Simple Span Bridge Design Using eSPAN140

Gregory K. Michaelson, Ph.D., P.E.

Marshall University, College of Engineering and Computer Sciences

michaelson@marshall.edu

SSSBA Webinar Series – June 8, 2022

Designing Cost-Effective and Resilient Bridges

Outline of Today's Presentation

- Introduction
- Development of Standard Designs
- eSPAN140 Example Project
- Case Studies & Economic Assessments
- Questions & Answers

Introduction

Short Span Steel Bridge Alliance

http://www.shortspansteelbridges.org/

http://www.espan140.com/

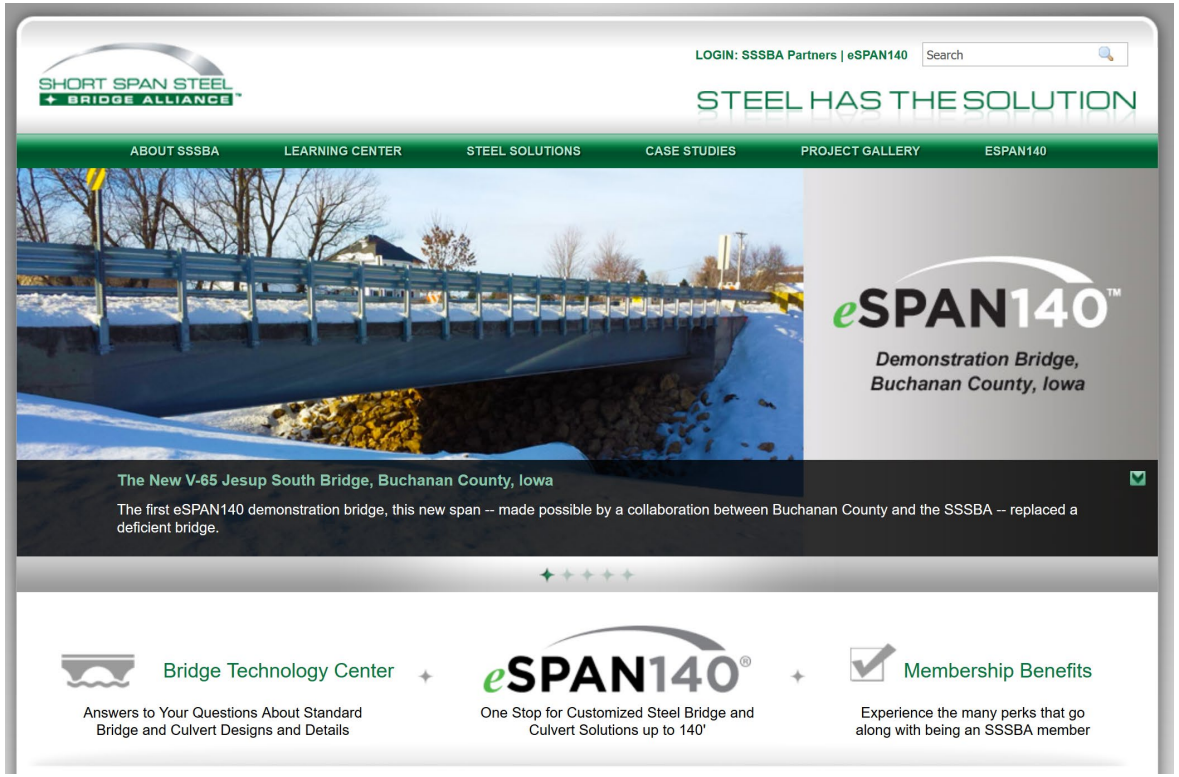
The Short Span Steel Bridge Alliance (SSSBA)

- Program officially started September 2007
  - Objective – make steel the material of choice for short span steel bridges.
  - Short span steel bridges have spans up to 140 ft

SSSBA Website

https://www.shortspansteelbridges.org/

- eSPAN140 Web-based Design Tool
- Bridge Technology Center
- Technical Design Resources
- Project Case Studies
- News Updates & Social Media
  - Twitter
  - LinkedIn
  - Facebook
- Email Newsletter (sign-up to receive it)

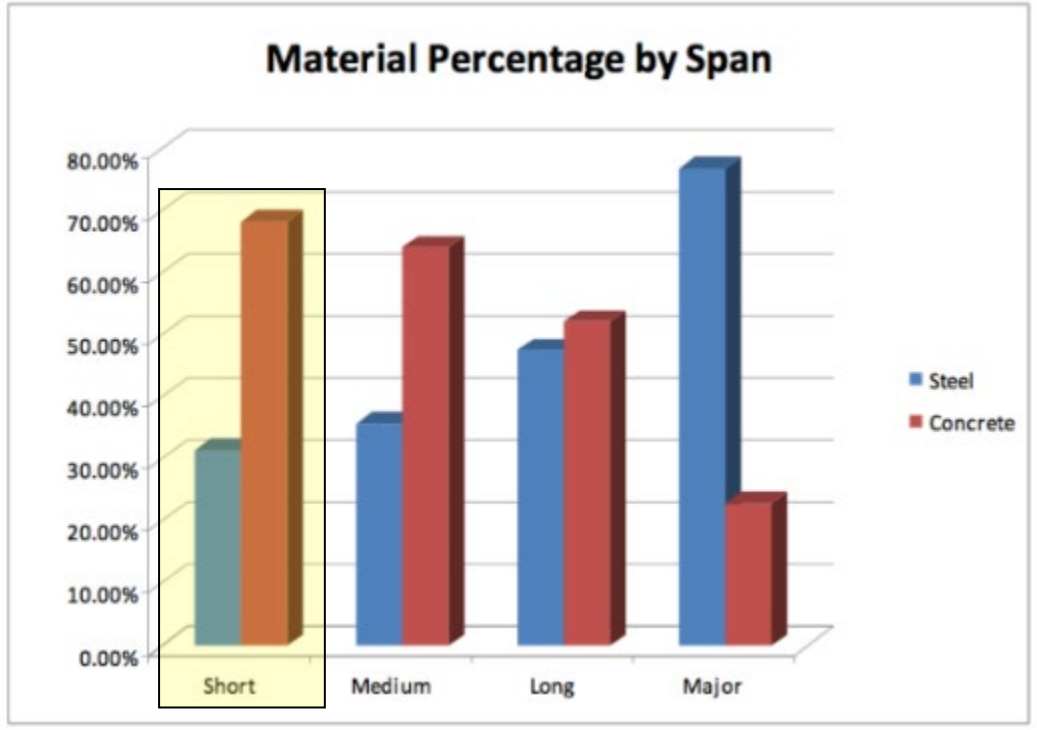


Join Today!

Dan Snyder (SSSBA Director)
dsnyder@steel.org
(301) 367-6179

The Problem

- Bridge engineers are well trained on the use of short span concrete bridges.
  - In fact, over than 80% of the short span bridges in the United States are made of concrete.
- **Many County and (DOT) engineers are simply not educated/familiar with the design, construction, and economics of short span steel bridges.**
  - Concrete provides simple, standardized, cost-effective, “tinker toy” solutions to construct short span steel bridges.
  - **Steel bridges are “perceived to be too” complex, “Swiss watch”-like, and too expensive.**



The Solution

- Standardized designs for short span steel bridges
  - BTC led a 3-year industry-wide effort (owners, fabricators, designers, associations, service centers, etc. involved)
    - Over 3,000 designs evaluated
  - Result = simple standardized designs for short span bridges
    - Rolled beam, plate, & buried soil steel structures
  - Standards used to develop eSPAN140
    - 650 total preliminary bridges designed
  - BTC working with states to adopt state-specific standards

Short Span Steel Bridge Design Standards

Goals, Design Parameters, Weight Comparisons

Standards for Short Span Steel Bridge Designs

- Goals:
  - Economically competitive
  - Expedite & economize the design process
  - Simple repetitive details & member sizes.
- Bridge Design Parameters:
  - Span lengths: 40 feet to 140 feet (5-foot increments)
  - Girder spacing: 6 feet, 7.5 feet, 9 feet and 10.5 feet
  - For each of these increments, the following were designed:
    - Steel girders
    - Shear stud & stiffener layouts
    - Welding and fabrication details
    - Elastomeric bearings
    - Concrete deck design

Primary value is use as an estimating tool!

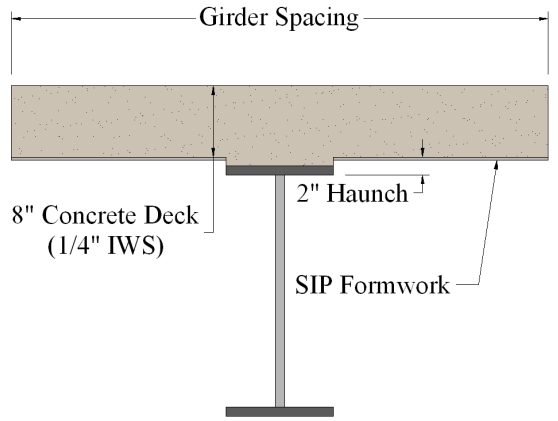
- Now have the ability to produce a valid steel bridge design in minutes
- Obtain a cost estimate from a fabricator within a day
- Can directly compete with concrete alternate
- Design can then be further optimized

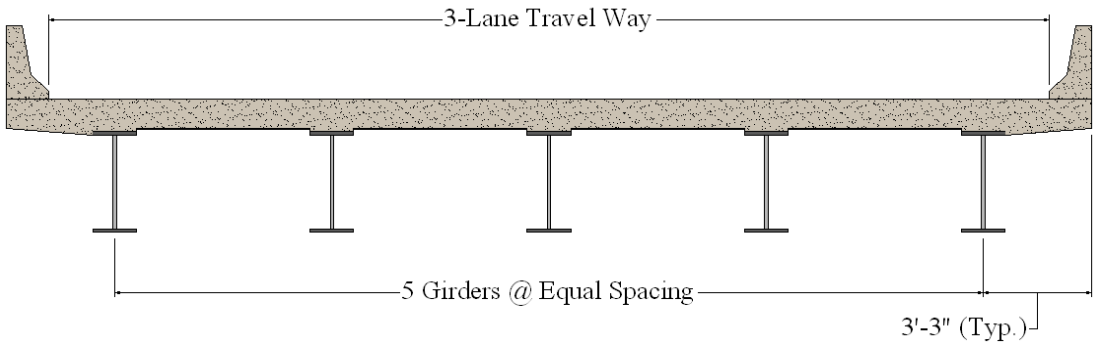
Standards for Short Span Steel Bridge Designs (cont'd)

- Four types of girder types:
  - Homogeneous plate girders (50 ksi steel)
  - Hybrid plate girders
    - 50 ksi top flanges and webs, 70 ksi bottom flanges
  - Lightest weight rolled beams (50 ksi steel)
    - Utilizing the lightest weight girder necessary
  - Limited depth rolled beams (50 ksi steel)
    - Designed to meet a target L/D of 25
- In addition, girders were designed to accommodate commonly stockpiled plate thicknesses and rolled beam sizes.

Standards for Short Span Steel Bridge Designs (cont'd)

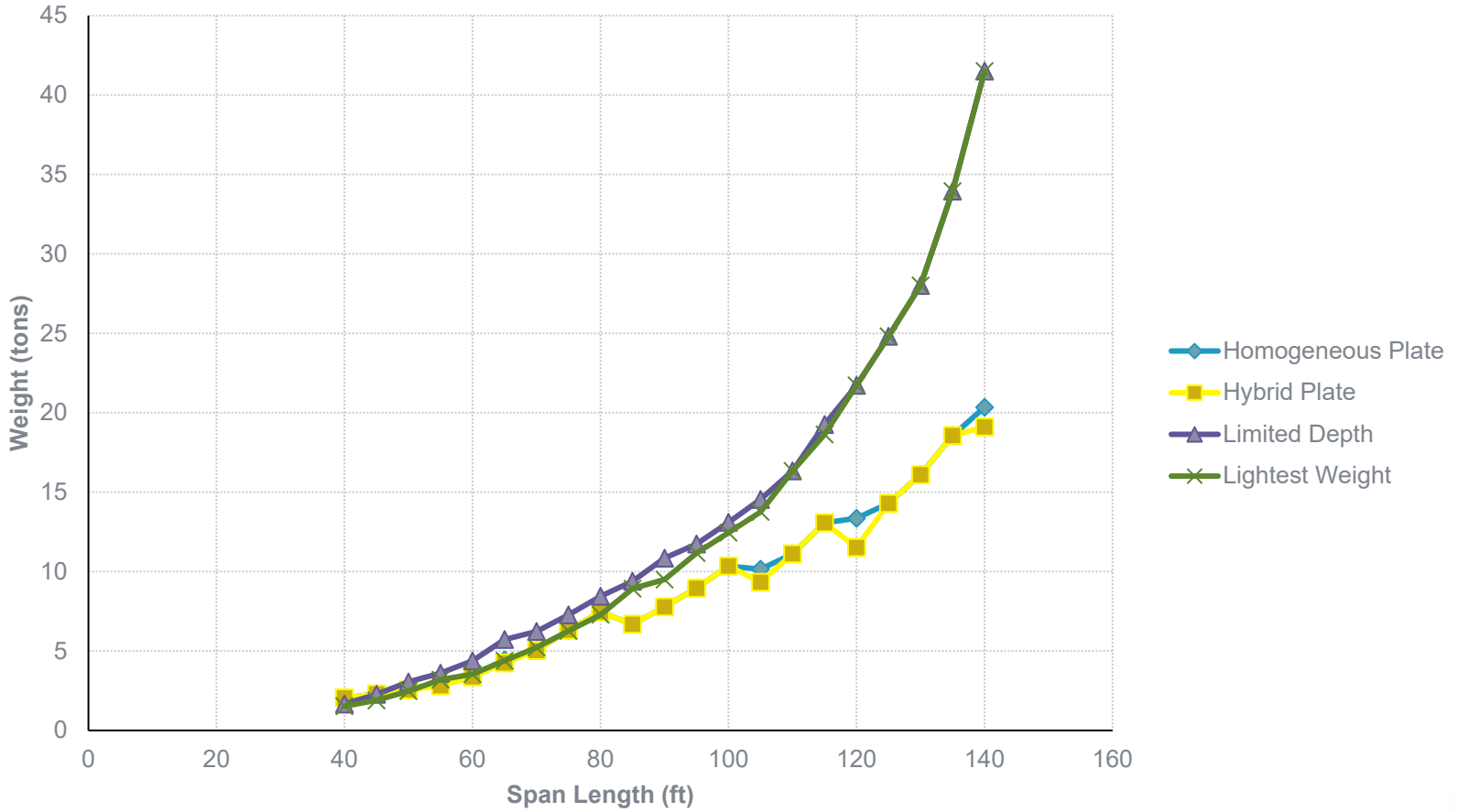
- Bridges were designed according to AASHTO LRFD Specs:
  - Strength I, Service II, Fatigue, Constructability, L/800 Deflection
  - HL-93 Vehicular Live Loading
- Additional Design Loads:
  - SIP Unit Weight = 15 psf
  - Future Wearing Surface = 25 psf
  - Concrete barriers = 520 lb/ft
  - Misc. Steel Wt. Increase = 5%
  - f_c' = 4,000 psi
  - Concrete Unit Weight = 150 pcf
  - Steel Unit Weight = 490 pcf
  - Concrete Haunch = 2 in
  - Constant Flange Width
  - Constant Web Height





Standards for Short Span Steel Bridge Designs (cont'd)

- Weight comparisons (9'-0" girder spacing):



Resulting Economical Standard Selections

- Based on weight comparisons of resulting designs, the following solutions are recommended for the span ranges shown:

Solution Type*	Bridge Span Length	Skew Angle	Overhang Width
	0' 20' 40' 60' 80' 100' 120' 140'		
Rolled Beam (40' to 100')**		+/- 20 degrees	3'3" or less
Homogeneous Plate Girder (60' to 140')**		+/- 20 degrees	3'3" or less
Hybrid Plate Girder (80' to 140')**		+/- 20 degrees	3'3" or less

eSPAN140 Example Project

Step-By-Step Process for Obtaining a Steel Solution

One-stop shop for customized steel bridge and culvert solutions!

- eSPAN140 provides:
  - Standard designs and details for short span steel crossings
    - Rolled Beam and Plate Girders
    - Buried Soil Steel Bridge Structures
  - Manufacturers' Steel Solutions (SSSBA Partners)
  - Coatings Solutions
  - Industry Contacts
    - Contacts can provide budget estimates and pricing information

Free and easy to use!!!
https://www.espan140.com/

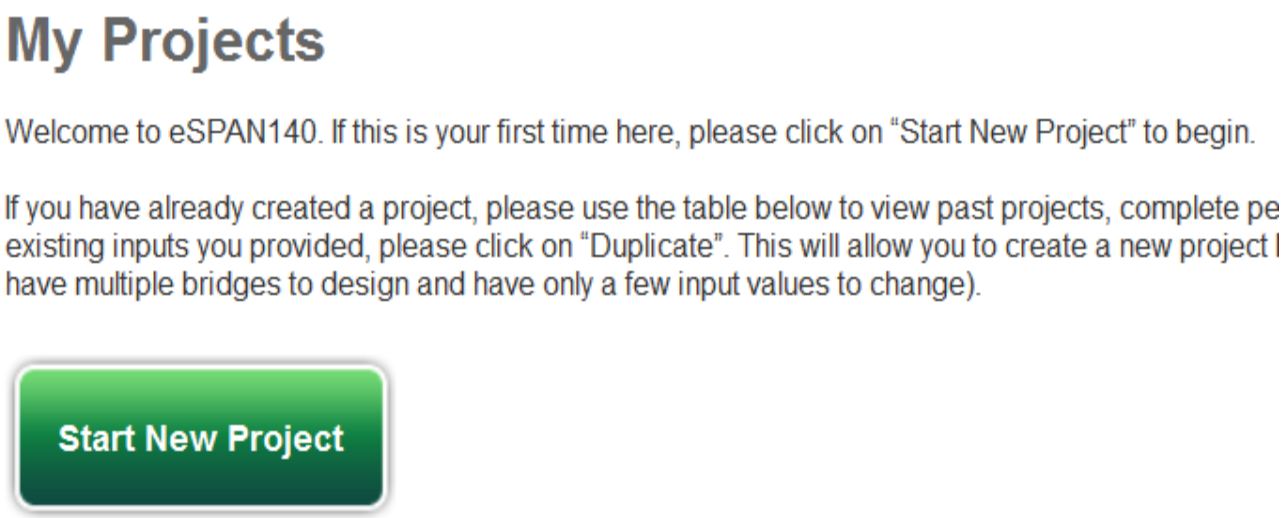
Step 1.
Create a User's Account

Step 2.
Input Your Specific Project Details

Step 3.
View Your Instant Customized Solutions Books

eSPAN140 Example Project

- Start new project:



eSPAN140 Example Project (cont'd)

- Step 1: Project Information

Project Name*

Sample Bridge

City/County*

Morgantown

State/Province*

West Virginia

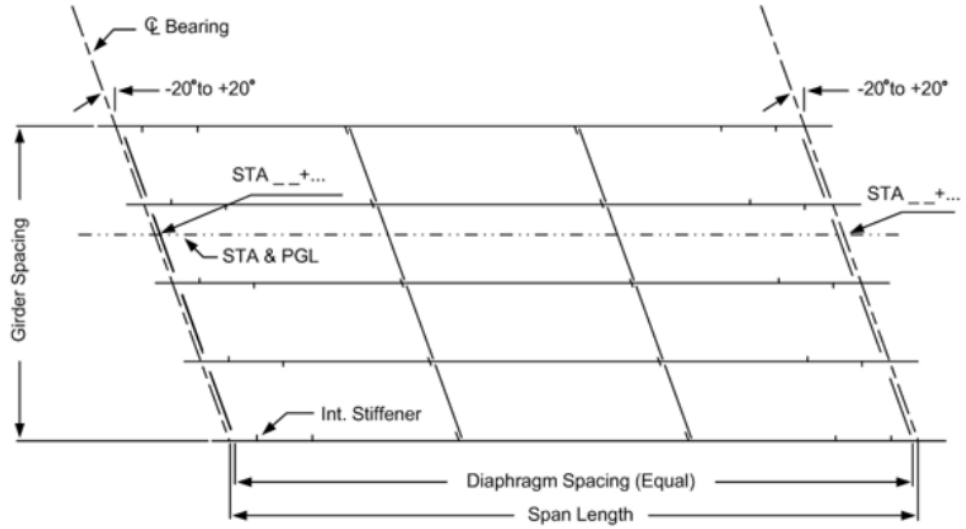
Roadway Name

Main Street

Bridge Span Length*

82 *Feet* 4 *Inches*

Next > Return to Projects



eSPAN140 Example Project (cont'd)

- Step 2: Project Details (general dimensions)

# of Striped Traffic Lanes*

2

Roadway Width*

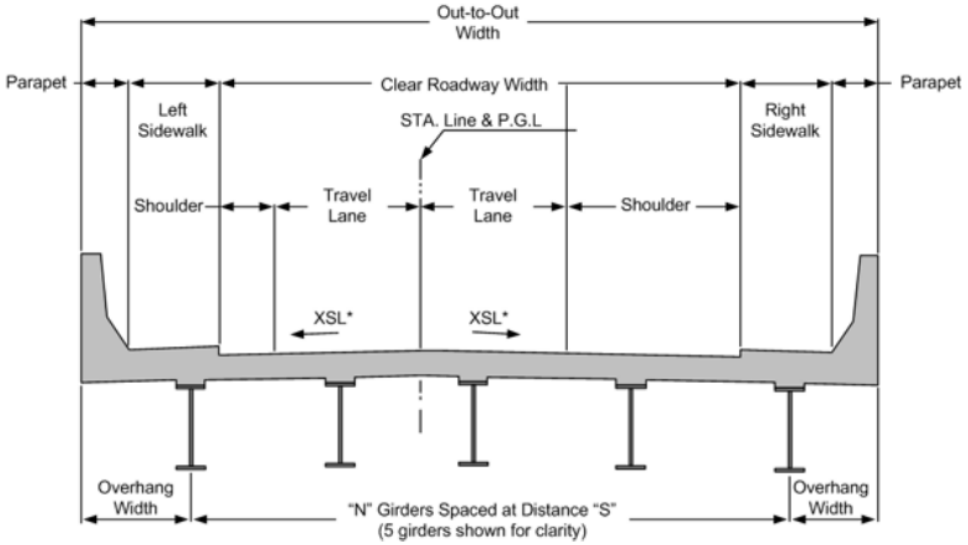
30 Feet 0 Inches

Individual Parapet Width

1 Feet 3 Inches

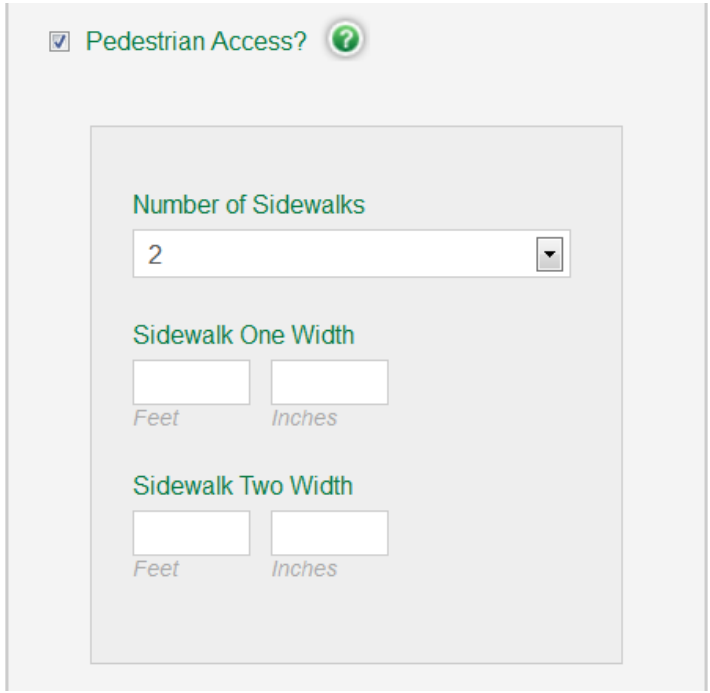
Individual Deck Overhang Width

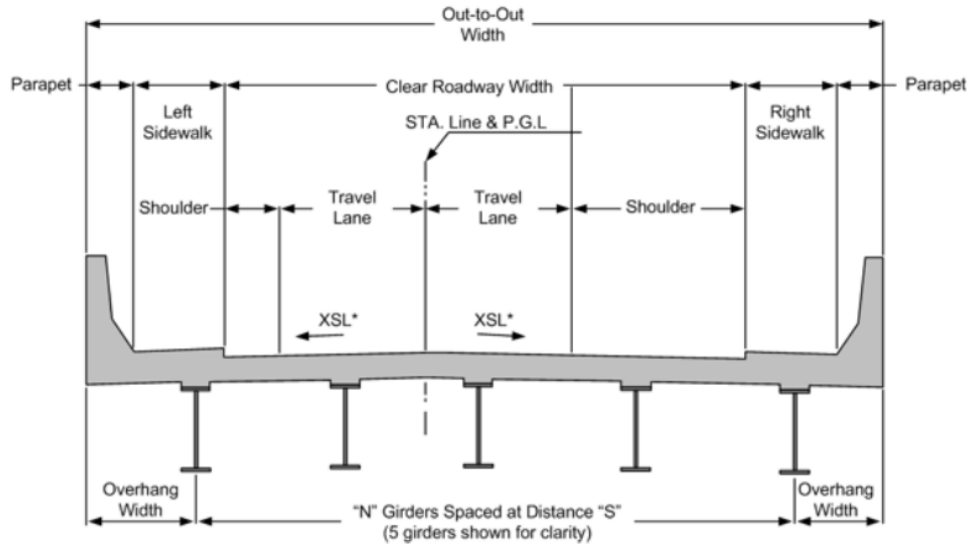
3 Feet 0 Inches



eSPAN140 Example Project (cont'd)

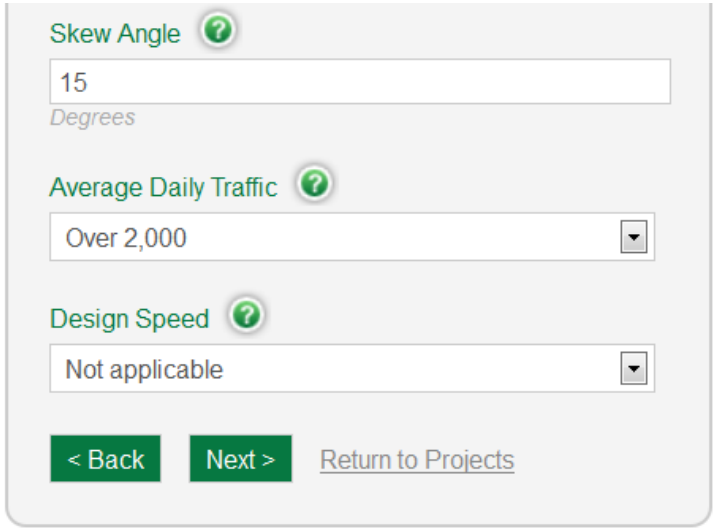
- Step 2: Project Details (pedestrian access option)

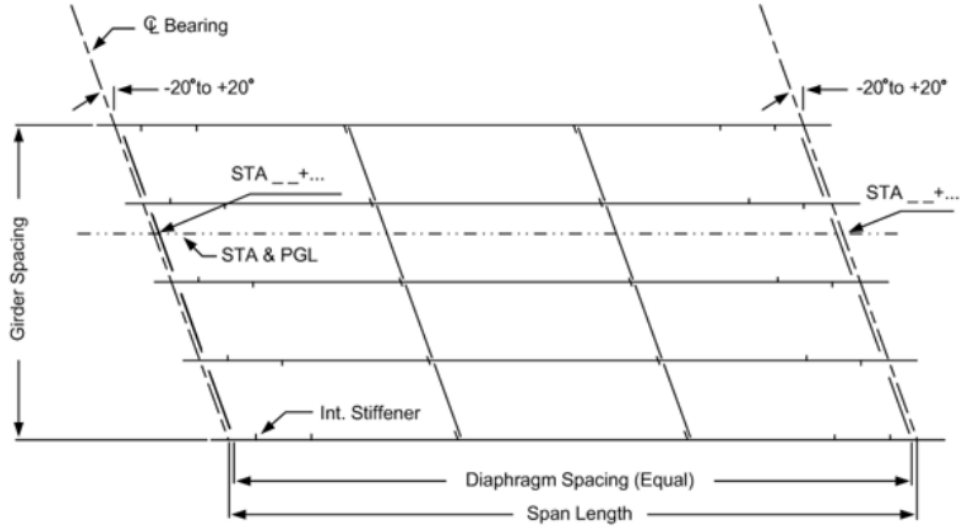




eSPAN140 Example Project (cont'd)

- Step 2: Project Details (remaining details)

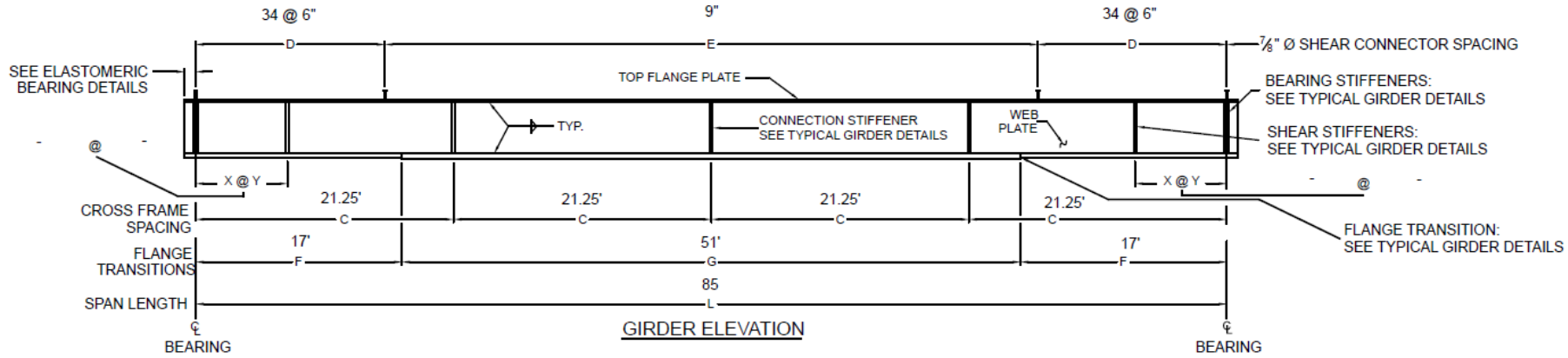




eSPAN140 Example Project (cont'd)

- Example output (sample plate girder elevation):

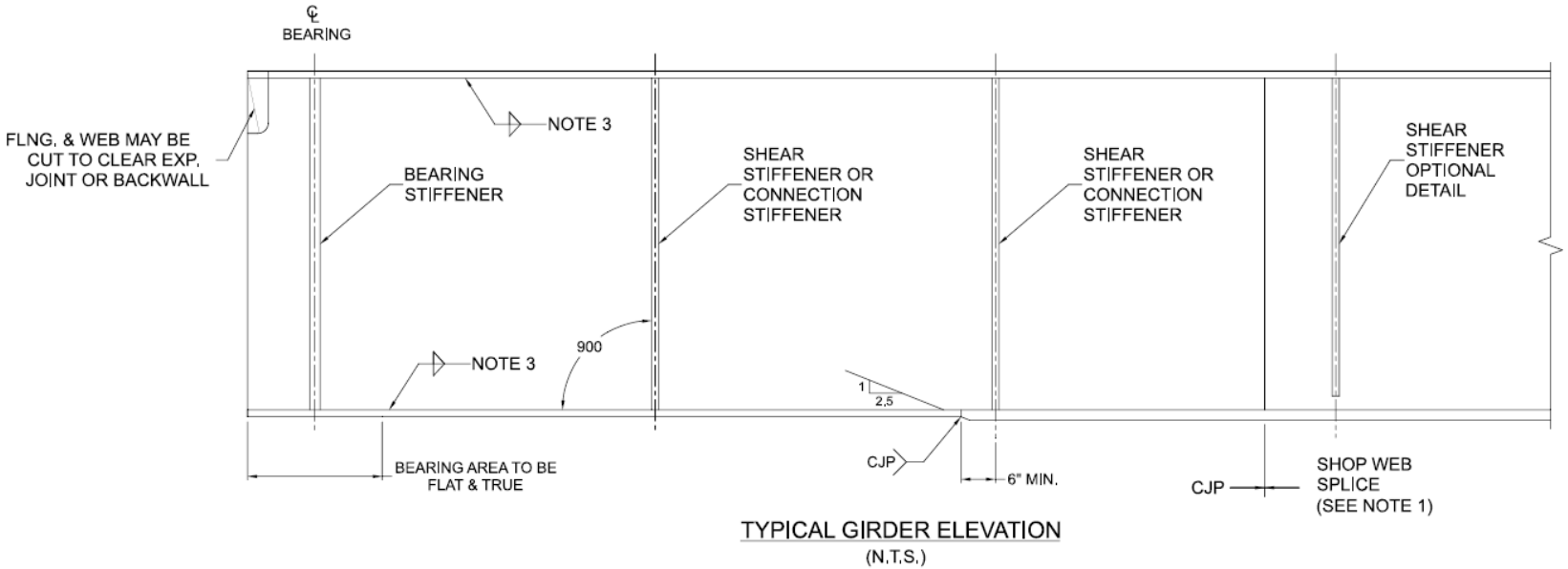
COMPOSITE PLATE GIRDER WITH PARTIALLY STIFFENED WEB - 4 GIRDERS AT 8' 10" GIRDER SPACING, HOMOGENEOUS



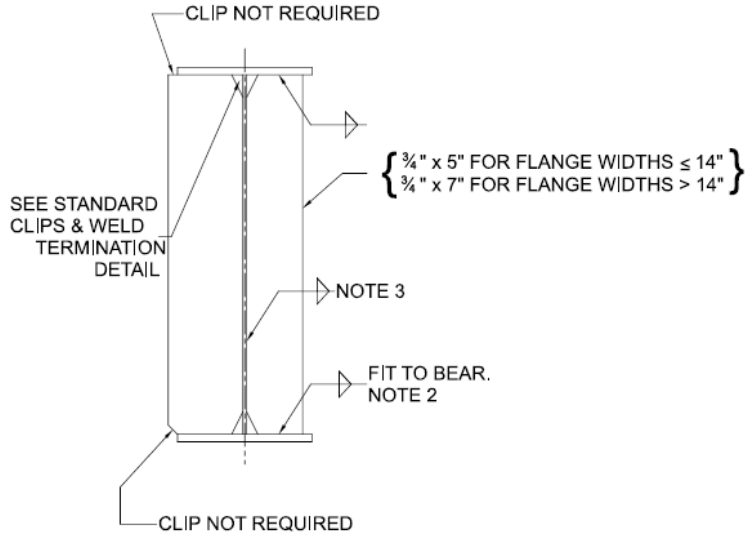
SPAN (L) - ft	PLATE GIRDER SIZE						DIAPHRAGM SPACING (C) - ft	SHEAR STIFFENERS		SHEAR CONNECTOR MAX. SPACING		INDIVIDUAL GIRDER WEIGHT
	TOP FLANGE - in	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE- in		X (NO. REQ'd)	Y - ft. (SPACING)	D	E	
		PLATE - in	LENGTH - Ft	PLATE - in	LENGTH - Ft							
85	14 x 3/4"	14 x 1"	17'	14 x 2"	51'	32 x 1/2"	21.25'	-	-	34 @ 6"	9"	14,144 lbs

eSPAN140 Example Project (cont'd)

- Example output (typical fabrication details):



TYPICAL GIRDER ELEVATION
(N.T.S.)

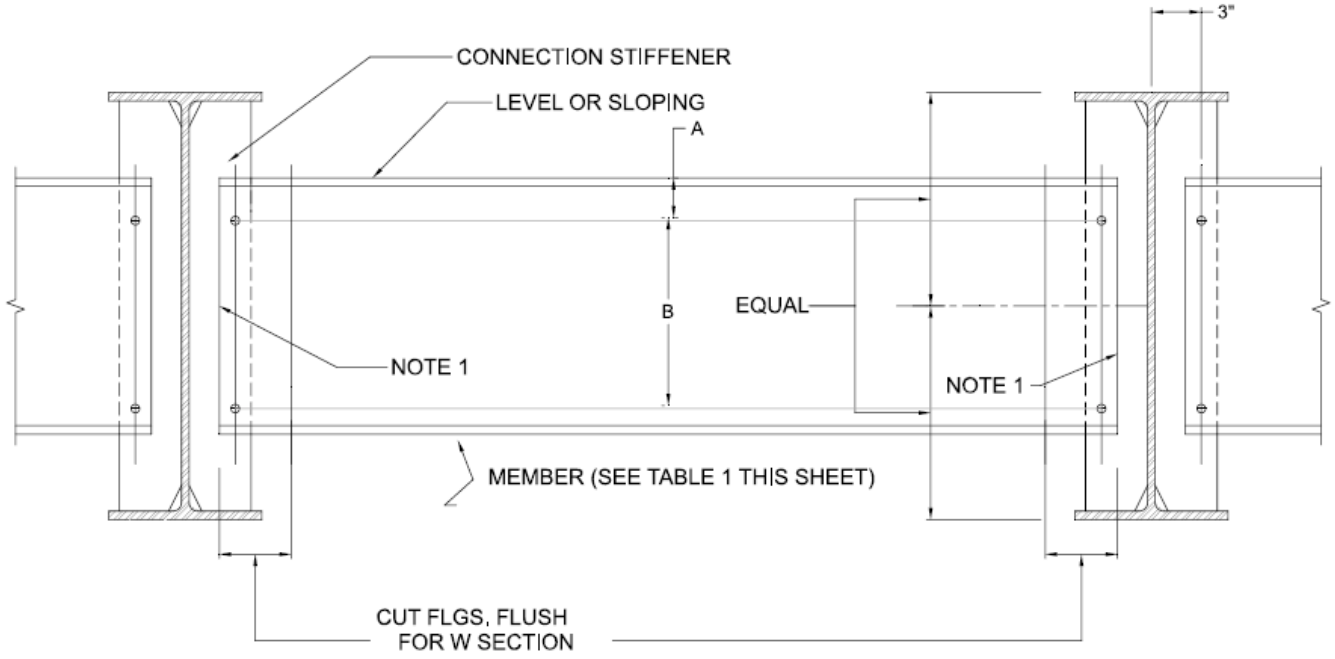


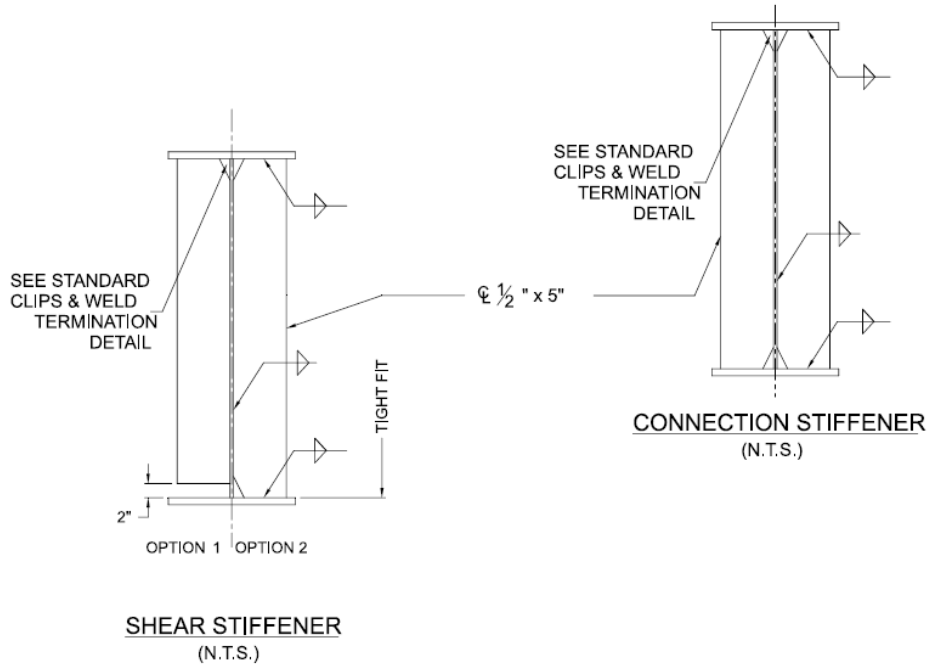
BEARING STIFFENER
(N.T.S.)

BEARING STIFFENER TO FLANGE WELDING IS REQUIRED IF A DIAPHRAGM OR CROSS FRAME IS ATTACHED TO THE STIFFENER

eSPAN140 Example Project (cont'd)

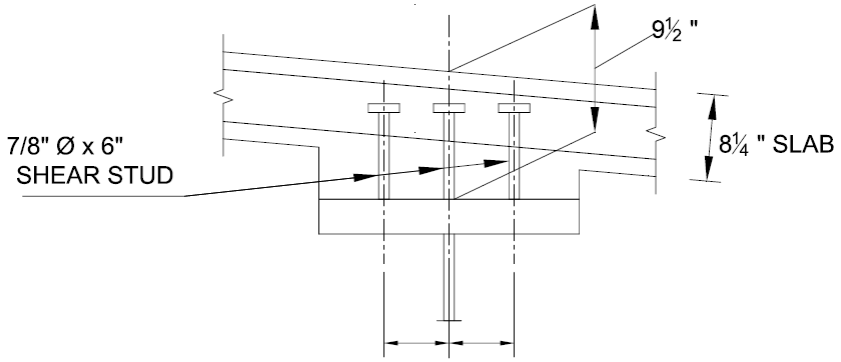
- Example output (typical fabrication details, cont'd):



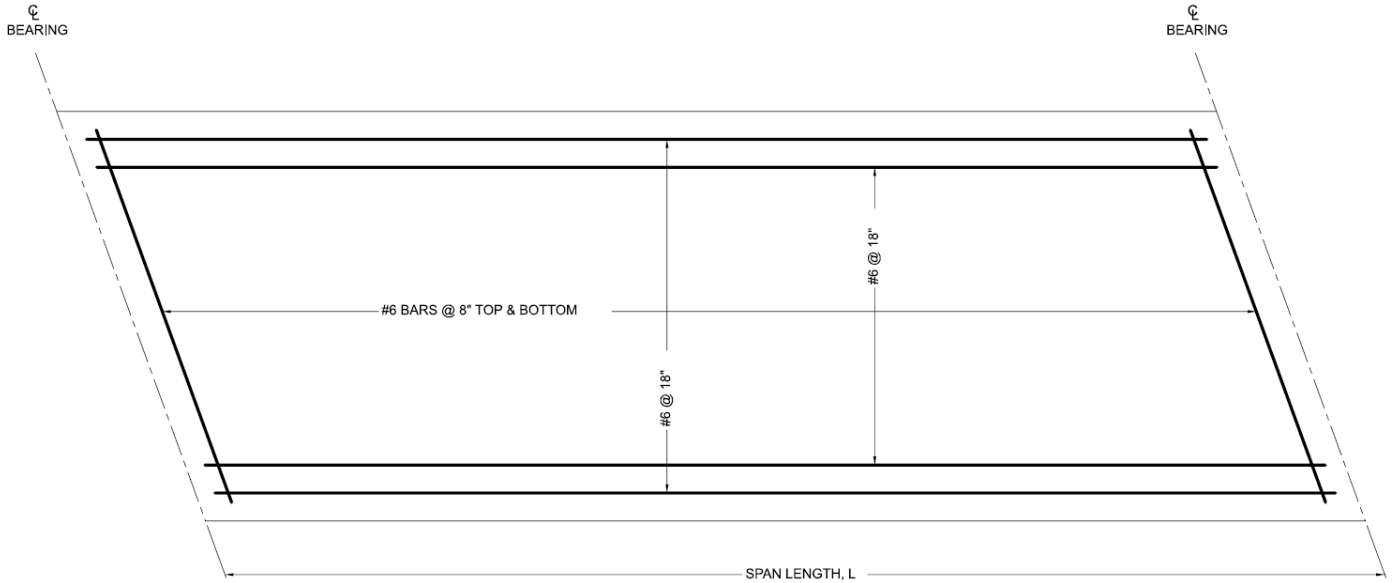


eSPAN140 Example Project (cont'd)

- Typical section & deck details:



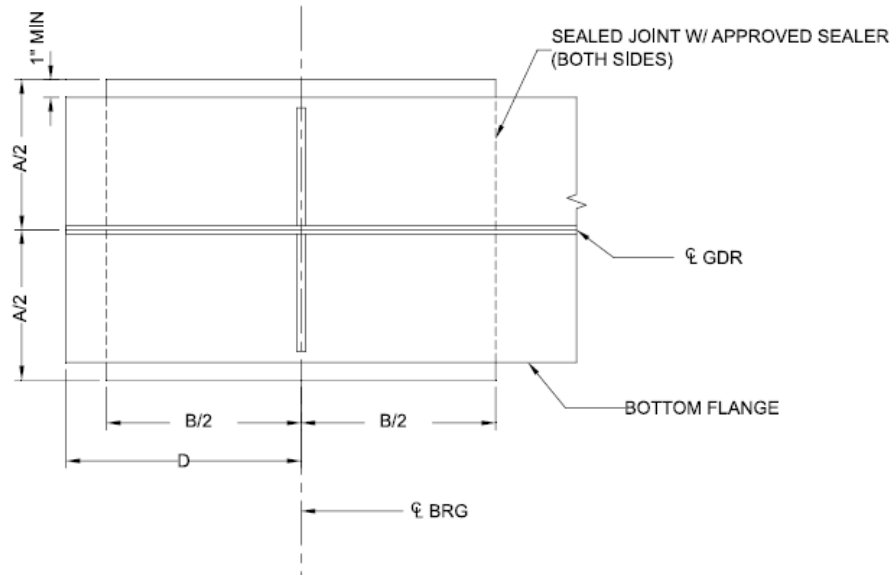
DETAIL A

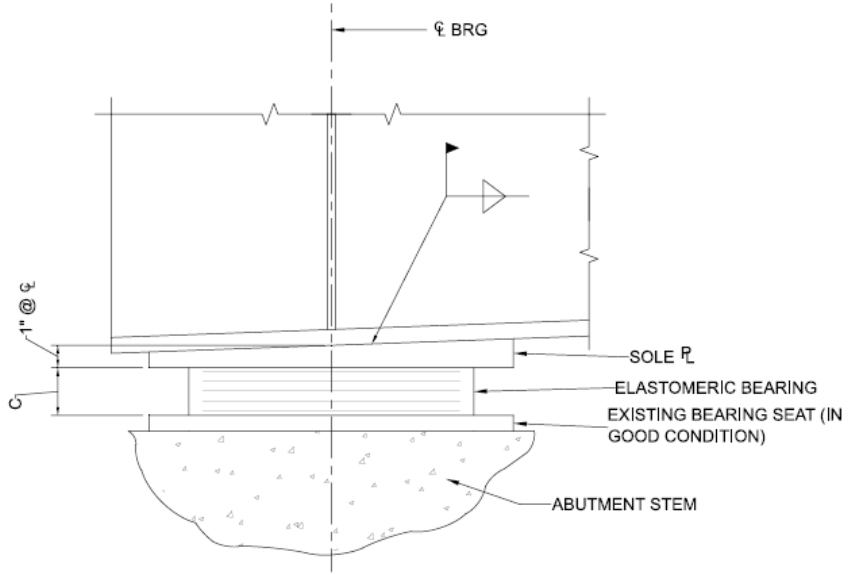


REINFORCING PLAN
(N.T.S.)

eSPAN140 Example Project (cont'd)

- Typical bearing details:



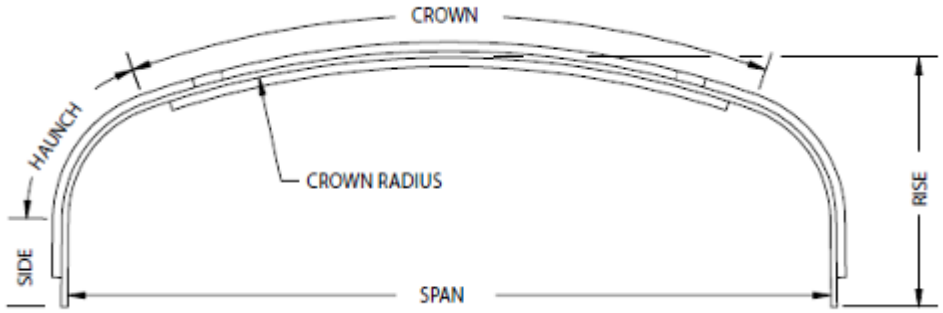


BEARING ELEVATION
OPTION "A"
(N.T.S.)

ELASTOMETRIC BEARING DETAILS - in					
A	B	C	D	INTERNAL ELASTOMER LAYERS	
				NO. OF LAYERS	THICKNESS - in
16"	18"	4.375"	12"	5	0.625"

eSPAN140 Example Project (cont'd)

- Buried Bridge Solutions



eSPAN140 Example Project (cont'd)

- Manufacturer Solutions

eSPAN140 Example Project (cont'd)

- Durability Solutions:
  - Weathering steel
  - Galvanized steel
  - Painted steel

Questions & Answers

Thank You!

Gregory K. Michaelson, Ph.D., P.E.

michaelson@marshall.edu