INTEROFFICE MEMORANDUM

DATE: Oct. 17, 1996

TO: Bridge Division Personnel

FROM: Dale Loe , Bridge Engineer *Signed as–Dale F. Loe*

SUBJECT: Detailing and Designing for Permanent Steel Deck Forms

Two types of permanent steel deck forms are permitted for steel and concrete girder bridges--forms that *match* the transverse slab reinforcing spacing and forms that *do not match* ('drop slab') the spacing. Both of these types are shown on Standard Drawing No. 36515 (14991). Bridges that have large girder spacings, flared girders, unusual reinforcing spacing, or curved bridges with a relatively small radius are more likely to be formed with a 'drop slab' than other bridges.

Due to the extra concrete that may be added to the structure when permanent forms are used, detailing and design practices shall conform to the following:

A) Superstructure Detail Drawings.

1. Base superstructure detailing on removable deck forms. Show the slab thickness between beams as 't_s = · · · ', and add the following note to the *span detail drawings*:

   > The superstructure details shown are for use when removable deck forming is used and are the basis for measurement of Class S(AE) Concrete. See Standard Drawing No. 36515 (14991) for allowable modifications and for tolerances when permanent steel bridge deck forms are used.

   The note should preferably be the first note of the general notes (or, after "Stations and elevations are in meters. All other dimensions are in millimeters unless otherwise noted.")

2. Slab thickness tolerances for removable deck will be:
   - When haunches are not detailed: + 25 mm (1"), – 6 mm (¼")
   - When haunches are detailed: + 12 mm (½"), – 6 mm (¼")

   These values shall be shown on the superstructure details.

3. Slab thickness tolerance for permanent deck forms will be: +12 mm (½"), – 6 mm (¼"). These values shall be shown only on Std. Dwg. No. 36515 (14991).

B) Design.

1. Add an extra non-composite dead load to the weight of the 'as detailed' slab. This dead load shall conform to the following table, taking into account the *likely* method of forming. Include the extra load in the design of all bridge components when designing for maximum loads/stresses (i.e., girder flexure

and shear, cap design, elastomeric bearings, etc.). Do not include this extra load when designing for minimum load/stress cases (i.e., overturning, uplift, elastomeric bearings, etc.)

	Extra Non-composite load to apply for design	
	Simple Steel Spans, and all Prestressed AASHTO girders	Continuous Steel Spans
Matching forms likely	0.57 kN/m^2 (12 psf)	0.72 kN/m^2 (15 psf)
Non-matching forms likely	0.72 kN/m^2 (15 psf)	0.86 kN/m^2 (18 psf)

2. The effective slab depth for design purposes (i.e., slab design and composite properties) will continue to be 12 mm ($^1/_2$″) less than the detailed thickness. This accounts for any poor-quality surface concrete and for abrasion of the concrete that will occur over the service life of the deck.
3. The dead load deflections and the loads to the girders shown on the plans shall be based on the detail drawings, *without* the above extra non-composite dead load.

C) Shop Drawings.

1. Prior to approval of the permanent deck form shop drawings, the girder dead load deflections shall be investigated for effects due to the permanent steel forms. The design plans shall be revised if a change of more than 6 mm ($^1/_4$″) occurs. All costs associated with such revision, including re-cambering of a previously approved girder will be borne by the Contractor. See the General Notes on Std. Dwg. No. 36515 (14491).

2. The dimension from the top of slab to the top of the deck form must be shown on the permanent steel deck form shop drawings. This dimension is shown in Section C-C on Std. Dwg. No. 36515 (14991).

Standard Drawing Nos. 14990H, 14991 and 36515 have been revised to include the above changes (effective date 11/27/96). Copies of these drawings and a typical example of a superstructure detail drawing are attached. Supporting calculations that are the basis for this memorandum are also attached for information.

Jobs advertised for the January 1997 and subsequent lettings should include the above applicable Standard Drawings. For projects currently under design, the applicability of the design portion of this memorandum will be determined by the Staff Engineer.

CPB
Attachments

[DSNWSIP.POL]

COMPARISON

	Ratio of Actual Stress to Design Stress																	
	Removable forms						Matching forms						Non-matching forms					
Case	**1** (tol.=0”)			**2** (tol.=+1”)			**3** (tol.=0”)			**4** (tol.=+ ½”)			**5** (tol.=0”)			**6** (tol.=+ ½”)		
Extra non-composite design load	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf
65’ Simple span	0.970	0.962	0.955	0.997	0.990	0.982	0.992	0.984	0.977	1.006	0.998	0.990	1.009	1.001	0.994	1.023	1.015	1.008
360’ P.G.-- S Pt. 1.4	0.972	0.965	0.958	0.997	0.991	0.983	0.994	0.987	0.980	1.005	0.998	0.991	1.008	1.001	0.994	1.021	1.014	1.007
“ “ -- S Pt. 2.0 bottom flange	0.961	0952	0.942	1.002	0.992	0.983	0.986	0.976	0.967	1.006	0.996	0.987	1.012	1.002	0.992	1.032	1.022	1.012
“ “ -- S Pt. 2.0 top flange	0.956	0.945	0.935	1.002	0.991	0.980	0.984	0.973	0.963	1.007	0.996	0.985	1.013	1.002	0.991	1.036	1.025	1.014

	Ratio of Actual Stress to Design Stress, expressed as %																	
	Removable forms						Matching forms						Non-matching forms					
Case	**1** (tol.=0”)			**2** (tol.=+1”)			**3** (tol.=0”)			**4** (tol.=+ ½”)			**5** (tol.=0”)			**6** (tol.=+ ½”)		
Extra non-composite design load	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf	12 psf	15 psf	18 psf
65’ Simple span	-3.0	-3.8	-4.5	-0.3	-1.0	-1.8	-0.8	-1.6	-2.3	+0.6	-0.2	-1.0	+0.9	+0.1	-0.6	+2.3	+1.5	+0.8
360’ P.G.-- S Pt. 1.4	-2.8	-3.5	-4.2	-0.3	-0.9	-1.7	-0.6	-1.3	-2.0	+0.5	-0.2	-0.9	+0.8	+0.1	-0.6	+2.1	+1.4	+0.7
“ “ -- S Pt. 2.0 bottom flange	-3.9	-4.8	-5.8	+0.2	-0.8	-1.7	-1.4	-2.4	-3.3	+0.6	-0.4	-1.3	+1.2	+0.2	-0.8	+3.2	+2.2	+1.2
“ “ -- S Pt. 2.0 top flange	-4.4	-5.5	-6.5	+0.2	-0.9	-2.0	-1.6	-2.7	-3.7	+0.7	-0.4	-1.5	+1.3	+0.2	-0.9	+3.6	+2.5	+1.4

SUMMARY OF STRESSES

	Bending Stress, ksi, with:								
	Adn'l. load of:			Removable forms		Matching forms		Non-matching forms	
	12 psf	15 psf	18 psf						
Case	-	-	-	**1**	**2**	**3**	**4**	**5**	**6**
Tolerance (tol)	-	-	-	0"	+1"	0"	+ ½"	0"	+ ½"
65' Simple span	47.69	48.06	48.42	46.24	47.57	47.31	47.96	48.11	48.79
360' P.G.-- S Pt. 1.4	51.35	51.71	52.08	49.90	51.22	51.02	51.61	51.78	52.42
" " -- S Pt. 2.0 bottom flange	50.13	50.62	51.11	48.17	50.22	49.42	50.44	50.71	51.73
" " -- S Pt. 2.0 top flange	51.11	51.68	52.24	48.85	51.22	50.30	51.47	51.78	52.96

Assume:

- Permanent forms weigh 3 psf
- Average thickness of 1" of concrete will fill the forms flush with top
- ½ " deducted from plan deck thickness for stress calculations (composite properties) to account for long-time surface abrasion

Let:

- t_s = plan deck thickness, inches
- t_{dl} = concrete thickness for dead load calculations, inches
- t_{eff} = concrete thickness for stress calculations, inches
- tol = slab thickness tolerance, inches
- b_{eff} = effective composite slab width, inches
- c = distance from bottom of t_{eff} to top of top flange, inches
- w_{extra} = extra weight due to forming and tolerances, klf

Then:

When matching forms are used: $t_{dl} = t_s$ - 1" + 3/8 " + 1" + tol or $\underline{t_{dl} = t_s + 3/8\text{"} + tol}$

$t_{eff} = t_s$ - ½" - 1" + 3/8 " + tol or $\underline{t_{eff} = t_s - 1.125\text{"} + tol}$

$w_{extra} = \{[t_{dl} - t_s] \times {}^{0.15}/_{12} + 0.003\}$ x Beam Spacing

When non-matching forms are used: $\underline{t_{dl} = t_s + 1\text{"} + tol}$

$\underline{t_{eff} = t_s - ½\text{"} + tol}$

$w_{extra} = \{[t_{dl} - t_s] \times {}^{0.15}/_{12} + 0.003\}$ x Beam Spacing

For 65' Simple Span

Given:

- Standard W-Beam drawing for 28 ft. Roadway; Beam Spacing = 8.6667'
- 8.00" slab thickness; No haunch
- w_{ncdl} = 0.885 klf (due to slab only); w_{cdl} = 0.350 klf (due to parapet and future wearing surface)
- WF_{LL} = 1.576 wheels; Impact = 1.228; HS20 live load
- W 36 x 135, w/o coverplate; ASTM A588
- Stress calculations are for overload ⇒ D + 1.67(LL + I)

Calculations:

Top of deck to bottom of beam = 8.00" + 35.55" - 0.79" = 42.76"

c = 42.76" - 0.5" - 35.55" - t_{eff} or c = 6.71" - t_{eff}

${}^{ncdl}M = [(w_{extra}/ 0.885) + 1][451.96^{A}] + 81.8^{B}$

${}^{cdl}M = 178.7^{C}$ ft-kip

${}^{live+i}M = 864.2^{D} \times 1.67 = 1443.2$ ft-kip

CASE	1	2	3	4	5	6
t_s, in.	8	8	8	8	8	8
tol, in.	0	1	0	½	0	½
t_{dl}, in.	8	9	8.375	8.875	9	9.5
t_{eff}, in.	7.5	8.5	6.875	7.375	7.5	8.0
b_{eff}, in.	90	102	82.5	88.5	90	96
c, in.	-0.79	-1.79	-0.165	-0.665	-0.79	-1.29
w_{extra}, klf	0	0.108	0.067	0.121	0.134	0.189

${}^{ncdl}S_b$, in^3	438.8	438.8	438.8	438.8	438.8	438.8
${}^{24}S_b$, in^3	569.1	574.9	564.0	568.2	569.1	572.3
${}^{8}S_b$, in^3	621.3	624.5	619.0	620.8	621.3	622.9

${}^{ncdl}M$, in-k	6405.1	7067.0	6815.7	7146.6	7226.3	7563.4
${}^{cdl}M$, in-k	2144.4	2144.4	2144.4	2144.4	2144.4	2144.4
${}^{live+i}M$, in-k	17318.4	17318.4	17318.4	17318.4	17318.4	17318.4

[A] Dead load moment at centerline span due to uniform slab load of 0.885 klf
[B] Dead load moment at centerline span due to weight of beam + framing
[C] Dead load moment at centerline span due to uniform load of 0.350 klf
[D] Live load moment at centerline span - includes impact, wheel factor, and load factor of 1.67

For 360' Continuous Plate Girder

Given:

- 40 ft. Roadway; Beam Spacing = 9.0000'
- 8.00" slab thickness; 1" haunch
- w_{ncdl} = 0.900 klf (due to slab only); w_{cdl} = 0.348 klf (due to parapet and future wearing surface)
- WF_{LL} = 1.636 wheels; HS20 live load
- 54" web depth; ASTM A588
- Stress Calculations are for **1.3[D + 1.67(LL + I)]** --- Moments obtained from 'Georgia Continuous Beam' computer program.

At **S. Pt. 1.4** (¾ " top flange; 1" bottom flange)

Calculations:

Girder depth $_{\mathbf{pos}\ \mathrm{mom}}$ = .75" + 54" + 1" = 55.75"

Top of deck to bottom of girder $_{\mathbf{pos}\ \mathrm{mom}}$ = 8.00" + 1" + 54" + 1" = 64.00

c = 64.00" - 0.5" - 55.75" - t_{eff} or c = 7.75" - t_{eff}

$^{ncdl}M_{S\ Pt\ 1.4} = [(1.3\ w_{extra}/ 1.17^{A}) + 1][825.2^{A}] + 154.4^{B}$

$^{cdl}M_{S\ Pt\ 1.4} = 348.7^{C}$ ft-kip; $^{live+\ i}M_{S\ Pt\ 1.4} = 2997.2^{D}$ ft-kip

CASE	1	2	3	4	5	6
t_s, in.	8	8	8	8	8	8
tol, in.	0	1	0	½	0	½
t_{dl}, in.	8	9	8.375	8.875	9	9.5
t_{eff}, in.	7.5	8.5	6.875	7.375	7.5	8.0
b_{eff}, in.	90	102	82.5	88.5	90	96
c, in.	0.25	-0.75	0.875	0.375	0.25	-0.25
w_{extra}, klf	0	0.113	0.069	0.125	0.140	0.196

$^{ncdl}S_b$, in^3	819.5	819.5	819.5	819.5	819.5	819.5
$^{24}S_b$, in^3	1049.3	1063.4	1037.7	1047.2	1049.3	1057.0
$^{8}S_b$, in^3	1139.3	1144.7	1134.0	1138.4	1139.3	1142.3
$^{ncdl}S_t$, in^3	722.8	722.8	722.8	722.8	722.8	722.8
$^{24}S_t$, in^3	2468.6	2939.8	2198.3	2413.0	2468.6	2698.7
$^{8}S_t$, in^3	7179.0	9206.6	6049.5	6493.9	7179.0	8162.1

^{ncdl}M, in-k	11755.2	12998.5	12514.4	13130.5	13295.6	13911.7
^{cdl}M, in-k	4184.4	4184.4	4184.4	4184.4	4184.4	4184.4
$^{live+\ i}M$, in-k	35966.4	35966.4	35966.4	35966.4	35966.4	35966.4

[A] Dead load moment due to uniform slab load of 1.3 • 0.900 = 1.17 klf

[B] Dead load moment due to 1.3 • [weight of beam + framing]

[C] Dead load moment due to uniform load of 1.3 • 0.348 klf

^{D} Live load moment - includes impact, wheel factor, and load factor of 1.3 • 1.67

For 360' Continuous Plate Girder

At **S. Pt. 2.0** (1¼ " top flange; 1½" bottom flange)

${}^{ncdl}M_{S\ Pt\ 2.0} = [(1.3\ w_{extra}/\ 1.17^{A}) + 1][2126.4^{A}] + 445.5^{B}$

${}^{cdl}M_{S\ Pt\ 2.0} = 746.6^{C}$ ft-kip

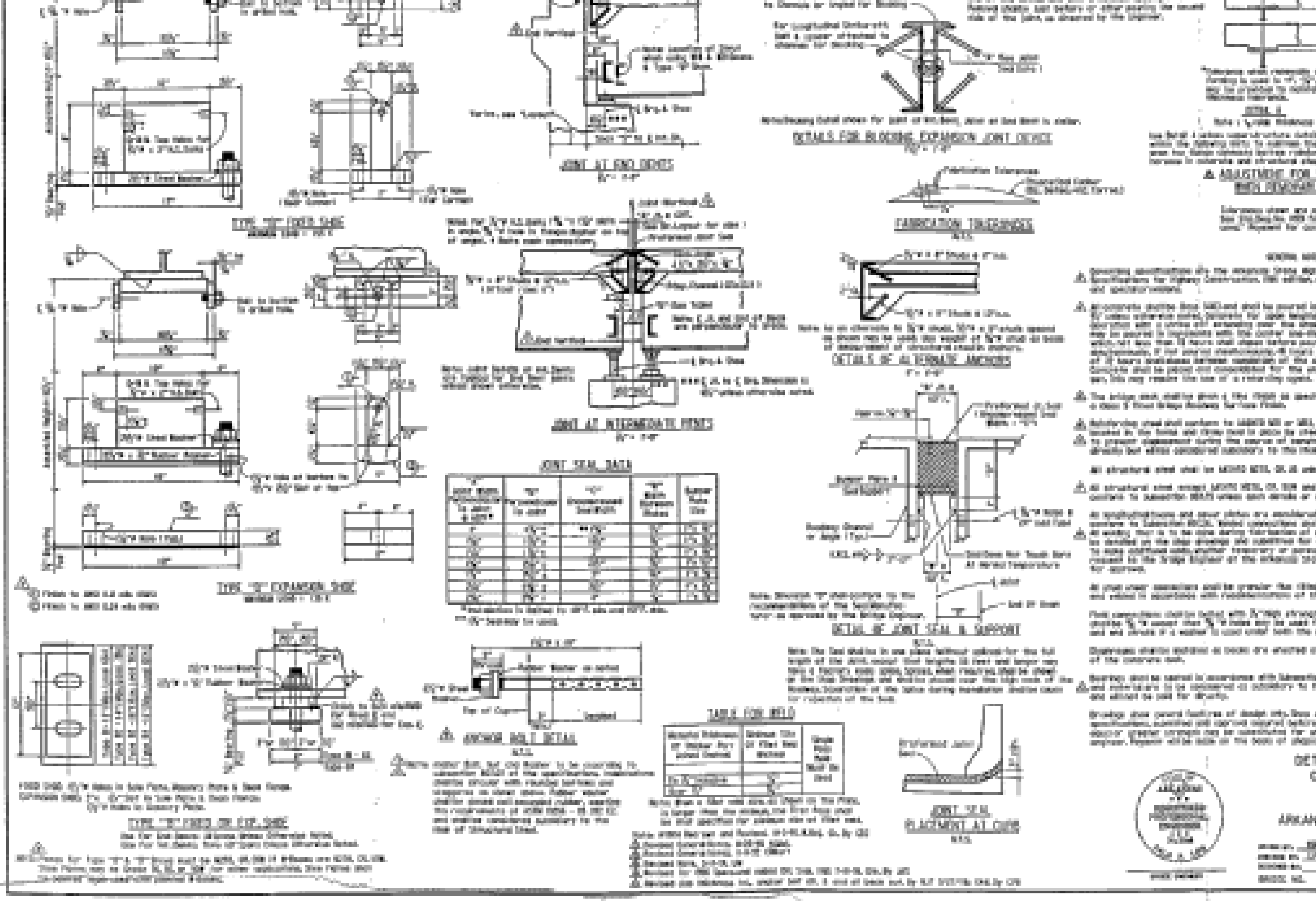
${}^{live+i}M_{S\ Pt\ 2.0} = 3181.7^{D}$ ft-kip

CASE	1	2	3	4	5	6
t_s, in.	8	8	8	8	8	8
tol, in.	0	1	0	½	0	½
t_{dl}, in.	8	9	8.375	8.875	9	9.5
t_{eff}, in.	7.5	8.5	6.875	7.375	7.5	8.0
w_{extra}, klf	0	0.113	0.069	0.125	0.140	0.196

${}^{ncdl}S_b$, in^3	1560.5	1560.5	1560.5	1560.5	1560.5	1560.5
${}^{r}S_b$, in^3	1660.3	1660.3	1660.3	1660.3	1660.3	1660.3
${}^{ncdl}S_t$, in^3	1353.6	1353.6	1353.6	1353.6	1353.6	1353.6
${}^{r}S_t$, in^3	1809.6	1809.6	1809.6	1809.6	1809.6	1809.6

${}^{ncdl}M$, in-k	30862.8	34066.6	32819.1	34406.8	34832.1	36419.8
${}^{cdl}M$, in-k	8959.2	8959.2	8959.2	8959.2	8959.2	8959.2
${}^{live+i}M$, in-k	38180.4	38180.4	38180.4	38180.4	38180.4	38180.4

^{A} Dead load moment due to uniform slab load of 1.3 • 0.900 = 1.17 klf
^{B} Dead load moment due to 1.3 • [weight of beam + framing]
^{C} Dead load moment due to uniform load of 1.3 • 0.348 klf
^{D} Live load moment - includes impact, wheel factor, and load factor of 1.3 • 1.67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TYPE "E" EXPANSION SHOE
TYPE "F" FIXED OR EXP. SHOE
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TABLE FOR WELD
DETAILS FOR BLOCKING EXPANSION JOINT DEVICE
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DETAILS OF ALTERNATE ANCHORS
DETAIL OF JOINT SEAL & SUPPORT
JOINT SEAL
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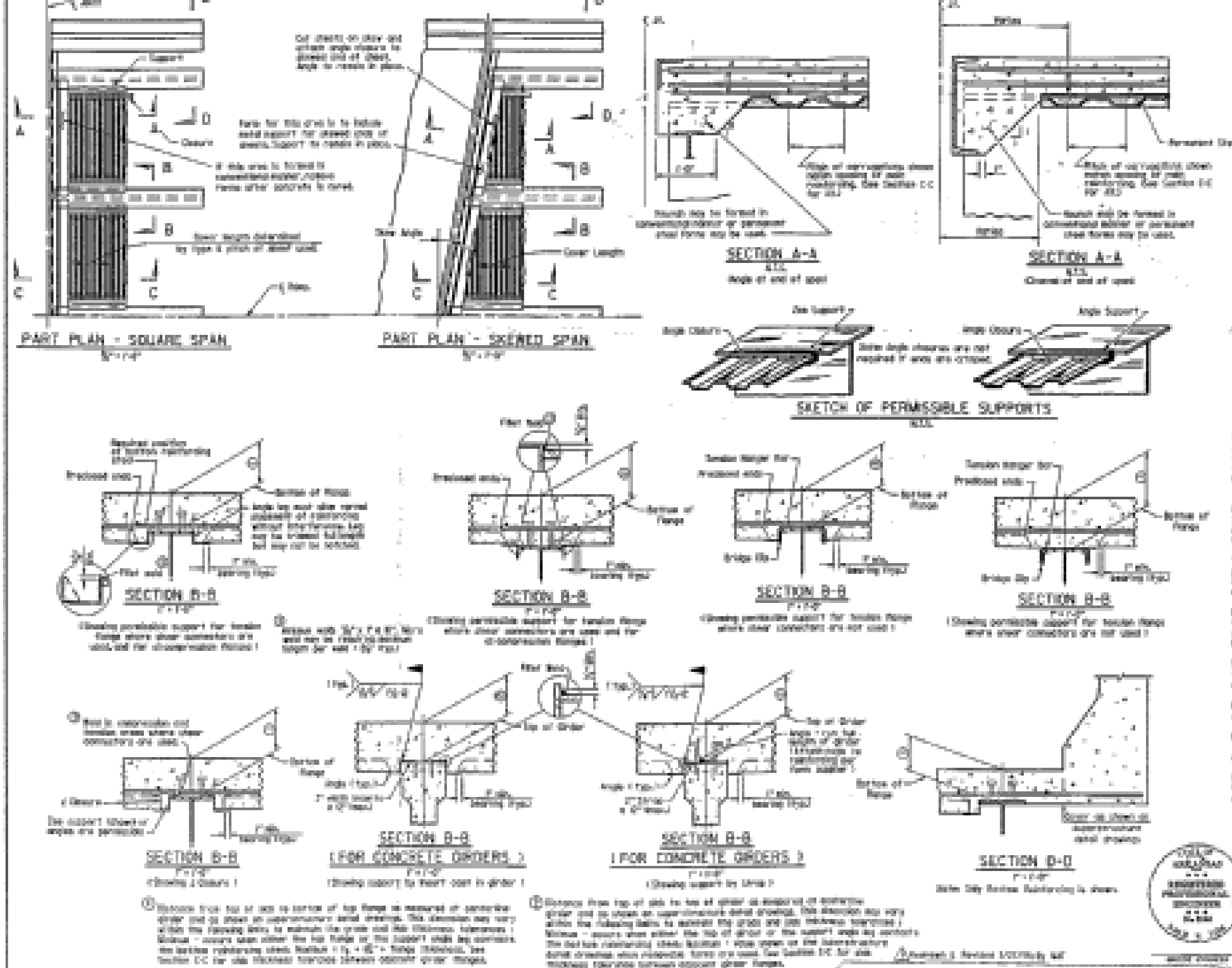

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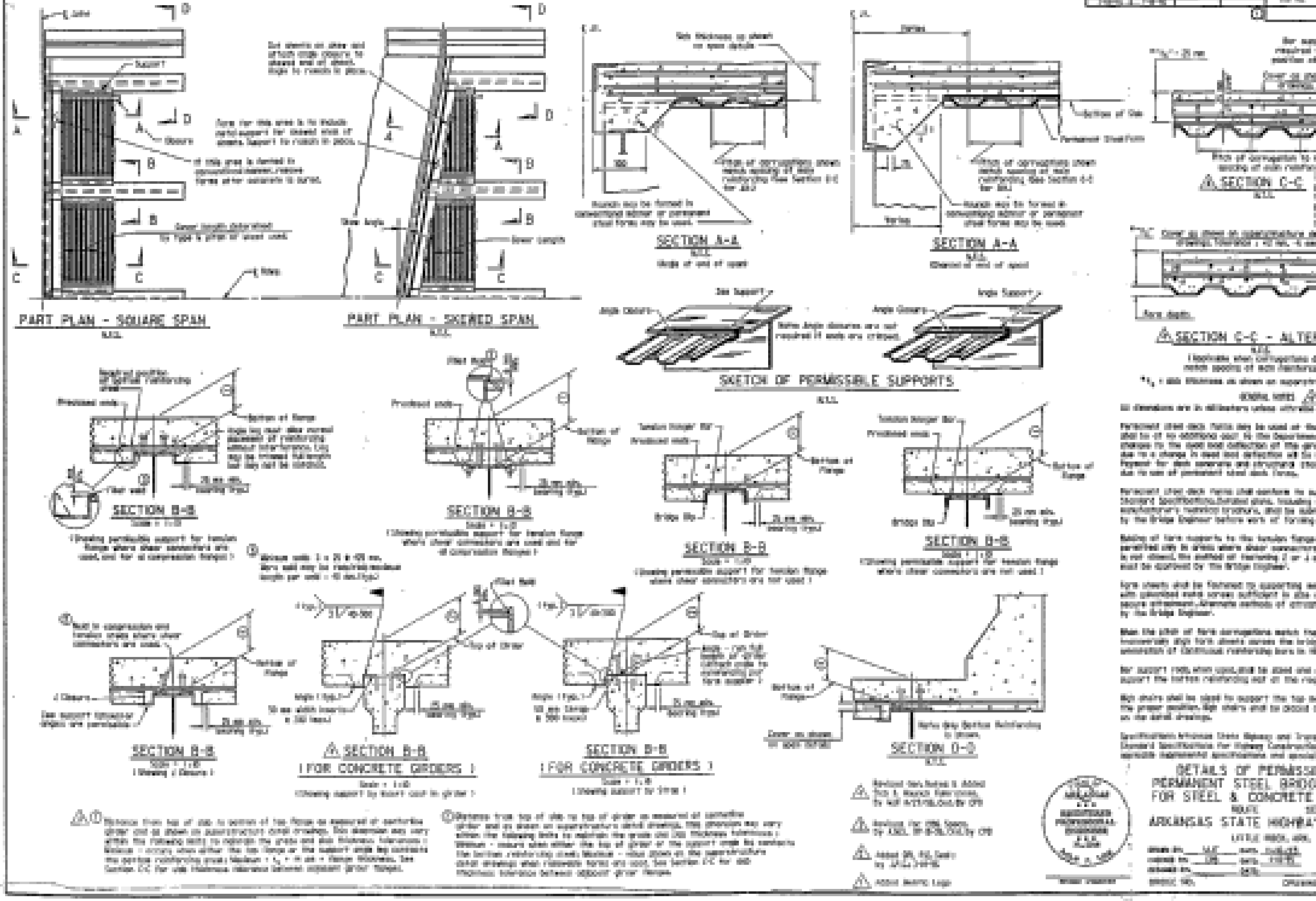

PART PLAN - SQUARE SPAN
PART PLAN - SKEWED SPAN
SECTION A-A
SECTION A-A
SECTION C-C
SKETCH OF PERMISSIBLE SUPPORTS
SECTION C-C - ALTER
SECTION B-B
SECTION B-B
SECTION B-B
SECTION B-B
SECTION B-B
SECTION B-B
(FOR CONCRETE GIRDERS)
SECTION B-B
(FOR CONCRETE GIRDERS)
SECTION D-D
DETAILS OF PERMISS
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