Predicting Major Bridge Construction Costs

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A Tale of Two Bridges

Baldwin Bridge – Old Lyme, CT (1990)

Fig. 29. Final segments being placed in last span of new, parallel segmental bridges; existing bridge is in foreground.

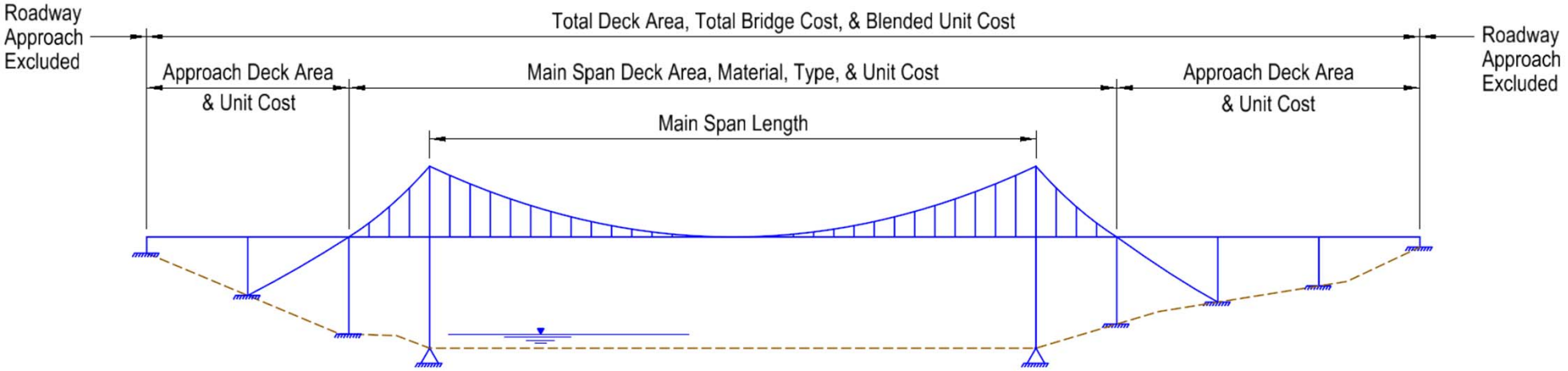
From PCI Journal

$232 per Sq. Ft.

Lafayette Bridge – St. Paul, MN (2010)

$227 per Sq. Ft.

Definition - Unit Cost Breakdown



Excluded Items:
Mobilization
Right-of-Way
Roadway/Civil/Utilities
Force Account
Traffic Control/Flagging/Railroad Flagging
Bridge Demolition (even if required for phased construction)
Temporary Detour Bridges

Dimensionality of Cost

- Inflation over time
- Geographic
  - Number of bidders
  - Union vs. non-union labor
- Material consumption (i.e. span length)
- Productivity/Technological advancement
  - Site constraints
  - Structure type/means & methods
- Noisy data
- Good old-fashioned risk

Explicitly defined

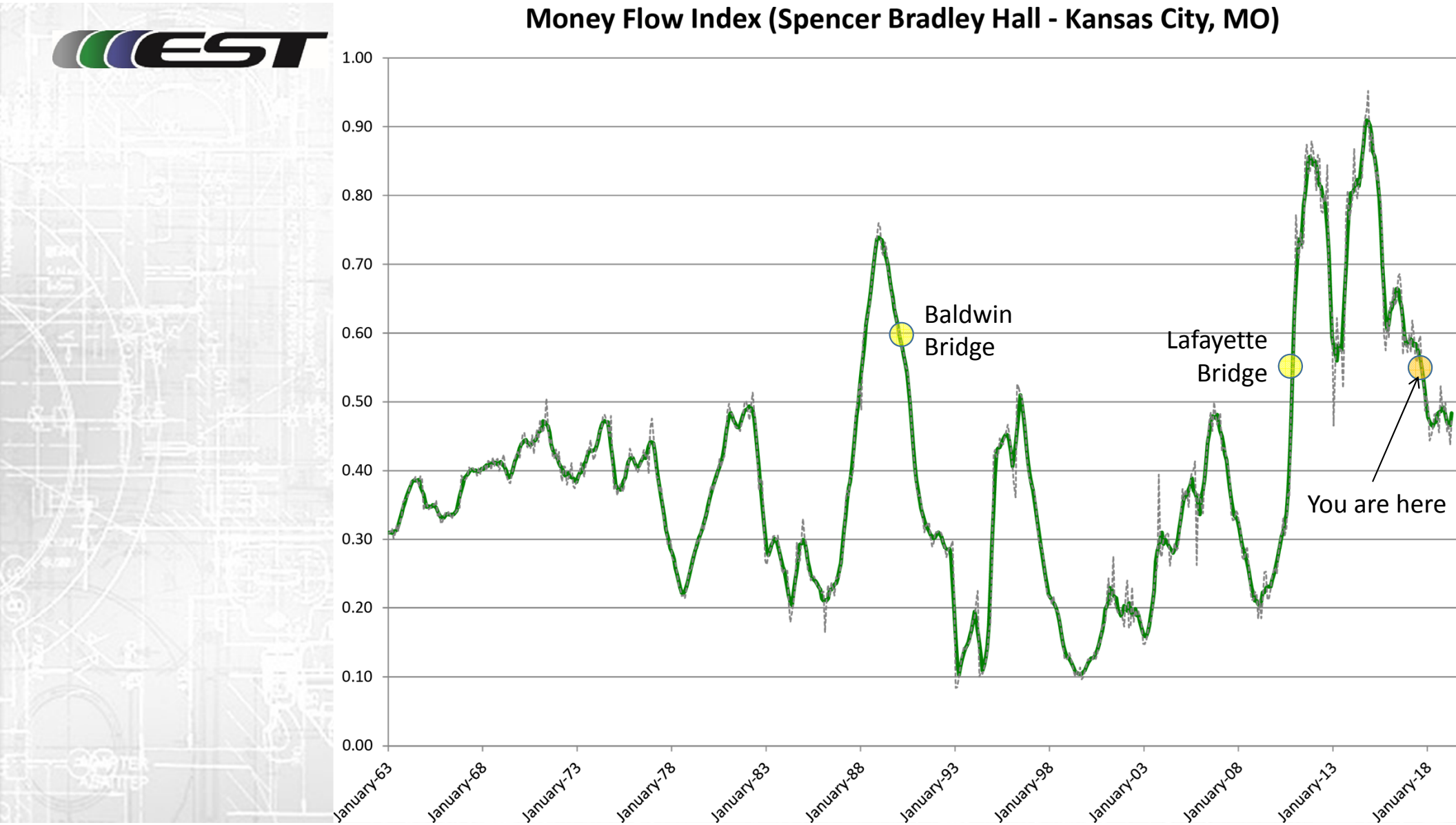
Implicit in selection of bridge cost prototype

Cost Extrapolation Function

For a given structure type:

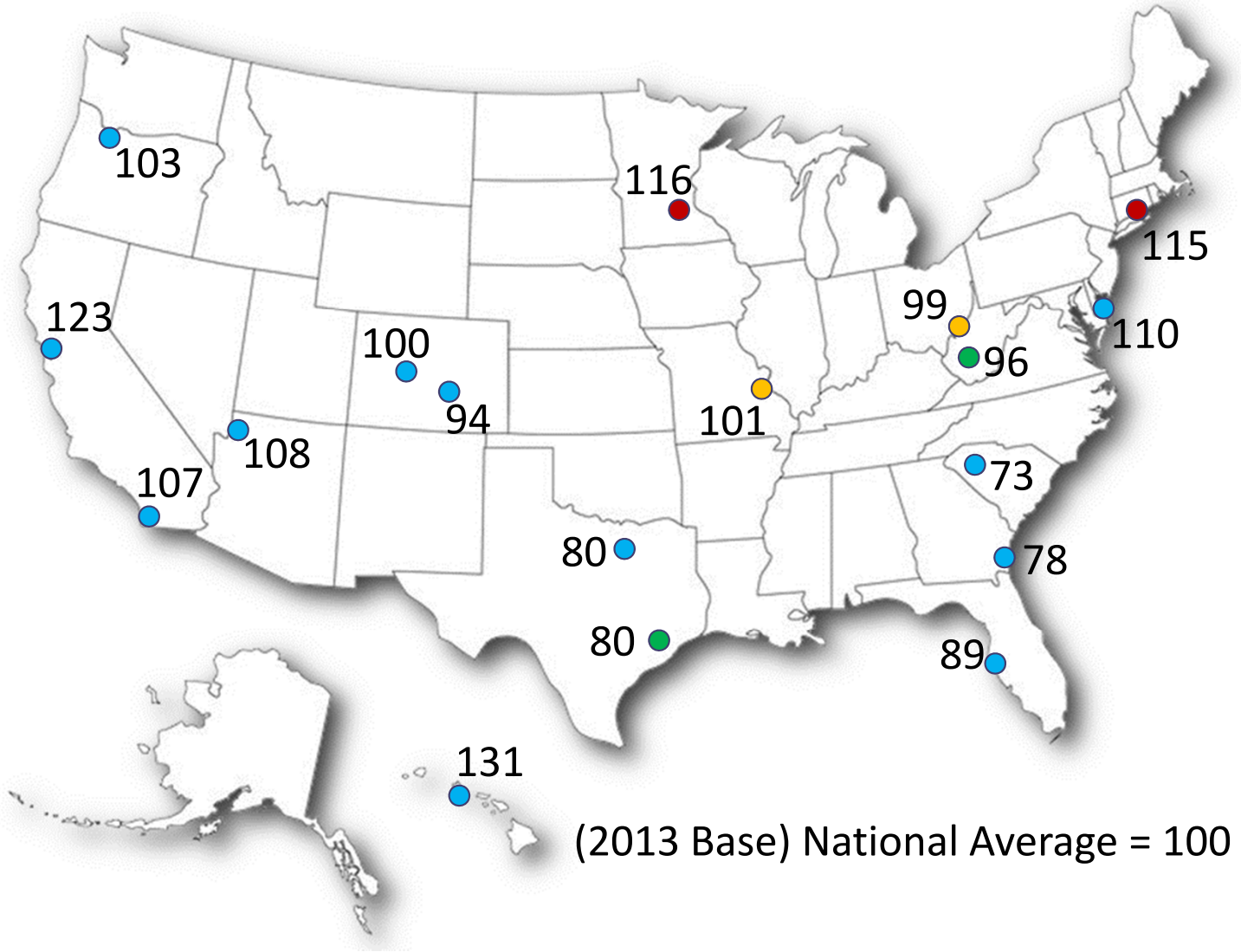
- $UC_j = UC_i \left(\frac{MFI_j}{MFI_i}\right)\left(\frac{GF_j}{GF_i}\right)\left(\frac{SF_j}{SF_i}\right)$
  - *UC = Unit cost*
  - *MFI = Inflation factor*
  - *GF = Geographic factor*
  - *SF = span length factor*

Cost Over Time


Money Flow Index (Spencer Bradley Hall - Kansas City, MO)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Baldwin Bridge
Lafayette Bridge
You are here
January-63
January-68
January-73
January-78
January-83
January-88
January-93
January-98
January-03
January-08
January-13
January-18

Geographic Cost Variation

RS Means City Index



(2013 Base) National Average = 100

Example 1

Baldwin Bridge – Old Lyme, CT (1990)

Fig. 29. Final segments being placed in last span of new, parallel segmental bridges; existing bridge is in foreground.

From PCI Journal

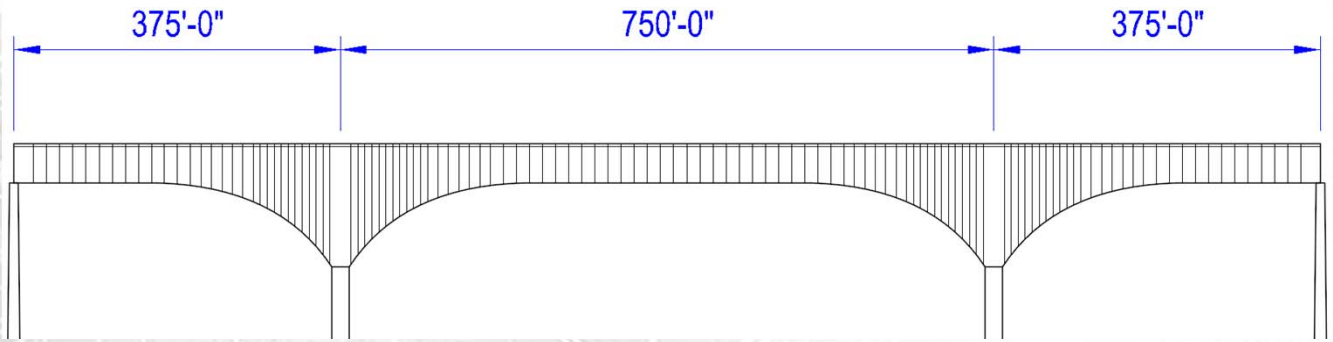
Main Span Unit Cost = $232 per Sq. Ft.
MFI = 0.60
GF = 115
Normalized Unit Cost = 3.4

Lafayette Bridge – St. Paul, MN (2010)

Main Span Unit Cost = $227 per Sq. Ft.
MFI = 0.55
GF = 116
Normalized Unit Cost = 3.6

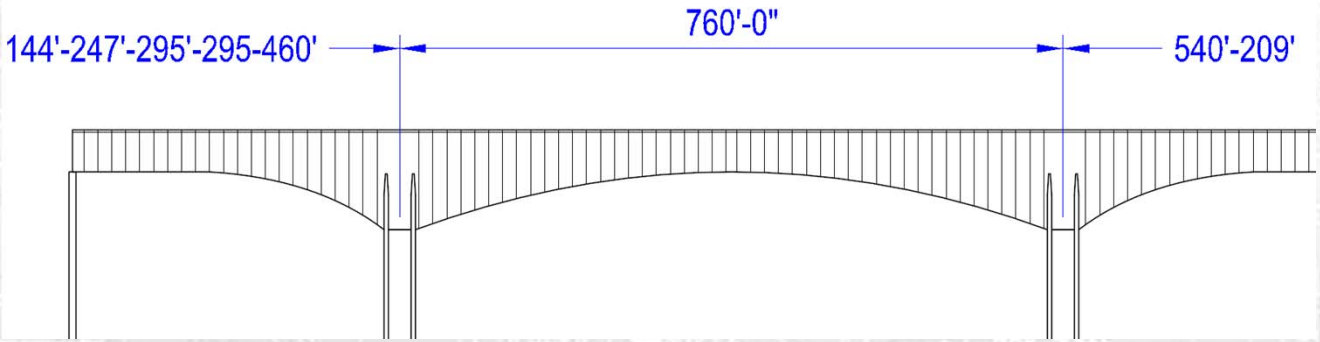
Example 2

Ship Channel Bridge – Houston, TX (1979)



Main Span Unit Cost = $221 per Sq. Ft.
MFI = 0.28
GF = 80
Normalized Unit Cost = 9.9

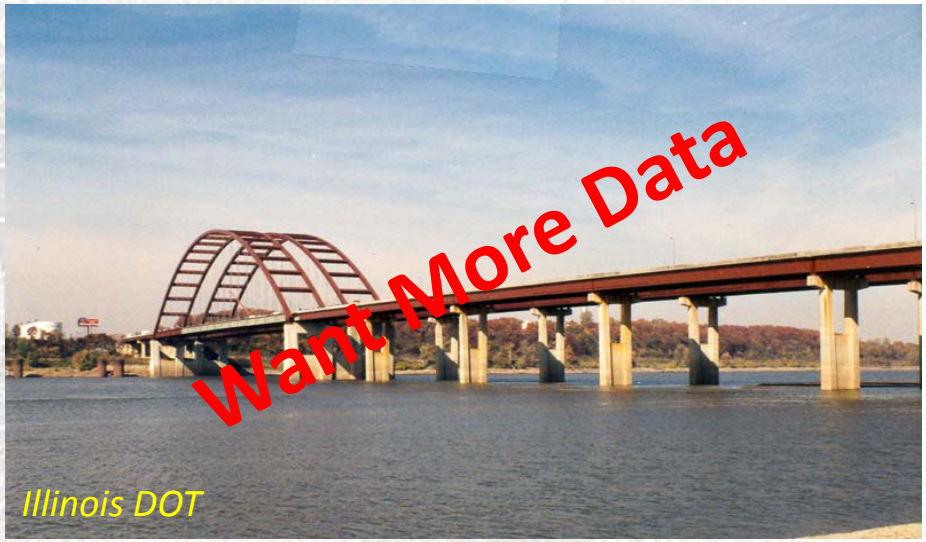
Kanawha River Bridge – Charleston, WV (2007)



Main Span Unit Cost = $382 per Sq. Ft.
MFI = 0.42
GF = 96
Normalized Unit Cost = 9.5

Example 3

Jefferson Barracks Bridge – St. Louis, MO (1983, 1986)



Blended Unit Cost = $281 per Sq. Ft.
MFI = 0.27
GF = 101
Normalized Unit Cost = 10.3

Blennerhassett Island Bridge – Parkersburg, WV (2005)

Blended Unit Cost = $264 per Sq. Ft.
MFI = 0.36
GF = 99
Normalized Unit Cost = 7.4

Example 4

West 7th Street Bridge – Ft. Worth, TX (2011)

Main Span Unit Cost = $209 per Sq. Ft.
MFI = 0.67
GF = 78
Normalized Unit Cost = 4.0

Maple Avenue Bridge – Redmond, OR (2006)

Main Span Unit Cost = $154 per Sq. Ft.
MFI = 0.48
GF = 99
Normalized Unit Cost = 3.2

Span Length Effect

Definition - Weighted Average Span

Example – Hoover Dam

- Average span = 237’
- Weighted average span =

$$\left[\frac{1090^2}{1896}\right]+\left[\frac{115^2}{1896}\right]_7 = 676’$$

Span Length Effect

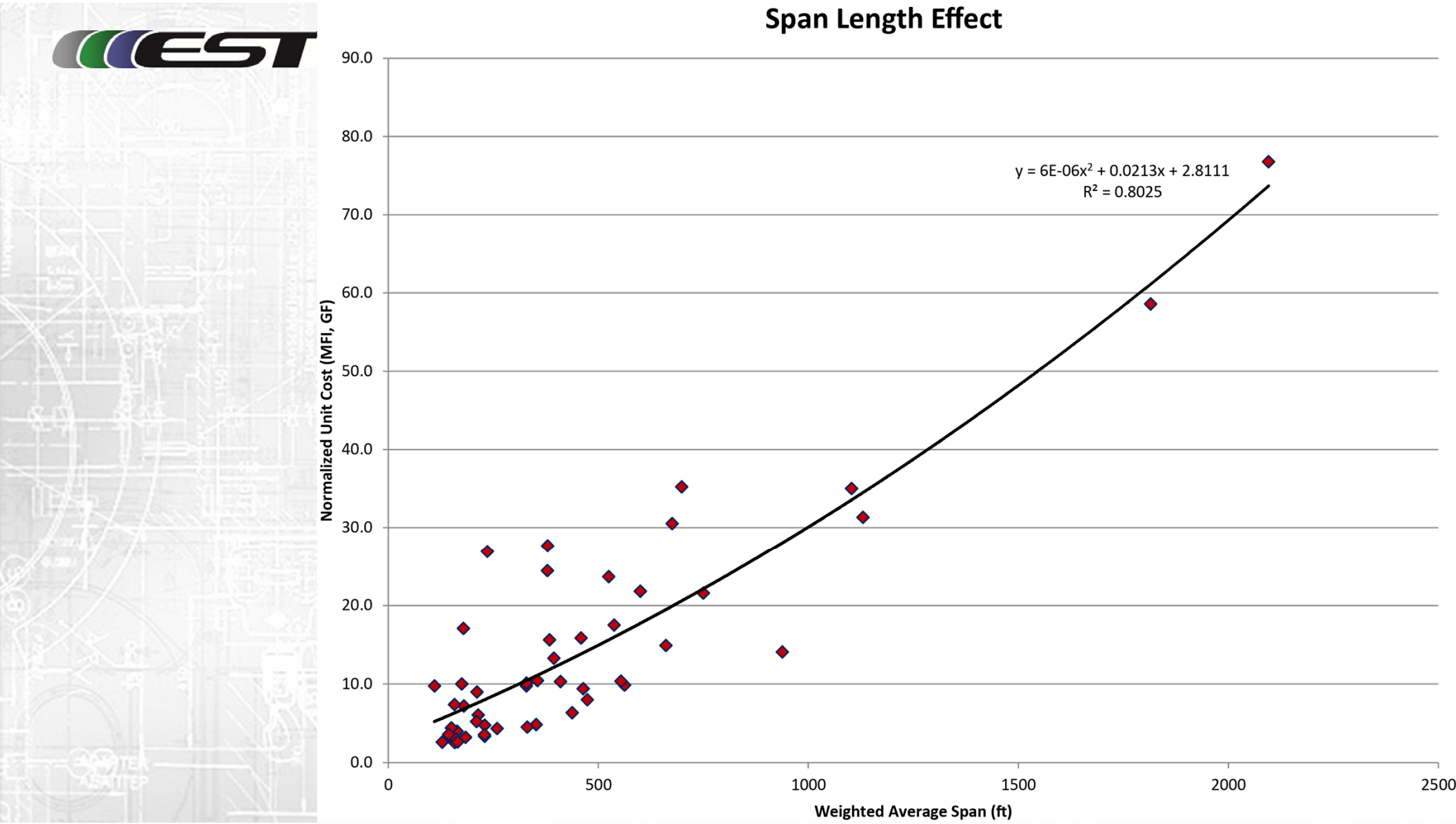
Normalized Unit Cost (MFI, GF)

90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0

0
500
1000
1500
2000
2500

Weighted Average Span (ft)

- Large Suspension
- Small Suspension
- Cable Stayed
- Arches
- Precast Segmental
- CIP Segmental
- Steel Tub
- Precast Tub

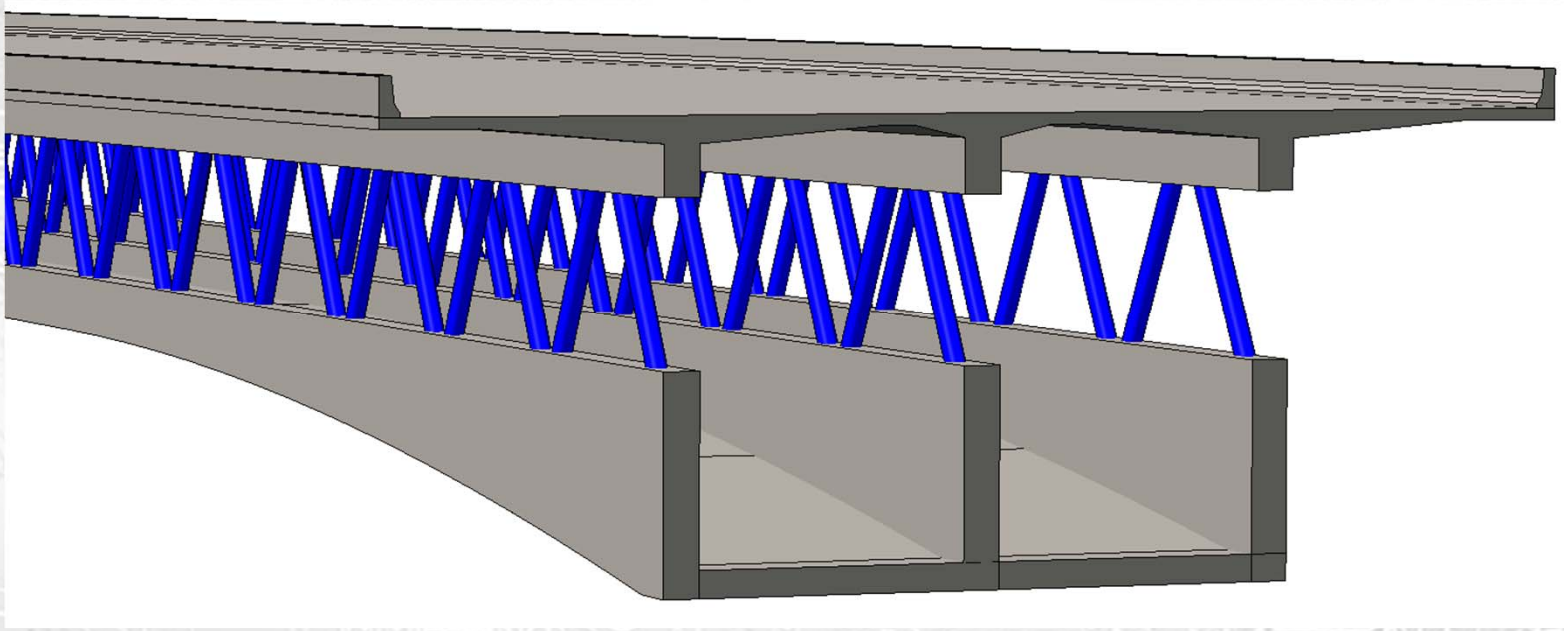

Span Length Effect
y = 6E-06x² + 0.0213x + 2.8111
R² = 0.8025
Normalized Unit Cost (MFI, GF)
Weighted Average Span (ft)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
500
1000
1500
2000
2500

Using The Model

Hypothetical Prediction – I-5 CRC

Proposed 2,865’ Main Span Unit (Bid January 2019)

- Spans of 270’-5@465’-270’ (weighted avg. span = 428’)
- Composite concrete segmental box girder/steel tube diagonals



Hypothetical Prediction – I-5 CRC

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Cost Prototype 1
I-205 Glenn Jackson Bridge – Portland, OR (1978)

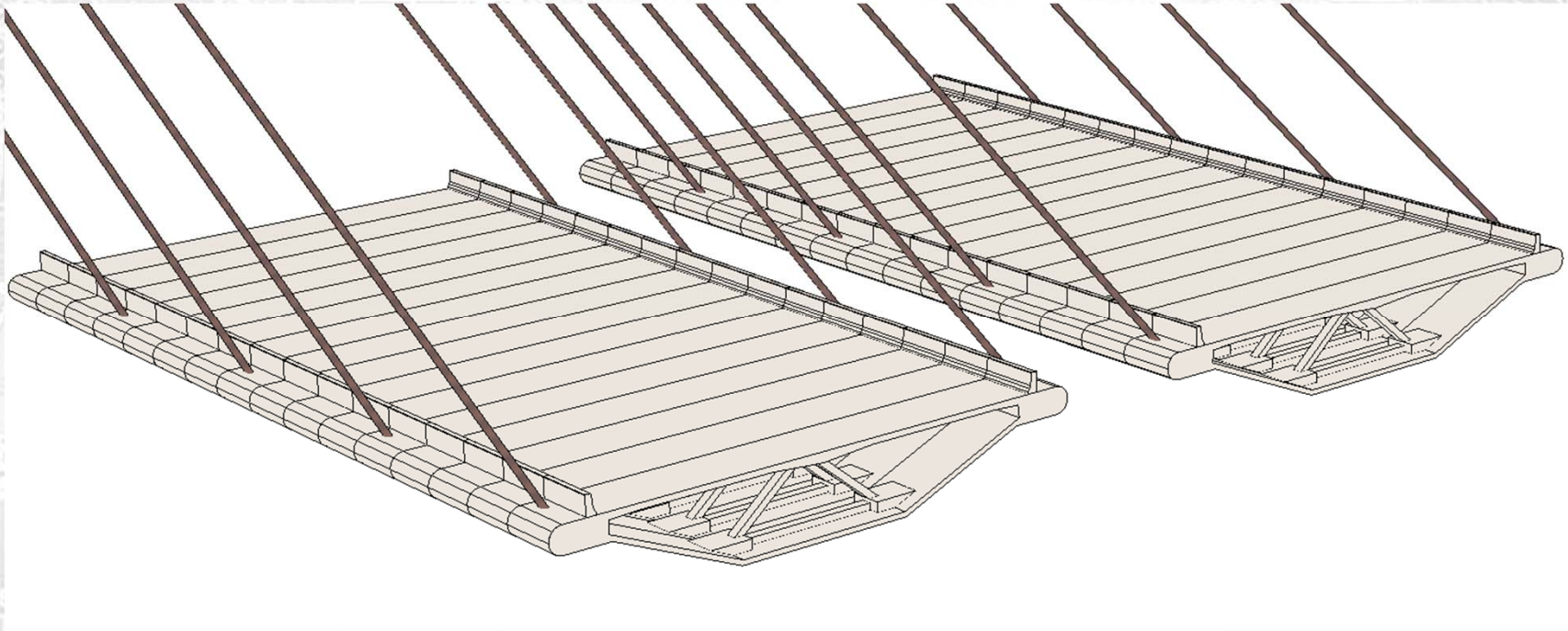
UC_j = **\$214** $\left[\frac{0.47}{0.26}\right]\left[\frac{103}{103}\right]\left[\frac{11.0}{8.0}\right]$ = **\$532 per Sq. Ft.**

Cost Prototype 2
Willamette River Bridge – Portland, OR (2010)

UC_j = **\$845** $\left[\frac{0.47}{0.47}\right]\left[\frac{103}{103}\right]\left[\frac{11.0}{17.5}\right]$ = **\$532 per Sq. Ft.**

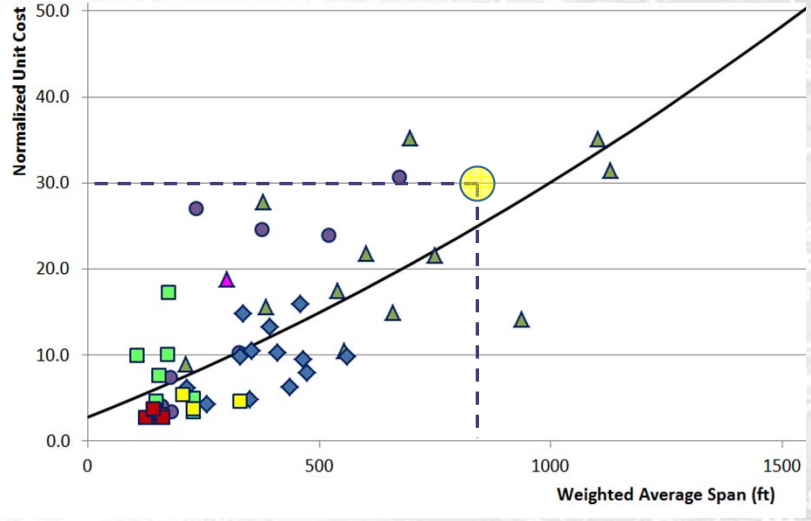
Prediction – Ship Channel Bridge

- Concrete cable-stayed main span (240’-460’-1320’-460’-240’)
  - Weighted average span = 838.5’; bid June 2017



Prediction – Ship Channel Bridge

Main Span Cost Prototype
Sidney Lanier Bridge – Brunswick, GA (1997)



$$UC_j = \$354 \left[\frac{0.58}{0.32}\right] \left[\frac{80.0}{78.4}\right] \left[\frac{30.0}{14.1}\right] = \$1393 \text{ per Sq. Ft.}$$

386,240 SF x $1,393/SF =
$538M Main Span Bridge Cost

Conclusions

- Summary/judgment
- Reporting of project cost/bridge cost
- Inflation
- Limitations