

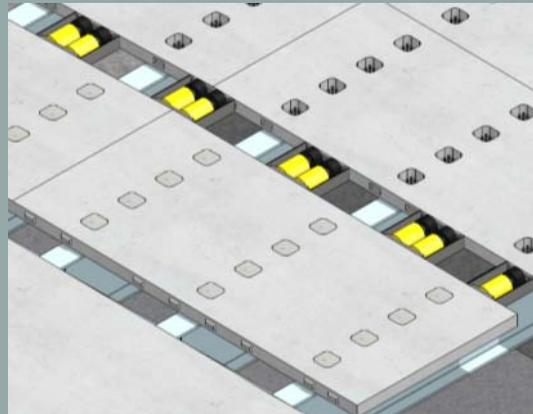


# External Post-Tensioning for Full-Depth Precast Deck Panels

Prepared for 2012 Virginia Concrete Conference  
Information presented herein pertains to proprietary products.

# Today's Presentation

- **Full-Depth Precast Decks - Current Industry Practice**
- **The AccelBridge Systems - Construction / Engineering**



# The Search for an Ideal ABC System

SPMTs



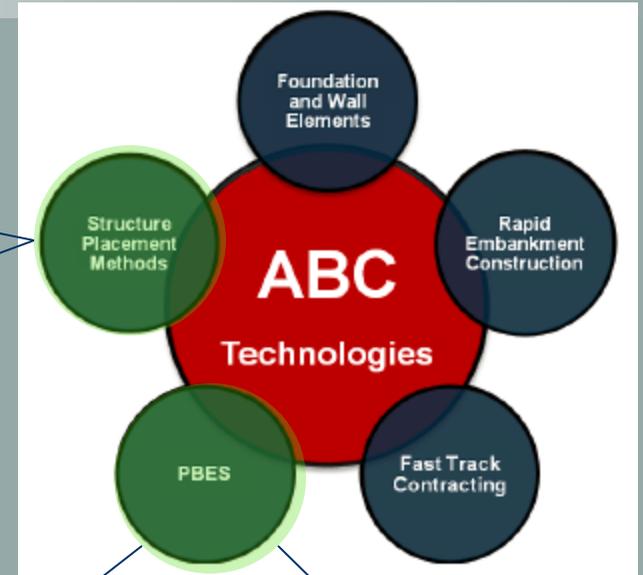
Slide-In / Float-In



Full-Depth Precast Decks



Segmental



## Full-Depth Precast Decks

Full depth precast deck system advantages:

- Uses standard girder shapes
- Doesn't require special equipment
- Relatively simple technology



### I-287 Cross Westchester Expressway, New York

- Value engineering
- A+B project
- Minimize field labor
- 300,000 sq ft of precast deck

# Full-Depth Precast Panels: Current Practice



**Shim pack to support panel**



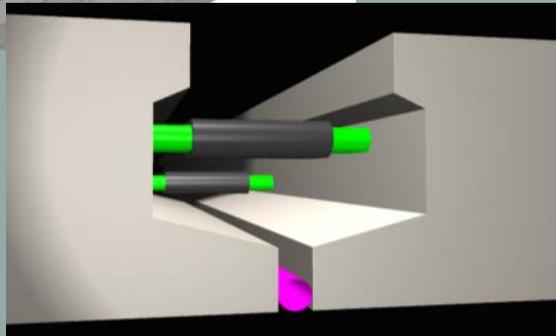
# Full-Depth Precast Panels: Current Practice



- **Duct Coupling**
- **Durability Concerns**



- **Extensive Duct Work**
- **Panel Alignment**

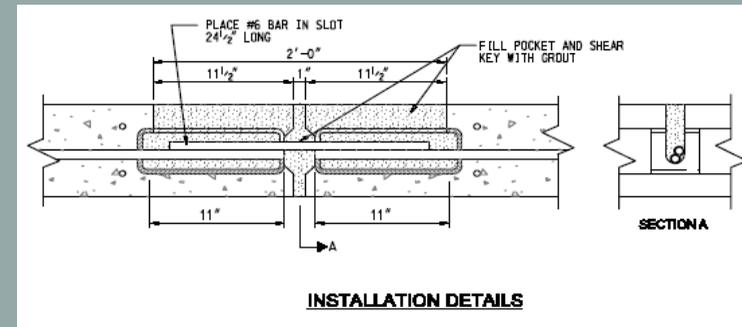


- **CIP joint field works**
- **Durability concerns**

## Full-Depth Precast Panels:

### Attempts to Eliminate Deck PT Anchorage Tube Connection

- Unreliable grouted joint interfaces



### UHPC (Ultra-High Performance Concrete)

- Very expensive
- Demanding on workmanship

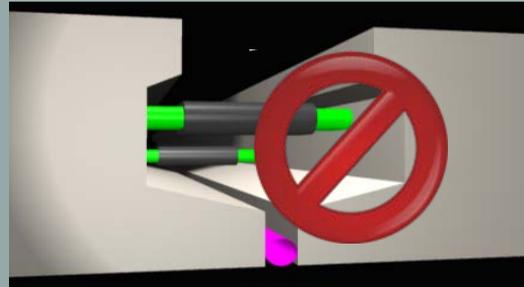
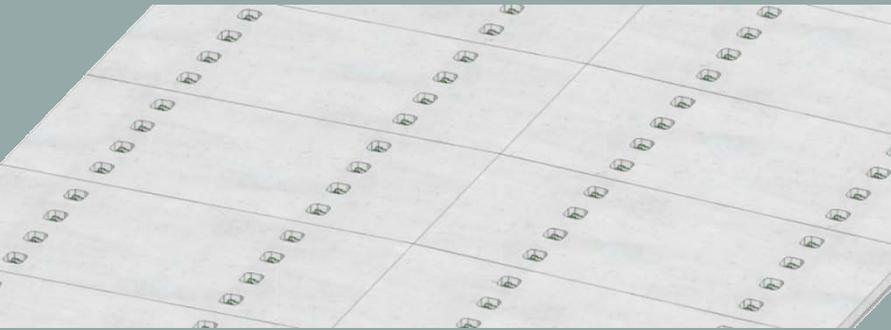


**No compression across deck joints = Durability Concerns**

# Full-Depth Precast Panels: AccelBridge

## Goal Achieved:

**Maintaining compression across deck joints without PT in the panels**



	Simplicity	Durability	Speed	Cost	Current system
No PT ducts in panels	■	■		■	400+ pcs
No grouted joints	■	■	■	■	20 joints
No duct couplers	■	■	■	■	400+ couplers
Save materials				■	12,000 lbs PT or two girder lines

*(Comparison from example bridge: 43 ft wide, 105 ft – 105 ft span)*

# The AccelBridge Systems

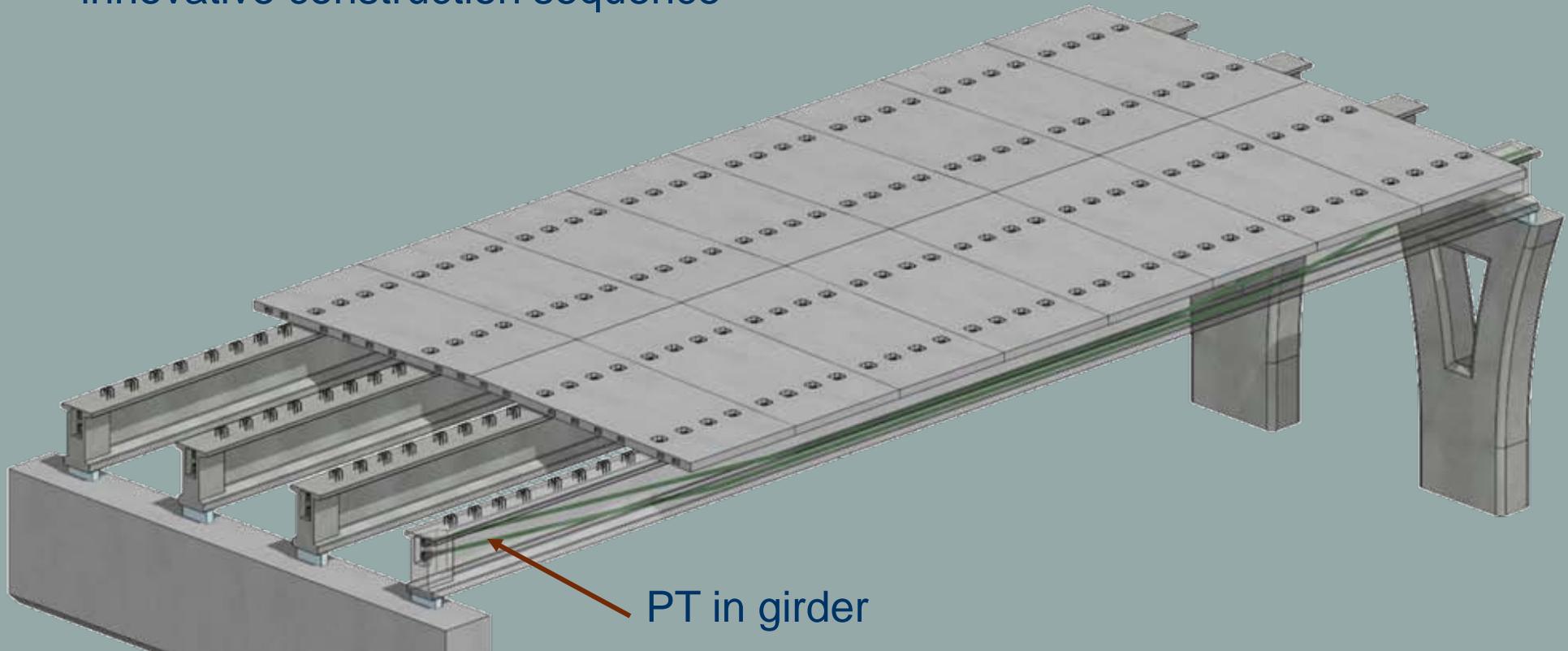
AccelBridge is a patented technology consisting of four systems:

- **Accel<sup>NP</sup>:** Steel girders - no post-tensioning
- **Accel<sup>PB</sup>:** Concrete girders with tensioned rods at pier
- **Accel<sup>PG</sup>:** Concrete girders with post-tensioning in the girders
- **Accel<sup>PD</sup>:** Concrete tub girders with external post-tensioning

***Simple construction with proven technologies.***

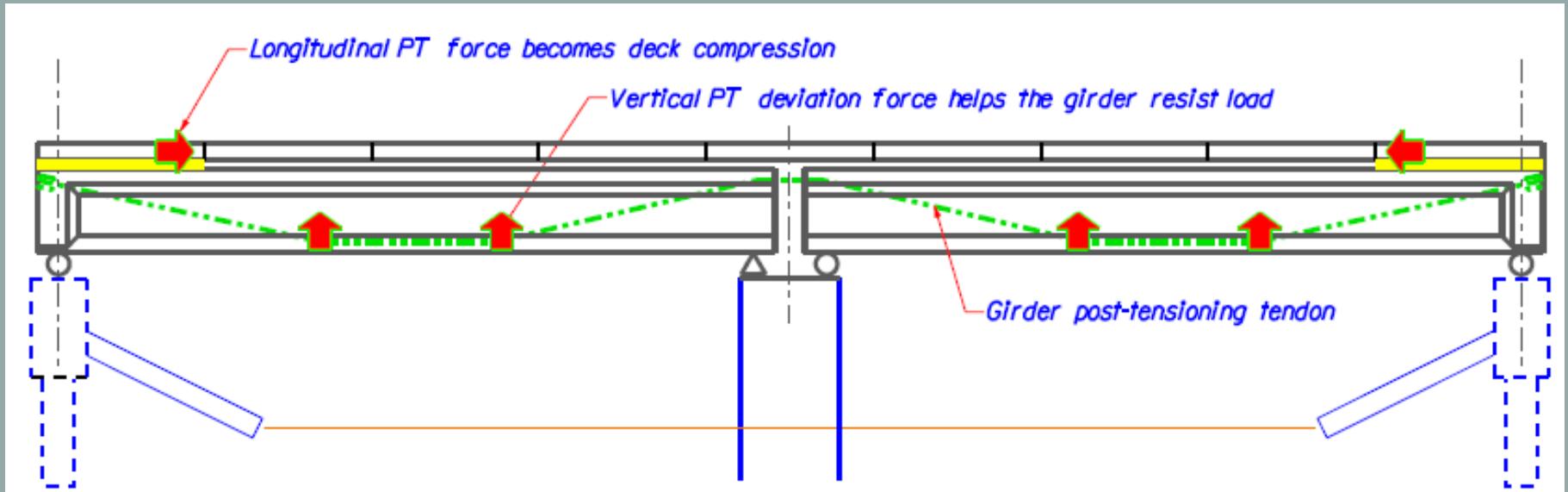
# Accel<sup>PG</sup> System

- No internal deck post-tensioning
- Deck compression is provided by PT internal to precast concrete girders (no coupling, less duct work, more efficient girder)
- System is very similar to typical post-tensioned precast girders, but with an innovative construction sequence



# Accel<sup>PG</sup> System

## Principles

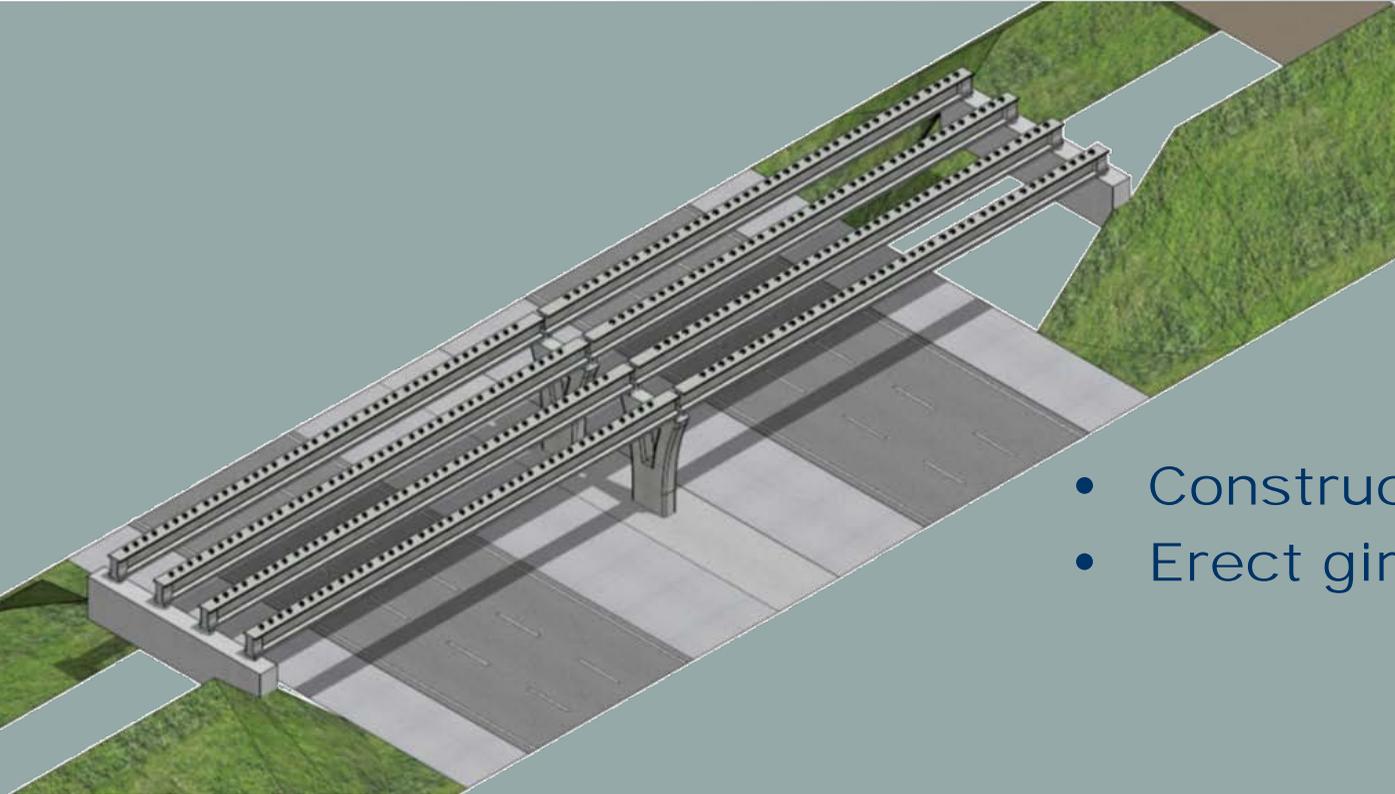


Dual function of girder post-tensioning:

- Longitudinal component provides deck compression
- Vertical component (deviation force) helps the girder resist load

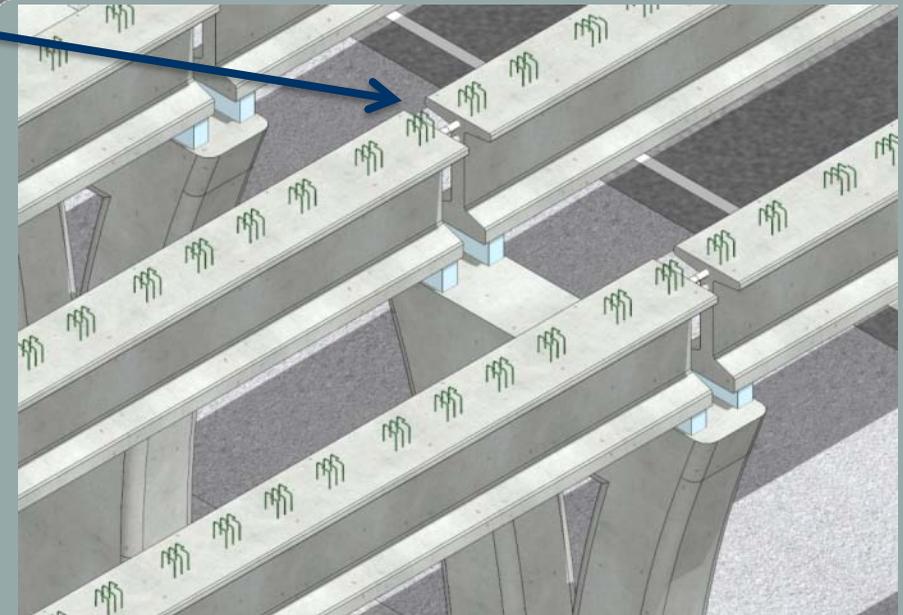
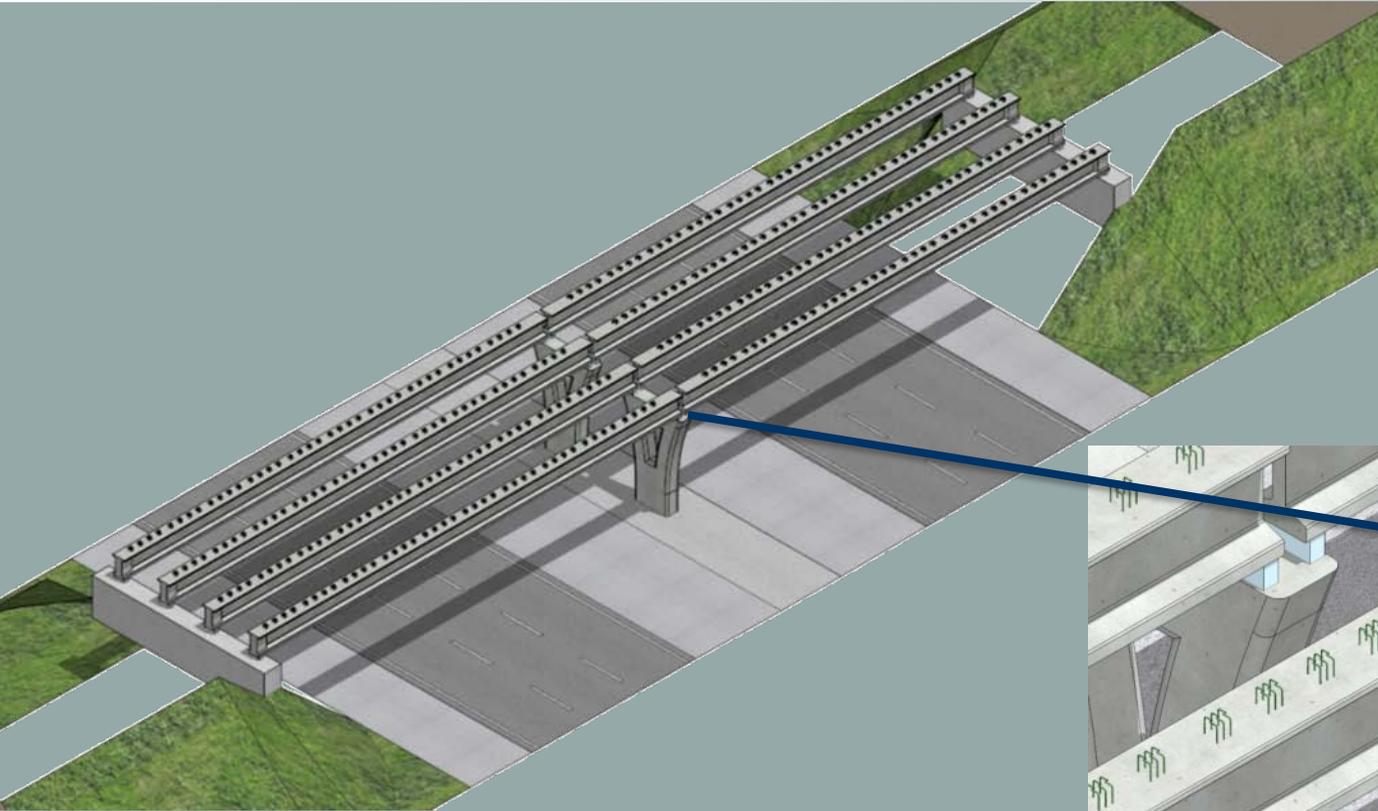
*-Very effective use of PT, saving girder materials*

# Accel<sup>PG</sup> System - Construction



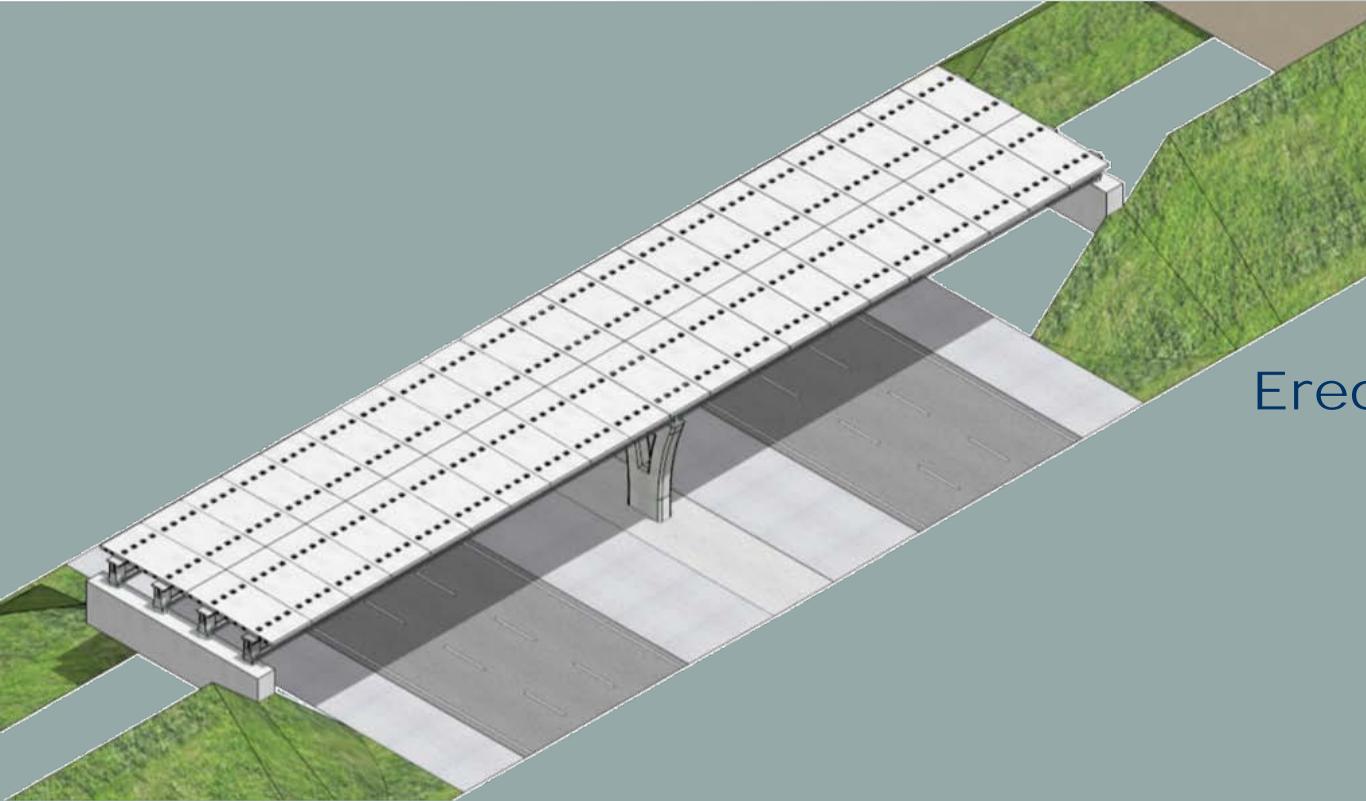
- Construct substructures
- Erect girders

# Accel<sup>PG</sup> System - Construction



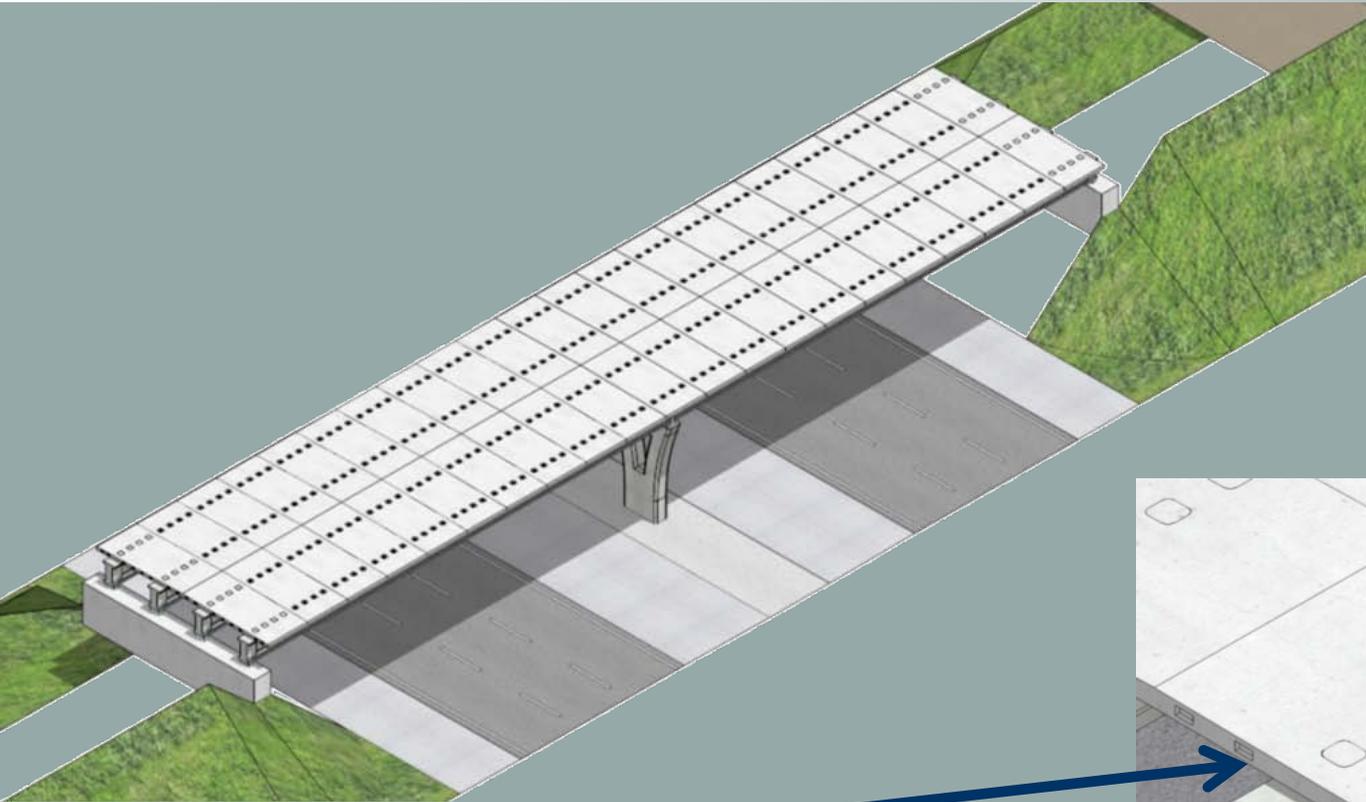
Leave a small gap between girders at pier

# Accel<sup>PG</sup> System - Construction



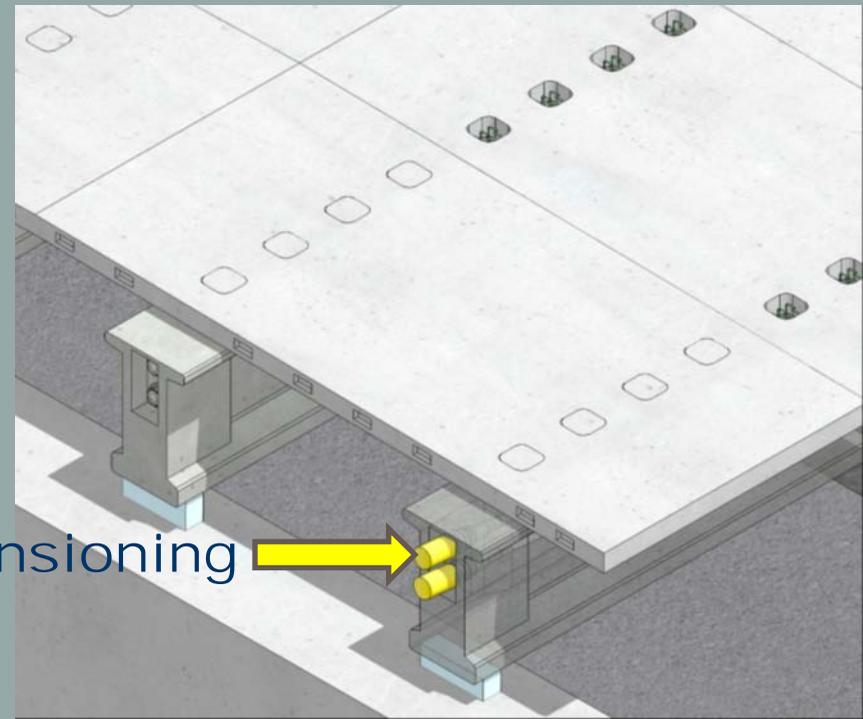
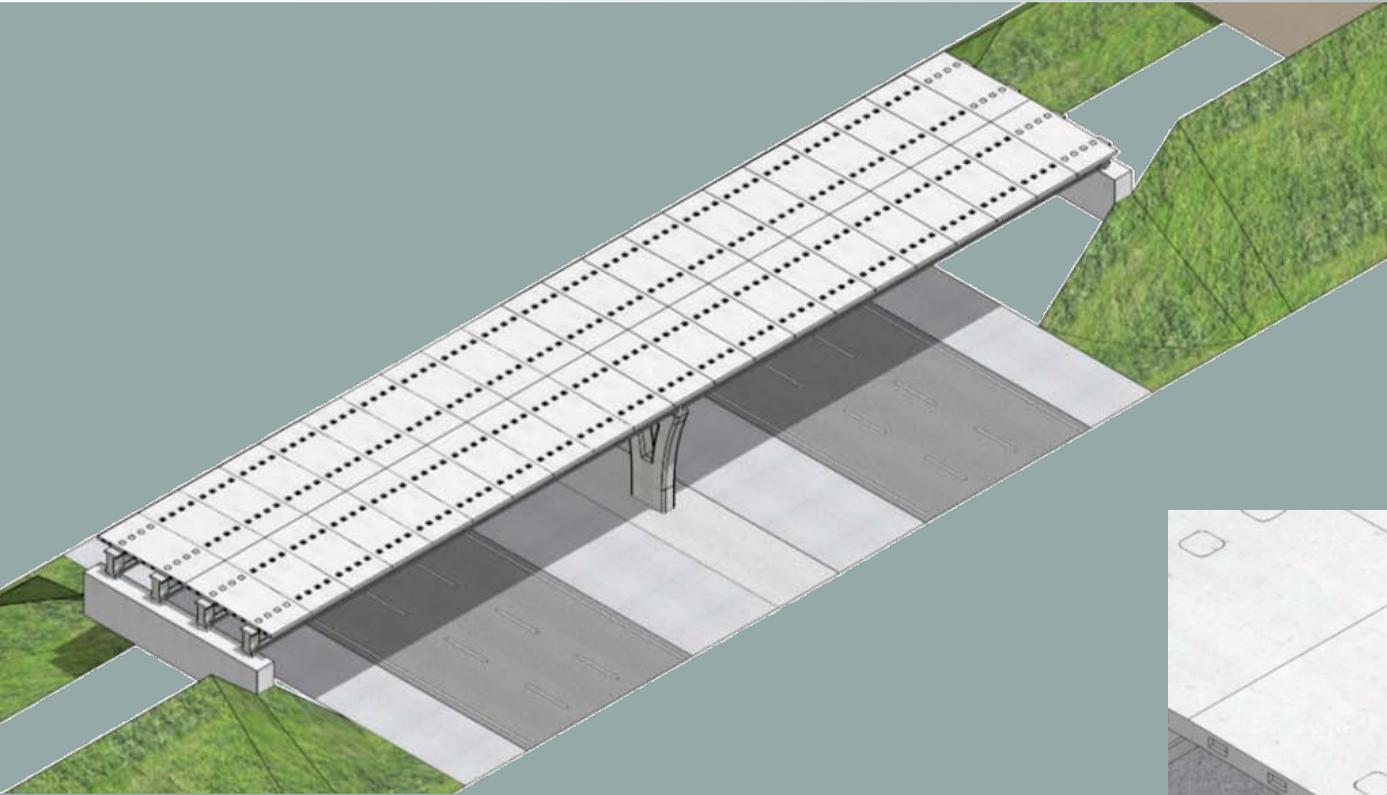
Erect all deck panels

# Accel<sup>PG</sup> System - Construction



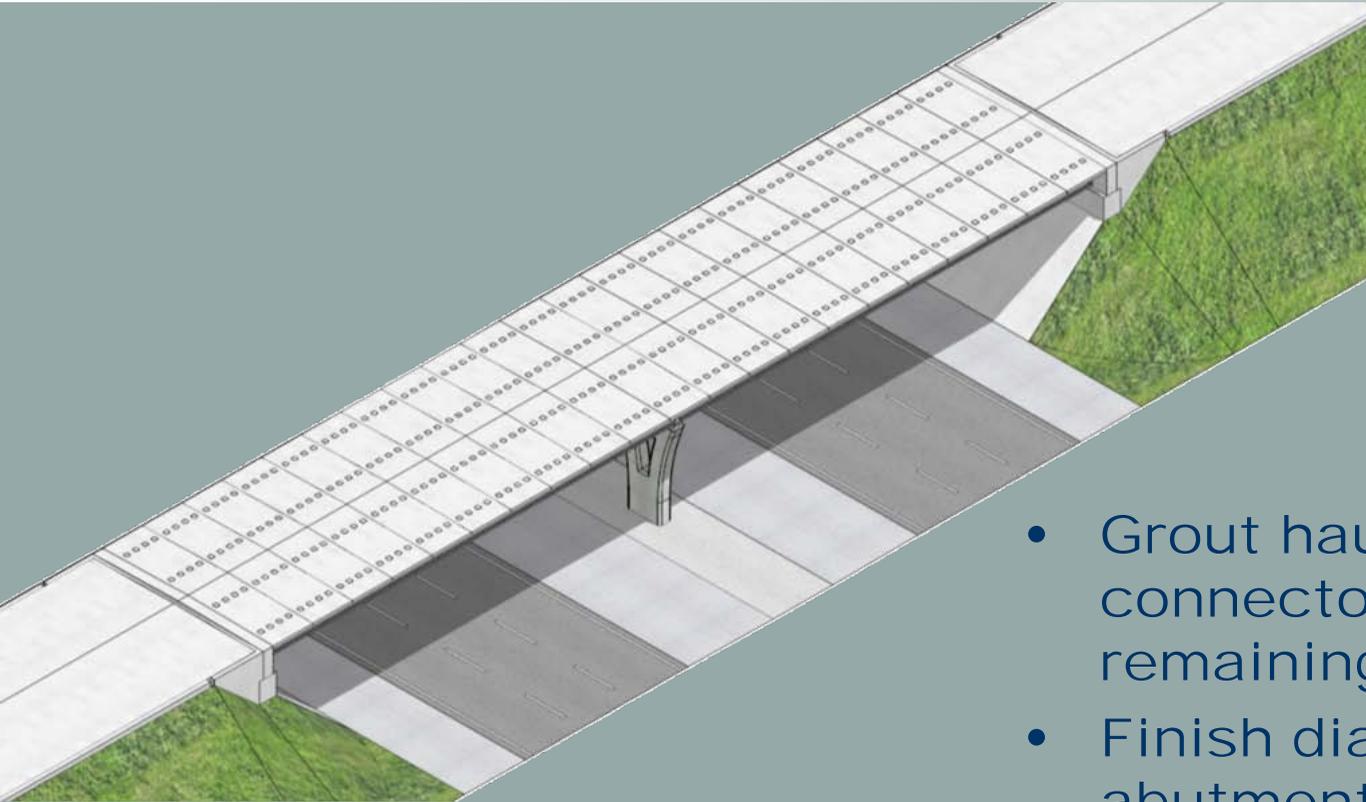
Grout Pockets in End Panels

# Accel<sup>PG</sup> System - Construction



Stress girder post-tensioning  
tendons

# Accel<sup>PG</sup> System - Construction

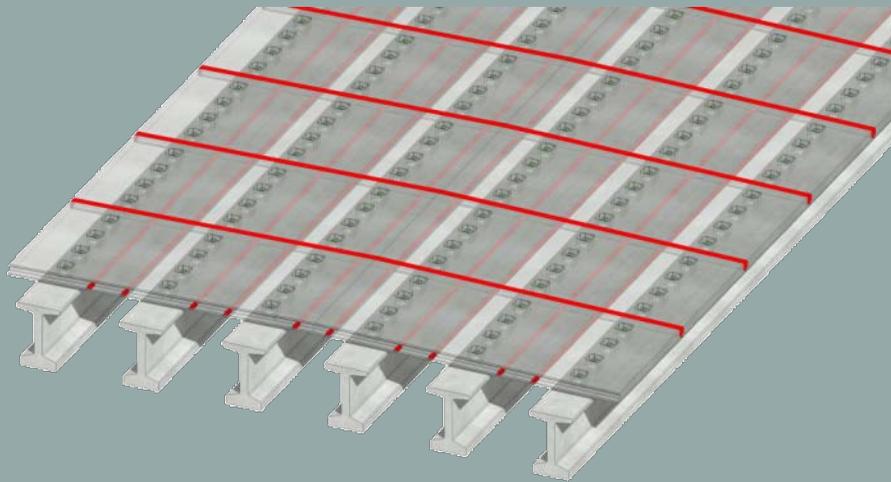


- Grout haunch and shear connectors for all remaining panels.
- Finish diaphragms at abutments and pier

# Accel<sup>PG</sup> System - Advantages

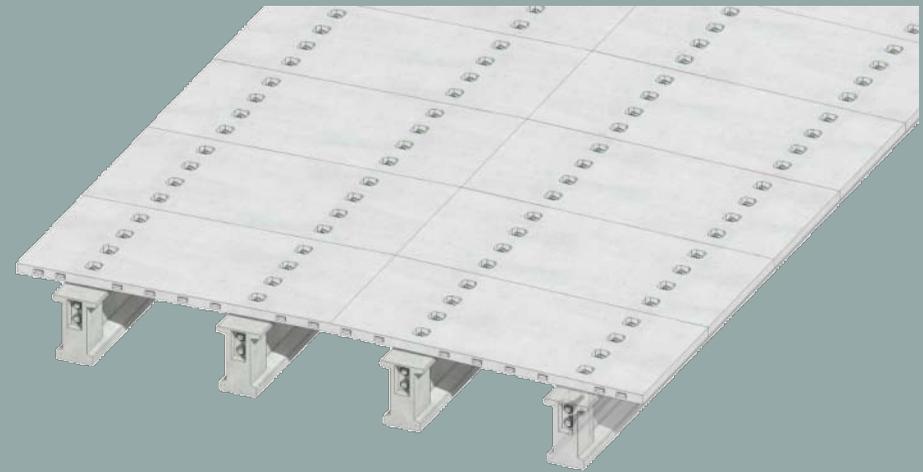
## Conventional Full Depth Precast

- 6 girder lines
- 360 duct couplers
- 18 tendons (11,340 lbs)



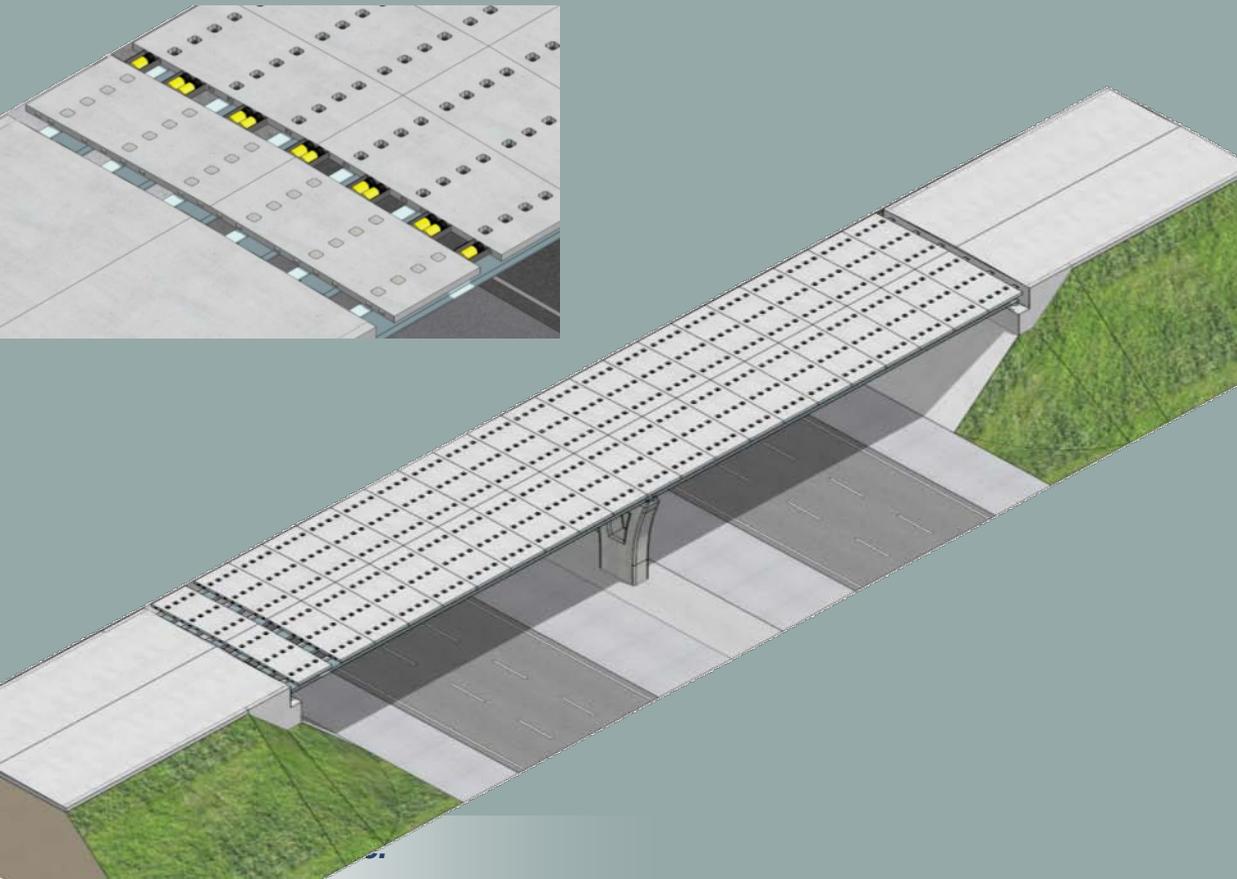
## AccelBridge

- 4 girder lines
- 8 duct couplers
- 8 tendons (11,340 lbs)

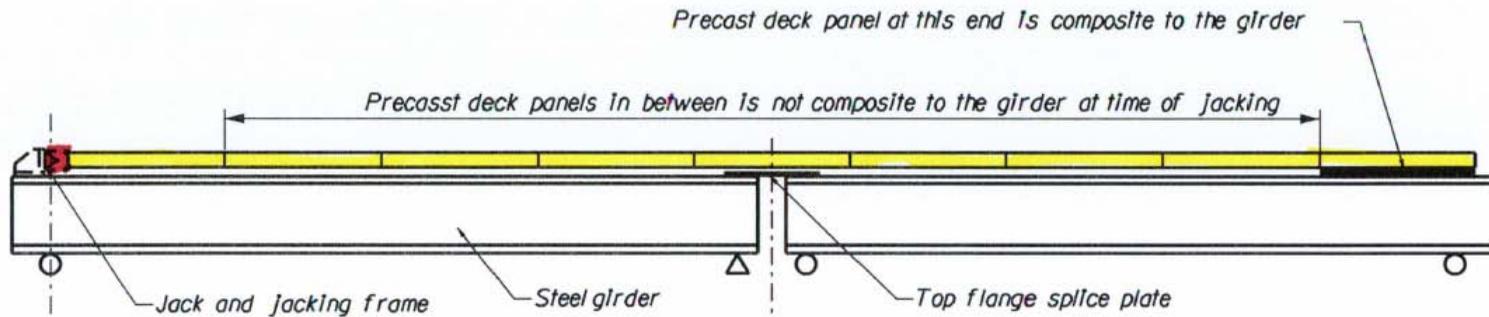


# Accel<sup>NP</sup> System

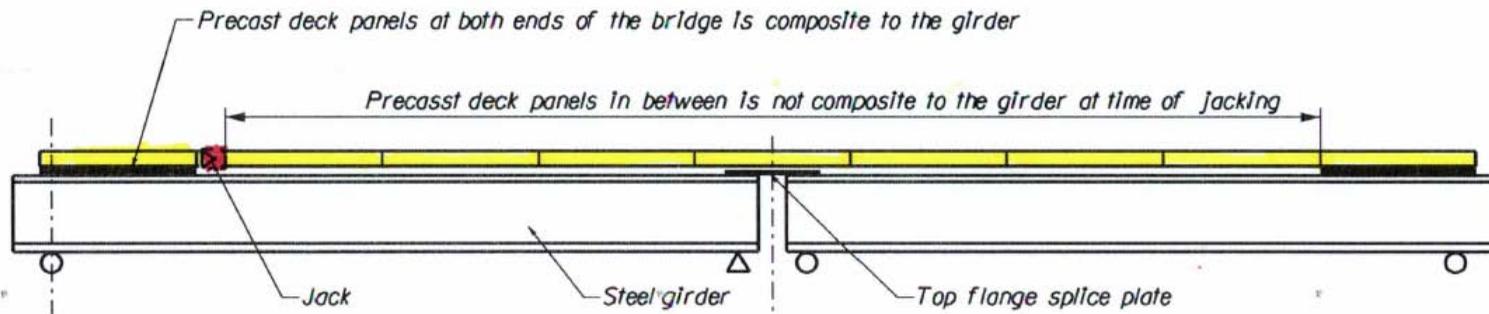
- Precast deck with steel girders
- Precompression of precast deck is provided by jacking against steel girders
- Best with NSBA simple for dead load and continuous for live load detail
- Can be used for deck replacement reusing existing girders



# Accel<sup>NP</sup> System



USE JACKING FRAME TO APPLY DECK COMPRESSION

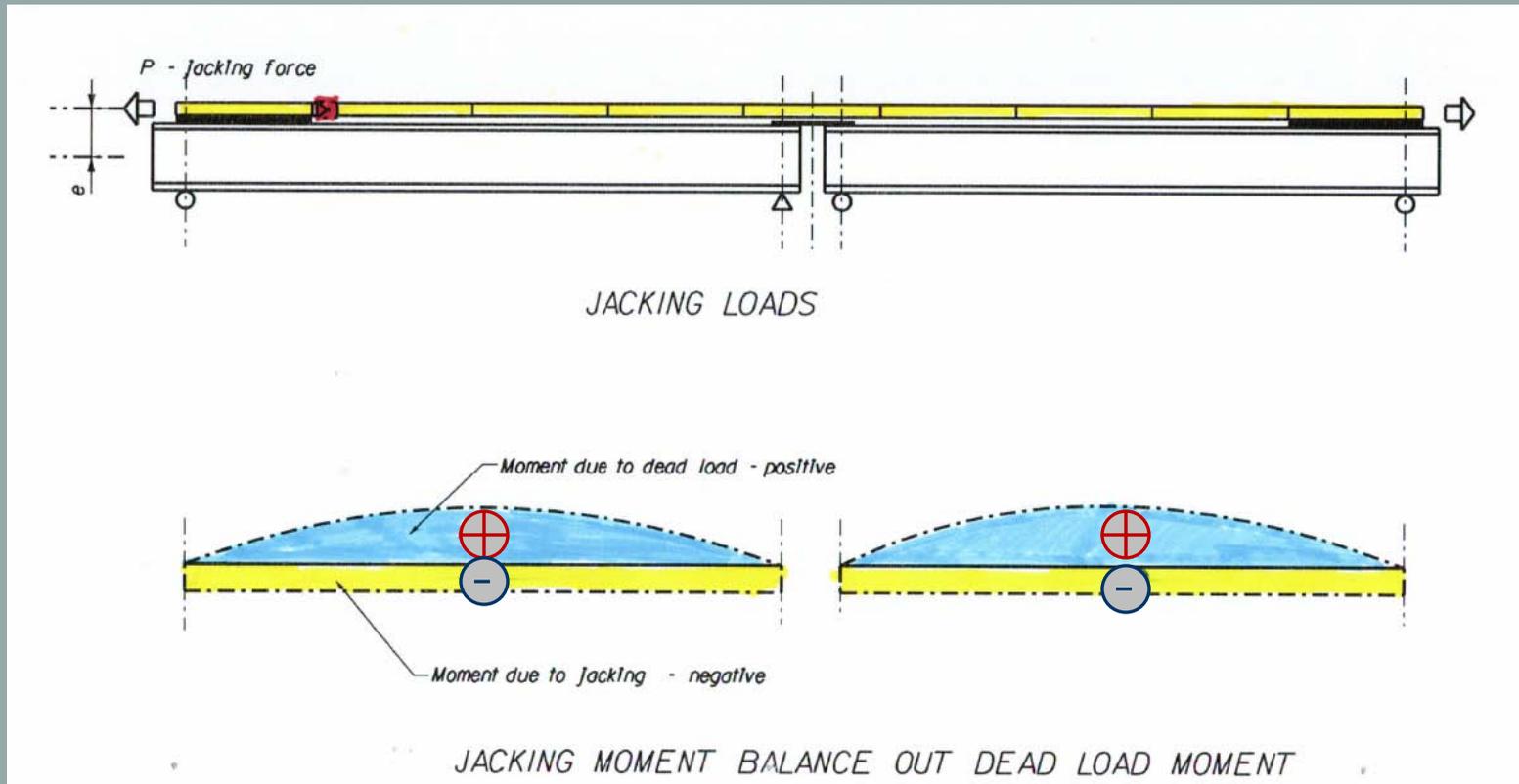


JACK AGAINST END PANELS

# Accel<sup>NP</sup> System

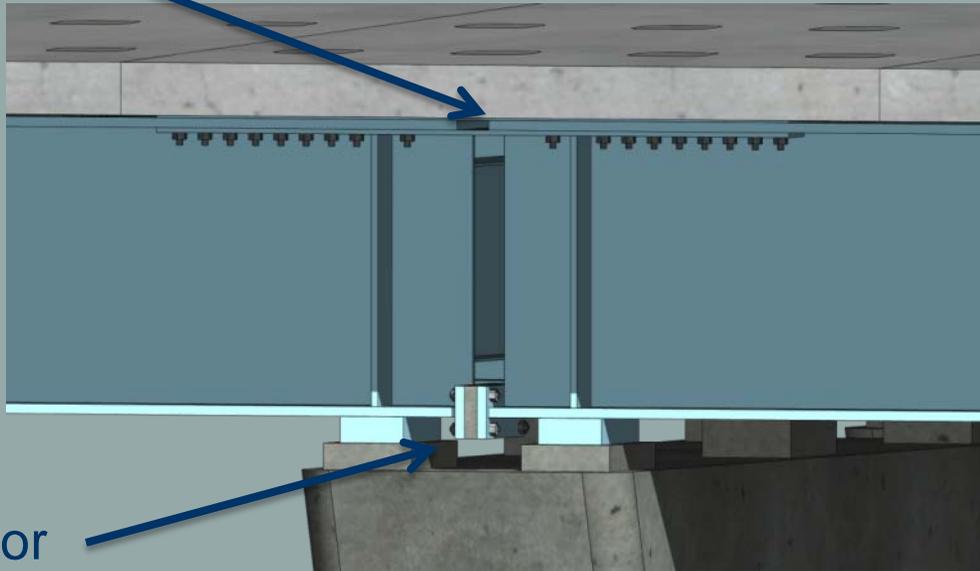
Simple span for dead load, continuous for live load layout:

► *Jacking helps the girder resist load*



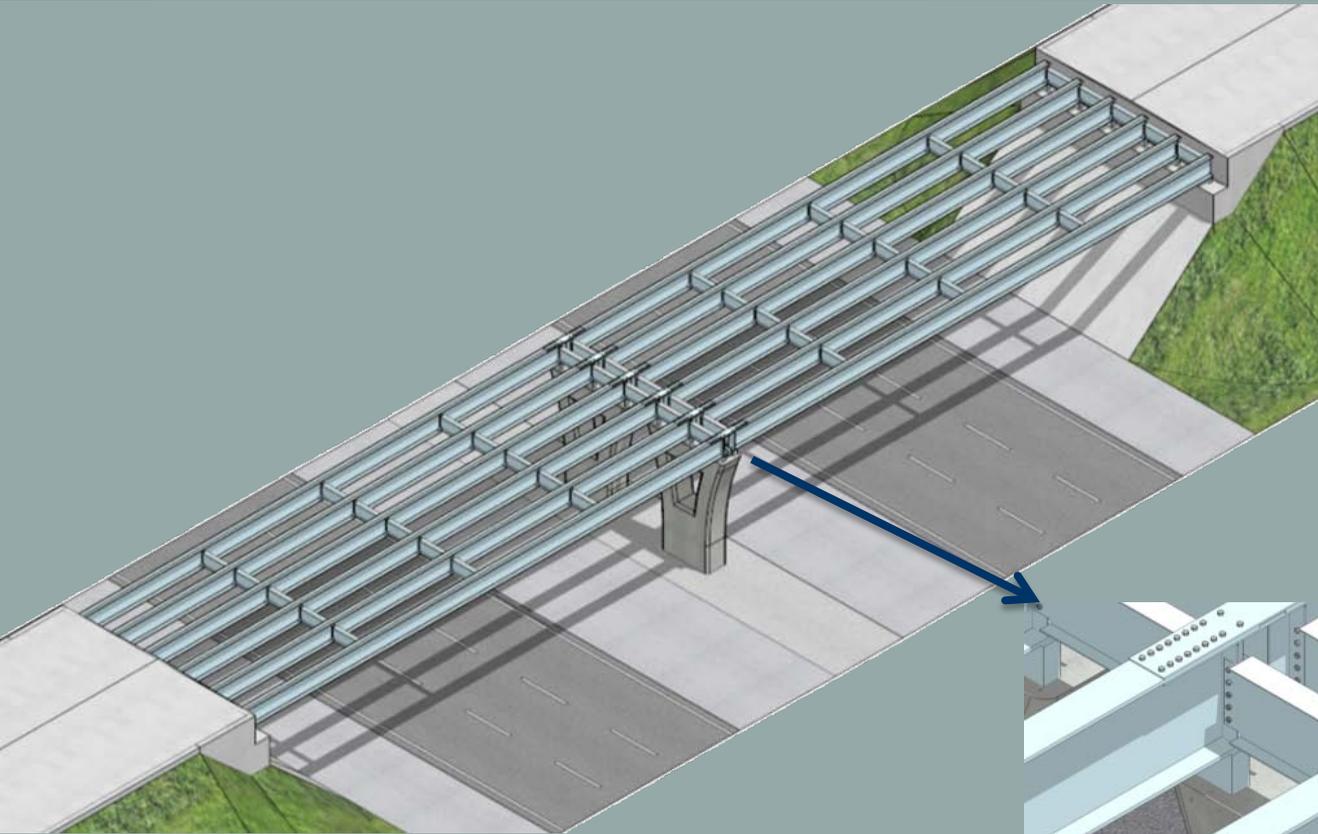
# Accel<sup>NP</sup> System – Pier Connection

Top Flange Splice for Dead Load

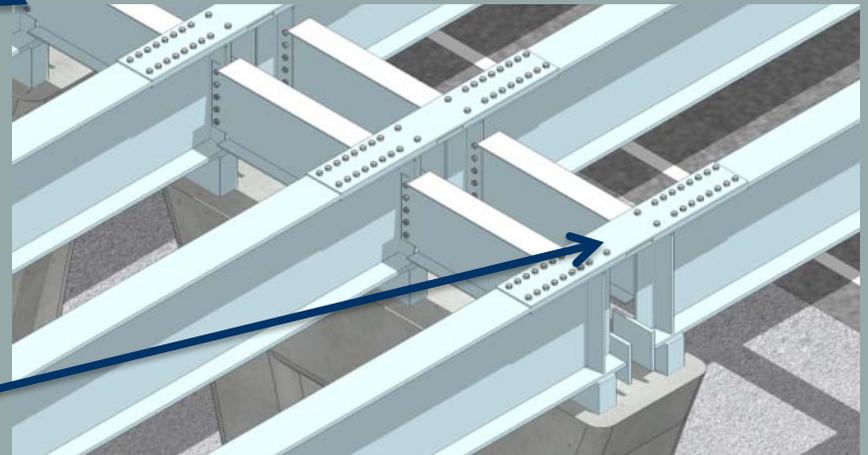


Bottom Flange Grouted Splice for Live Load (*Modified NSBA*)

# Accel<sup>NP</sup> System – Construction

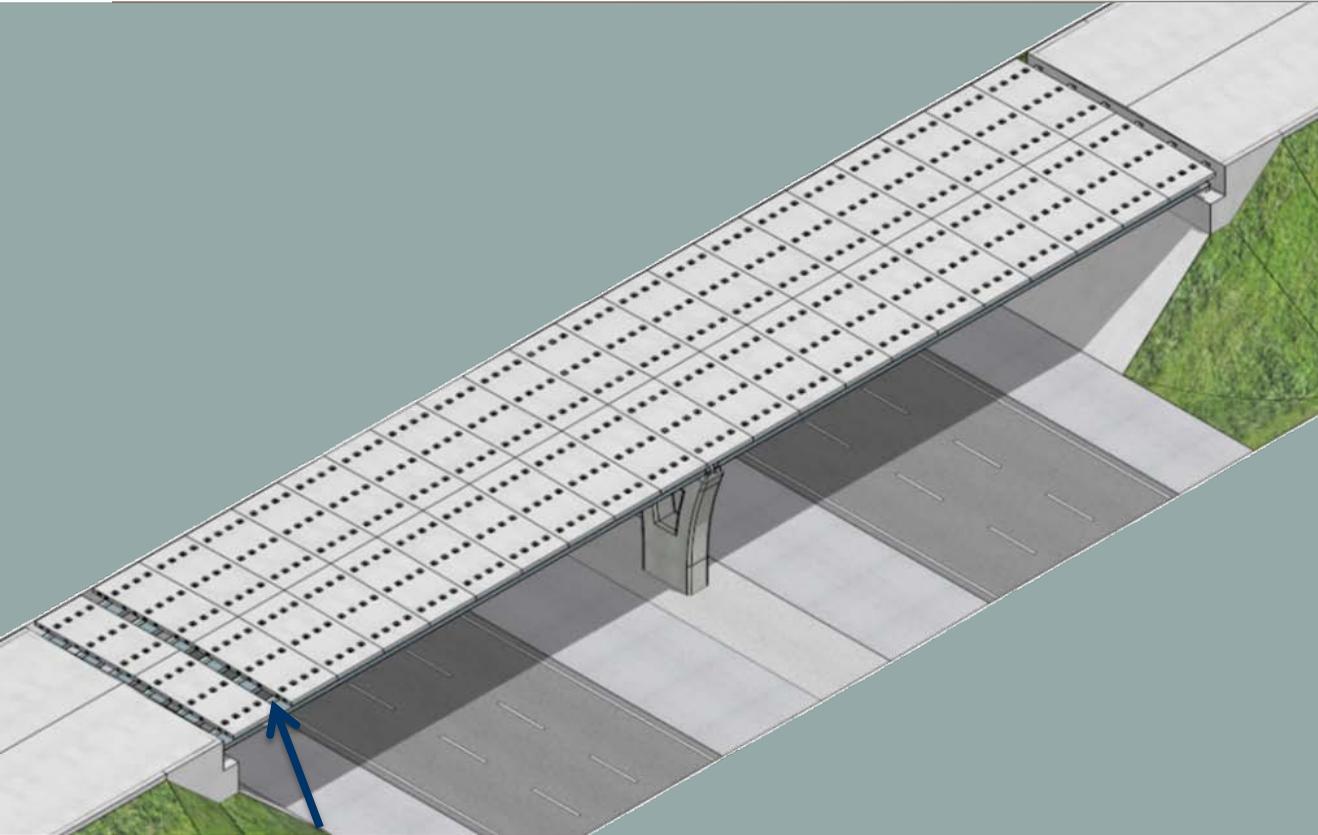


Erect Girders



Top Flange Splices

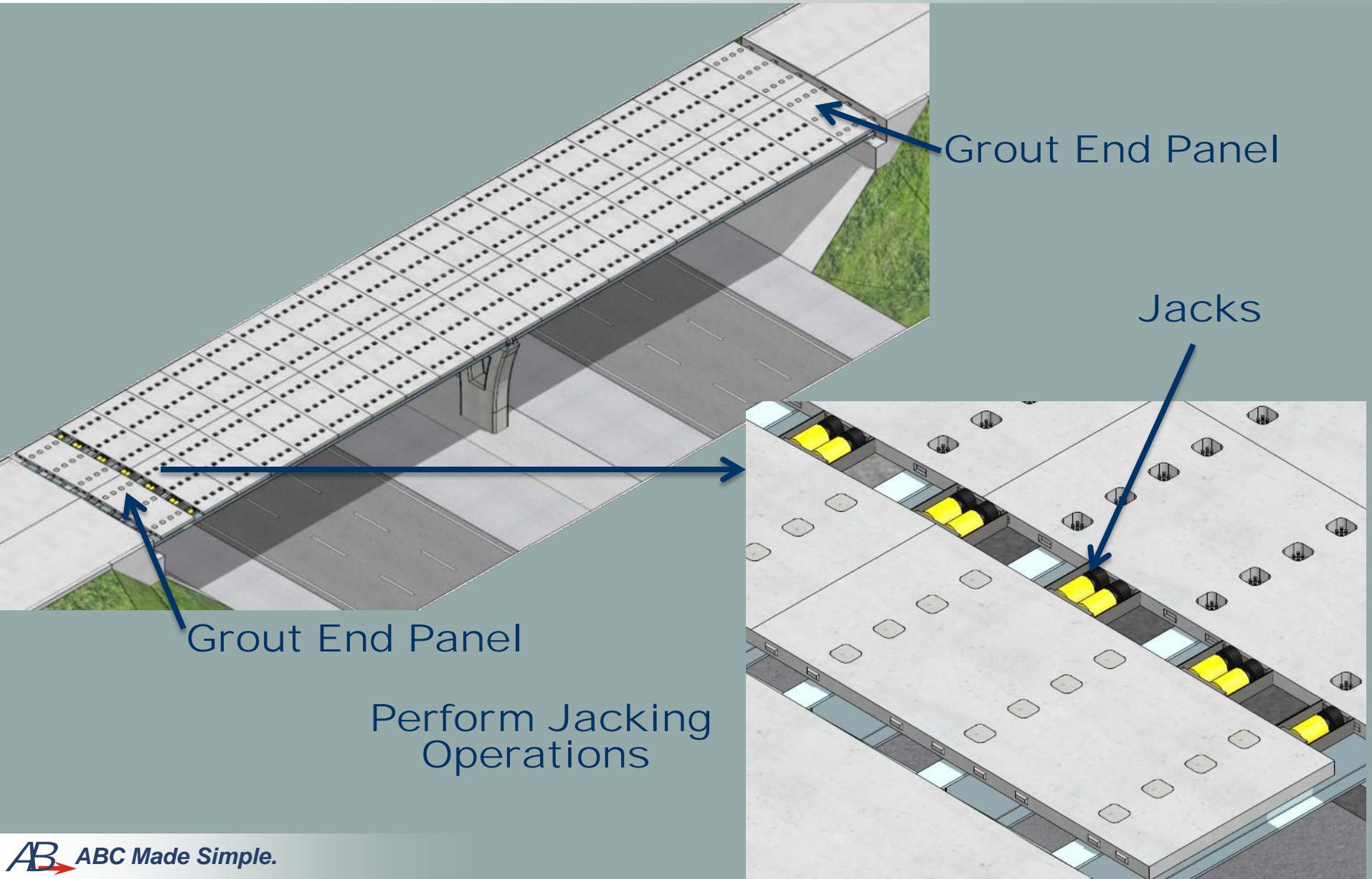
# Accel<sup>NP</sup> System – Construction



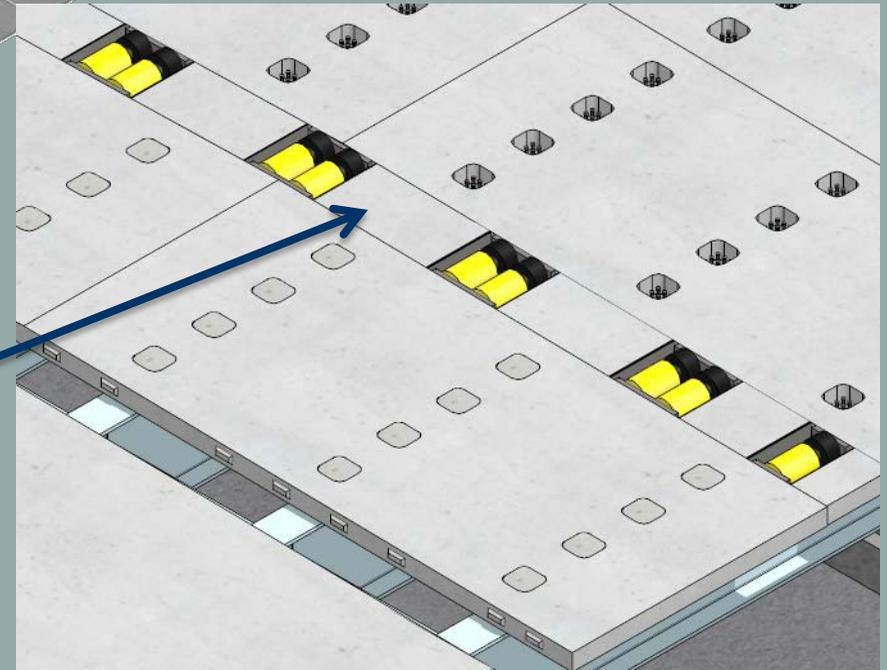
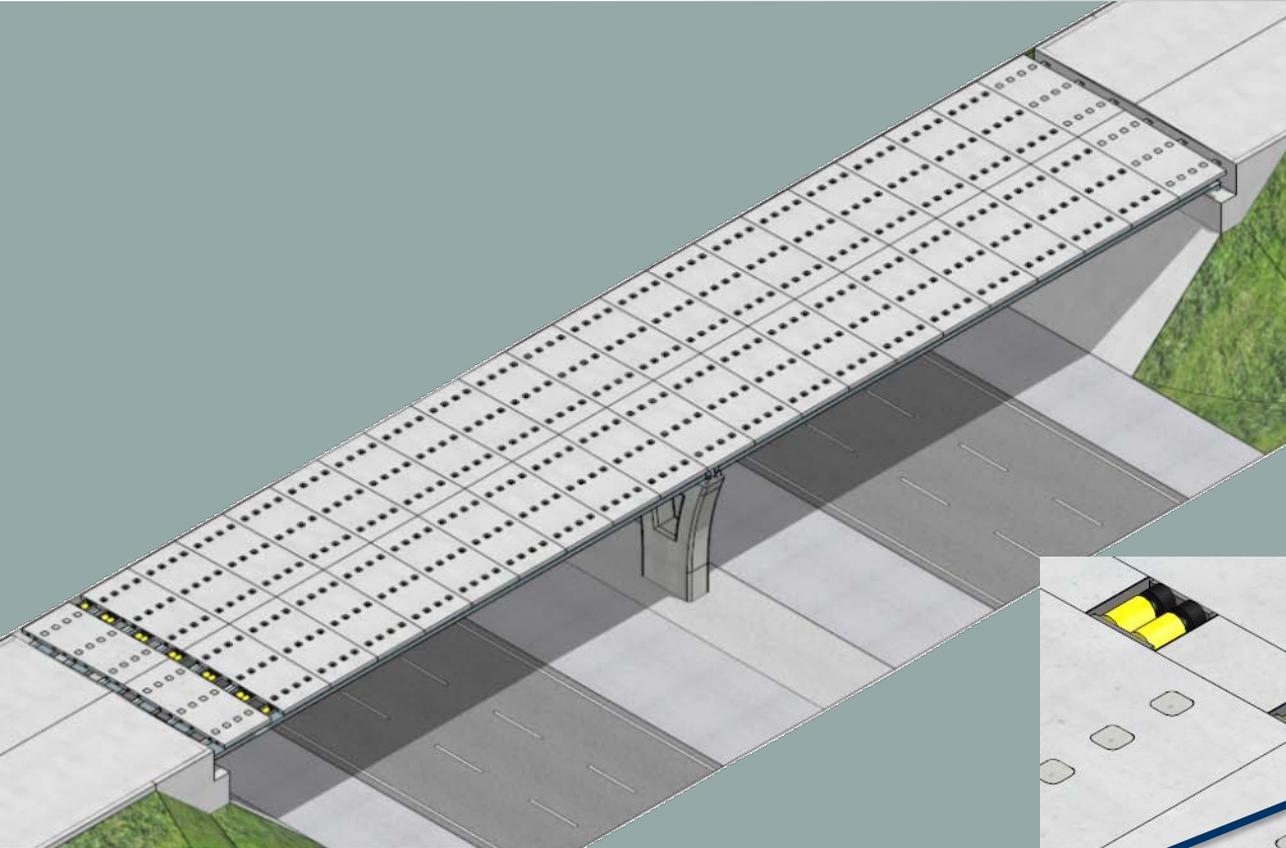
Place Deck Panels

Space to Place Jacks

# Accel<sup>NP</sup> System – Construction



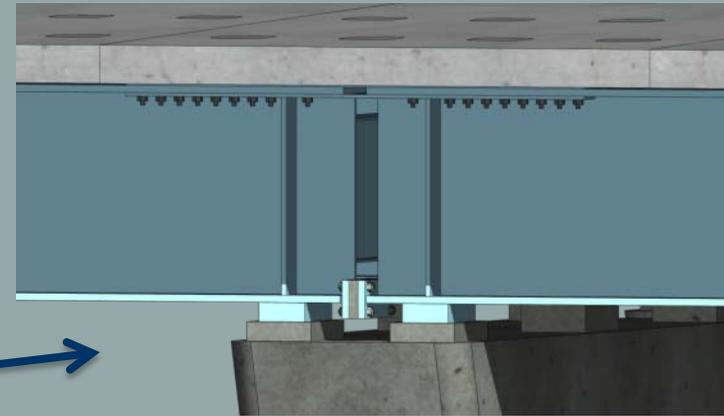
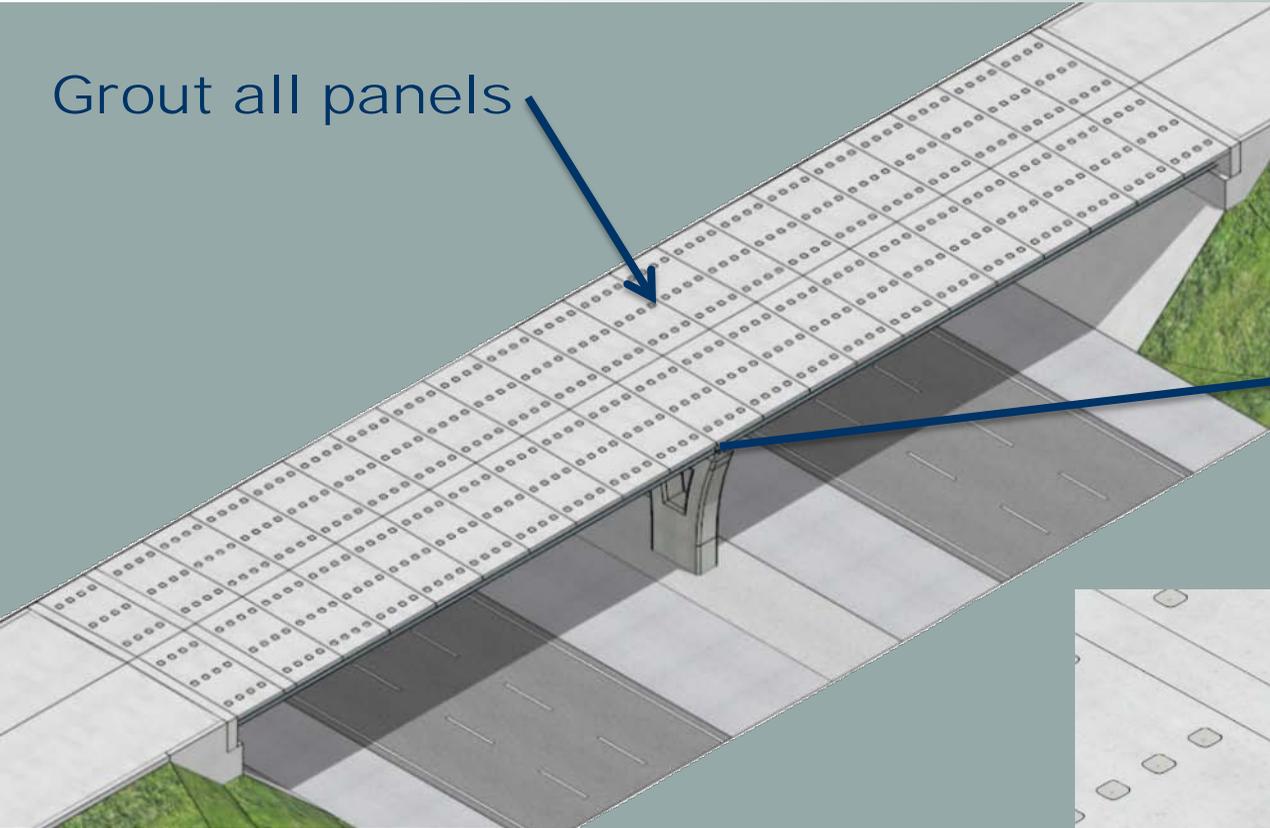
# Accel<sup>NP</sup> System – Construction



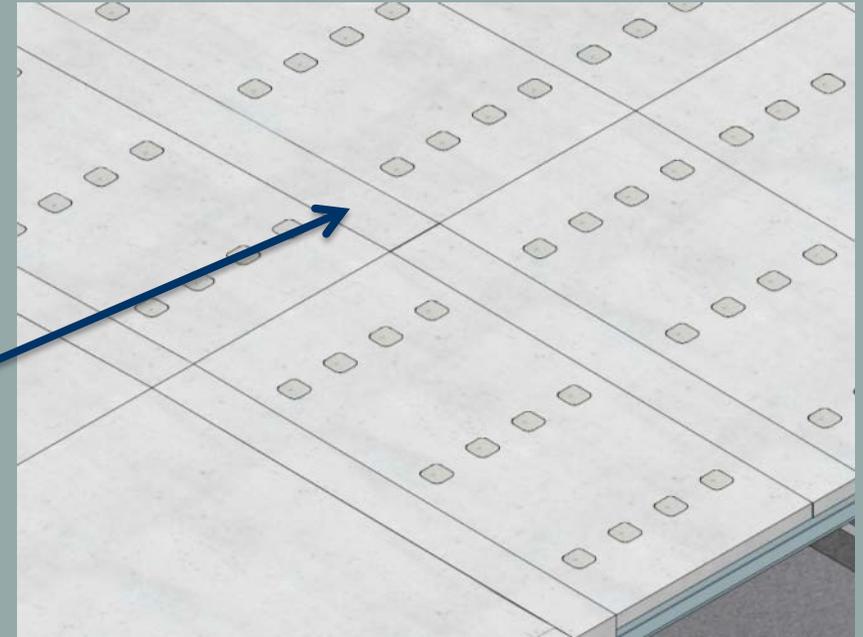
Place CIP Pour Backs prior to Removing Jacks

# Accel<sup>NP</sup> System - Construction

Grout all panels



Bottom Flange  
Grouted Splice at Pier

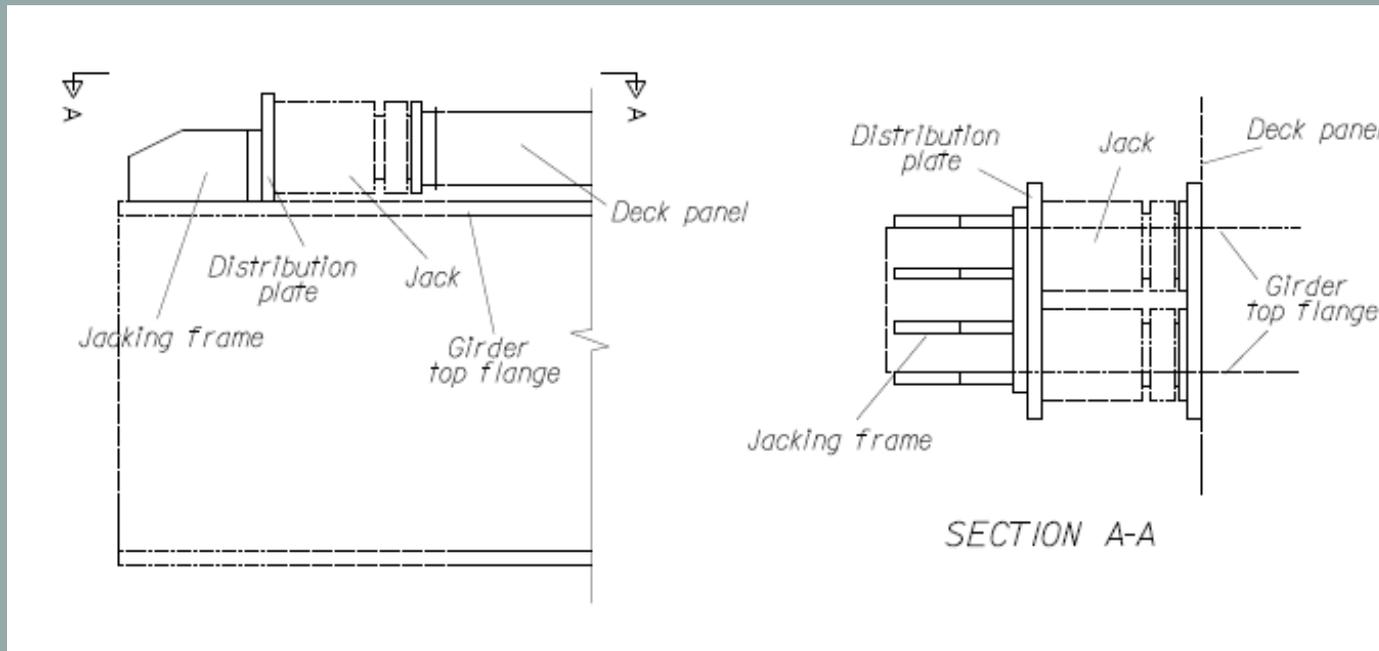


Remove Jacks and  
Complete Closure Pour

# Accel<sup>NP</sup> System

## Alternative Jacking method

- Use jacking frame welded to steel girder
- Eliminate closure pour



# Accel<sup>NP</sup> System – Advantages

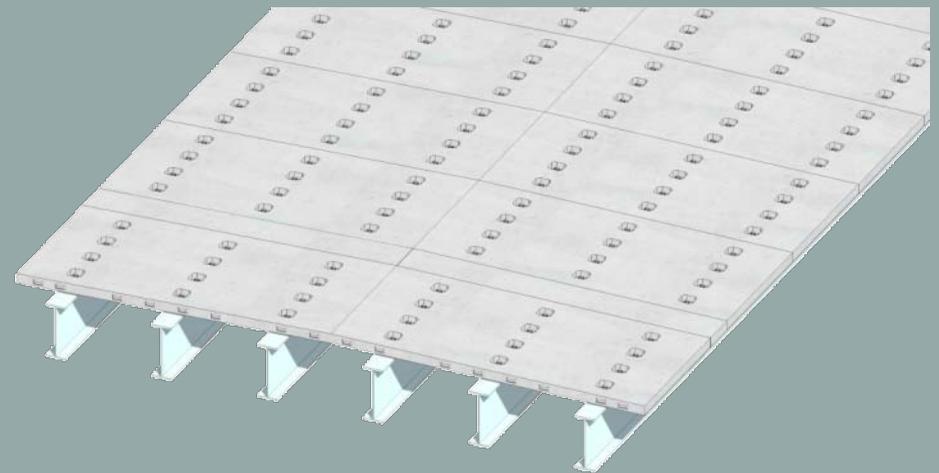
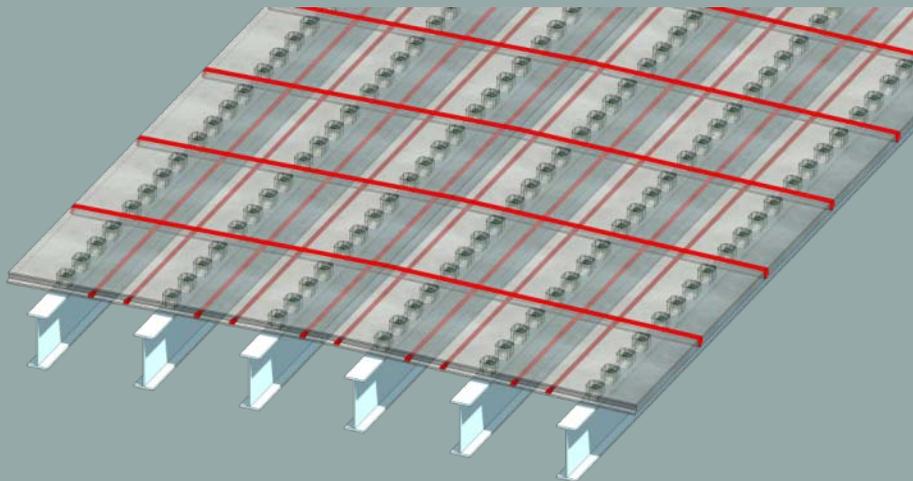
## Conventional Full Depth Precast

- 22 x 4-0.6" PT (13,860 lbs)
- 440 duct couplers

## AccelBridge

- No PT (maintains same deck compression)
- No duct couplers

Also applicable to deck replacement of existing bridges.

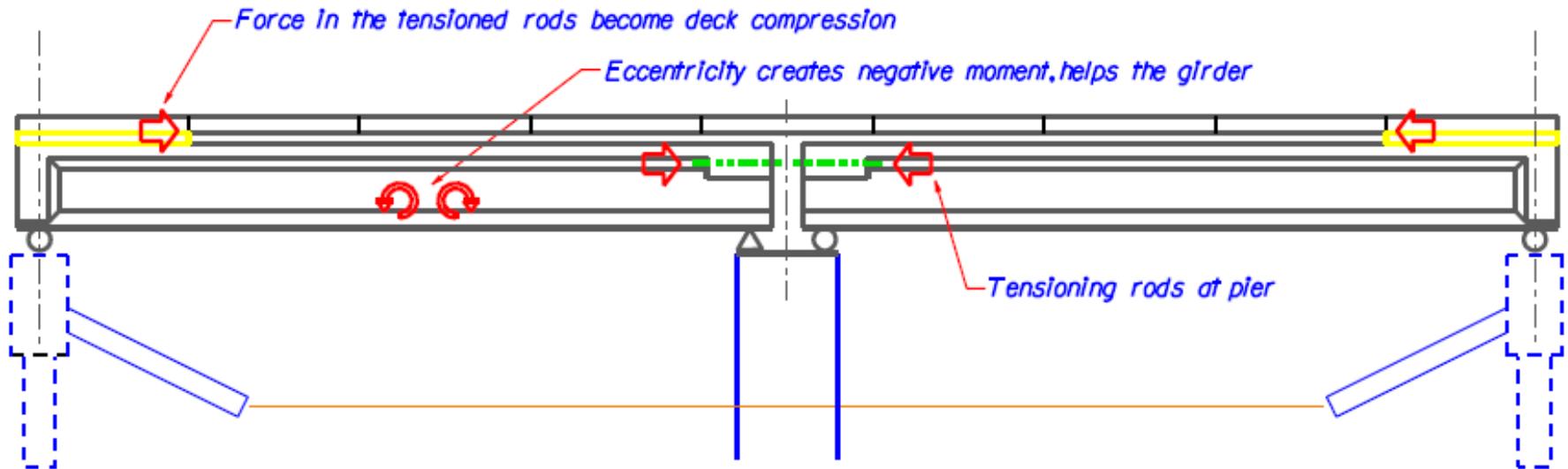


# Accel<sup>PB</sup> System

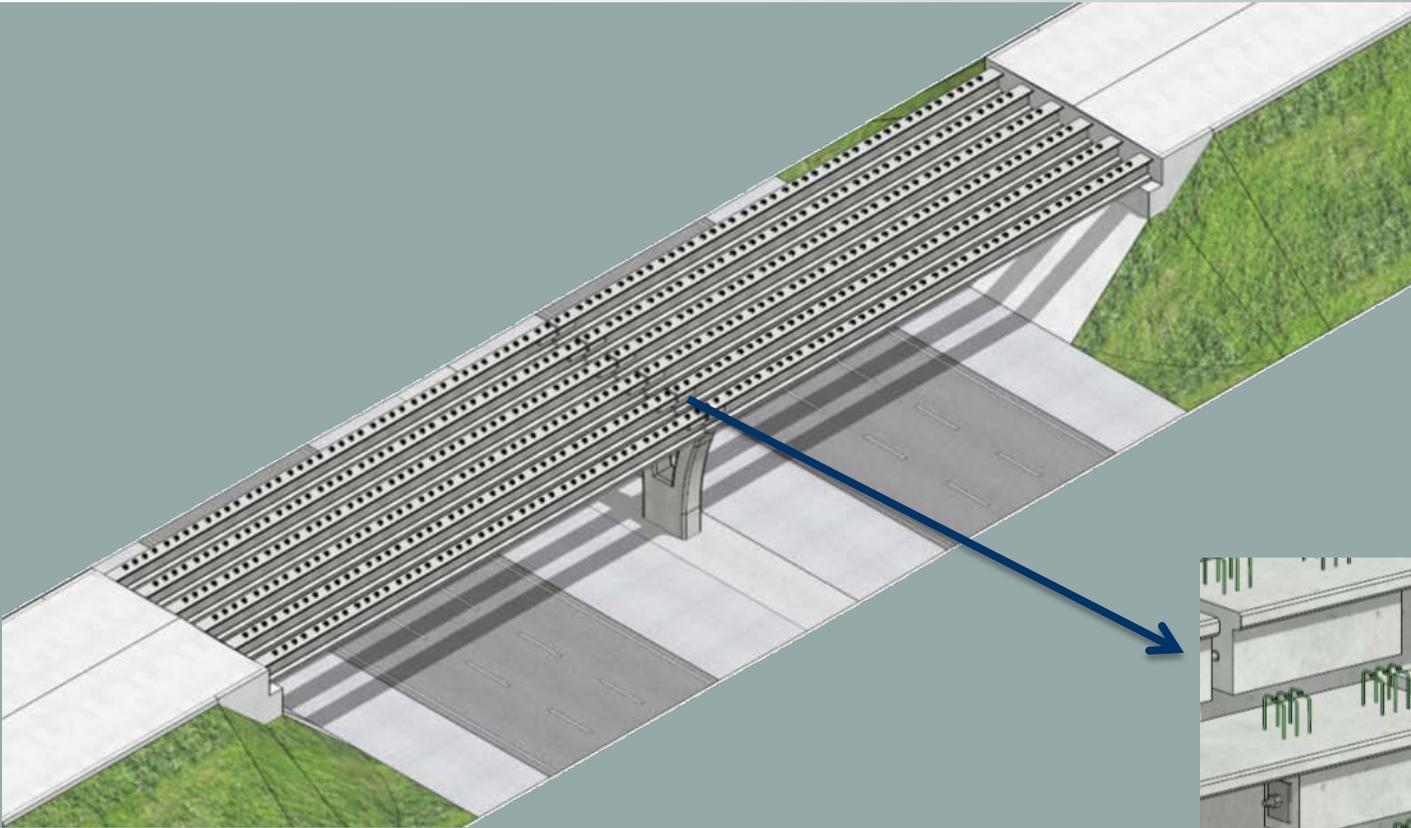
- Typical precast prestressed concrete girders
- Two or more spans
- Deck compression provided by tensioning rods at pier



# Accel<sup>PB</sup> System



# Accel<sup>PB</sup> System - Construction

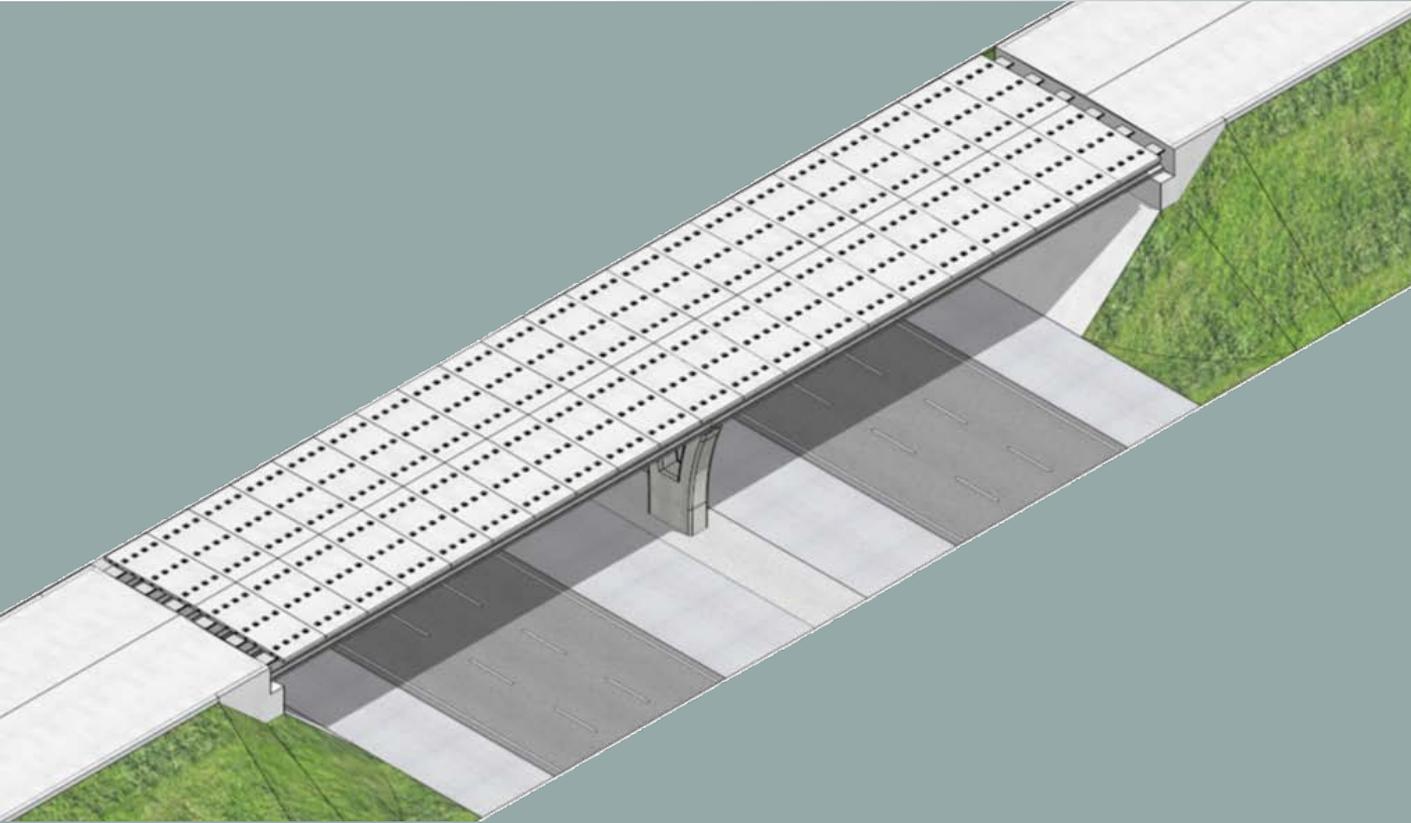


Erect girders



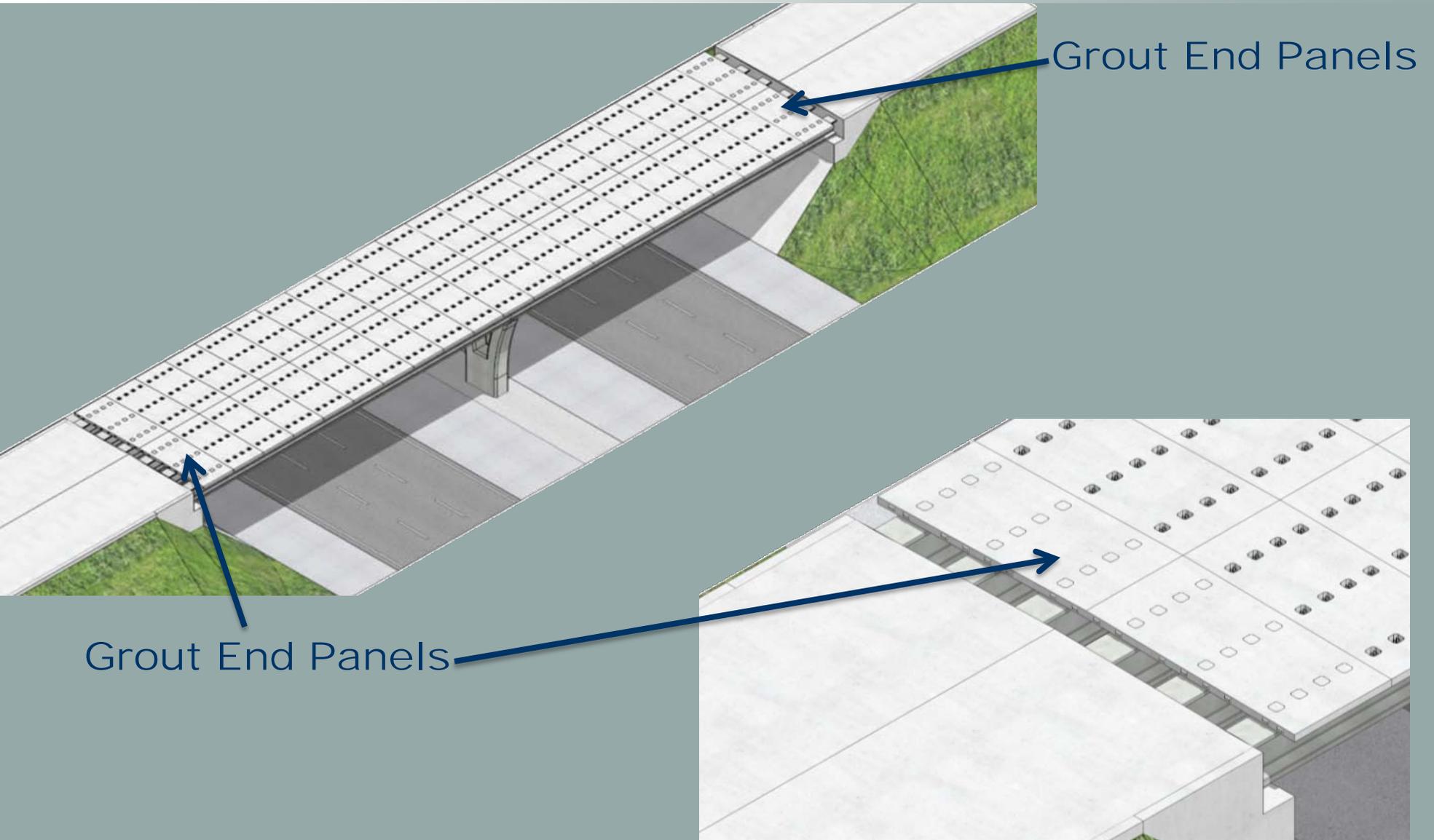
PT Bars Details at Piers

# Accel<sup>PB</sup> System - Construction

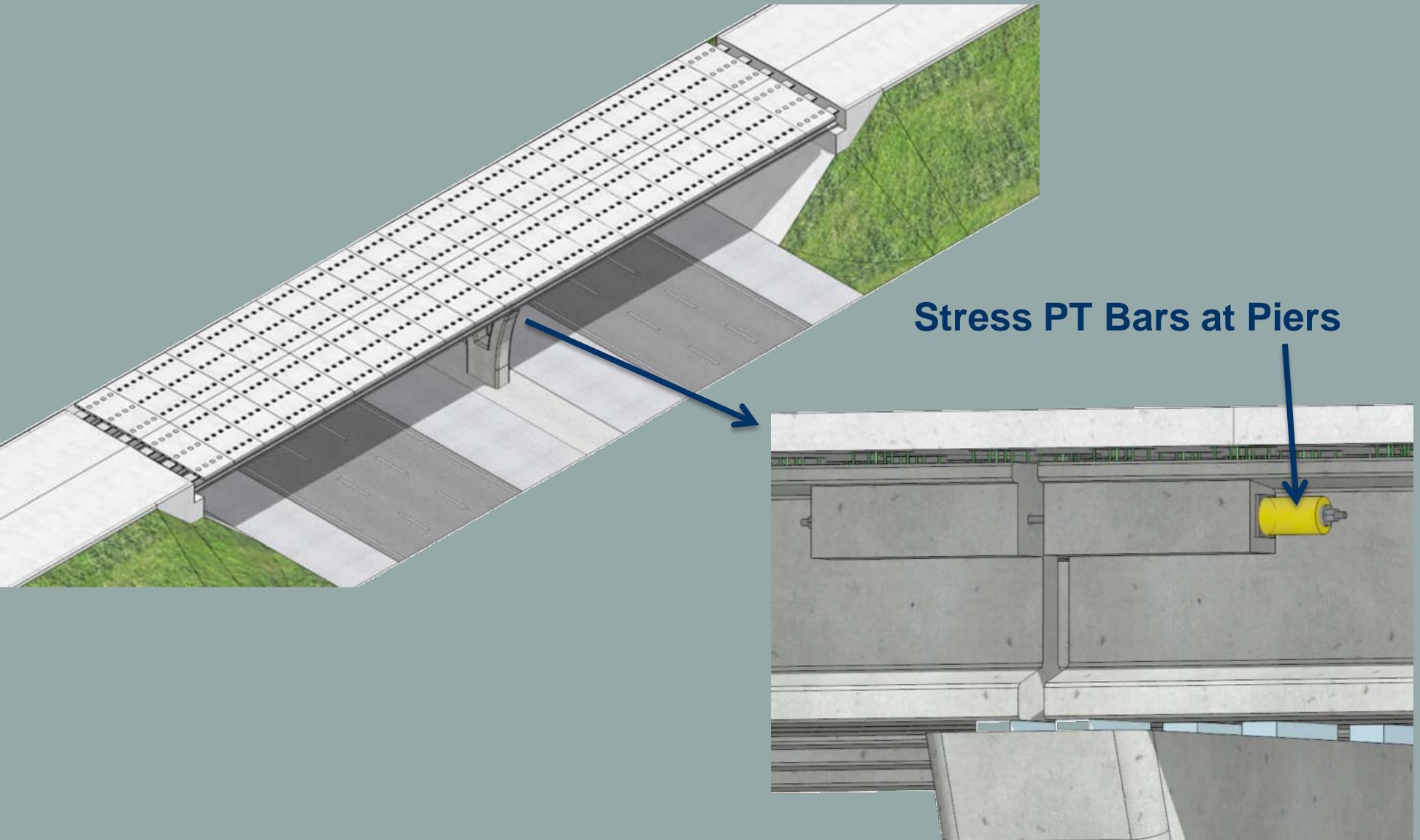


Place Deck Panels

# Accel<sup>PB</sup> System - Construction

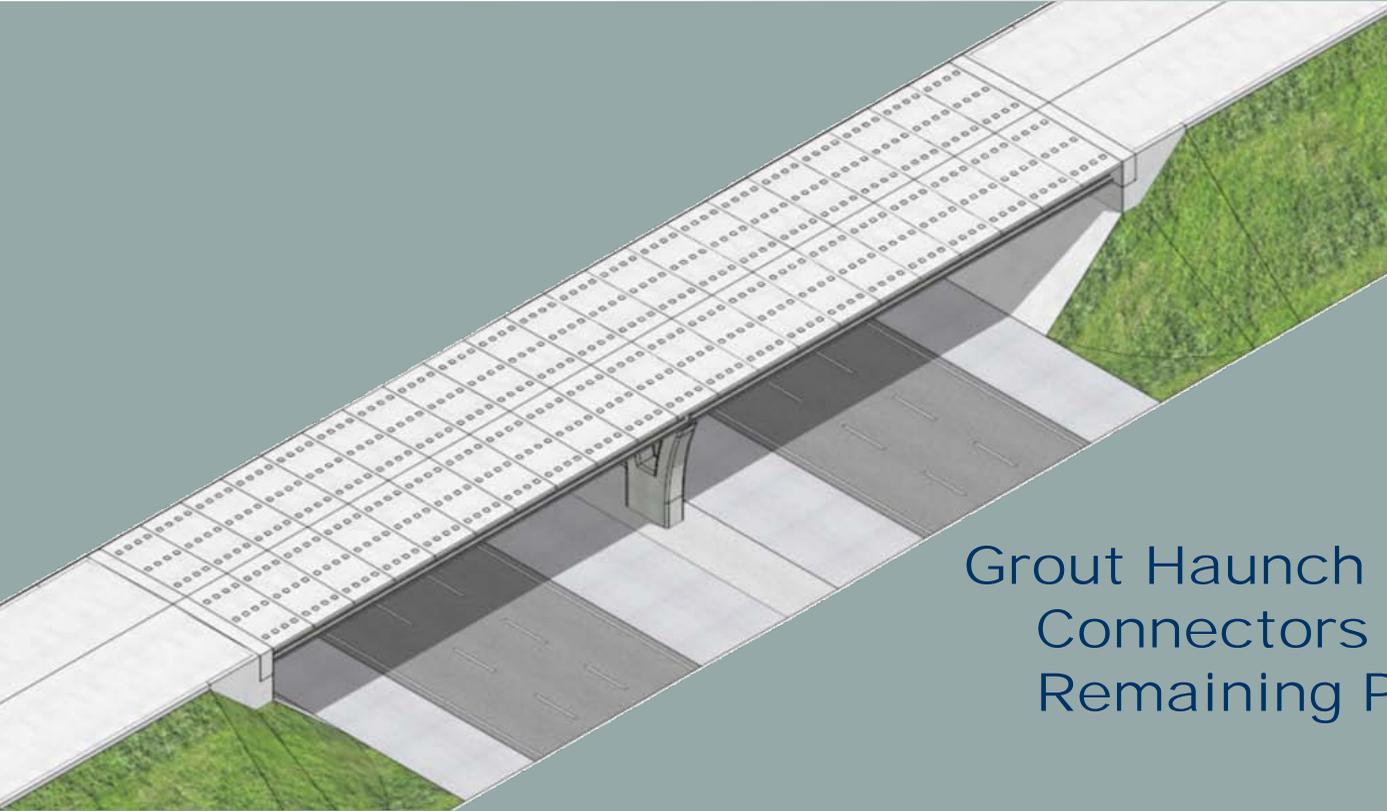


# Accel<sup>PB</sup> System - Construction



**Stress PT Bars at Piers**

# Accel<sup>PB</sup> System - Construction

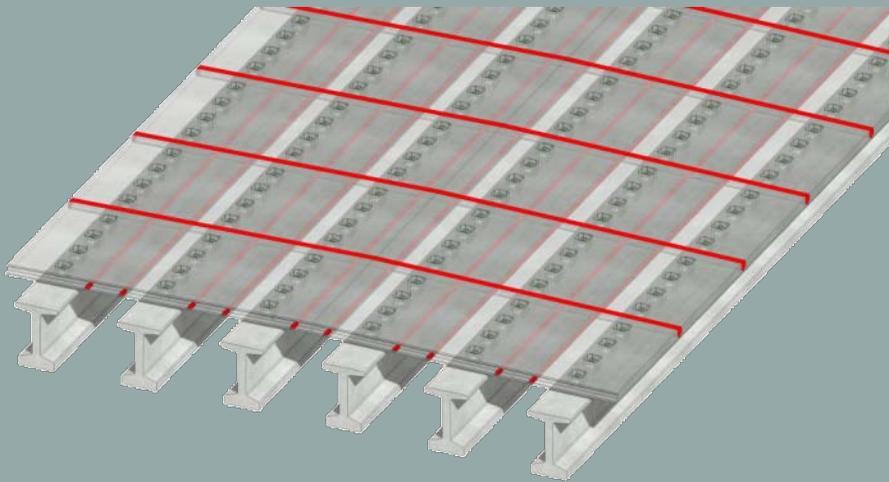


Grout Haunch and Shear  
Connectors for All  
Remaining Panels.

# Accel<sup>PB</sup> System - Advantages

## Conventional Full Depth Precast

- 18 x 4-0.6" PT Tendons  
(11340 lbs)
- 360 duct couplers



## AccelBridge

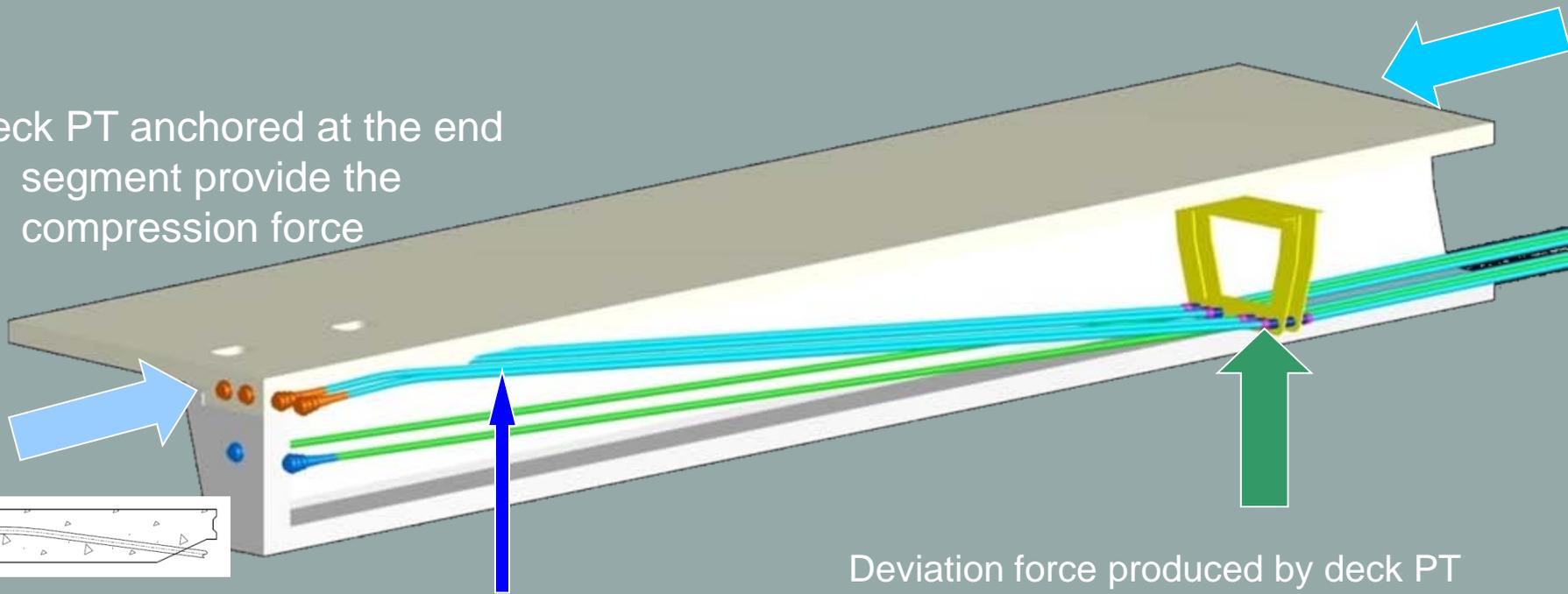
- 12 x 1 ¾" dia threaded rod  
(1150 lbs)
- No duct couplers
- Girder strand savings



# Accel<sup>PD</sup> System

- Precast deck with external post-tensioning inside Precast Tub girders
- An economical alternate to segmental box girder
- Combines the best from two proven technologies:
  - Concrete segmental bridges with external post-tensioning
  - Full depth precast deck

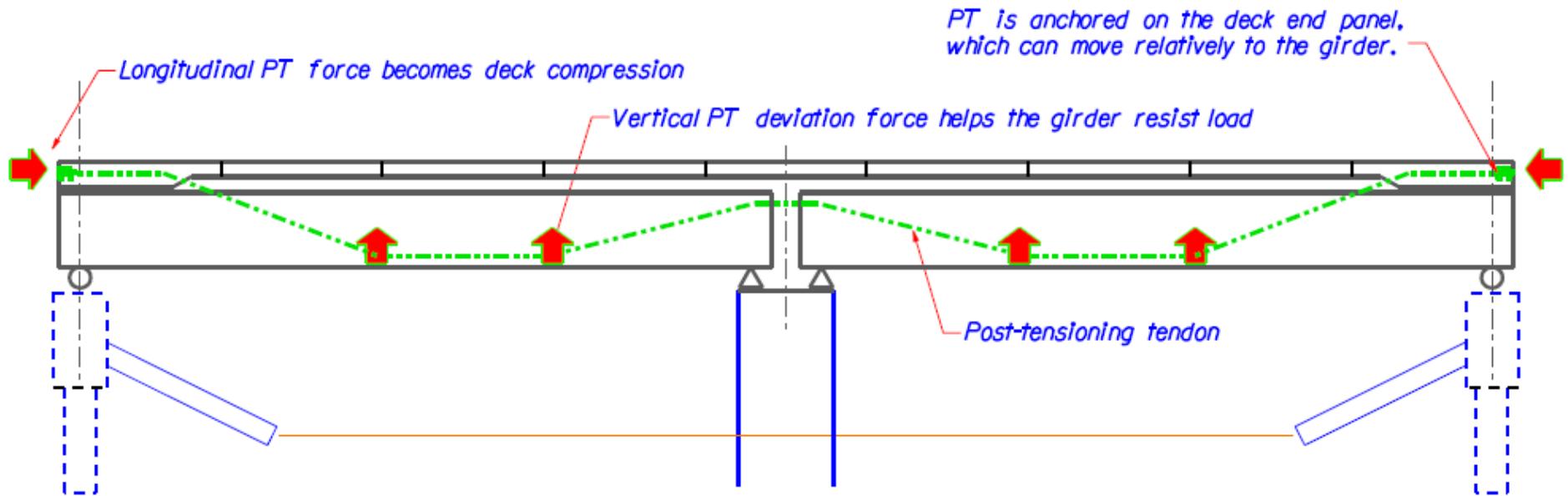
Deck PT anchored at the end segment provide the compression force



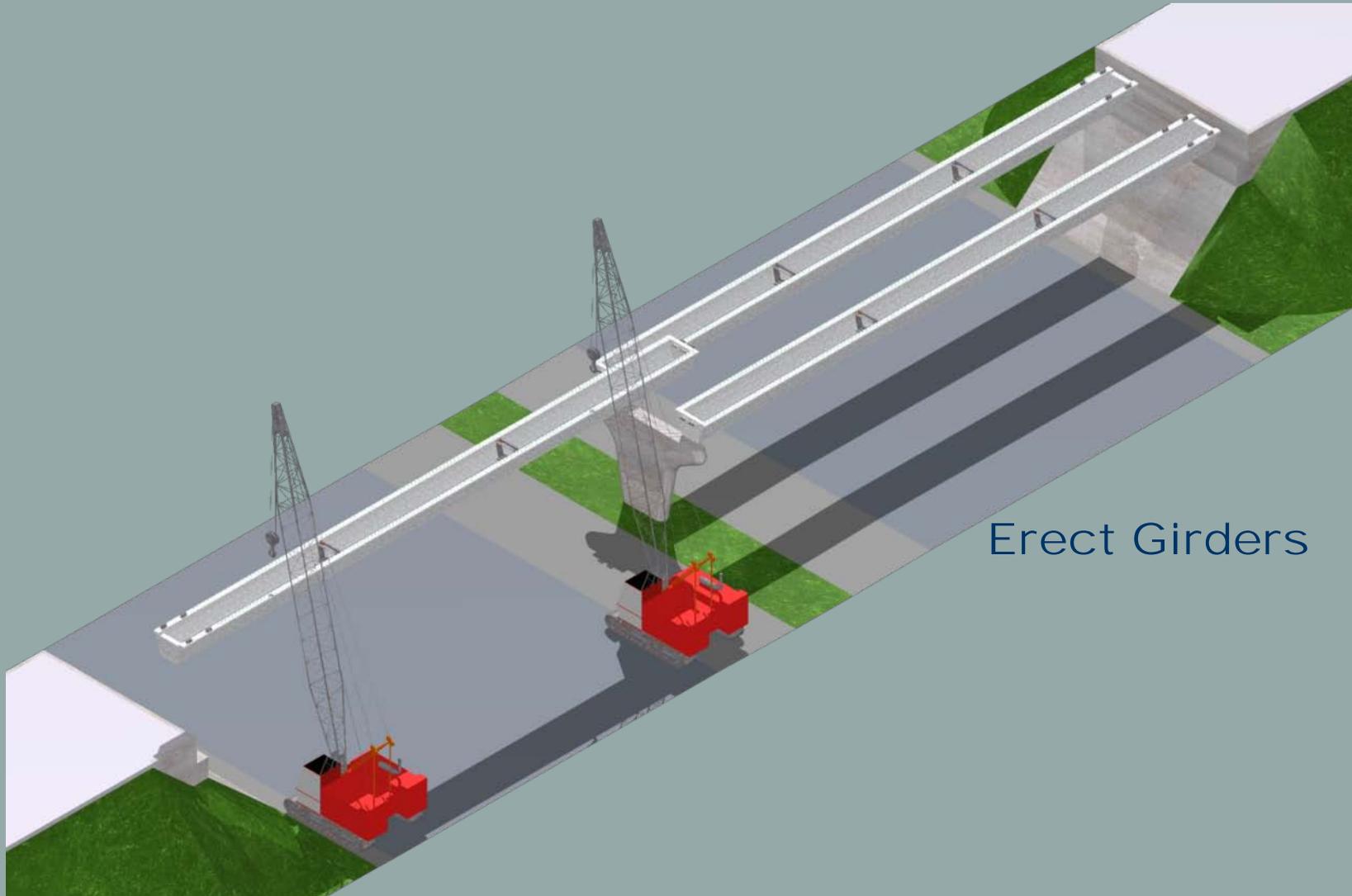
Deck PTs exit end segment and become external

Deviation force produced by deck PT assists the girder in resisting load

# Accel<sup>PD</sup> System



# Accel<sup>PD</sup> System - Construction



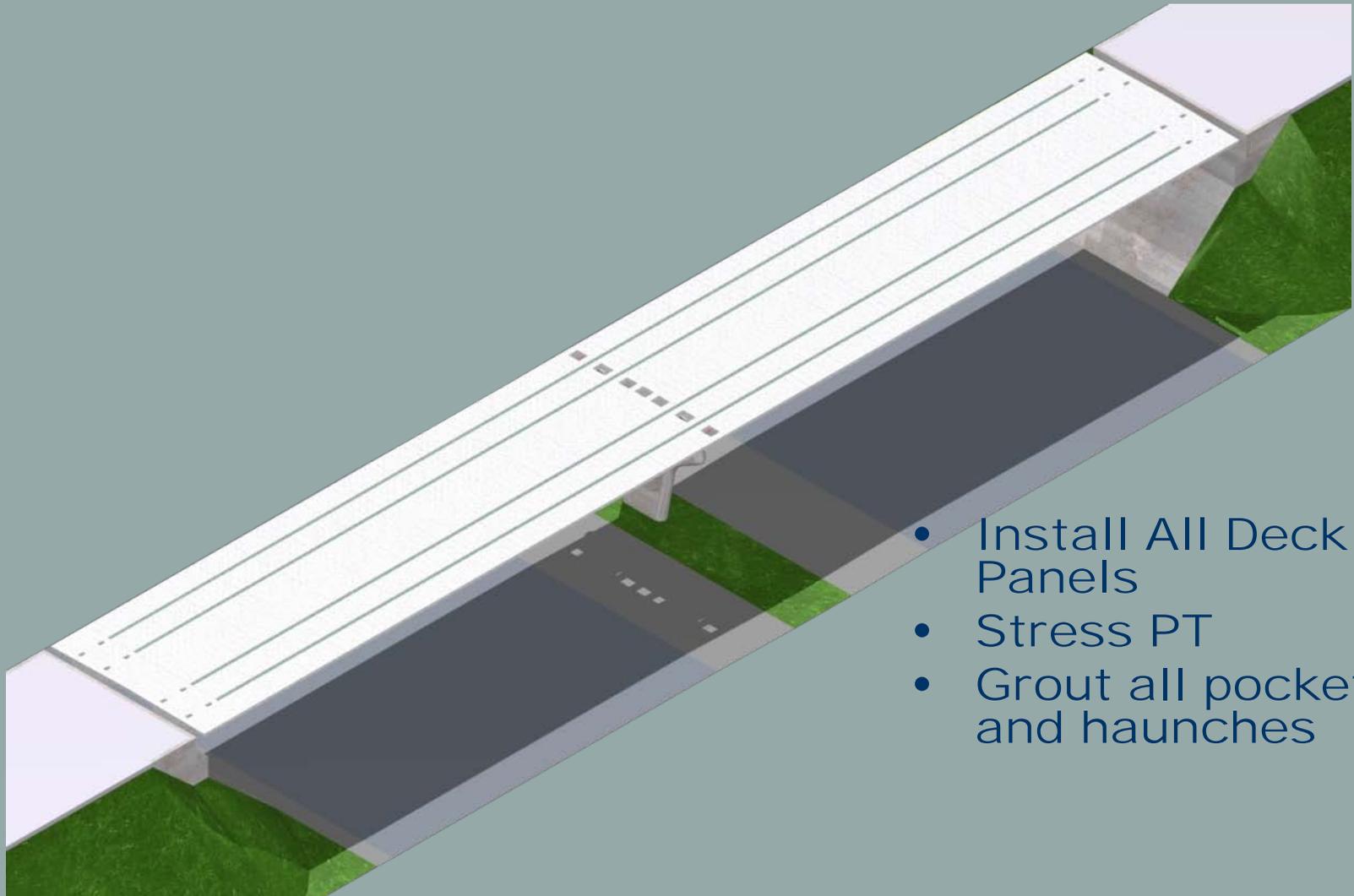
Erect Girders

# Accel<sup>PD</sup> System - Construction



Install PT and  
Place End Panels

# Accel<sup>PD</sup> System - Construction



- Install All Deck Panels
- Stress PT
- Grout all pockets and haunches

# Accel<sup>PD</sup> System - Advantages

## Segmental

- Expensive formwork
- Expensive erection system
- Special construction experience required



## Accel<sup>PD</sup>

- No expensive formwork
- Conventional erection
- No special construction experience required



# AccelBridge Applications

**The AccelBridge Systems are extremely versatile:**

- **U- and I-girder shapes**
- **Steel and concrete girders**
- **New construction and deck replacements**
- **Single and multiple spans**

	Spans		Construction		Girders	
	Single	Multi	New	Deck Replace	Conc.	Steel
Accel <sup>PD</sup>	■	■	■		■	
Accel <sup>PG</sup>		■	■		■	
Accel <sup>PB</sup>		■	■		■	■
Accel <sup>NP</sup>	■	■	■	■	■	■

# Match-Cast Joints

The match cast method, popular in segmental construction, is an ideal solution for full depth precast deck

- Simplified long-line match casting method
  - “Flat” casting
  - Maximum deck curvature only results in <math><2\text{mm}</math> gap at joints
  - Segmental construction typically allows 3mm epoxy joints.
- MODOT’s very successful example of Nemo Bridge  
*(construction by Columbia Curb & Gutter)*

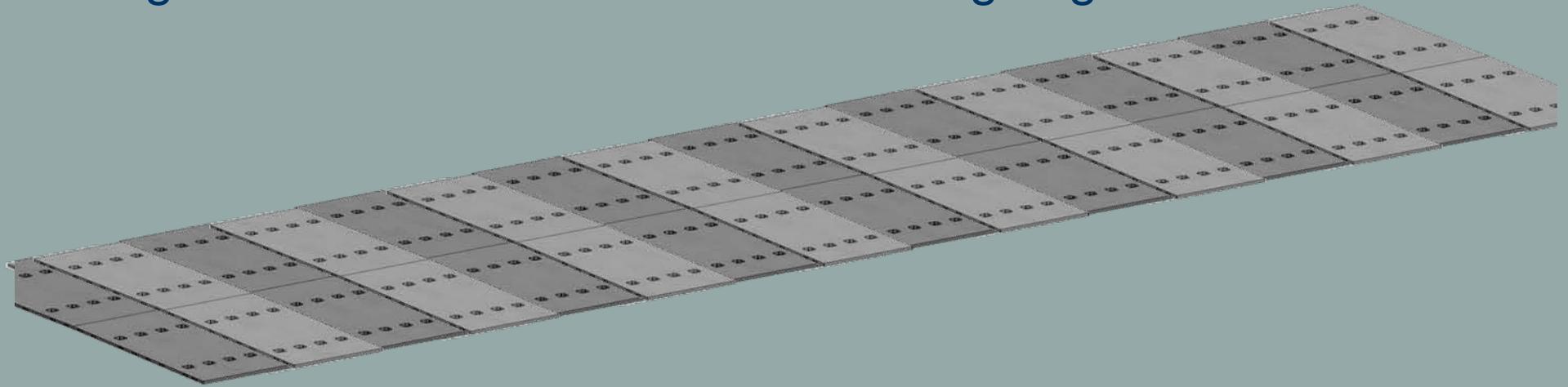
Figure 1: Casting Bed (Every other 10' section has concrete poured burlap curing mats on it and the others with green rebar and blockouts showing are waiting to be match cast.)



# Match-Cast Joints

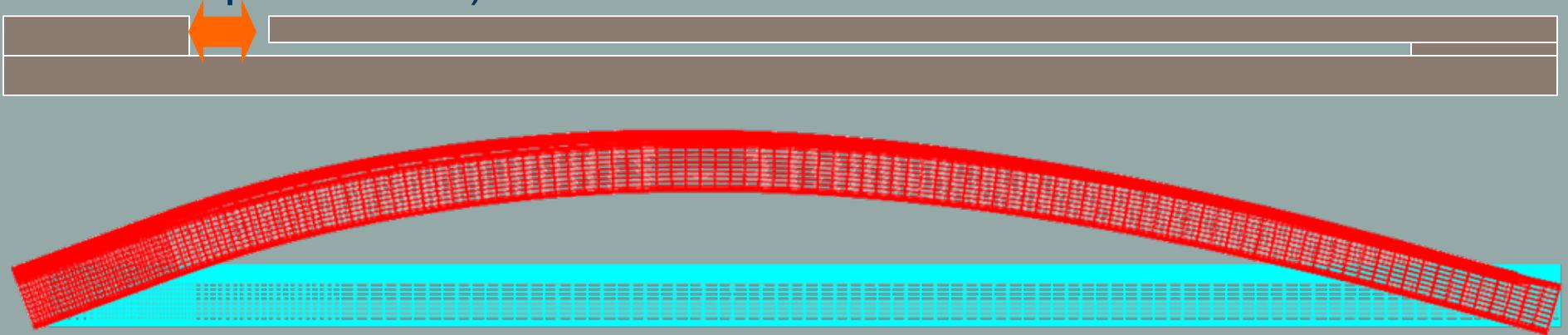
Step 1 - Cast every other segment with bulkheads

Step 2 – Match cast the remaining segments

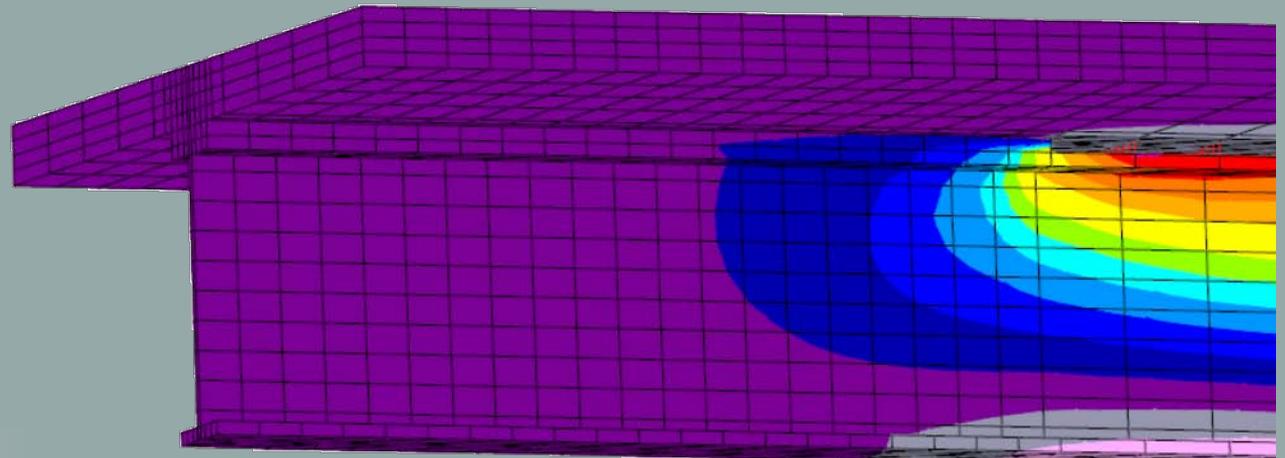


# Engineering Topics

- Need to consider camber due to stressing the deck (after deck placement)



- Girder Stress Distribution



## Engineering Topics: *Deck Stability*

The deck is very thin in the vertical direction -- its stability must be ensured under such a large compression force.

Therefore:

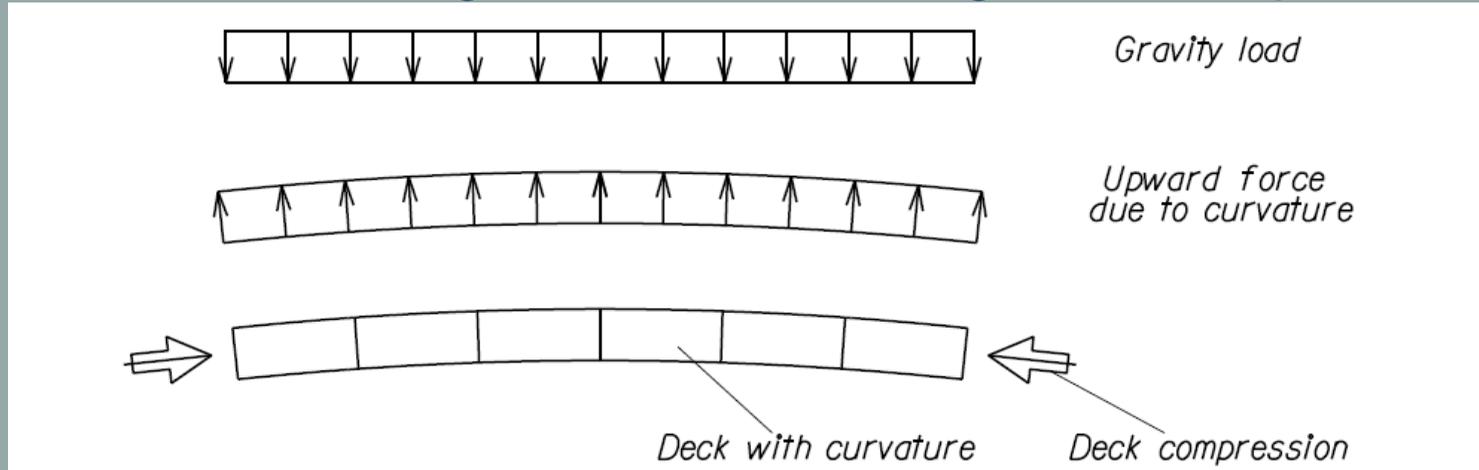
*Checking deck stability is one of the most important tasks in the design of the AccelBridge systems.*

Theory:

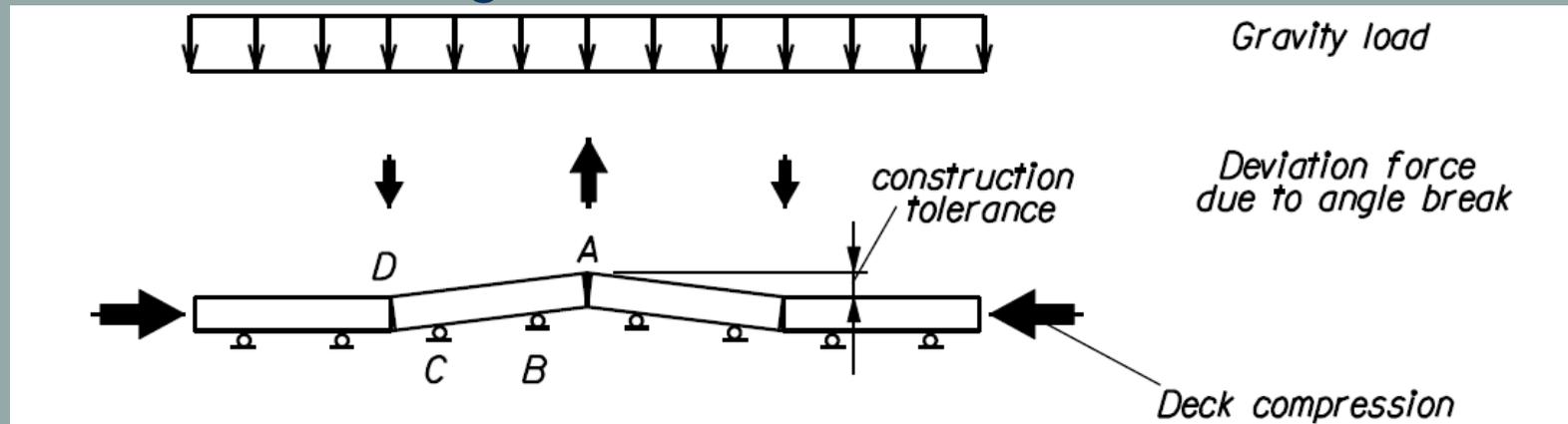
- Gravity force provides the stabilizing force – buckling of the deck has to overcome the gravity force first
- The deck stability shall consider bridge profile geometry and construction tolerance.

# Engineering Topics: *Deck Stability*

Potential destabilizing effects from bridge vertical profiles:



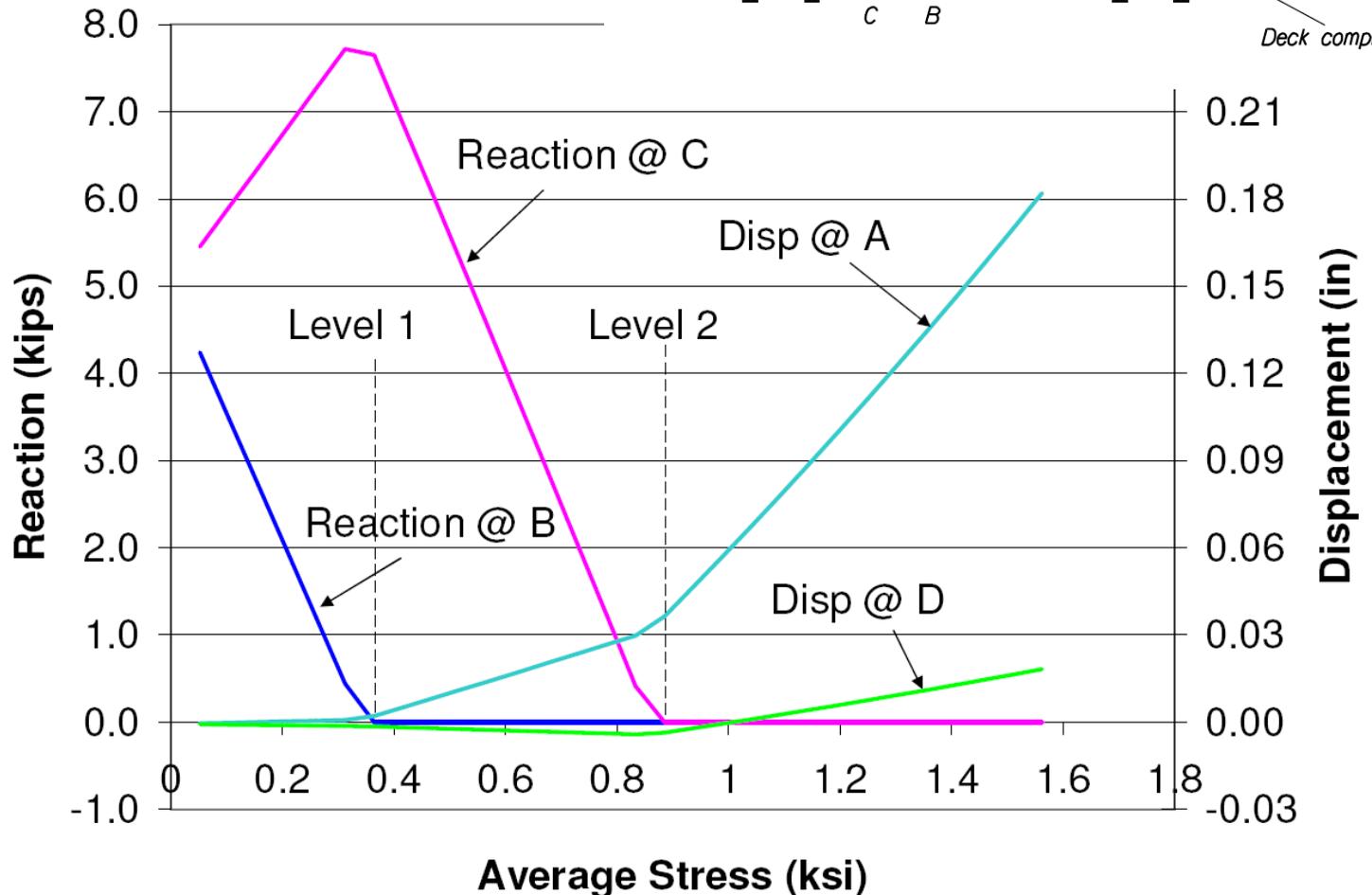
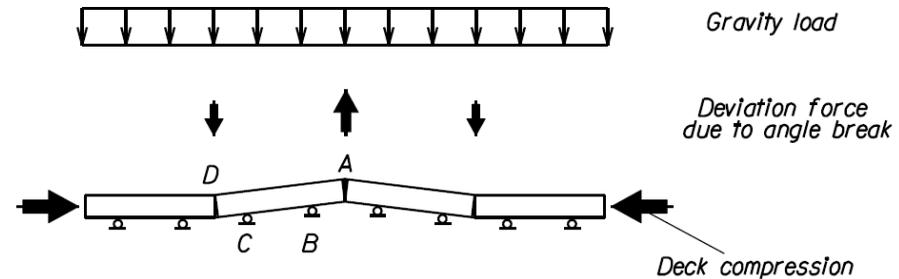
Potential destabilizing effects from construction tolerance:



# Engineering Topics: *Deck Stability*

Level 1 – Point B unloads

Level 2 – Point C unloads

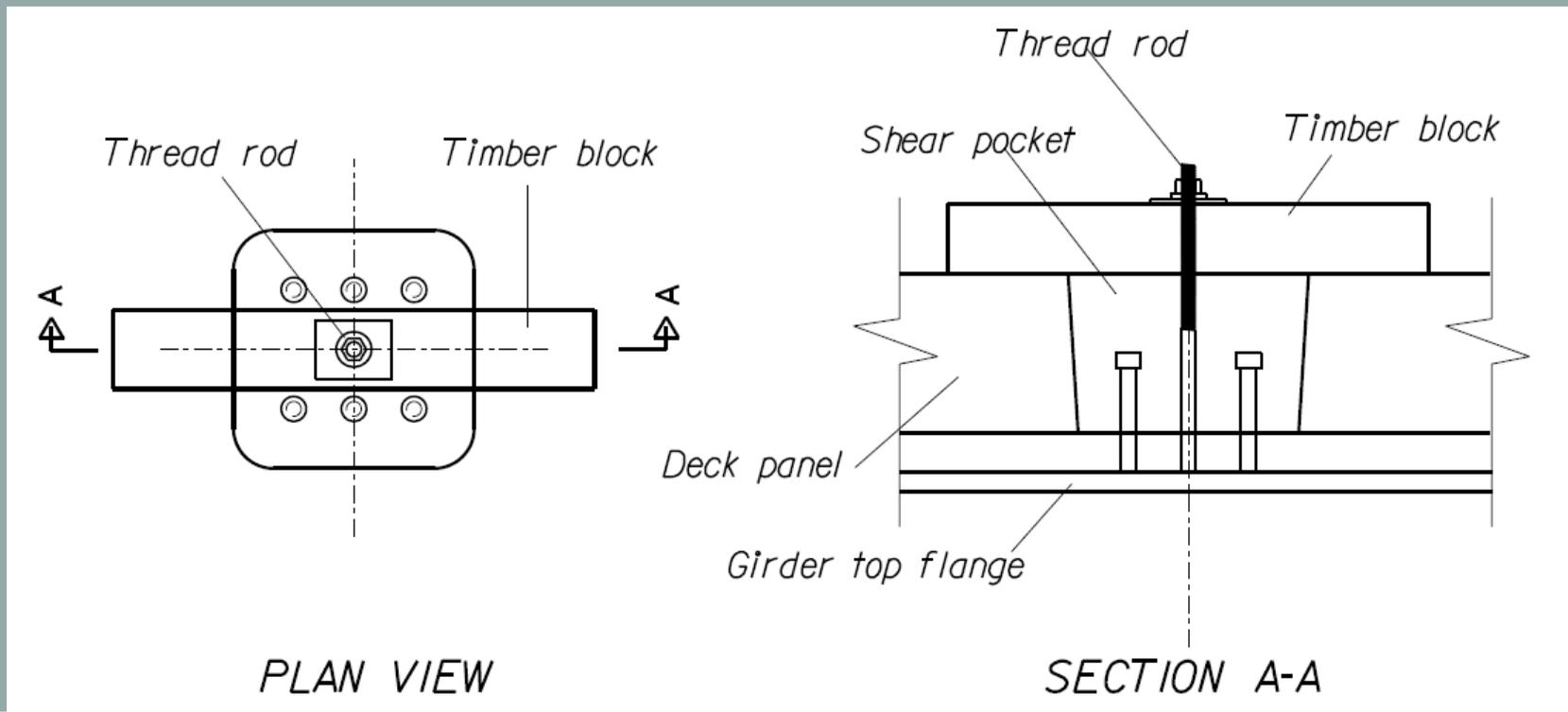


# Engineering Topics: *Deck Stability*

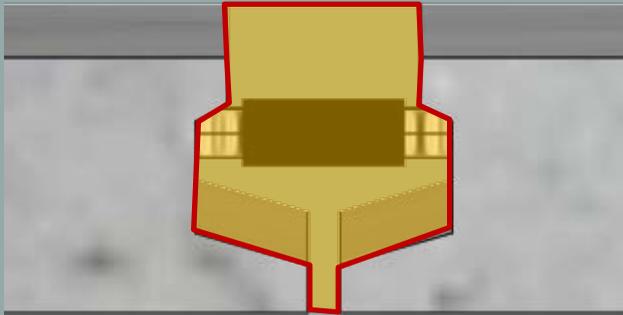
## Engineering Evaluation Results:

Typically, a safety factor of two against buckling can be readily achieved.

However, hold-down devices can provide additional safety margin:

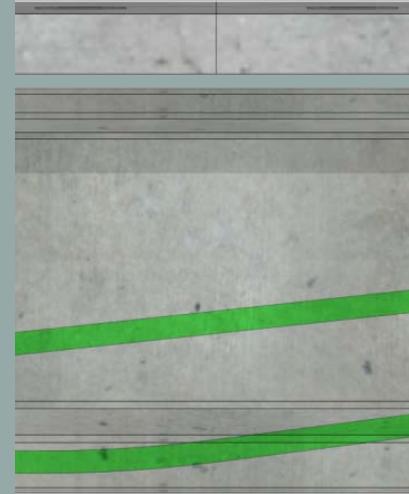


# The AccelBridge Advantage: *Durability*



## Typical Deck Internal PT

- Joints and couplers are always the “weak links”
- Chloride can penetrate through joints and couplers



## AccelBridge

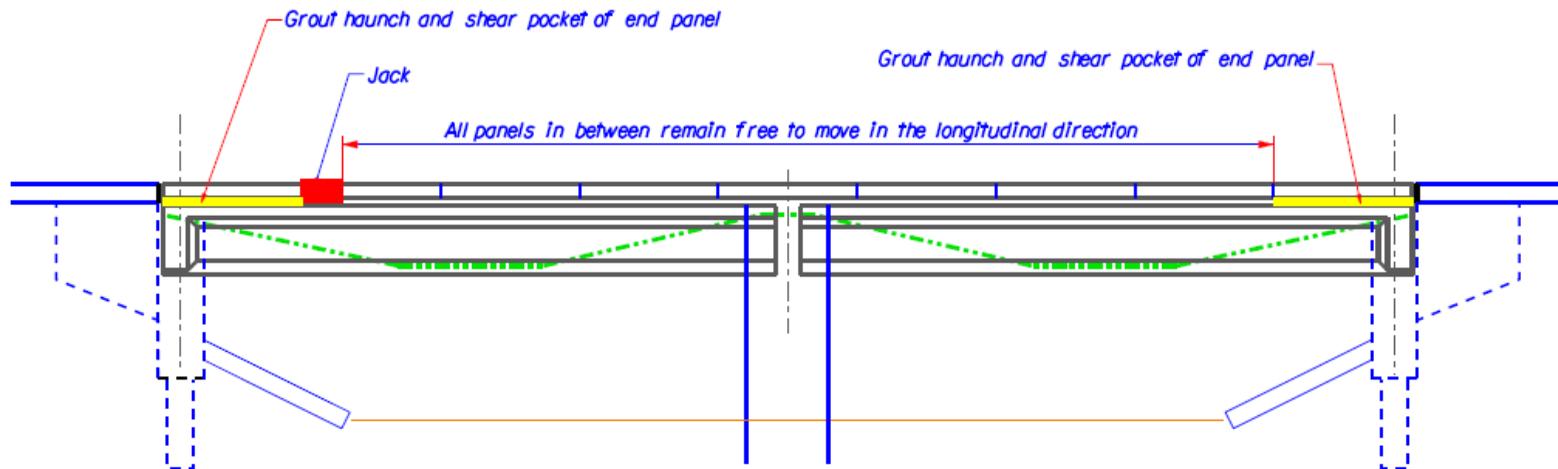
- PT ducts are away from deck and are well protected (Accel<sup>PG</sup> and Accel<sup>PD</sup>)
- No PT ducts (Accel<sup>NP</sup> and Accel<sup>PB</sup>)

## Extremely Durable Deck System

- Precast and cured in shop environment
- Can provide zero tension in the deck
- No weak spots (no PT, no coupler in the deck)

## The AccelBridge Advantage: *Deck Replacement*

- All four AccelBridge systems can accommodate future deck replacement
- Future deck replacement for **Accel<sup>NP</sup>**, **Accel<sup>PB</sup>** and **Accel<sup>PD</sup>** can follow the same sequence as for their original construction
- Future deck replacement for **Accel<sup>PG</sup>** uses a jacking method similar to **Accel<sup>NP</sup>**



# The AccelBridge Advantage



***Field Labor  
Minimized***



***No Complicated  
Equip.***



***Deck Panels  
Simplified***



***Durability  
Enhanced***

## The AccelBridge Advantage

### AccelBridge

*Improves constructability; less field labor, less risk.*

### AccelBridge

*Offers an extremely durable deck system.*

### AccelBridge

*Saves money -- both upfront and over the bridge lifecycle.*

AccelBridge = *ABC Made Simple.*



Put AccelBridge to work for you.

Contact us at:

**Eddie He**, PE, SE, PhD, LEED AP

Phone: 312.952.3071

E-mail: [info@accelbridge.com](mailto:info@accelbridge.com)

Information presented herein pertains to proprietary products.