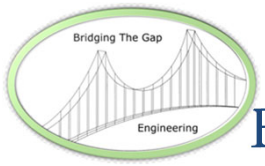


Bridging the Gap

Engineering

BRANDON ADAMS

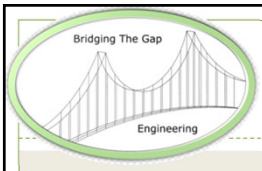
MICHAEL ASHWORTH

ZACH CUMM

BRANDON DIAL

NATASHA NAPIER

JOHN SKAGGS



Alternatives Summary

- Comparison Criteria
  - Cost
    - Construction
    - Material
  - Shipping Limitations
    - 100 feet shipping limit
  - Scheduling
  - Manufacturing Availability
  - Capacity Requirements
- Alternatives
  - Steel Plate Girder
  - AASHTO Type V Concrete I-Beam
  - Steel Rolled Beam

Design Alt. #1

- Steel Plate Girder
  - AASHTO M 270 (ASTM 709M) – Grade 50 Steel
    - F_y = 50 ksi
    - F_u = 65 ksi
  - 4 plate girders
    - 9.0 feet spacing (center-to-center)
    - 2 ft – 10 in deck overhang
    - 18 in x 20 in x 5.875 in elastomeric bearing pad (e-Span 140)

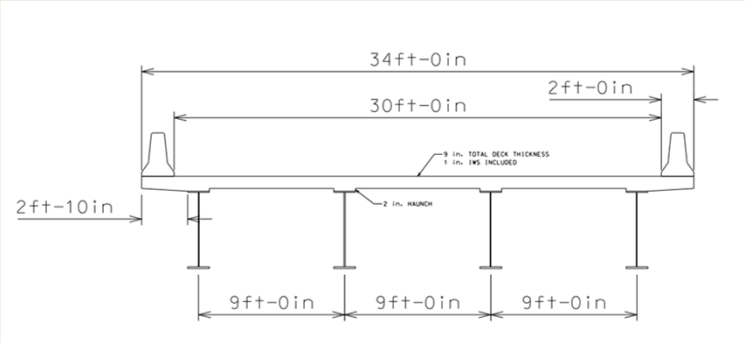
Design Alt. #1

- Steel Plate Girder
  - Spliced at L = 100' and L = 25'
    - AASHTO M 164 Type 3 Bolts
      - 7/8 in diameter
      - 328 bolts/beam x 4 beams = 1312 bolts total

Splice Plate Dimensions (in)			
Component	Plate Thickness	Plate Dimensions	Number of Plates
Top Flange	0.5	16 x 39.5	1 (top)
	0.5	7.5 x 39.5	2 (bottom)
Web	0.5	45 x 34	2
Bottom Flange	1.0	69.5 x 8.5	2 (top)
	1.0	69.5 x 16	1 (bottom)

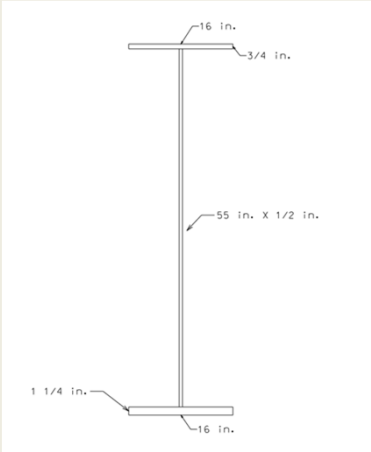
Plans

- Steel Plate Girder Bridge Section



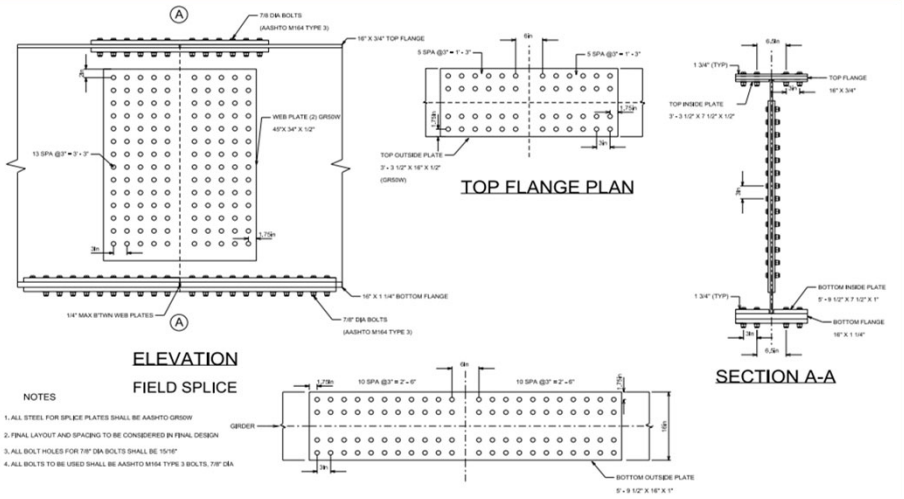
Plans

- Steel Plate Girder Detail - Section



Plans

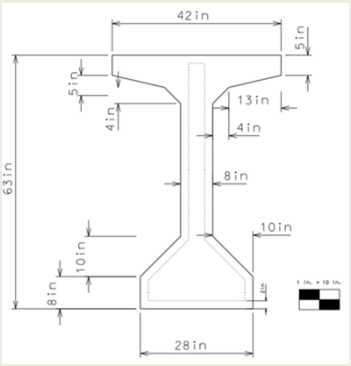
- Connection Detail – Steel Alternatives



Design Alt. #2

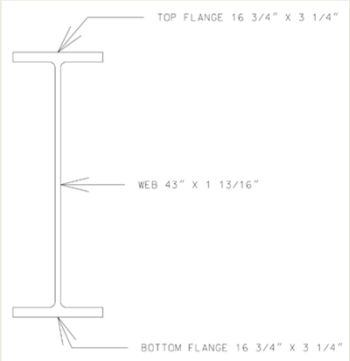
- AASHTO Type V Concrete I-Beam
  - 4 girders
    - 8.0 feet spacing (center-to-center)
    - 125 feet span length

*Due to shipping limitations the concrete I-beam is not a feasible alternative.



Design Alt. #3

- Rolled Steel Beam (W Shape)
  - W40x593
    - 4 Beams
      - 9' spacing
      - 34" overhang
  - 593lbs per foot.
    - Total weight = 148.5 tons



*The total weight of the rolled beam is greater than the plate girder. The rolled steel beam is a more expensive alternative.

Cost Assumptions

- Excludes any features that have a consistent design & cost (deck, parapet wall, etc.)
- Crane size calculated using an online crane calculator based off of weight and radius required.
- Running percent of 15% on job office overhead (Primary Contractor), 15% on home office overhead (Primary Contractor), 10% on Profit (Primary Contractor), 2% on bond (Primary Contractor), and 6% on taxes (Project). 25% running percent for sub-contractor.
- MII & RSMeans cost books used for any pricing that is not separately noted.
- 10% of girder cost estimated for shipping

Cost Comparison

Cost Comparison of Alternatives			
Alternative	Direct Material Cost	Project Cost	Direct Cost
Steel Plate Girders	$215,000	$445,000	$295,000
AASHTO Type V Concrete I-Beam	$225,000	$500,000	$330,000
Steel Rolled Beam	$231,000	$511,000	$339,000

- Steel Plate Girder Alternative was determined to be the cheapest with the next closest being 12% higher in cost
- Difference between Steel Plate Girder and Rolled Steel Girder is significant enough ($45,000) to deem the Steel Plate Girder as a better choice from a cost perspective.

Alternative Selection

- Selected Alternative:
  - Alternative #1 - Steel Plate Girder
  - Justification for Alternative #1:
    - Shipping length made the AASHTO Type V Beam Concrete I-Beams not feasible
    - Cost of the Rolled Beam alternative compared to the Plate Girder alternative was too high

Beam Optimizations

- Calculated deflection limit
  - 1.875”
- Flange changes required
  - Top flange thickness increased from ¾” to 1 ½”
  - Bottom flange thickness increased from 1 ¼” to 1 ¾”
- New optimized deflection
  - 1.731”

Design Capacity

- Design capacity
  - Ultimate Moment
    - 10,215.625 foot-kips
  - Ultimate Shear
    - 335.09 kips
  - Plastic moment (AASHTO Table D6.1-1)
    - 10,924.141 foot-kips
  - Nominal moment (AASHTO 6.10.7.1.2)
    - 10,601.84 foot-kips
  - Nominal moment > Ultimate moment
    - Moment Capacity Performance Ratio of 96%

Design Calculations

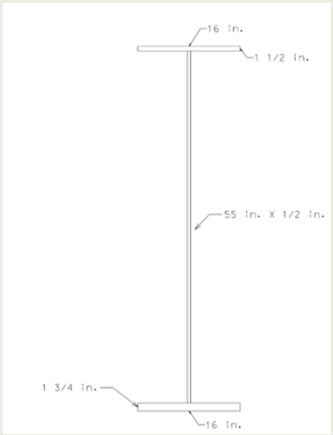
- Shear capacity
  - Longitudinal stiffener required 55 inches from abutment
  - Nominal shear (AASHTO 6.10.9.3.2-2)
    - 479.336 kips
  - Nominal Shear > Ultimate Shear
    - Shear capacity is adequate

Final Design

- Final design contains
  - Four steel plate girders
  - Reinforced concrete deck
  - Diaphragms
  - Shear studs
  - Parapet wlls
  - Elastomeric bearings

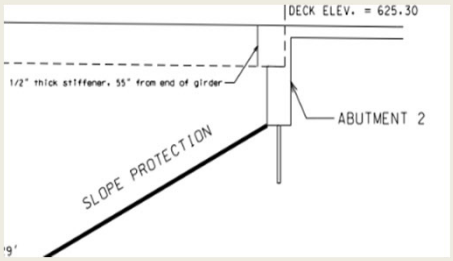
Final Design

- Steel Plate Girder – AASHTO M 270 (ASTM 709M)
  - Grade 50 steel
  - Top Flange
    - 16”x 1 ½”
  - Web
    - 55” x ½”
  - Bottom Flange
    - 16” x 1 ¾”
- Girder spacing
  - 9 feet center to center



Final Design

- Longitudinal stiffener
  - ½” thick
  - 4 ½” wide
  - 55” deep
  - Located 55” from abutment
- Shear studs
  - 50 studs every 9”
  - Transition to 12” spacing
- Diaphragms
  - W30 x 90
  - 31.25 feet apart



Final Design

- Elastomeric bearing pads
  - 18” x 20” x 5.875”
  - 1/8” thick internal steel plates
- Bridge Deck
  - 8” thick reinforced concrete deck
  - ¼” integral wearing surface
  - Total deck thickness of 8 ¼”
  - Compressive strength of 4 ksi
  - Reinforced with #5 steel reinforcing bars
- Parapets
  - WVDOT Type F barrier
  - Minimum height of 32”

Plate Girder Costs

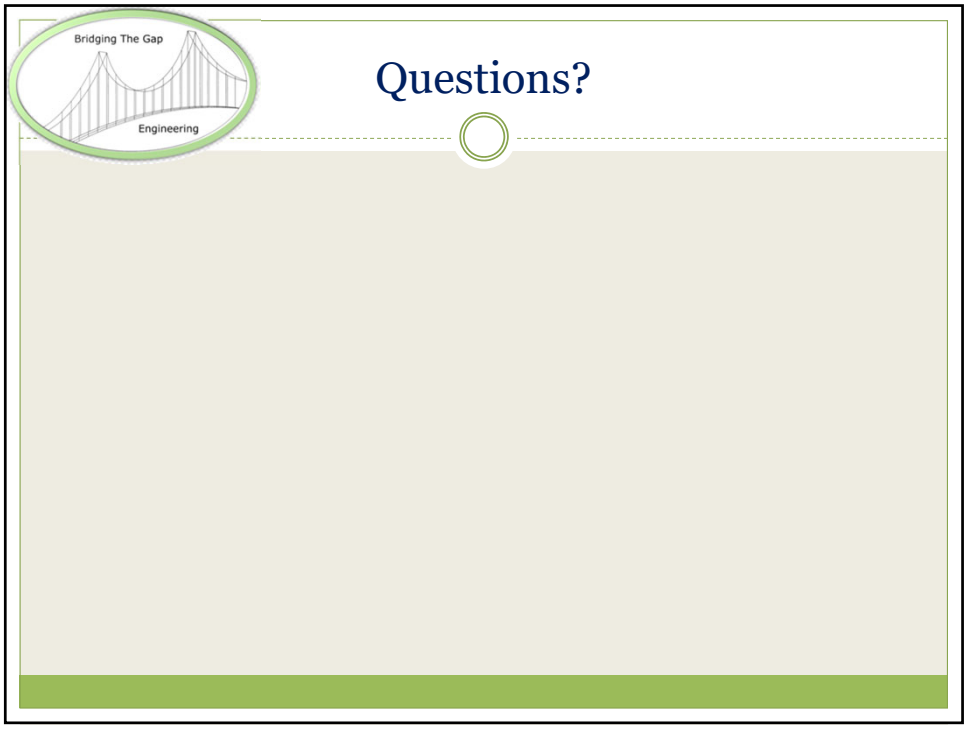
Steel Plate Girders: grade 50, 125’ long	$343,669
Steel Plate Girder Installation	$102,817
Shipping for Steel Plate Girder	$35,483
Steel Plate Girder Misc. (Bolts, Plates, stiffeners, sheer studs, etc.)	$34,573
Total Cost for Steel Plate Girders	$516,542

Final Costs

Class H concrete Deck: Includes material, equipment, and labor	$367,528
Deck: Rebar including material and labor	$22,447
Standard Type V Barrier: Includes material, equipment, and labor	$38,475
Elastomeric Bearing Pad: 5/8" T layers w/ 5.875" T total	$12,648

Final Costs

Concrete Class H Haunches:	$16,158
Splice Connection Installation: Crane- 40 Ton	$4,701
Predicted Project Cost:	$985,000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Engineering
Questions?