ORTHOTROPIC STEEL DECK SYSTEMS

New Jersey Short Span Steel Bridge Workshop

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OUTLINE

Background

Level 1 Guide Contents

Demonstration Project

Federal Funding

BACKGROUND

OSD bridges have been constructed throughout the world since the 1940s

Thousands world wide, but primarily in Europe, Asia, and South America

Only 100+ bridges in US

OSD often used only for specific applications for US bridges such as minimization of dead load or rapid redecking (Signature Bridges)

ADVANTAGES AND CHALLENGES

Advantages

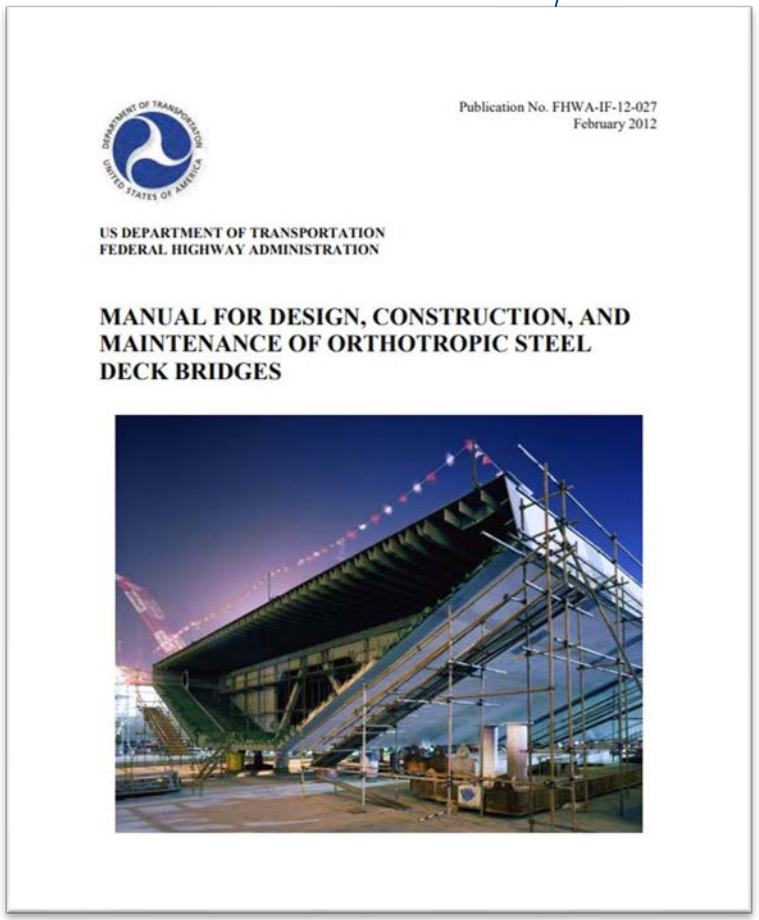
- Durable
- Redundant
- Lightweight
- New Design
- Rehabilitation

Challenges

- Complexity of Design
- Sophisticated analysis needs
- High fabrication costs
- Owner-mandated experimental fatigue

BACKGROUND

- Manual for Design, Construction, and Maintenance of Orthotropic Steel Deck Bridges
- Published in 2012 to supplement and modernize the 1963 Design Manual for Orthotropic Steel Deck Bridges
- Covers analysis, design, detailing, fabrication, testing, inspection, evaluation, and repair of OSD



3 LEVELS OF DESIGN

Design Level	Description
1	Design verification by little or no structural analysis, but by selection of details that are verified to have adequate resistance by experimental testing
2	Design verification by refined three-dimensional or two-dimensional analysis of certain panel details where such analysis is sufficiently accurate or for certain details that are similar to previous tested details described in Level 1
3	Design verification by refined three-dimensional analysis of the panel to quantify the local stresses to the most accurate extent reasonably expected from a qualified design engineer experienced in refined analysis

BACKGROUND

In 2014, formation of AASHTO/NSBA TG16

- Established to help make OSD more readily manufacturable in the US
- Effort toward standard sizes and details
- Particular focus on common bridges
- Suitable for short span bridge applications

FHWA PROJECT

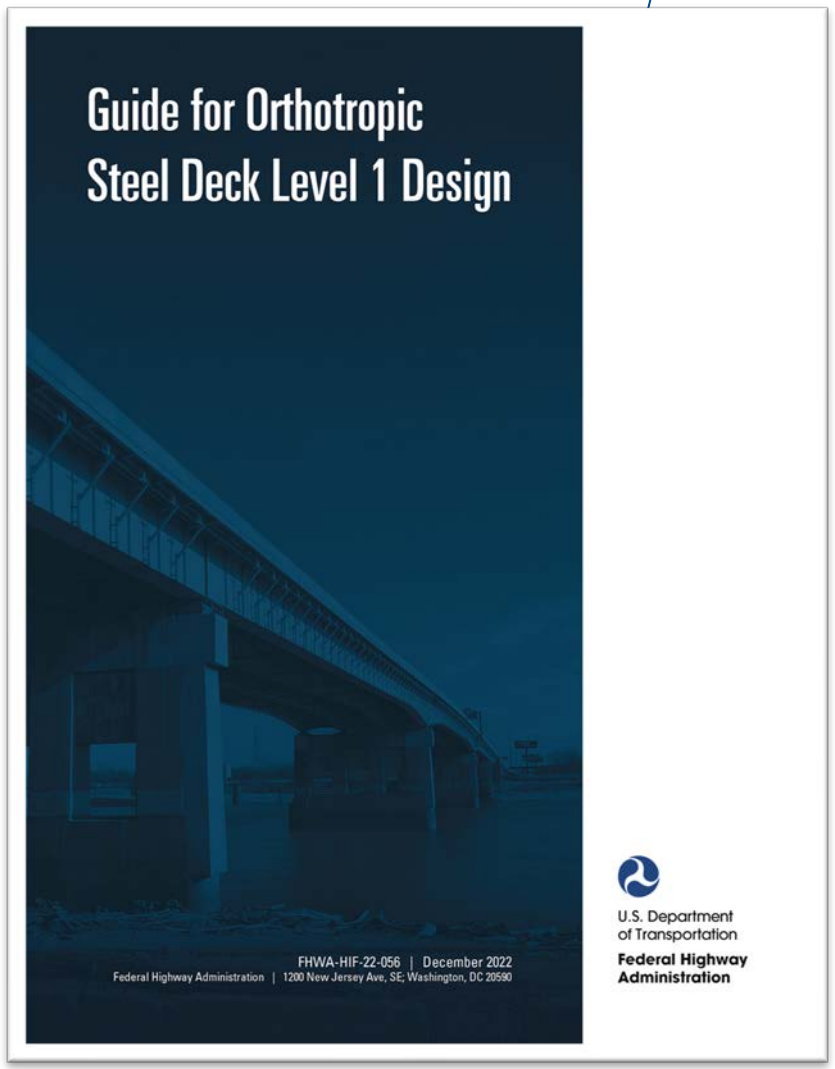
In 2020, initiation of FHWA OSD Project for Level 1 Design Guide

GUIDE OBJECTIVES

Deliver a guide for simplified OSD solutions to encourage implementation of OSD systems

Use proven designs to develop details for use on commonplace bridges

Align with Level 1 design guidelines described in the 2012 manual and LRFD Specifications



Guide for Orthotropic Steel Deck Level 1 Design

GUIDE CONTENTS

INTRODUCTION

The “why”

- OSD challenges are a deterrent
- FHWA recognition of Level 1 development needed

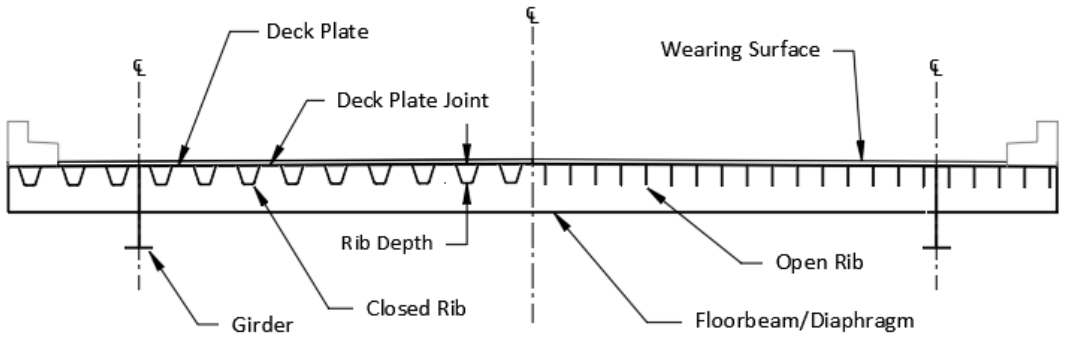
The “what”

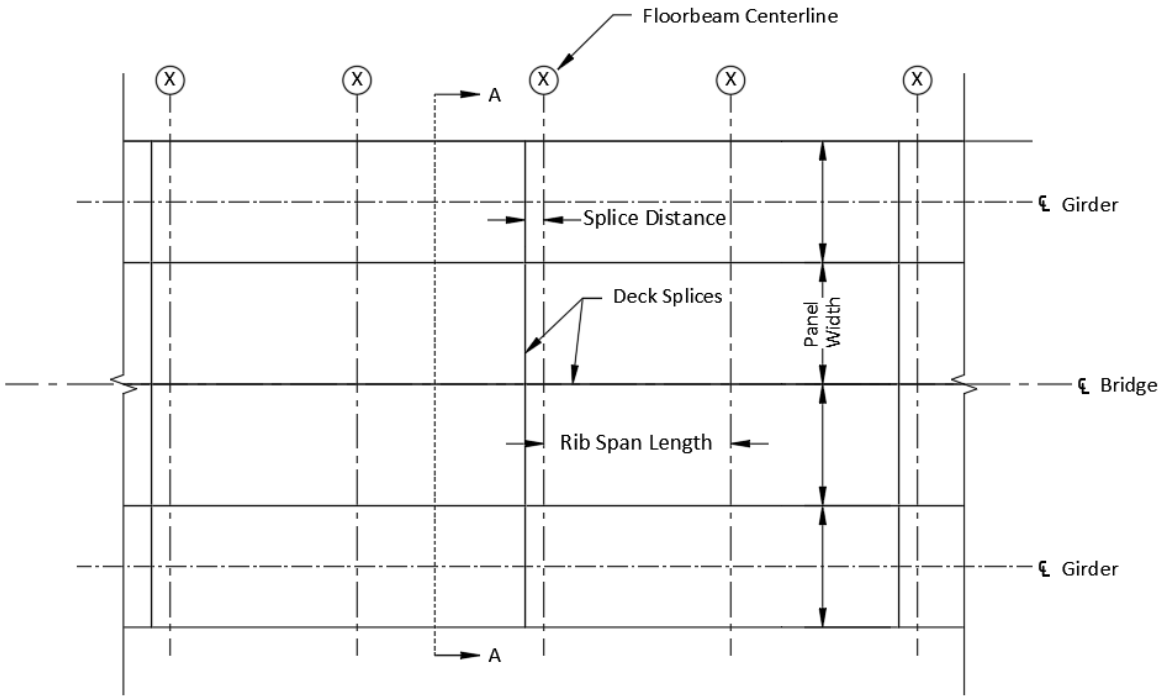
- Open- and closed-rib systems, decks, floorbeams
- Key points
- Advantages and challenges
- Short case studies of in-service bridges

GLOSSARY

Define key terms to ensure certainty by guide user

- Ex: Blow-through, Melt-through





BIG PICTURE CONSIDERATIONS

- Optimization of material use is a secondary concern
- High redundancy alleviates safety concerns due to potential fatigue cracking or corrosion loss
- Maintenance is similar to that for other steel bridges
- Automation is not a requirement for quality fabrication
- Effort made to simplify connection details

CLOSED-RIB SYSTEM

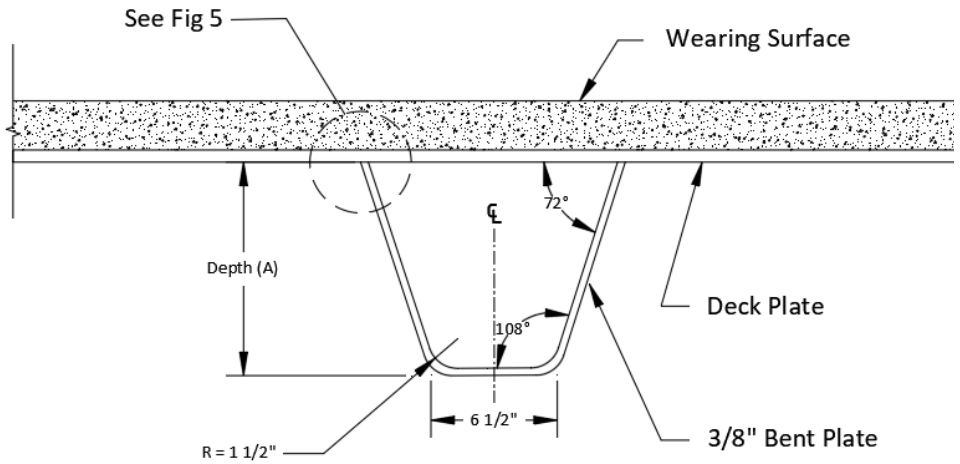
Have shown to be an effective OSD solution

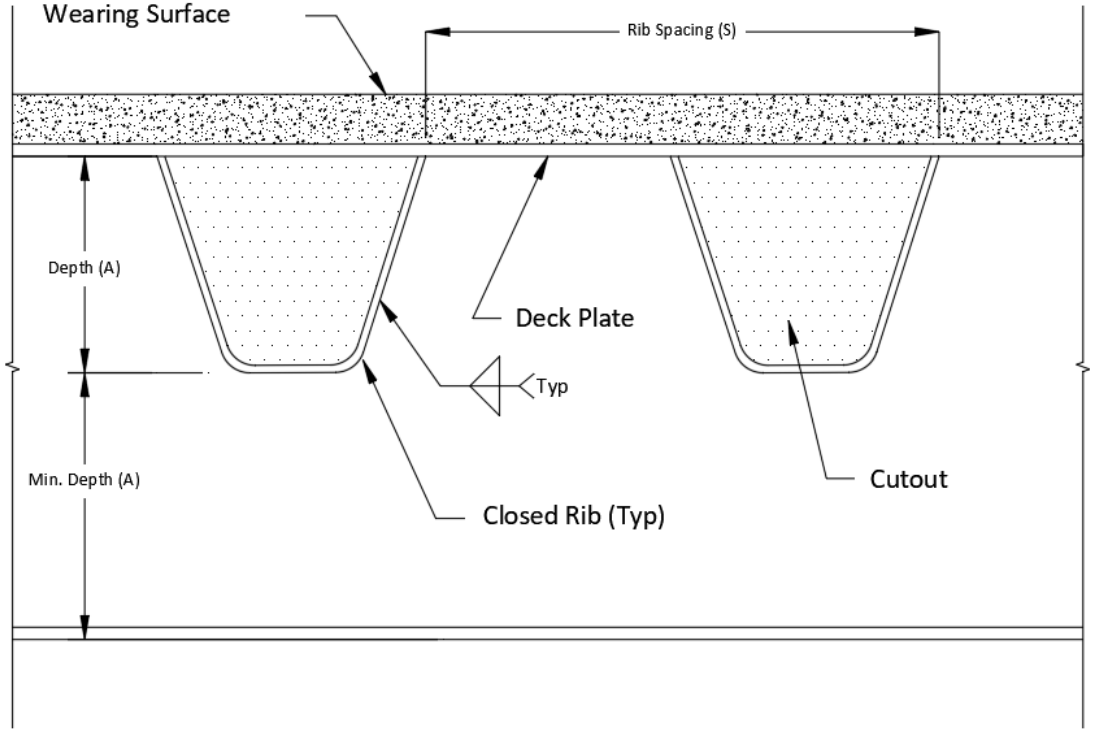
Trapezoidal ribs are simpler to fabricate than U-shaped ribs

A relaxation of minimum penetration of rib-to-deck PJP welds established by AASHTO

Flexibility in fabricator rib preparation

CLOSED-RIB SYSTEM

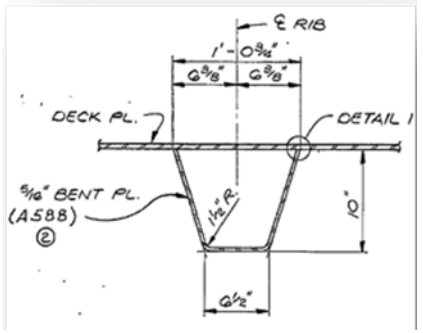


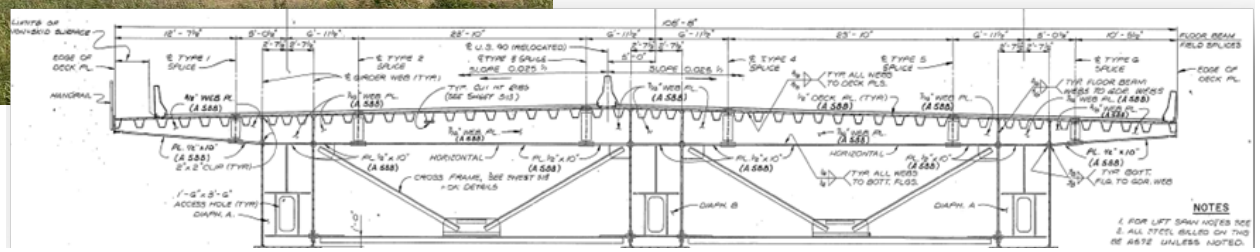


Option	Rib Depth (A)	Max Span Length*	Deck Plate Thickness
#1	10 1/2 inch	15 ft	5/8 inch
#2	14 inch	18 ft	3/4 inch

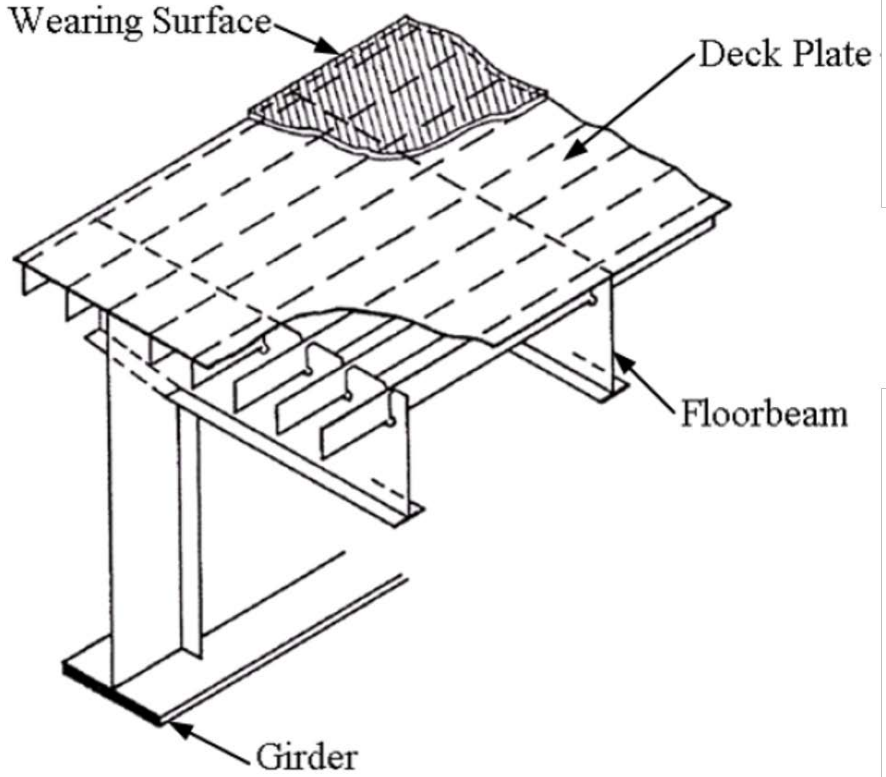
DANZIGER

- Trapezoidal closed ribs
- 80% rib-to-deck PJP weld
- 1/2” thick deck plate





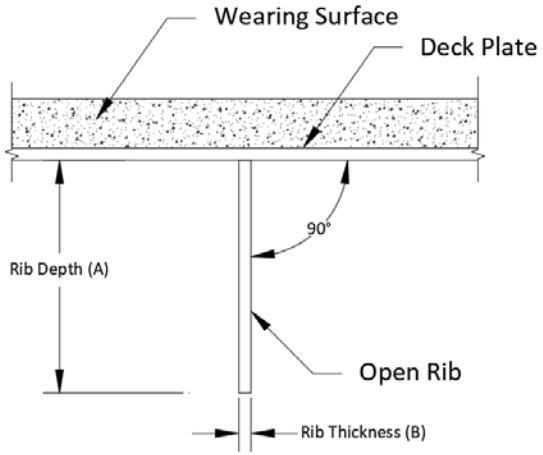
OPEN-RIB SYSTEM

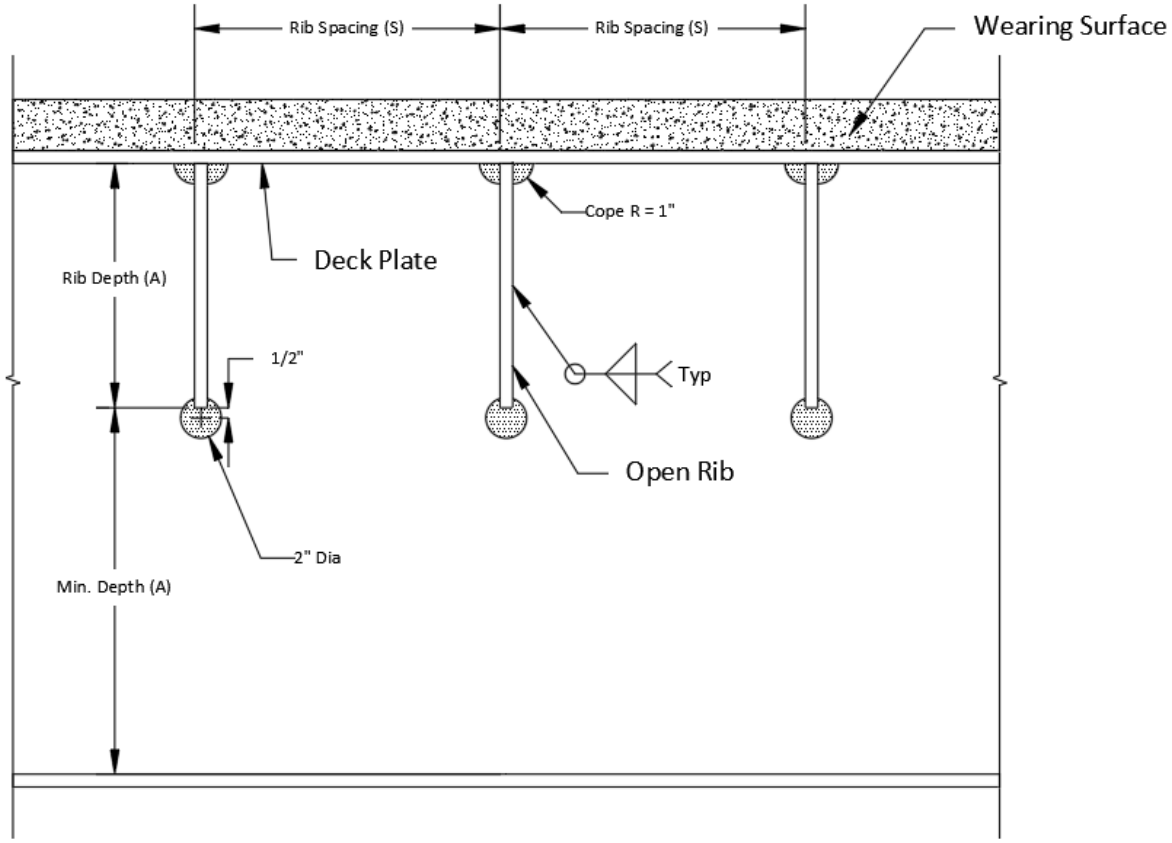


Design Manual for Orthotropic Steel Plate Deck Bridges, AISC1963

- Inherent fabrication simplicities
- Fillet welds between rib and deck plate simplifies fabrication compared to PJP groove welds
- Connections at floorbeam are easier to accomplish than closed connections
- Field splicing between deck segments is performed with relative ease

OPEN-RIB SYSTEM

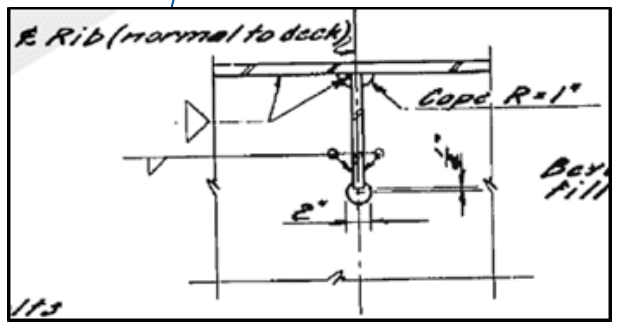




Option	Rib Depth (A)	Rib Thickness (B)	Max Span Length	Deck Plate Thickness
#1	10 inch	5/8 inch	10 ft	5/8 inch
#2	12 inch	3/4 inch	15 ft	3/4 inch

SAN MATEO-HAYWARD

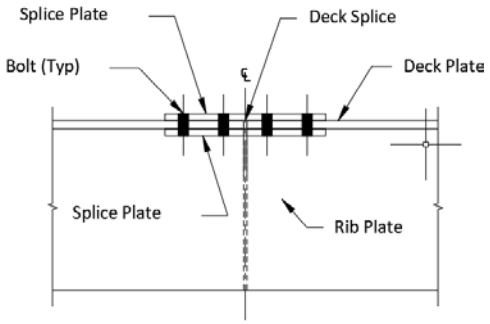
- 8” to 12” Deep 5/8” to 3/4” thick ribs
- Continuous pass through of ribs at floorbeams
- Splice plates and bolts at field completed splices

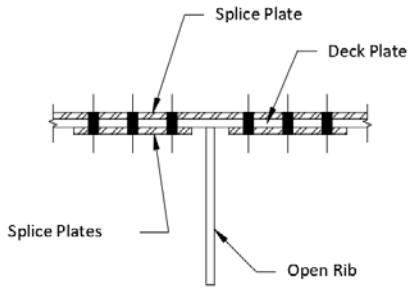


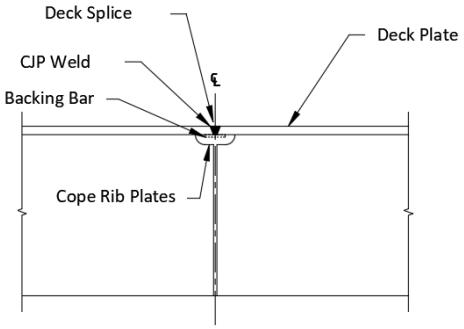
DECK PLATE

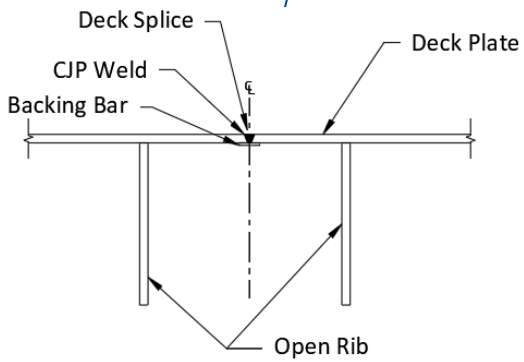
- A minimum thickness of 5/8 in. has been effectively demonstrated with in-service bridges
- Bolted splices are more easily erected in the field than welded splices
- Bolted splices need a thicker wearing surface
- Welded splices are suitable and have been used more often
- Wearing surface suitability should be discussed with product manufacturers

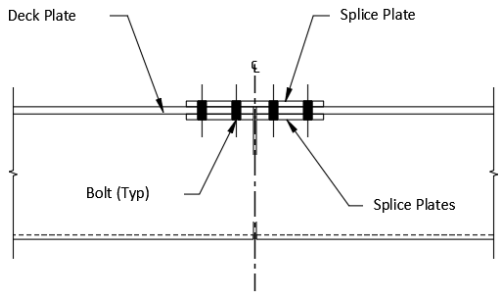
DECK PLATE

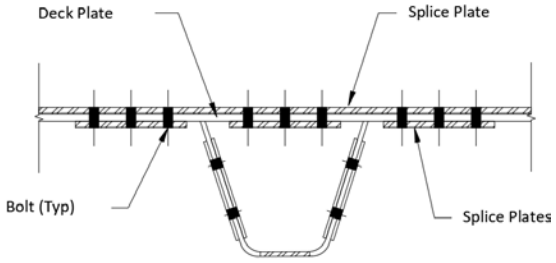

Splice Plate
Deck Splice
Bolt (Typ)
Deck Plate
Splice Plate
Rib Plate

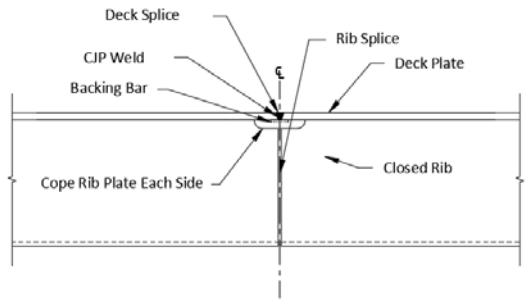

Splice Plate
Deck Plate
Splice Plates
Open Rib

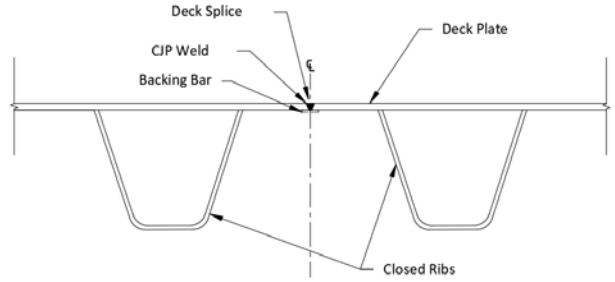

Deck Splice
Deck Plate
CJP Weld
Backing Bar
Cope Rib Plates


Deck Splice
Deck Plate
CJP Weld
Backing Bar
Open Rib


Deck Plate
Splice Plate
Bolt (Typ)
Splice Plates

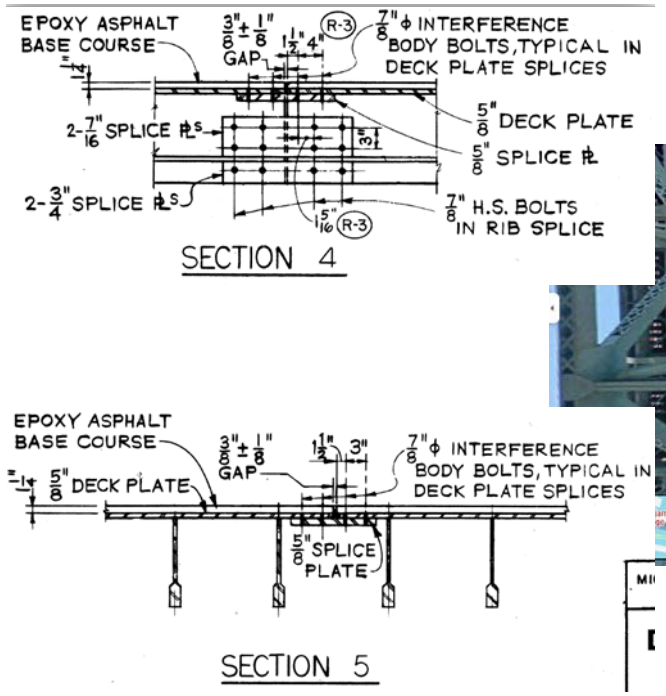

Deck Plate
Splice Plate
Bolt (Typ)
Splice Plates


Deck Splice
Rib Splice
CJP Weld
Deck Plate
Backing Bar
Closed Rib
Cope Rib Plate Each Side


Deck Splice
Deck Plate
CJP Weld
Backing Bar
Closed Ribs

BEN FRANKLIN

- Mid-1980s redecking with open rib OSD
- 5/8” deck plate, resurfaced in 2018
- Satisfactory performance of deck plate



WEARING SURFACE

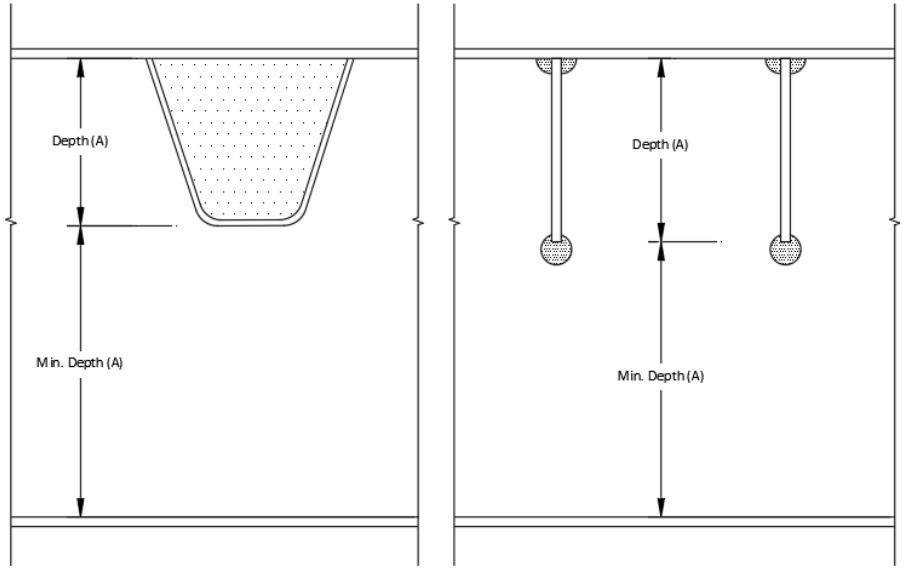
- Typical options are bituminous, polymer, or concrete surfacing systems
- Thick wearing surfaces contribute to overall deck stiffness and can reduce live-load stresses
- Each type of wearing surface option has its own prescribed installation procedure

POPLAR STREET

- Poor performance of wearing surface at 9/16” deck plate and 1/2” epoxy concrete
- Improved performance using studded 4” fiber-reinforced lightweight concrete

FLOORBEAM

- For new construction, floorbeam depth is not restricted as with retrofit scenarios
- It is beneficial to use a deeper floorbeam for added system stiffness and improved fatigue performance at rib-to-floorbeam connections
- Fit-up of ribs is readily achieved with appropriate tolerances



Grant Programs

FEDERAL GRANT PROGRAMS

1. Accelerated Innovation Deployment Demonstration Program (AID)

   "supports the implementation of proven operational and material innovations in surface transportation"

2. Bridge Investment Program

   "funds planning and construction projects that replace or protect aging and at-risk bridges"

3. Accelerating Market Readiness

   " provides funding to spur the advancement of emerging transformative innovations"

https://www.transportation.gov/rural/grant-toolkit/usdot-competitive-grants-by-agency/fhwa

https://www.fhwa.dot.gov/innovation/amr/

FHWA AID GRANT

- AID: Accelerated Innovation Deployment
- Provides funding as an incentive for eligible entities to accelerate the implementation and adoption of proven innovations in highway transportation
- Construct longer lasting highways through the use of innovative technologies

FHWA AID GRANT

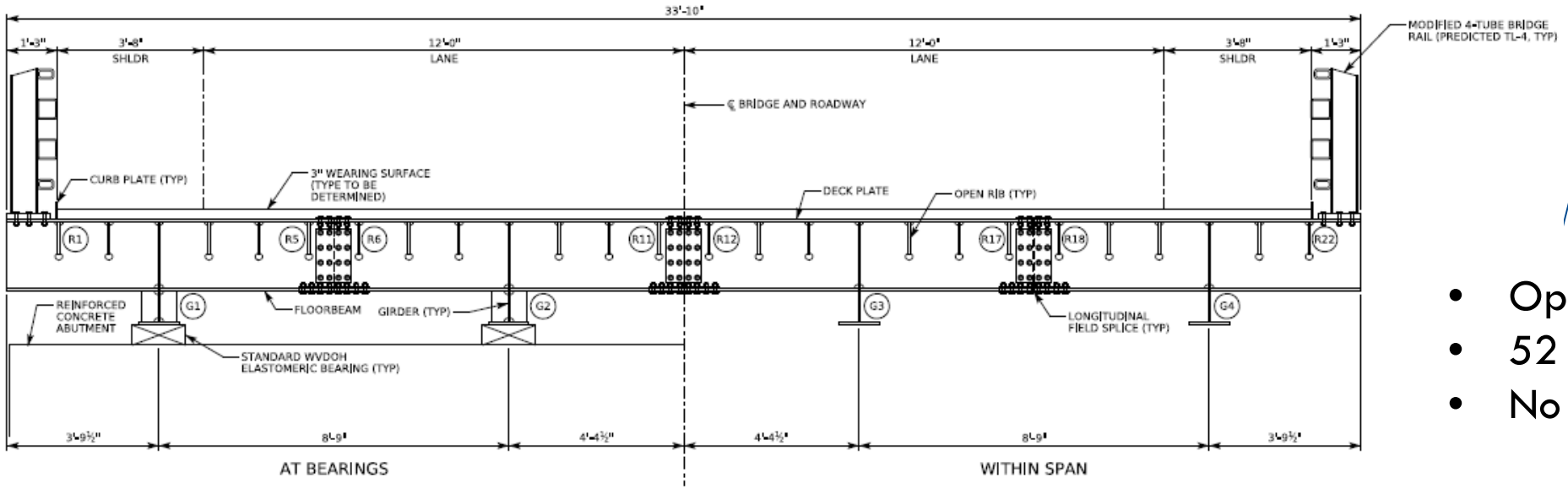
- Awards given to State DOTs and Local Public Agencies (via State DOTs)
- Minimum award $100,000
- Maximum award $1,000,000
- Total awards $10,000,000

WVDOH AID GRANT

Purgitsville, WV
US Route 220
Existing bridge built in 1956
35 ft long x 30 ft wide
41 deg skew

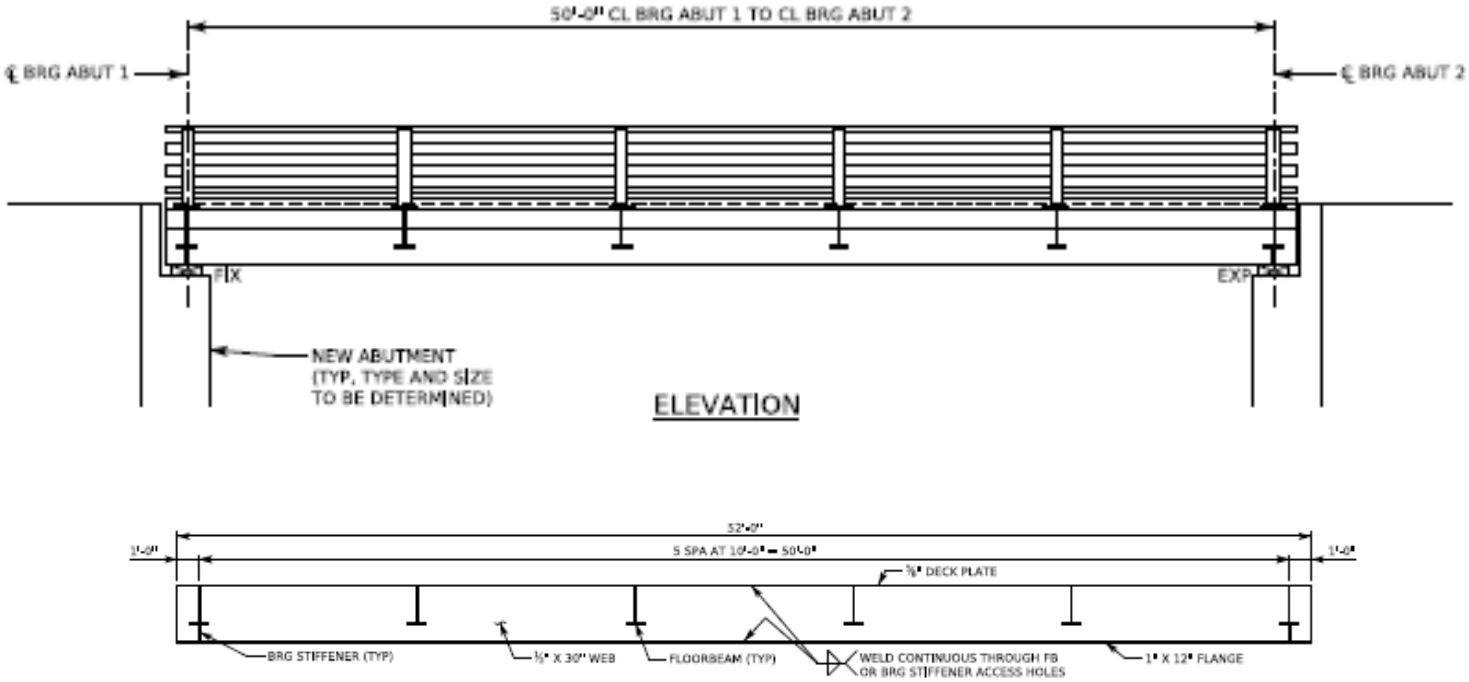
WVDOH AID GRANT

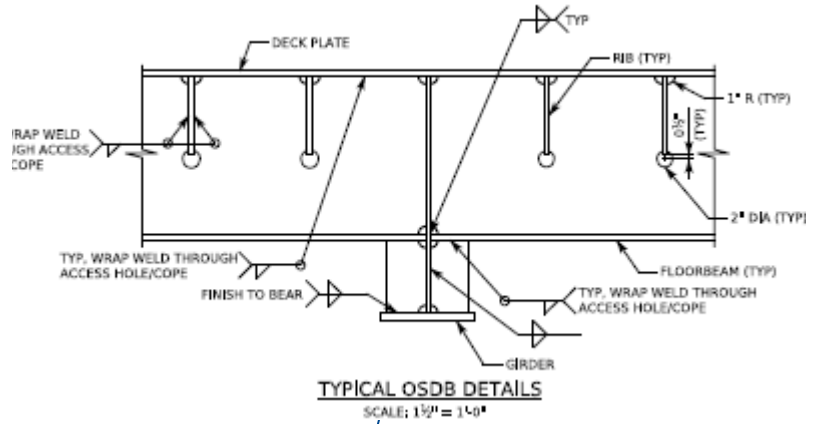
Preliminary plans have been completed



- Open Rib OSD Design
- 52 ft long x 34 ft wide
- No skew

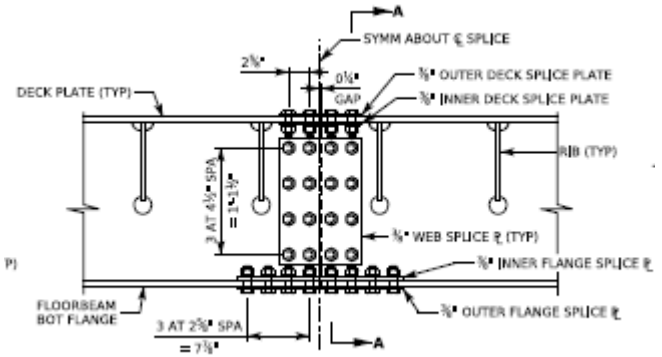
WVDOH AID GRANT





TYPICAL OSDB DETAILS

SCALE: 1½" = 1'-0"



LONGITUDINAL SPLICE DETAIL

FINAL EXAM

Which of the following is a primary reason orthotropic steel deck bridges have seen limited use in the United States compared to other regions?

A. Poor durability in cold climates
B. Lack of redundancy in the system
C. Complexity of design and high fabrication costs
D. Incompatibility with LRFD specifications

FINAL EXAM

Which statement best reflects the philosophy behind the FHWA Level 1 Orthotropic Steel Deck Design Guide?

A. Prioritize material optimization and weight reduction above all else
B. Encourage experimental fatigue testing for all projects
C. Use proven designs and simplified details suitable for commonplace bridges
D. Require automated fabrication for quality assurance

FINAL EXAM

Why was the Purgitsville, West Virginia bridge a strong candidate for an FHWA AID demonstration project using an orthotropic steel deck system?

A. It required long-span construction exceeding 300 ft
B. It involved a short-span bridge suitable for a simplified, Level 1 OSD application
C. It was located on an urban interstate with high traffic volumes
D. It required experimental fatigue testing prior to construction

THANK YOU

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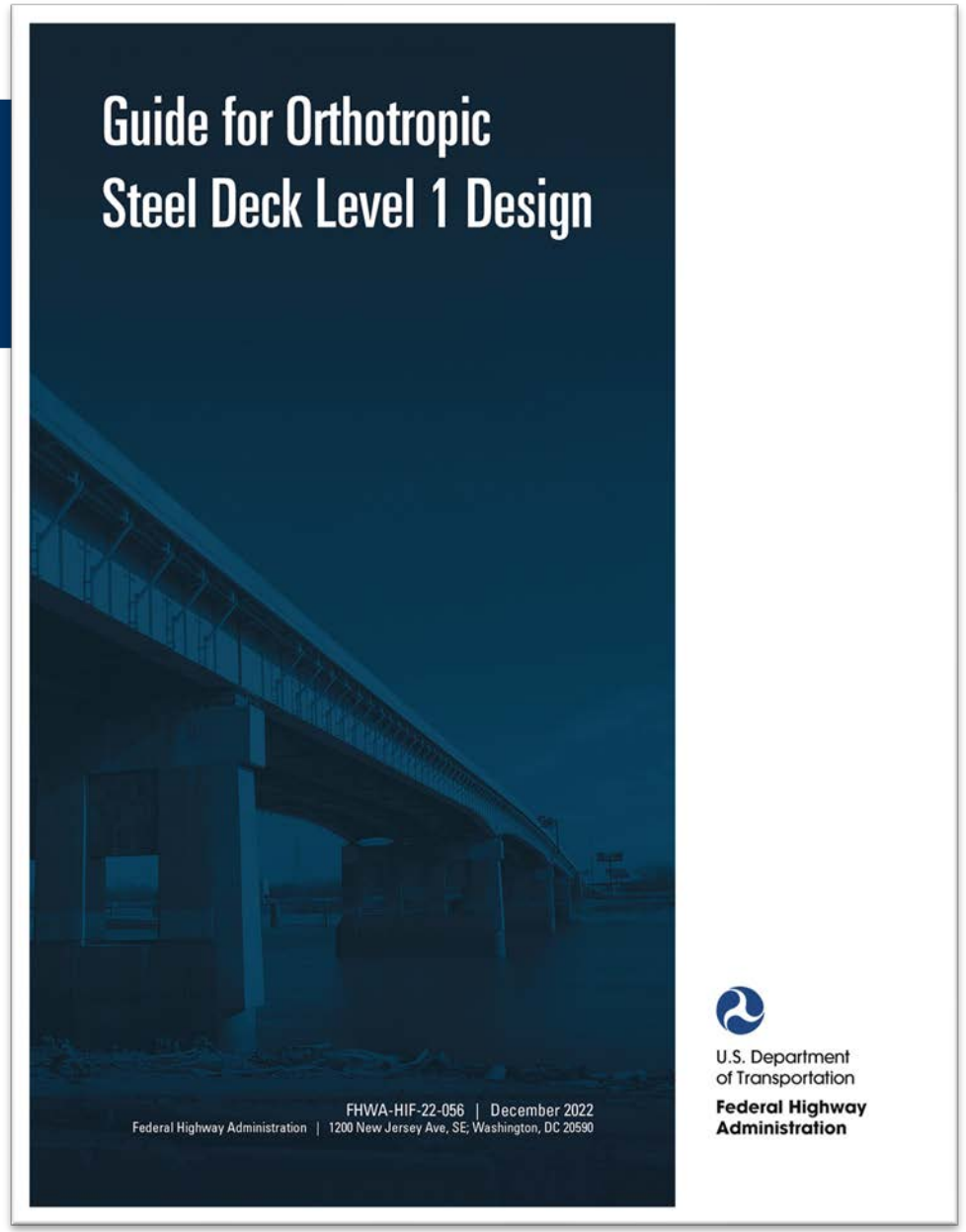

www.fhwa.dot.gov/bridge/pubs/hif22056.pdf