

CONTINUOUS DECK POUR FOR PRESTRESSED BEAM SUPERSTRUCTURES

Reference: IDM 404-2.06(02) Transverse Construction Joint

The Engineer of Record, EOR, is responsible for review and approval of Contractor submitted deck pour sequences, per the [LPA & State Shop Drawing & Falsework Review Procedure](#). For prestressed beam superstructures, if the Contractor's proposed sequence combines individual pours from the contract plans or proposes to pour the deck continuously in a single pour, the EOR should use the [INDOT Continuous Bridge Deck Pour Sequence Review Spreadsheet](#) to evaluate the proposed pour sequence. The acceptance criteria shown on the spreadsheet should be used as the EOR's primary basis for approving or rejecting a pour sequence post-letting and setting a minimum pour rate for a continuous pour pre-letting, if deemed possible by the spreadsheet.

Multi-span prestressed beam superstructures are simple spans prior to the deck and pier diaphragms being constructed. Continuity between the spans is established once the deck and pier diaphragms have cured and are able to resist the applied loads. During the deck pour, the beams are loaded with the plastic deck concrete which causes the beams to deflect downward. The deflections and beam end rotations are able to occur in the simple span configuration provided the concrete remains plastic at the piers. However, if the concrete in the pier diaphragms or deck begins to set as the subsequent span is being loaded with plastic concrete, excessive cracking may develop in the negative moment region. Therefore, IDM 404-2.06(02) suggests that the pier diaphragms and a 5'-0" wide portion of deck directly above the piers be poured after all the positive moment regions are constructed, thereby eliminating the risk of applying tension to setting concrete.

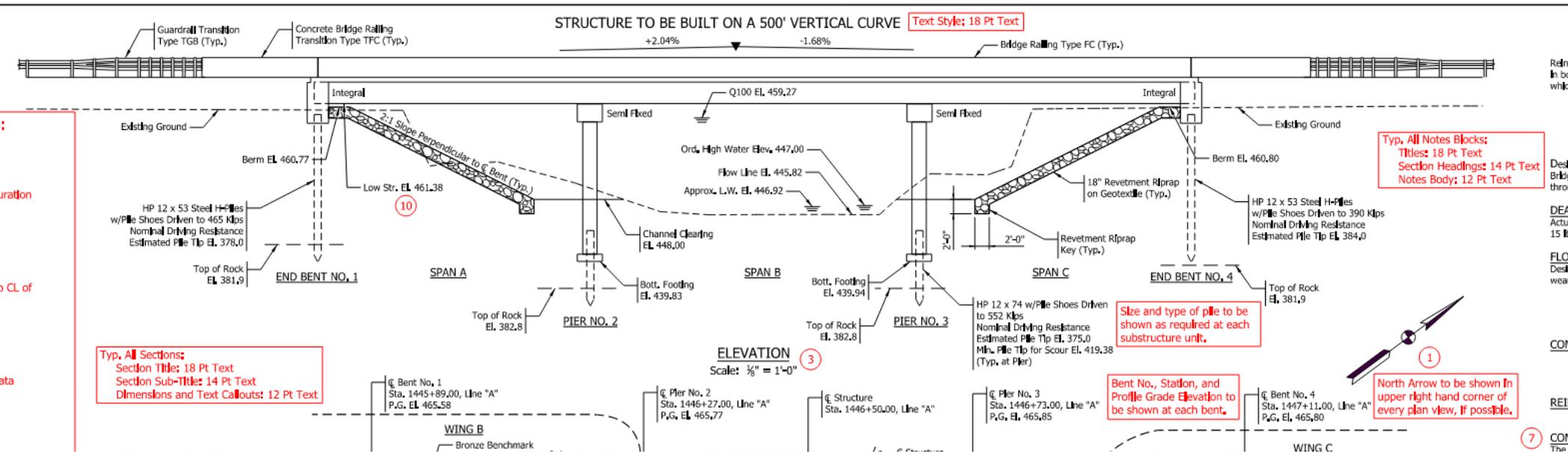
Constructing the pier diaphragms and portions of the deck above the piers separately from the remainder of the deck also presents some disadvantages. Transverse construction joints are required at each side of the pier, which creates potential locations for chloride ingress. Separate deck pours also have the potential to reduce ride quality due to the risk of slope breaks or abrupt surface changes between pours. The most common disadvantage of requiring multiple deck pours is the increased construction time and cost. For these reasons, INDOT's preference is to allow continuous deck pours for prestressed beam superstructures when the criteria described in this Bridge Design Aid is satisfied.

An example application using the spreadsheet with the Bridge Sample Plans for a pre-letting situation is attached.

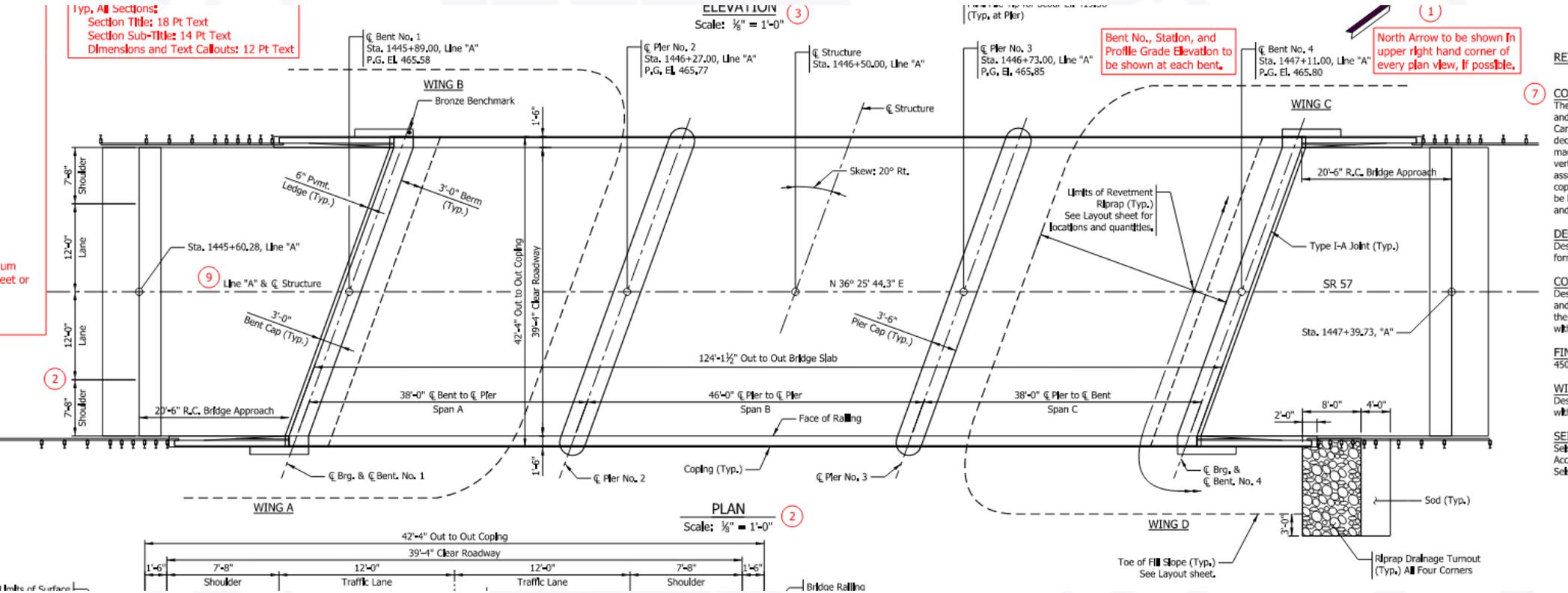
Deck Pour Sequence Example

For Prestressed Concrete Beam Superstructures Only

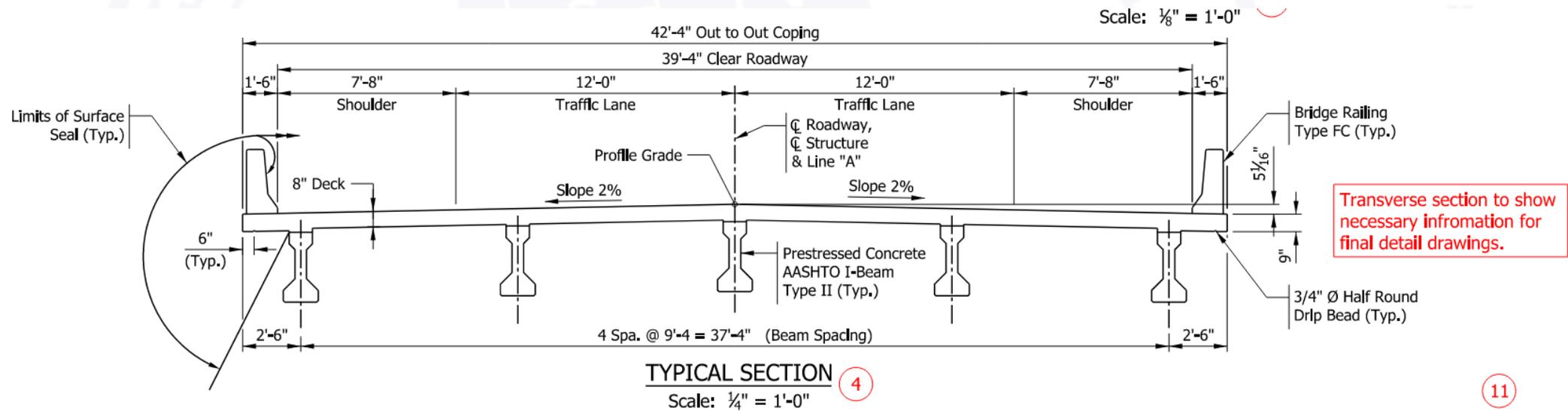
Workbook Example



Workbook Example



Workbook Example



Workbook Example



INDOT Continuous Bridge Deck Pour Sequence Review

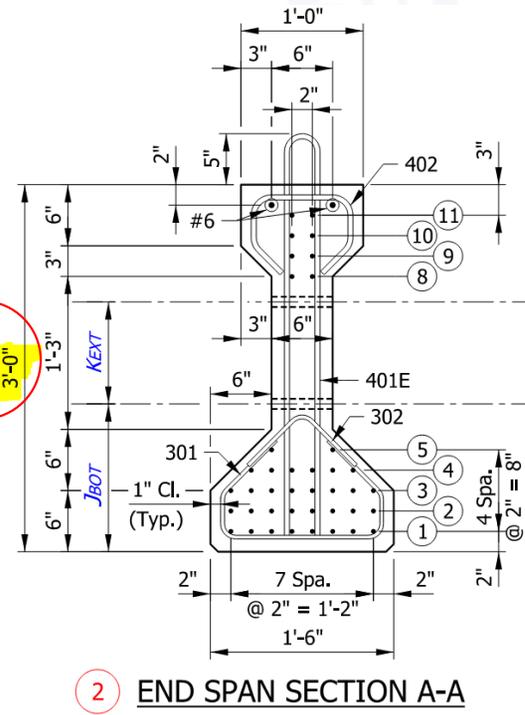
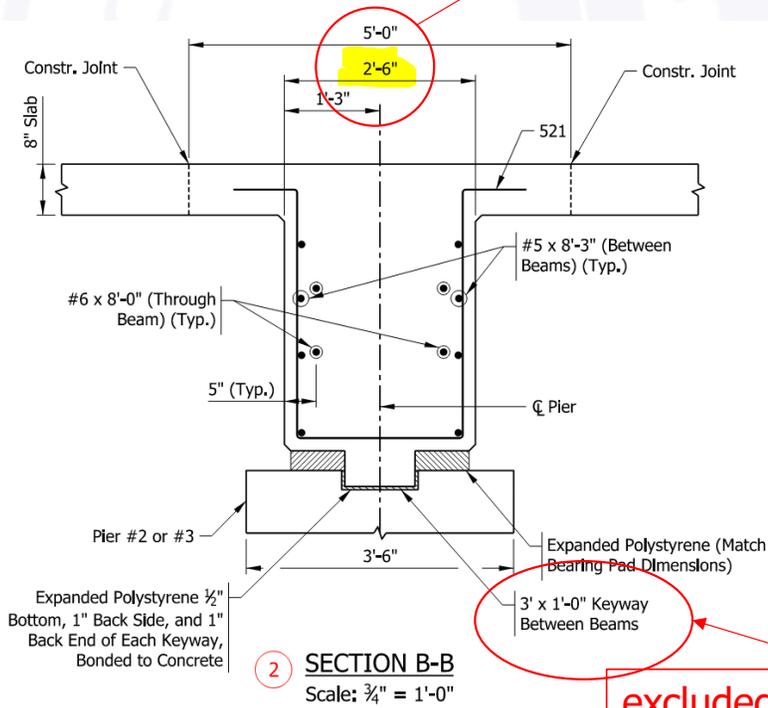
Geometry, span type, pour rate and concrete set time are factors that significantly impact the probability of excessive early cracking in bridge decks.

Today's Date:	9/14/2022
Des. #:	9999999
Contract #:	B-99999
Ready Mix Provider:	Pre-Letting
Contractor:	Pre-Letting



Workbook Example

Pier Diaphragm Height (in): 36
 Pier Diaphragm Width (in): 30

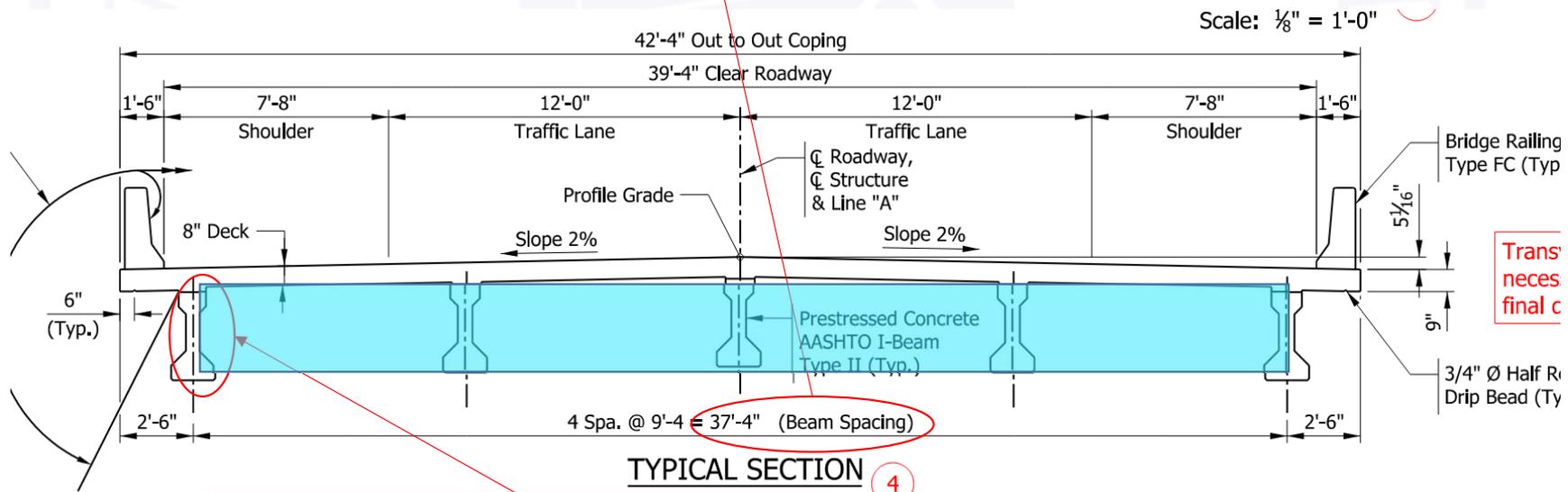


Workbook Example

Pier Diaphragm Length (ft):

37.33333333

Perpendicular to the coping



Trans
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final c

Not 100% accurate, but conservative

Workbook Example

Are END BENT diaphragms poured during this pour sequence?

No

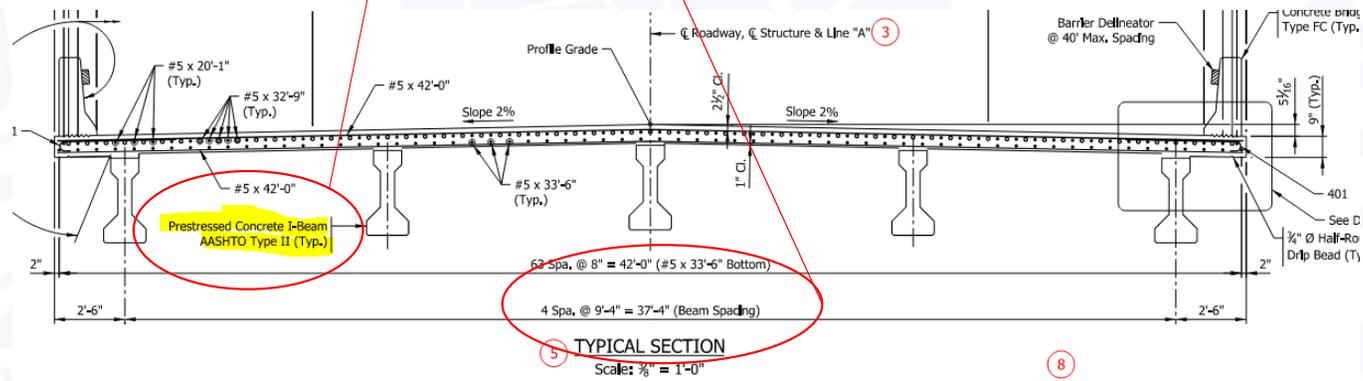
Are PIER diaphragms poured during this pour sequence?

Yes

- End bent diaphragms
 - Usually a separate pour
 - Not included in calculations
 - no structural significance in pour review
- Pier diaphragms
 - Required to be poured with continuous pour
 - Otherwise, not simple spans
 - workbook not applicable

Workbook Example

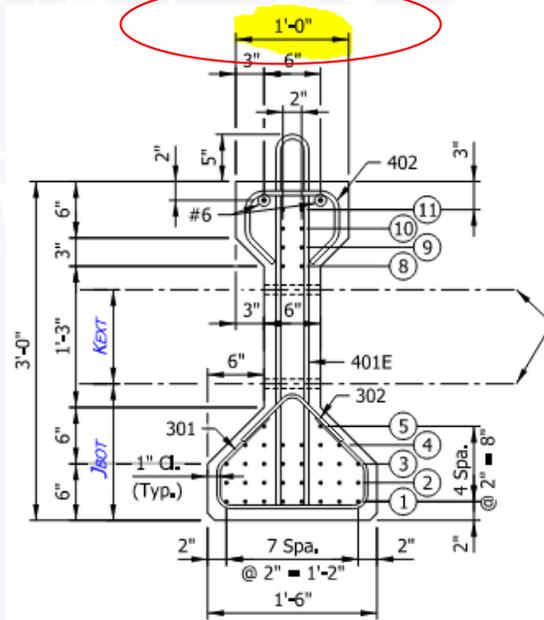
Quantity of Beam Lines:	5
Beam Type:	AASHTO Type II
Beam Area (in ²):	368



Workbook Example

Avg. Fillet Depth (in):	1
Avg. Fillet Width (in):	12
Stay-in-Place Form (SIP) Factor:	15%

Typical



② **END SPAN SECTION A-A**
Scale: 1" = 1'-0"

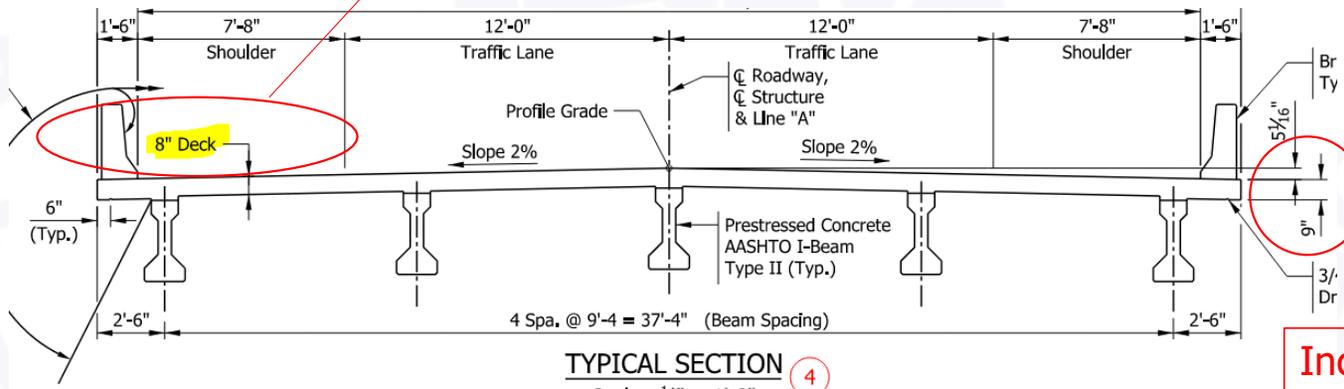
Workbook Example

Average Slab Thickness (in):	8
Anticipated Pour Rate (CY/hr):	40
Time to Concrete Set (hrs):	3.50

40 CY/hr to 80 CY/hr is recommended for pre-letting use.

Continuous Pour Sequence Approved? **YES**

INDOT prefers to assume 3.5 hr. until Class C concrete begins initially setting up



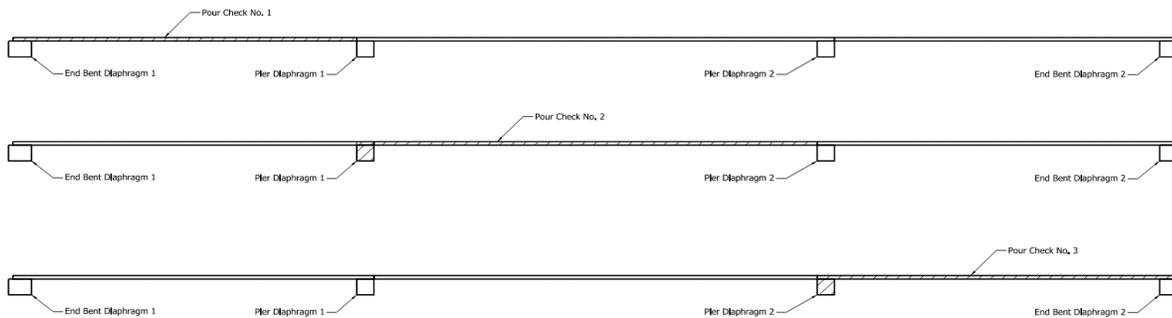
Increased overhang thickness excluded from calcs



INDOT Continuous Bridge Deck Pour Sequence Review

Purpose

The purpose of this BDA is to determine if a continuous bridge deck pour is possible under a set of criteria that aims to minimize as the likelihood of excessive early deck cracking. For an acceptable continuous bridge deck pour, the time required to pour each span, as defined below, must be less than INDOT's criteria of 3.5 hr. concrete set time. This criteria was established to ensure the highest probability the concrete will remain plastic while each span is being poured.



Procedure

This BDA is recommended to be used in two scenarios:

1) Prior To Letting

- If your bridge deck pour **can** pass the checks contained within IDM 404-2.06(02) and calculated in this BDA using 80 cubic yards per hour pour rate or less, then it is suggested to include a note on the deck pour sequence plan sheet prior to STG 3 submittal as shown below:

"As an alternate, the Contractor may elect to pour the deck and diaphragms as one continuous pour from one end to the other.

This will be allowed provided the following criteria is met:

- *The minimum required pour rate shall be "X" cys/hr.*
- *Each span (deck + prior pier diaphragm) shall be completed within 3 1/2 hrs measured from the time the concrete within that span is discharged."*

Note: "X" is the minimum pour rate necessary to achieve an approved continuous pour sequence. This is determined by reducing the "Anticipated Pour Rate" on the "Pour Review" sheet as low as possible while maintaining an approved continuous pour sequence.

- If your bridge deck pour **cannot** pass the checks contained within this BDA using 80 cubic yards per hour pour rate or less, then it is suggested to include a note on the deck pour sequence plan sheet prior to STG 3 submittal as shown below:

"Preliminary calculations have shown a continuous bridge deck pour sequence will require a pour rate greater than 80 cubic yards per hour and is not likely feasible. "

2) Post Letting

- If the Contractor submits a pour sequence for review that differs from the sequence shown on the deck pour sequence plan sheet, this BDA is recommended for checking the Contractor's proposed pour sequence. The "SIP Form Factor" may be updated based on the Contractor's proposed pour sequence.

Important Notes

- This BDA is **only** for prestressed concrete girder superstructure bridges
- Designer should input the average fillet depth to include the minimum fillet thickness and computed residual camber
- Residual camber is not provided separately in quantities
- 15% SIP Form Factor is typical however, designer may input desired factor
 - SIP Form Factor: $100\% \times [(15 \text{ psf} / 150 \text{ pcf}) \times 12] \div 8 \text{ in. (typical deck thickness)} = 15\%$ of the deck volume. This equates to about 8%-15% of a typical total pour volume.
- End Bent Diaphragms: If user inputs "Yes", end bent diaphragms are included in the pour. This BDA will consider one at the beginning and one at the end. However, the end bents are not necessary for review, therefore they are not considered for pour sequence review and for information only.
- Pier Diaphragms: If user inputs "Yes", pier diaphragms are included in the pour. This BDA will consider one at each interior support (pier). User cannot ignore some pier diaphragms and consider others. "Yes", every pier diaphragm is included, or "No", none of the pier diaphragms are included. If pier diaphragms are not included on a multispan bridge, this workbook will not approve the continuous pour sequence.
- Quantity for the keyway between beams at the pier is not included in calculations
- Cell Color Meanings:
 - White Cells - cells with preset or calculated values
 - Green Cells - cells that require user input
 - Blue Cells - cells referencing the "Pour Review" sheet
 - Red Cells - cells that denote user input error or cells that do not meet the BDA criteria

Assumptions (Can be edited in the "Concrete Calculations" sheet)

- Deck thickness is constant across the entire pour width and length
- All end bents are identical
- All piers are identical



INDOT Continuous Bridge Deck Pour Sequence Review

Geometry, span type, pour rate and concrete set time are factors that significantly impact the probability of excessive early cracking in bridge decks.

Today's Date: 9/14/2022
 Des #: 9999999
 Contract #: B-99999

Ready Mix Provider: Pre-Letting
 Contractor: Pre-Letting

Span Type:	Concrete
End Bent Diaphragm Height (in):	36
End Bent Diaphragm Width (in):	36
End Bent Beam Embedment (in):	25.125
Pier Diaphragm Height (in):	36
Pier Diaphragm Width (in):	30
Pier Diaphragm Length (ft):	37.33333333
Quantity of Beam Lines:	5
Beam Type:	AASHTO Type II
Beam Area (in ²):	368
Avg. Fillet Depth (in):	1
Avg. Fillet Width (in):	12
Stay-in-Place Form (SIP) Factor:	15%
Skew (deg.):	20
Out-Out Bridge Floor (ft):	124.125
Number of Spans:	3
Span A Length (ft):	38.000
Span B Length (ft):	46.000
Span C Length (ft):	38.000
Span D Length (ft):	
Span E Length (ft):	
Span F Length (ft):	
Span G Length (ft):	
Width of Pour Normal to Coping (ft):	42.333
Average Slab Thickness (in):	8
Anticipated Pour Rate (CY/hr):	40
Time to Concrete Set (hrs):	3.50

Are END BENT diaphragms poured during this pour sequence?
No

Are PIER diaphragms poured during this pour sequence?
Yes

Span = Q_{End Bent} to C_{Pier}
 or Q_{Pier} to C_{Pier}

Continuous Pour Sequence Approved? **YES**

Calculated by: DAS Date: 9/14/2022

Checked by: _____ Date: _____

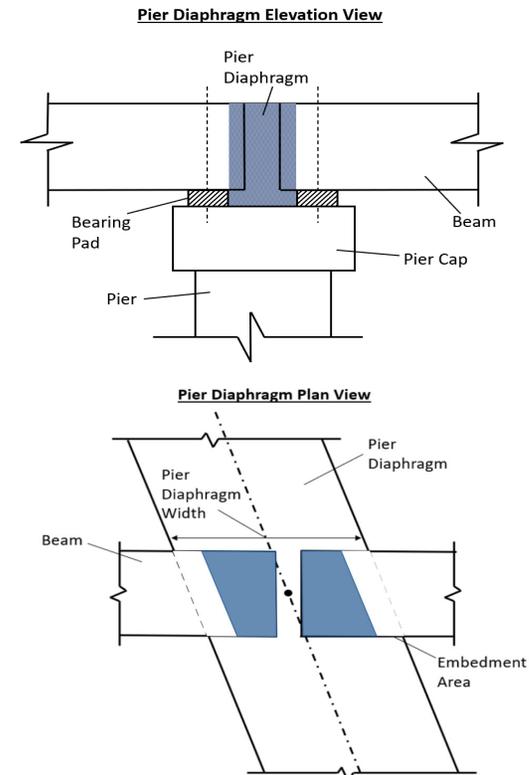
Span Type: Concrete

Span Summary									
Number of Spans =	3								
Span Letter:	A	B	C*	D	E	F	G	Totals	
Length of Span (Ft.)	38	46	38	0	0	0	0	SUM =	122 Feet
Volume of Pour (CYD)	47.541	66.074	57.630	0.000	0.000	0.000	0.000	SUM =	171.245 CYD
Time to Complete Pour (Hr.)	1.189	1.652	1.441	0.000	0.000	0.000	0.000	MAX =	1.652 Hr.
Pour Rate =	40	CYD / Hr.							
Concrete Span? =	Y								
Time to Concrete Set (Hr.) =	3.5								

Review Results				
Pour Approved?	<u>YES</u>	Time:	1.652 hr.	≤ 3.5 hr.
<i>Approved when Total Time to Complete Pour (Hr.) ≤ Time to Concrete Set (Hr.)</i>				

Assumptions		
Fillet Volume = 5 beams * 1" depth * 12" width * 12" / 12 ³ / 27		<i>Included in all checks. User may update to check a proposed post letting pour sequence</i>
Fillet Volume = 0.015	CYD / FT	
SIP Form Factor =	15.00%	

Net Pier Diaphragm Volume Calculation (Closure Pour)		
Gross Pier Diaphragm Volume		
Quantity of Pier Diaphragms =	2	
Gross Pier Diaphragm Volume = (36" * 30" / 144) * 37.3333333333333' / cos(20 deg.)		
Gross Pier Diaphragm Volume = 297.97		CFT (per diaphragm)
Gross Pier Diaphragm Volume = 11.036		CYD (per diaphragm)
		<i>Beam embedment <u>is not</u> withdrawn from this volume</i>
Pier-Beam Embedment Volume		
Quantity of Beam Lines =	5	
Beam Area =	368	in ²
Pier Diaphragm Width =	30	in
Pier Beam Embedment = 30" - 3" - 3"		<i>IDM Fig. 406-16G & IDM Fig. 406-16M</i>
Pier Beam Embedment = 24		in
Pier Beam Embedment Volume = 5 * 368 in ² * 24" / 12 ³ / 27		
Pier Beam Embedment Volume = 0.947		CYD (per diaphragm)
		<i>See the Figures to the right</i>
Net Pier Diaphragm Volume		
Net Pier Diaphragm Volume = 11.036 CYD - 0.947 CYD		
Net Pier Diaphragm Volume = 10.089		CYD (per diaphragm)
		<i>Beam embedment <u>is</u> withdrawn from this volume</i>



Net End Bent Diaphragm Volume Calculation (For Information Only)

Gross End Bent Diaphragm Volume

Quantity of End Bent Diaphragms = 0

Gross End Bent Diaphragm Volume = $(36" * 36" / 144) * 42.333333333333' / \cos(20 \text{ deg.})$

Gross End Bent Diaphragm Volume = 405.45 CFT (per diaphragm)

Gross End Bent Diaphragm Volume = 15.017 CYD (per diaphragm)

Beam embedment is not withdrawn from this volume

End Bent Embedment Volume

Quantity of Beam Lines = 5

Beam Area = 368 in²

End Bent Beam Embedment = 25.125 in

End Bent Beam Embedment Volume = $5 * 368 \text{ in}^2 * 25.125" / 12^3 / 27$

End Bent Beam Embedment Volume = 0.000 CYD (per diaphragm)

Net End Bent Diaphragm Volume

Net End Bent Diaphragm Volume = 15.017 CYD - 0 CYD

Net End Bent Diaphragm Volume = 0.000 CYD (per diaphragm)

Beam embedment is withdrawn from this volume

Span A Total Volume Calculation

Bridge Parameters

Out-Out Bridge Floor =	124.125	FT
Width of Pour =	42.33333333	FT
Average Slab Thickness =	8	IN

Deck Volume

Span A Deck Length =	$38' + (124.125' - 122') / 2$	
Span A Deck Length =	39.063	FT
Span A Deck Volume =	$(8" / 12) * 42.3333333333333' * 39.0625'$	
Span A Deck Volume =	1102.431	CFT
Span A Deck Volume =	40.831	CYD
Span A Deck Volume × SIP Form Factor =	6.125	CYD
Span A Total Deck Volume =	40.831 CYD + 6.125 CYD	
Span A Total Deck Volume =	46.955	CYD

Fillet Volume

Span A Fillet Volume =	$39.0625' * 0.015$	CYD / FT
Span A Fillet Volume =	0.586	CYD

Total Volume

Span A Total Volume =	Deck + Fillet	
Span A Total Volume =	46.955 CYD + 0.586 CYD	
Span A Total Net Volume =	47.541	CYD

Span B Total Volume Calculation

Bridge Parameters

Out-Out Bridge Floor =	124.125	Feet
Width of Pour =	42.33333333	Feet
Average Slab Thickness =	8	Inches

Deck Volume

Span B Deck Length = 46'	
Span B Deck Length = 46.000	Feet
Span B Deck Volume = (8" / 12) * 42.3333333333333' * 46'	
Span B Deck Volume = 1298.222	CFT
Span B Deck Volume = 48.082	CYD
Span B Deck Volume × SIP Form Factor = 7.212	CYD
Span B Total Deck Volume = 48.082 CYD + 7.212 CYD	
Span B Total Deck Volume = 55.295	CYD

Fillet Volume

Span B Fillet Volume = 46' * 0.015 CYD / FT	
Span B Fillet Volume = 0.690	CYD

Total Volume

Span B Total Volume = Pier Diaphragm + Deck + Fillet	
Span B Total Volume = 10.089 CYD + 55.295 CYD + 0.69 CYD	
Span B Total Volume = 66.074	CYD

Span C Total Volume Calculation

Bridge Parameters

Out-Out Bridge Floor =	124.125	Feet
Width of Pour =	42.33333333	Feet
Average Slab Thickness =	8	Inches

Deck Volume

Span C Deck Length =	$38' + (124.125' - 122') / 2$	
Span C Deck Length =	39.063	Feet
Span C Deck Volume =	$(8" / 12) * 42.3333333333333' * 39.0625'$	
Span C Deck Volume =	1102.431	CFT
Span C Deck Volume =	40.831	CYD
Span C Deck Volume × SIP Form Factor =	6.125	CYD
Span C Total Deck Volume =	40.831 CYD + 6.125 CYD	
Span C Total Deck Volume =	46.955	CYD

Fillet Volume

Span C Fillet Volume =	$39.0625' * 0.015$ CYD / FT	
Span C Fillet Volume =	0.586	CYD

Total Volume

Span C Total Volume =	Pier Diaphragm + Deck + Fillet	
Span C Total Volume =	10.089 CYD + 46.955 CYD + 0.586 CYD	
Span C Total Volume =	57.630	CYD

Span D Total Volume Calculation		
Bridge Parameters		
Out-Out Bridge Floor =	124.125	Feet
Width of Pour =	42.33333333	Feet
Average Slab Thickness =	8	Inches
Deck Volume		
Span D Deck Length =	0'	
Span D Deck Length =	0.000	Feet
Span D Deck Volume =	$(8" / 12) * 42.3333333333333' * 0'$	
Span D Deck Volume =	0.000	CFT
Span D Deck Volume =	0.000	CYD
Span D Deck Volume × SIP Form Factor =	0.000	CYD
Span D Total Deck Volume =	0 CYD + 0 CYD	
Span D Total Deck Volume =	0.000	CYD
Fillet Volume		
Span D Fillet Volume =	$0' * 0.015 \text{ CYD} / \text{FT}$	
Span D Fillet Volume =	0.000	CYD
Total Volume		
Span D Total Volume =	0	
Span D Total Volume =	0	
Span D Total Volume =	0.000	CYD

Span E Total Volume Calculation

Bridge Parameters		
Out-Out Bridge Floor	124.125	Feet
Width of Pour	42.33333333	Feet
Average Slab Thickness	8	Inches
Deck Volume		
Span E Deck Length = 0'		
Span E Deck Length = 0.000		Feet
Span E Deck Volume = (8" / 12) * 42.3333333333333' * 0'		
Span E Deck Volume = 0.000		CFT
Span E Deck Volume = 0.000		CYD
Span E Deck Volume × SIP Form Factor = 0.000		CYD
Span E Total Deck Volume = 0 CYD + 0 CYD		
Span E Total Deck Volume = 0.000		CYD
Fillet Volume		
Span E Fillet Volume = 0' * 0.015 CYD / FT		
Span E Fillet Volume = 0.000		CYD
Total Volume		
Span E Total Volume = 0		
Span E Total Volume = 0		
Span E Total Volume = 0.000		CYD

Span F Total Volume Calculation

Span F Total Volume Calculation		
Bridge Parameters		
Out-Out Bridge Floor =	124.125	Feet
Width of Pour =	42.33333333	Feet
Average Slab Thickness =	8	Inches
Deck Volume		
Span F Deck Length =	0'	
Span F Deck Length =	0.000	Feet
Span F Deck Volume =	$(8" / 12) * 42.33333333333333' * 0'$	
Span F Deck Volume =	0.000	CFT
Span F Deck Volume =	0.000	CYD
Span F Deck Volume × SIP Form Factor =	0.000	CYD
Span F Total Deck Volume =	0 CYD + 0 CYD	
Span F Total Deck Volume =	0.000	CYD
Fillet Volume		
Span F Fillet Volume =	$0' * 0.015 \text{ CYD / FT}$	
Span F Fillet Volume =	0.000	CYD
Total Volume		
Span F Total Volume =	0	
Span F Total Volume =	0	
Span F Total Volume =	0.000	CYD

Span G Total Volume Calculation

Bridge Parameters

Out-Out Bridge Floor =	124.125	Feet
Width of Pour =	42.33333333	Feet
Average Slab Thickness =	8	Inches

Deck Volume

Span G Deck Length = 0'		
Span G Deck Length = 0.000		Feet
Span G Deck Volume = (8" / 12) * 42.3333333333333' * 0'		
Span G Deck Volume = 0.000		CFT
Span G Deck Volume = 0.000		CYD
Span G Deck Volume × SIP Form Factor = 0.000		CYD
Span G Total Deck Volume = 0 CYD + 0 CYD		
Span G Total Deck Volume = 0.000		CYD

Fillet Volume

Span G Fillet Volume = 0' * 0.015 CYD / FT		
Span G Fillet Volume = 0.000		CYD

Total Volume

Span G Total Volume = 0		
Span G Total Volume = 0		
Span G Total Volume = 0.000		CYD