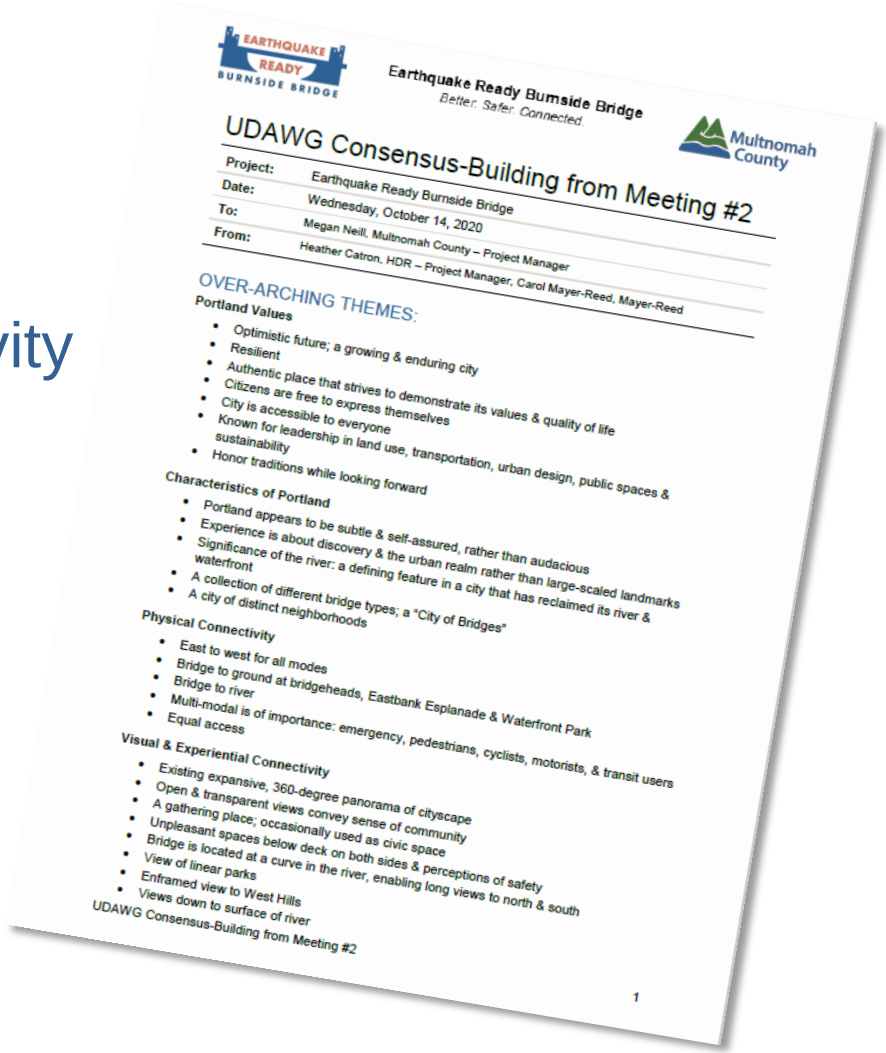
GENERAL COMMENTS

Prior Meeting Summary:
What We Heard

UDAWG Prior Meetings Summary

What we heard … Key Themes

- Portland Values
- Characteristics of Portland
- Physical Connectivity
- Visual and Experiential Connectivity
- Relationship to River
- Bridge Site & Location



Earthquake Ready Burnside Bridge
Better. Safer. Connected.

Multnomah County

UDAWG Consensus-Building from Meeting #2

Project:	Earthquake Ready Burnside Bridge
Date:	Wednesday, October 14, 2020
To:	Megan Neill, Multnomah County – Project Manager
From:	Heather Catron, HDR – Project Manager, Carol Mayer-Reed, Mayer-Reed

OVER-ARCHING THEMES:

Portland Values

- Optimistic future; a growing & enduring city
- Resilient
- Authentic place that strives to demonstrate its values & quality of life
- Citizens are free to express themselves
- City is accessible to everyone
- Known for leadership in land use, transportation, urban design, public spaces & sustainability
- Honor traditions while looking forward

Characteristics of Portland

- Portland appears to be subtle & self-assured, rather than audacious
- Experience is about discovery & the urban realm rather than large-scaled landmarks
- Significance of the river: a defining feature in a city that has reclaimed its river & waterfront
- A collection of different bridge types; a "City of Bridges"
- A city of distinct neighborhoods

Physical Connectivity

- East to west for all modes
- Bridge to ground at bridgeheads, Eastbank Esplanade & Waterfront Park
- Bridge to river
- Multi-modal is of importance: emergency, pedestrians, cyclists, motorists, & transit users
- Equal access

Visual & Experiential Connectivity

- Existing expansive, 360-degree panorama of cityscape
- Open & transparent views convey sense of community
- A gathering place; occasionally used as civic space
- Unpleasant spaces below deck on both sides & perceptions of safety
- Bridge is located at a curve in the river, enabling long views to north & south
- View of linear parks
- Enframed view to West Hills
- Views down to surface of river

UDAWG Consensus-Building from Meeting #2 1

UDAWG Prior Meetings Summary

Portland Values

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- Resilient
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- Citizens are free to express themselves
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UDAWG Prior Meetings Summary

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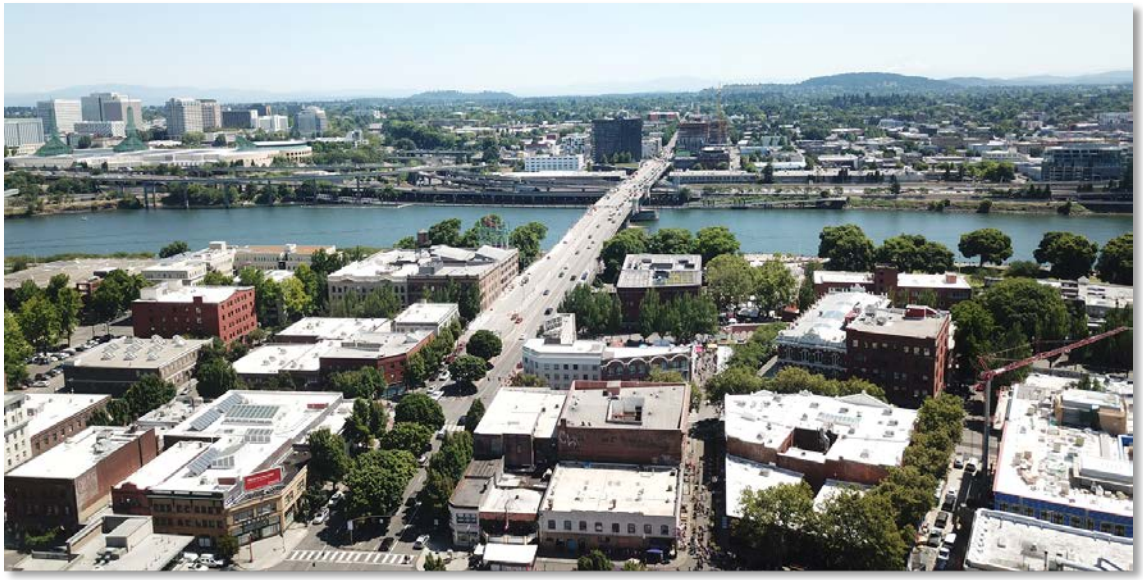

UDAWG Prior Meetings Summary

Physical Connectivity

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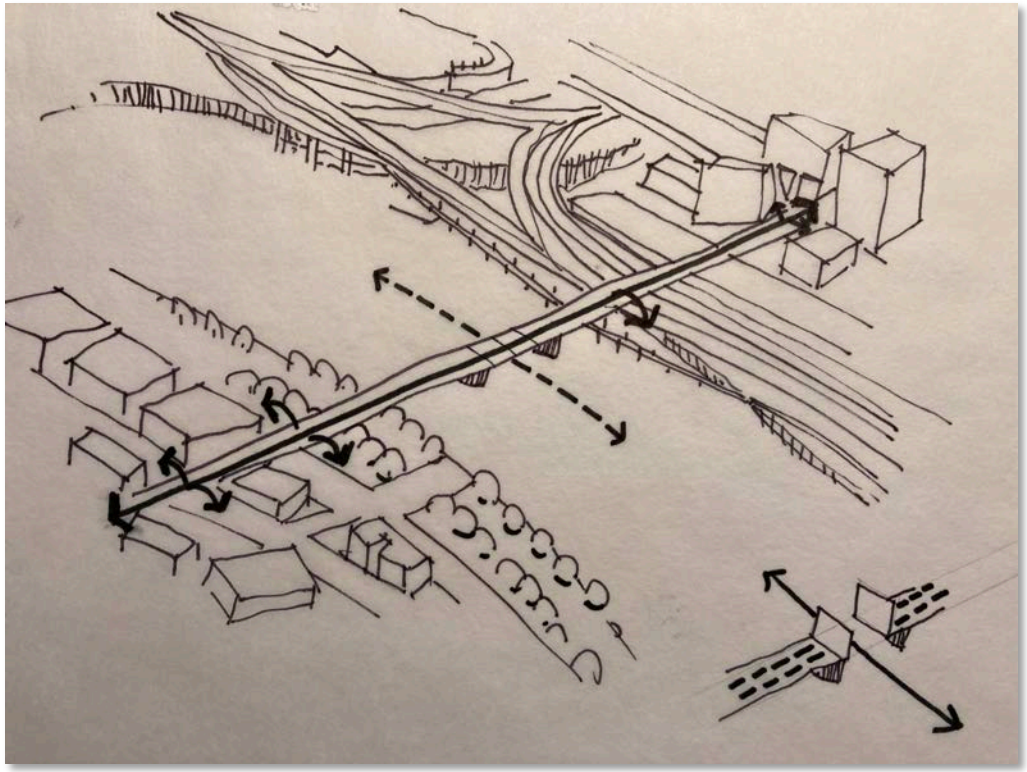
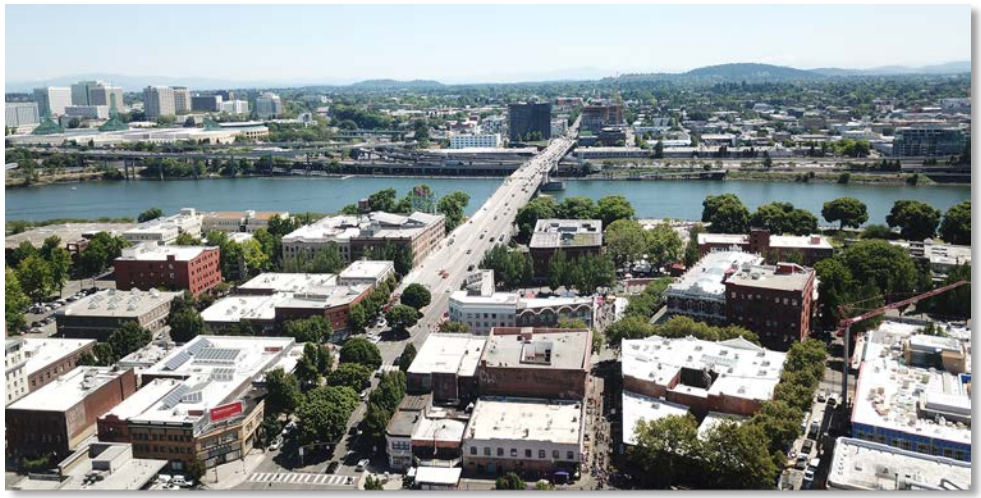


UDAWG Prior Meetings Summary

Visual and Experiential Connectivity

- Existing expansive, 360-degree panorama of cityscape
- Open & transparent views convey sense of community
- A gathering place; occasionally used as civic space
- Unpleasant spaces below deck on both sides & perceptions of safety
- Bridge is located at a curve in the river, enabling long views to north & south
- Perceptions of personal safety relative to traffic and speed of traffic
- Bridgehead architecture and park trees as enframement devices
- Series of city landmarks & bridges surrounding it
- View of linear parks and down to the river surface
- Views & sounds of freeway system
- Enframed view to West Hills



UDAWG Prior Meetings Summary

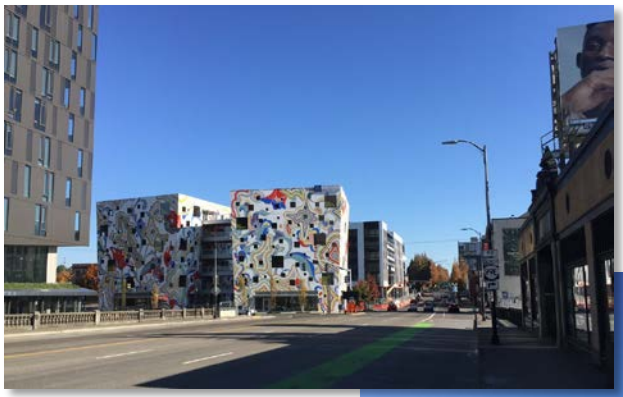
Relationship to River

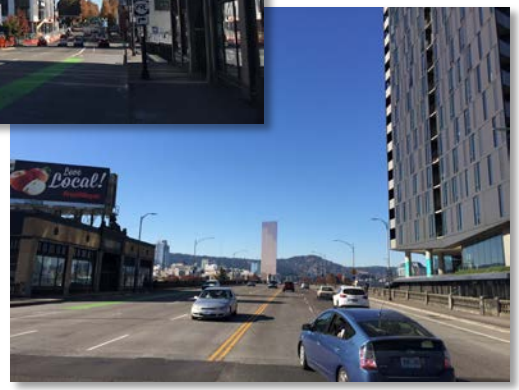
- River history; a “River City”
- History of navigation since time immemorial
- Transportation
- Commerce
- Fishing
- Recreation
- Qualities of the river conveys a mood
- Concern for river ecology, fisheries & clean water
- Upland urban development patterns based on river
- Fluid dynamics of river: bridge piers as a necessary cut-water device

UDAWG Prior Meetings Summary

Bridge Site & Location

- Episodic sequence of unfolding spaces
- Contrasts of east & west neighborhoods
- Unifying urban characteristics
- Context of city landmarks immediately surrounding it:
  - Oregon sign, US Bank Tower (Big Pink), OCC Towers, Moda Center, The Yard
- Context of City bridges as distinctive landmarks:
  - Fremont, Broadway, Steel, Morrison, Hawthorne, Marquam, Tilikum

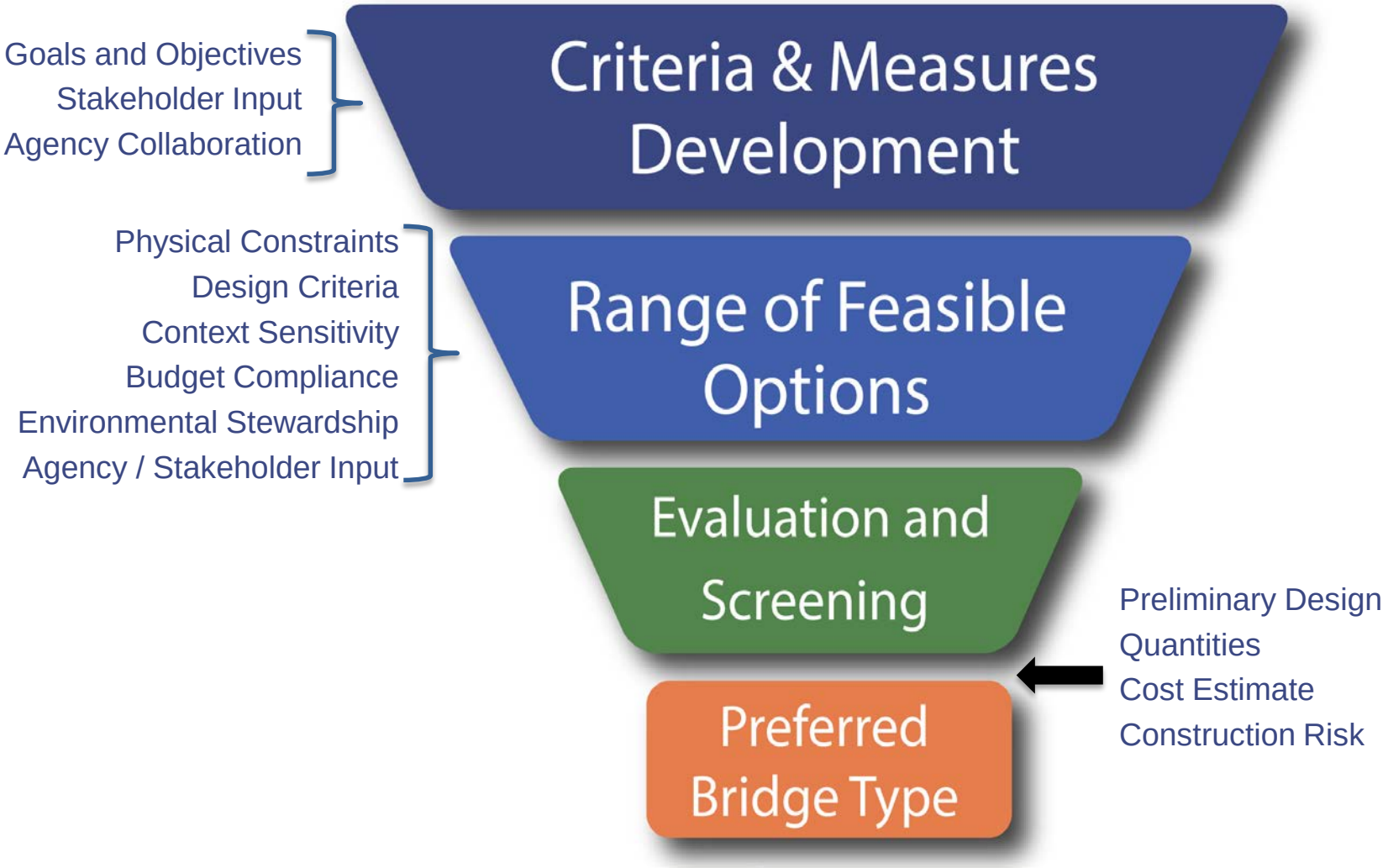




Type Selection Process

Bridge Type Selection Phase

Type Selection Process



Bridge Type Selection Phase

Information to CTF

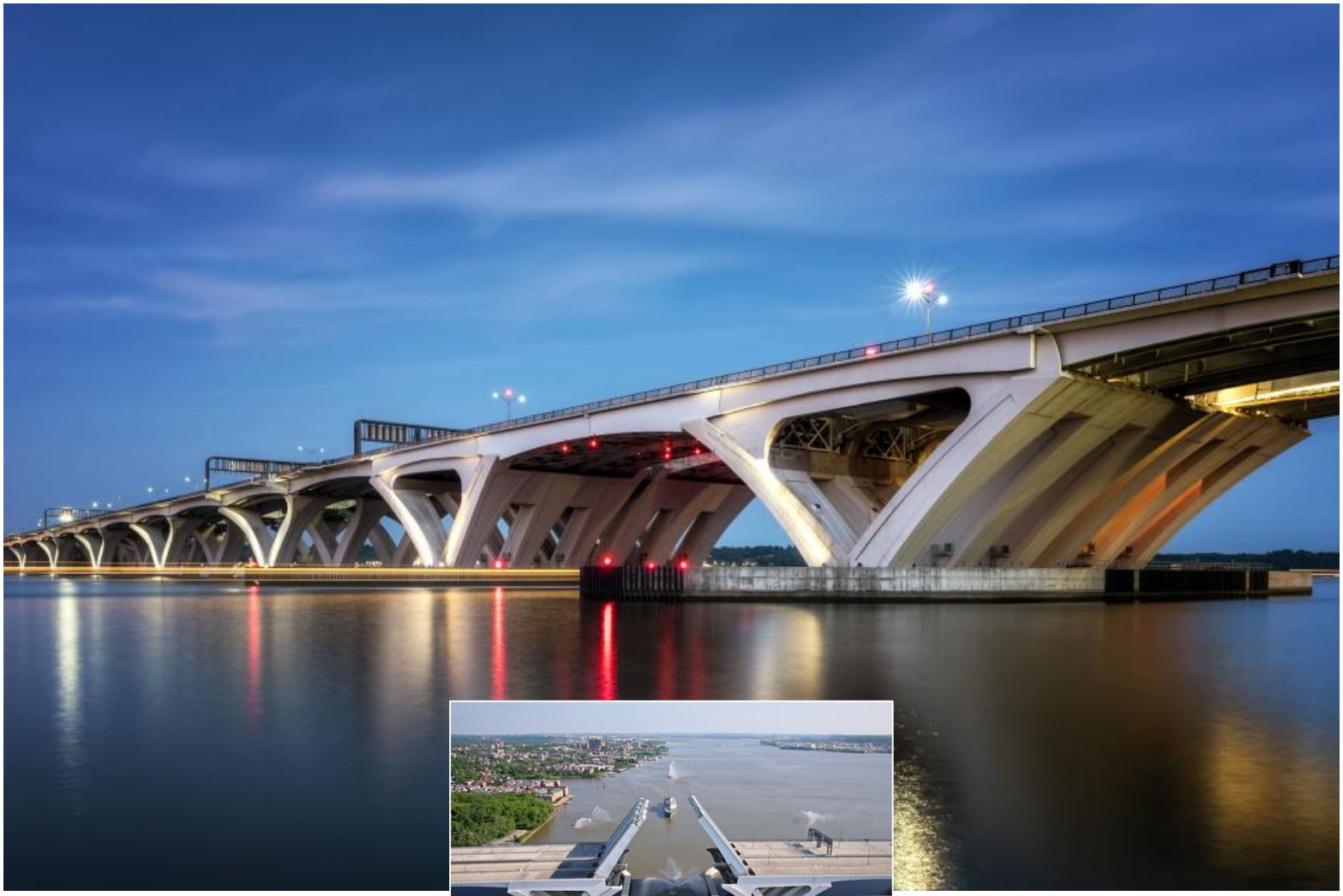
Similar Bridge Type Selection Experiences

New Johnson Street Bridge

Woodrow Wilson Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples



Jacques Chaban-Delmas Lift Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

Sarah Mildred Long Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

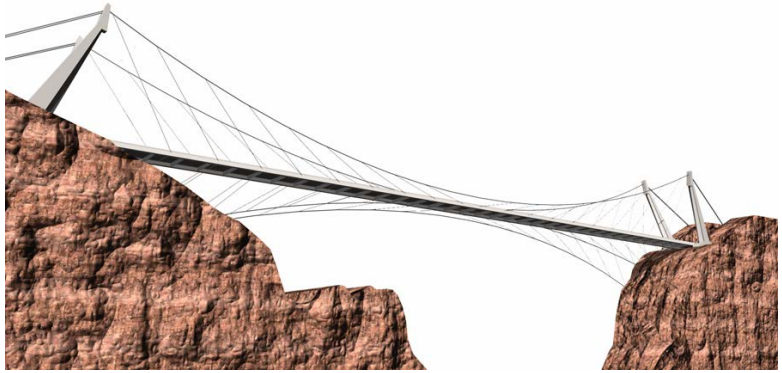
Type Study Examples

Sellwood Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

Hoover Dam Bridge



Lowry Avenue Bridge

Type Study Examples

Dagu Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

Caiyuanba Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

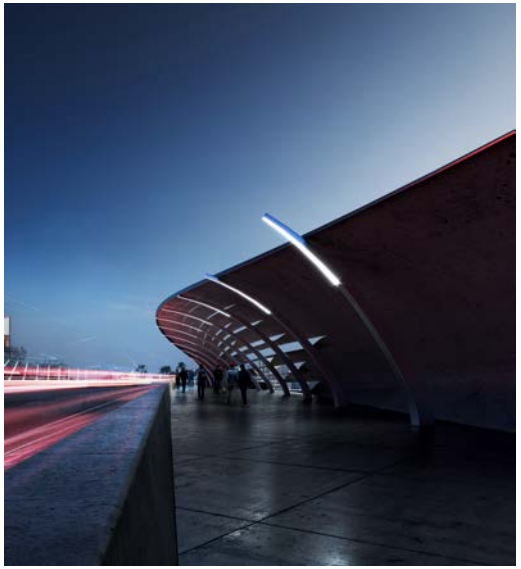
Twin River Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

Idaho Trail Bridge

Shoemaker Bridge



Highway 101 Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

Lower Don Bridge

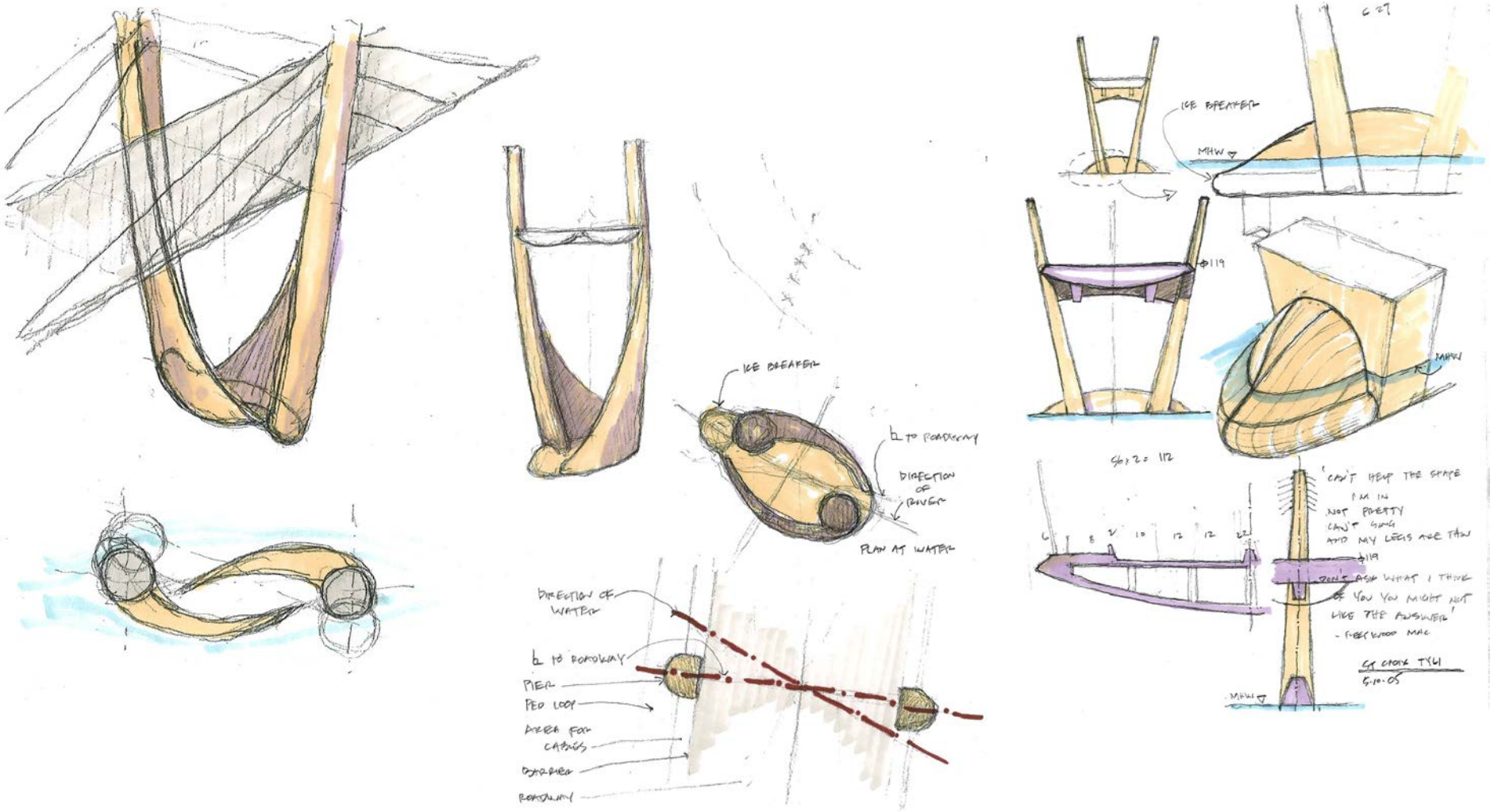
EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples

St. Croix Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

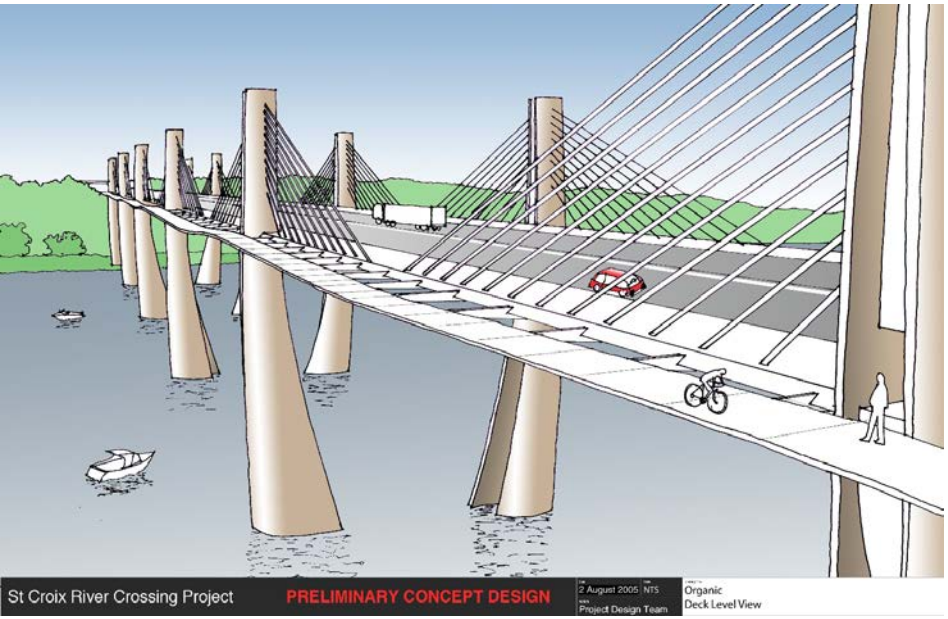
Type Study Examples - Initial Concepts

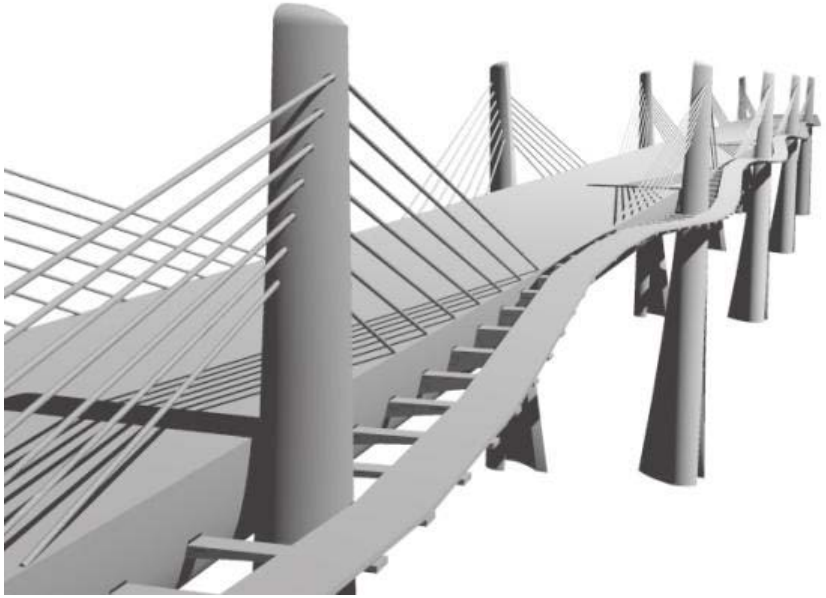


St. Croix Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

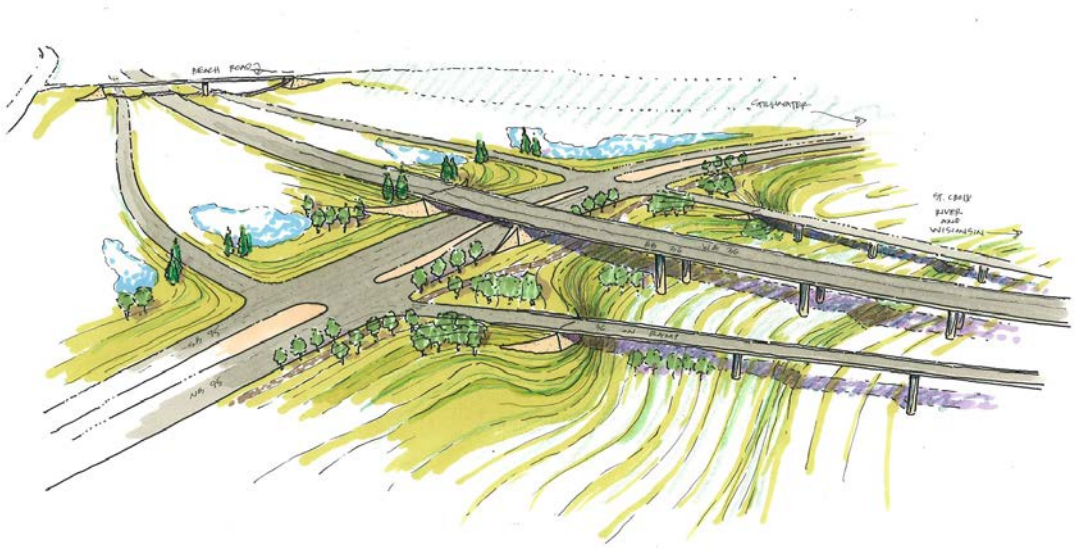
Type Study Examples - Initial Concepts





St. Croix Bridge

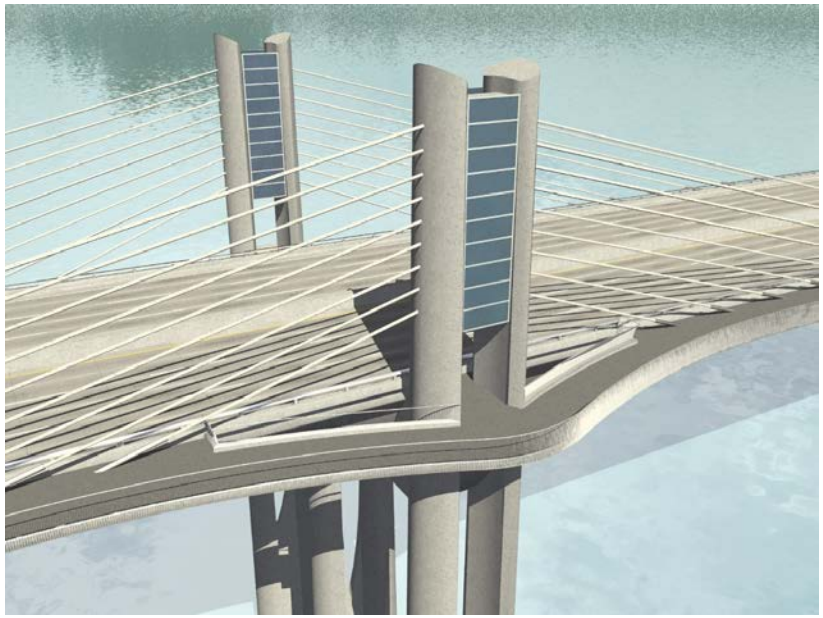
Type Study Examples - Initial Concepts

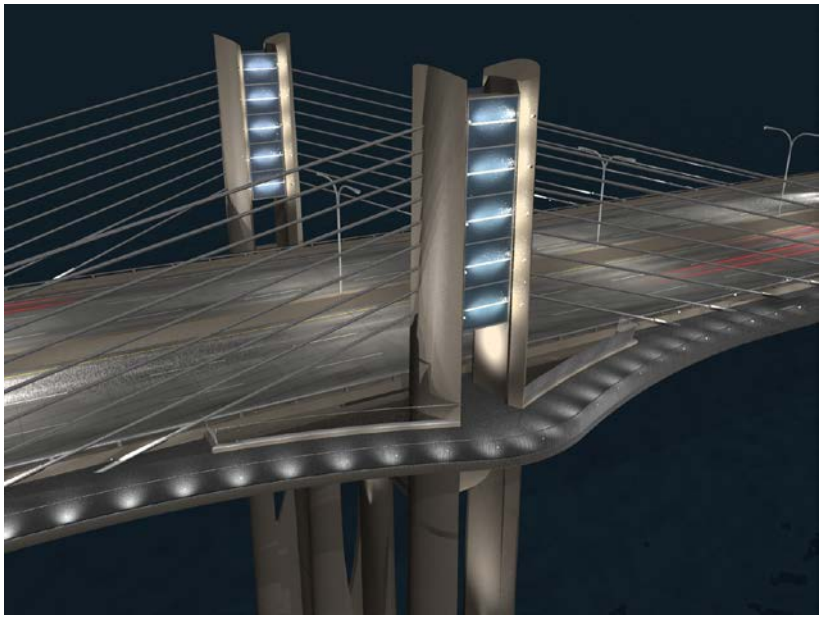


St. Croix Bridge

EARTHQUAKE READY BURNSIDE BRIDGE

Type Study Examples - Final Design





St. Croix Bridge

Type Study Examples – Final Constructed Outcome

Burnside Bridge Timeline

Type Study Examples

PRELIM. DESIGN DETAILS

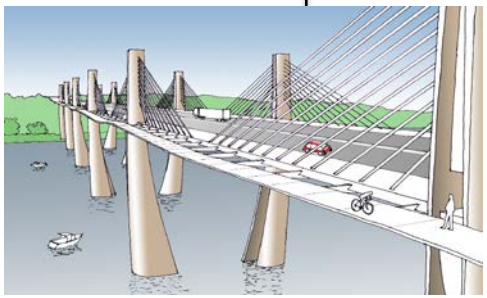
CONSTRUCTED SOLUTION

NEPA / TYPE SELECTION

CONSTRUCTION

2020	2021	2022	2023	2024	2025	2026	2027	2028

FINAL DESIGN



TYPE SELECTION CONCEPT

FINAL DESIGN DETAILS

Menu of Bridge Types

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Existing Willamette River Bridges

① Fremont Bridge

② Broadway Bridge

③ Steel Bridge

④ Burnside Bridge

⑤ Morrison Bridge

⑥ Hawthorne Bridge

⑦ Marquam Bridge

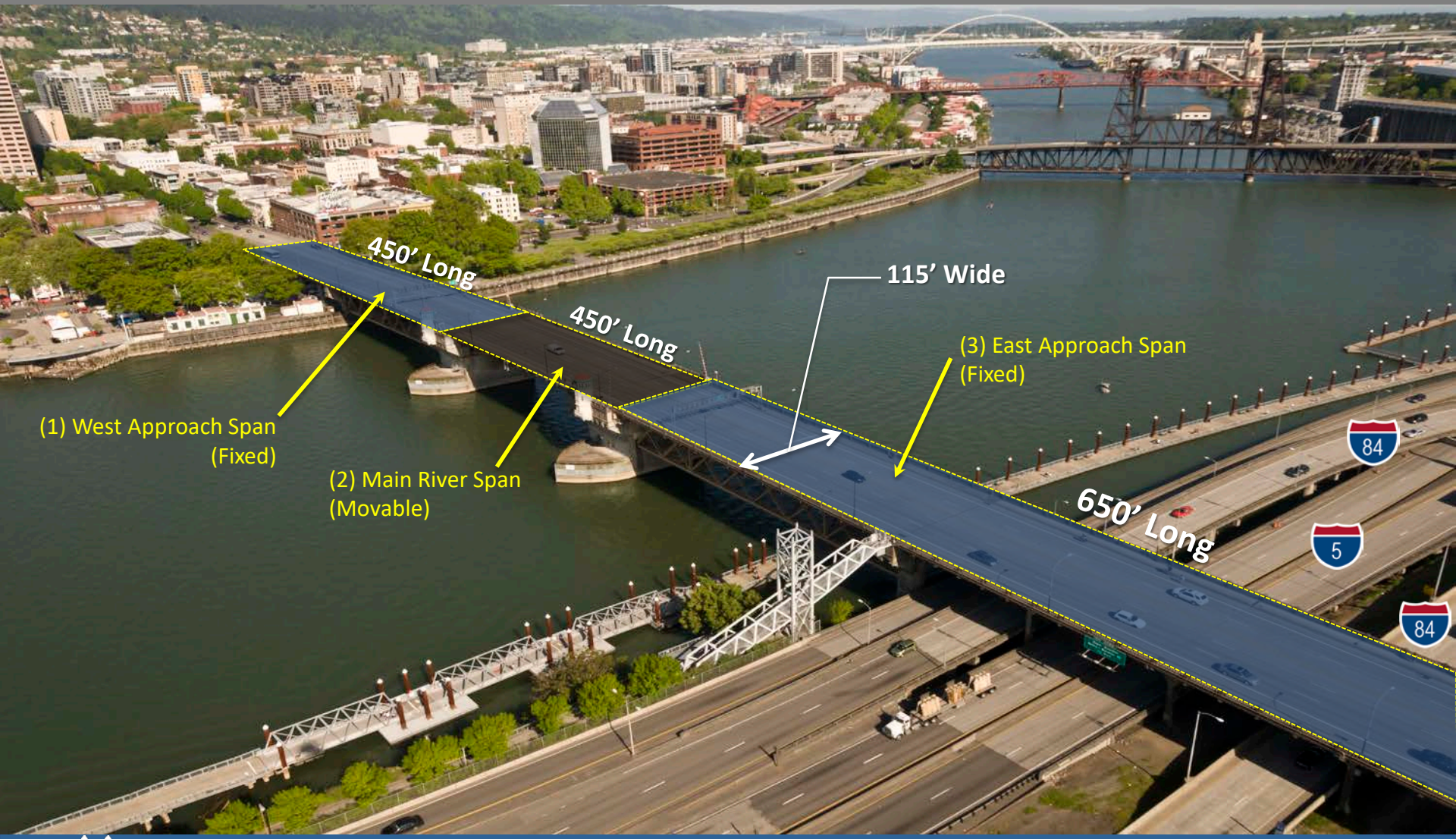
⑧ Tilikum Crossing

⑨ Ross Island Bridge

Long-span Alternative

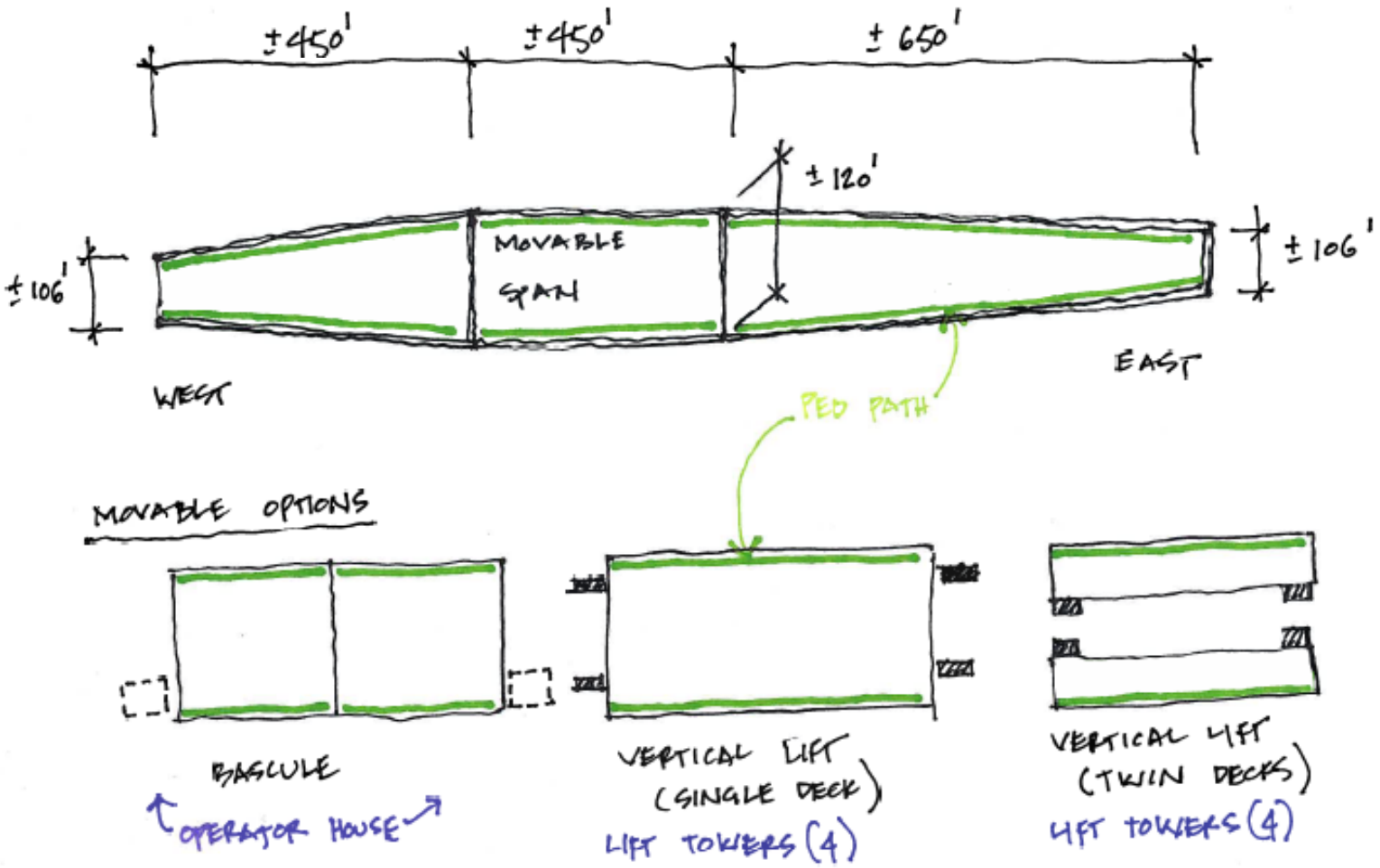
EARTHQUAKE READY BURNSIDE BRIDGE

“Three bridges in one”



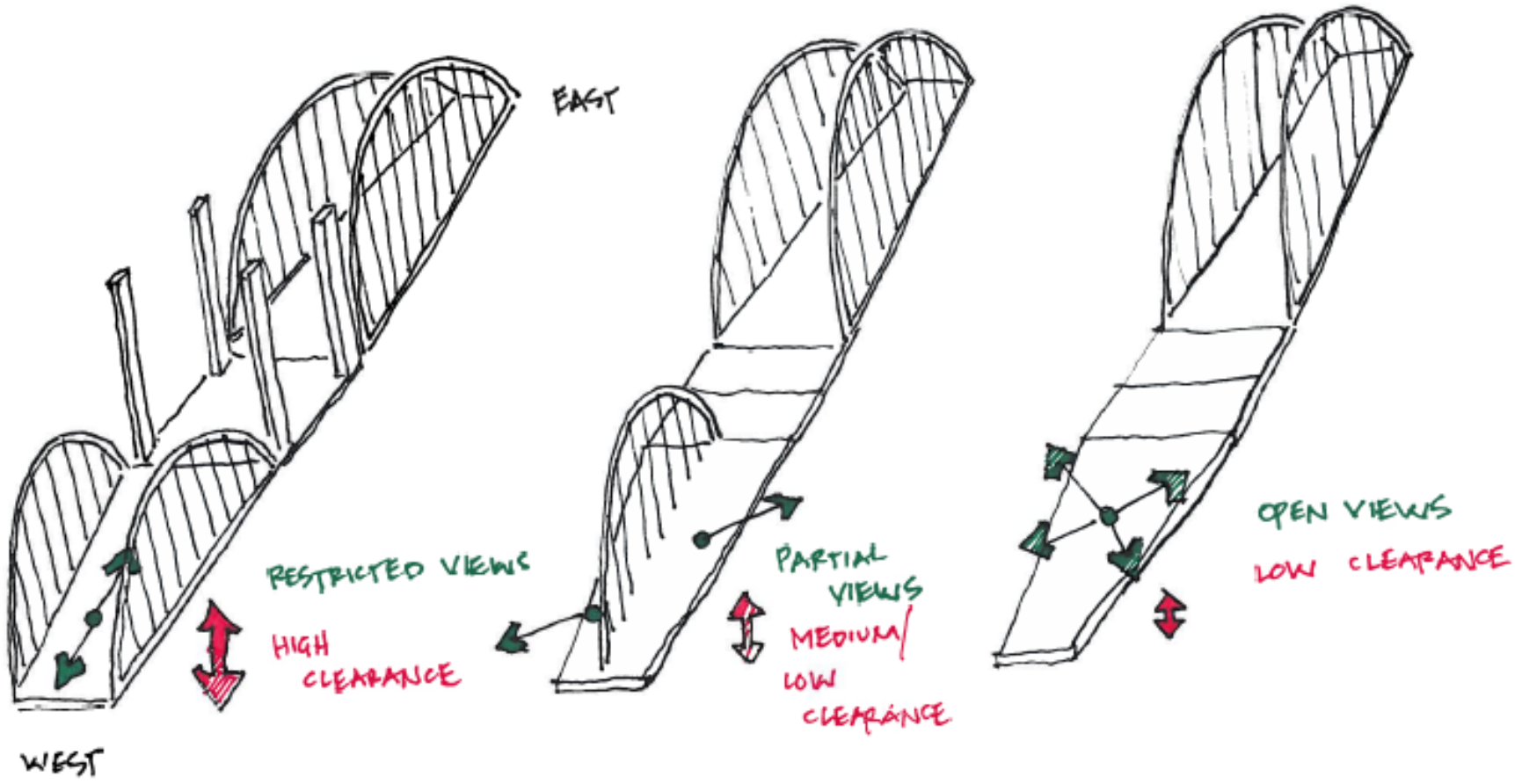
Long-span Alternative

Bridge Width Transitions



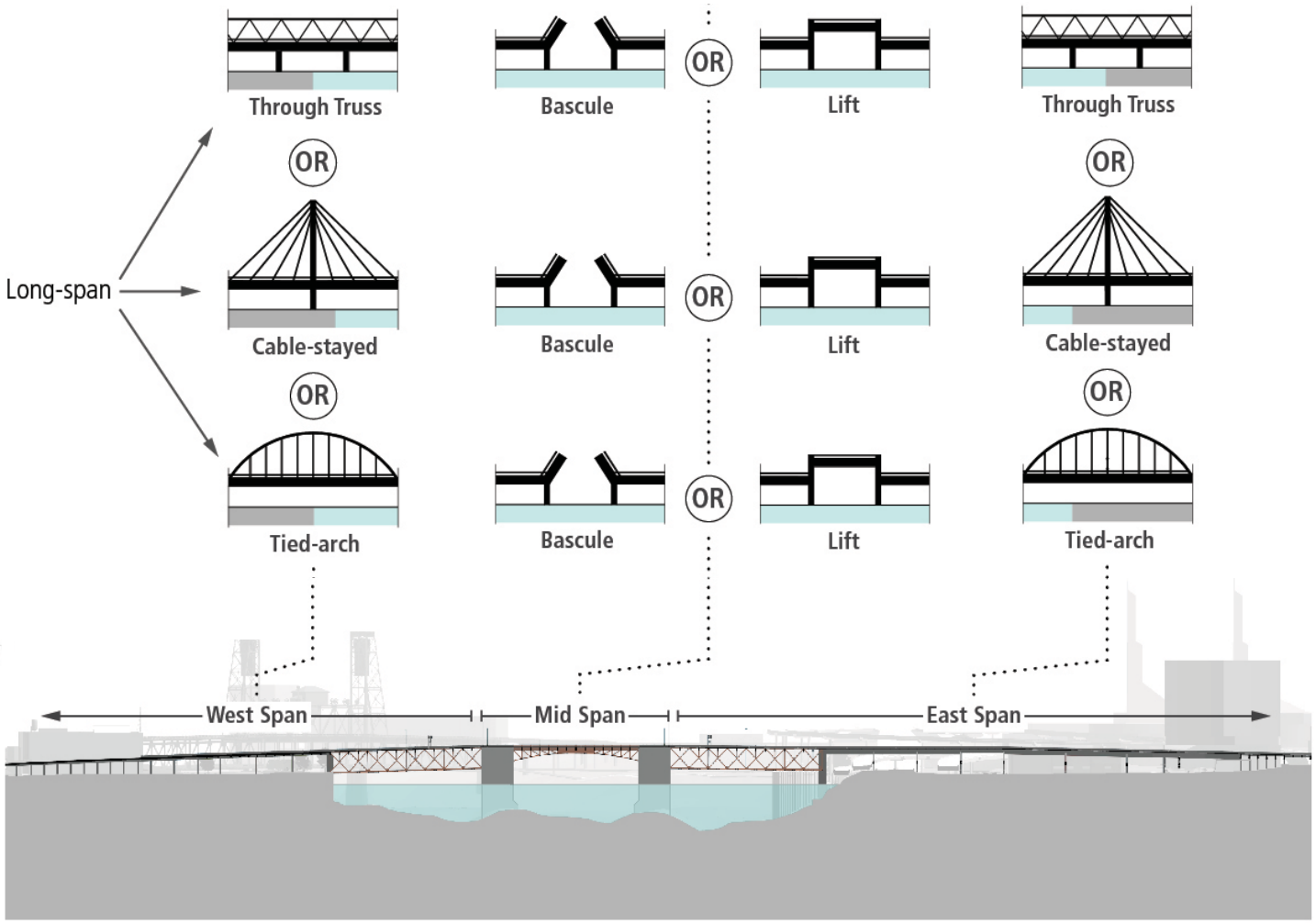
Long-span Alternative

Superstructure Influence on Views



Menu of Bridge Types

Representative Bridge Types



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Representative Bridge Types

BRIDGE TYPE OPTION: Tied Arch examples


Hastings Bridge, Minnesota


Torikai Ohas Bridge, Japan


Siuslaw River Bridge, Oregon


Tacony-Palmyra Bridge, Pennsylvania


Gateway Bridge, Michigan

BRIDGE TYPE OPTION: Cable Stayed examples


Indian River Inlet Bridge, Delaware


Chongqing Expressway Bridge, China


Cooper River Bridge, South Carolina


Tilikum Crossing Bridge, Oregon

BRIDGE TYPE OPTION: Through Truss examples


Main Street Bridge, Florida


Triborough (Harlem River) Bridge, New York


Tower Bridge, CA


Broadway Bridge, Oregon


Hawthorne Bridge, Oregon

MOVABLE SPAN: Bascule examples


South Park Bridge, Washington


Harbor Bridge, Spain


New Johnson St. Bridge, Canada


Woodrow Wilson Bridge, Maryland

MOVABLE SPAN: Vertical Lift examples


Teregganu Bridge, Malaysia

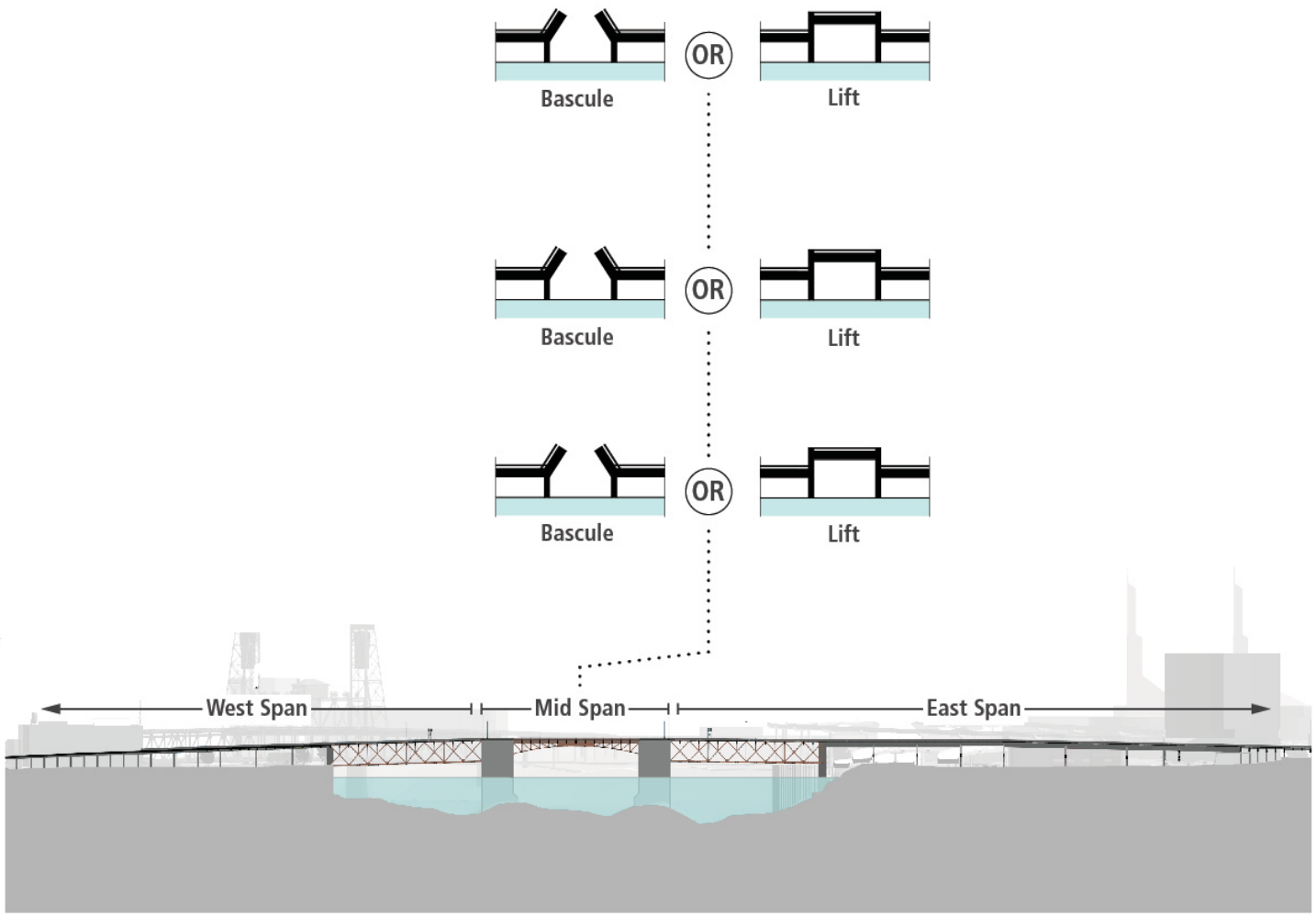

Fore River Bridge, Massachusetts


Pont Jacques Chaban, Delmas


Manchester Millenium Bridge, England

Menu of Bridge Types

Movable Bridge Types



Menu of Bridge Types

Bascule Bridge Types

MOVABLE SPAN: Bascule examples


South Park Bridge, Washington


Harbor Bridge, Spain


New Johnson St. Bridge, Canada


Woodrow Wilson Bridge, Maryland

Bascule Movable Bridge Types:

- Bascule Bridge Fundamentals
- Technically Feasible Types
- Technically “Challenged” Types

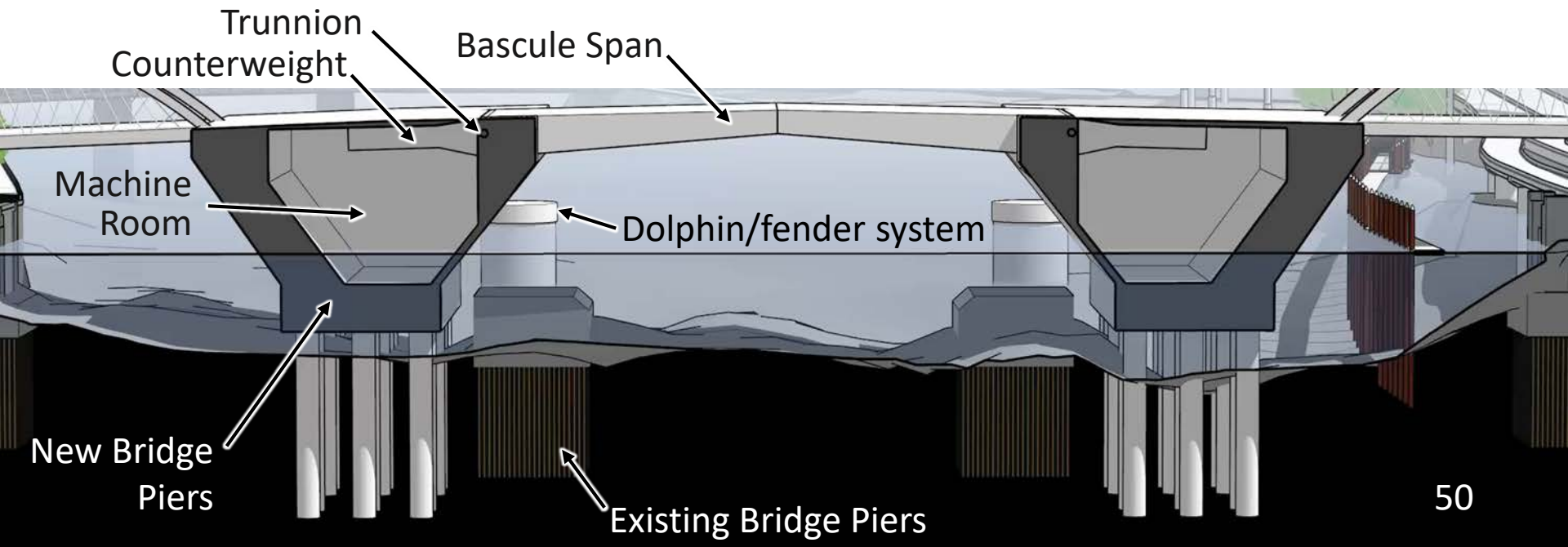
Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Bascule Type Application for the Burnside Bridge: "Delta Pier"

Key Attributes:

- **Bascule Span:**
  - "Split-leaf" (2 halves) type due to opening length
  - Can be above or below deck
- **Pier Locations:** West and east of the existing piers to avoid foundation conflicts
- **Pier Sizing:** Needs to accommodate counterweight movements and machine room
- **Trunnion Placement:** Towards main channel span to reduce bascule leaf length
- **Vessel Collision Protection:** Likely requires a fender or dolphin system for large ships



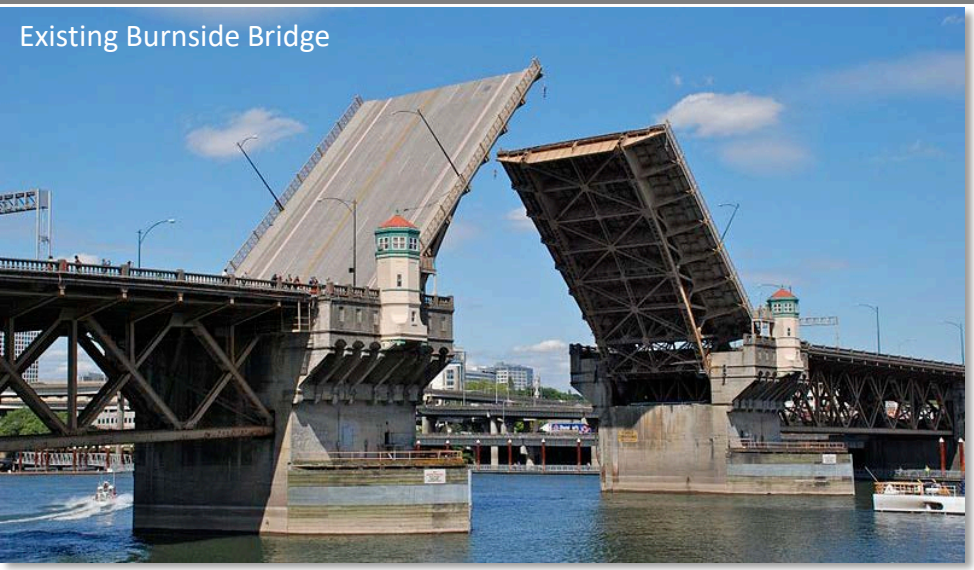
Menu of Bridge Types

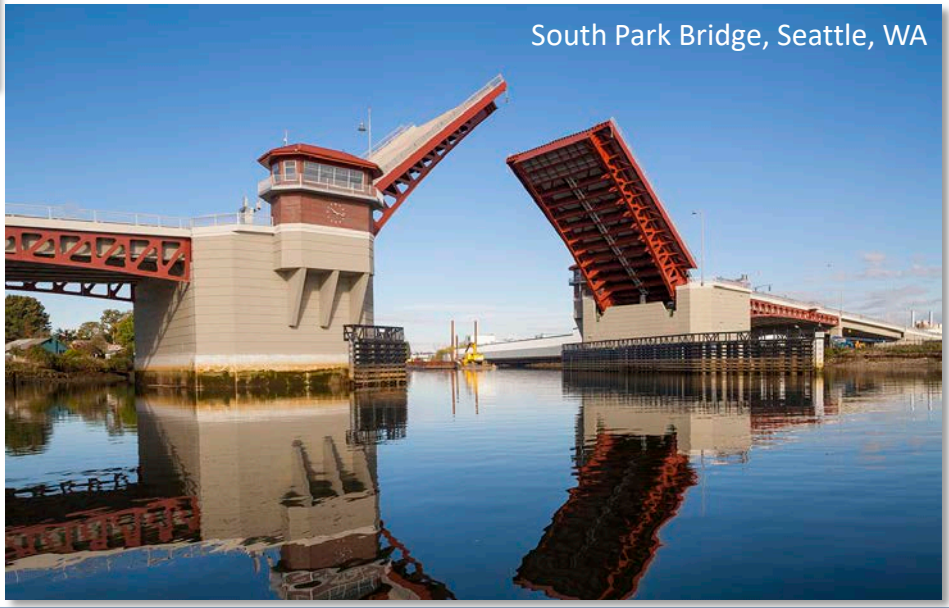
Bascule Type Application for the Burnside Bridge: “Delta Pier”

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Types: Traditional Twin-Leaf Bascule


Existing Burnside Bridge


South Park Bridge, Seattle, WA

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Types: Rustic Bascule Styles

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Types: Tower-framed Bascule Style

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Types: Modern Bascule Styles

Technically Feasible:

- Support struts / cables must be:
  - Sized for large loads
  - Placed near exteriors of roadway deck

Technically Challenged:

- May need twin bridges due to the larger Burnside Bridge width


Pont Y Ddraig Harbor Bridge, Wales


Harbor Bridge, Barcelona

Menu of Bridge Types

Technically Feasible Types – Modern Bascule Styles

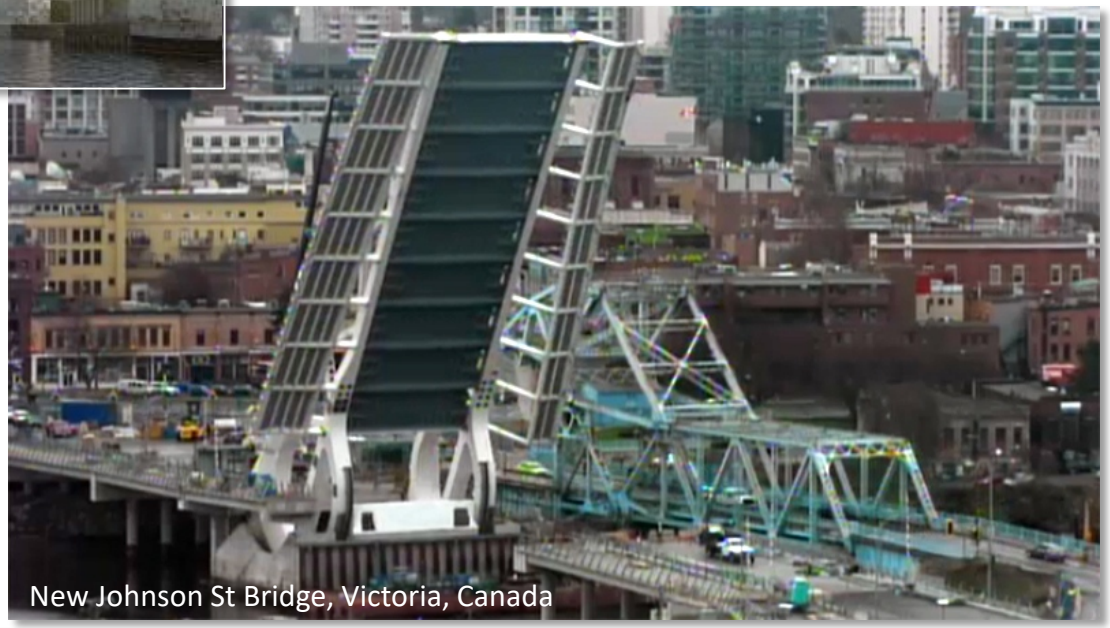

New Johnson St Bridge, Victoria, Canada

Technically Feasible:

- Bascule shape (partially open pit)
- Limited ability to suspend bike/ped walkway below deck

Technical Challenge:

- 175’ Single leaf (vs ~300’ needed for Burnside)


New Johnson St Bridge, Victoria, Canada

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

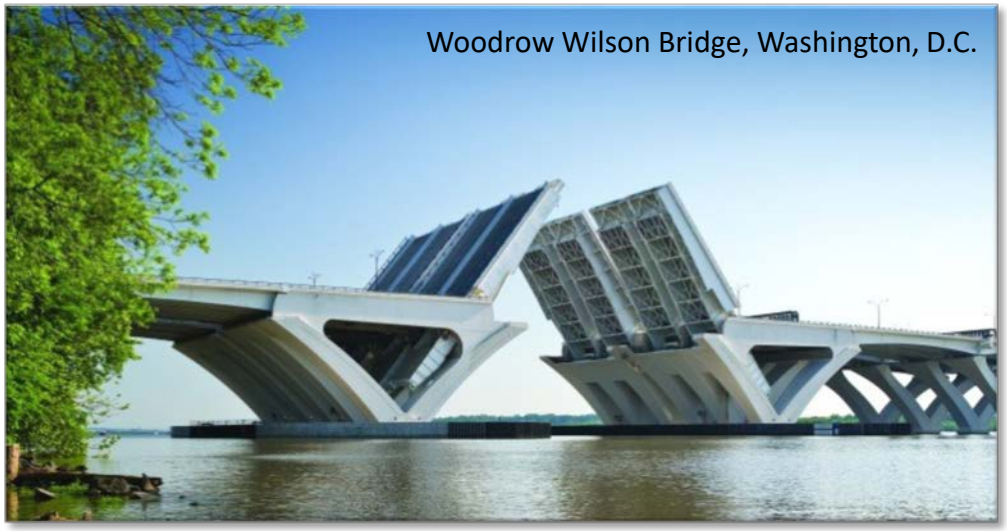
Technically Feasible Types: Delta Pier Bascule

Technically Feasible:

- Bascule shape (Delta pier shape)

Technical Challenge:

- Split-leaf (each bascule side split in half):
  - Bifurcates the into roadway into narrower twin pieces, limiting flexibility for future lane alterations
  - Increases permit risk via a larger bridge footprint
  - Results in twice the mechanical and electrical equipment to construct, operate, and maintain



Woodrow Wilson Bridge, Washington, D.C.

17th Street Causeway, Ft. Lauderdale, Florida

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Types: Rotating (aka, "Swing") Bridge

Why?

- Requires more in-river piers or a larger turret on each side of the main navigation channel
- Expensive to construct, operate, and maintain
- Less safe than lift or bascule due to large motions over the river
- Longer opening times:
  - To clear on-bridge and in-river users
  - To rotate open and to close

Scale Lane Bridge, England

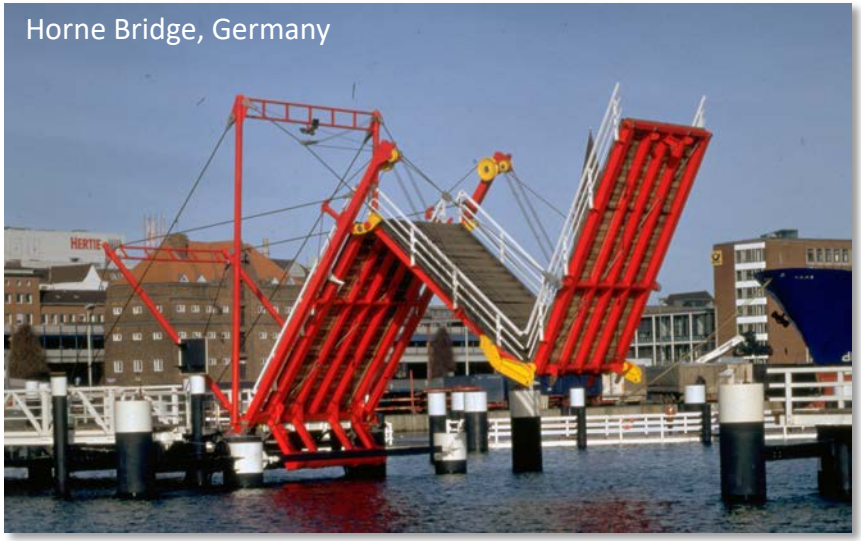
Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Types: Unique Movements - 1

Why?

- Unproven response in high seismic zones
- Requires more structure and mechanical equipment to achieve the same function
- Expensive to construct, operate, and maintain
- Less safe than traditional lift or bascule types
- Generally longer operating times
- Generally used for smaller-scaled bridges


Horne Bridge, Germany

Gateshead Millennium Bridge, England


Slauwerhoffbrug Bridge, The Netherlands

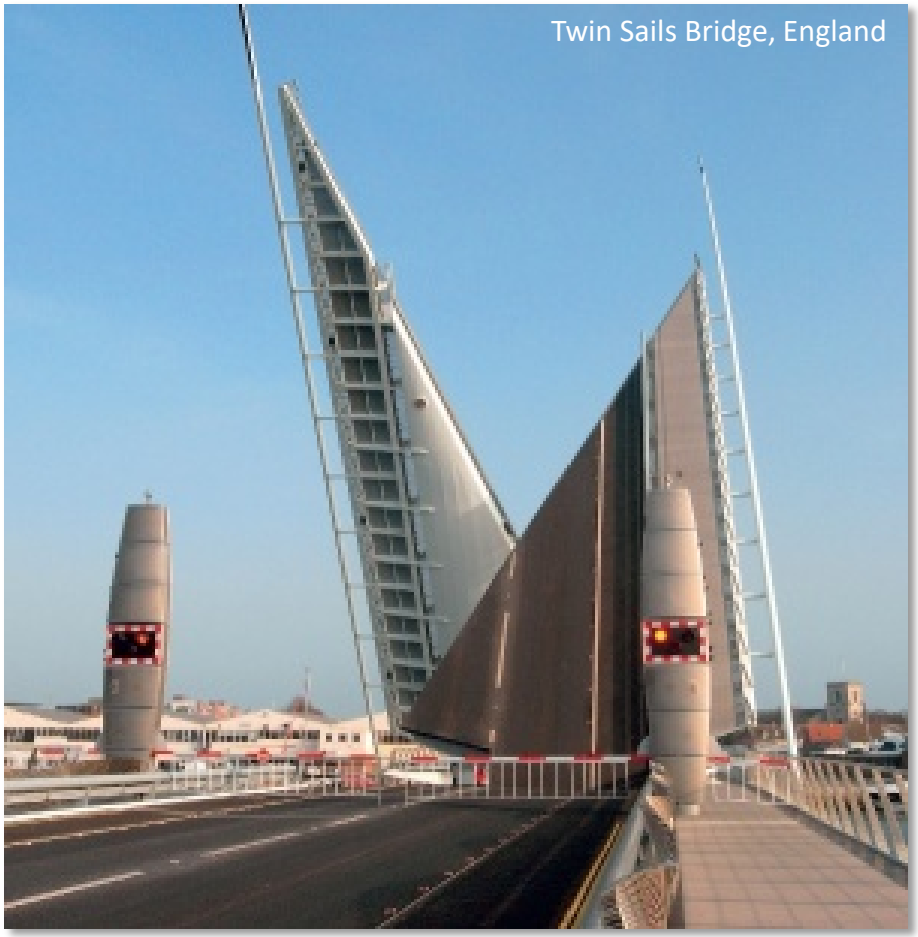
Menu of Bridge Types

Technically Challenged Types: Unique Movements - 2

Why?

- Requires more structure and mechanical equipment to achieve the same function
- Unproven response in high seismic zones
- Expensive to construct, operate, and maintain
- Less safe than traditional lift or bascule types
- Generally longer operating times
- Generally used for smaller-scaled bridges


Falkirk Wheel, Scotland


Twin Sails Bridge, England

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift Bridge Types

Fore River Bridge, Massachusetts

Pont Jacques Chaban, Delmas

Manchester Millenium Bridge, England

Lift Movable Bridge Types:

- Lift Bridge Fundamentals
- Technically Feasible Types
- Technically “Challenged” Types

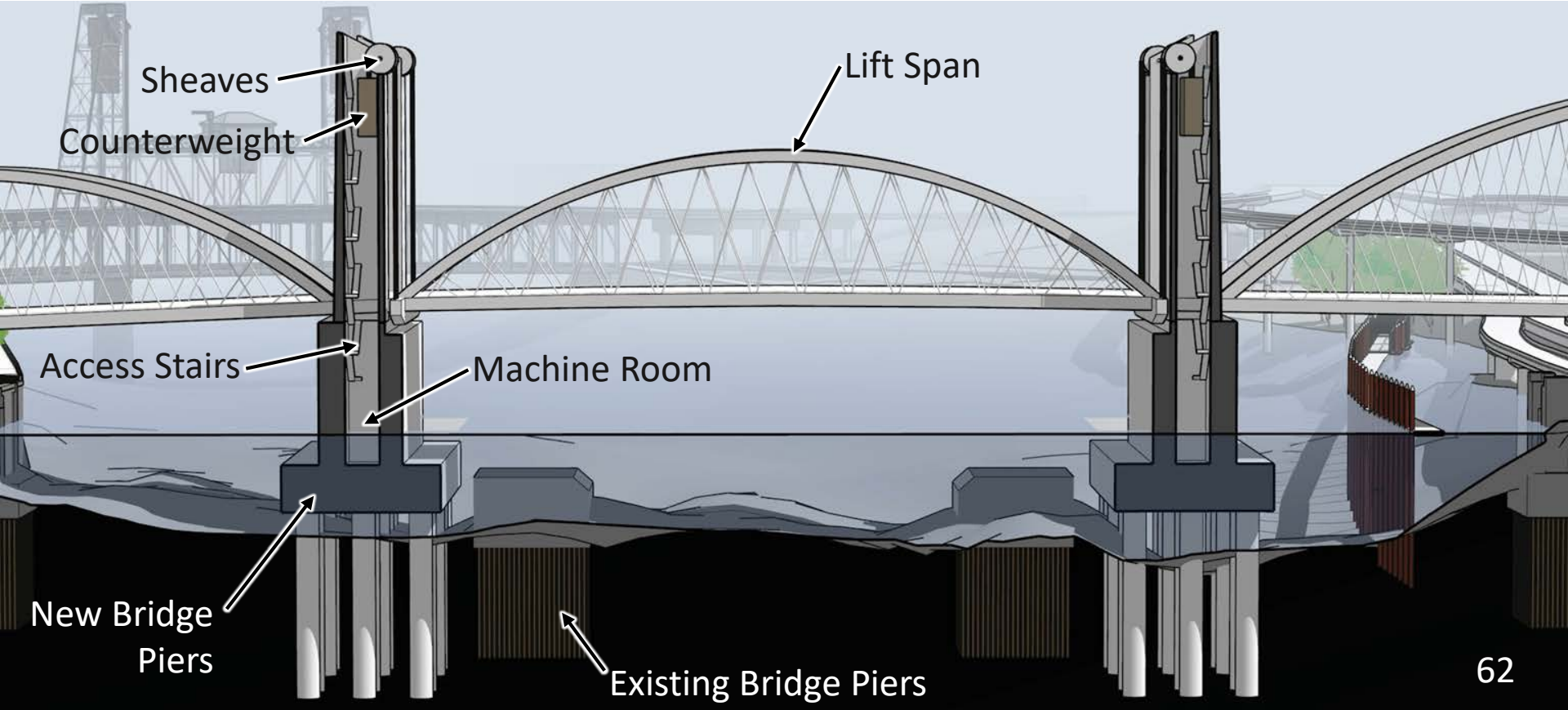
Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift Type Application for the Burnside Bridge

Key Attributes:

- **Lift Span:** Can be above or below deck
- **Pier Locations:** West and east of the existing piers to avoid foundation conflicts
- **Pier Sizing:** Needs to accommodate counterweight movements, machine room, and stairs
- **Sheaves Placement:** Towards main channel span to raise span



Menu of Bridge Types

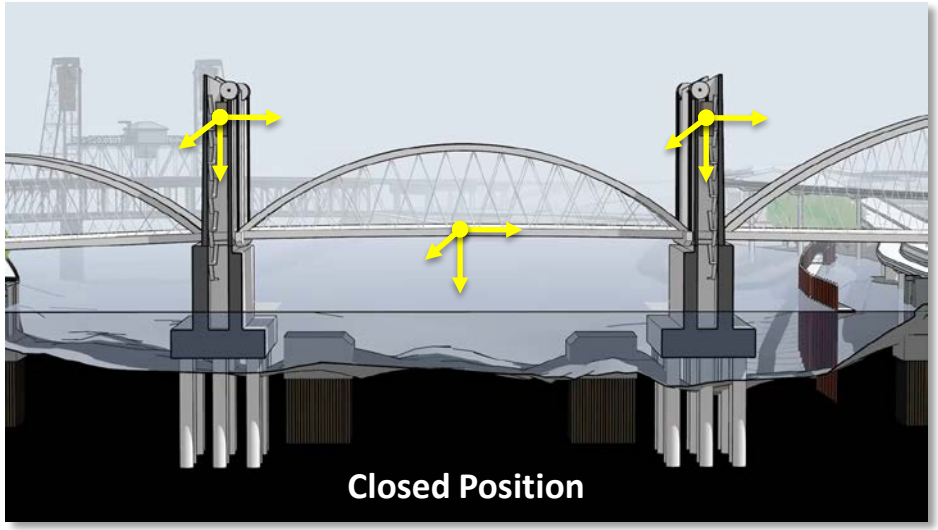
Lift Type Application for the Burnside Bridge

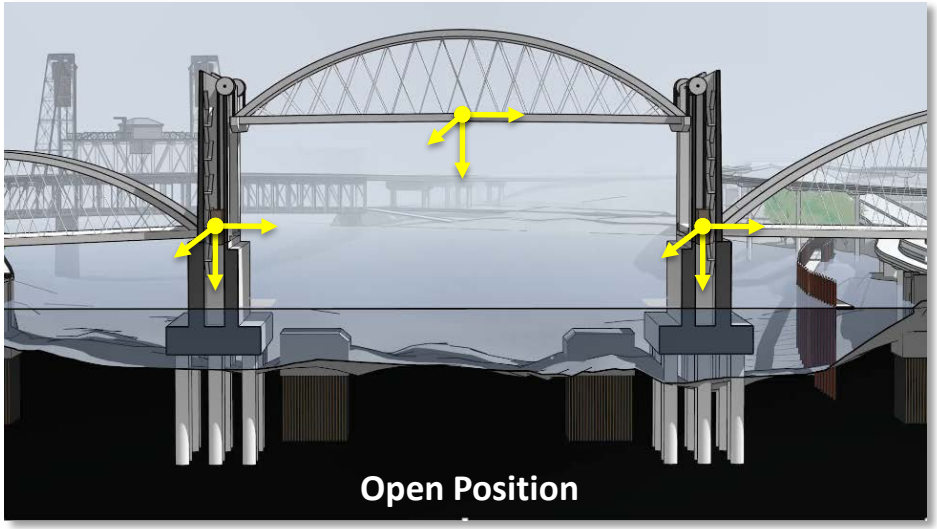
Menu of Bridge Types

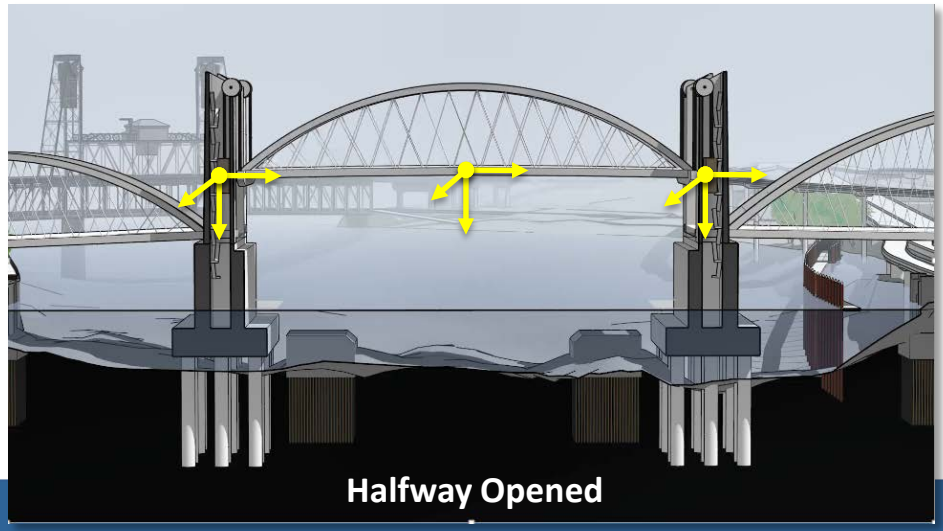
EARTHQUAKE READY BURNSIDE BRIDGE

Seismic Loading Points

= seismic loading directions

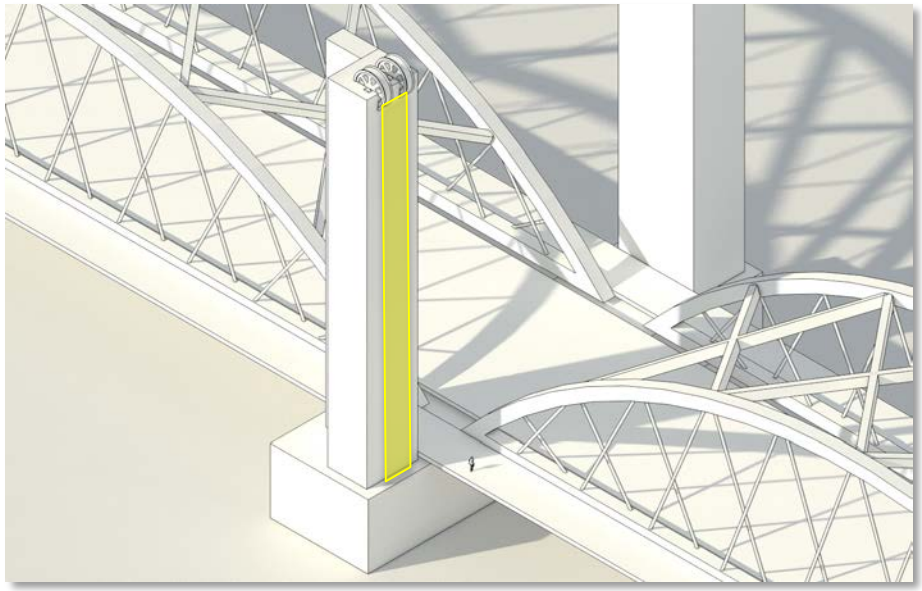




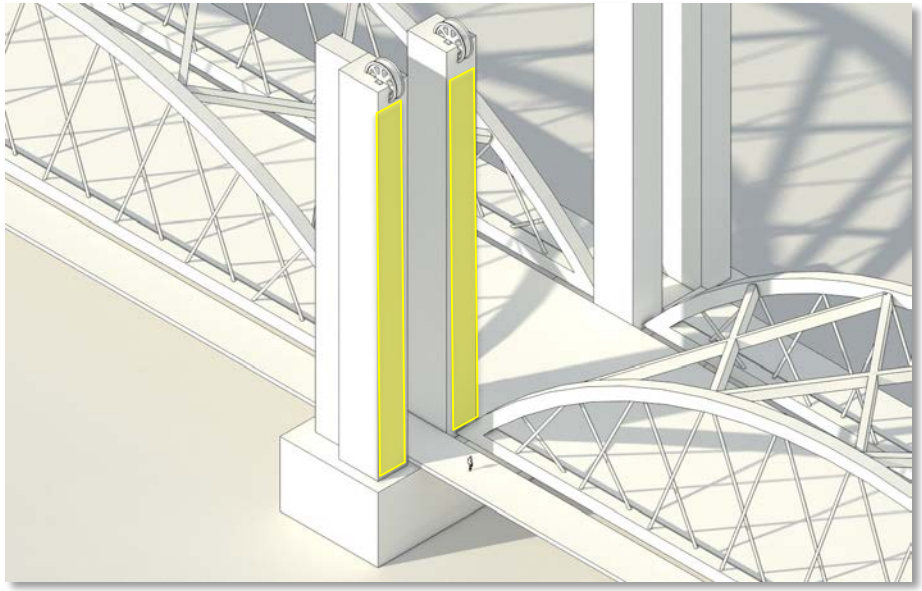


Menu of Bridge Types

Tower Types: Single Tower versus Split Towers



Single Tower

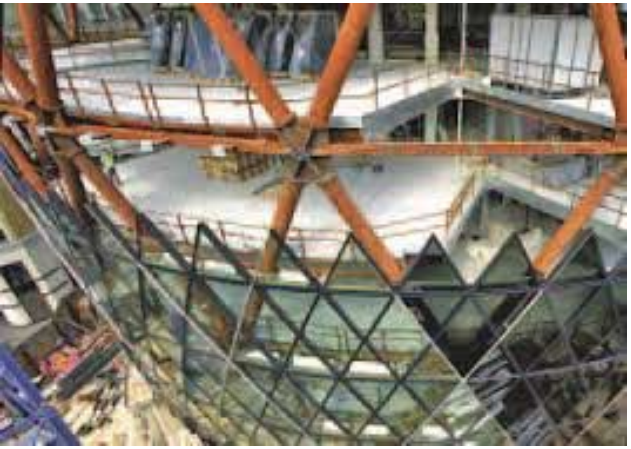


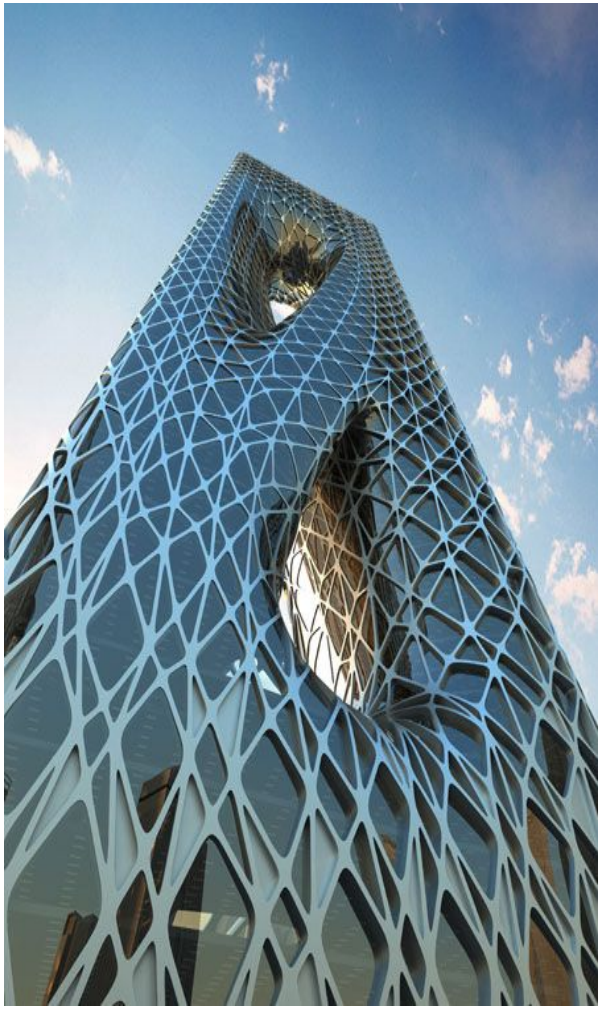
Split Tower

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Tower Exterior: a key Design Element





Menu of Bridge Types

Lift Span Type

Burnside Bridge Cross Section of Lift Span
(Below deck option)

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Lift Types: Modern Truss Tower Style


Fore River Bridge, Quincy, Massachusetts


Tower Bridge, Sacramento


Chelsea St Bridge, Massachusetts

Movable Bridge Span

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Lift Types: Individual Tower Style

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Lift Types: Individual Tower Style

"I" St Bridge Sacramento, CA

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Lift Types: Slender Steel Truss Towers


Hawthorne Bridge


Manchester Millenium Bridge, England

Why?

- Seismic resiliency requires a much more robust structural system

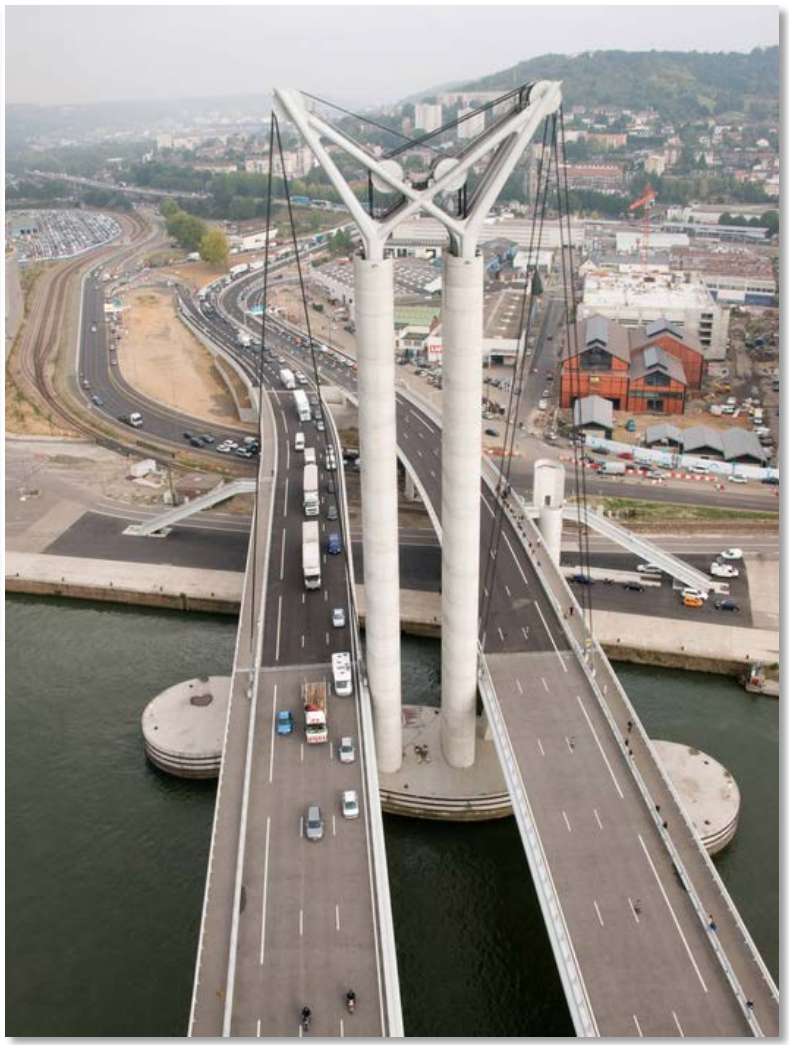

Steel Bridge

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Lift Types: Unrestrained cable lifting mechanisms


Pont Gustave Flaubert Bridge, France



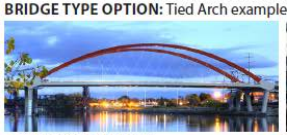
Why?

- Seismic resiliency requires a much more restrained structural system
- Bifurcates the into roadway into narrower twin pieces, limiting flexibility for future lane alterations
- Increases permit risk via a larger bridge footprint

Menu of Bridge Types

Fixed Approach Bridge Types

BRIDGE TYPE OPTION: Tied Arch examples


Hastings Bridge, Minnesota


Torikai Ohas Bridge, Japan


Siuslaw River Bridge, Oregon


Tacony-Palmyra Bridge, Pennsylvania


Gateway Bridge, Michigan

BRIDGE TYPE OPTION: Cable Stayed examples


Indian River Inlet Bridge, Delaware


Chongqing Expressway Bridge, China


Cooper River Bridge, South Carolina


Tilikum Crossing Bridge, Oregon

BRIDGE TYPE OPTION: Through Truss examples


Main Street Bridge, Florida


Triborough (Harlem River) Bridge, New York


Tower Bridge, CA


Broadway Bridge, Oregon


Hawthorne Bridge, Oregon

Fixed Approach Bridge Types

- Tied Arch
- Truss
- Cables Stayed
- Extradosed
- Suspension
- “Other”

Menu of Bridge Types

Fixed Approach Bridge Types


Hastings Bridge, Minnesota


Torikai Ohas Bridge, Japan


Siuslaw River Bridge, Oregon


Tacony-Palmyra Bridge, Pennsylvania

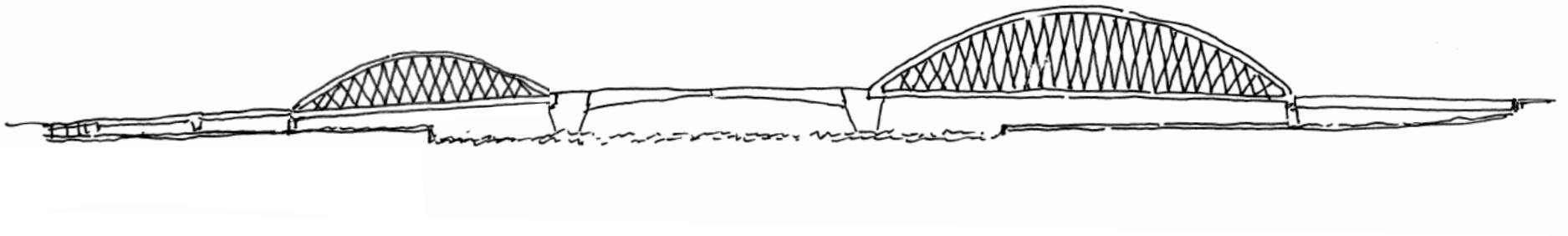

Gateway Bridge, Michigan

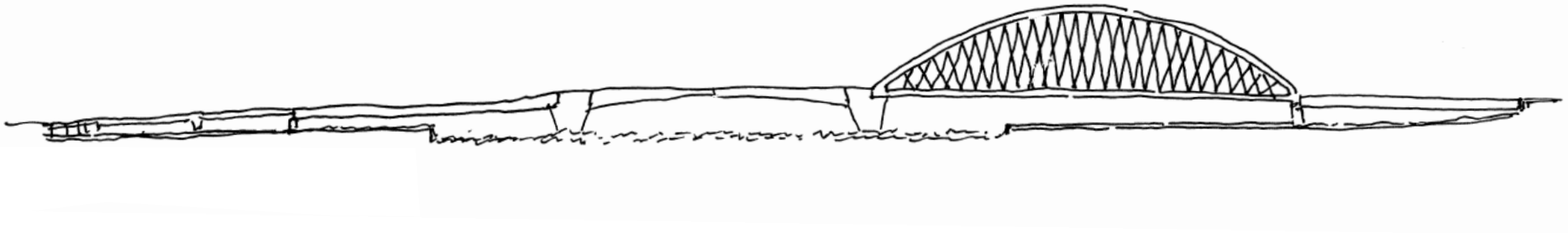
Study Type:
Tied Arch

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Bascule + Tied Arch

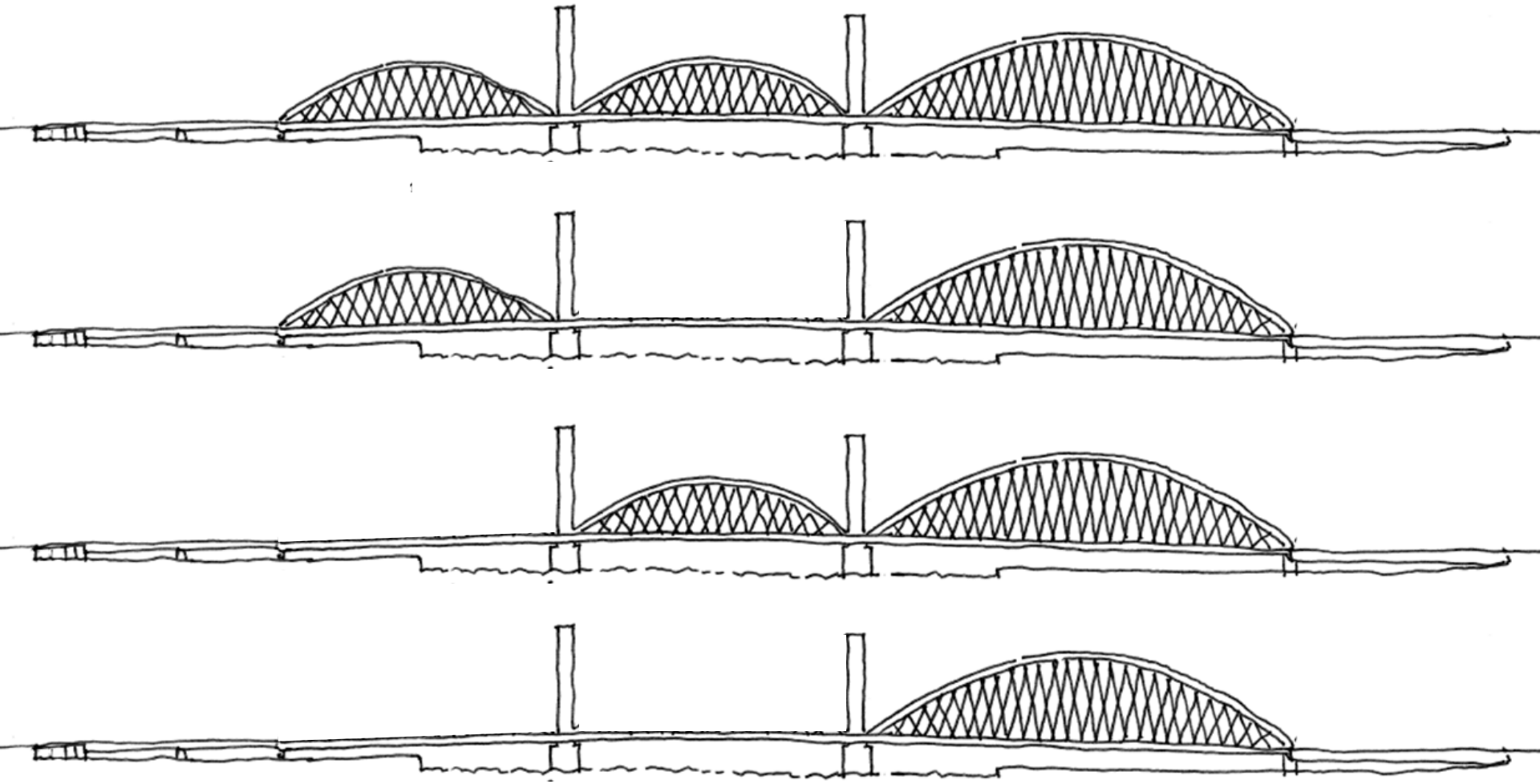




Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift + Tied Arch



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Tied Arch Types: Conventional Style

Key Technical Attributes:

- Proven reliability in a seismic event
- Height variability (by up to 45’ on east)
- Offers a variety of shapes and styles
- Arch Height:~85’ (west approach) and ~130’ tall (east approach)

Key Technical Trade-offs:

- Impacts on views / openness
- May require cross-bracing

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Tied Arch Types: Conventional Style (Network cable)

Blennerhassett Island Bridge, West Virginia

Sauvie Island Bridge

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

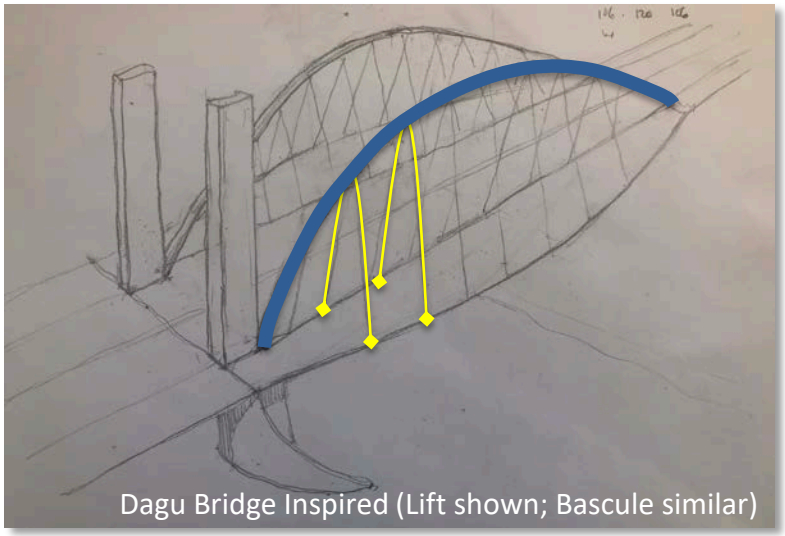
Technically Feasible Tied Arch Types: Conventional Style (Open Rib)

Hastings Bridge, Minnesota

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Tied Arch Types: Inclined and Cable Stiffened Style


Dagu Bridge Inspired (Lift shown; Bascule similar)

Menu of Bridge Types

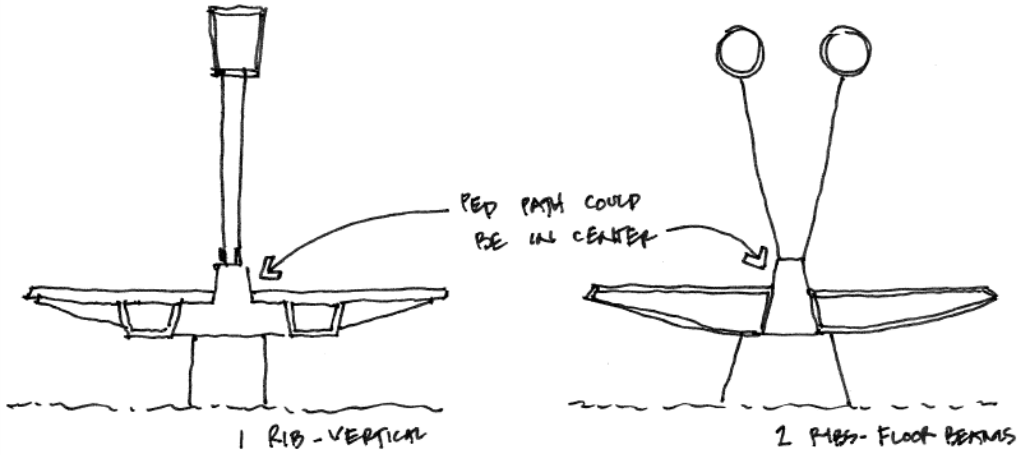
EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Tied Arch Types: Single Arch Rib Alignment

Why?

- Bifurcates the roadway into narrower pieces, limiting flexibility for future lane alterations
- For west approach at Naito Parkway, this requires more superstructure depth, causing insufficient vertical clearances below deck
- Subject to material type, increases seismic demands requiring larger in-water foundations
- Constructability challenges over I-5/I-84/UPRR


Lucitania Bridge, Merida, Spain



Menu of Bridge Types

Fixed Approach Bridge Types


Main Street Bridge, Florida


Triborough (Harlem River) Bridge, New York


Tower Bridge, CA


Broadway Bridge, Oregon

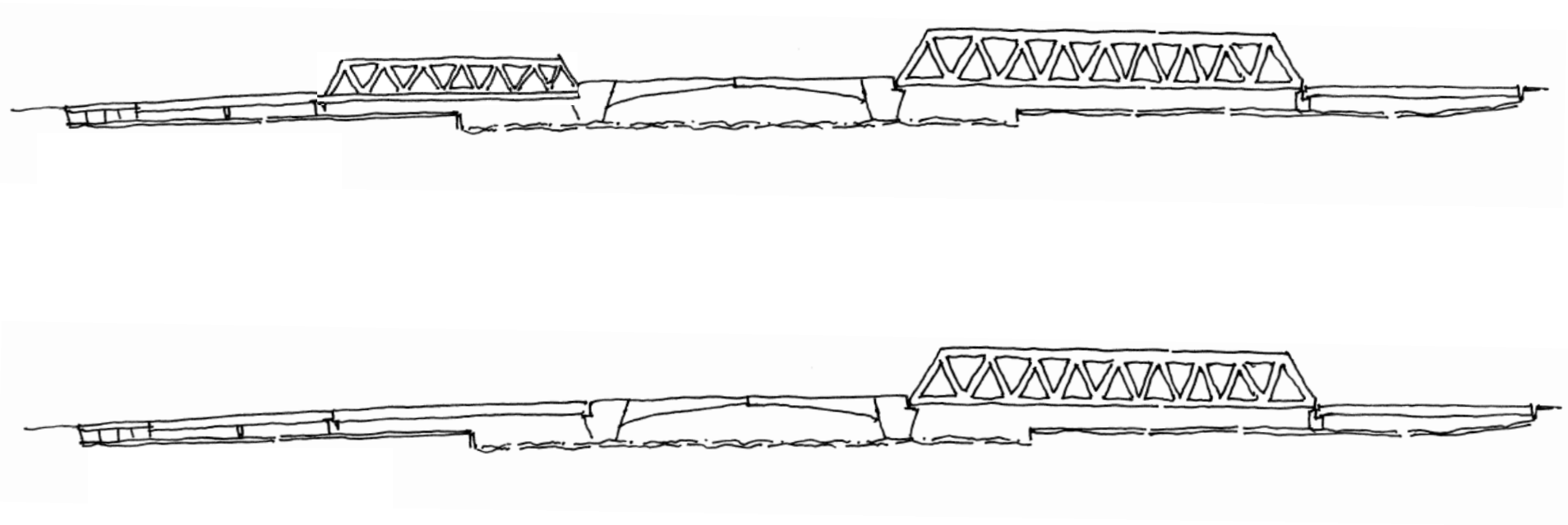

Hawthorne Bridge, Oregon

Study Type:
Truss

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

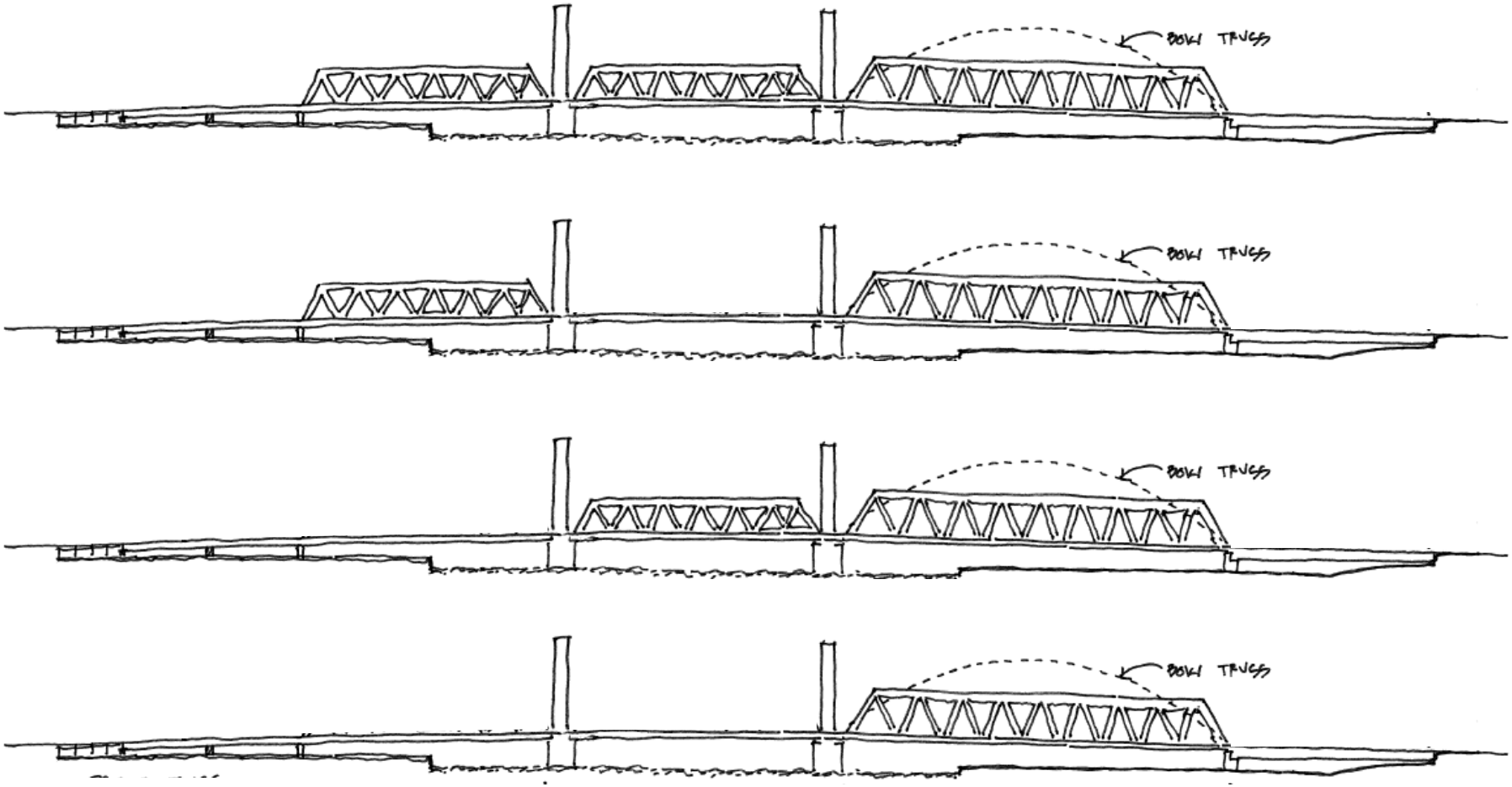
Bascule + Truss



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift + Truss



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Truss Types: Conventional Style

Key Technical Attributes:

- Proven reliability in a seismic event
- Cost effective
- Offers a variety of truss shapes
- Truss Height: ~65’ (west approach) and ~80’ tall (east approach)

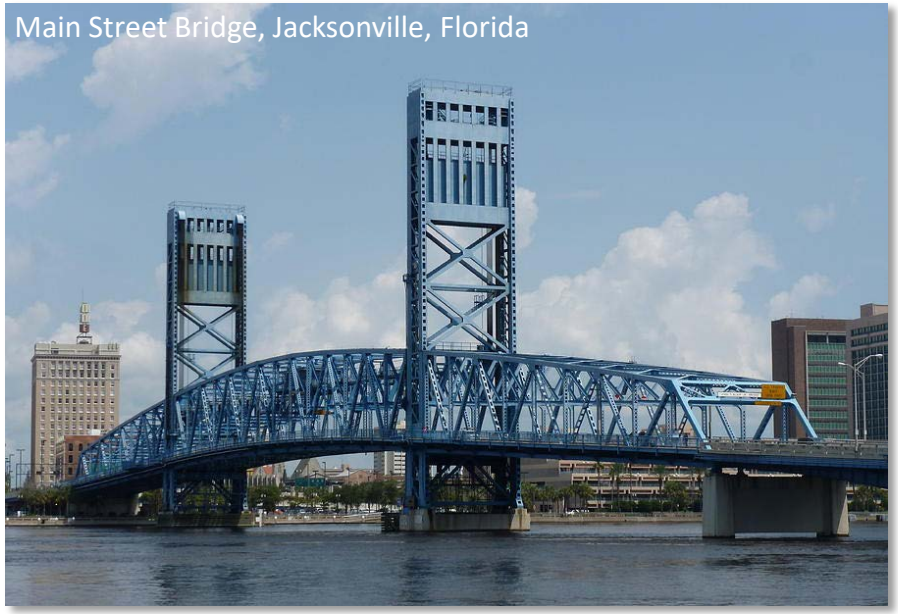
Key Technical Trade-offs:

- Impacts on views / openness
- Requires cross-framing (i.e., truss roof)


Chelsea St Bridge, Massachusetts

Menu of Bridge Types

Technically Feasible Truss Types: Conventional Style



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Truss Types: Circular and Deck Truss Styles


Helix Bridge, Singapore


Tokyo Gate Bridge, Japan

Why for Circular?

- Unproven for seismic resiliency
- Expensive to construct and maintain
- Generally used for smaller-scaled bridges

Why for Deck Truss?

- Insufficient vertical clearances below deck (Waterfront Park and I-5/I-84/UPRR)

Menu of Bridge Types

Fixed Approach Bridge Types


Indian River Inlet Bridge, Delaware


Chongqing Expressway Bridge, China


Cooper River Bridge, South Carolina


Tilikum Crossing Bridge, Oregon

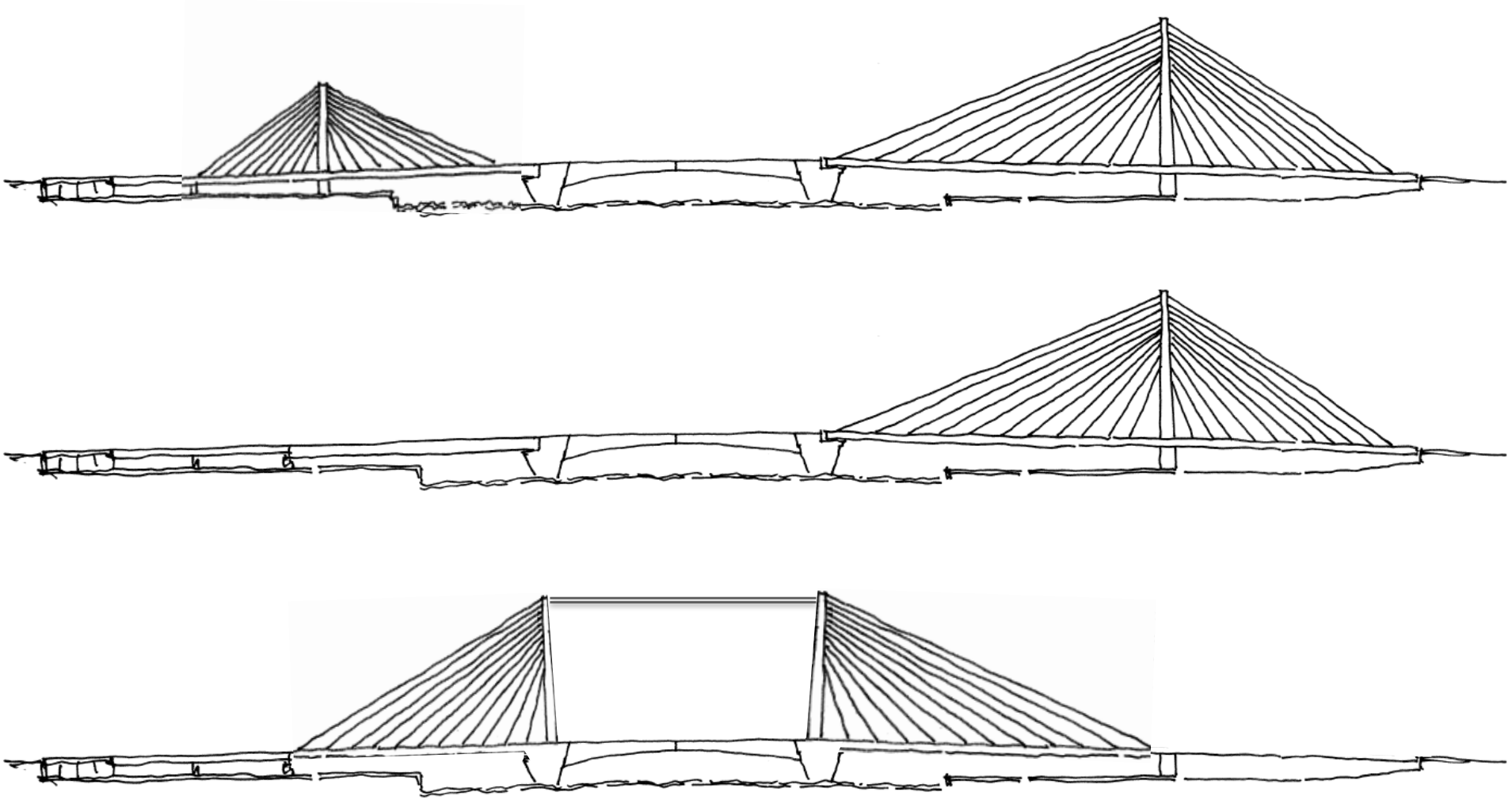
Study Type:

Cable Stayed

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

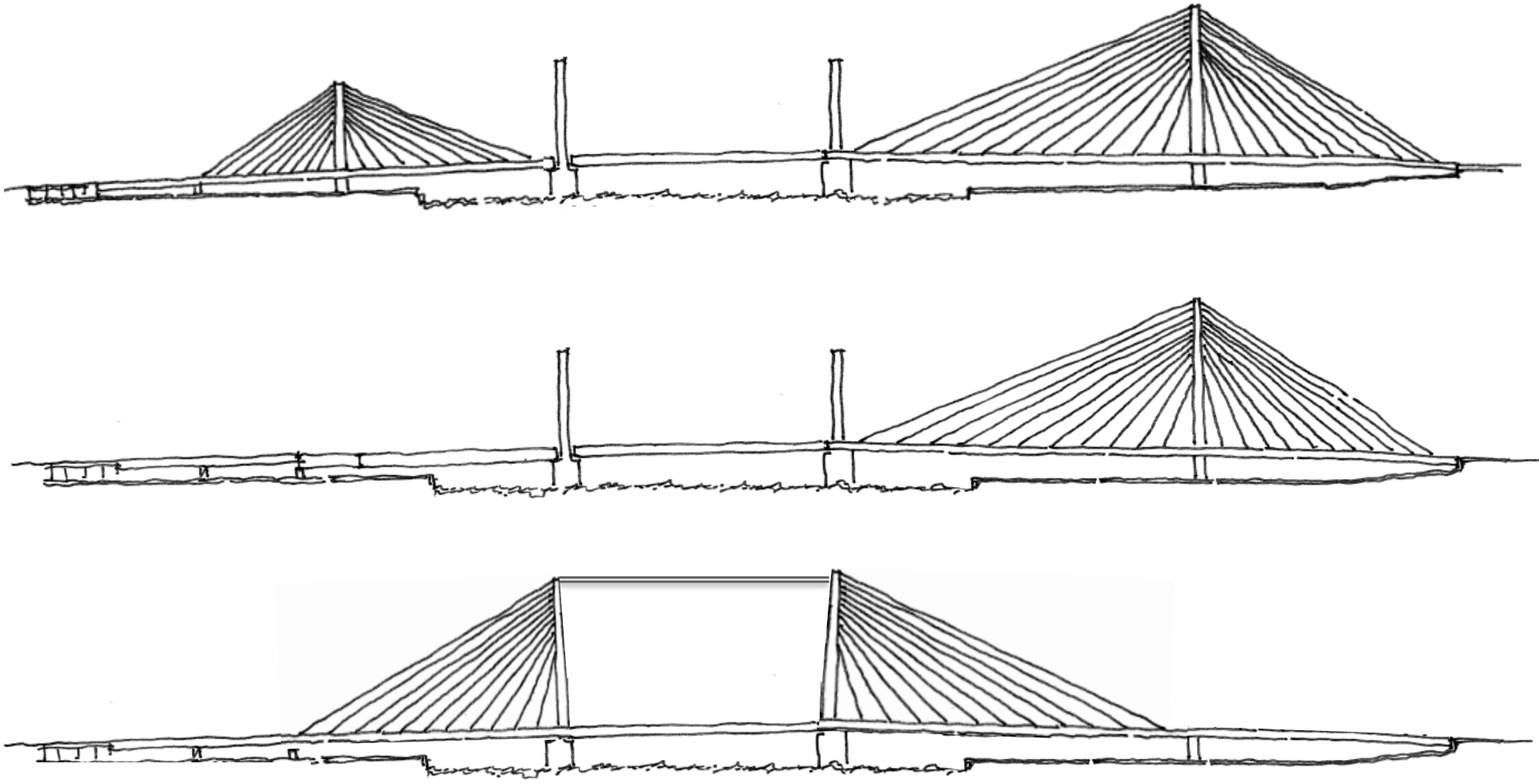
Bascule + Cable Stayed



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

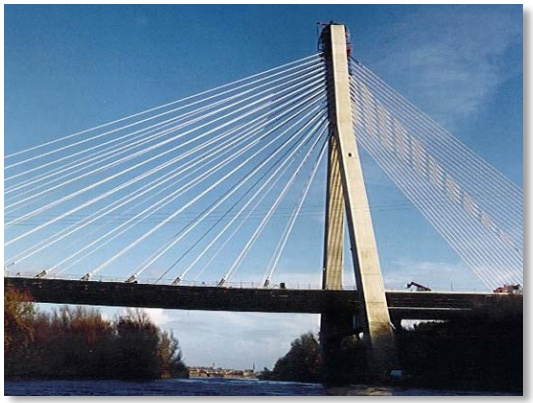
Lift + Cable Stayed

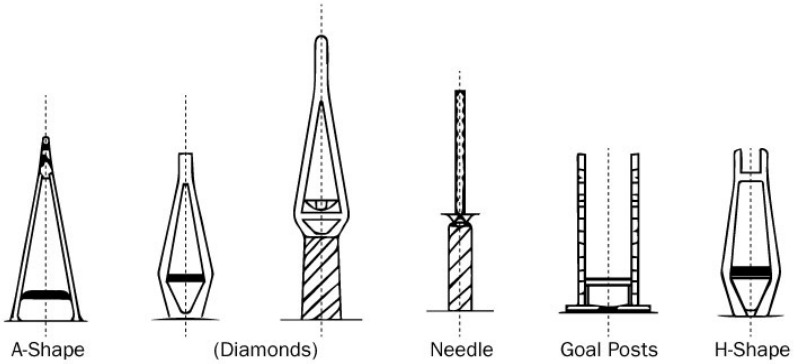


Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Cable Stayed Types: Multiple Tower and Cable Arrangement Styles





Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Cable Stayed Types: Conventional "Goalpost" Style

Key Technical Attributes:

- Proven reliability in a seismic event
- Cost effective
- Offers a variety of cable stay shapes
- Tower Height: ~85' (west approach) and ~130' tall (east approach)

Key Technical Trade-offs:

- Impacts on views / openness, especially on east side adjacent to The Yard building
- West Approach towers needs to be located within Waterfront Park

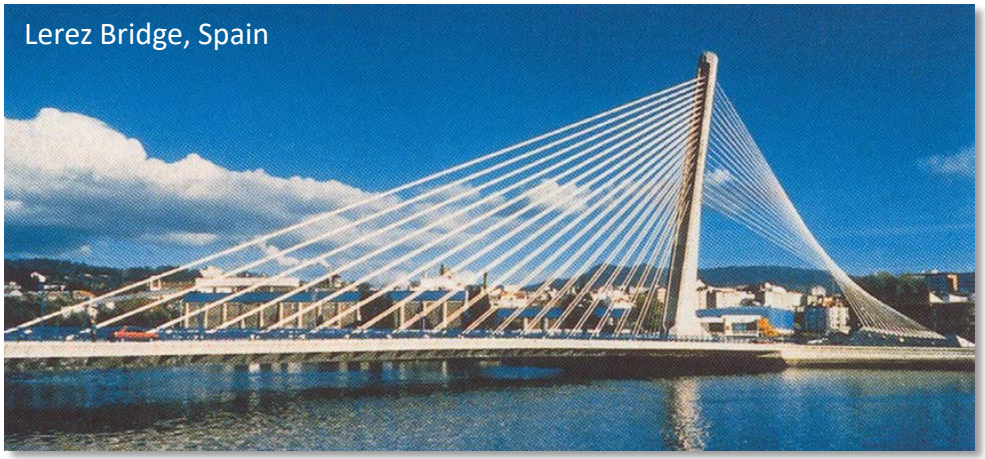

Tappan Zee Bridge, New York


Indian River Bridge, Florida

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Cable Stayed Types: Single Tower


Lerez Bridge, Spain


Sunshine Skyway, Florida

Why?

- Bifurcates the roadway into narrower pieces, limiting flexibility for future lane alterations
- Requires a deeper superstructure, resulting in insufficient vertical clearances at Naito Parkway
- Subject to material type, increases seismic demands requiring larger in-water foundations
- Constructability challenges over I-5/I-84/UPRR


Puente del Alamillo Bridge, Spain

Menu of Bridge Types

Fixed Approach Bridge Types

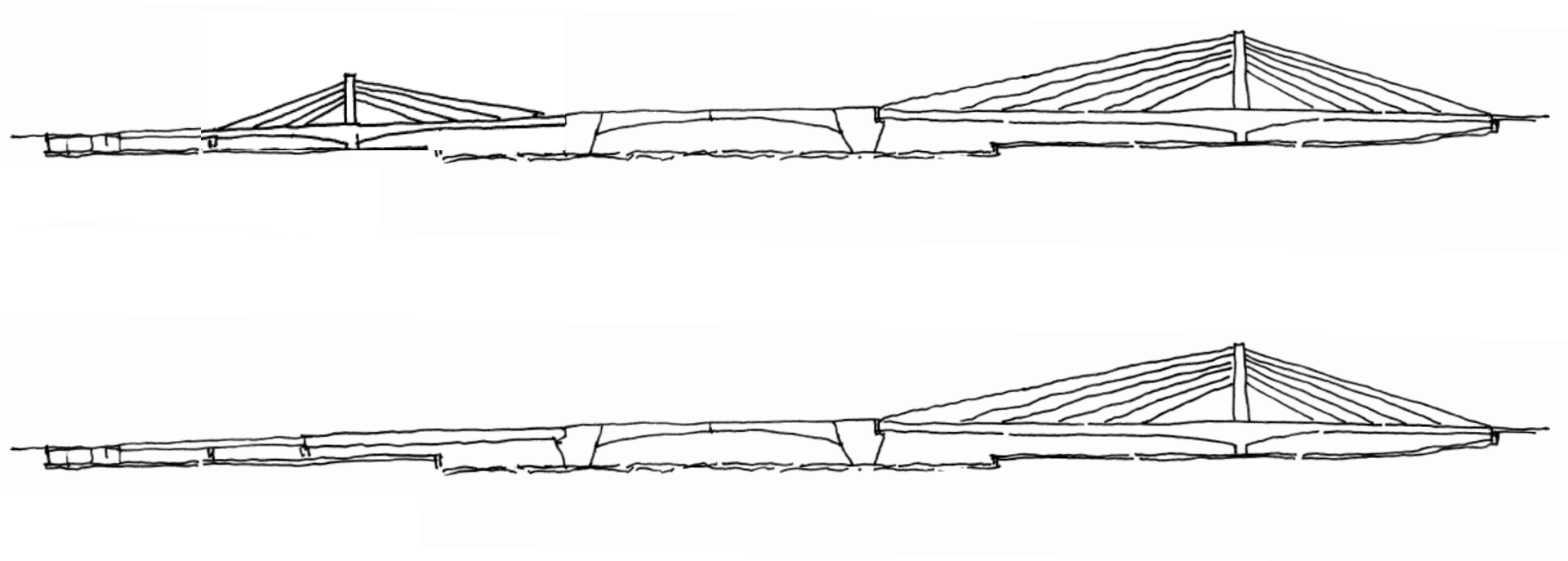
Study Type:

Extradosed

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

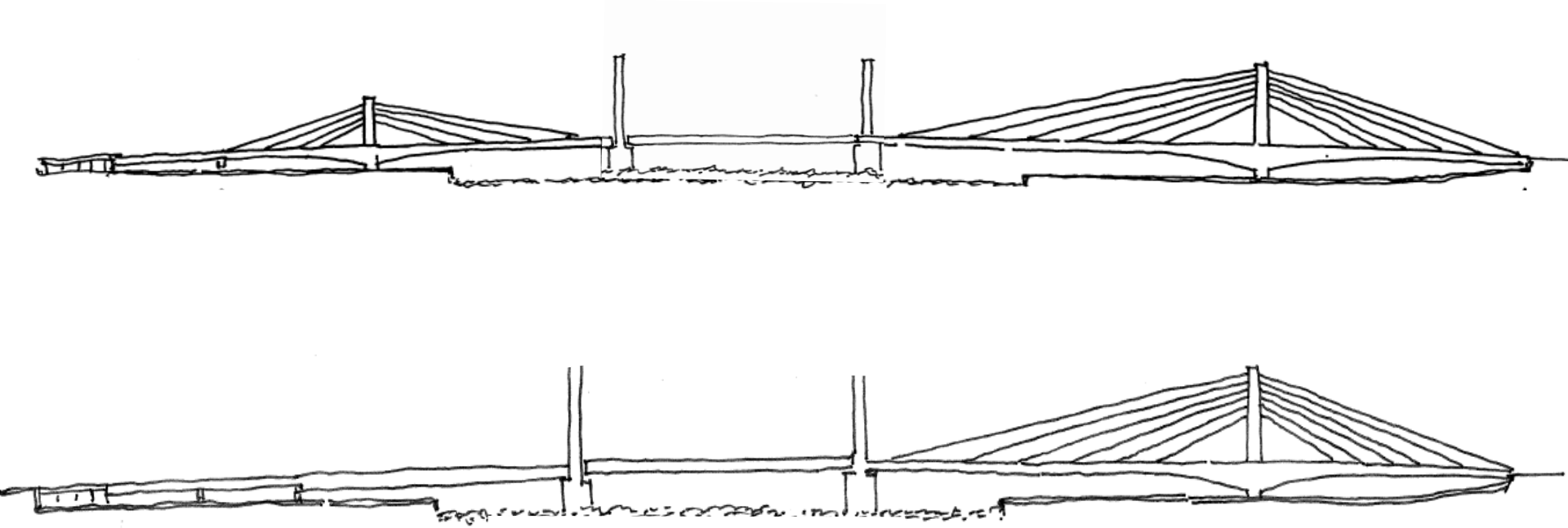
Bascule + Extradosed



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift + Extradosed



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Feasible Extradosed Types: Conventional "Goalpost" Style

Key Technical Attributes:

- Proven reliability in a seismic event
- Offers a variety of tower shapes and cable patterns (similar to Cable Stayed option)
- Tower Height: ~50' (west approach) and ~80' tall (east approach)

Key Technical Trade-offs:

- Heavier bridge requires larger foundations
- West Approach tower needs to be located within Waterfront Park
- Requires a deeper superstructure, causing insufficient vertical clearances below deck at Naito Parkway


St Criox Bridge, Minnesota


Jiayue Bridge, China

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Fixed Approach Bridge Types

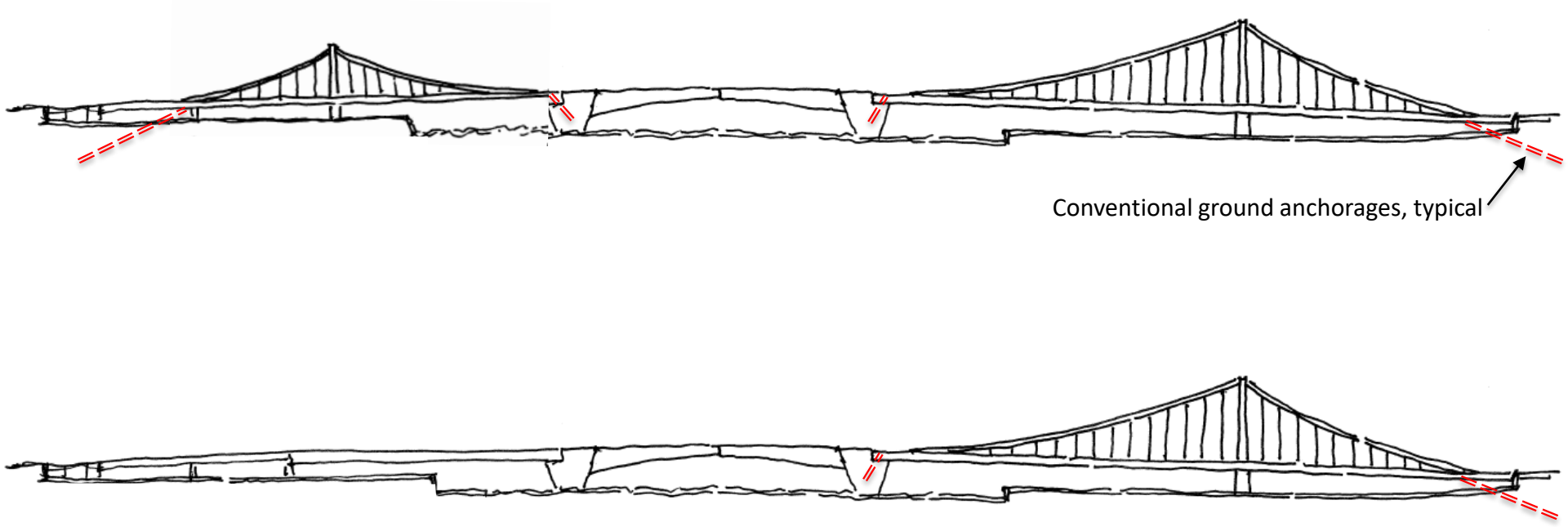
Study Type:

Suspension

(including Self-anchored)

Menu of Bridge Types

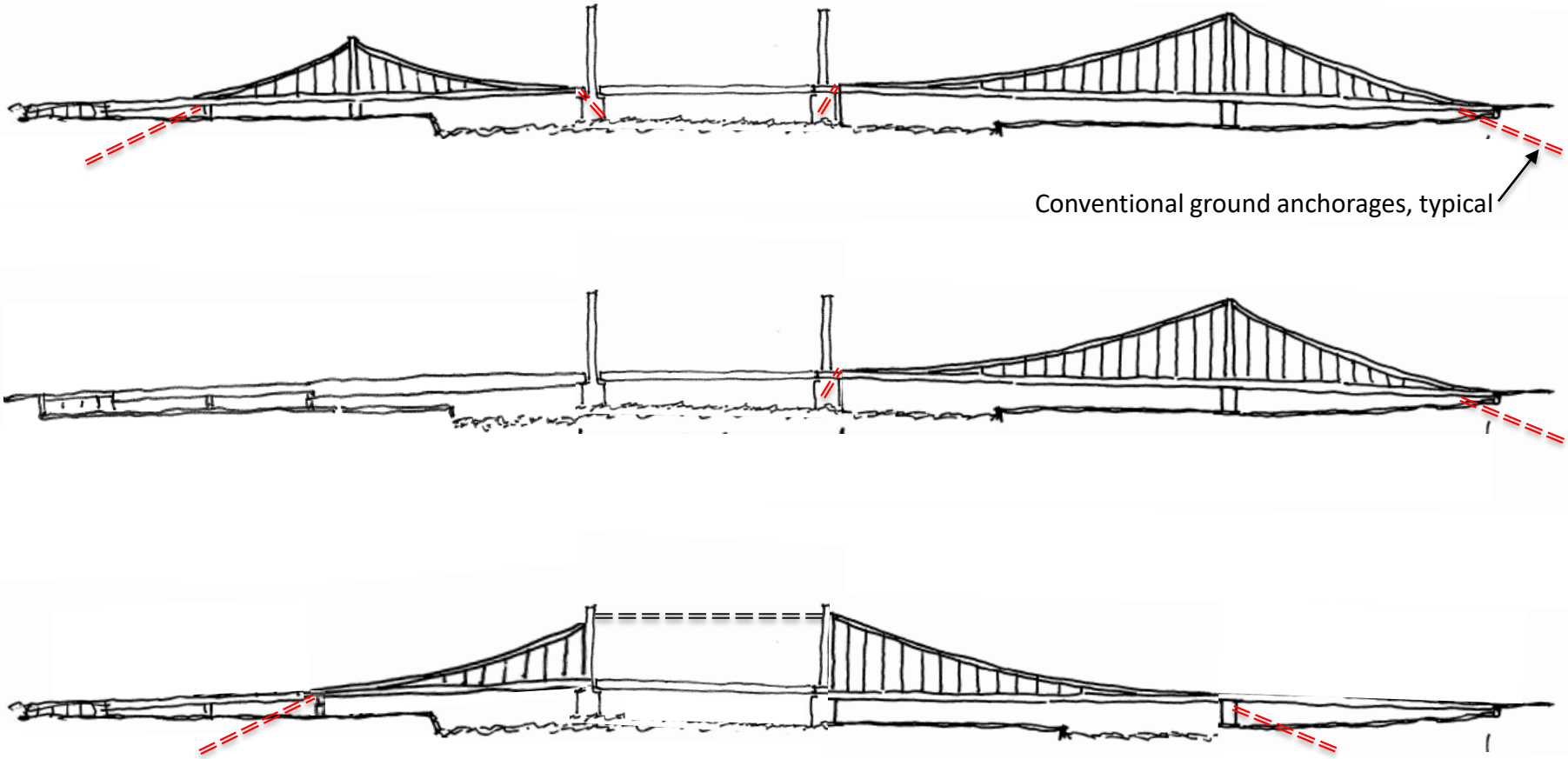
Bascule + Suspension (Conventional or Self-anchored)



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Lift + Suspension (Conventional or Self-anchored)



Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Suspension Type: Conventional In-ground Anchored Style

Key Technical Attributes:

- Suspension cables are anchored into the ground via “anchorage houses” or supports
- Tower Height: ~100’ (west approach) and ~150’ tall (east approach)

Key Technical Trade-offs:

- East anchorage placed in geotechnical hazard zone, requiring more mitigation
- Larger right of way impacts
- Uneconomical span lengths

Verrazano-Narrows Bridge, New York

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

Technically Challenged Suspension Type: Self-anchored Style

Key Technical Attributes:

- Utilizes lift towers to support approach spans
- Tower Height: ~100’ (west approach) and ~150’ tall (east approach)

Key Technical Trade-offs:

- Requires entire bridge to be supported by falsework during construction
- Expensive to construct


Roberto Clemente Bridge, Pittsburgh


San Francisco – Oakland Bay Bridge, CA

Menu of Bridge Types

Fixed Approach Bridge Types

Study Type:

“Other”

Menu of Bridge Types

EARTHQUAKE READY BURNSIDE BRIDGE

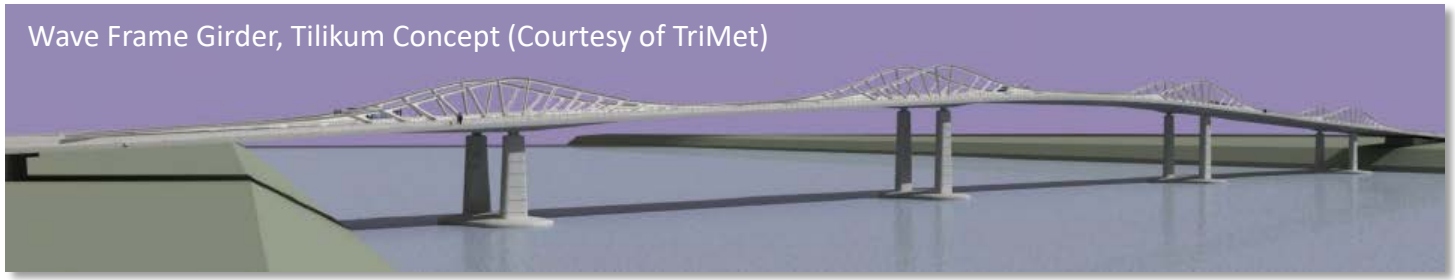
Technically Challenged "Other" Types: Wave Frame and Sail Blade Girder Types

Key Technical Attributes:

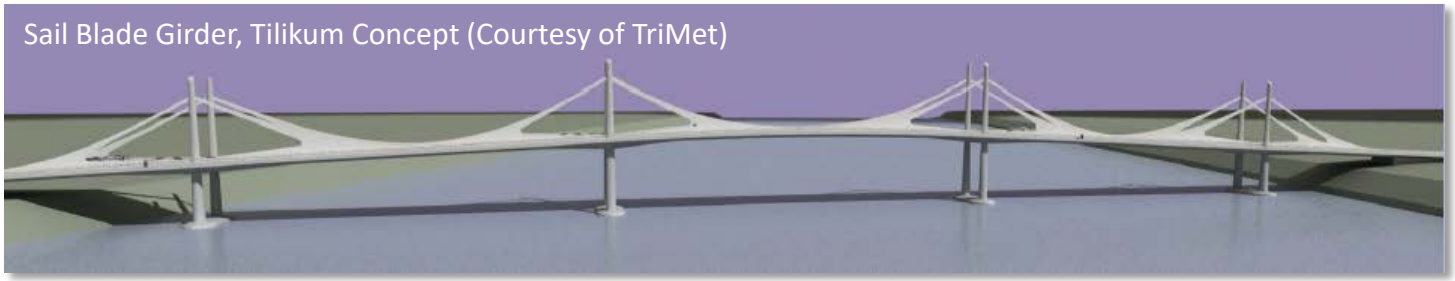
- Hybrid of truss, girder, and cable-supported structural elements
- Designed for slenderness and transparency
- Generally used for smaller-scaled bridges

Key Technical Trade-offs:

- Unproven seismic resiliency
- Will likely need more girder lines due to the bridge width
- Expensive to fabricate, construct, and maintain



Wave Frame Girder, Tilikum Concept (Courtesy of TriMet)



Sail Blade Girder, Tilikum Concept (Courtesy of TriMet)

10 Minute Break

Bridge Aspirations and Opportunities

EARTHQUAKE READY BURNSIDE BRIDGE

What should the bridge achieve?

Bridge Aspirations and Opportunities

GROUP DISCUSSION
(PLEASE NO WEBEX CHATS)

CTF Initial Interests Discussion

EARTHQUAKE READY BURNSIDE BRIDGE

Meeting #18 (Oct 26, 2020)

- Reliable for earthquake response and resiliency
- Connectivity for all users
- Elegant, light, and transparent; visually unobtrusive
- Visuals/Aesthetics fits with urban environment
- Fits into Portland culture and values
- Attractive place to travel and convene
- Leads to community gathering and enjoyment; Draws people
- Safe and comfortable
- Recognizes and preserves history
- Integrates into east and west neighborhoods; “A neighborhood bridge”
- Unresolved discussions about what iconic means to Portland
- Mixed opinions on symmetry vs. asymmetry

Bridge Aspirations and Opportunities

EARTHQUAKE READY BURNSIDE BRIDGE

Desired Bridge Experience

Question: How might a large structure take on elements of human scale?

Bridge Aspirations and Opportunities

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Bridge Design Opportunities

Question: What would make a new bridge iconic for Portland?

Question: What would make this Portland's "signature bridge" or a landmark?

Question: How should "Engineering as an art form" be expressed?

Bridge Aspirations and Opportunities

EARTHQUAKE READY BURNSIDE BRIDGE

Urban Design Opportunities

Question: What changes in the urban fabric might be needed to accommodate this new bridge?

Next Steps

Proposed Meeting Sequence

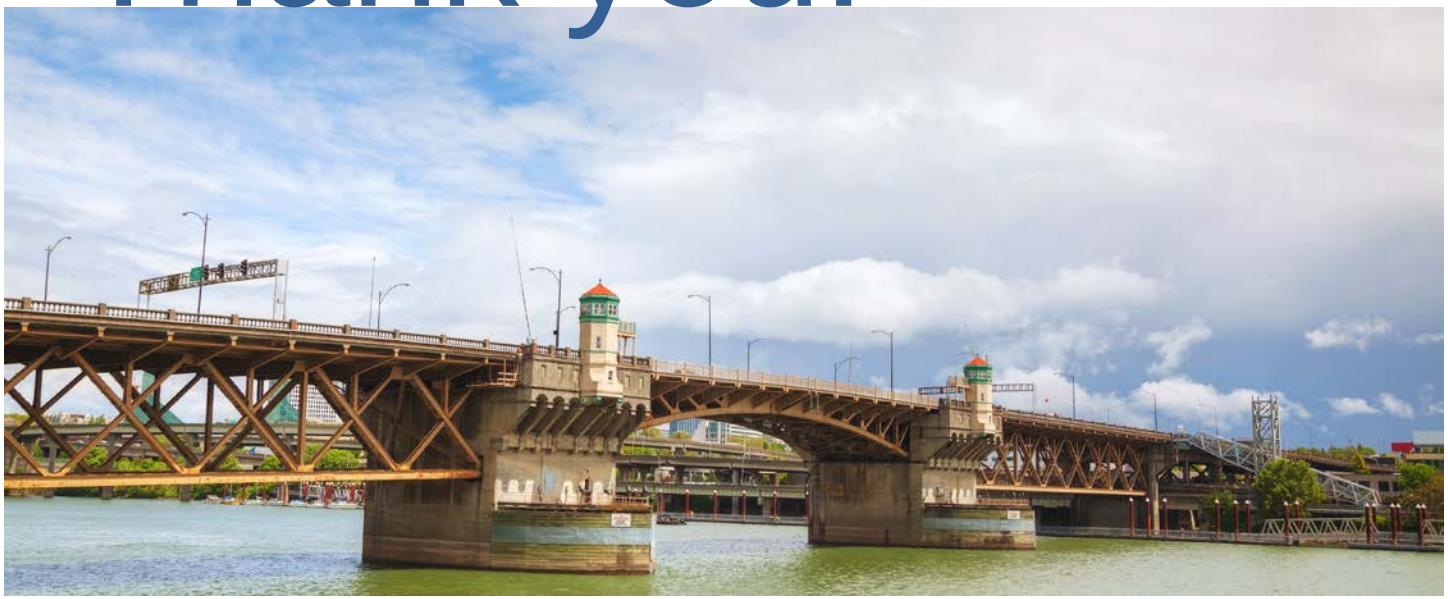
Proposed Meeting Dates and Durations:

- **Mtg #4 (2 hrs) – Wed 11/4/20**
  - Key Topics: Menu of Bridge Types (Refinement)
- **Mtg #5 (2 hrs) – Wed 11/18/20**
  - Key Topics: Range of Feasible Bridge Types; Visual Design Guidelines; Type Selection Evaluation Topics
- Mtg #6 (2 hrs) – Wed 12/2/20
- Mtg #7 (2 hrs) – Wed 12/16/20
- Mtg #8 (2 hrs) – Wed 3/10/21
- Mtg #9 (2 hrs) – Wed 6/2/21

Questions

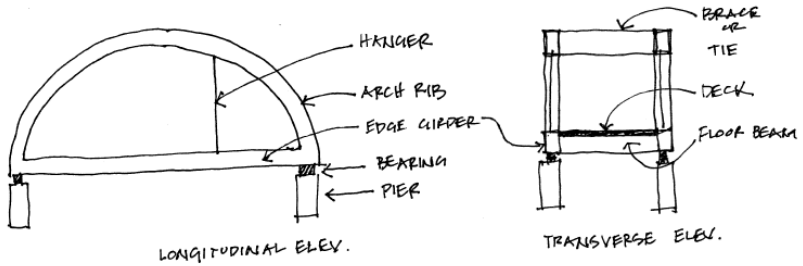
EARTHQUAKE READY BURNSIDE BRIDGE

Thank you!

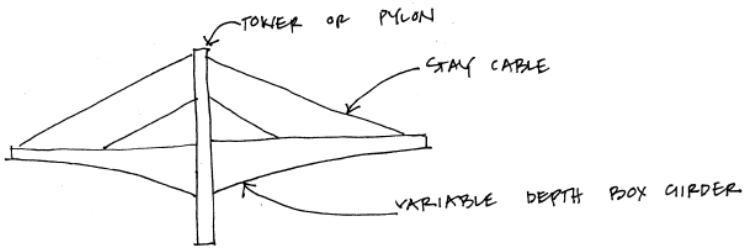


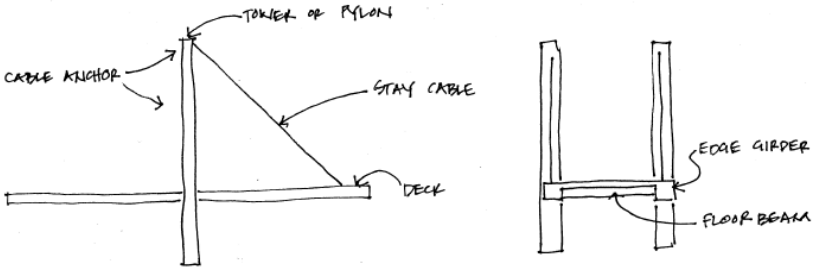
Bridge Design Fundamentals

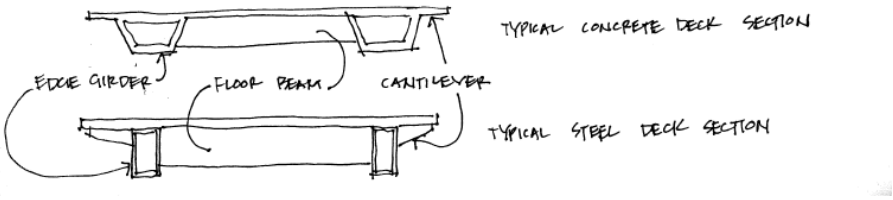
Bridge Terminology

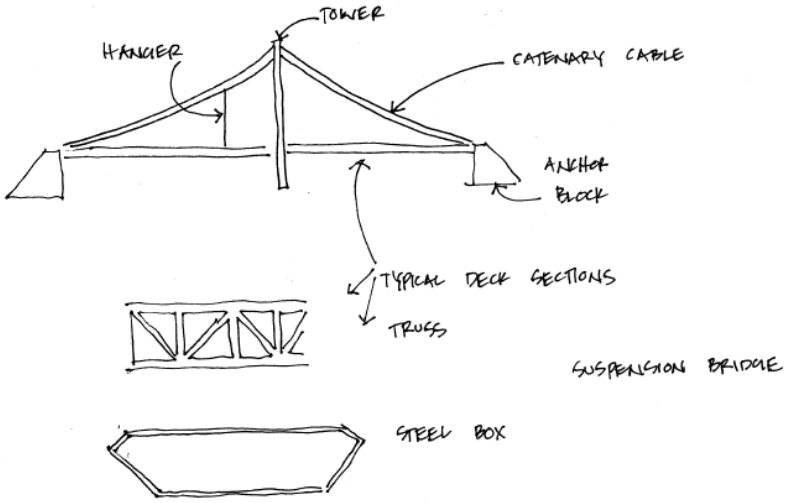


ARCH BRIDGE









Bridge Design Fundamentals

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Flow of Bridge Forces