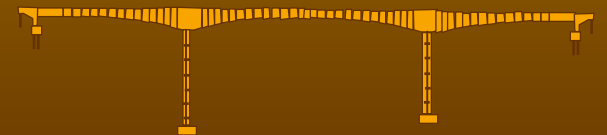
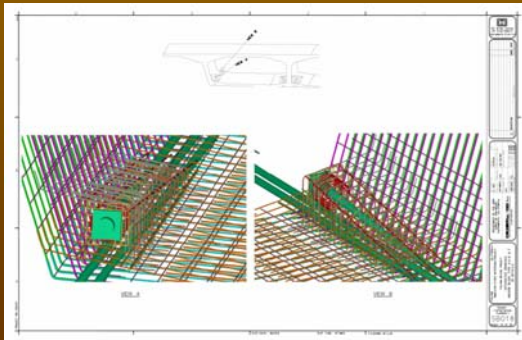
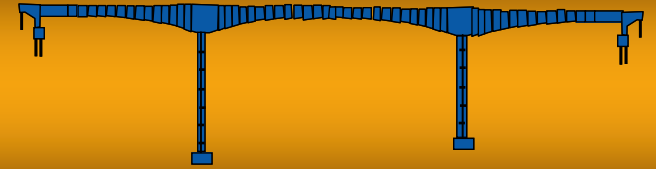


# The Use of 3D Integrated Drawings on the Design and Construction of the New Folsom Bridge

Alex Harrison  
Ed Maechler

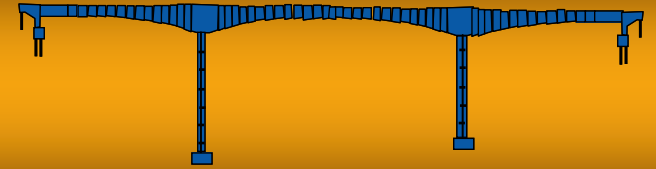


# Topics



- **Project Overview**
  - Bridge Structure Overview
- **Design and Detailing**
  - Design Plans (PS&E)
  - 2D Integrated Details
  - 3D Integrated Details
  - 3D Video Details from a Unique Perspective
- **Construction**
  - Adapting to Changes and Requests

# Project Team



## Client



US Army Corps  
of Engineers®  
Sacramento District

US Army Corp of Engineers (USACOE),  
Sacramento Division (City of Folsom)

## Design Consultants

**CH2MHILL / URS** Team  
a joint venture

CH2M HILL responsible for  
Bridge Design

## Constructors



**Kiewit**

Kiewit



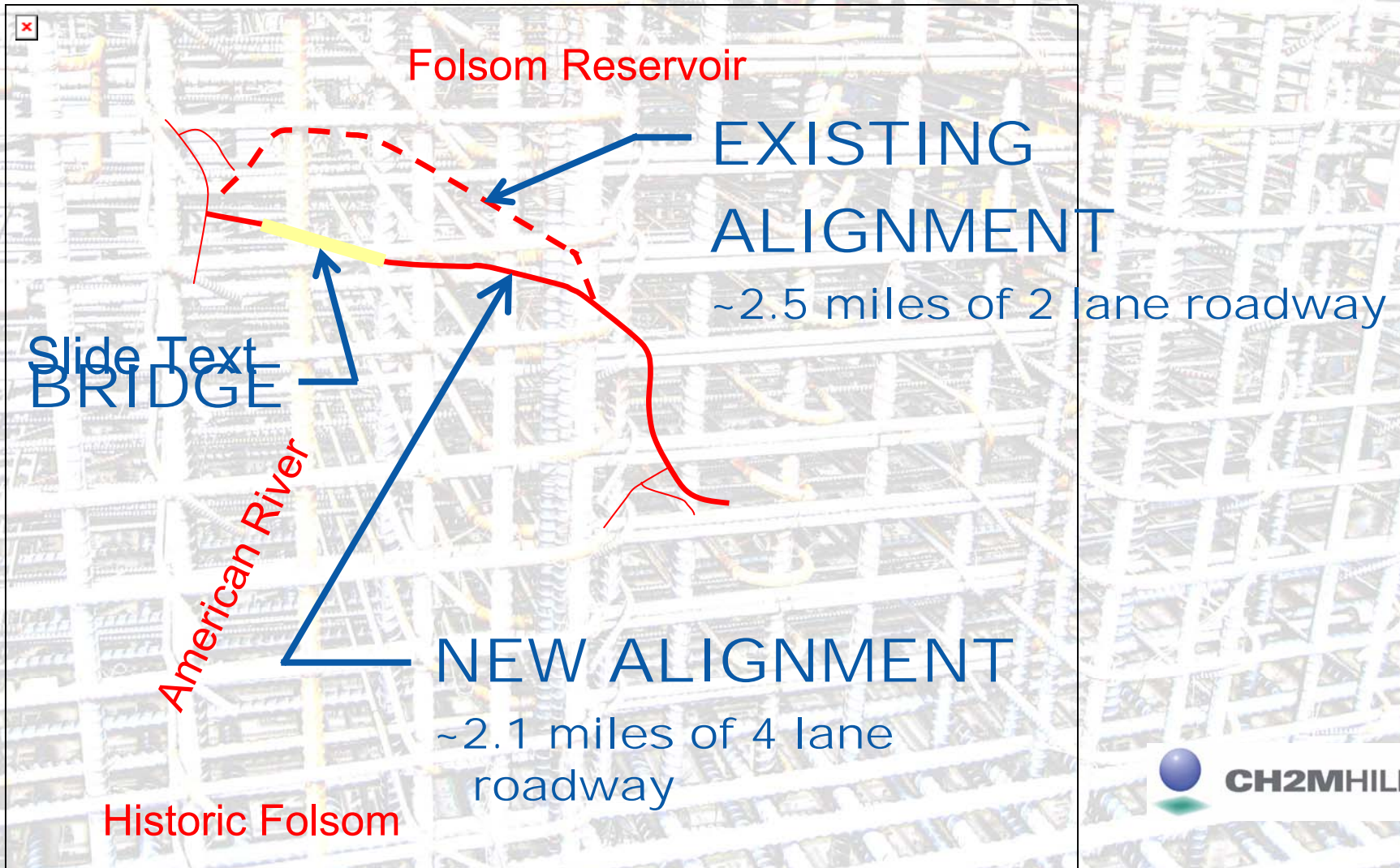
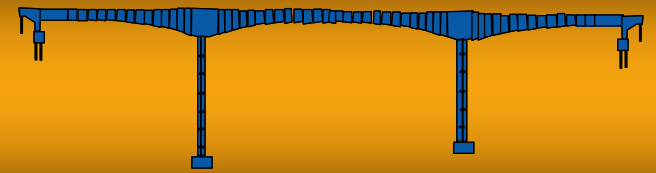
**CH2MHILL**

# Folsom Bridge



*DWR*

# Bridge Site



# Folsom Bridge: A signature structure on the American River Canyon

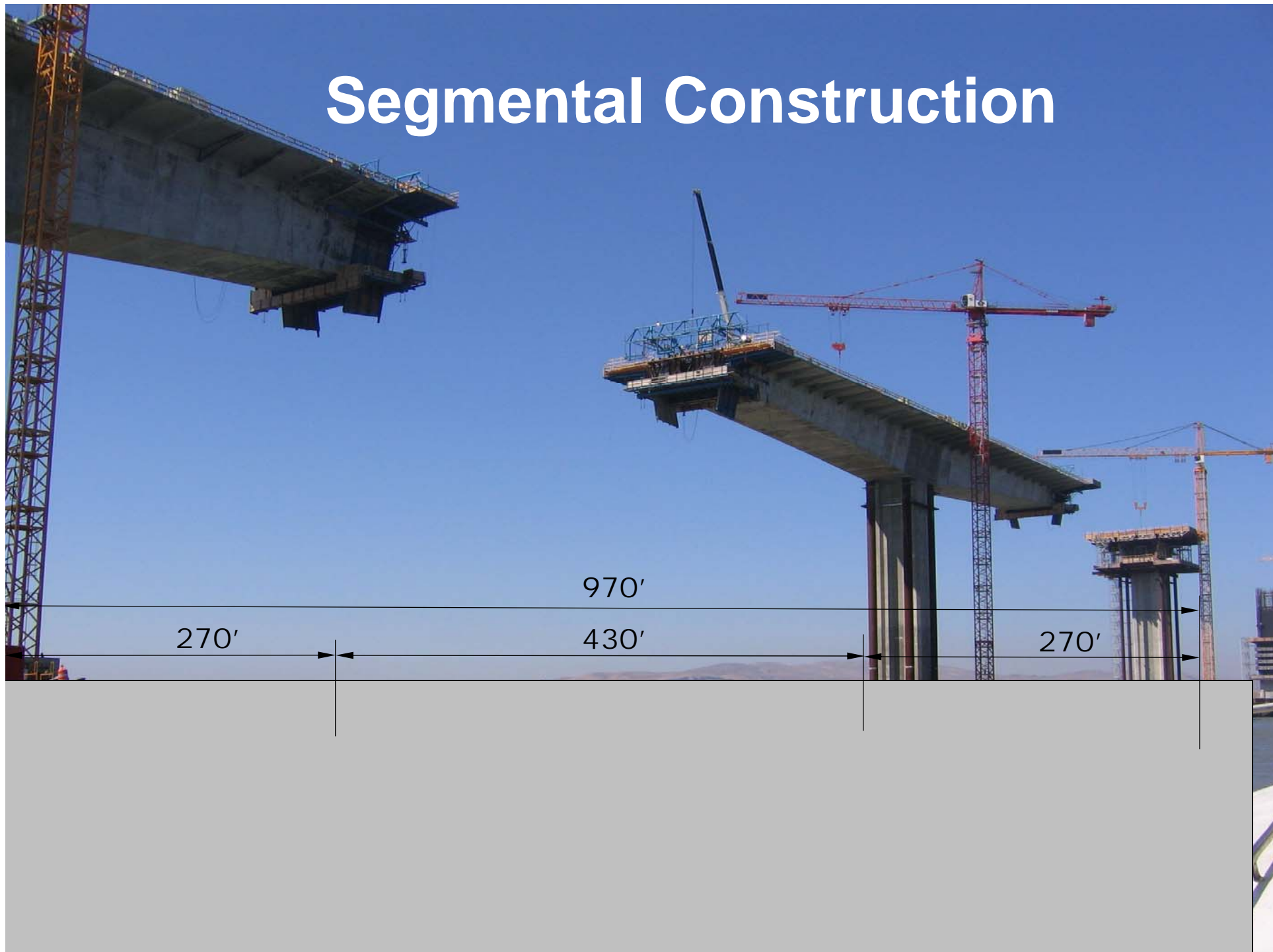


- Cast In Place Concrete
- Segmental Construction

# Segmental Construction

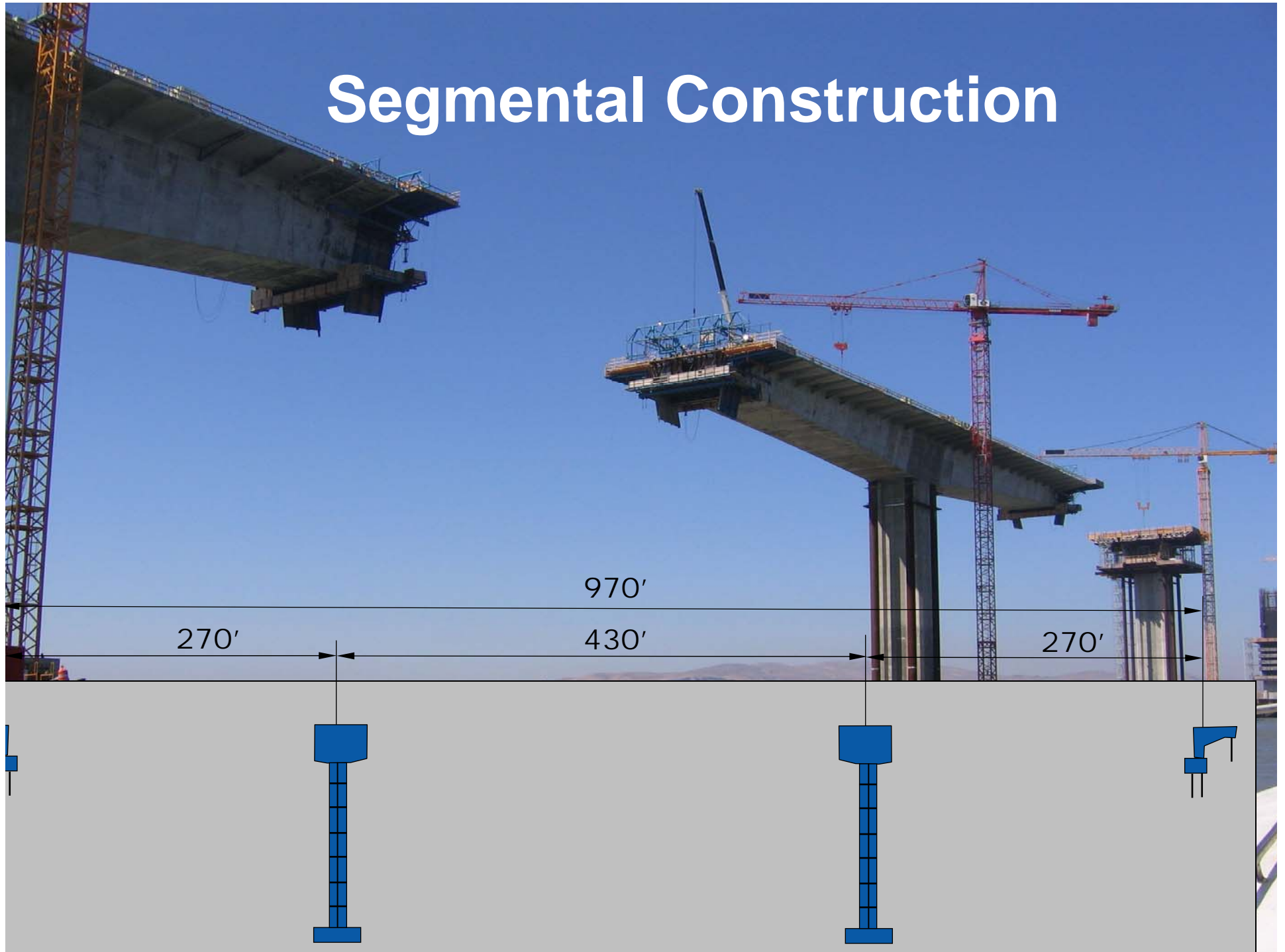


# Segmental Construction

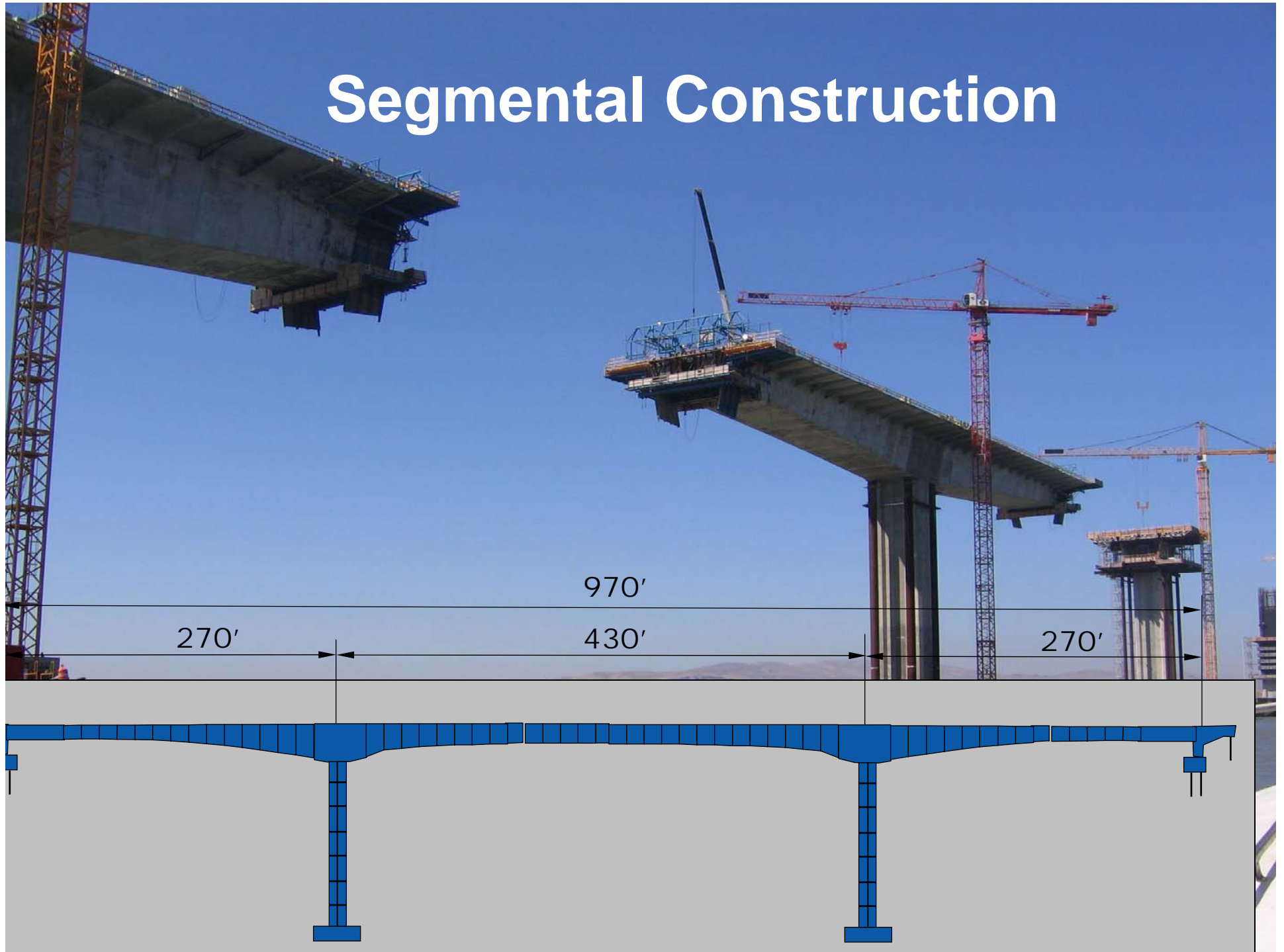




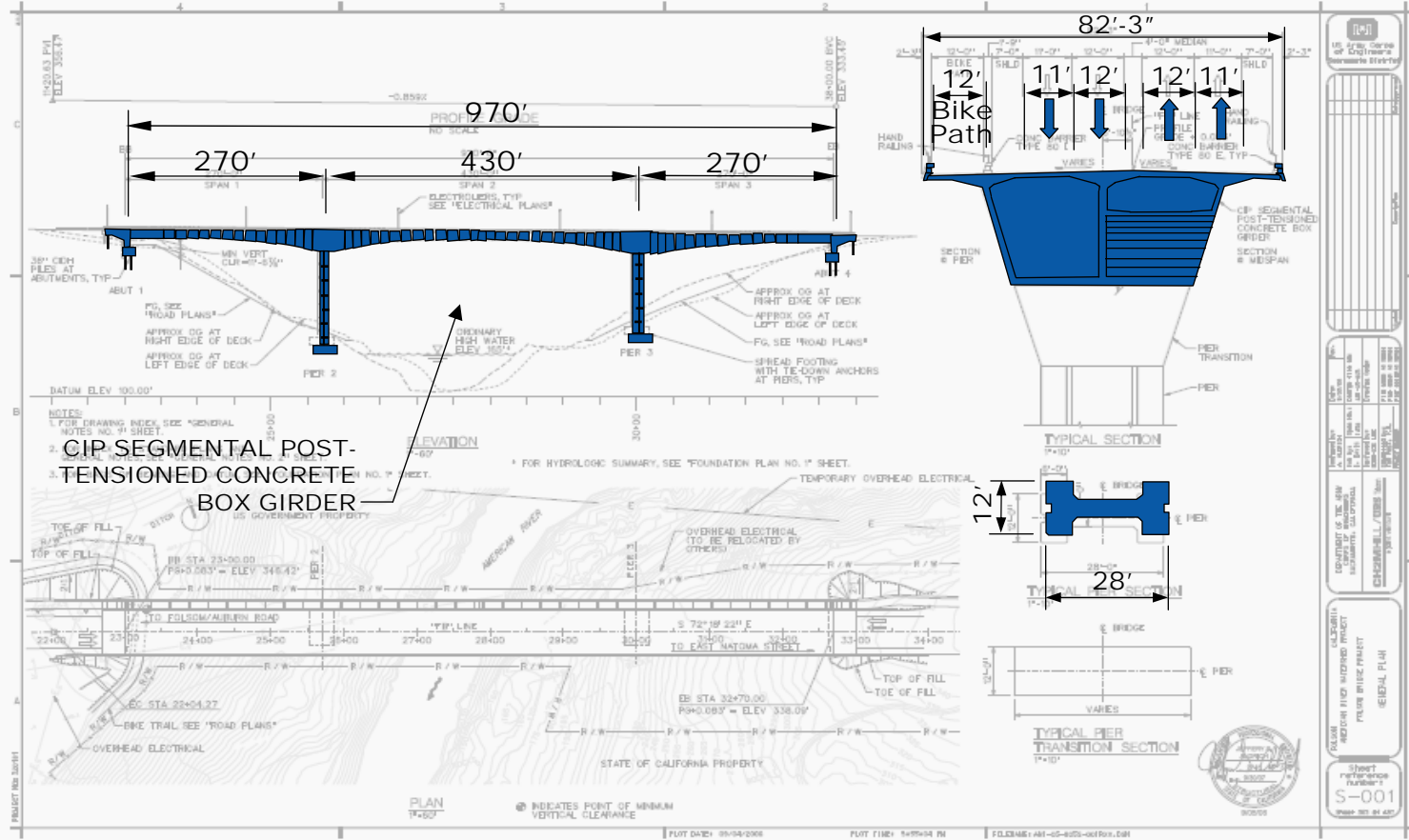
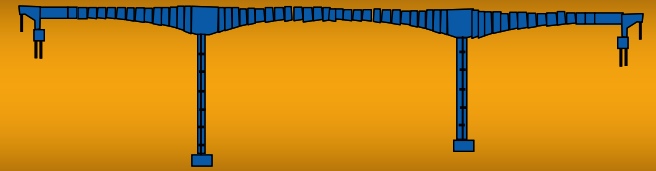
# Segmental Construction



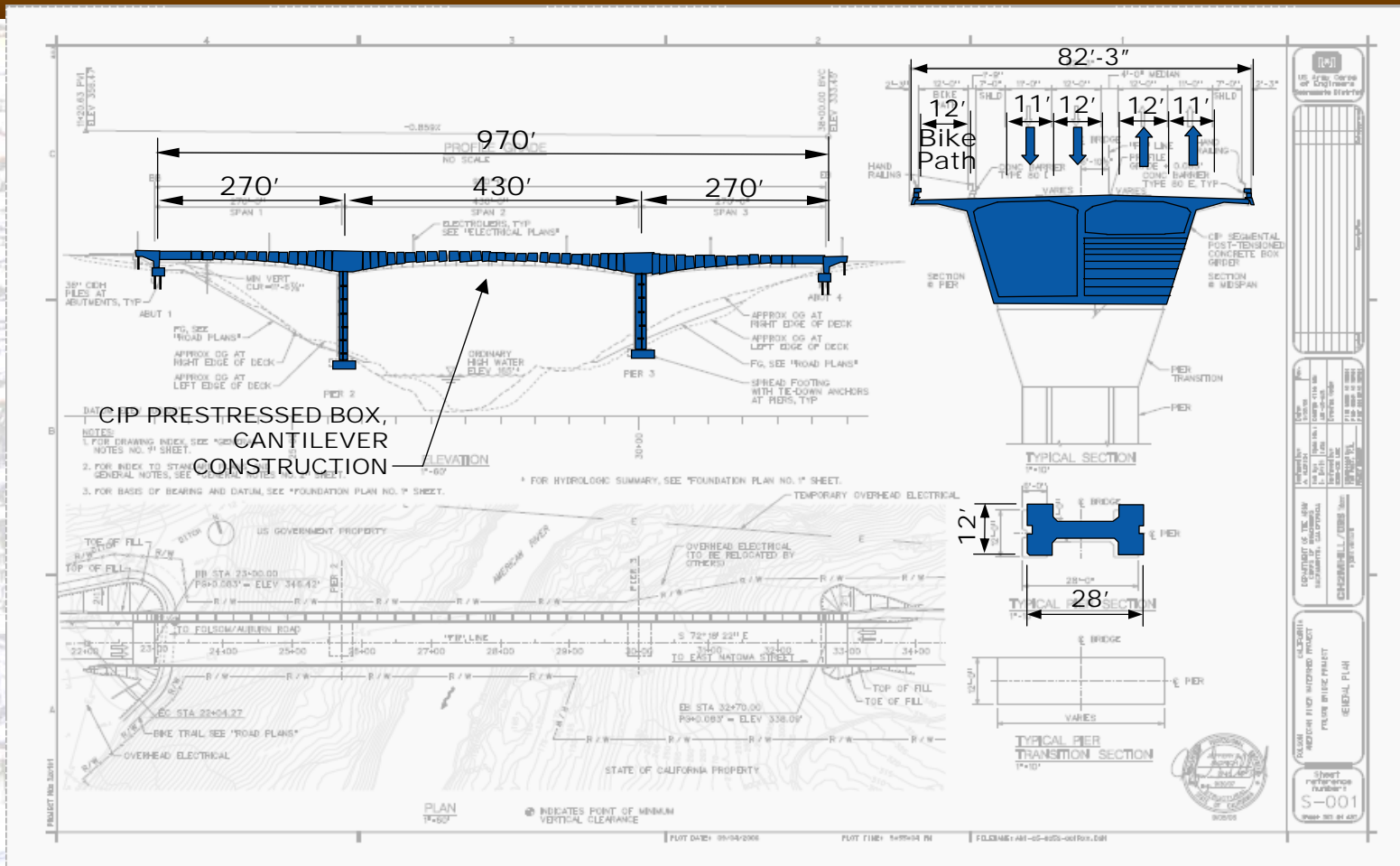
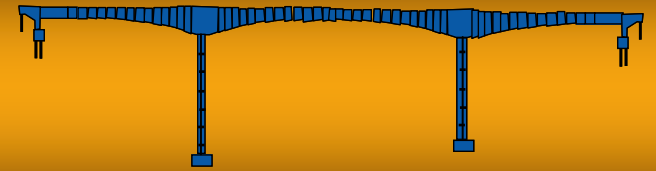
# Segmental Construction



# Bridge Data



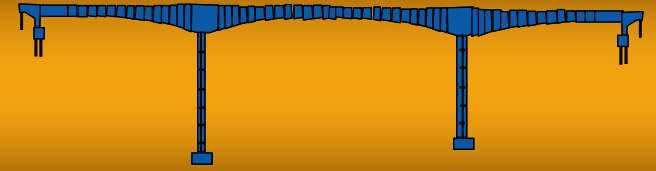
# Bridge Data



# Under Construction

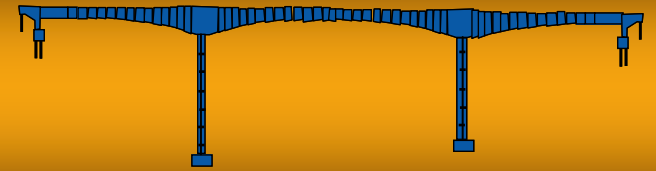


# Integrated Drawings



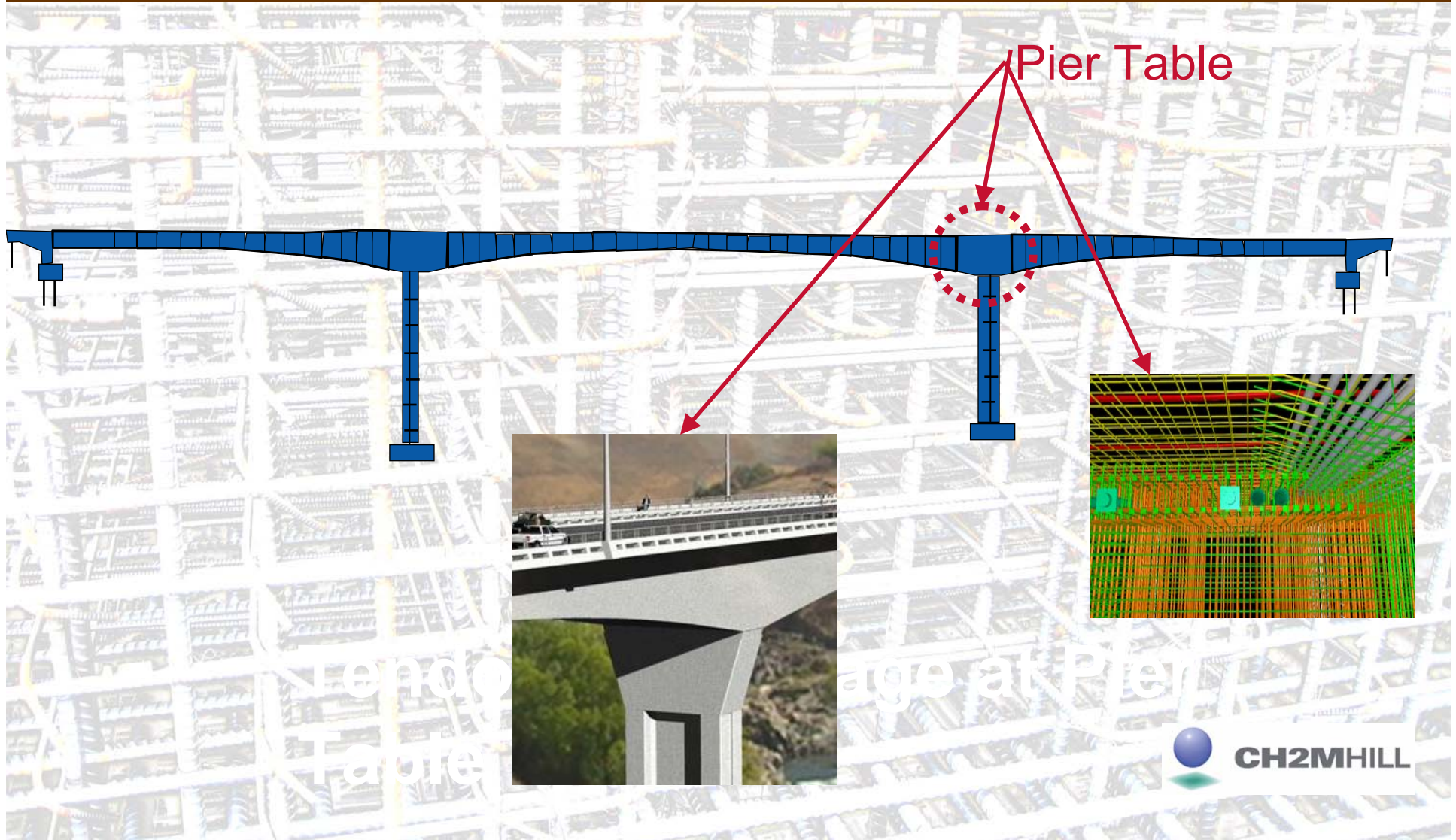
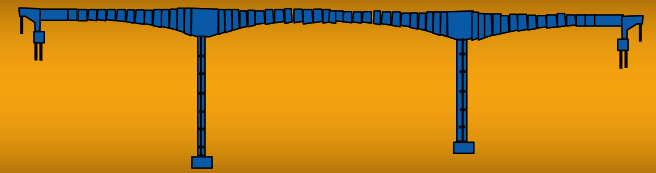
- Incorporate All Details
  - Post Tensioning
  - Rebar
  - Misc. Hardware
- Use Physical Dimensions
  - Post Tensioning Hardware
  - Deformed Rebar Diameter
- Resolve Conflicts
  - Shift Rebar
  - Adjusting Design
- Iterative Process!

# Integrated Drawing Techniques



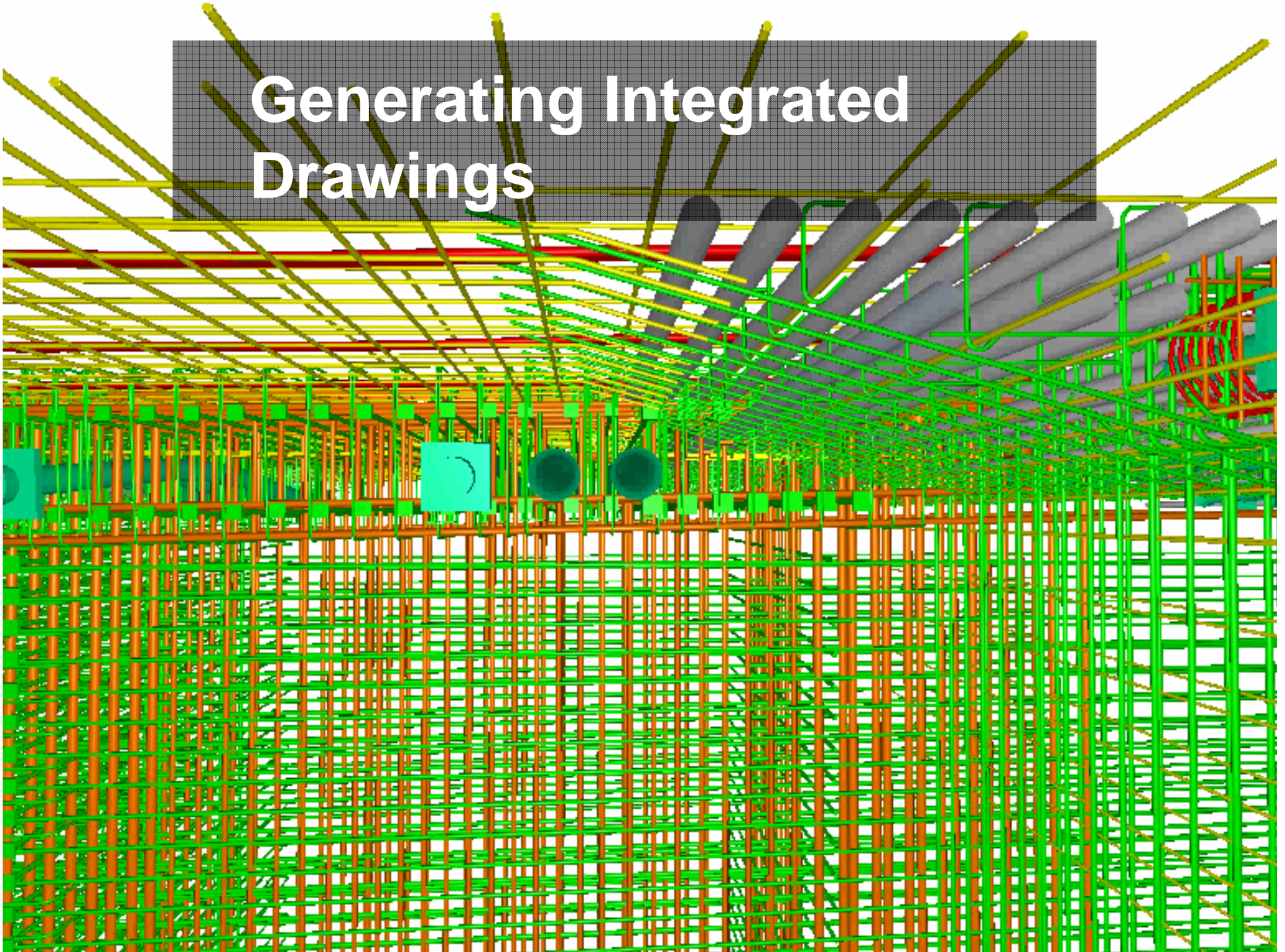
- 2D Sketches
- Automated Interference Checks
- 3D Drafting
  - Bentley Microstation
  - GeoPack Rebar

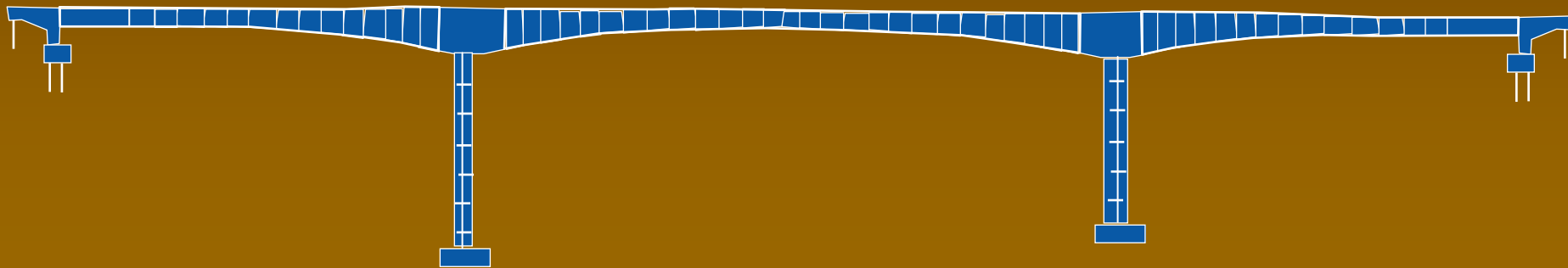
# Target Key Areas





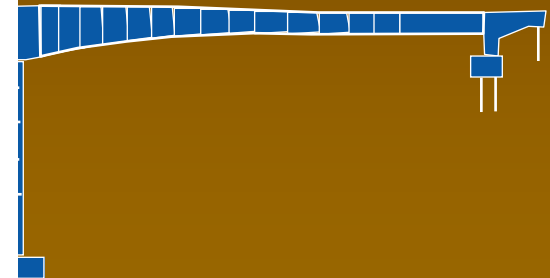
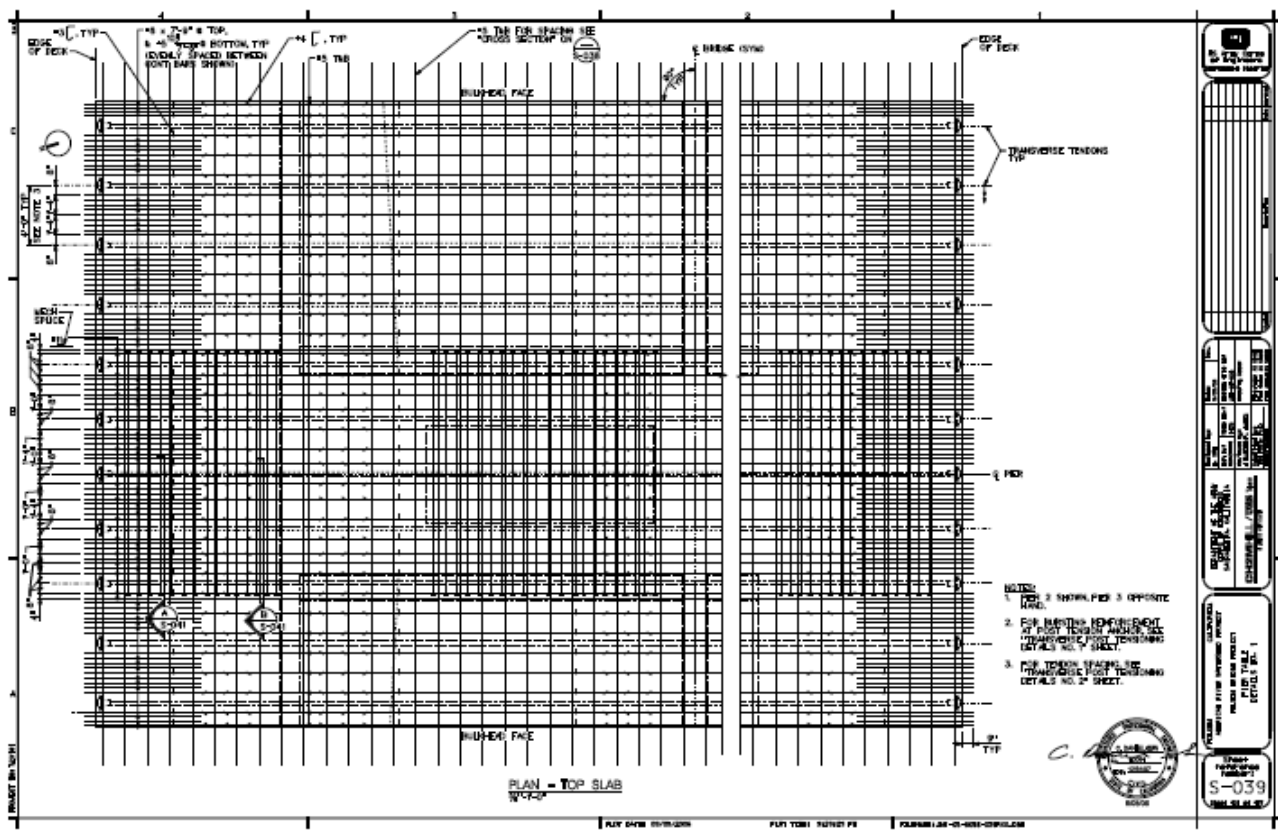
# Generating Integrated Drawings





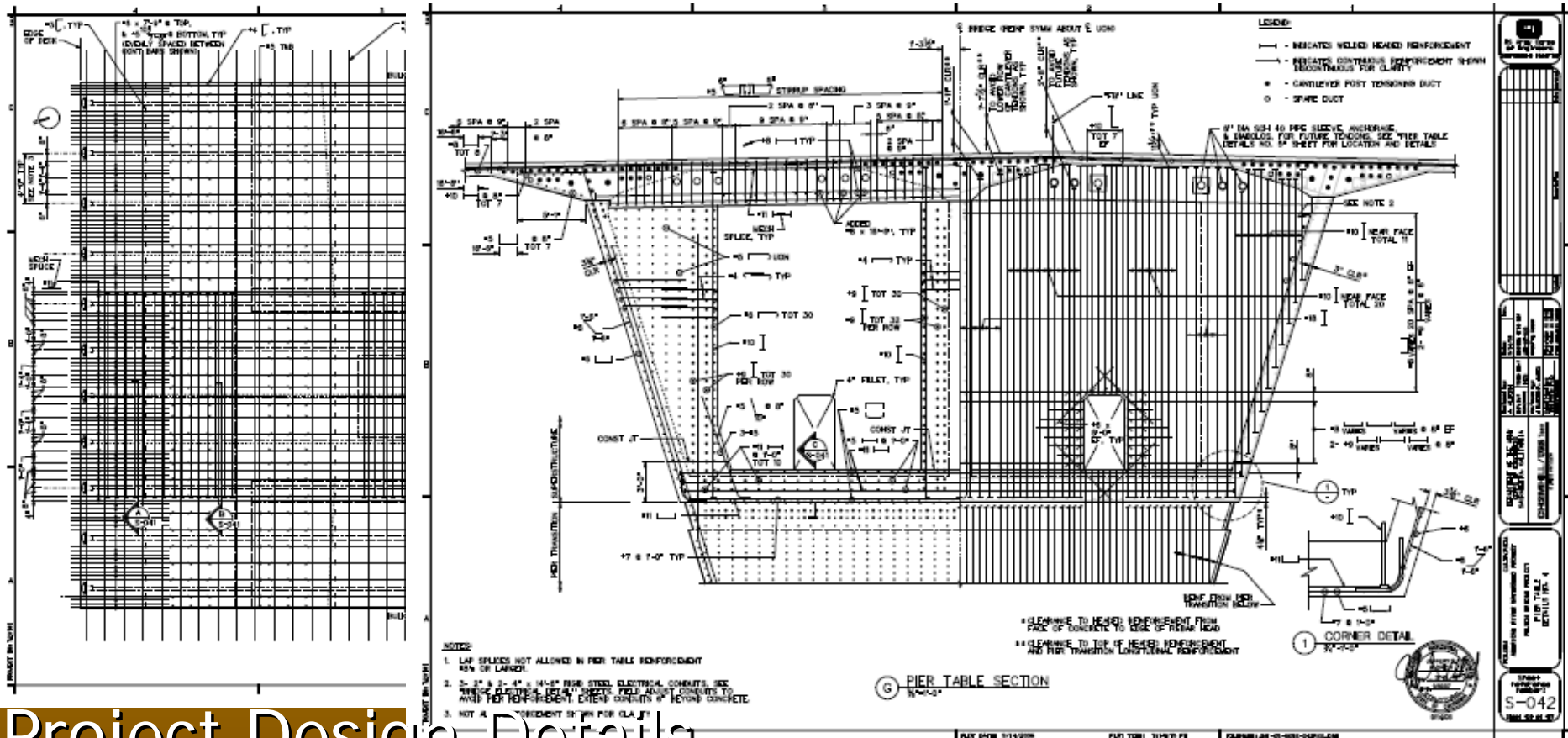
Project Design Details  
Modeled

Tendon Anchorage at Pier  
Table



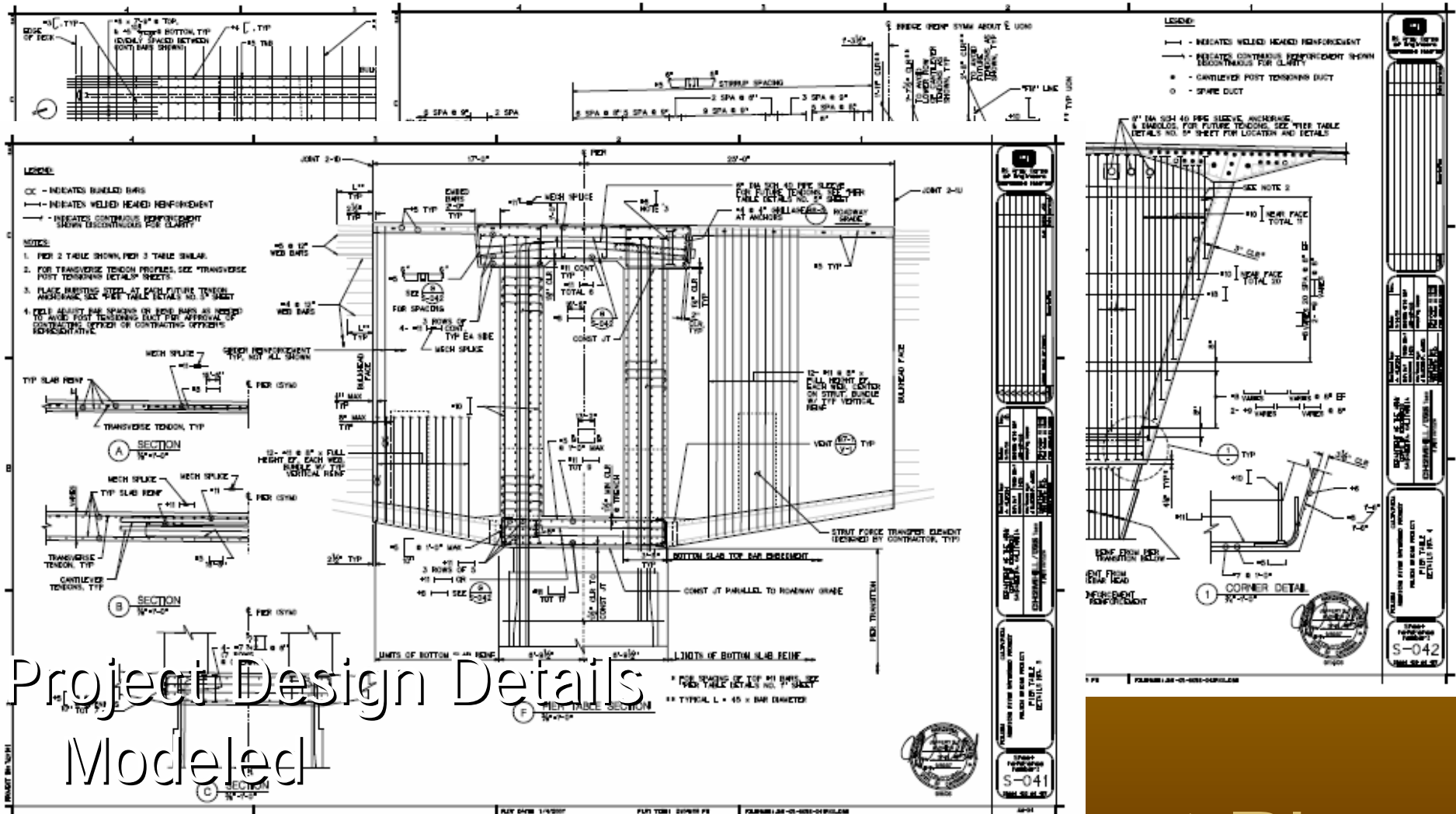
Project Design Details  
Modeled

Tendon Anchorage at Pier  
Table



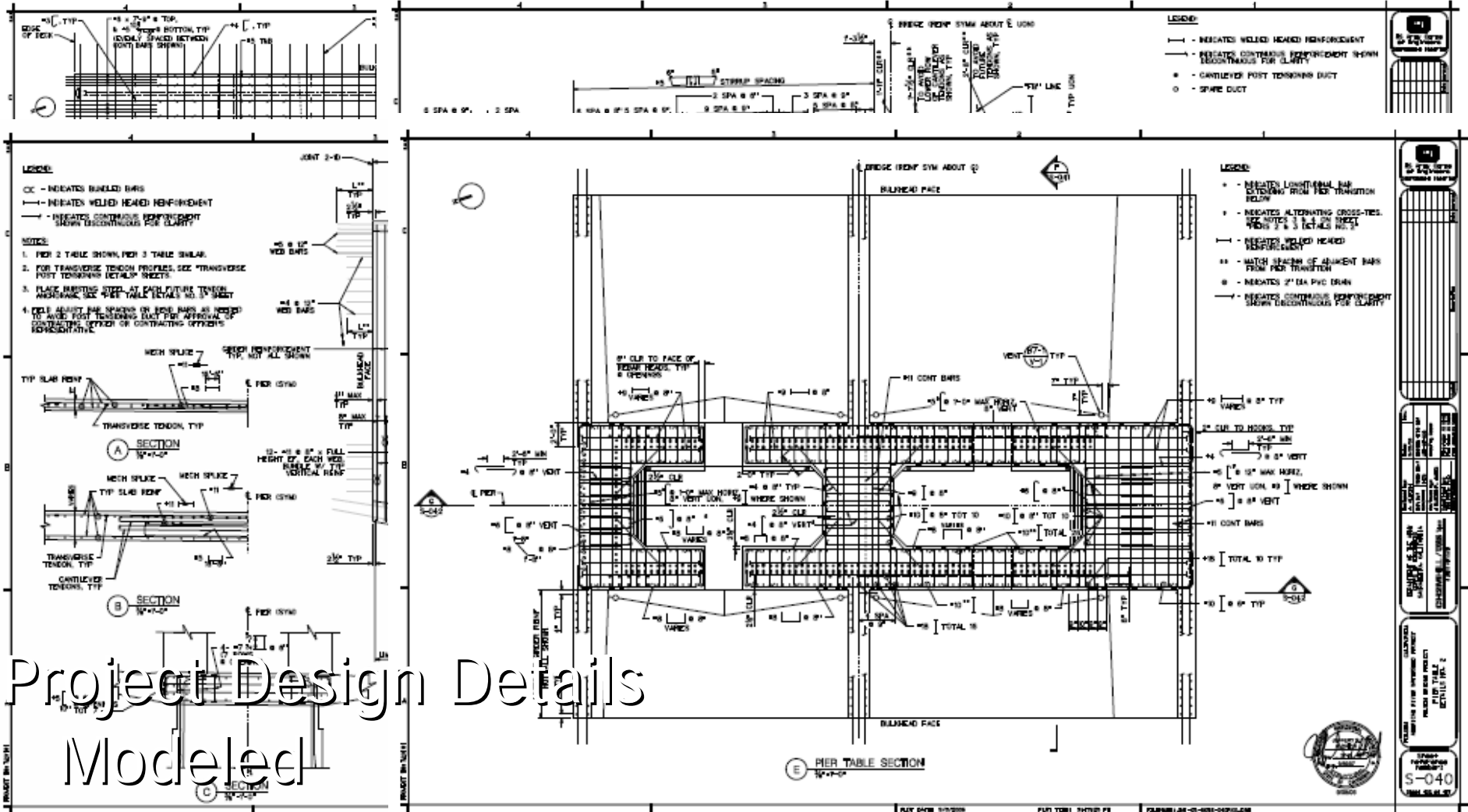
# Project Design Details Modeled

# Tendon Anchorage at Pier Table



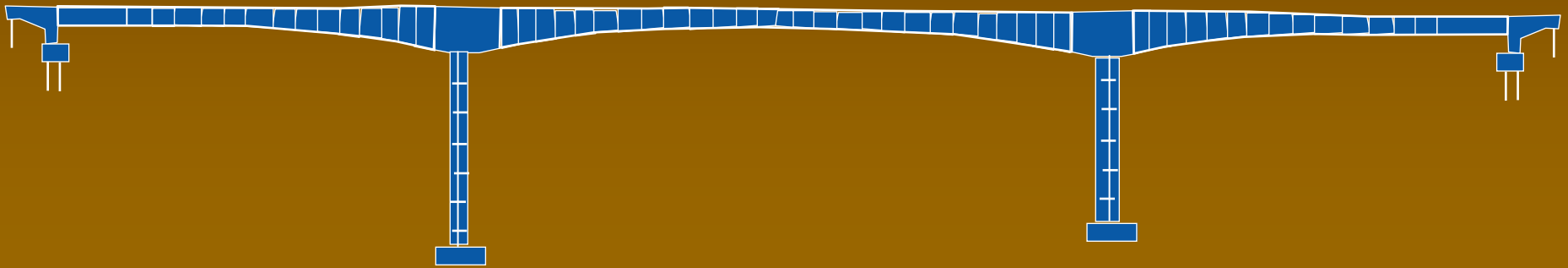
Project Design Details  
 Modeled

# Tendon Anchorage at Pier Table



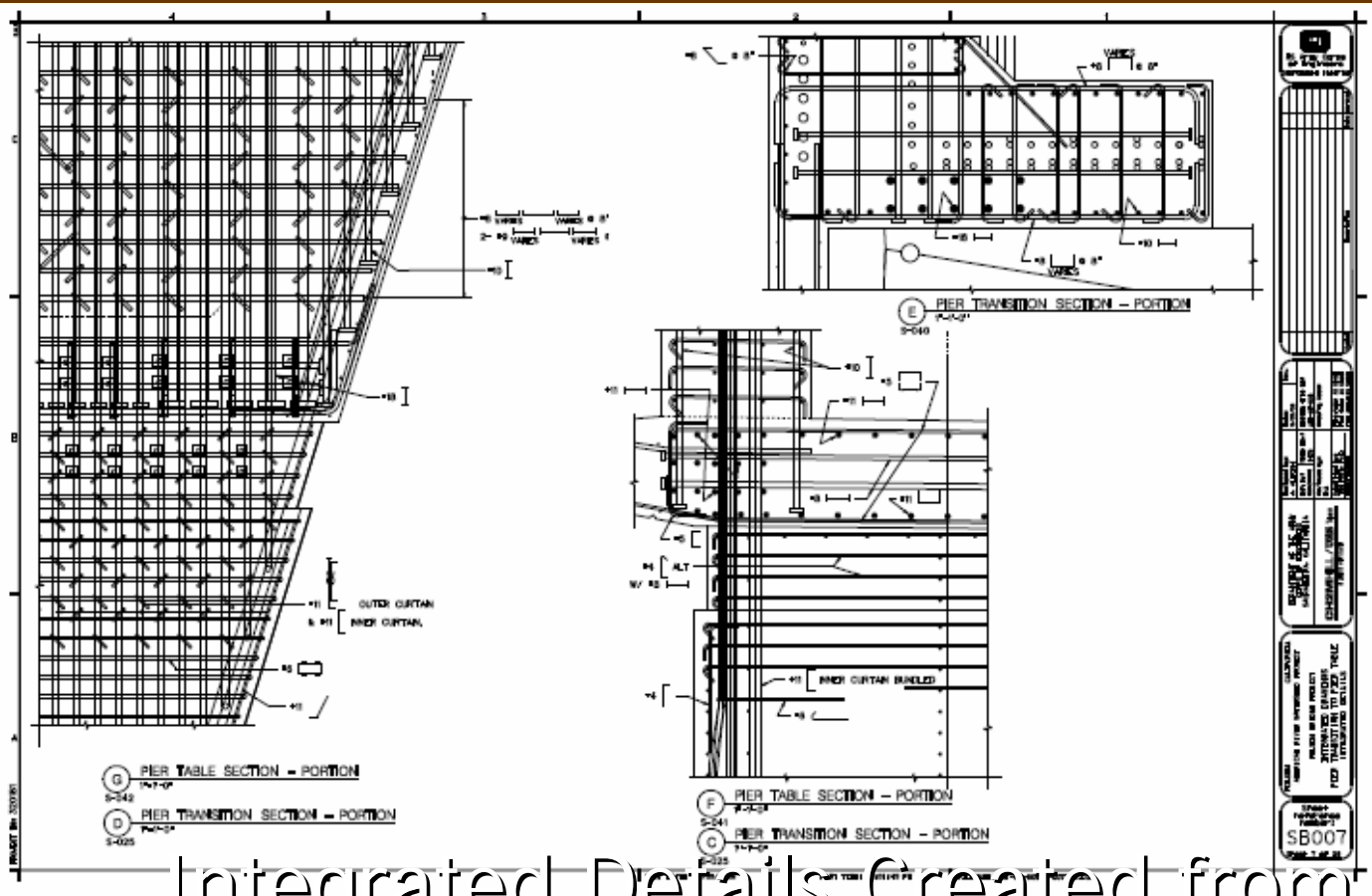
Project Design Details  
Modeled

# Tendon Anchorage at Pier Table



Integrated Details Created from  
Models

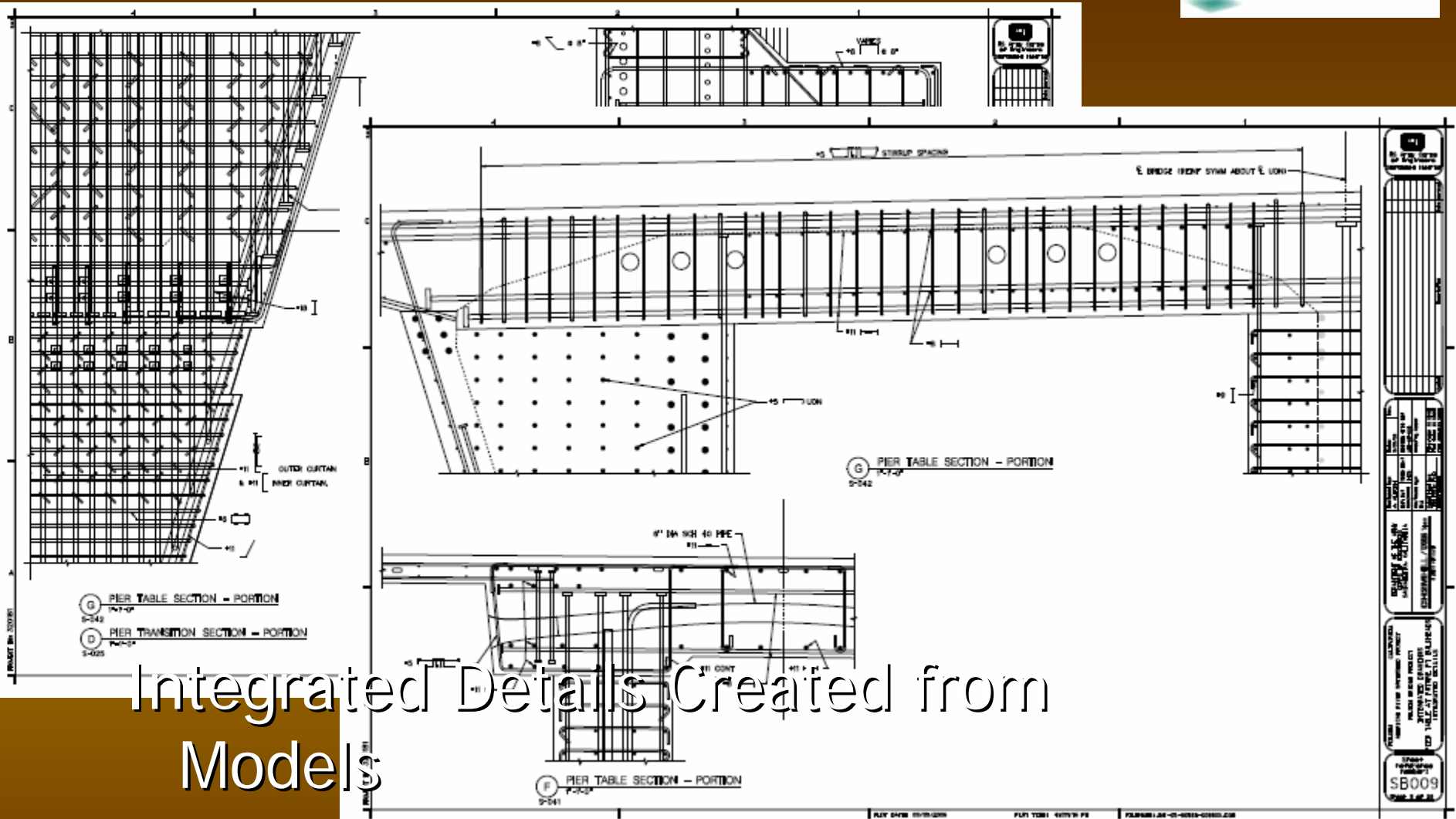
Tendon Anchorage at Pier  
Table



Integrated Details Created from Models

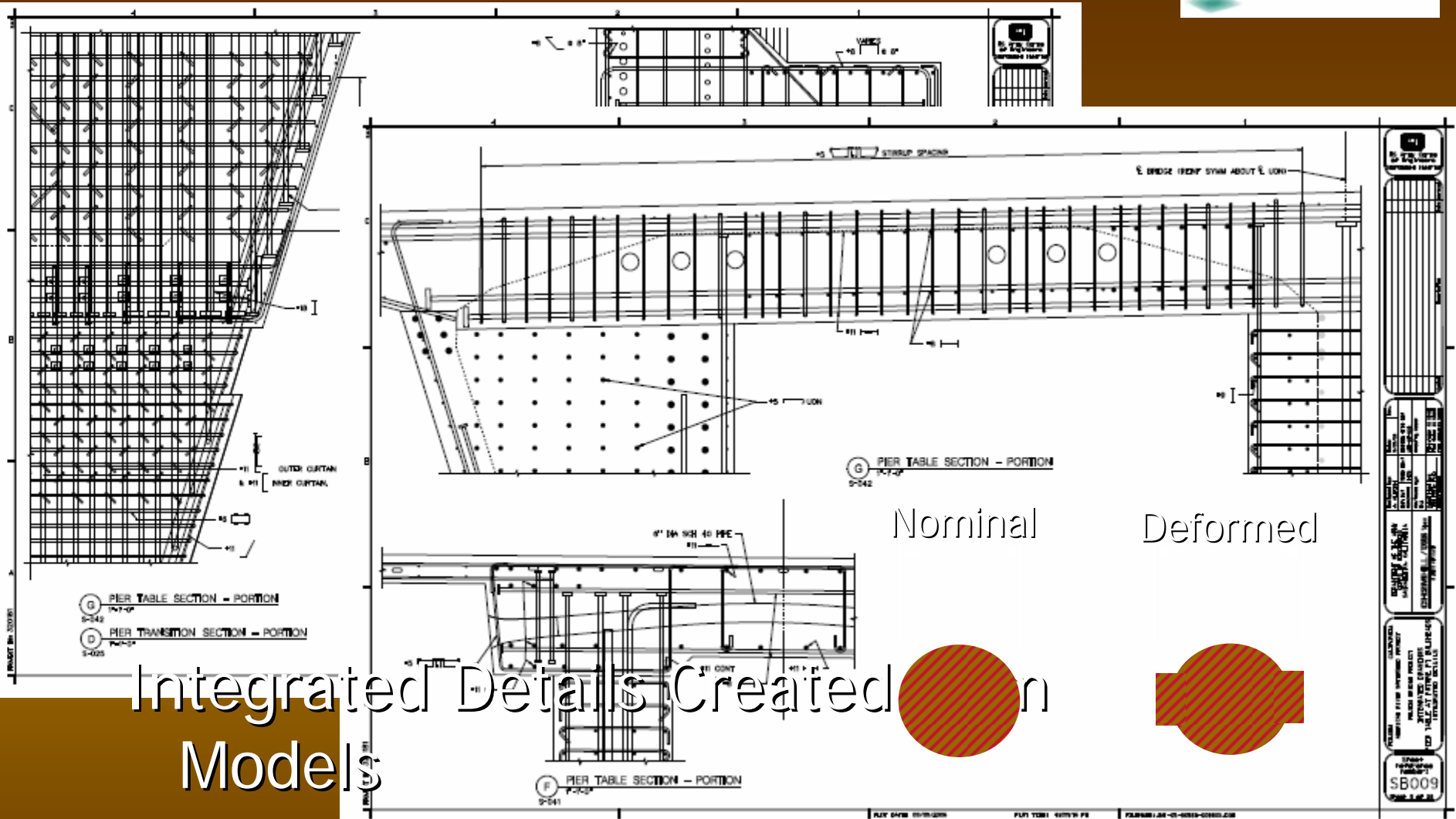
Tendon Anchorage at Pier Table





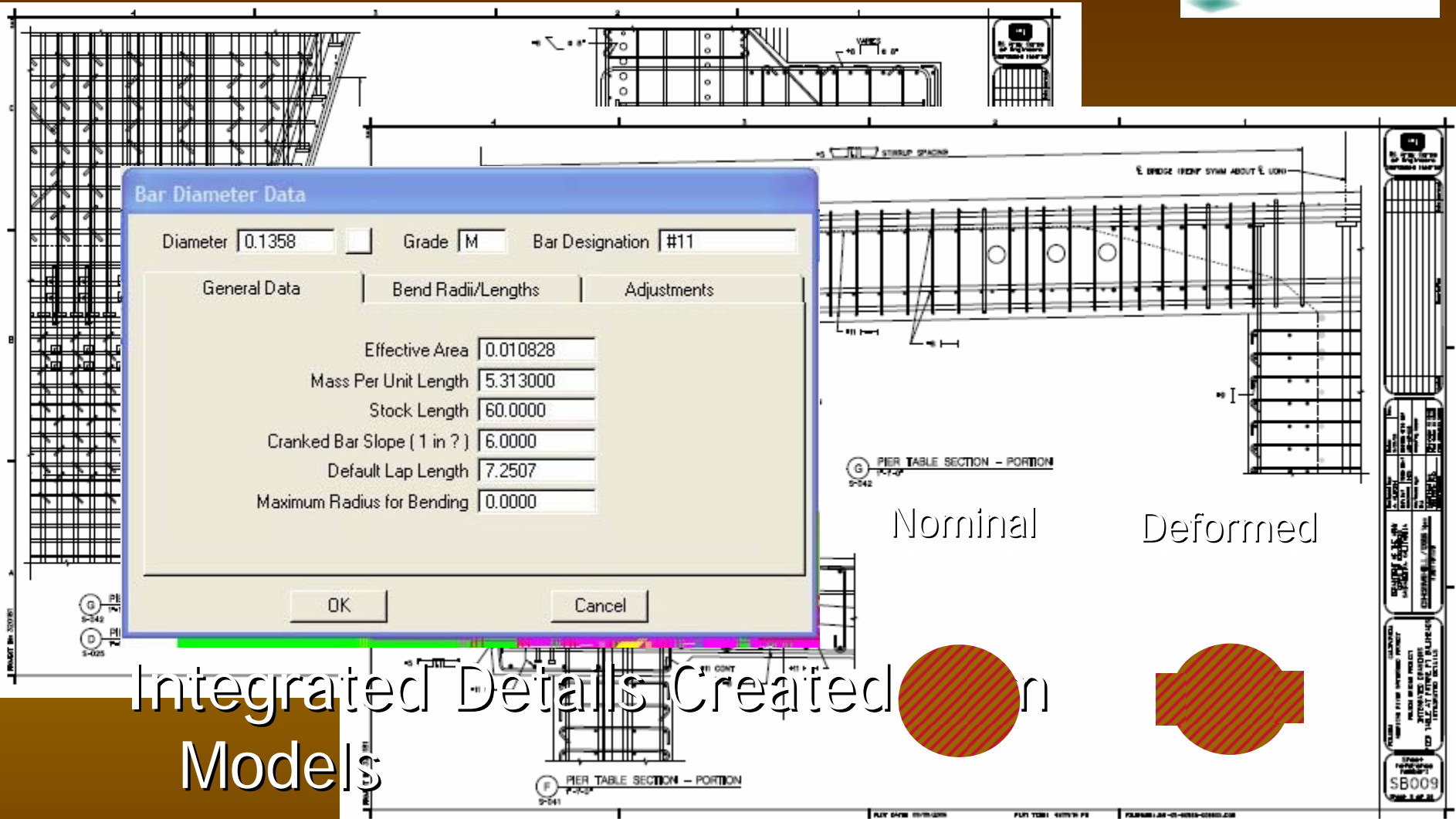
Integrated Details Created from Models

# Tendon Anchorage at Pier Table



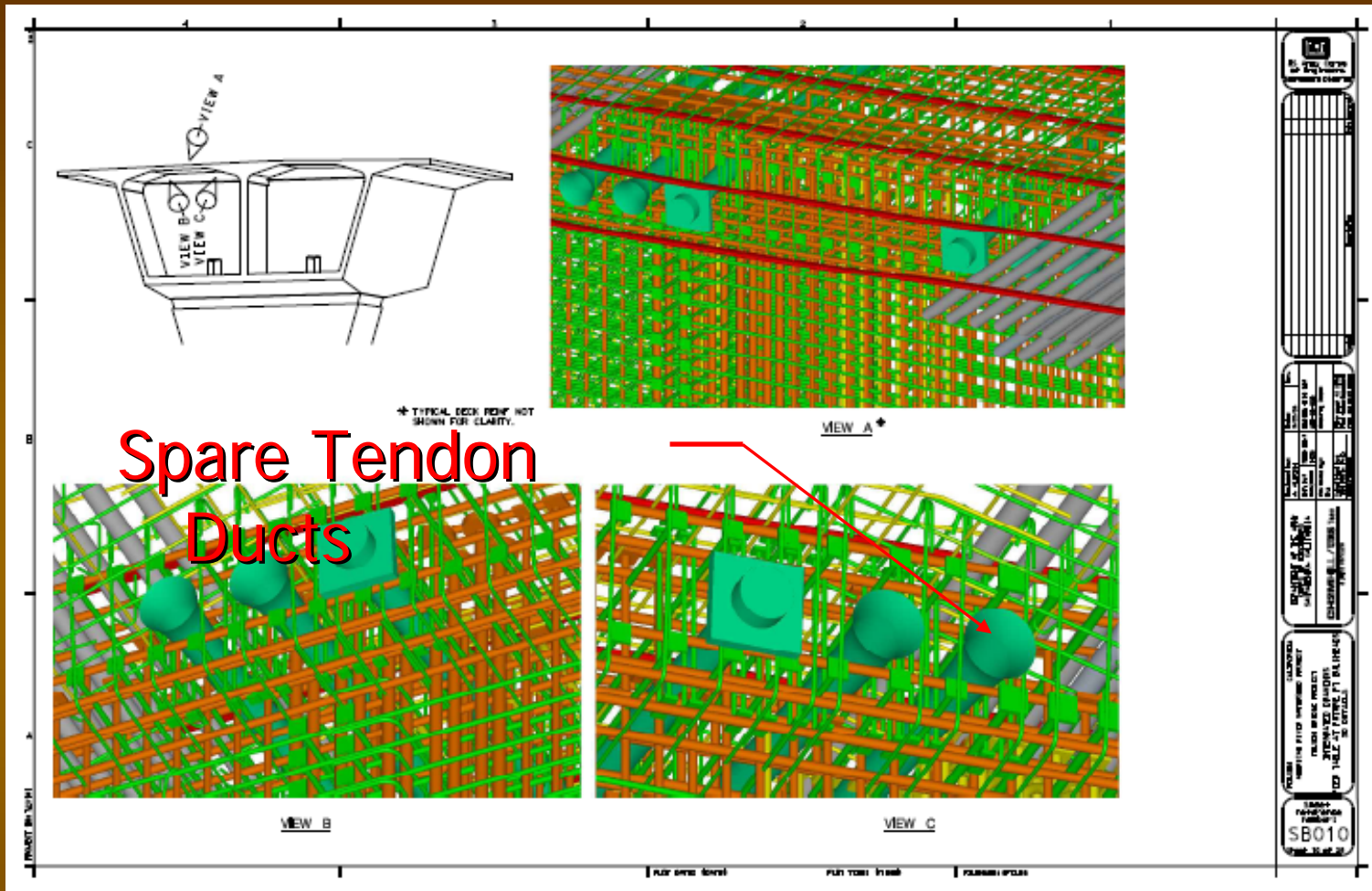
Integrated Details Created on Models

# Tendon Anchorage at Pier Table



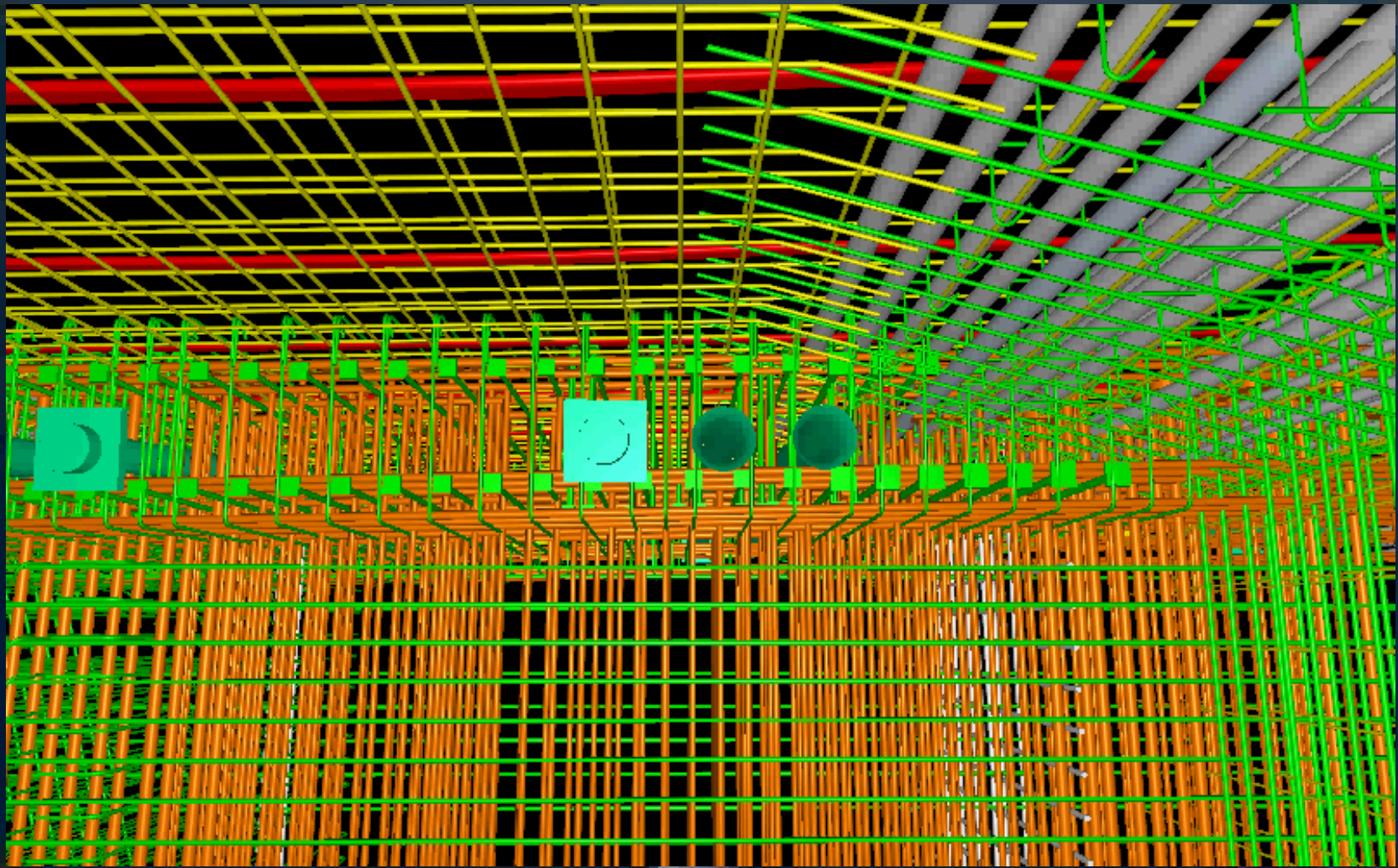
Integrated Details Created on Models

# Tendon Anchorage at Pier Table



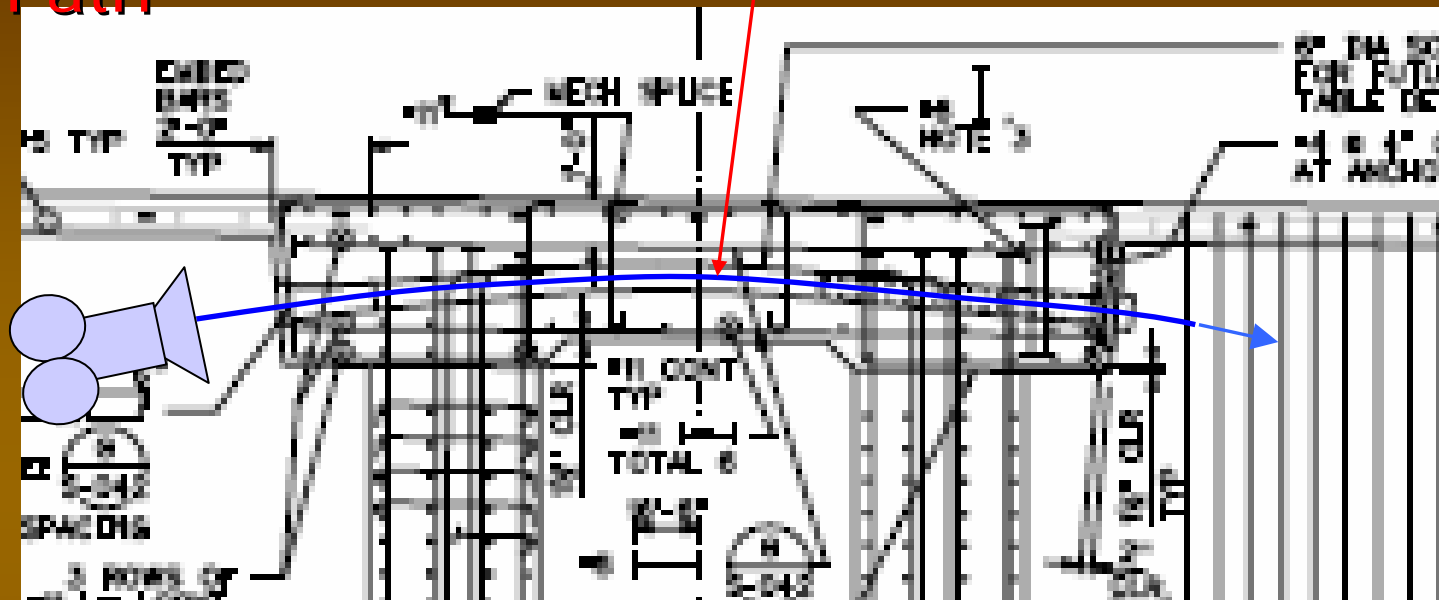
Models

# Tendon Anchorage at Pier Table

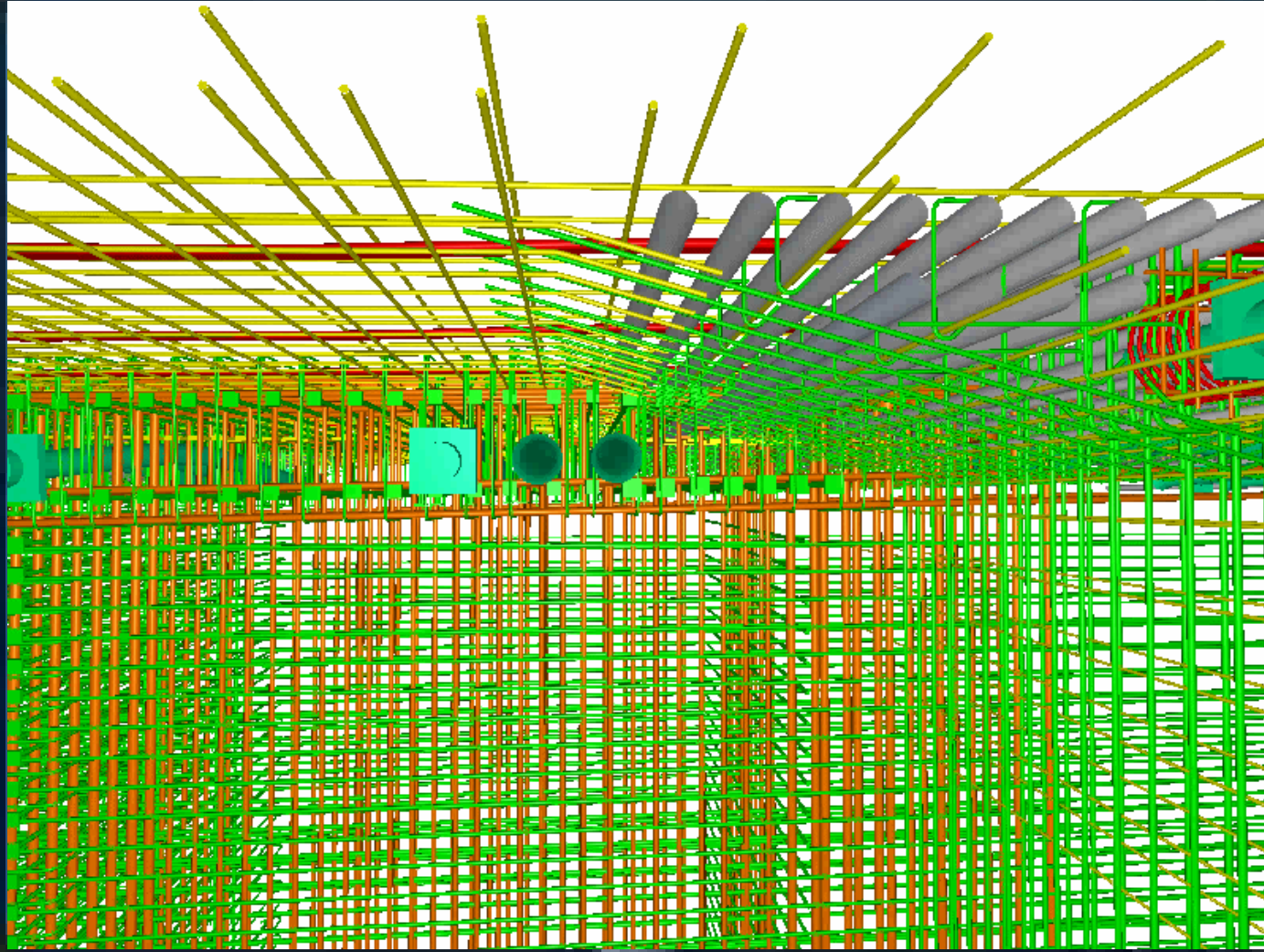


3D Video created from Integrated 3D  
Tendon Anchorage at Pier  
Details  
Table

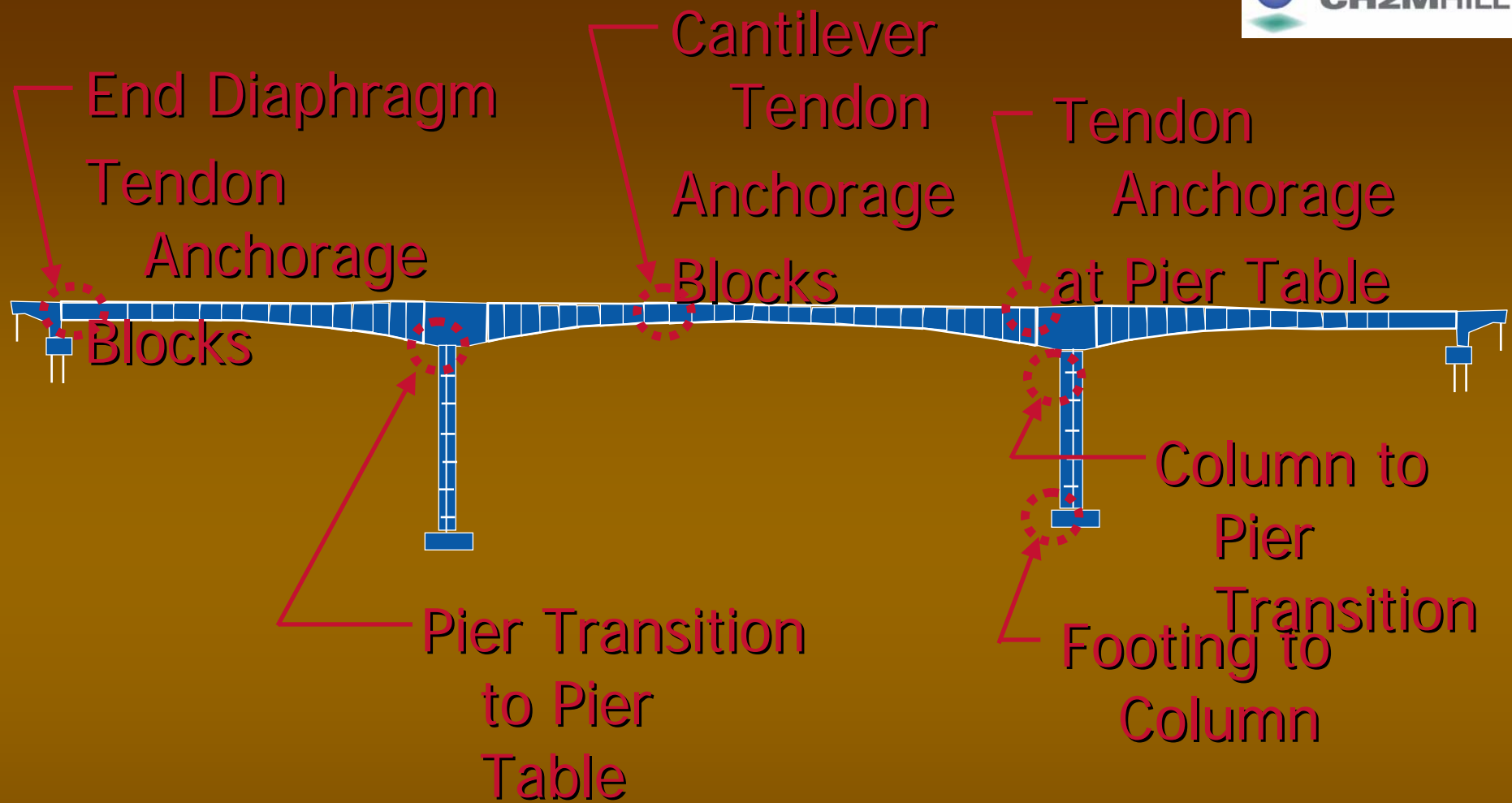
## Spare Tendon Ducts Path



Project Design Details  
Modeled  
Thru-Tendon Ducts  
Camera Anchorage Path

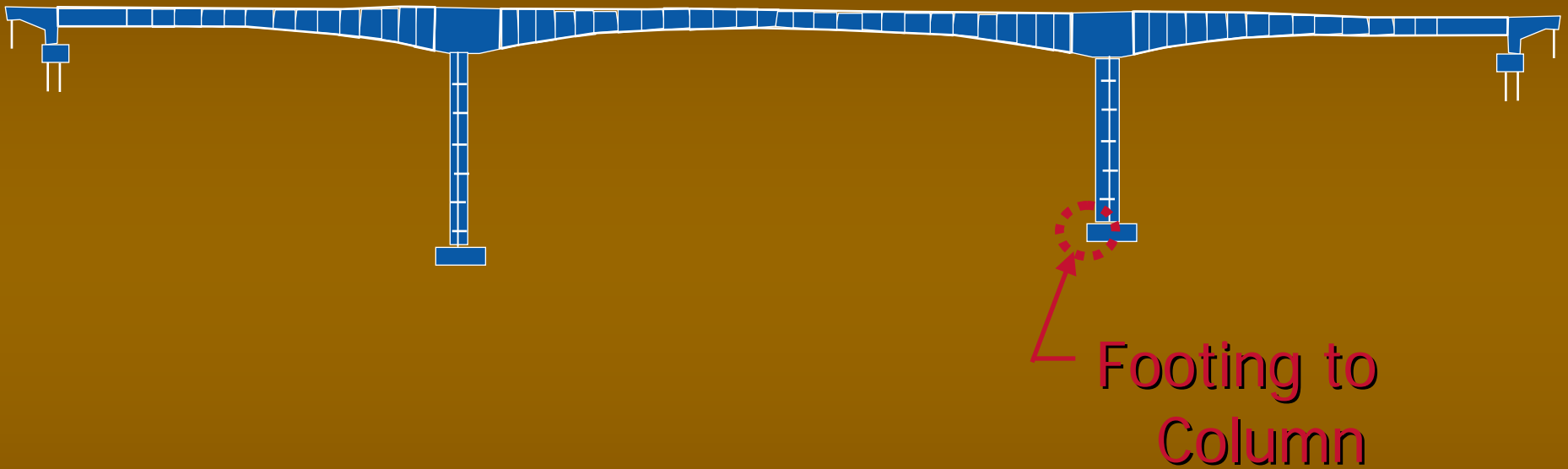


3D Video from a New  
Tendon Anchorage at Pier  
Perspective  
Table

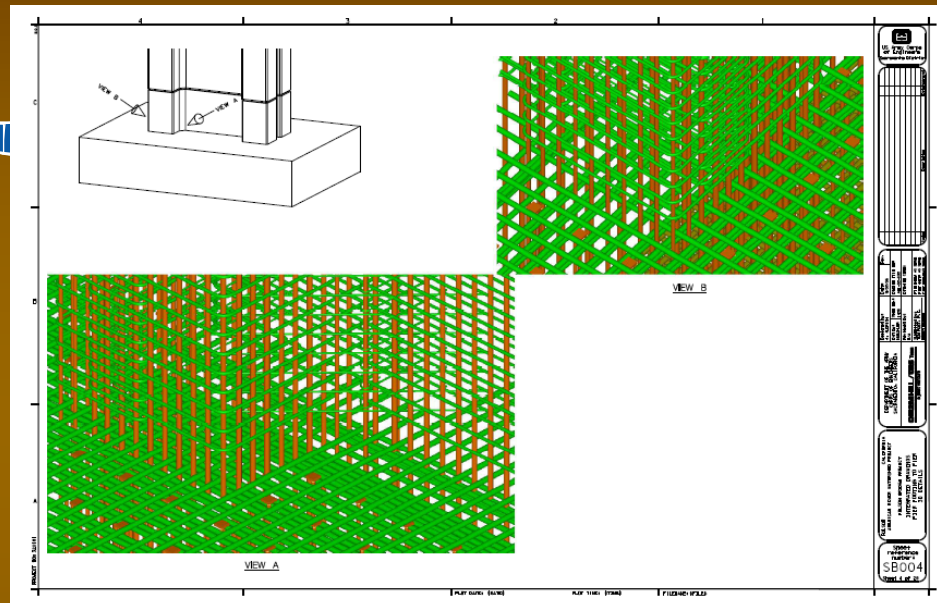


# INTEGRATED DETAIL LOCATIONS



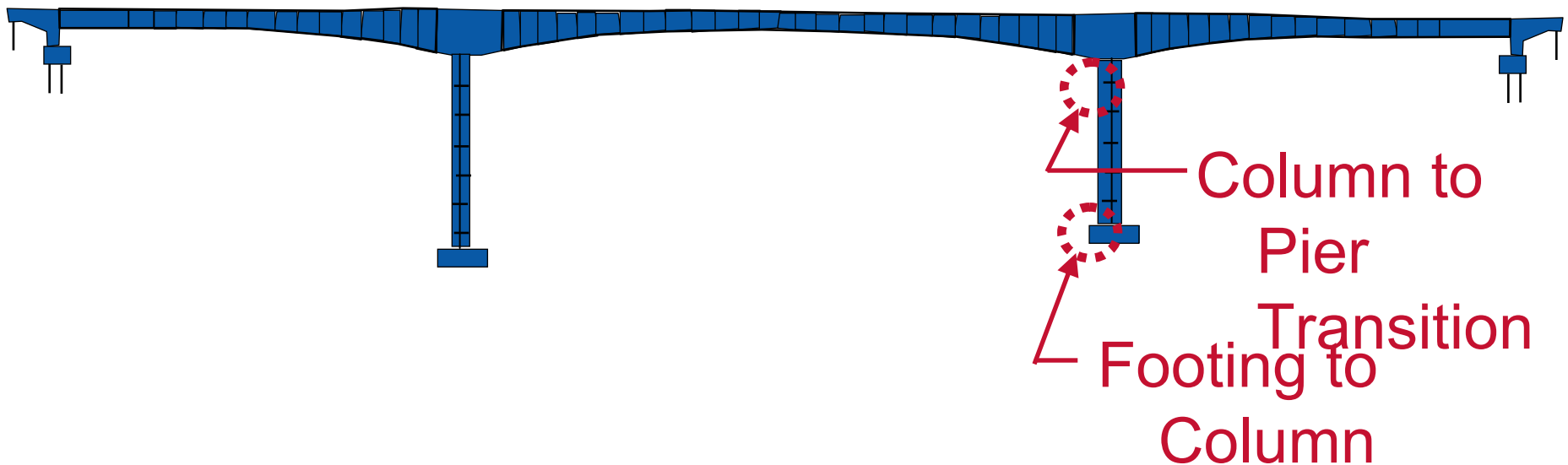


# INTEGRATED DETAIL LOCATIONS

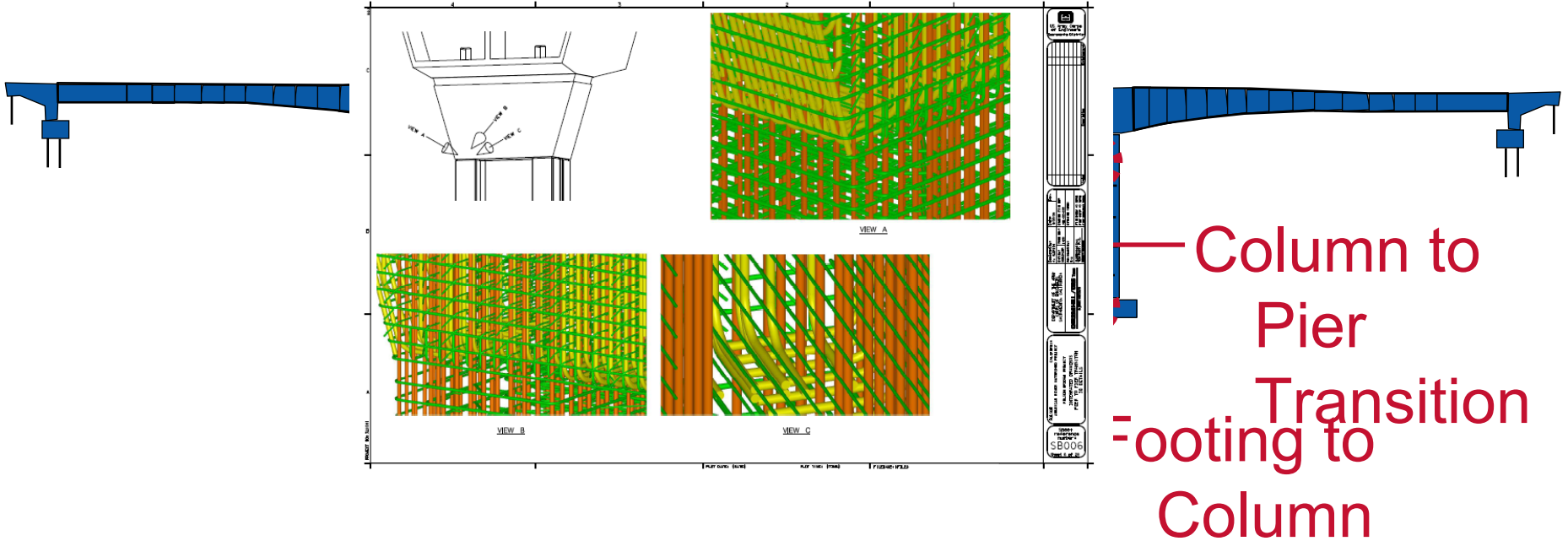


ooting to  
Column

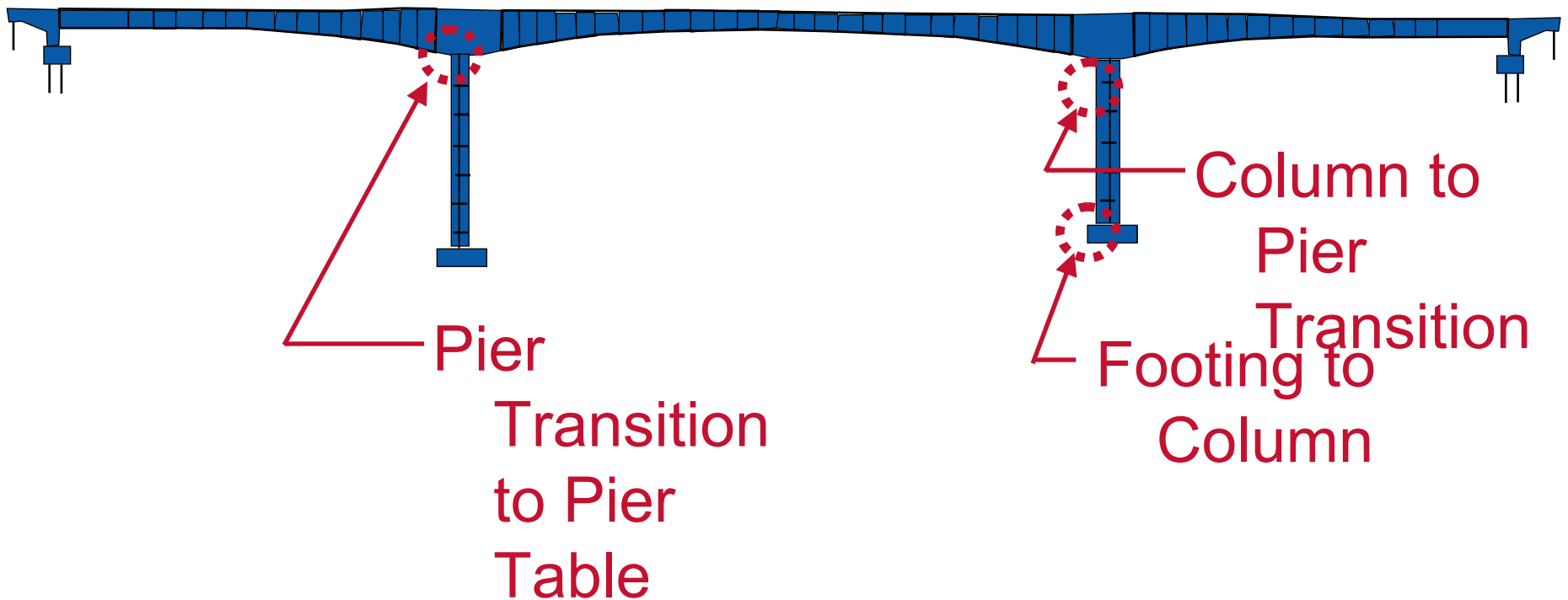
# INTEGRATED DETAIL LOCATIONS



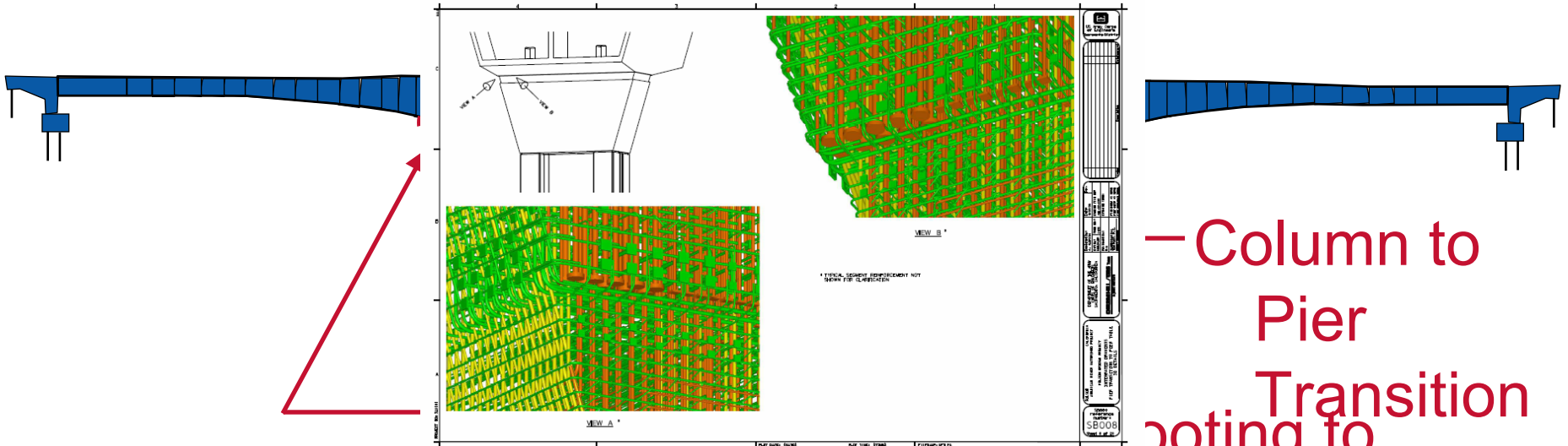
# INTEGRATED DETAIL LOCATIONS



# INTEGRATED DETAIL LOCATIONS



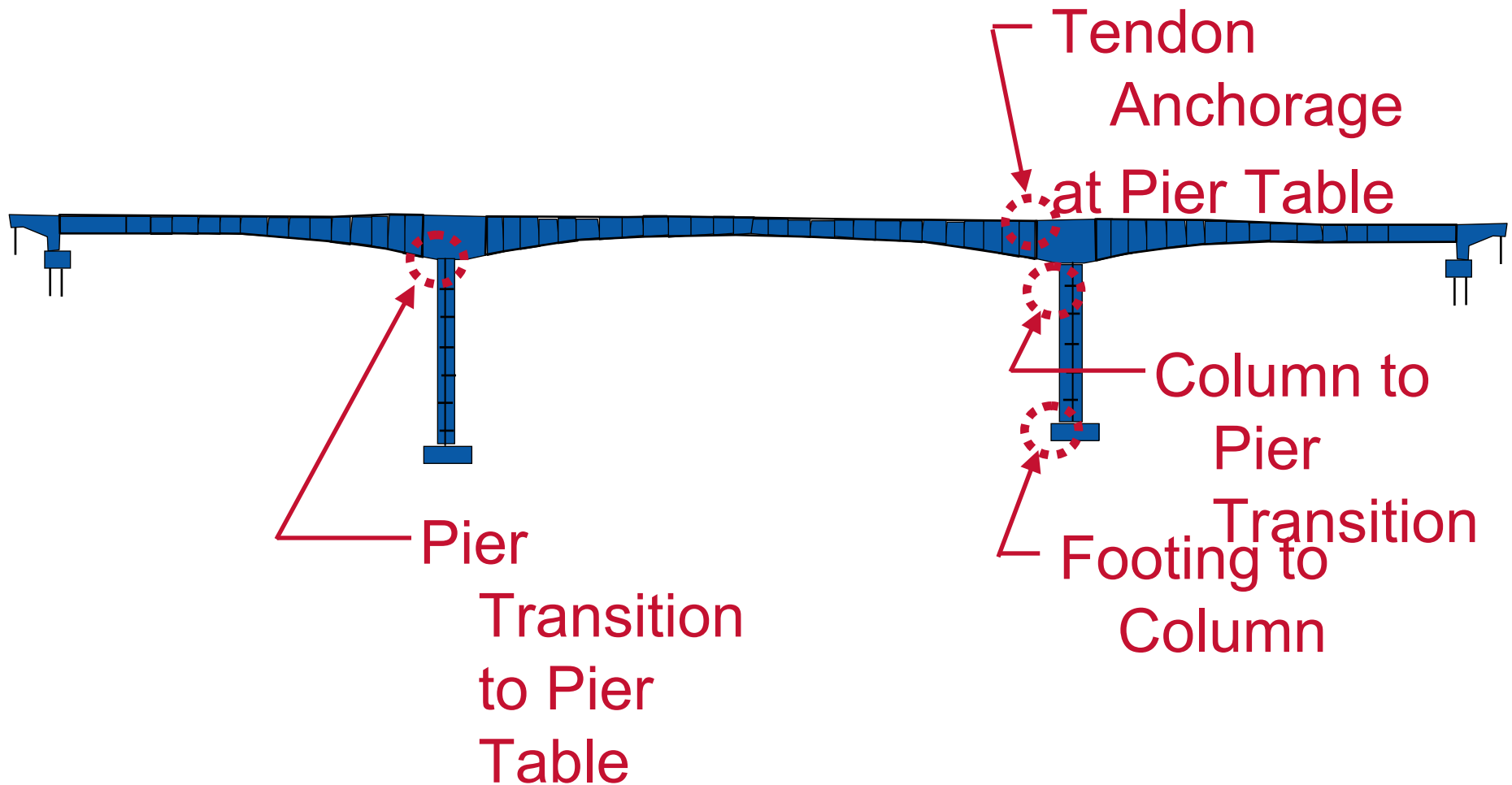
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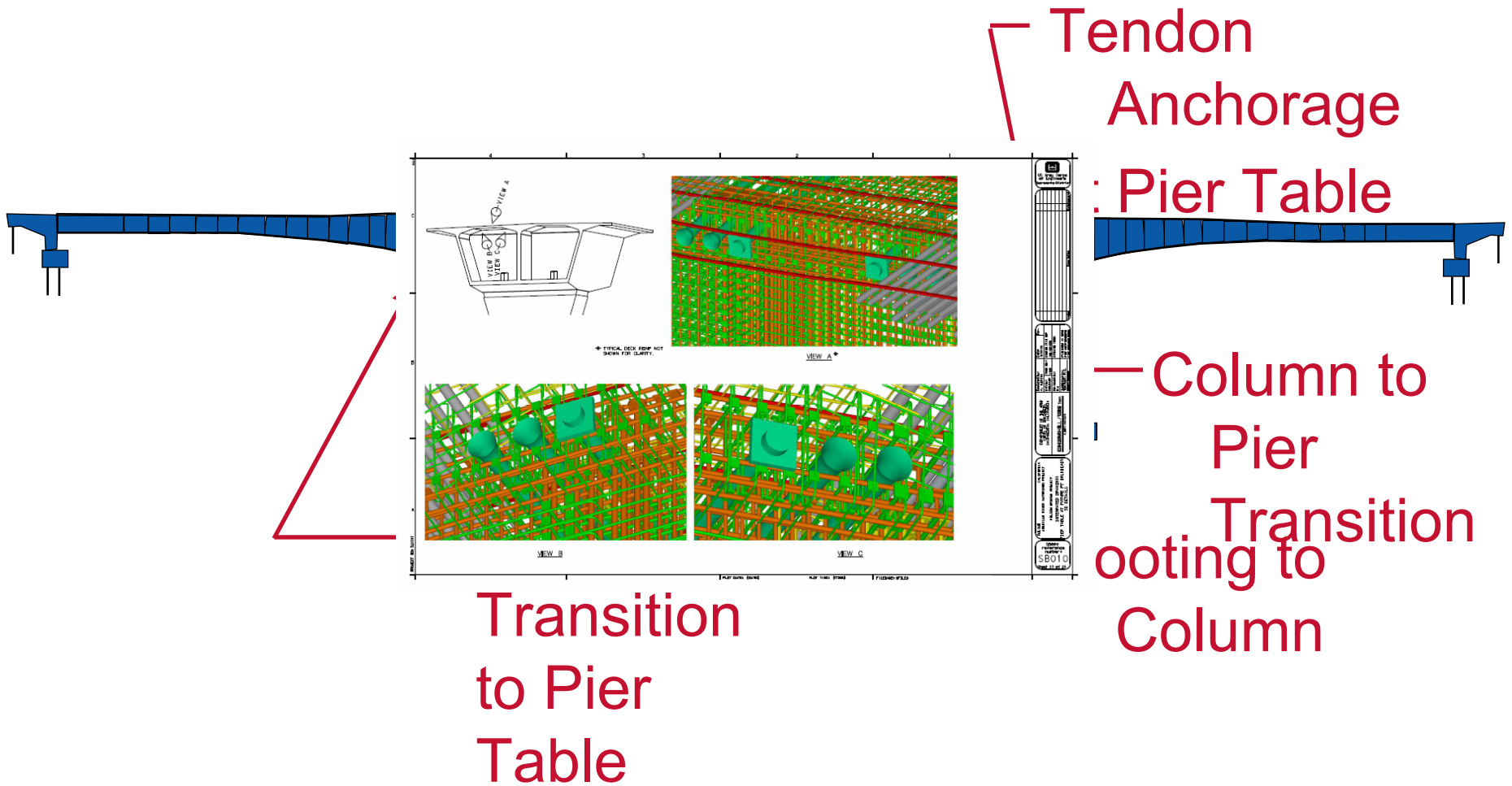
Transition  
to Pier  
Table

– Column to  
Pier  
Transition  
Detailing to  
Column

# INTEGRATED DETAIL LOCATIONS

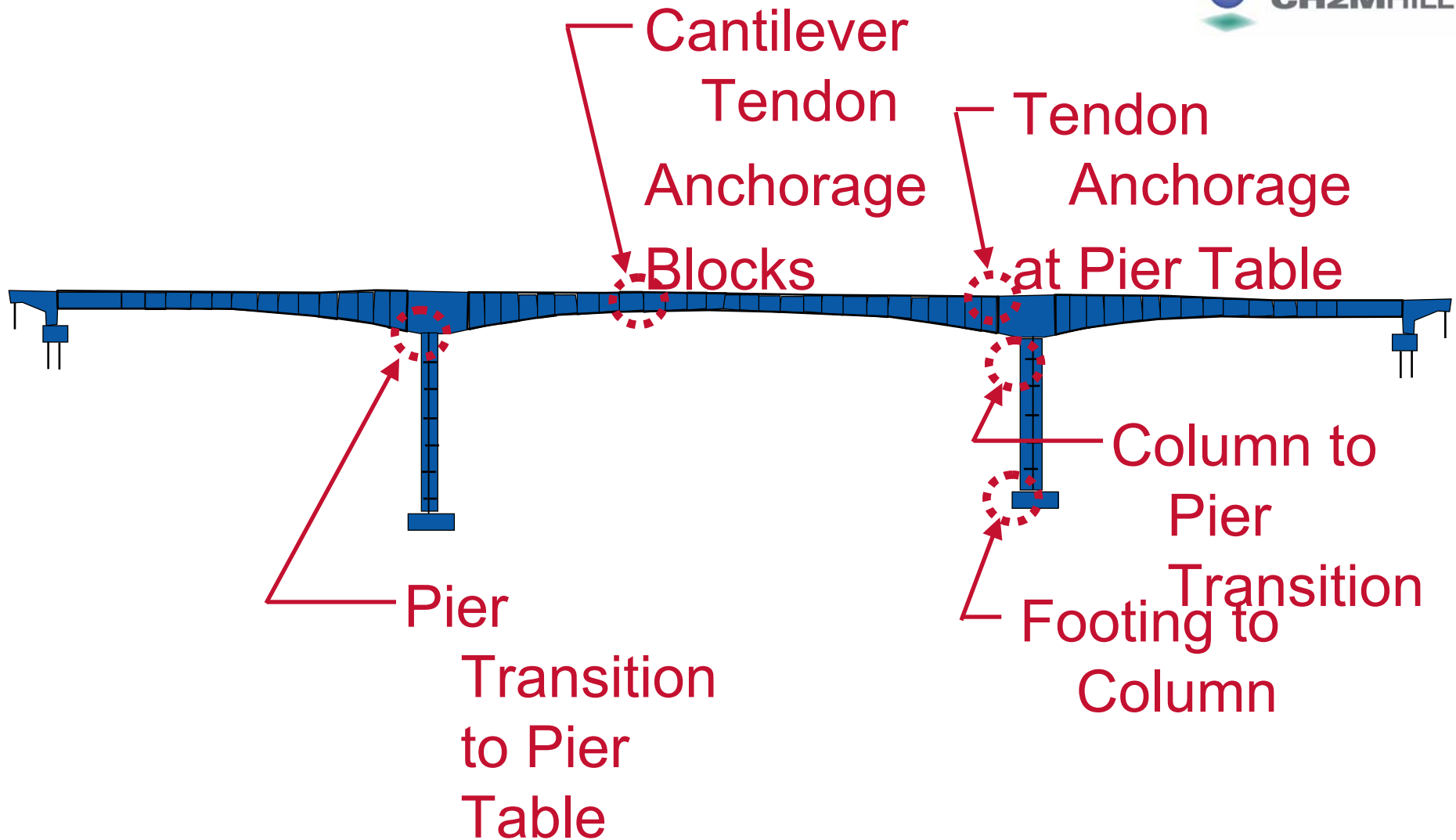


# INTEGRATED DETAIL LOCATIONS



# INTEGRATED DETAIL LOCATIONS



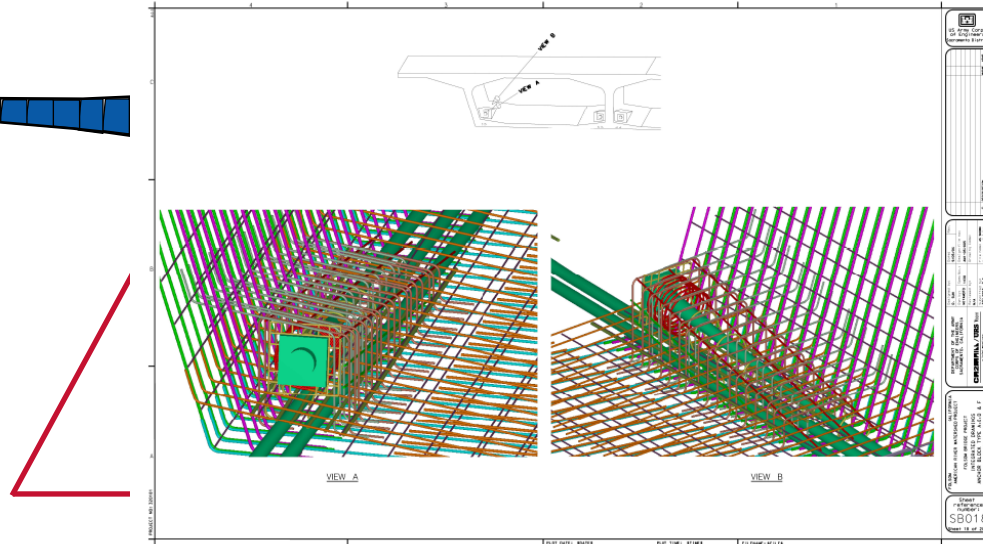
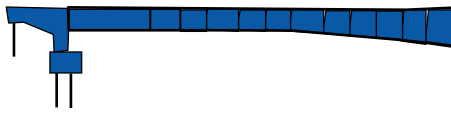


# INTEGRATED DETAIL LOCATIONS

Cantilever  
Tendon  
Anchorage

Tendon  
Anchorage

Pier Table

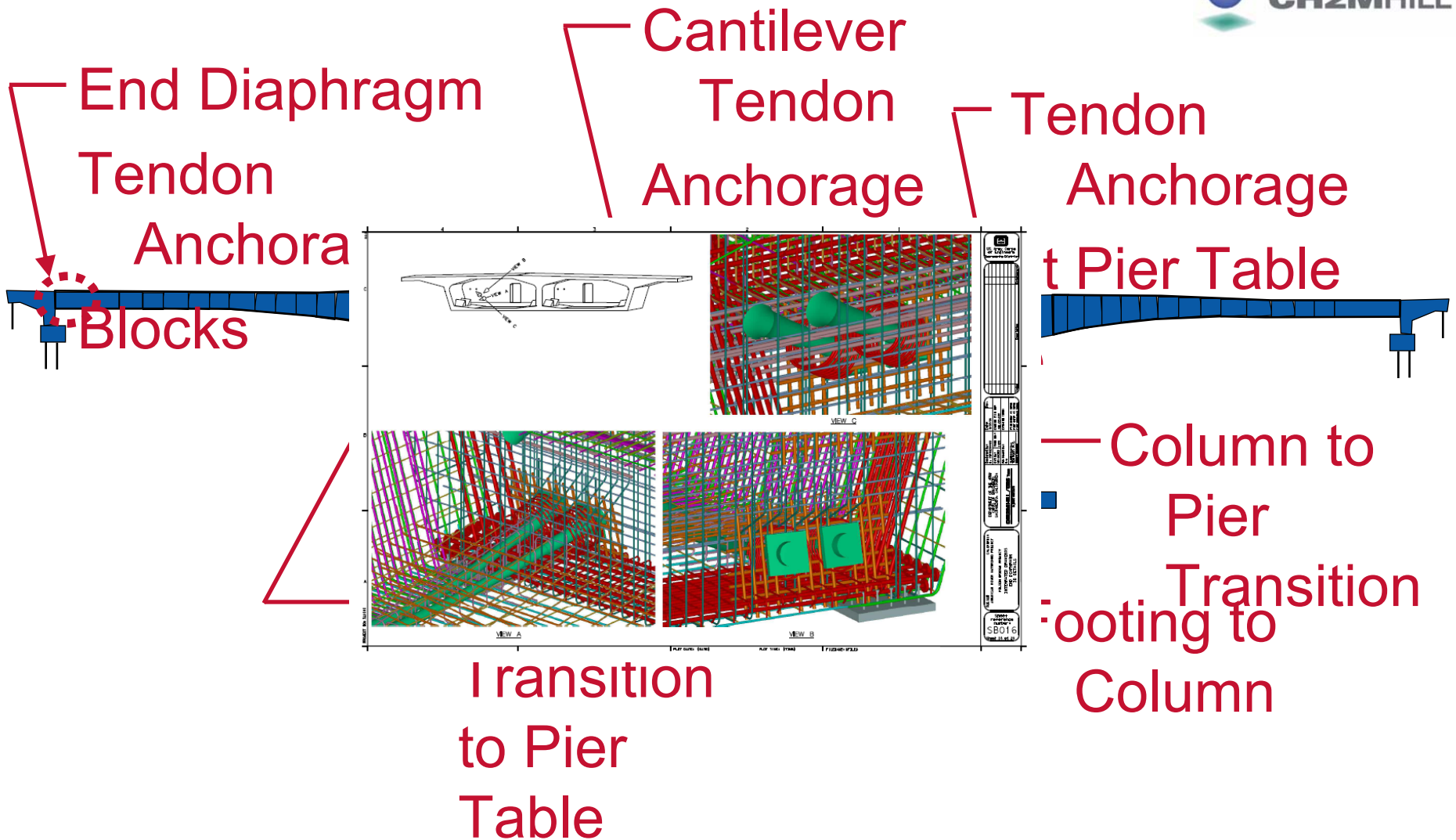


Column to  
Pier  
Transition  
rooting to  
Column

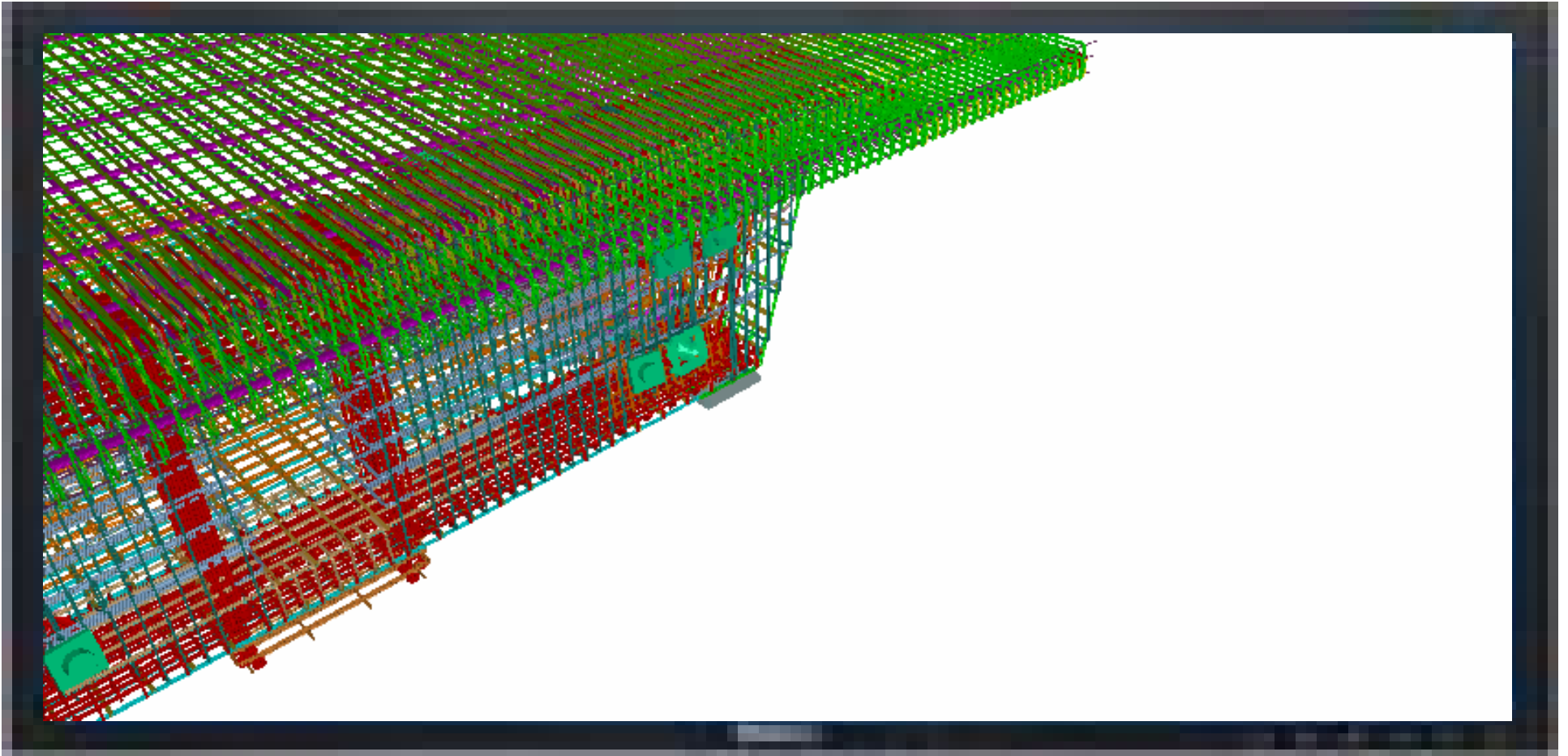
Transition  
to Pier  
Table

# INTEGRATED DETAIL LOCATIONS

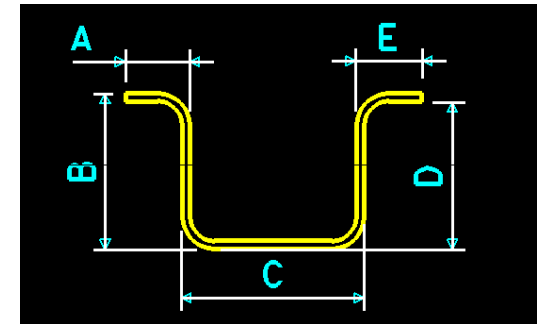
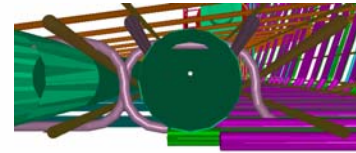
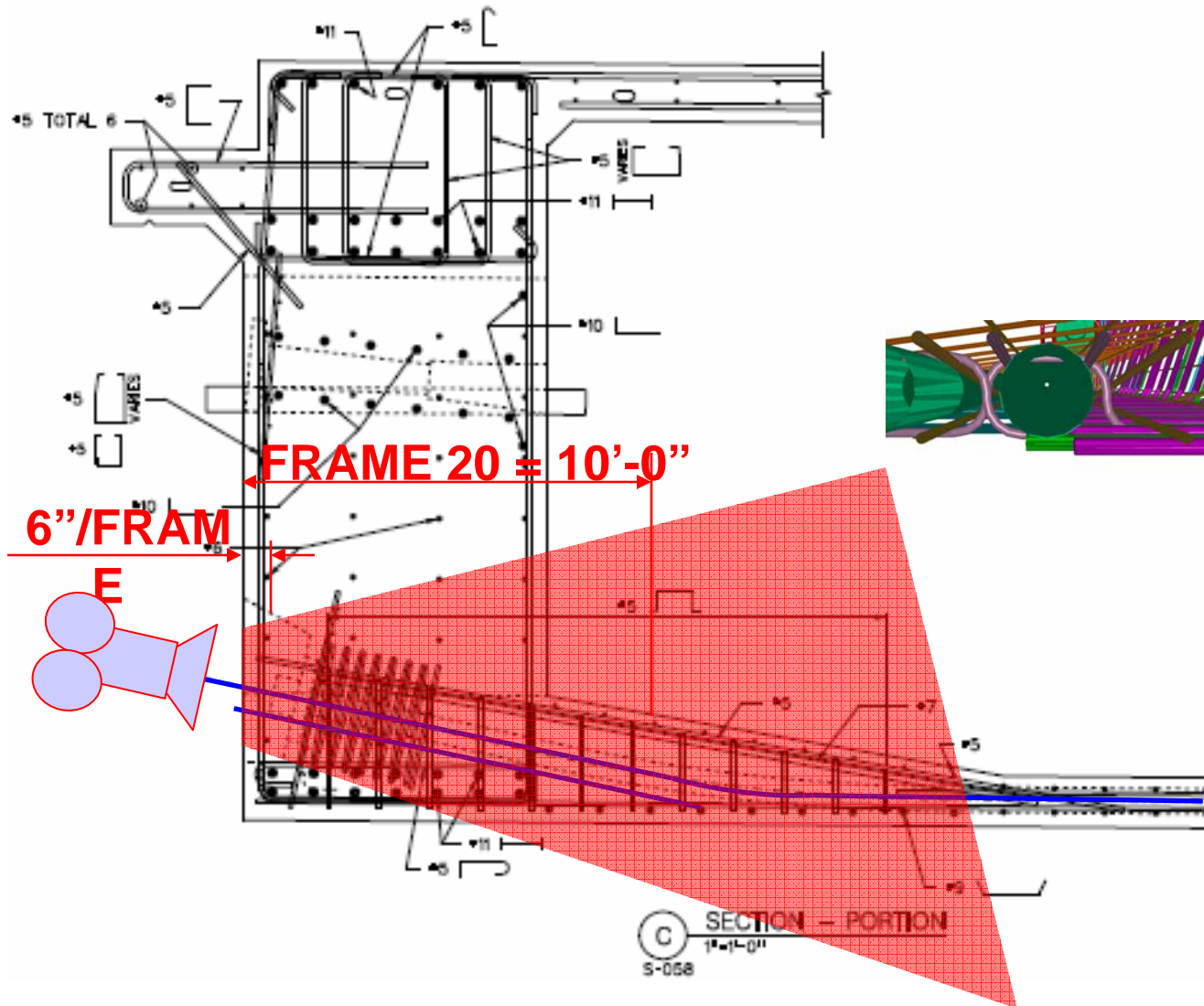




# INTEGRATED DETAIL LOCATIONS



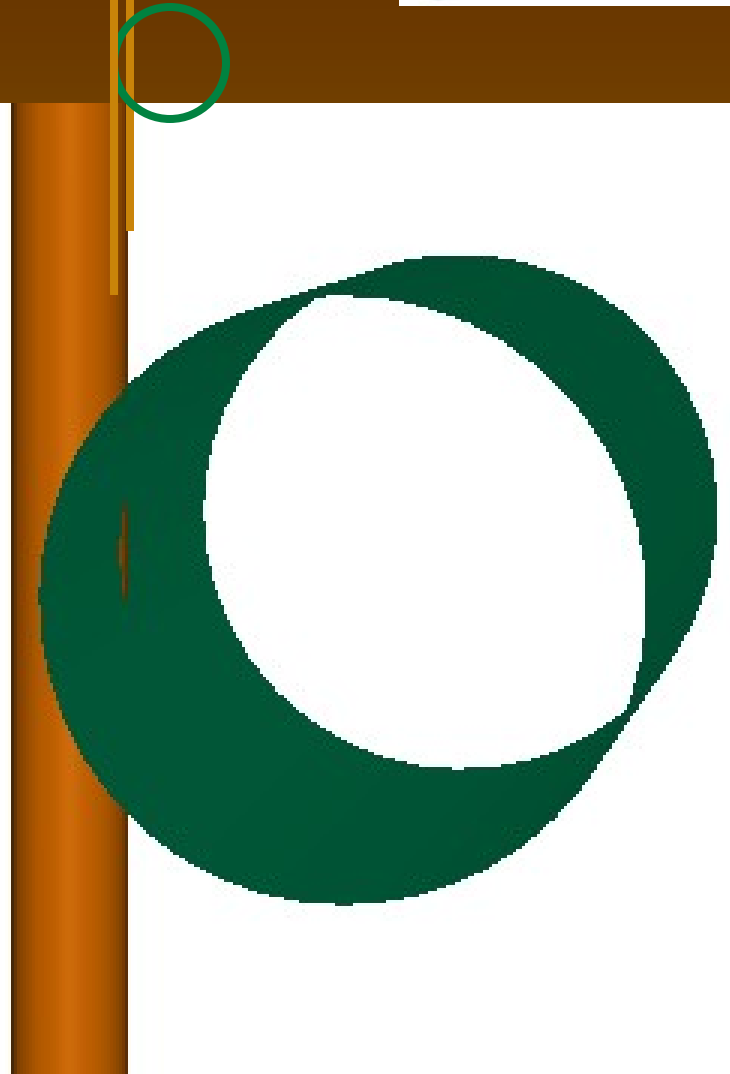
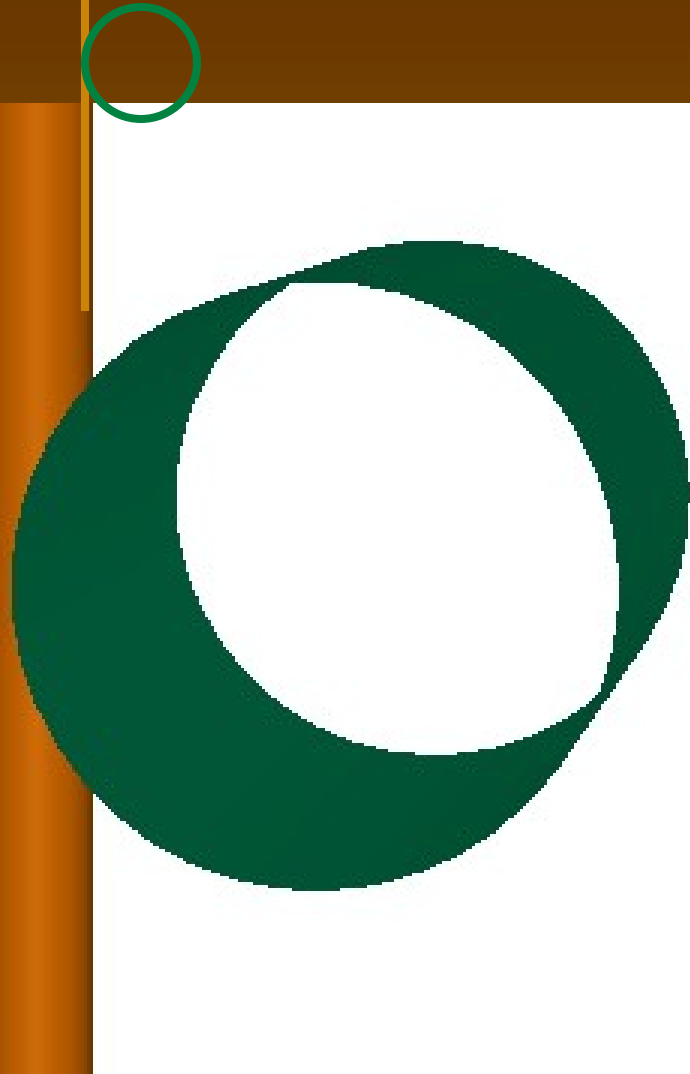
3D Video from a New  
End Diaphragm Anchorage



# Locating Bar in Conflict End Diaphragm Anchorage

0.000' Offset

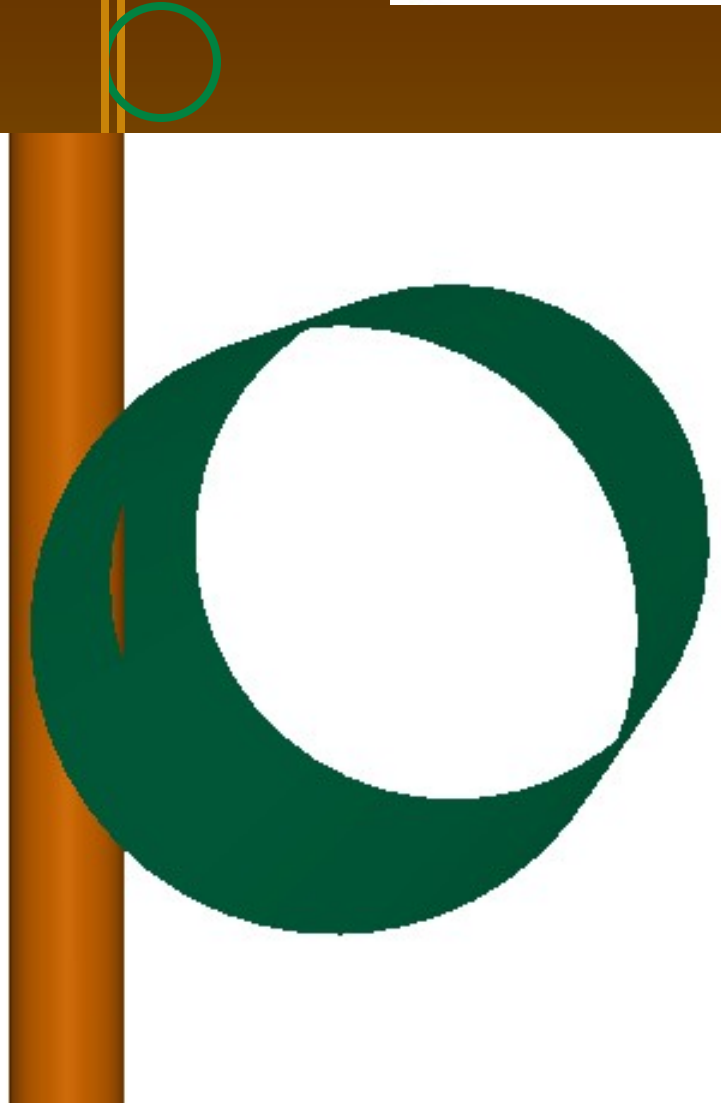
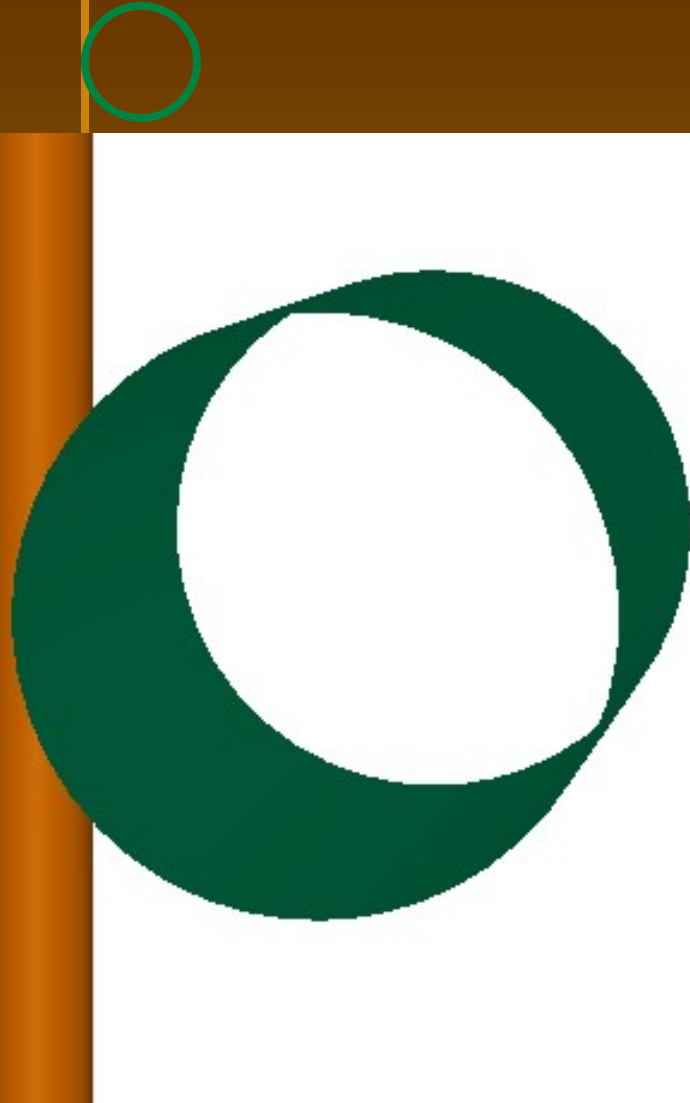
0.005' Offset



Accuracy of 3D Images

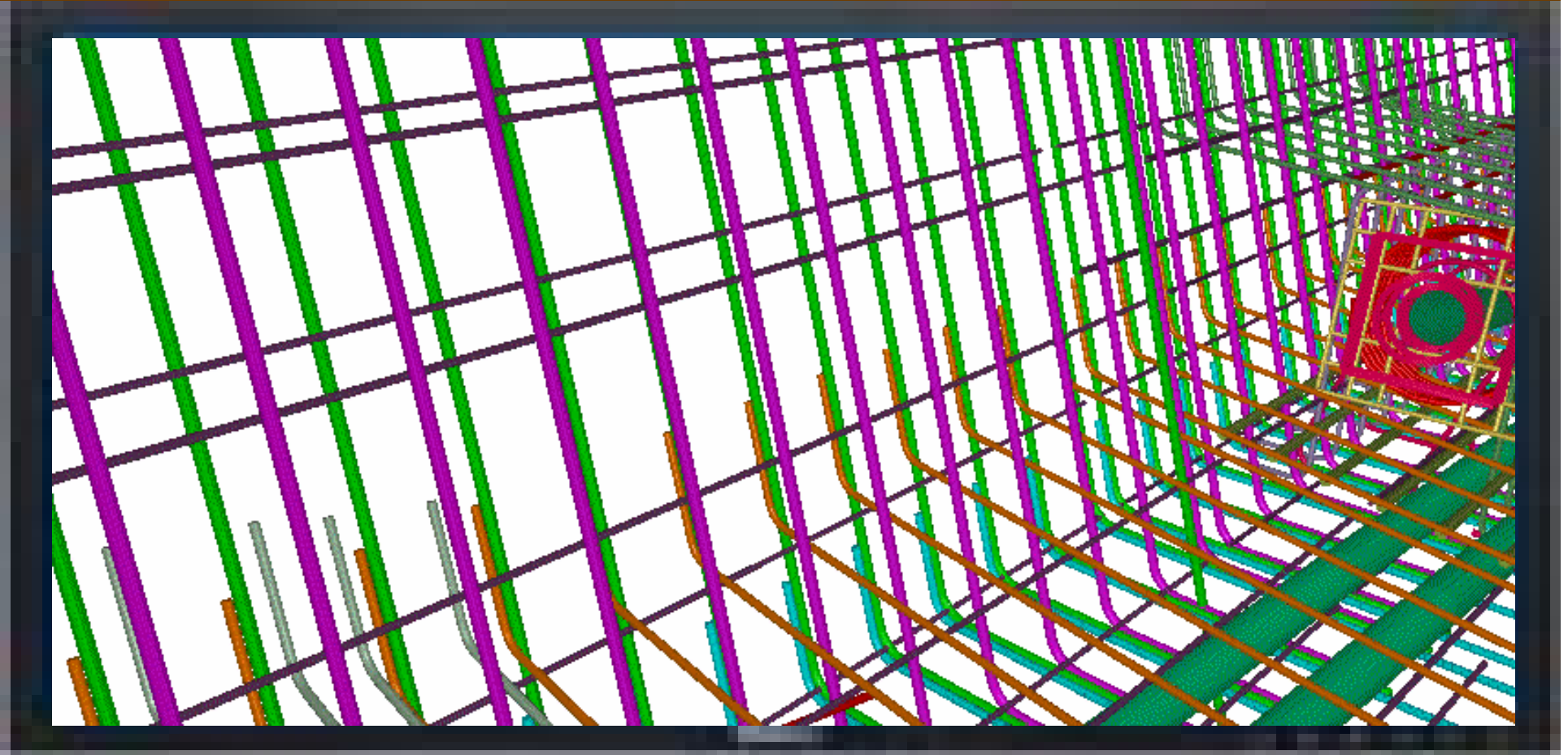
0.000' Offset

0.01' Offset



Accuracy of 3D Images



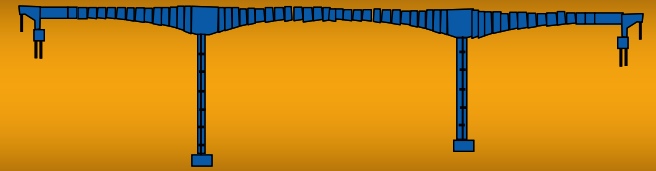


# Continuity Tendon Blockout Anchorage

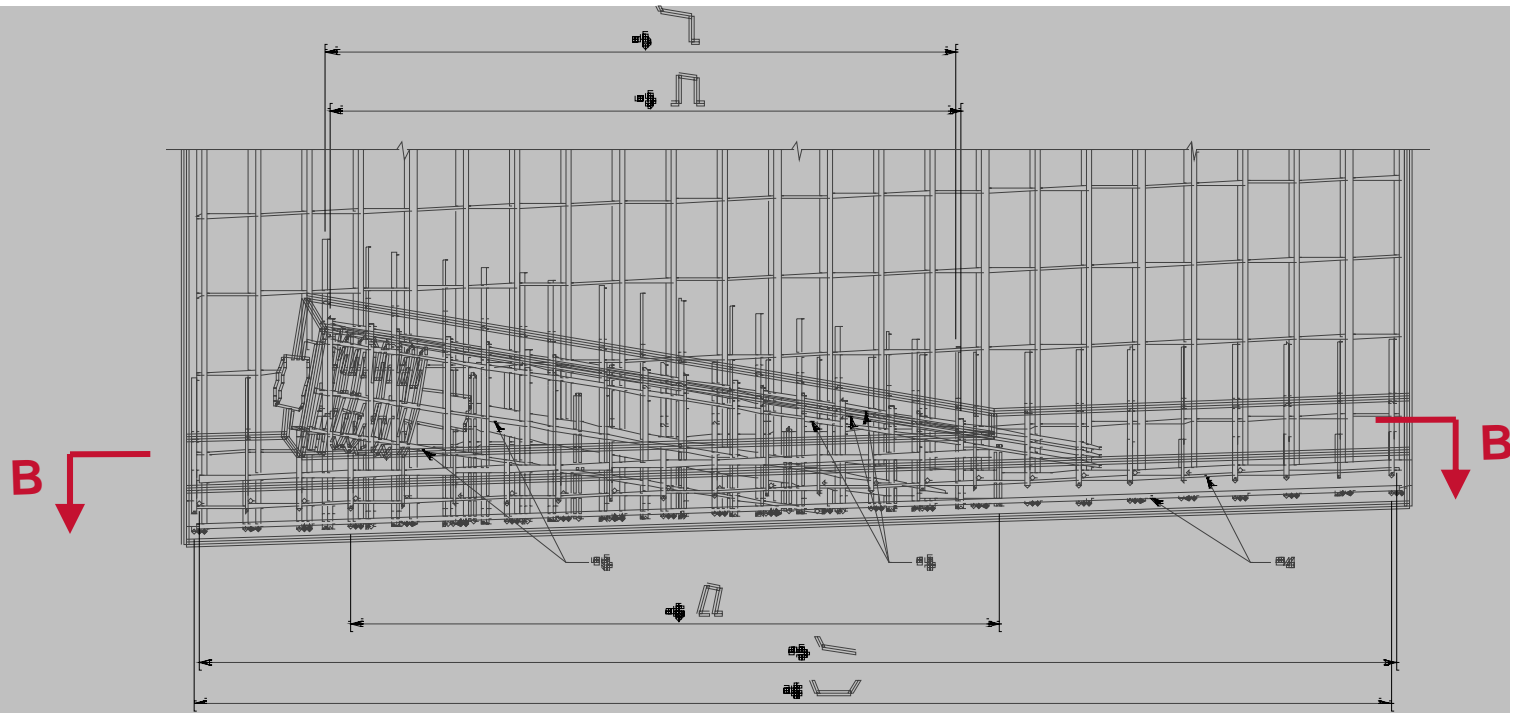
**Construction**



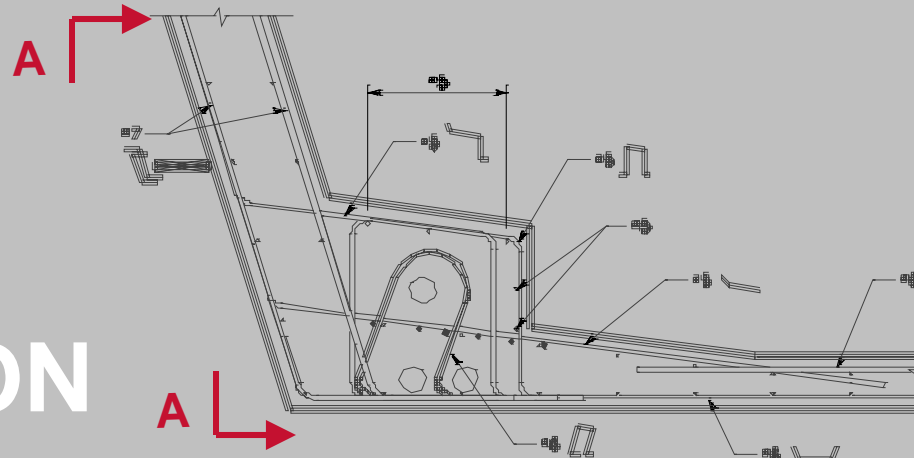
# Integrated Drawings in Construction



- Respond to Contractor RFI's
  - Resolve Conflicts
    - » Adjust Spacing
    - » Change Bar Shapes
- Final Rebar Configurations
- Re-Use existing Models

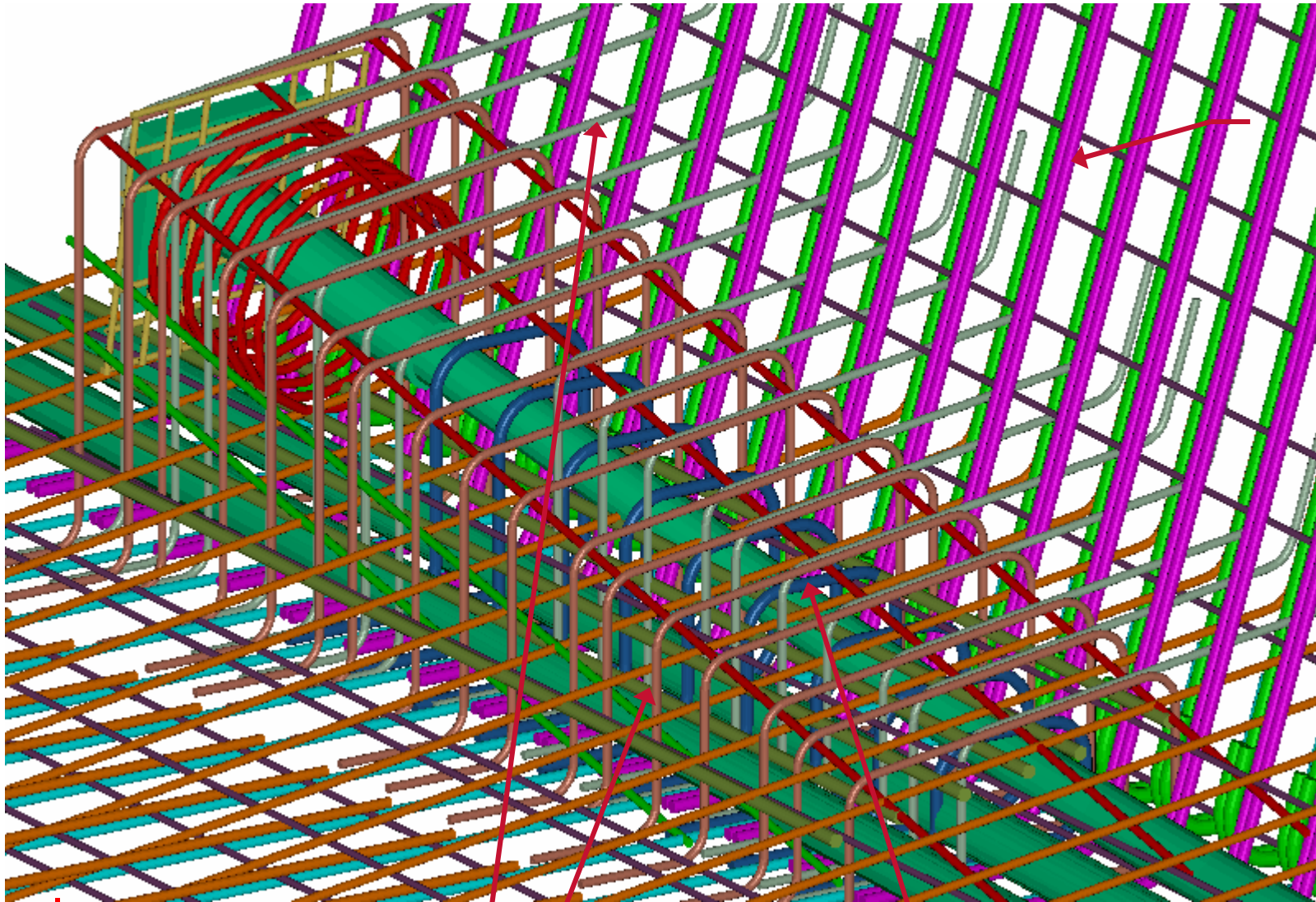


**ANCHOR BLOCK ELEVATION**

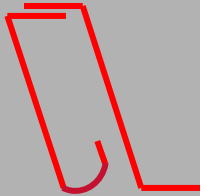


**ANCHOR BLOCK SECTION**

**CLARIFICATION  
AT ANCHOR  
BLOCKS**

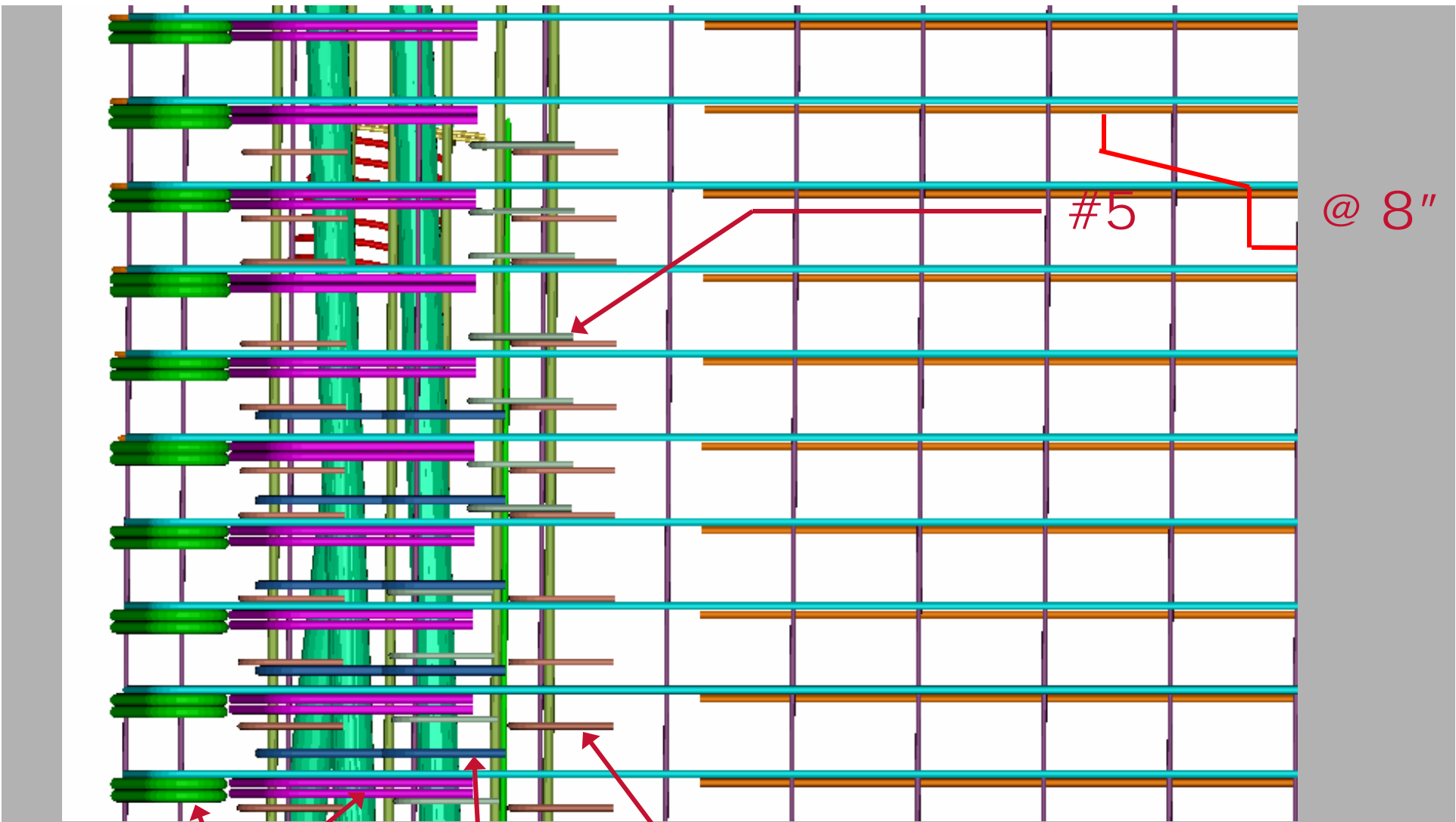


#7  
BUNDLE



#5 @ 8" #5 @ 8" #6 @ 8"

ISOMETRIC VIEW



#5

@ 8"

#7

BUNDLED

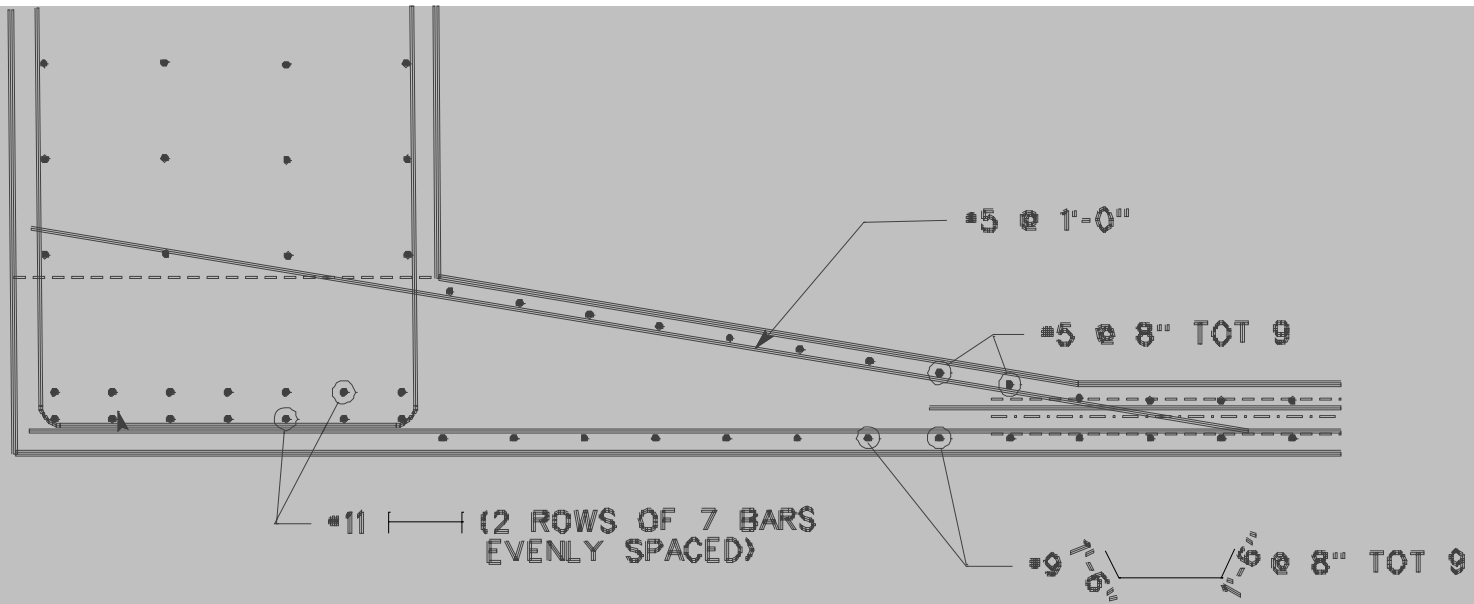
#5

@ 8"

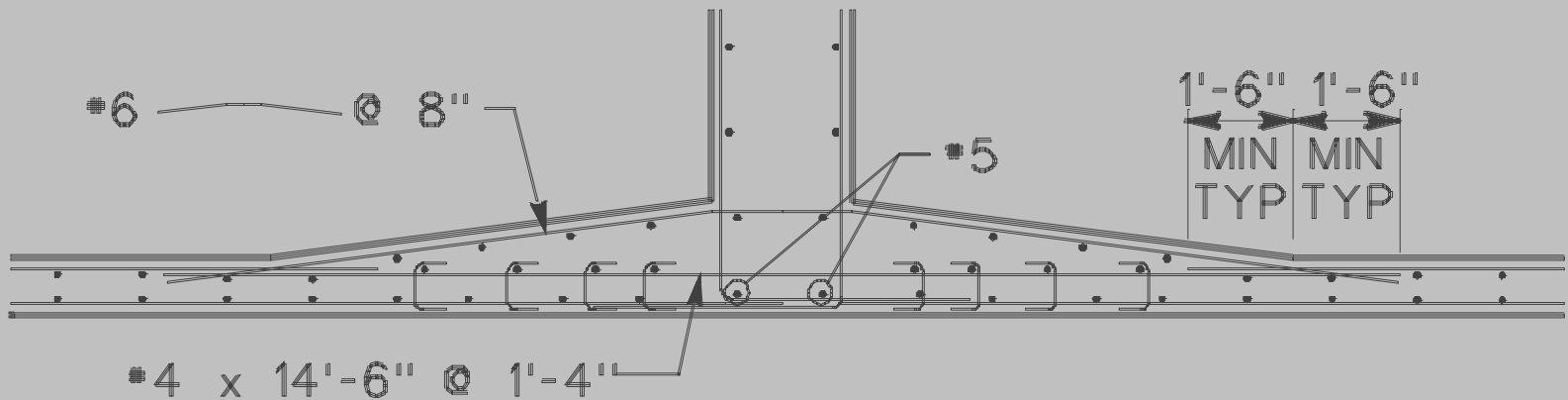
#6

@ 8"

**BOTTOM VIEW B**

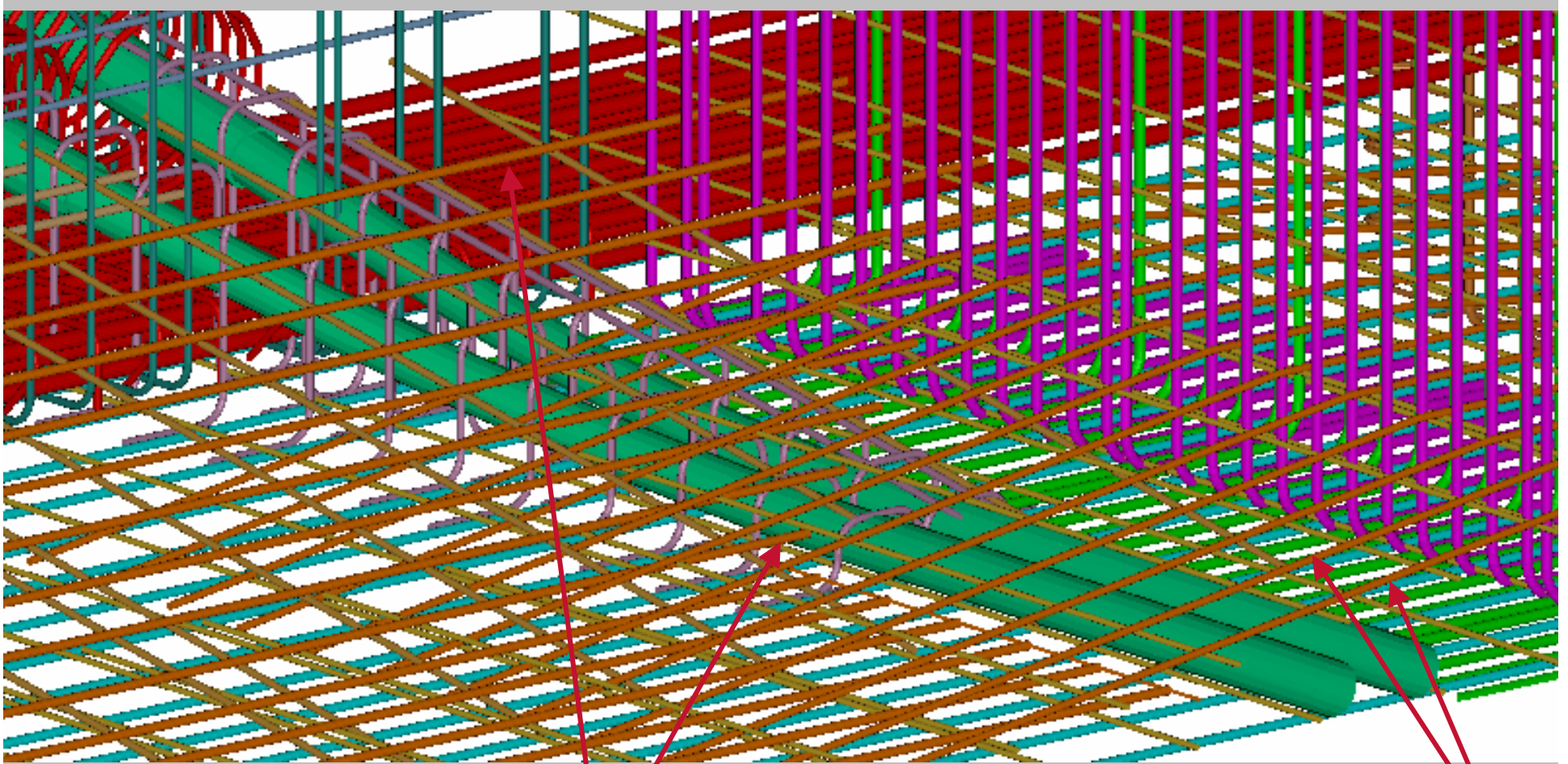


## END DIAPHRAGM FLARE



## GIRDER FLARE

# CLARIFICATION AT GIRDER & DIAPHRAGM FLARES



#5 @ 8"

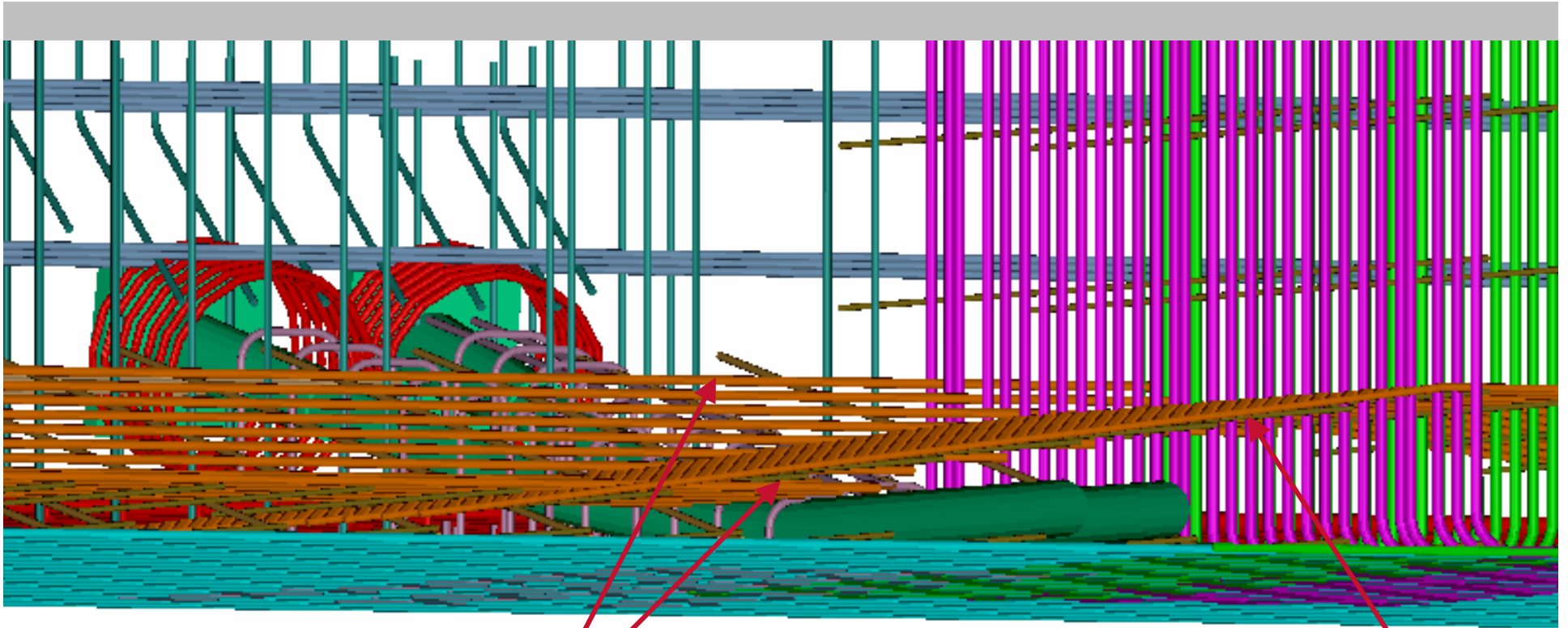
#6

@ 8"

ISOMETRIC VIEW

CLARIFICATION AT GIRDER &  
DIAPHRAGM FLARES





#5 @ 8"

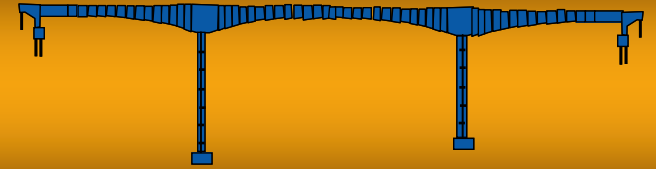
#6

@ 8"

ISOMETRIC VIEW

CLARIFICATION AT GIRDER &  
DIAPHRAGM FLARES

# SUMMARY



- MicroStation and Rebar are powerful tools for creating Models from PS&E to 3D renderings and visualization.
- The Pier Table alone contained over 85,000 reinforcement bars and 128 tendons that would have taken endless hours to detail with a CADD program alone.
- With the models created, integrated sheets, 3D renderings, and Fly-Throughs we were able to identify and correct many potential conflicts.
- During Construction the design team was able to re-use their models to quickly respond to contractor RFI's.