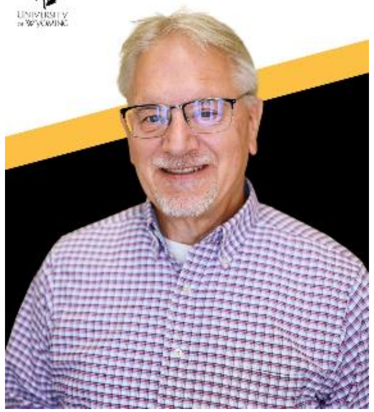
SHORT SPAN STEEL BRIDGE ALLIANCE™

Bridge Economy, Initial Costs and Life Cycle Costs

New Jersey Short Span Steel Bridge Workshop
February 12, 2026

Dr. Michael G. Barker, PE
University of Wyoming &
SSSBA, Director of Education



Steel

www.shortspansteelbridges.org

Steel & Concrete Bridges

Initial Costs

Life Cycle Costs

Initial Costs: Steel & Concrete

Preconception that Concrete is Less Expensive than Steel for Typical Bridges

Many Times Steel is Not Even Considered

Owners Paying More Than They Could for Bridges

Unwarranted Lack of Competition Not Good

Missouri County Bridges – Where the SSSBA Began

Steel

<u>Audrain County, MO Bridge 411</u>
Built 2012
Steel 4 Girders
47.5 ft. Span
24 ft. Roadway Width
2 ft. Structural Depth
No Skew

Concrete

<u>Audrain County, MO Bridge 336</u>
Built 2012
Precast 6 Hollowcore Slab Girders
50.5 ft. Span
24 ft. Roadway Width
2 ft. Structural Depth
20º Skew

County Crew Built Bridges

Side-by-Side Comparison Total Cost of Structure

Steel

19.3% Total Bridge Cost Savings with Steel

Concrete

Total Bridge Costs (Steel)	
Material	= $41,764
Labor	= $24,125
Equipment	= $21,521
Guard Rail	= $ 7,895
Rock	= $ 8,302
Engineering	= $ 8,246
TOTAL	= $111,853 ($97.48 / sq. ft.)

Total Bridge Costs (Concrete)	
Material	= $67,450
Labor	= $26,110
Equipment	= $24,966
Guard Rail	= $ 6,603
Rock	= $ 7,571
Engineering	= $21,335
TOTAL	= $154,035 ($120.83 / sq. ft.)

Superstructure Only Comparison

Steel		Concrete	
Superstucture Costs		Superstructure Costs	
Material		Material	
Girders	= $ 21,463	Slab Girders	= $ 50,765
Deck Panels	= $ 7,999	Deck Panels	= $ 0
Reinf Steel	= $ 3,135	Reinf Steel	= $ 724
Concrete	= $ 4,180	Concrete	= $ 965
Labor	= $ 5,522	Labor	= $ 4,884
Equipment*	= $ 500	Equipment*	= $ 4,000
SUPER TOTAL	= $ 42,799	SUPER TOTAL	= $ 61,338
SUPER TOTAL	= $37.54 / sq. ft.	SUPER TOTAL	= $50.61 / sq. ft.

**Added cost to use galvanized steel = $5,453.80 or $0.22 / lb. (includes est. 10% fabrication fee)*
*** Cost to use weathering steel is approximately $0.04 / lb. (already included in cost in example)*

*County Crane (30 Ton) used for Steel, Larger Rented Crane (100 Ton) Required for Concrete
(Equivalent County Crane Cost is $1520, would result in Steel Cost of $38.88 / sq. ft.)

True Cost Comparison Steel vs Concrete

Steel: Superstructure $37.54 per sq. ft.

Concrete: Superstructure Cost $50.61 per sq. ft.

25.8% superstructure cost savings

Same bridge conditions:

- Structural Depth = 2 ft. (No Difference in Approaches)
- Roadway Width = 24 ft.
- Same Abutments for Both Can be Used (Steel Could Use Lighter)
- Same Guard Rail System
- Same Work Crew

Case Study Bridges: Other Bridges in Audrain County

Superstructure	Steel						Concrete				
Bridge Number	061	140	149	152	710	AVG	028	057	069	520	AVG
Year Built	2008	2008	2008	2009	2010	AVG	2009	2010	2011	2006	AVG
Span Length	50	50	40	62	64	**53.2**	36	36	38	40	**37.5**
Skew	0	0	0	30	35	**13**	0	15	20	30	**16.25**
Cost Summary											
- Labor	$14,568	$21,705	$15,853	$24,765	$31,949	**$21,768**	$12,065	$15,379	$14,674	$19,044	**$15,291**
- Material	$56,676	$53,593	$46,282	$92,821	$69,357	**$63,746**	$51,589	$54,450	$50,576	$46,850	**$50,866**
- Rock	$6,170	$6,216	$3,694	$8,235	$6,501	**$6,163**	$5,135	$7,549	$5,378	$3,621	**$5,421**
- Equipment	$7,487	$12,026	$7,017	$19,579	$15,266	**$12,275**	$5,568	$10,952	$11,093	$14,742	**$10,589**
- Guardrail	$4,715	$7,146	$3,961	$7,003	$7,003	**$5,966**	$4,737	$4,663	$5,356	$3,323	**$4,520**
Construction Cost	$89,616	$100,686	$76,807	$152,403	$130,076	**$109,918**	$79,094	$92,993	$87,077	$87,580	**$86,686**
CONST. COST PER FT^2	**$74.68**	**$83.91**	**$80.01**	**$102.42**	**$84.68**	**$86.09**	**$91.54**	**$107.63**	**$95.48**	**$91.23**	**$96.32**

Missouri DOT State Bridges

Both Bridges Cross US 63 in Boone County

Concrete P/S: 92 ft – 92 ft

Route H (Columbia Airport)

Built 2011

Steel Plate Girder: 98 ft – 98 ft

Discovery Parkway (Columbia)

Built 2007

Contractor Built Bridges

Missouri DOT State Bridges

Both Bridges Cross US 63 in Boone County

Concrete P/S: 92 ft – 92 ft

Route H (Columbia Airport)

Built 2011

Steel Plate Girder: 98 ft – 98 ft

Discovery Parkway (Columbia)

Built 2007

Letting Date 5/27/2011					
1800	206-10.00	Class 1 Excavation	85	CUYD	$1,700.00
1810	702-10.12	Structural Steel Piles (12 in.)	737	LF	$33,533.50
1820	702-60.00	Pre-Bore for Piling	240	LF	$9,600.00
1830	702-70.00	Pile Point Reinforcement	22	EA	$2,420.00
1840	703-20.03	Class B Concrete (Substructure)	76.2	[illegible]	[illegible]
1850	703-42.13	Slab on Concrete I-Girder	[illegible]	[illegible]	[illegible]
1860	703-42.15	[illegible]	[illegible]	[illegible]	[illegible]
1870	705[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1880	706-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
~~1890~~	~~707-[illegible]~~	[illegible]	[illegible]	[illegible]	[illegible]
1900	712-3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1910	715-1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1920	716-10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1930	716-10[illegible]	[illegible]	[illegible]	[illegible]	$2,480.00
1940	725-10[illegible]	[illegible] Spacers	10	EA	$20,000.00
				Total Bridge Cost =	$440,632.50
				Cost/ft² =	$77.71

Letting Date 9/28/2007					
1560	206100	Class 1 Excavation	[illegible]	[illegible]	[illegible]
1580	7021012	Structural [illegible]	[illegible]	[illegible]	[illegible]
~~1570~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$15,029.00
[illegible]	[illegible]	[illegible]		~~L.S.~~	~~$7,000.00~~
[illegible]	[illegible]	[illegible]	12	EA	$2,400.00
[illegible]	7151001	Vertical Drain at End Bents	2	EA	$4,000.00
1720	7162000	Laminated Neoprene Bearing Pad	9	EA	$10,800.00
1710	7161003	Laminated Neoprene Bearing Pad (Tapered)	18	EA	$6,750.00
1730	7251000	Corrugated Metal Pipe Pile Spacers	20	EA	$5,000.00
1670	7125365A	Intermediate Field Coat (System G)	22100	SQFT	$30,940.00
1680	7125370A	Finish Field Coat (System G)	2800	SQFT	$3,220.00
~~1690~~	~~7129911~~	~~Misc. Fab. Struc. Low Alloy Steel (Aesthethics~~	~~24330~~	~~LB~~	~~$54,742.50~~
				Total Bridge Cost =	$1,057,538.80
				Cost/ft² =	$64.04
				Cost/ft² with ENR CCI Adjustment of 1.139 =	$72.94

Using ENR CCI Index Increase of 2.7%/yr
For 2017

Concrete = $ 91.18/ft²

Steel = $ 85.58/ft²

Summary on Initial Costs

SSSBA Conducted Case Studies:

- County & State Bridges
- Bids & Actual Costs
- Case Studies of County Bridges
- **Others Not Shown Here**

NSBA Cost Study

Superstructure	Steel						Concrete				
Bridge Number	061	140	149	152	710	AVG	028	057	069	520	AVG
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CONST. COST PER FT^2	$74.68	$83.91	$80.01	$102.42	$84.68	$86.09	$91.54	$107.63	$95.48	$91.23	$96.32

tate Bridge (Designed by eSPAN140)

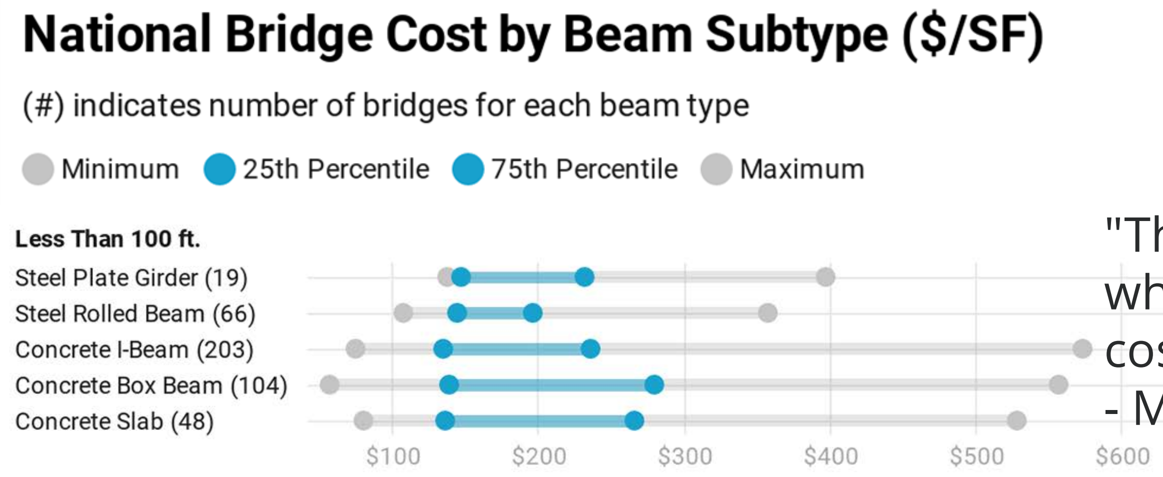
nsas Department of Transportation
- Shawnee County
- 112 feet (5 plate girder bridge)
- Competitive bid process (steel vs. concrete)
- DOT used eSPAN140 for preliminary design
- Constructed in summer 2014

Steel Bridge Bid
Concrete Bridge Bids

Steel = $ 1.240 mil
Concrete = $ 1.243 – $ 1.425 mil

County Bridge (Designed by eSPAN140)

- **Boone County, Missouri (Local)**
  - High Point Lane Bridge
  - 102 feet (2 lane rural road plate girder bridge)
  - 44" weathering steel plate girders (4 lines)
  - Constructed in summer 2013



"These conclusions come as a surprise to the authors, who assumed that concrete bridges would be more cost-competitive than steel bridges."
- Mike Digregorio, HDR

https://www.aisc.org/nsba/hdr-pricing-study/

Steel Bridges Compete and Win!

What About Life Cycle Costs?

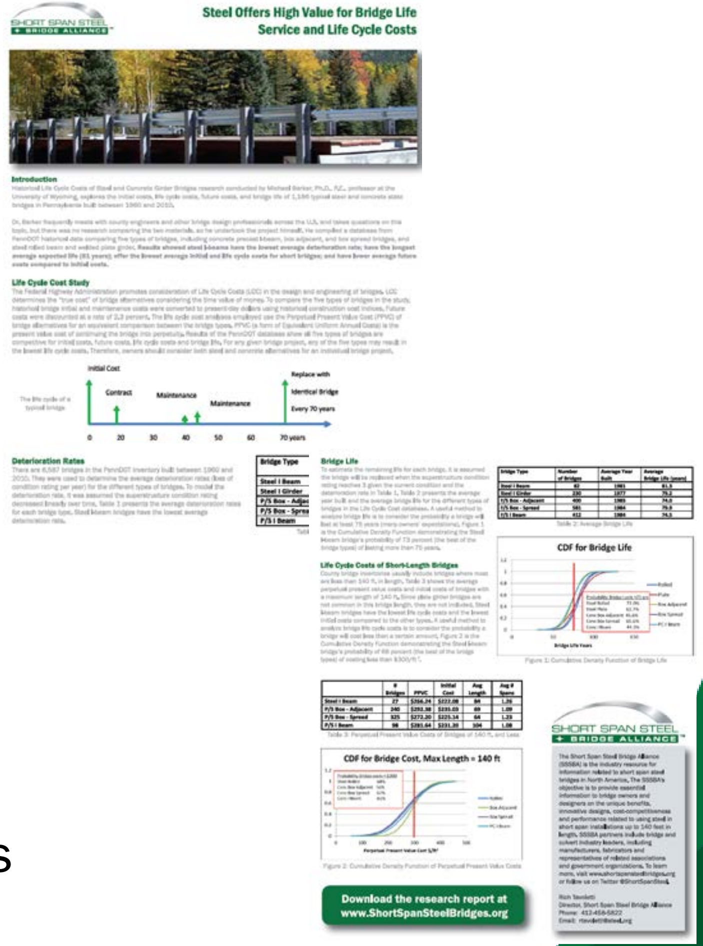
As owners replace their bridge infrastructure, the question of Life Service and Life Cycle Costs routinely comes up between concrete and steel bridge options

The bridge industry ~~does~~ did not have a good answer:

- Both steel and concrete bridge advocates claim an advantage
- Anecdotal information is not convincing

Historical Life Cycle Costs of Steel & Concrete Girder Bridges

Examine Historical Life Service (Performance and Maintenance) and Agency Life Cycle Costs (True Agency Costs for a Bridge) of Steel and Concrete Bridges in Pennsylvania



Report on ShortSpanSteelBridges.org

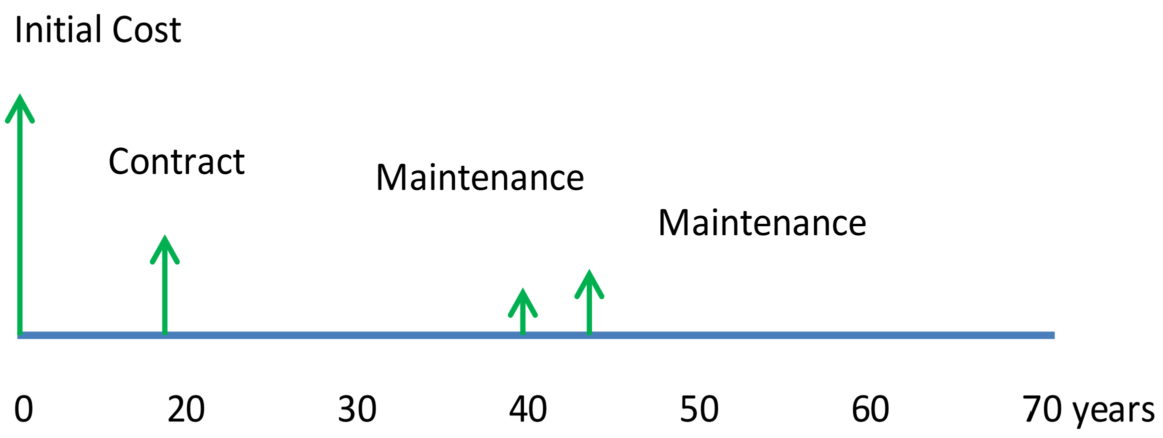
Additional Report on Galvanized Bridges

Thank You to PennDOT professionals for their participation
Support from AISI, NSBA and AGA

Life Cycle Cost Data Collection

Start with a Comprehensive Inventory of Bridges

Initial Costs & Date Built
Maintenance Costs and Date Performed
End of Service Date – End of Life Model



PennDOT Database Development

<u>Criteria to Develop LCC Bridge Database</u>

Modern typical bridge structures

Precast I-Beam, Box Adjacent, and Box Spread bridges

Steel Rolled Shape and Welded Plate Girder bridges

Bridges built between 1960 and 2010

Bridges with complete and accurate department maintenance records

Consider any maintenance cost that is equal to or greater than $0.25/ft^2

Bridges with known initial costs

Bridges with complete and accurate external contractor maintenance and rehabilitation

Initial cost limitation to bridges with initial cost less than $500/ft^2 and greater than $100/ft^2

Note: Total Recorded Initial and Maintenance Costs Used

PennDOT Database Development

All Bridges in PennDOT Inventory = 25,403
Number of Type Bridges in Inventory = 8,466
Number of Types Built 1960-2010 = 6,587

Bridges that Meet All Criteria

Bridge Type	Number of Bridges that Meet All criteria	Percentage of 1960 – 2010 database
Steel I Beam	82	14.9%
Steel I Girder	230	22.6%
P/S Box - Adjacent	400	27.8%
P/S Box - Spread	581	26.5%
P/S I Beam	412	29.8%
Total	1705	25.9%

PennDOT Database Bridge Life Model

Bridge Life Model uses Average Deterioration Rates of Total PennDOT Inventory

Assume Bridge Replacement at Condition Rating = 3
Super Structure Condition Rating Used

$$Deterioration\ Rate = \frac{(2014\ Condition\ Rating) - 9}{2014 - (Year\ Built)}$$

$$Remaining\ Life = \frac{3 - (2014\ Condition\ Rating)}{(Average\ Deterioration\ Rate)}$$

$$Bridge\ Life = 2014 - (Year\ Built) + Remaining\ Life$$

Bridge Type	Number of Bridges 1960 - 2010	Deterioration Rate (Condition Rating Loss/Year)
Steel I Beam	**550**	**-0.07114**
Steel I Girder	**1017**	**-0.08144**
P/S Box - Adjacent	**1440**	**-0.08125**
P/S Box - Spread	**2196**	**-0.07988**
P/S I Beam	**1384**	**-0.08383**

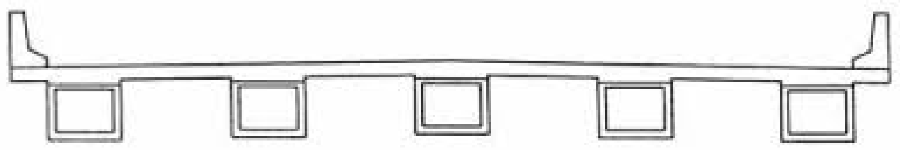
↑ Steel Rolled
Precast Box Spread

All are "similar" with None "Way Out" of Balance

Agency Life Cycle Costs – An Example

Precast Spread Box-Beam Bridge

BrKey:	30570
Bridge Type:	P/S, Box Beam (Spread)
County:	Shuylkill
Location:	0.75 mi. N of Exit 107(33)
Year Built:	1969
Spans:	3
Length:	176 ft
Deck Area:	7621 ft^2
Super Cond Rating:	5



Average Precast Box Beam – Spread bridge deterioration rate = -0.07988

$$Remaining\ Life = \frac{(3-5)}{-0.07988} = 25\ years$$

$$Bridge\ Life = 2014 + 25 - 1969 = 70\ years$$

Life Cycle Costs

Example Bridge Costs

Actual Costs / Years

Initial Cost:	Year = 1969	Cost = \$141475 (\$18.56/ft^2)	Work: Bridge Construction
External Contract:	Year = 1988	Cost = \$58401 (\$7.66/ft^2)	Work: Latex Overlay
Maintenance 1:	Year = 2009	Cost = \$1891 (\$0.25/ft^2)	Work: Repair Concrete Deck
Maintenance 2:	Year = 2013	Cost = \$2510 (\$0.33/ft^2)	Work: Repair Concrete Deck

Equivalent 2014 Costs / Years

ENR Construction Cost Indices

$$2014\ Dollars = \frac{CCI\ 2014}{CCI\ 19XX} 19XX\ Dollars$$

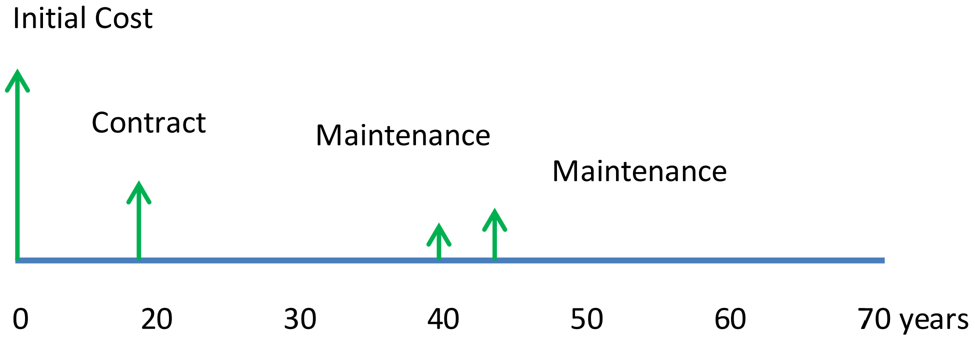
Transform the costs to constant 2014 dollars using Construction Cost

Initial Cost:	Year = 0	Cost = \$18.56/ft^2(9806/1269)	= \$143.45/ft^2
External Contract:	Year = 19	Cost = \$7.66/ft^2(9806/4519)	= \$ 16.63/ft^2
Maintenance 1:	Year = 40	Cost = \$0.25/ft^2(9806/8570)	= \$ 0.28/ft^2
Maintenance 2:	Year = 44	Cost = \$0.33/ft^2(9806/9547)	= \$ 0.34/ft^2

Life Cycle Costs

OMB Circular A-94 2011 30 yr Discount Rate = 2.3%

Example Bridge Life Cycle



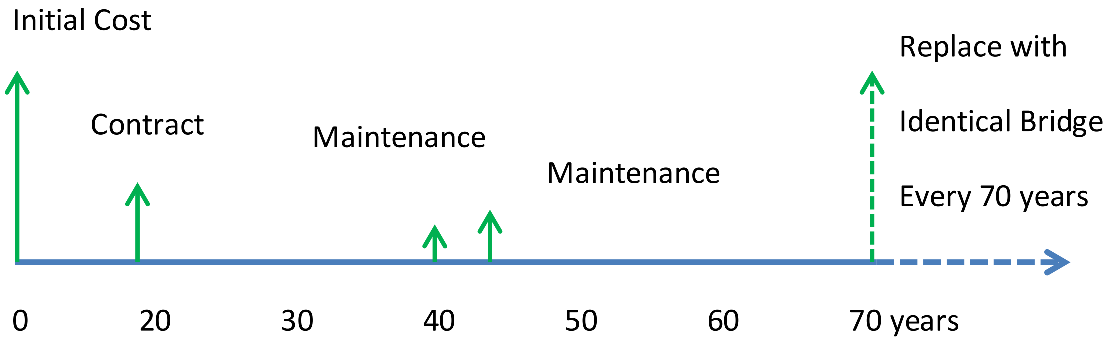
Present Value Cost for 1 Cycle

$$PVC = \$143.45 + \$16.63(1.023)^{-19} + \$0.28(1.023)^{-40} + \$0.34(1.023)^{-44} = \$154.49/ft^2$$

Life Cycle Costs

OMB Circular A-94 2011 30 yr Discount Rate = 2.3%

Example Bridge Life Cycle



Present Value Cost for 1 Cycle

$$PVC = \$143.45 + \$16.63(1.023)^{-19} + \$0.28(1.023)^{-40} + \$0.34(1.023)^{-44} = \$154.49/ft^2$$

Perpetual Present Value Cost = Capitalized Cost

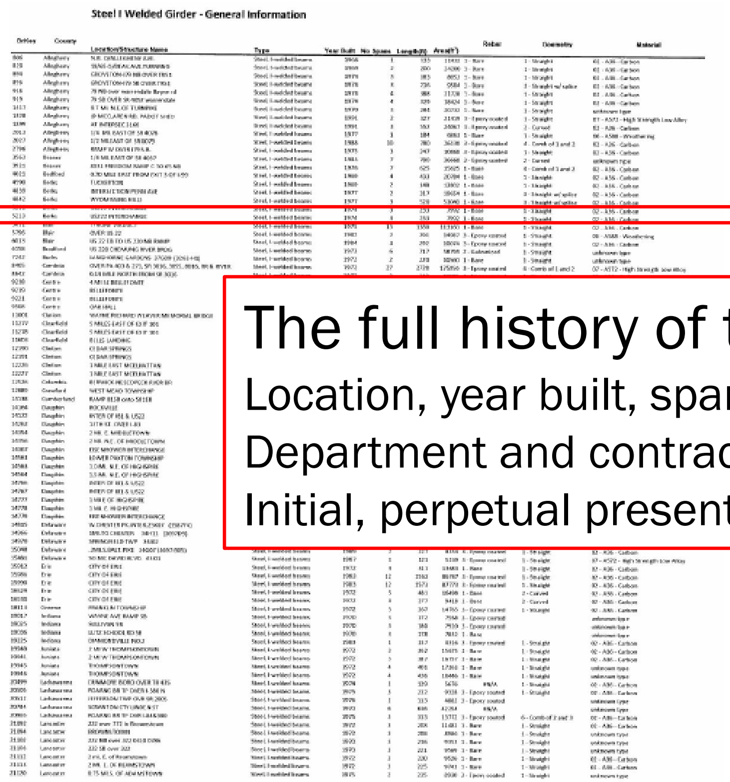
$$PPVC = \$154.49\left[\frac{(1+0.023)^{70}}{(1+0.023)^{70}-1}\right] = 1.256(\$154.49) = \$193.97/ft^2$$

With Capitalized Costs, Can Compare Bridges Directly

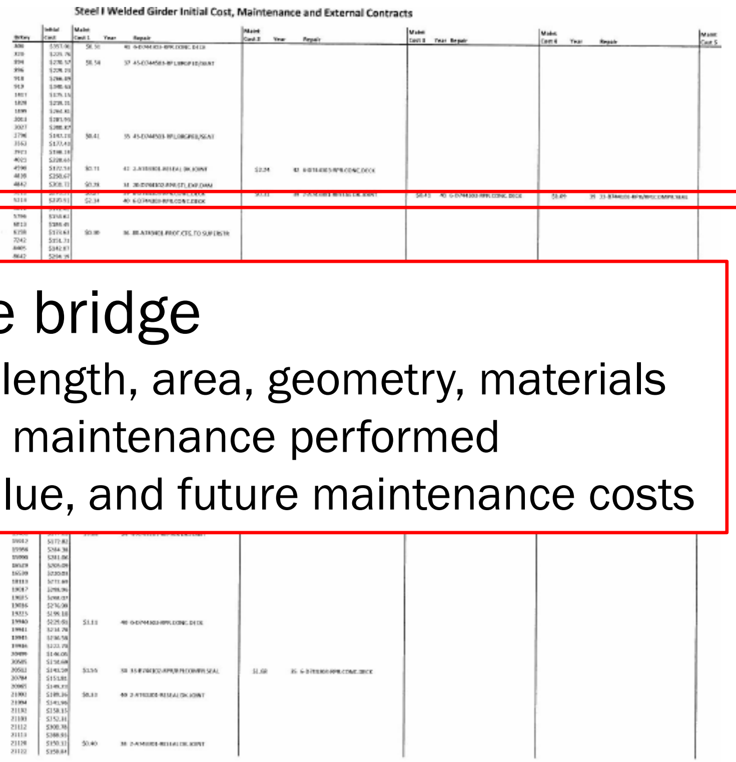
Life Cycle Cost Analyses

The Steel Plate Girder Bridge Data Base

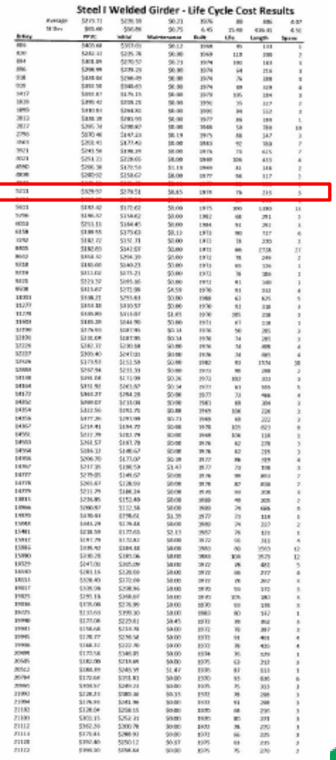
General Information



Maintenance & Contract Work



Initial & LCC



The full history of the bridge

Location, year built, spans, length, area, geometry, materials

Department and contractor maintenance performed

Initial, perpetual present value, and future maintenance costs

LCC Report

Analysis and Variables Examined in Report

- Bridge Life
- PPVC/Capitalized Costs
  - Number of Spans
  - Bridge Length
  - PVC Future Costs
  - Department Maintenance
  - External Contracts

For Steel Bridges

- Curved vs. Straight
- Fracture-Critical
- Protection (Painted, Weathering, Galvanized)

For the entire report:
www.ShortSpanSteelBridges.org

Additional LCC report on Galvanizing:
www.ShortSpanSteelBridges.org

Bridge Life

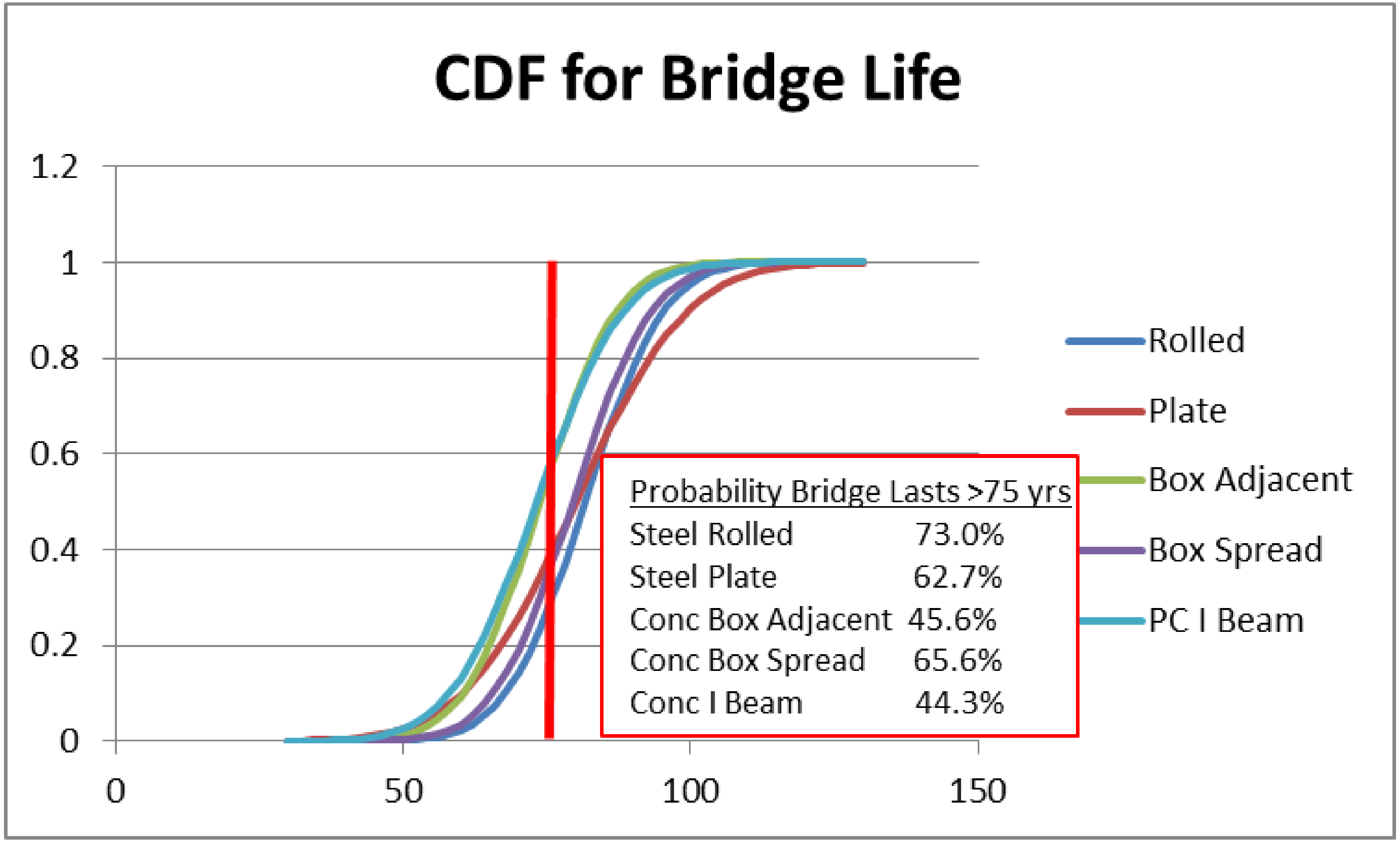
Bridge Type	Number of Bridges in Final LCC Database	Average Year Built	Average Bridge Life (years)
Steel I Beam	82	1981	81.3
Steel I Girder	230	1977	79.2
P/S Box - Adjacent	400	1985	74.0
P/S Box - Spread	581	1984	79.9
P/S I Beam	412	1984	74.5

↑

Steel Rolled
Precast Box - Spread

All are "similar" with None "Way Out" of Balance

Bridge Life


CDF for Bridge Life
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
Rolled
Plate
Box Adjacent
Box Spread
PC I Beam
Probability Bridge Lasts >75 yrs
Steel Rolled 73.0%
Steel Plate 62.7%
Conc Box Adjacent 45.6%
Conc Box Spread 65.6%
Conc I Beam 44.3%

Life Cycle Costs – All Bridges

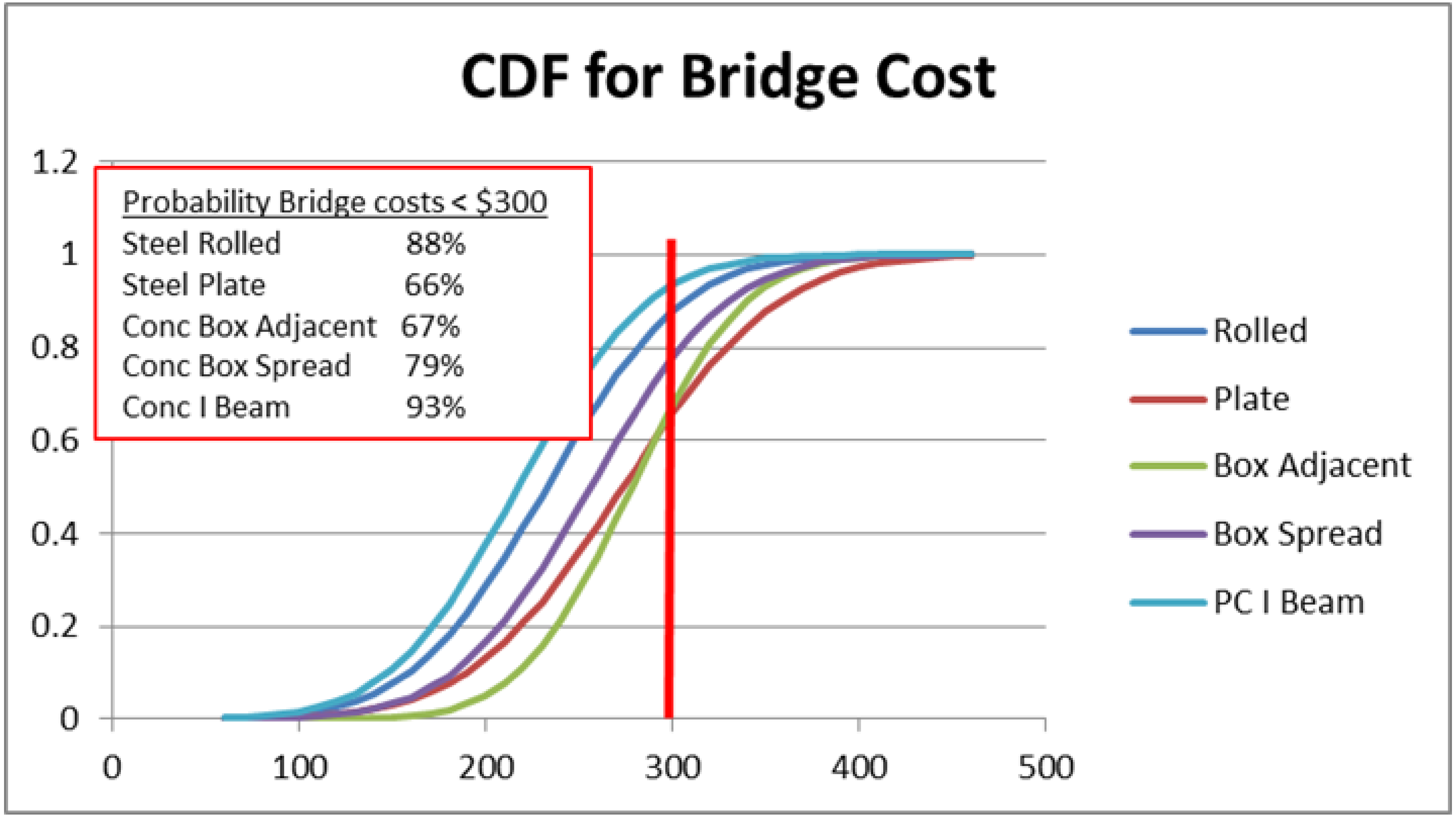
	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	54	$232.78	$194.78	$0.42	166	2.19	1980	82
Steel I Girder	144	$273.71	$226.10	$0.21	406	4.07	1976	80
P/S Box - Adjacent	282	$278.30	$223.74	$0.96	89	1.31	1987	74
P/S Box - Spread	397	$256.11	$210.65	$2.06	89	1.56	1986	79
P/S I Beam	309	$217.50	$174.10	$0.20	212	2.43	1985	73

↑

Precast I Beam
Steel Rolled

All are “similar” with None “Way Out” of Balance

Capitalized Costs – All Bridges



Life Cycle Costs– Length<140 ft

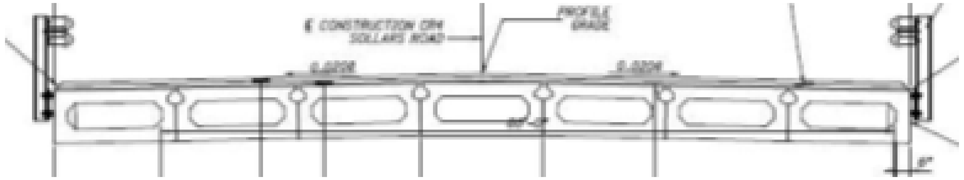
Short Length Bridges
Short Span Steel Bridge Alliance

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	27	$266.24	$222.08	$0.16	84	1.26	1978	82
Steel I Girder	18	$311.26	$257.19	$0.29	119	1.00	1977	81
P/S Box - Adjacent	240	$292.38	$235.03	$0.95	69	1.09	1987	74
P/S Box - Spread	325	$272.20	$225.14	$2.16	64	1.23	1986	81
P/S I Beam	98	$281.64	$231.20	$0.05	104	1.08	1987	77

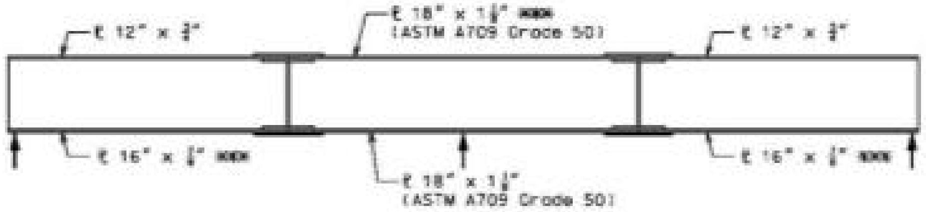
Steel Rolled
Precast Box Spread

All are "similar" with None "Way Out" of Balance

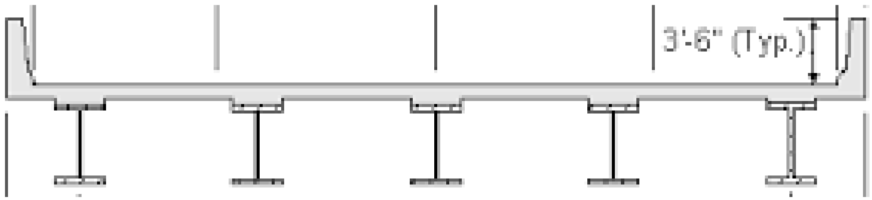
Which Type of Bridge is Best?



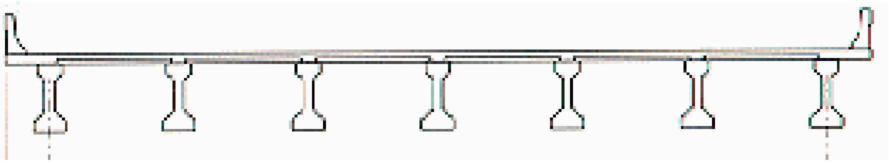
Precast Box Adjacent



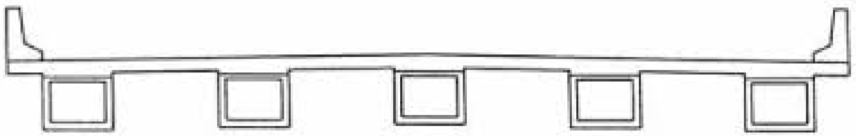
Steel Plate Girder



Steel Rolled Beam



Precast I Beam



Precast Box Spread

Which Type of Bridge is Best?

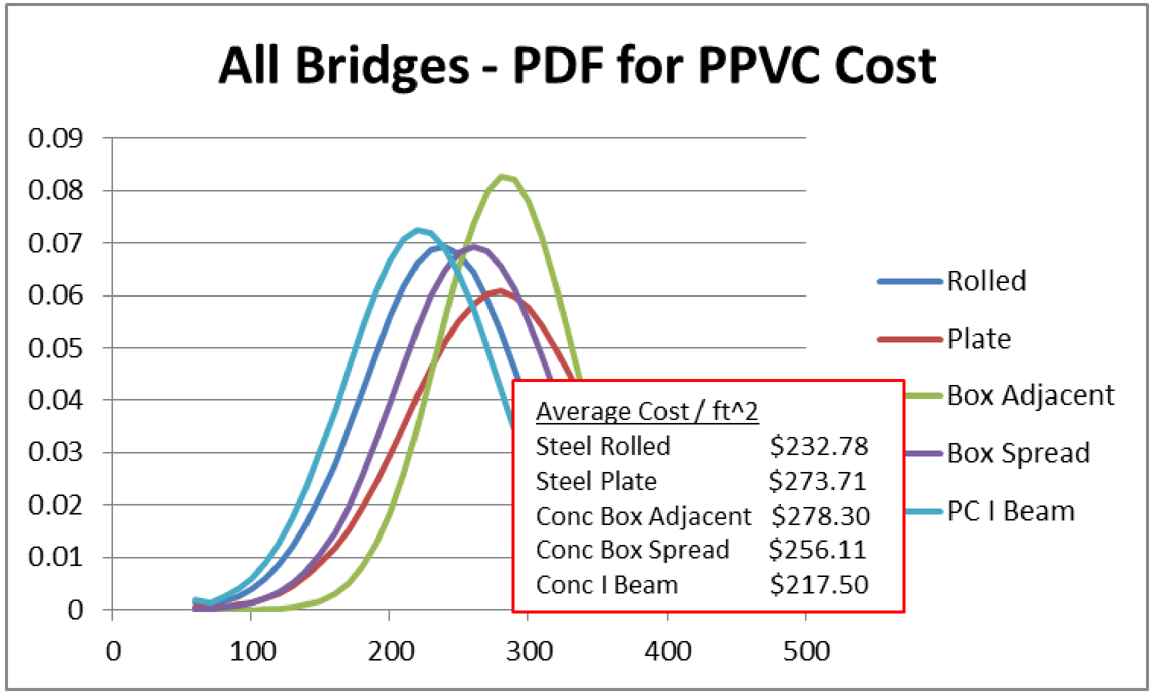
All are "similar" with None "Way Out" of Balance

Overall Weighted Average PPVC = $252.40/ft^2 – Capitalized Costs

All Bridge Types within 14% of Weighted Average

Standard Deviation Range
$48.02/ft^2 - $65.60/ft^2
[COV ≈ 20% - 25%]

Any One Type of Bridge May Be Most Economical for a Given Bridge Project



There is No One Type of Bridge That Clearly Beats the Others

Summary

Typical Steel & Concrete Bridges are Competitive on First Cost

Typical Steel & Concrete Bridges are Competitive on Life Cycle Costs

Owners Should Consider Both Steel and Concrete Alternatives for Individual Bridge Projects

Quiz

In a Life Cycle Cost Analysis, the engineer should consider future maintenance only if it is contracted by a third party (no DOT Maintenance Costs Considered)

a. True
b. False

False –

All Future Maintenance Costs Should be Considered for the Life Cycle

Quiz

Some of the Cost Advantages in Building Short Span Steel Bridges Are:

a. Lighter Equipment Required ←
b. Lower Cost Bridge Railing Barriers Required
c. Lighter Abutments May Be Used ←
d. Smaller Spans Required for Hydraulic Opening
e. Less Required Clear Road Width

Quiz

The Short Span Steel Bridge Alliance Claims that Steel Bridges Have Lower Initial and Life Cycle Costs Compared to Concrete Bridges.

a. True

b. False

False – the SSSBA Claims

Typical Steel & Concrete Bridges are Competitive on First Cost

Typical Steel & Concrete Bridges are Competitive on Life Cycle Costs