Design of a Post-Tensioned Straddle Beam

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Overview

- Introduction
- Bridge Description
- Design of Straddle Beam by Spreadsheet
- Design of Straddle Beam using Midas Civil
- Evaluation of Results

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Introduction

- What you will get from this presentation
  - Greater insight into the use of Construction Stages in Midas Civil
  - Some considerations for the design and modeling of a Post-Tensioned member built in stages
  - How to include various parameters in Midas Civil including PT losses
  - How to ensure that locked-in stresses are properly carried through
  - 1 PDH

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Bridge Description

- The Bridge:
  - SH92 over UPRR near Delta, CO
  - 4 Span PS girder superstructure: 130’ – 150’ – 150’ – 130’
  - 7 Colorado BT63 girders; simple for DL, continuous for LL and SIDL
  - 43’-0” Out to Out deck width, 40’ – 0” travelway
  - RC stub abutments on driven steel piles behind MSE wall
  - Piers 2 and 4 consist of RC columns and pier caps on RC caissons
  - Pier 3 consists of RC columns on RC caissons and a CIP, PT pier cap
    - Straddle beam allows for clearance above the RR while minimizing required earthwork and retaining walls

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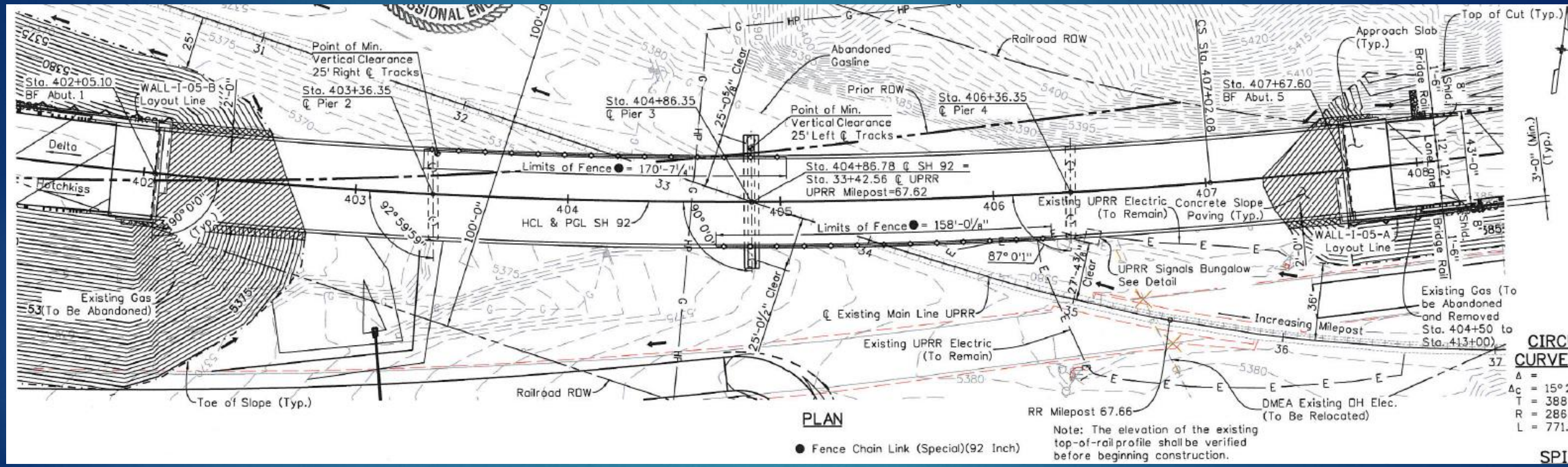
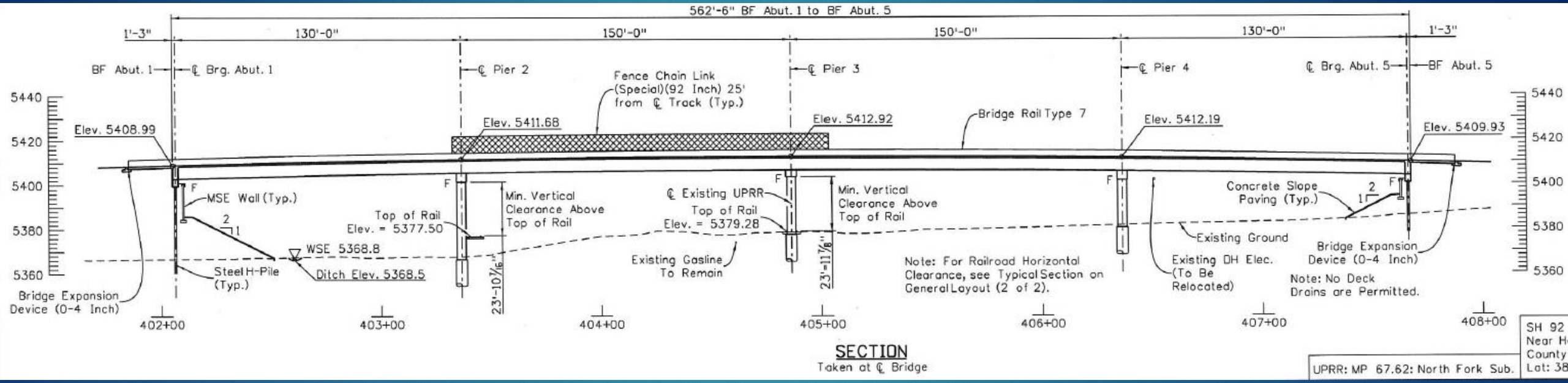
Plan View


Sta. 402+05.10
BF Abut. 1
WALL-I-05-B
Layout Line
Point of Min.
Vertical Clearance
25' Right ℄ Tracks
Sta. 403+36.35
℄ Pier 2
Sta. 404+86.35
℄ Pier 3
Abandoned
Gasline
Prior ROW
Point of Min.
Vertical Clearance
25' Left ℄ Tracks
Sta. 406+36.35
℄ Pier 4
Railroad ROW
CS Sta. 407+02.08
Sta. 407+67.60
BF Abut. 5
Approach Slab
(Typ.)
Top of Cut (Typ.)
Limits of Fence ● = 170'-7¼"
Sta. 404+86.78 ℄ SH 92 =
Sta. 33+42.56 ℄ UPRR
UPRR Milepost=67.62
HCL & PGL SH 92
Limits of Fence ● = 158'-0⅛"
Existing UPRR Electric
(To Remain)
Concrete Slope
Paving (Typ.)
UPRR Signals Bungalow
See Detail
WALL-I-05-A
Layout Line
Existing Gas
(To Be Abandoned)
℄ Existing Main Line UPRR
Existing UPRR Electric
(To Remain)
Increasing Milepost
Existing Gas (To
be Abandoned
and Removed
Sta. 404+50 to
Sta. 413+00)
Toe of Slope (Typ.)
Railroad ROW
RR Milepost 67.66
DMEA Existing OH Elec.
(To Be Relocated)
Delta
Hotchkiss
100'-0"
25'-0½" Clear
90° 0'0" (Typ.)
92° 59'59"
87° 0'1"
PLAN
● Fence Chain Link (Special)(92 Inch)
Note: The elevation of the existing top-of-rail profile shall be verified before beginning construction.

Elevation View



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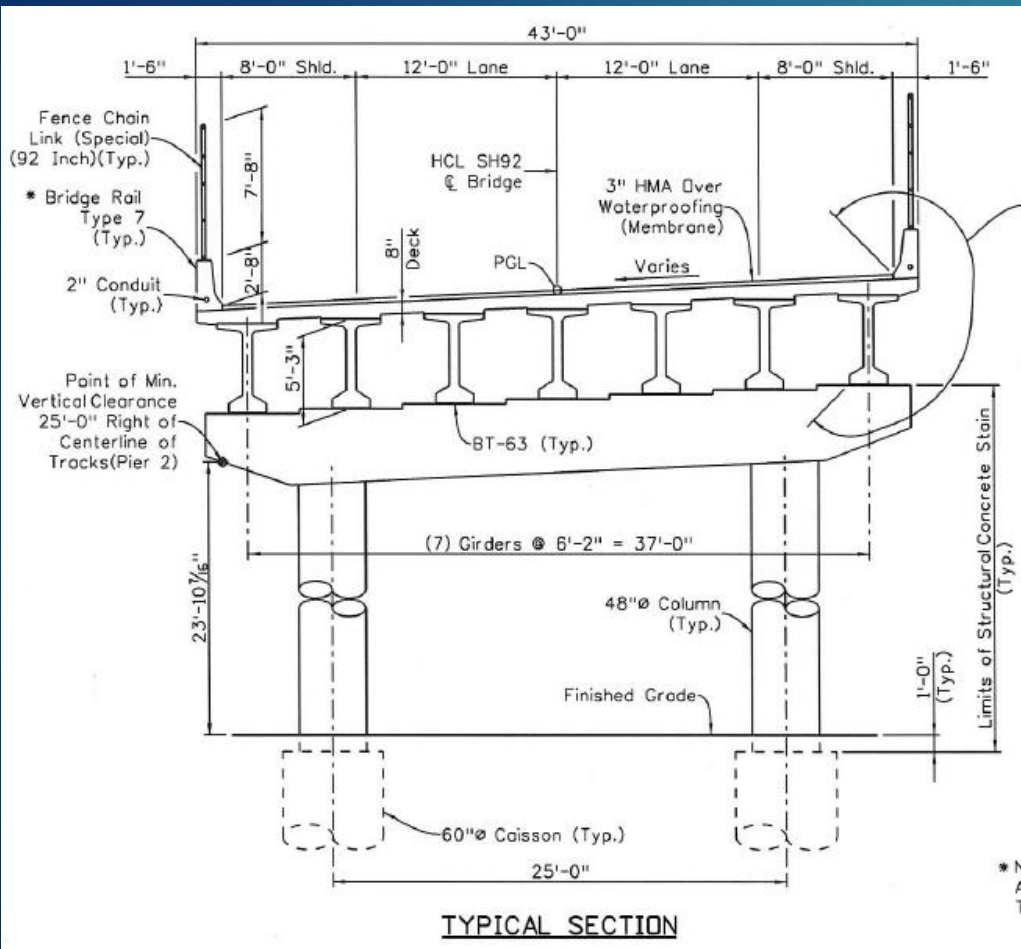
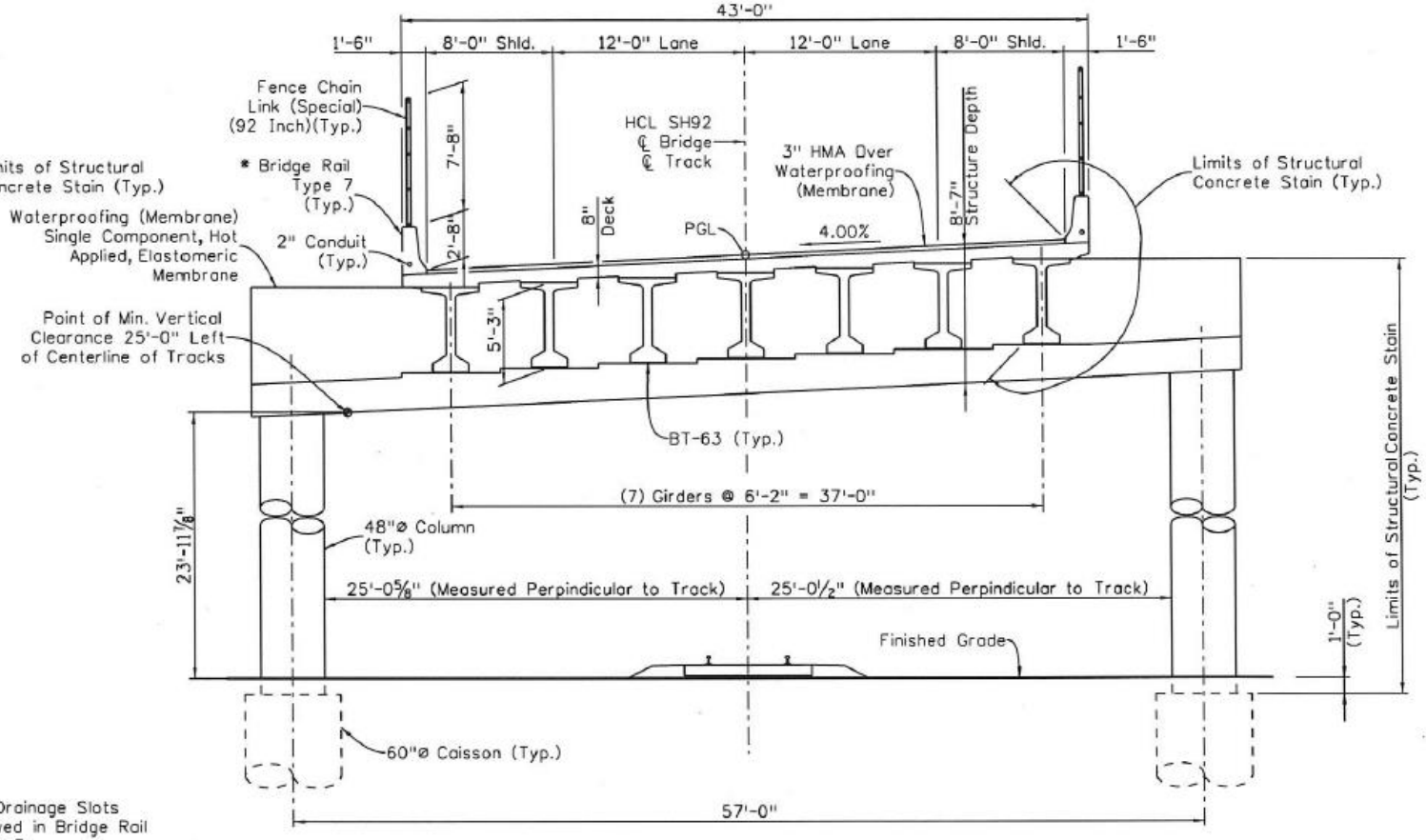
Typical Sections



TYPICAL SECTION

* No Drainage Slots Allowed in Bridge Rail Type 7



TYPICAL SECTION AT PIER 3

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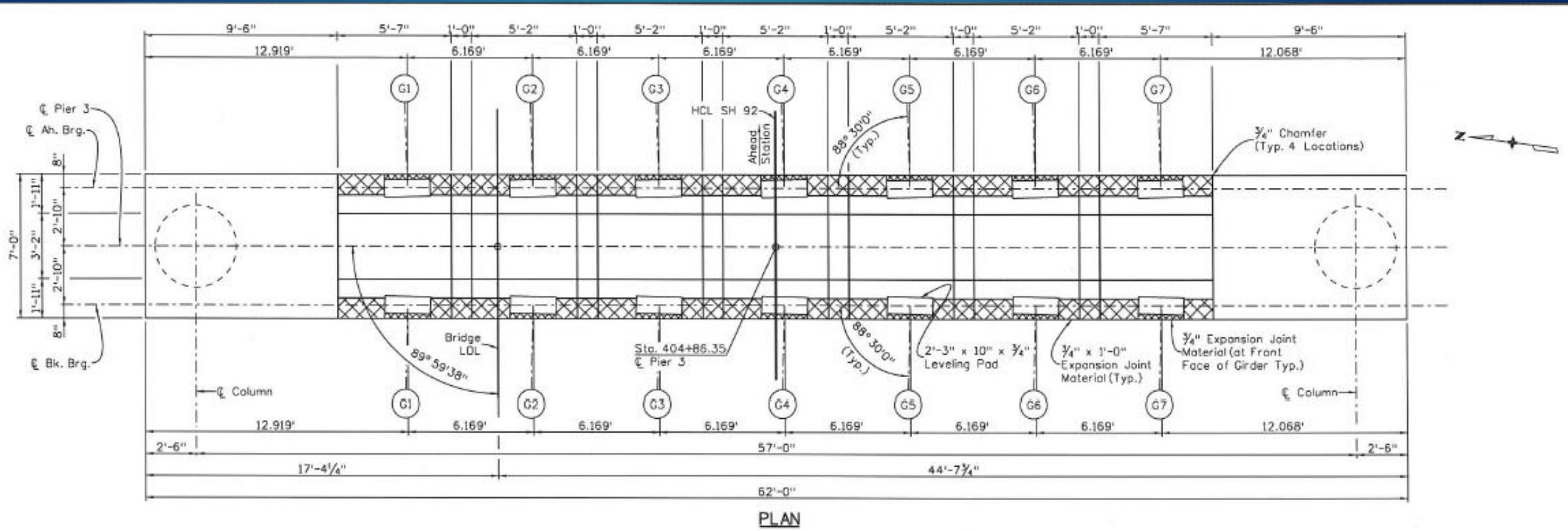
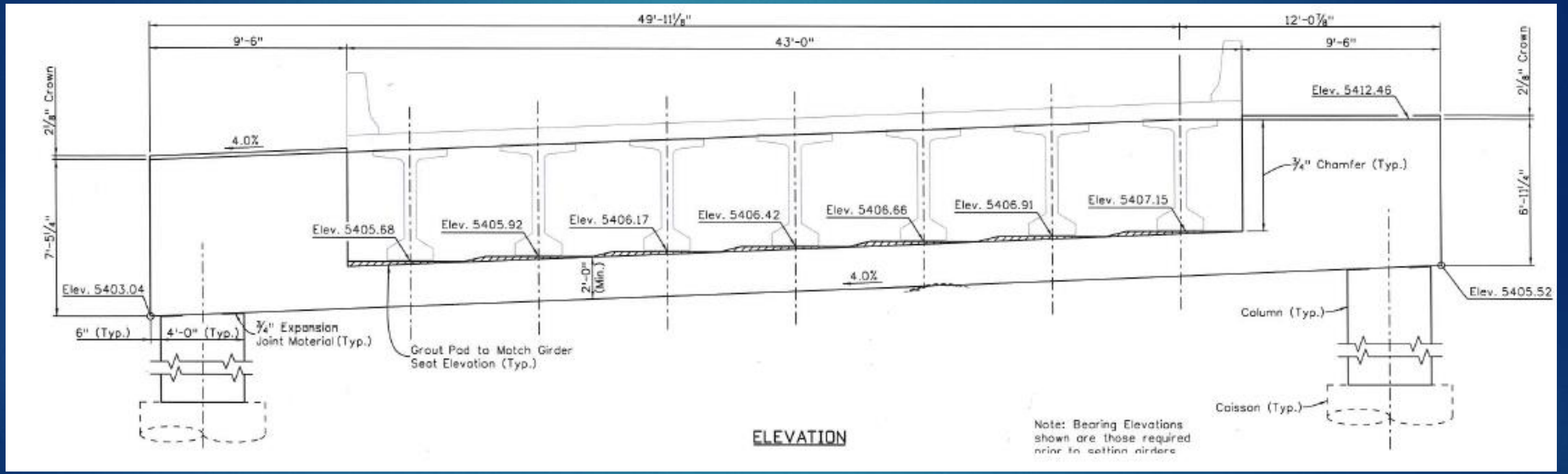
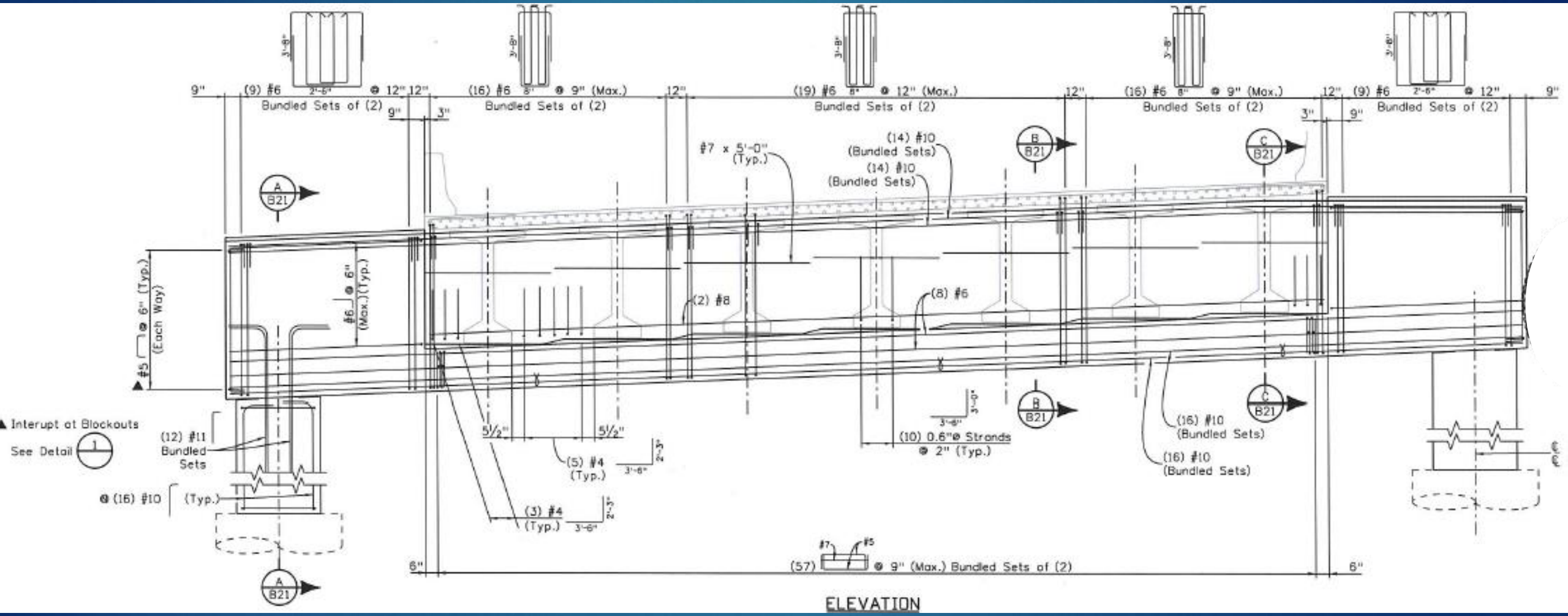
Pier 3 Details (1 of 3)



Pier 3 Details (1 of 3 Cont.)



Pier Details (2 of 3)



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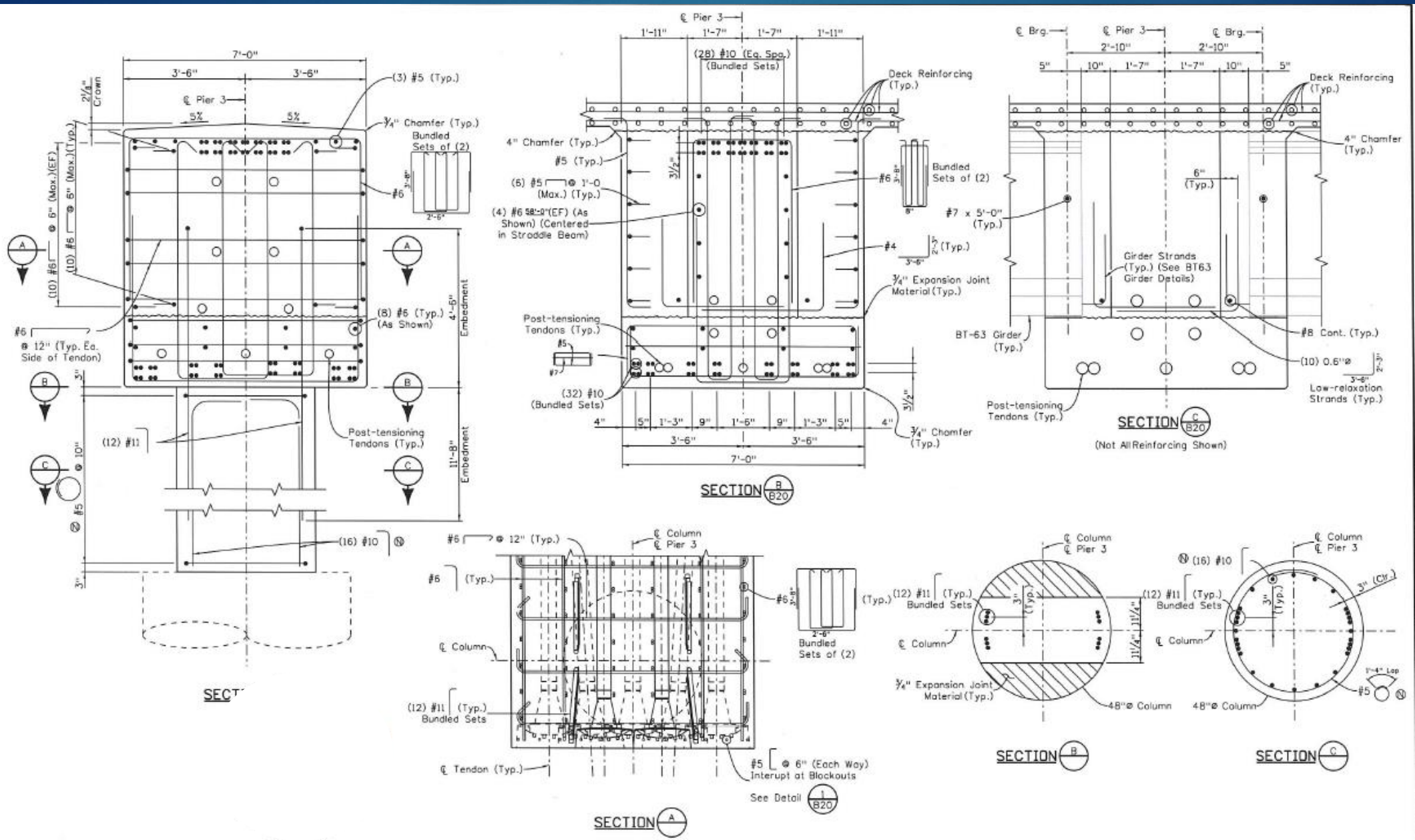
Pier Details (3 of 3)



Design of Straddle Beam by Spreadsheet

- At the time of design, a Midas license was not consistently available, so I ended up performing the design using a large spreadsheet
- The Spreadsheet consisted of one tab for each construction stage, including steps for adding new structural components, aging of concrete, and placing of additional loads
- This was necessary to ensure that locked-in stresses were correctly accounted for
- This also allowed for developing a better estimate of PT losses over time
- A summary sheet was also created, from which parameters could be adjusted, and stresses in each stage checked automatically

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Design of Straddle Beam by Spreadsheet

- The creation of this spreadsheet was very involved and required a significant time investment
- Once completed, it facilitated design well, since adjustments could be made from the summary tab, making it relatively simple to determine the required post tensioning quantity and tendon path
- Once a design was established, various aspects of the calculations needed to be verified (friction losses, for example), which were not programmed to update automatically

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Design of Straddle Beam Using Midas Civil

- As a result of being approached to offer this webinar, I developed a model in Midas Civil for this straddle beam
- Using the software, stresses in the concrete can more easily be computed for the various construction stages
- The model requires entering the structural components, loads, and post-tensioning appropriately in order to properly calculate forces and stresses
- The "construction stages" feature must be used to obtain proper calculations for creep and shrinkage and to account for locked-in stresses as components are added
  - As a result, you want to ensure that everything you create is in the correct group, so it can be activated at the appropriate time
  - Reasonable estimates must be made concerning the timing of the placement of all members and post-tensioning

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Design of Straddle Beam Using Midas Civil

- Now we will take a look at the model:
  - Defined properties: materials, time-dependent material properties, and sections
  - Members, boundary conditions, loads, etc. and their corresponding groups
  - Post Tensioning input
  - Quick review of output

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