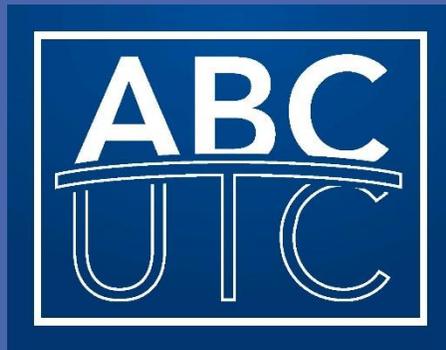


SYNTHESIS ON THE USE OF ACCELERATED BRIDGE CONSTRUCTION APPROACHES FOR BRIDGE REHABILITATION

By: Meghan Cronin

July 29th, 2016



Outline

- ❖ Introduction
- ❖ Deck Joints
- ❖ Decks
- ❖ Girders
- ❖ Piers and Columns
- ❖ Abutments
- ❖ Summary/Conclusions

INTRODUCTION

What is ABC? Why ABC? How?

Introduction

- ❖ What is ABC?
- ❖ Why ABC for rehab and repair?
- ❖ How to apply ABC to repair and rehab?

DECK JOINTS

Rapid removal and repair

Deck Joints

❖ Rapid Removal

❖ Hydrodemolition



Hydrodemolition machine



Surface after hydrodemolition

Deck Joints

❖ Rapid Repair

❖ Expansion Joints

- ❖ Compressed air to clean

- ❖ Compression seal armoring installed

- ❖ Silicoflex joint sealing system (inverted strip seal)

❖ Deck Closure Pours

- ❖ UHPC

DECKS

Rapid removal, protection, repair, and replacement

Decks

- ❖ Rapid Removal
 - ❖ Hydrodemolition
 - ❖ Milling
 - ❖ Sawing
 - ❖ Crushing
 - ❖ Peeling

Decks

❖ Rapid Protection

- ❖ Bituminous Concrete
- ❖ Polymer Overlay
- ❖ High Early Strength Hydraulic Cement Concrete
- ❖ Penetrating Sealers



Polymer Overlay

Decks

❖ Rapid Protection

| System | Avg. Area (yd ²) | Traffic control (hr.) | Surface Preparation (hr.) | Placing and Curing (hr.) | Total (hr.) | Average Service Life (years) | Average Initial Cost (\$/yd ²) |
|---|------------------------------|-----------------------|---------------------------|--------------------------|-------------|------------------------------|--|
| Bituminous Concrete Overlay on Membrane | 587 | 2.5 | 3.7 | 6.5 | <u>12.7</u> | <u>9.7</u> | <u>50.84</u> |
| Coating | 519 | 2.0 | 1.8 | 5.7 | <u>9.5</u> | -- | -- |
| PCC Overlay | 1181 | 0.9 | 2.3 | 5.6 | <u>8.8</u> | <u>17.9</u> | <u>83.21</u> |
| Penetrating Sealer | 673 | 1.5 | 2.2 | 3.4 | <u>7.1</u> | <u>5.0</u> | <u>5.45</u> |
| Polymer Overlay | 481 | 1.2 | 4.0 | 4.7 | <u>9.9</u> | <u>10.0</u> | <u>43.55</u> |
| Other Hydraulic Cement Overlay | 452 | 0.9 | 4.0 | 3.1 | <u>8.0</u> | -- | <u>6.08</u> |

Decks

❖ Rapid Repair (Patching)

- ❖ Asphalt Concrete
- ❖ Polymer Concrete Patching
- ❖ High Early Strength Hydraulic Cement Concrete
- ❖ Crack Repair and Sealing

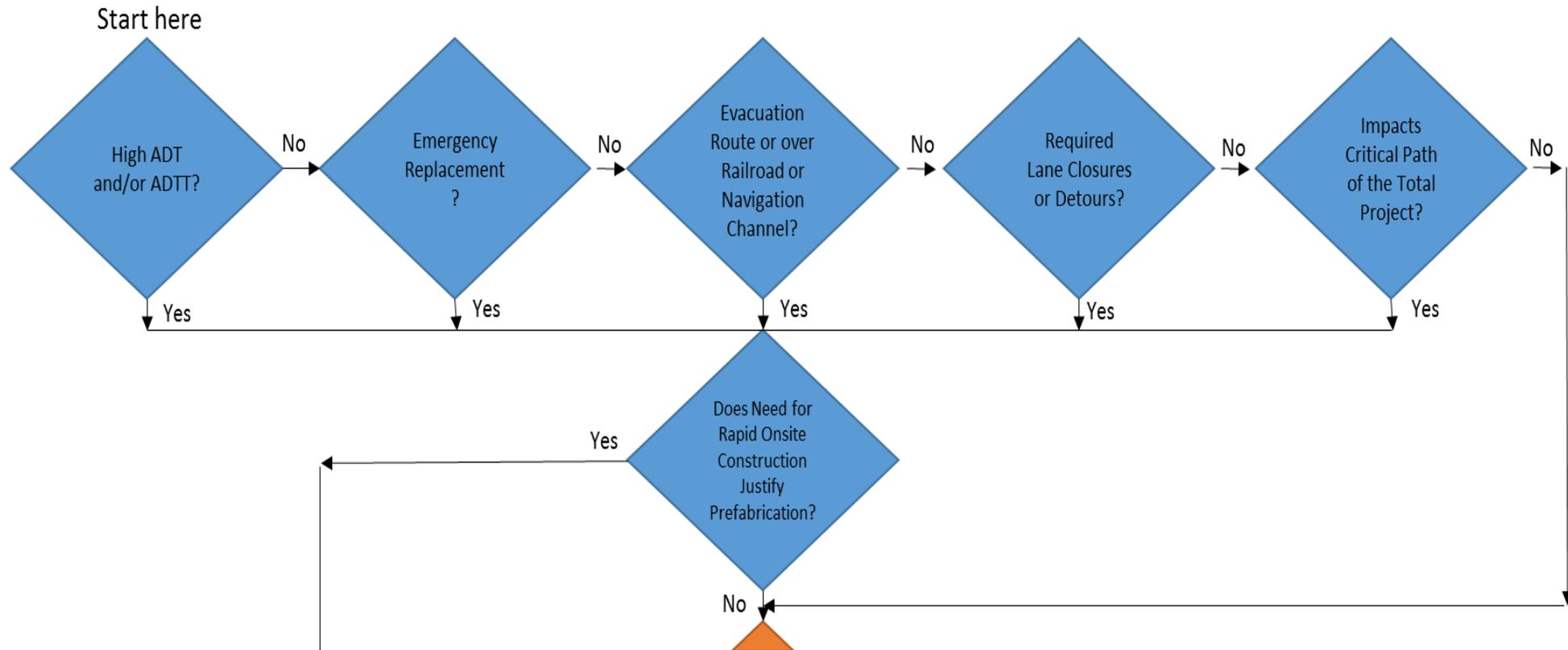
Decks

❖ Rapid Repair (Patching)

| System | Average Area (yd ²) | Traffic control (hr.) | Surface prep. (hr.) | Placing and curing (hr.) | Total (hr.) | Average Service Life (yrs.) | Average Initial Cost (\$/yd ²) |
|--------------------------------|---------------------------------|-----------------------|---------------------|--------------------------|-------------|-----------------------------|--|
| Bituminous Concrete Patch | 5 | 0.9 | 0.4 | 0.7 | <u>2.0</u> | <u>0.6</u> | <u>40.57</u> |
| Portland Cement Concrete Patch | 9 | 1.7 | 3.3 | 2.6 | <u>7.6</u> | <u>14.8</u> | <u>202.17</u> |
| Polymer Concrete Patch | 202 | 2.1 | 1.9 | 5.2 | <u>9.2</u> | <u>5.5</u> | <u>247.07</u> |
| Other HCC Concrete Patch | 43 | 1.5 | 2.2 | 3.1 | <u>6.8</u> | <u>3.8</u> | <u>235.16</u> |

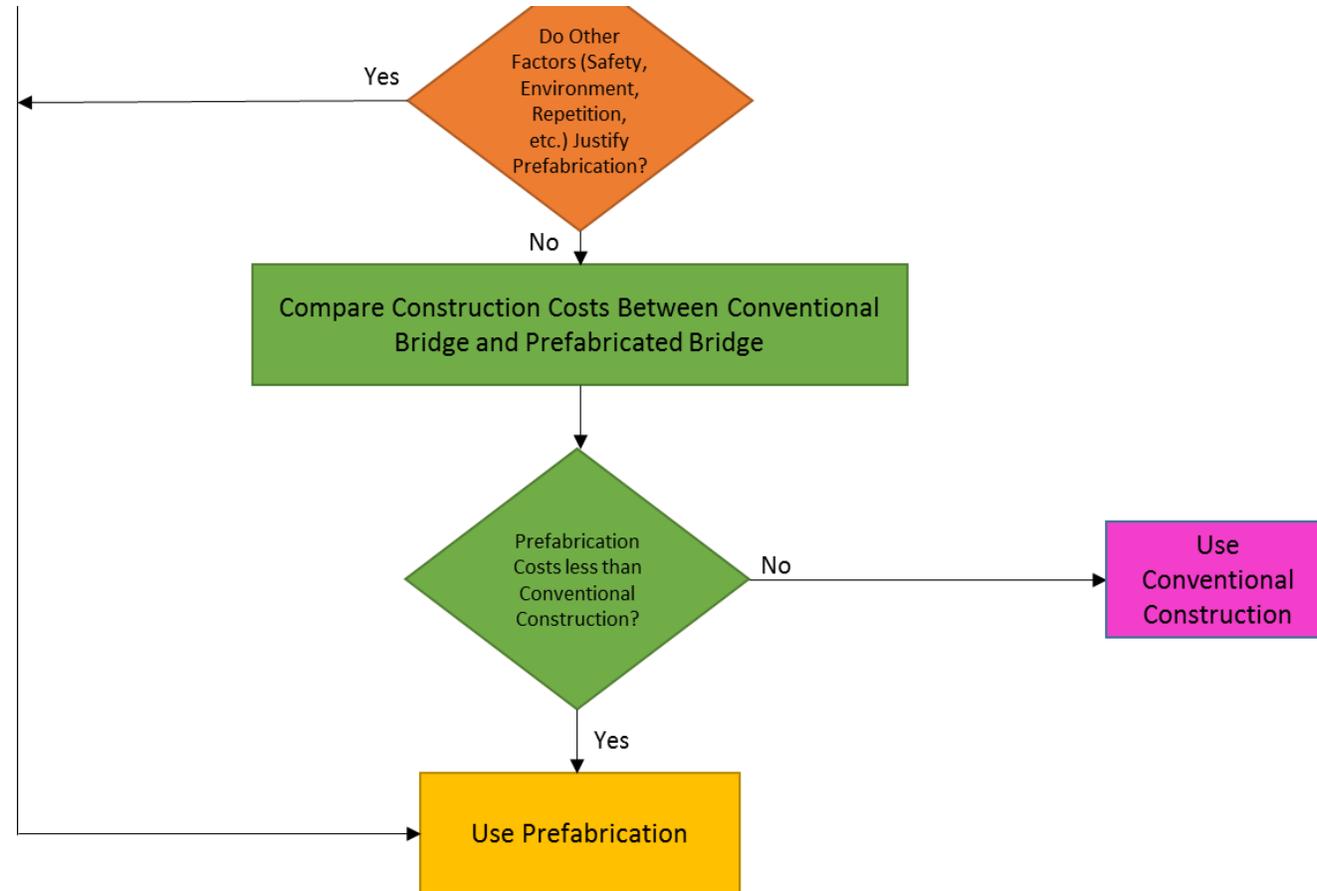
Decks

❖ Rapid Replacement



Decks

❖ Rapid Replacement



Decks

❖ Rapid Replacement

| Question | Yes | Maybe | No |
|---|-----|-------|----|
| Does the bridge have high average daily traffic (ADT) or average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway? | | | |
| Is this project an emergency bridge replacement? | | | |
| Is the bridge on an emergency evacuation route or over a railroad or navigable waterway? | | | |
| Will the bridge construction impact traffic in terms of requiring lane closures or detours? | | | |
| Will the bridge construction impact the critical path of the total project? | | | |
| Can the bridge be closed during off-peak traffic periods, e.g., nights and weekends? | | | |
| Is rapid recovery from natural/manmade hazards or rapid completion of future planned repair/replacement needed for this bridge? | | | |
| Is the bridge location subject to construction time restrictions due to adverse economic impact? | | | |
| Does the local weather limit the time of year when cast-in-place construction is practical? | | | |
| Do worker safety concerns at the site limit conventional methods, e.g., adjacent power lines or over water? | | | |

Decks

❖ Rapid Replacement

Is the site in an environmentally sensitive area requiring minimum disruption (e.g., wetlands, air quality, and noise)?

Are there natural or endangered species at the bridge site that necessitate short construction time windows or suspension of work for a significant time period, e.g., fish passage or peregrine falcon nesting?

If the bridge is on or eligible for the National Register of Historic Places, is prefabrication feasible for replacement/rehabilitation per the Memorandum of Agreement?

Can this bridge be designed with multiple similar spans?

Does the location of the bridge site create problems for delivery of ready-mix concrete?

Will the traffic control plan change significantly through the course of the project due to development, local expansion, or other projects in the area?

Are delay-related user costs a concern to the agency?

Can innovative contracting strategies to achieve accelerated construction be included in the contract documents?

Can the owner agency provide the necessary staffing to effectively administer the project?

Can the bridge be grouped with other bridges for economy of scale?

Will the design be used on a broader scale in a geographic area?

Totals:

Decks

❖ Rapid Replacement

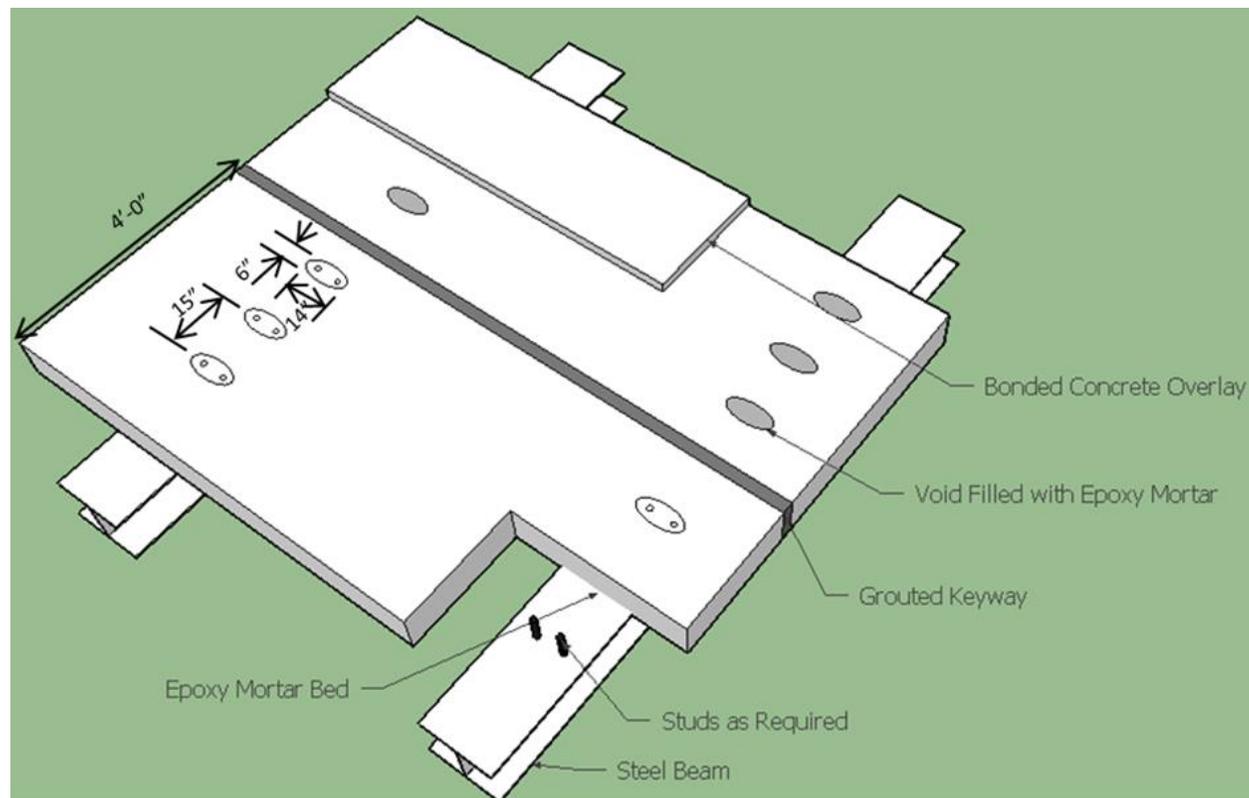
- ❖ Cast-in-place high early strength concrete
- ❖ Open steel grids
- ❖ Precast concrete deck panels
- ❖ Exodermic deck panels
- ❖ Orthotropic deck panels

Decks

- ❖ **Rapid Replacement**
 - ❖ CIP High early strength deck
 - ❖ Open Steel Grid Panel

Decks

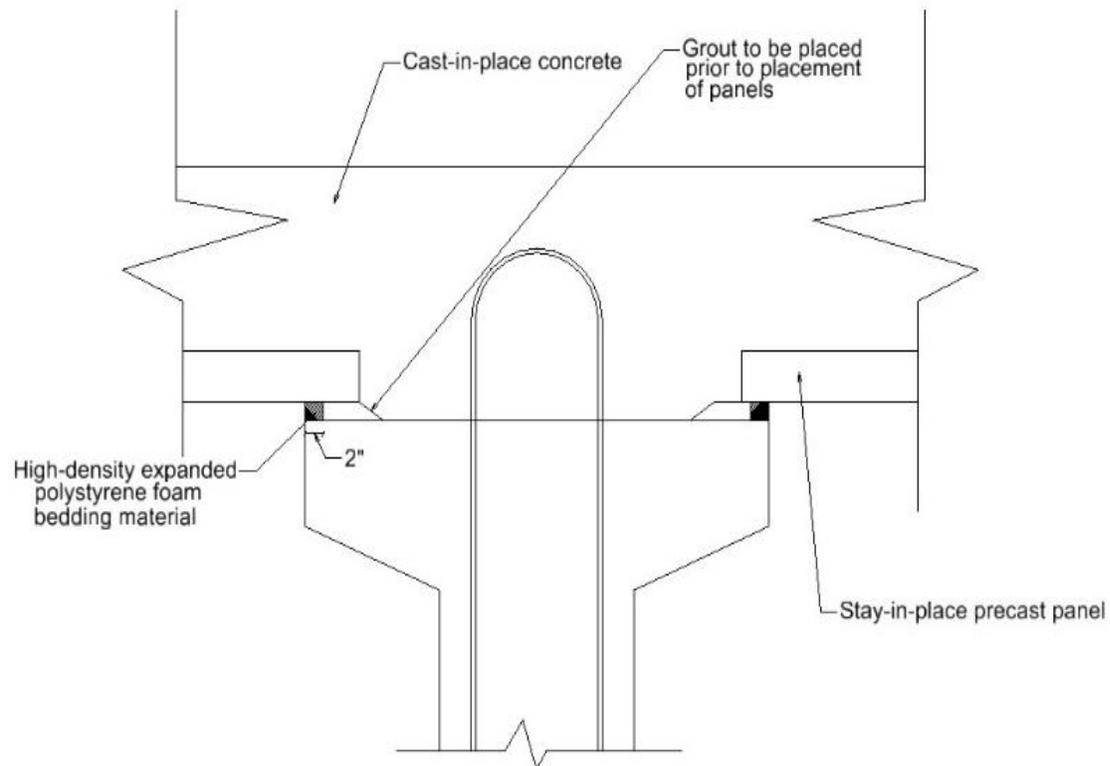
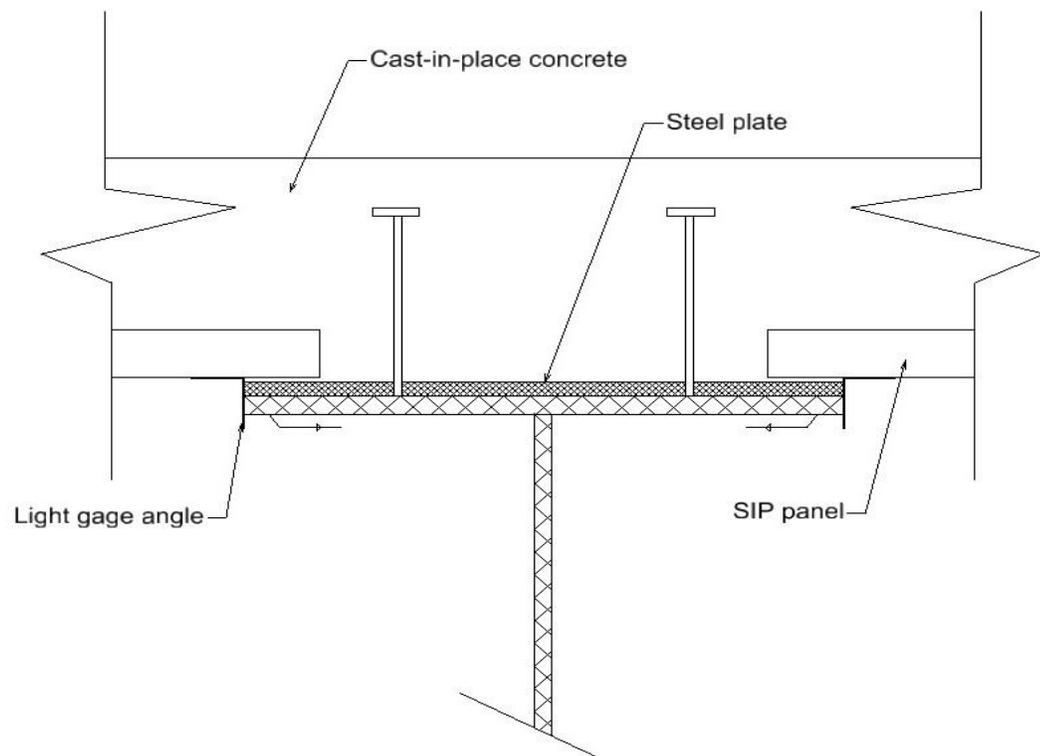
❖ Rapid Replacement



Typical precast deck panel

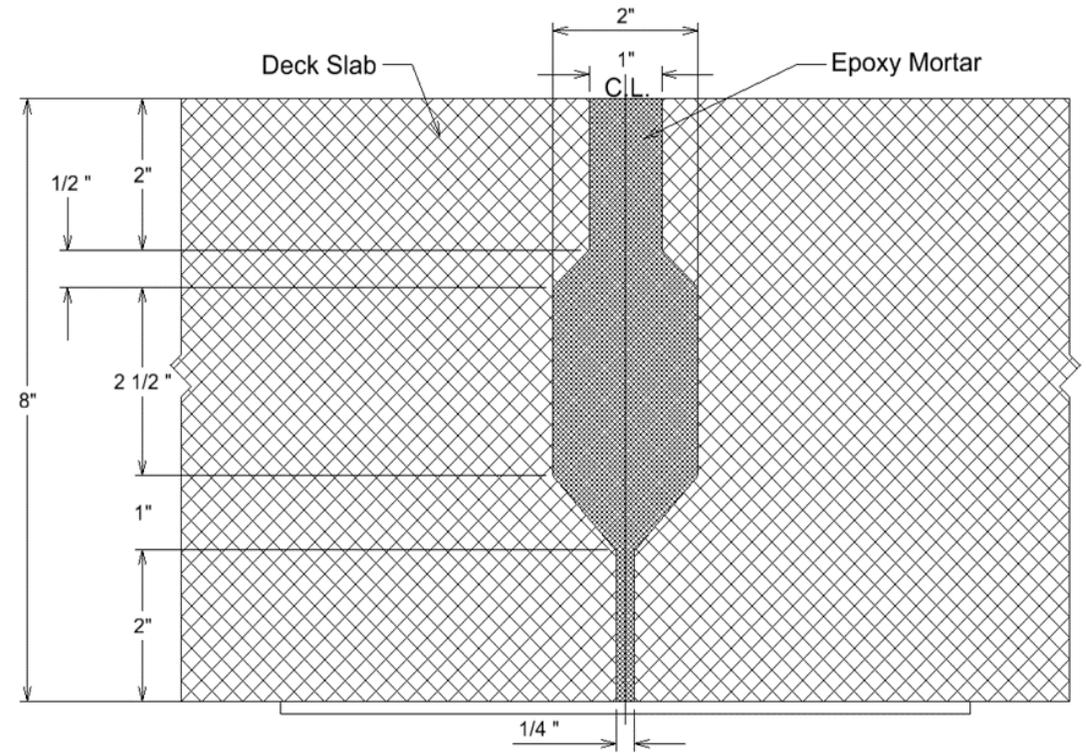
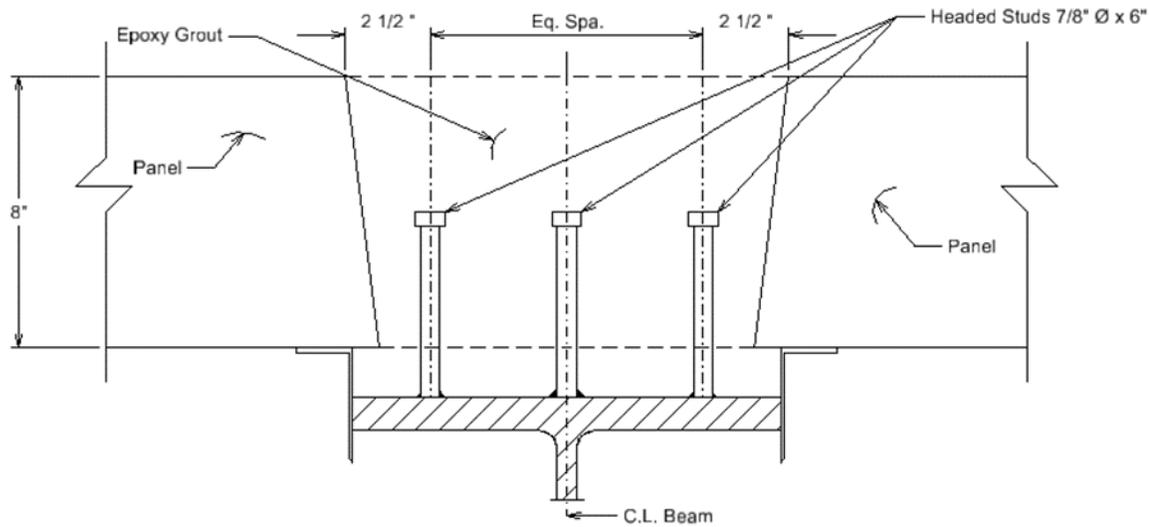
Decks

❖ Rapid Replacement



Typical partial-depth precast deck panel connections

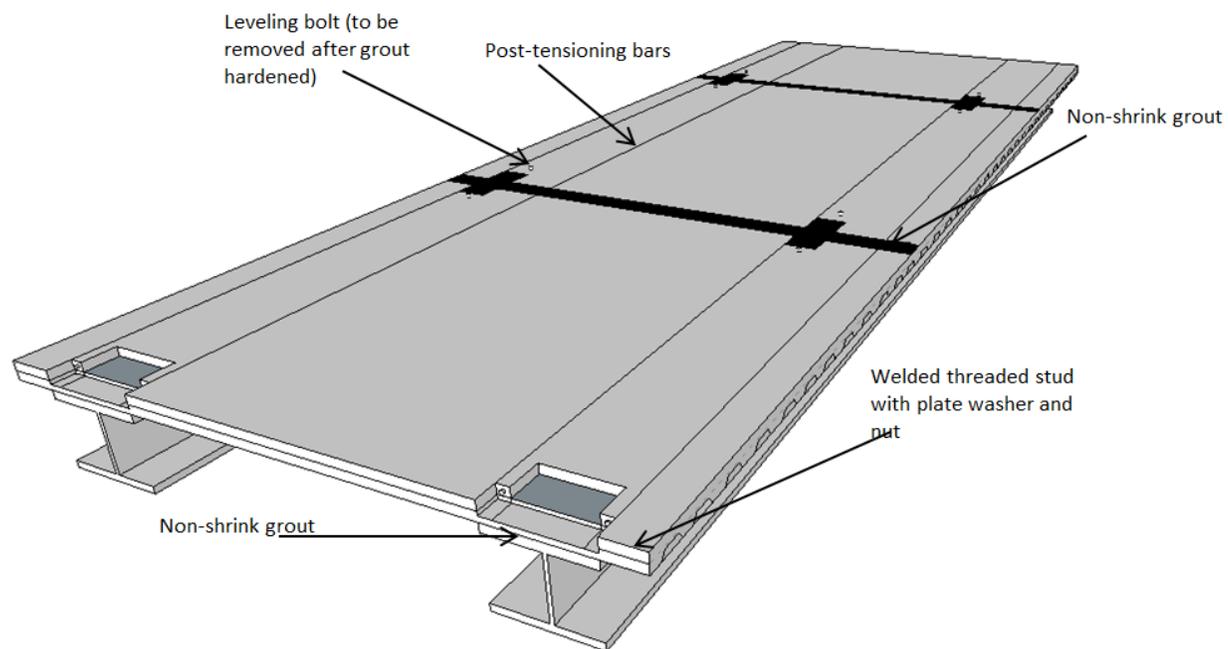
❖ Rapid Replacement



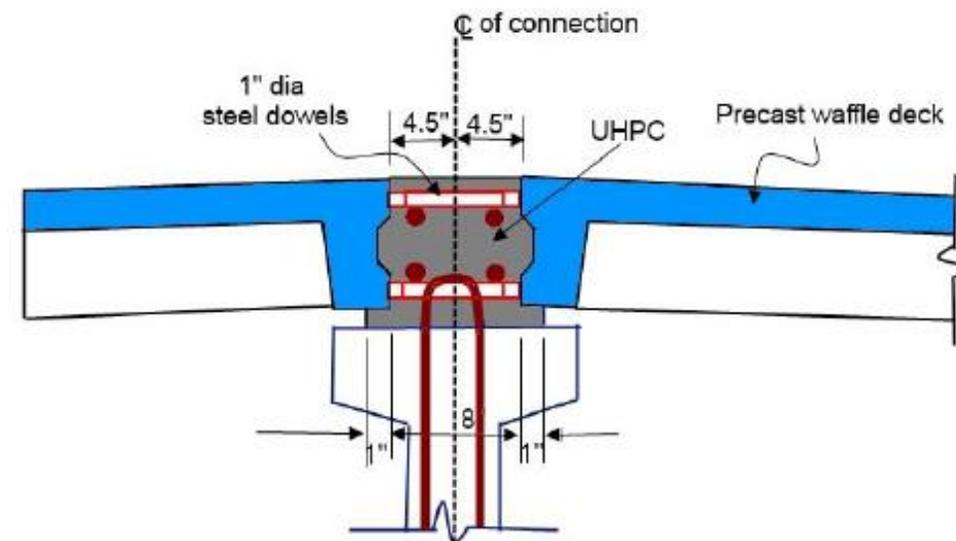
Typical full-depth precast deck panel details

Decks

❖ Rapid Replacement



Recreated from Tadros and Baishya 1998

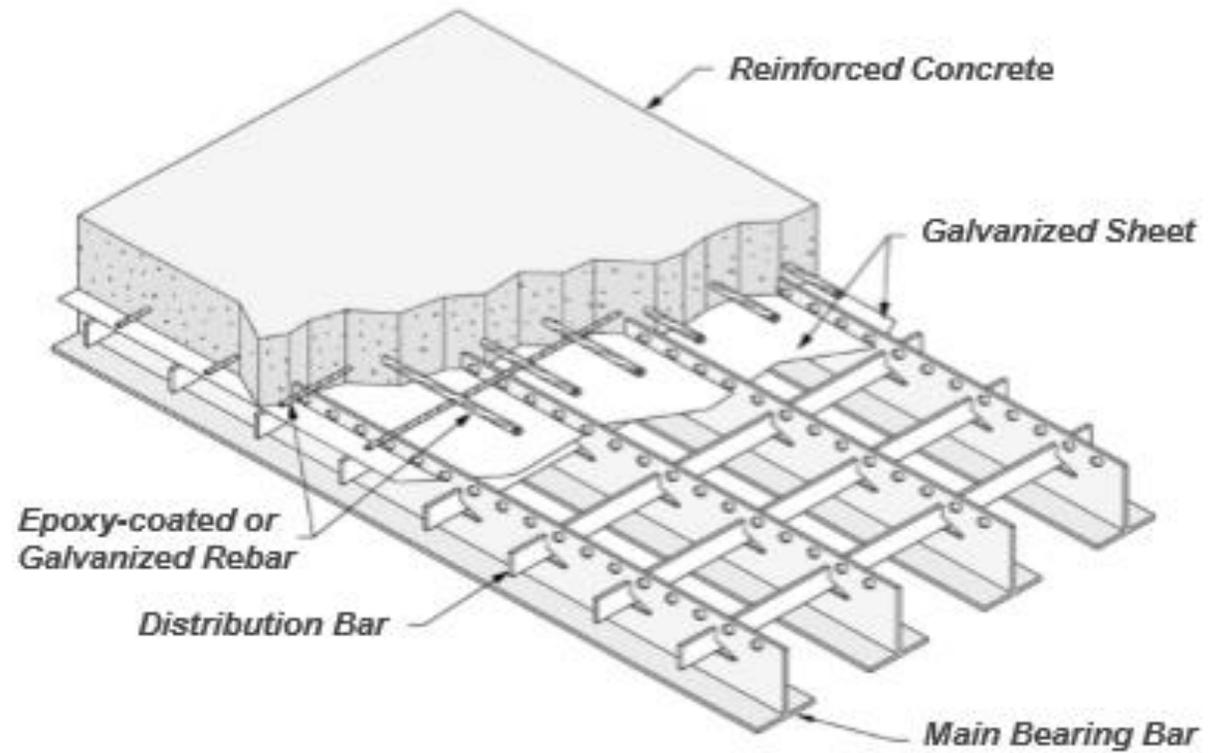


Aaleti et al. 2014

NU deck (left) and Waffle Deck (ISU) (right)

Decks

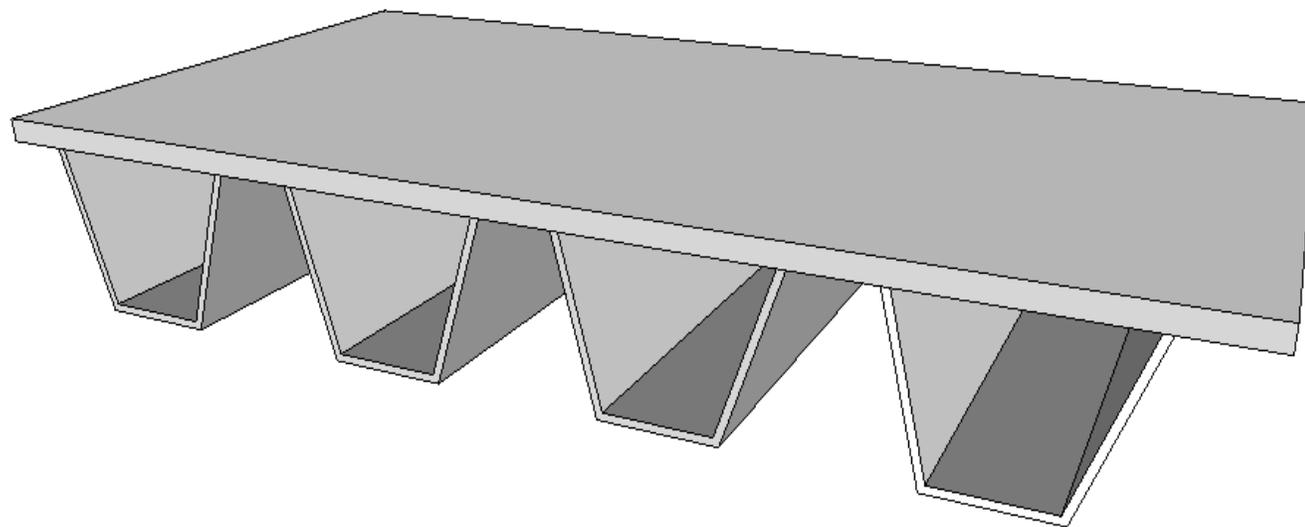
❖ Rapid Replacement



Exodermic Deck Panel

Decks

❖ Rapid Replacement



Orthotropic Deck Panel

GIRDERS

Rapid repair and replacement

Girders

❖ Rapid Repair

- ❖ Carbon fiber reinforced polymer strips

Girders

❖ Rapid Replacement

- ❖ Inverset Panels
- ❖ Precast modified beam-in-slab bridge (PMBISB) system
- ❖ Adjacent box, tee, and deck bulb tee beams
- ❖ Fenrich concrete girder

Girders

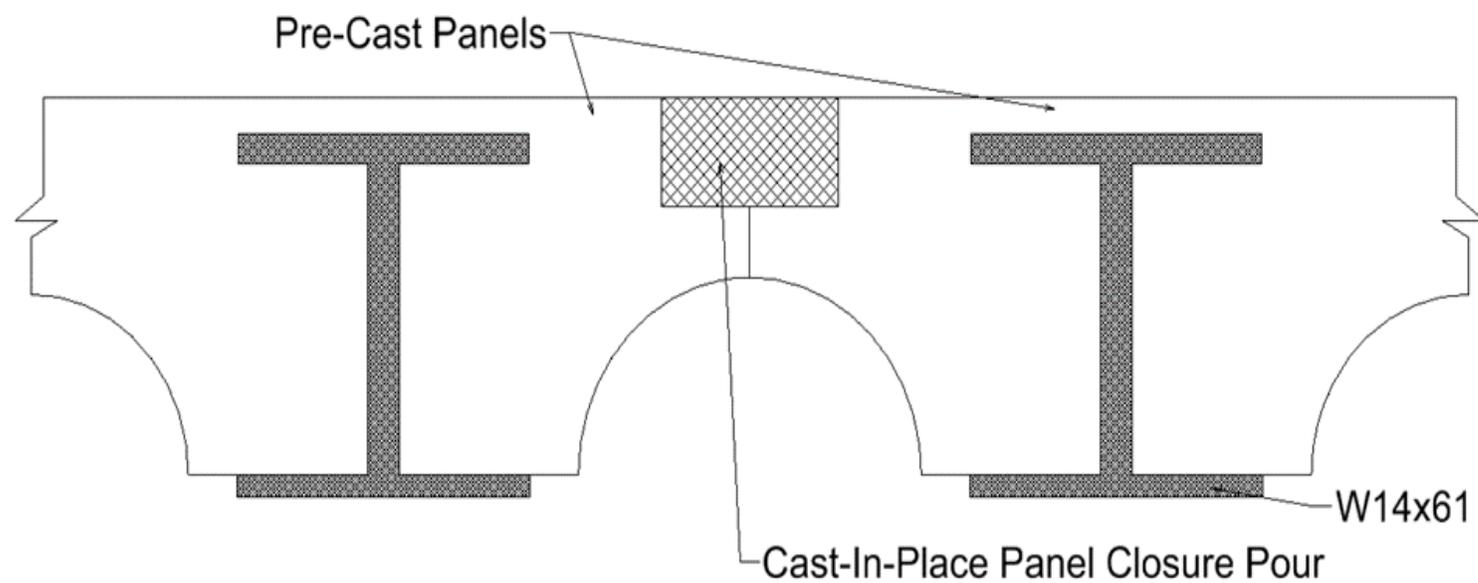
❖ Rapid Replacement



Inverset panels

Girders

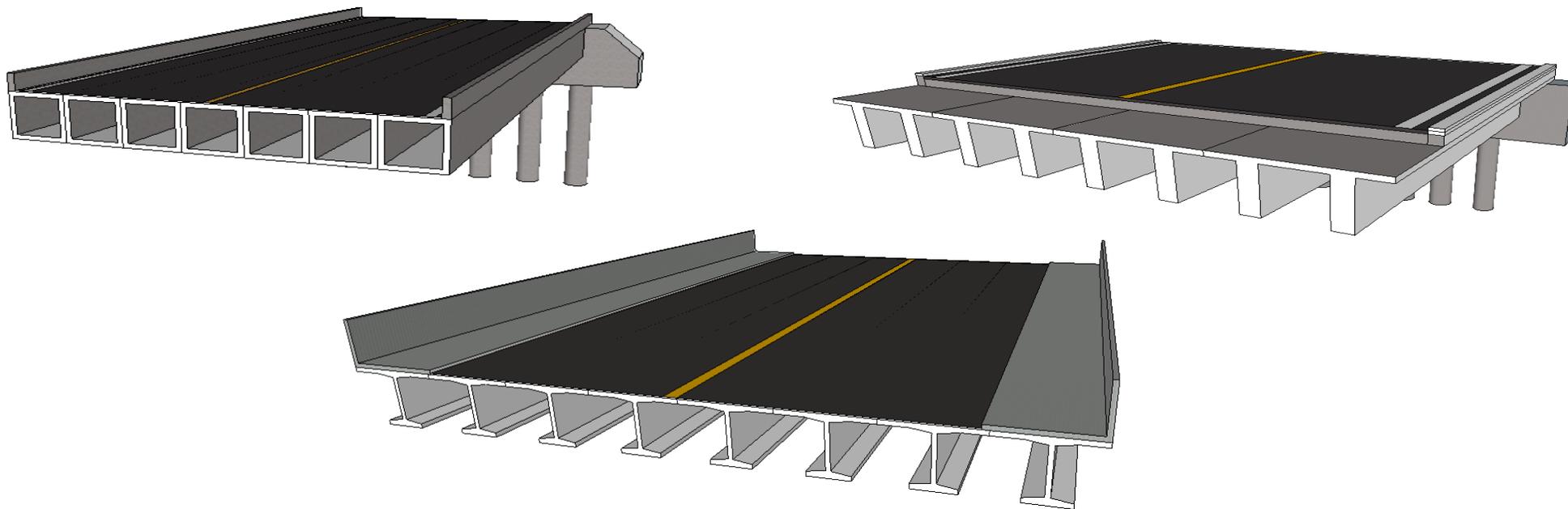
❖ Rapid Replacement



PMBISB system

Girders

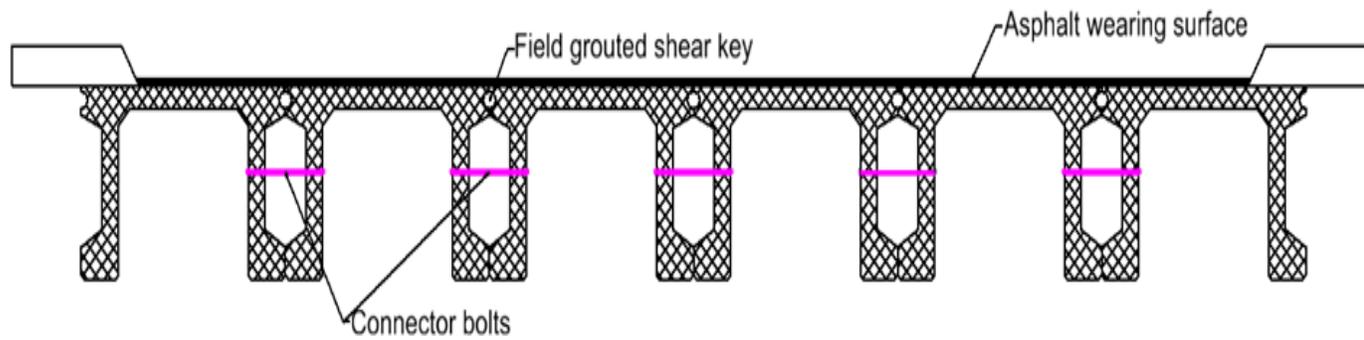
❖ Rapid Replacement



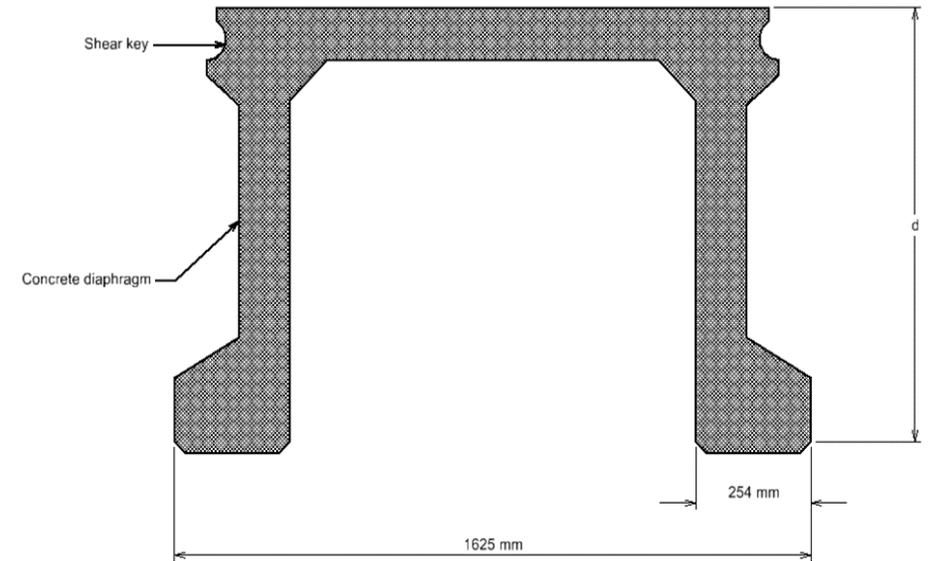
Adjacent box (left), tee (right), and deck bulb tee (bottom) beams

Girders

❖ Rapid Replacement



Fenrich Concrete girder



PIERS AND COLUMNS

Rapid repair and replacement

Piers and Columns

- ❖ Rapid Repair

- ❖ CFRP Jackets

- ❖ Rapid Replacement

- ❖ Precast Piers

- ❖ Temporary support for replacement

ABUTMENTS

Rapid repair and replacement

Abutments

❖ Rapid Repair

❖ Stabilization

❖ R/C struts

❖ Anchors

❖ Stabilization of backfill

❖ Crack repair

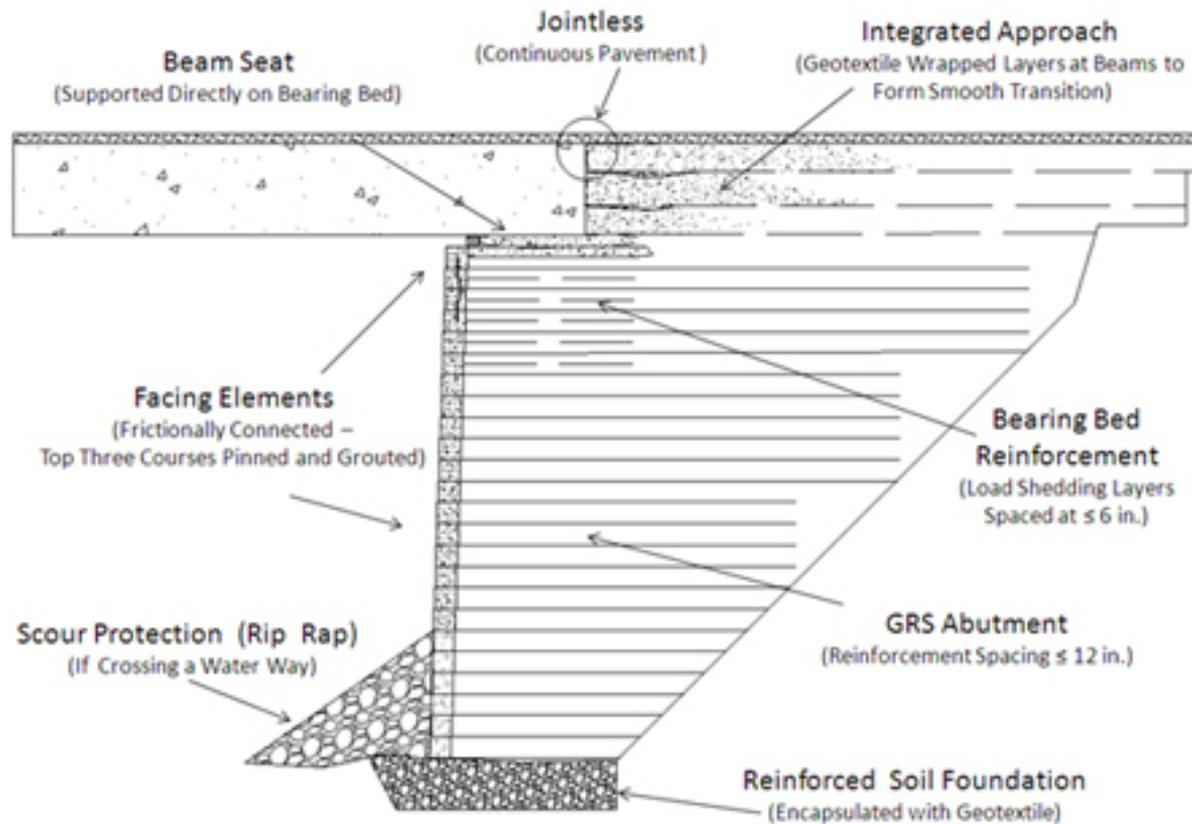
❖ Shotcrete

❖ Rapid setting mortar

Abutments

❖ Rapid Replacement

❖ Geosynthetic reinforced soil (GRS) abutment



CONCLUSION

Conclusion

- ❖ ABC can effectively be applied to bridge rehabilitation
 - ❖ Rapid repair of decks is heavily researched
 - ❖ Other areas could be studied more