California Department of Transportation

Caltrans Precast Concrete Committee Update

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Nov. 3rd, 2010

2010 Caltrans/PCMAC/Consultants Bridge Workshop

Current Committee Members

- Fritz Hoffman, SD
- Douglas Dunrud, SD
- Phil Lutz, SD
- Manode Kodsuntie, SD
- Eric Fredrickson, OSFP
- Say-Gunn Low, OSFP
- Jeremy S Wright, OSFP
- Keith Hoffman, METS
- Tom Ruckman, Specifications
- Cheryl Poulin, Construction
- Jim Ma, ESPD (Engineering Services Policy Development)
- Sue Hida, ESPD (Engineering Services Policy Development)

PC Committee Mission and Goal

Mission

- To Provide PRECAST (Policy, Resource, Expertise, Coordination, Assistance, Standards, Training)

Goal

- Provide Technical Support to Design and Construction for Precast Bridge Structures in CA
- Promote ABC by Using Precast Products
- Promote Prefabricated Bridge Elements and Systems (PBES) to Support FHWA “EDC” Initiative

Typical Cast-in-Place Falsework

California Precast Bridge Design Challenges

Current Bridge Data: CIP 70% +, Precast 25% -

WHY ???

Precast Advantages:

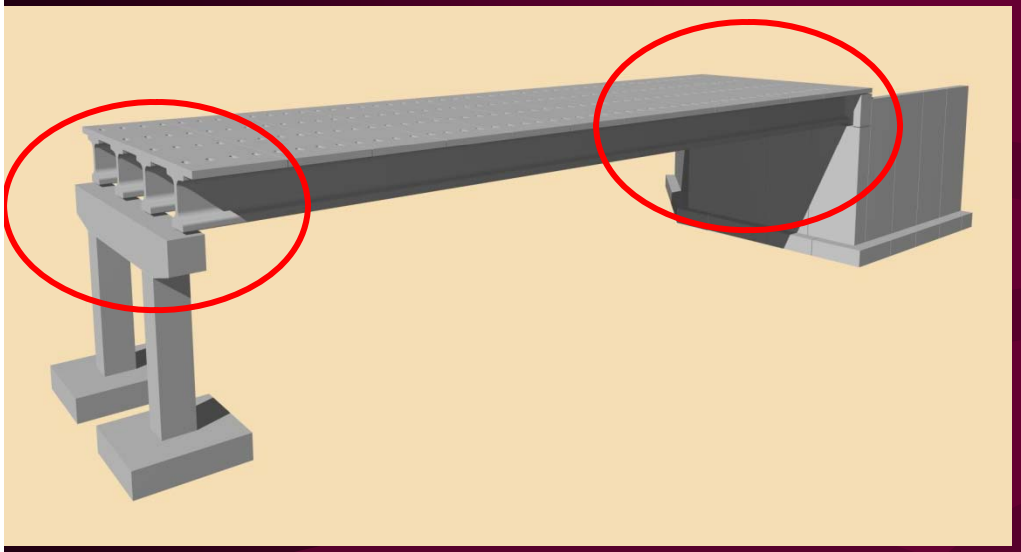
- Rapid construction
- Minimize falsework
- Reduce traffic disruptions on-site
- Improve safety for traffic and construction workers
- Minimize environmental impact
- Increase product quality

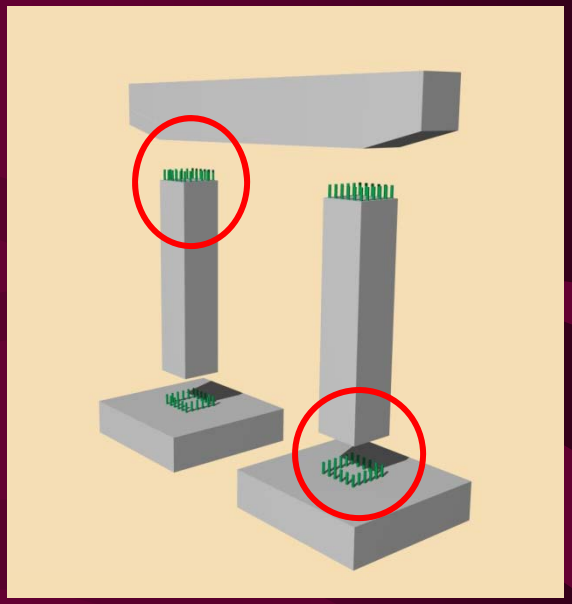
Precast Challenges:

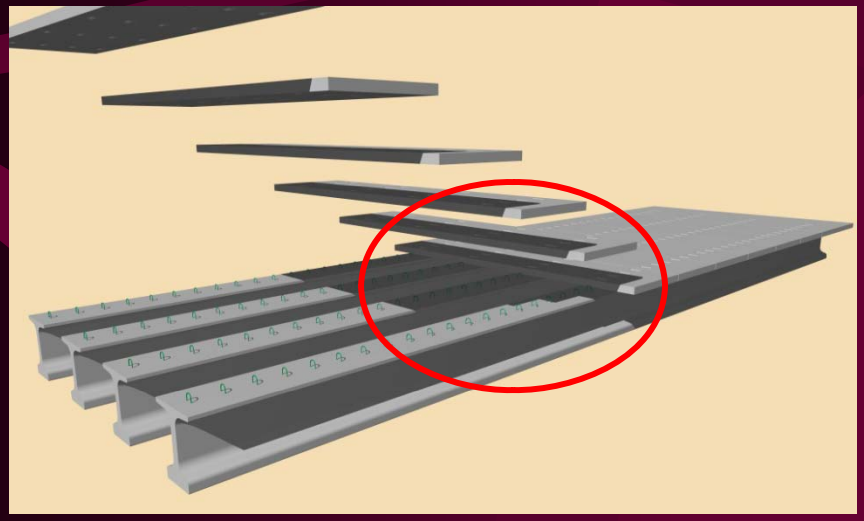
- Seismic Design
- Construction Cost
- Longer Span

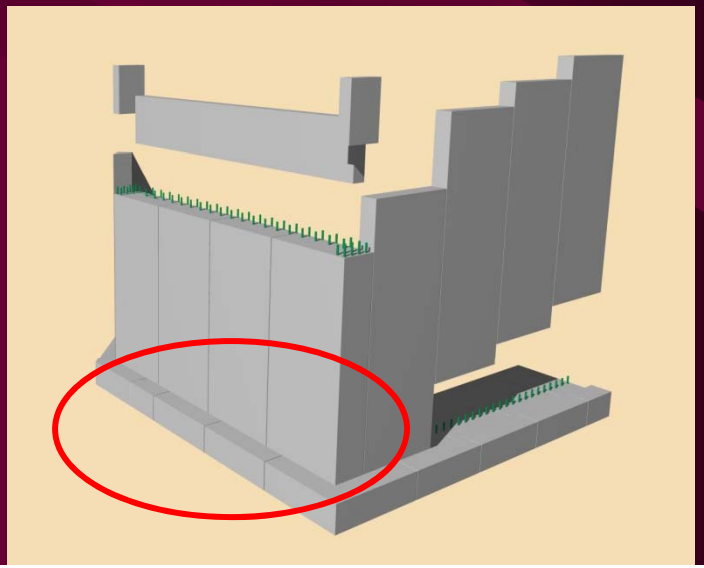
Precast Bridge Seismic Design

CONNECTION, CONNECTION, CONNECTION









California Precast Girder Bridge with Different Connections

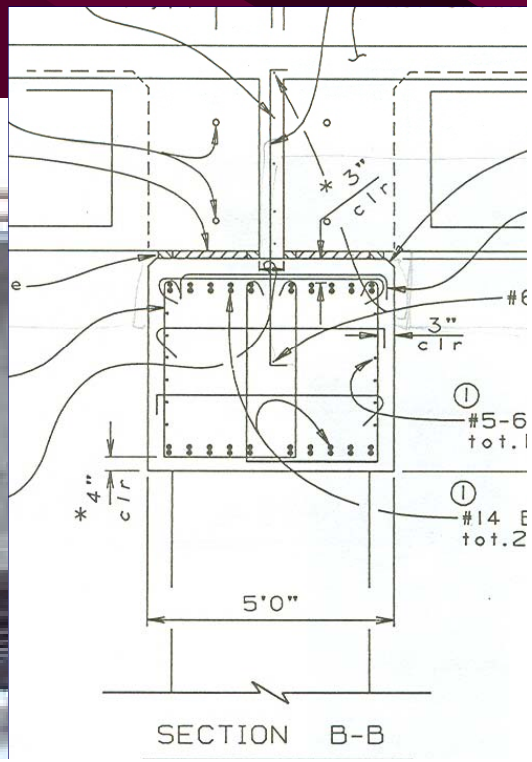
Typical California Precast Girder/Bent Cap Connections:

- Drop Bent Cap Connection
- Inverted-T Bent Cap Connection
- Integral Drop Bent Cap Connection
- Integral Bent Cap Connection

Precast Girder Connection Design and Details

Drop Bent Cap Connection

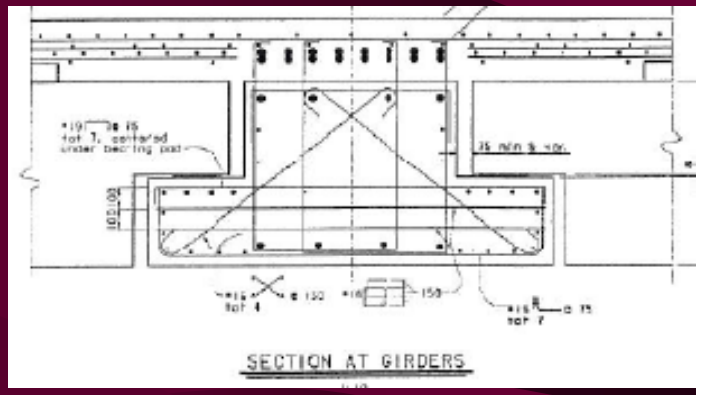
- Continuous superstructure
- Pinned between superstructure and cap
- Column/footing connection has to be fixed
- Extend PC girder bottom strands
- Good seismic connection

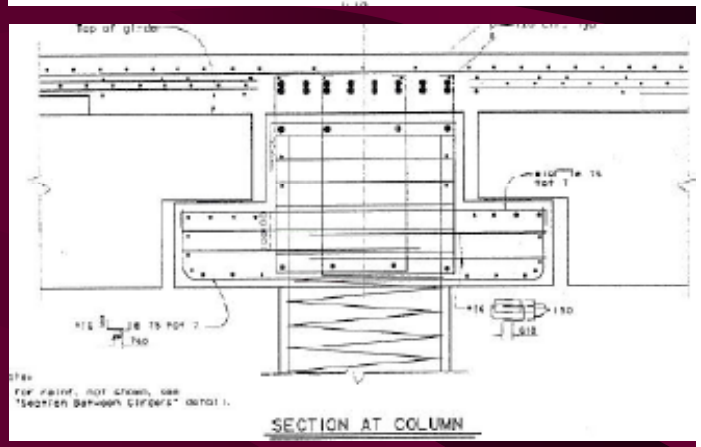


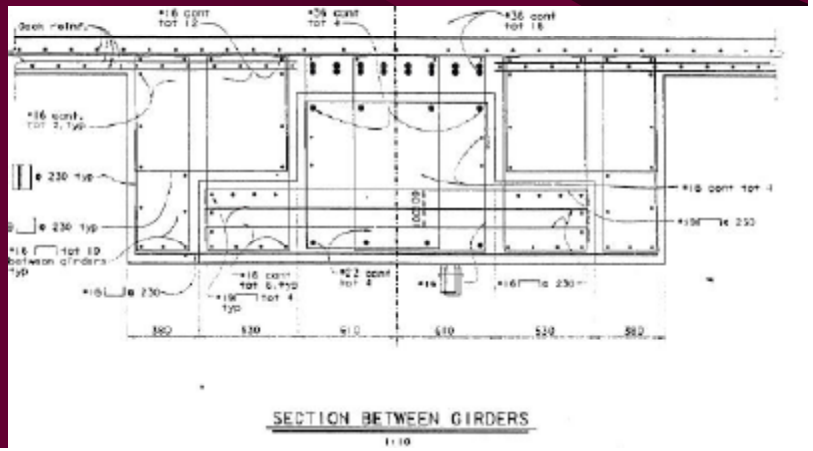
Precast Girder Connection Design and Details

Inverted-T Bent Cap Connection

- Semi-continuous superstructure
- Considered as pinned between superstructure and cap
- Column/footing connection has to be fixed
- Seismic research study on-going



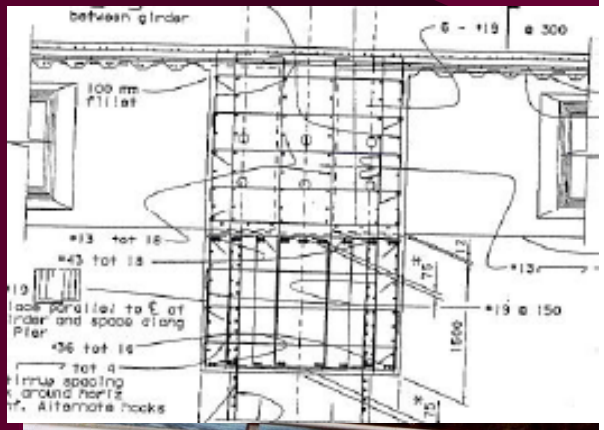


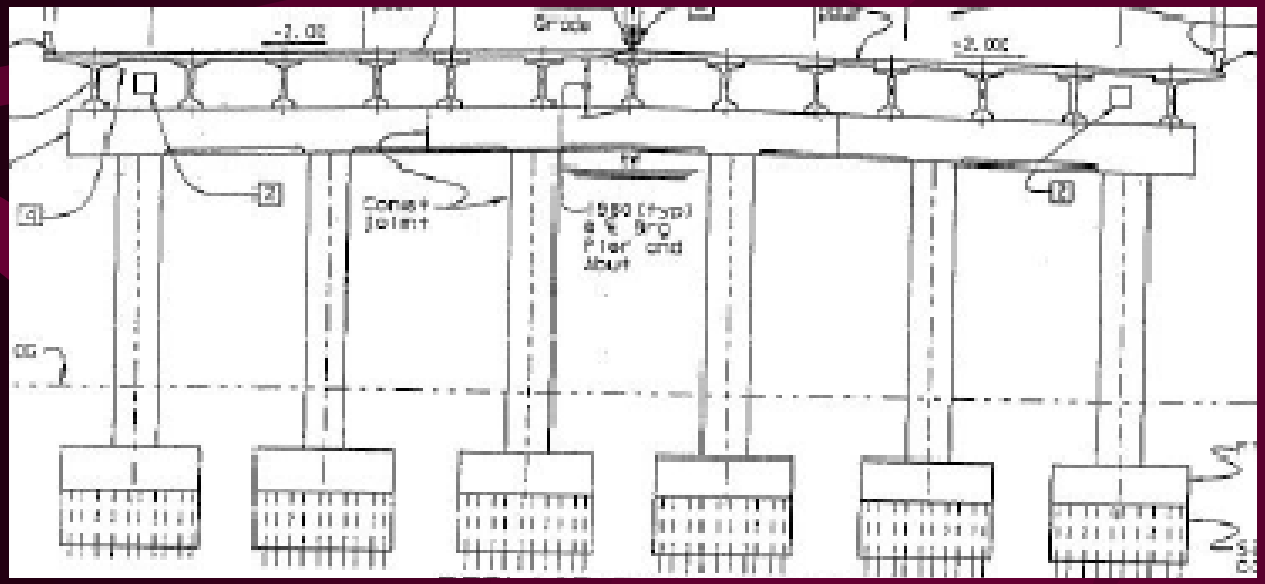


Precast Girder Connection Design and Details

Integral Drop Bent Cap Connection

- Continuous superstructure
- Fixed between superstructure and cap
- Column/footing connection could be pinned
- Good seismic connection

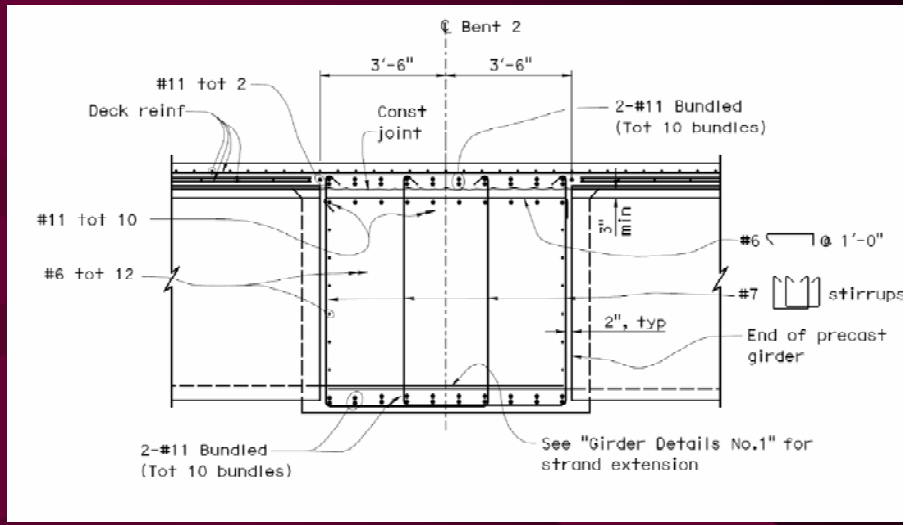


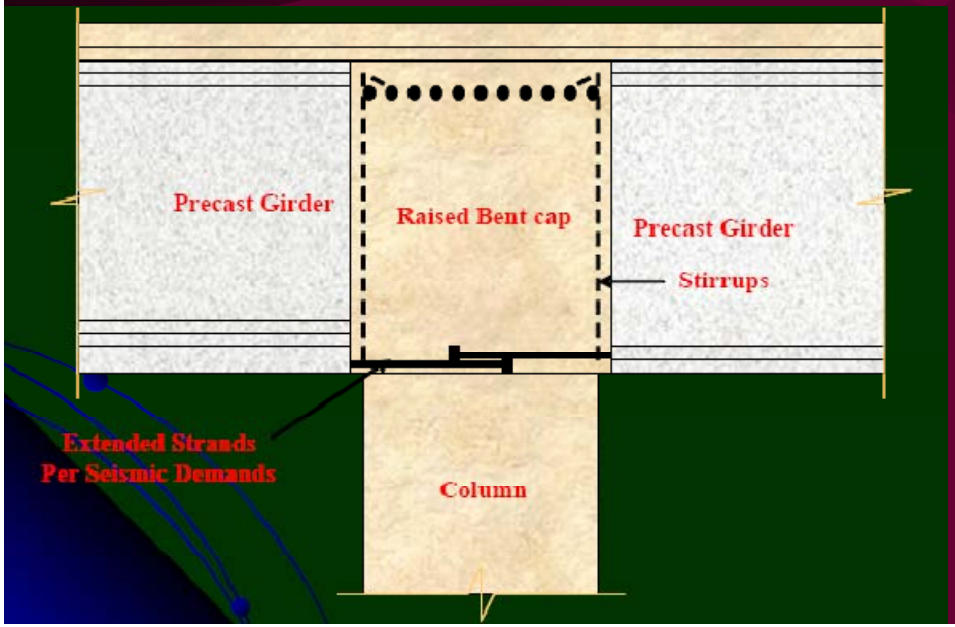


Precast Girder Connection Design and Details

Integral Bent Cap Connection

- Continuous superstructure
- Fixed between superstructure and cap
- Column/footing connection could be pinned
- Great seismic connection





Current Precast Bridge Cost

Year of 2008

Bridge Name	Girder Type	New/Widen	Area	SQFT COST	Net Bridge Cost
ANGELES CREST BRIDGE	Precast Bulb-Tee Girder	New	8,868	$240.73	$2,134,715.34
SAN ANTONIO CREEK BRIDGE	Precast Bulb-Tee Girder	New	7,830	$232.14	$1,817,656.20
PUTTS LAKE UNDERCROSSING	Precast I-Girder	New	4,738	$287.66	$1,362,959.99
MIRA MESA BOULEVARD UC	Precast I-Girder	Widen	10,597	$137.72	$1,459,363.27
COUNTY LINE ROAD UC	Precast I-Girder	Widen	2,098	$294.74	$618,287.98
NEW RIVER BRIDGE	Precast I-Girder	New	26,686	$250.17	$6,675,972.67
			AVG	$231.34	

Year of 2009

Bridge Name	Girder Type	New/Widen	Area	SQFT COST	Net Bridge Cost
ROUTE 145/99 SEP.	Precast I-Girder	Widen	15243	$145.00	$2,212,377.00
OLYMPIA BLVD UC	Precast I-Girder	Widen	3913	$328.00	$1,283,429.00
TAPO CANYON ROAD UC	Precast I-Girder	Widen	9619	$164.00	$1,578,647.00
HARBOR BLVD OC	Precast Bath-Tub Girder	Widen	14693	$147.00	$2,158,424.00
CHESTER AVE UC	Precast Bulb-Tee Girder	New	40034	$153.00	$6,113,645.00
COAL CANYON RD UC	Precast Bulb-Tee Girder	Widen	1938	$214.00	$414,810.00
			AVG	$161.06	

Current California Bridge Cost

DIVISION OF ENGINEERING SERVICES

BRIDGE SQUARE FOOT COST SUMMARY

2009

Bridge Code	BRIDGE TYPE	TOTAL NUMBER OF BRIDGES	NUMBER OF BRIDGE WIDENED	AMOUNT**	SQ.FT. OF DECK	AVERAGE COST/SQ.FT.**
10	RC SLAB	6	2	$9,079,369	36,754	$247
20	RC T-BEAM	3	3	$1,656,595	10,497	$158
21	RC U GIRDER	0	0	$0	0	$0
22	RC BOX GIRDER	9	1	$17,130,195	91,682	$187
30	CIP/PS U GIRDER	0	0	$0	0	$0
31	CIP/PS BOX GIRDER	44	11	$404,739,984	2,110,652	$192
32	CIP/PS SLAB	3	0	$5,707,900	38,983	$146
40	PC/PS SLAB	1	1	$2,870,390	2,747	$1,045
41	PC/PS "I" GIRDER	4	4	$5,874,114	29,765	$197
42	PC/PS "T" GIRDER	0	0	$0	0	$0
43	PC/PS 'INV T" GIRDER	0	0	$0	0	$0
44	PC/PS BOX GIRDER	1	1	$2,158,424	14,694	$147
45	PC/PS BULB "T" GIRDER	2	1	$6,528,455	41,972	$156
46	PC/PS BOX GIRDER-SEG	0	0	$0	0	$0
50	STEEL GIRDER	1	0	$7,059,689	34,225	$206
	TOTALS	**74**	**24**	**$462,805,115**	**2,411,971**	**$192**

Current PC Committee Working Items

LRFD Precast Guidance Materials for Designers:

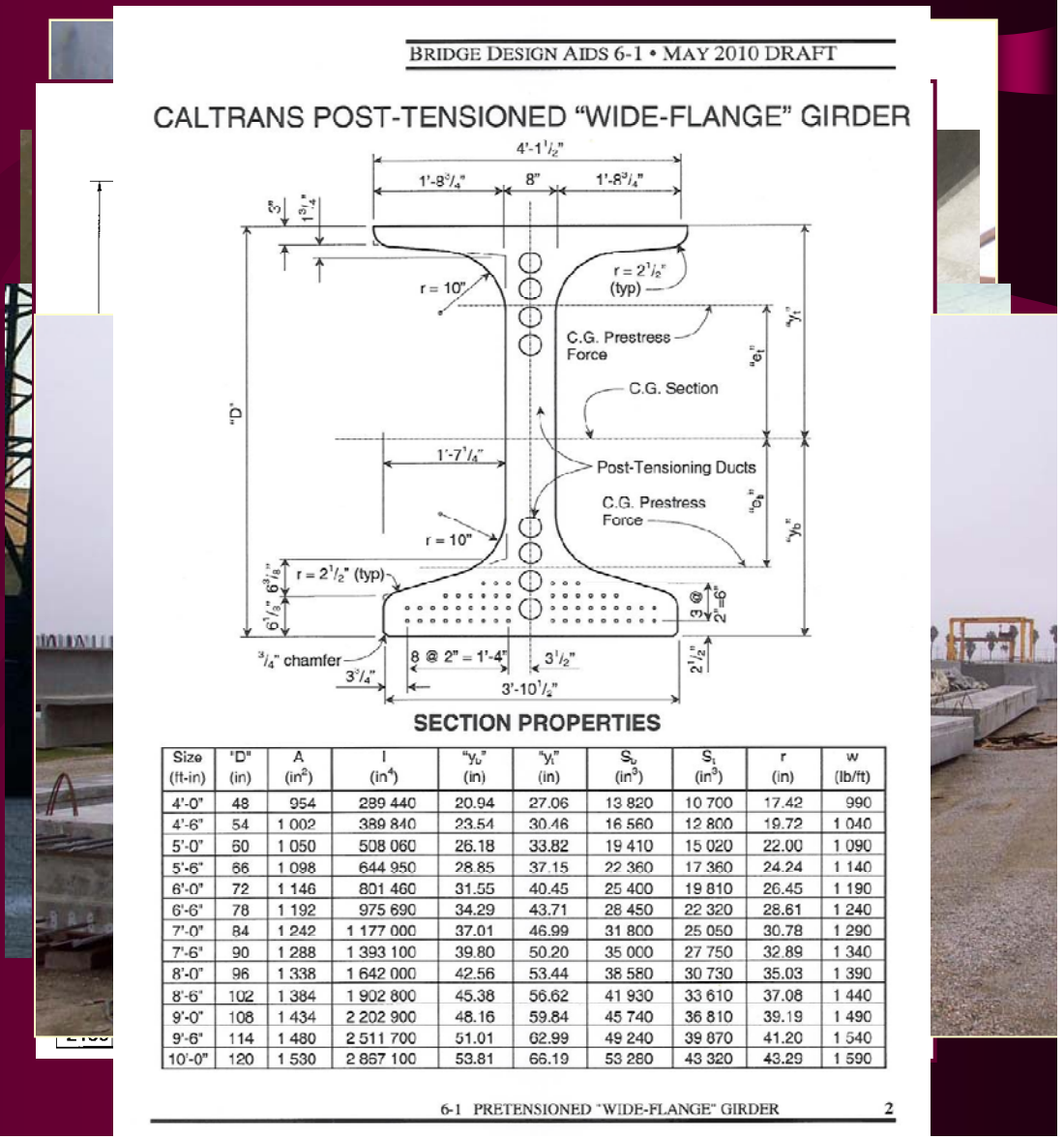
1. Bridge Design Aids Chapter 6 (New Wide-Flange Girder, Box Section, Trapezoidal Section, Voided Slab Table)
2. Bridge Memo to Designers: 11-8 “Design of Precast Prestressed Girders”
3. Bridge Design Practice Manual: Chapter 10 “PC/PS Concrete Girder Design Example”
4. Caltrans Standard Drawings:
   - Precast Prestressed I-Girder
   - Precast Prestressed Bulb-Tee Girder (Harped Strands 2 sheets, Debonded Strands 2 sheets)
   - Precast Prestressed Voided Slab
   - Precast Prestressed Wide-Flanged Girder (under-development)
   - Precast Deck Panel (under-development)

California Precast Girder Inventory and Span Capacity

California Precast-Pretensioned Girders

Precast Girder Shapes

- Common Used Shapes
  - California I-Girders
  - California Bulb-Tee
  - California Bath-Tub
  - California Voided Slabs
  - Precast Box Beams
  - Precast Delta Girders
  - CA WF Girder



BRIDGE DESIGN AIDS 6-1 • MAY 2010 DRAFT

CALTRANS POST-TENSIONED "WIDE-FLANGE" GIRDER

SECTION PROPERTIES

Size (ft-in)	"D" (in)	A (in²)	I (in⁴)	"y_b" (in)	"y_t" (in)	S_b (in³)	S_t (in³)	r (in)	w (lb/ft)
4'-0"	48	954	289 440	20.94	27.06	13 820	10 700	17.42	990
4'-6"	54	1 002	389 840	23.54	30.46	16 560	12 800	19.72	1 040
5'-0"	60	1 050	508 060	26.18	33.82	19 410	15 020	22.00	1 090
5'-6"	66	1 098	644 950	28.85	37.15	22 360	17 360	24.24	1 140
6'-0"	72	1 146	801 460	31.55	40.45	25 400	19 810	26.45	1 190
6'-6"	78	1 192	975 690	34.29	43.71	28 450	22 320	28.61	1 240
7'-0"	84	1 242	1 177 000	37.01	46.99	31 800	25 050	30.78	1 290
7'-6"	90	1 288	1 393 100	39.80	50.20	35 000	27 750	32.89	1 340
8'-0"	96	1 338	1 642 000	42.56	53.44	38 580	30 730	35.03	1 390
8'-6"	102	1 384	1 902 800	45.38	56.62	41 930	33 610	37.08	1 440
9'-0"	108	1 434	2 202 900	48.16	59.84	45 740	36 810	39.19	1 490
9'-6"	114	1 480	2 511 700	51.01	62.99	49 240	39 870	41.20	1 540
10'-0"	120	1 530	2 867 100	53.81	66.19	53 280	43 320	43.29	1 590

California Precast-Pretensioned Girders

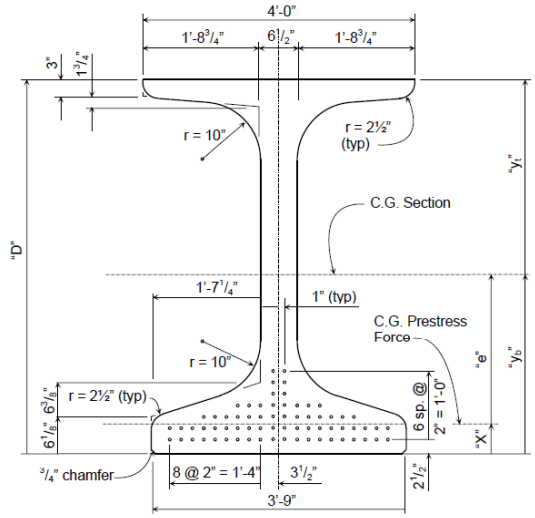
Common Shapes and Span Length Summary

Girder Type	Possible Span Length	Preferred Span Length
California I-Girder	50’ to 125’	50’ to 95’
California Bulb-Tee Girder	80’ to 150’	95’ to 150’
California Bath Tub Girder	80’ to 150’	80’ to 100’
California Wide-Flange Girder	100’ to 200’	100’ to 180’
California Voided Slab	20’ to 70’	20’ to 50’
Precast Box Girder	40’ to 100’	40’ to 80’
Precast Delta Girder	60’ to 120’	60’ to 100’
Precast Double T Girder	30’ to 100’	30’ to 60’
Precast Rectangular Girder	30’ to 120’	30’ to 100’

California Department of Transportation

California Wide-Flange Girder

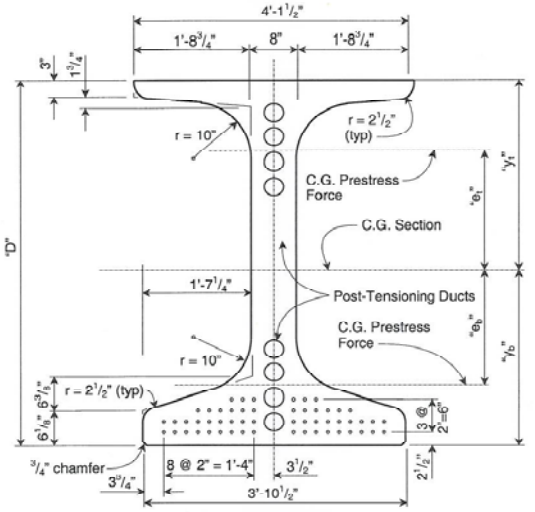
CALTRANS PRETENSIONED "WIDE-FLANGE" GIRDER



SECTION PROPERTIES

Size (ft-in)	"D" (in)	A (in²)	I (in⁴)	"yb" (in)	"yt" (in)	Sb (in³)	St (in³)	r (in)	w (lb/ft)
4'-0"	48	882	274 880	20.69	27.31	13 290	10 070	17.65	920
4'-6"	54	921	369 100	23.23	30.77	15 890	12 000	20.02	960
5'-0"	60	960	479 620	25.82	34.18	18 580	14 030	22.35	1 000
5'-6"	66	999	607 130	28.44	37.56	21 350	16 160	24.65	1 040
6'-0"	72	1 038	752 430	31.08	40.92	24 210	18 390	26.92	1 080
6'-6"	78	1 075	913 490	33.77	44.23	27 050	20 650	29.15	1 120
7'-0"	84	1 116	1 099 400	36.45	47.55	30 160	23 120	31.39	1 160
7'-6"	90	1 153	1 297 900	39.19	50.81	33 120	25 550	33.55	1 200
8'-0"	96	1 194	1 526 600	41.91	54.09	36 430	28 220	35.76	1 240
8'-6"	102	1 231	1 764 700	44.68	57.32	39 500	30 790	37.86	1 280
9'-0"	108	1 272	2 039 200	47.42	60.58	43 000	33 660	40.04	1 330
9'-6"	114	1 309	2 319 500	50.23	63.77	46 180	36 370	42.09	1 360
10'-0"	120	1 350	2 643 200	52.99	67.01	49 880	39 450	44.25	1 410

CALTRANS POST-TENSIONED "WIDE-FLANGE" GIRDER



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8'-0"	96	1 338	1 642 000	42.56	53.44	38 580	30 730	35.03	1 390
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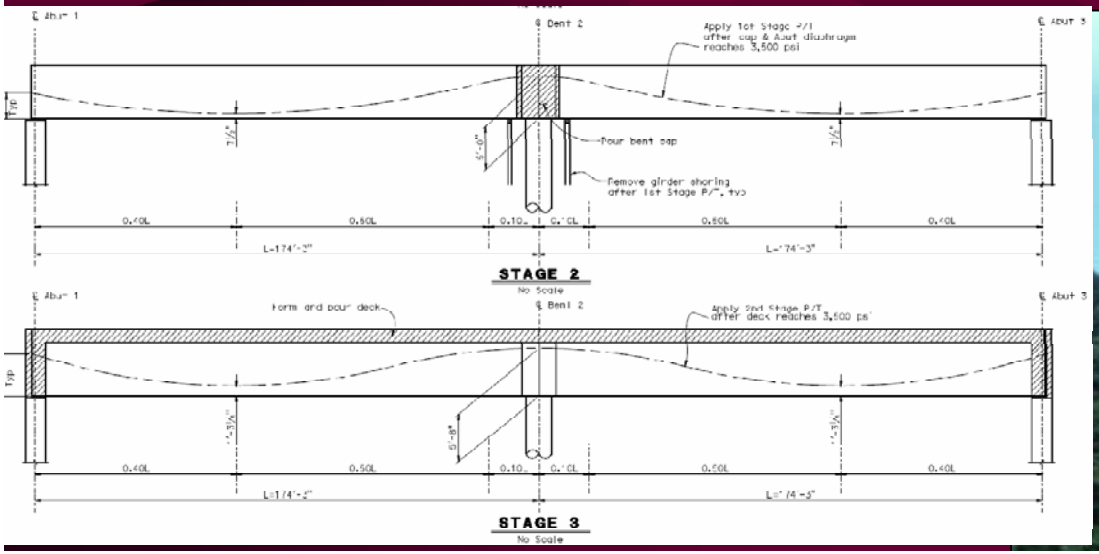
9'-6"	114	1 480	2 511 700	51.01	62.99	49 240	39 870	41.20	1 540
10'-0"	120	1 530	2 867 100	53.81	66.19	53 280	43 320	43.29	1 590

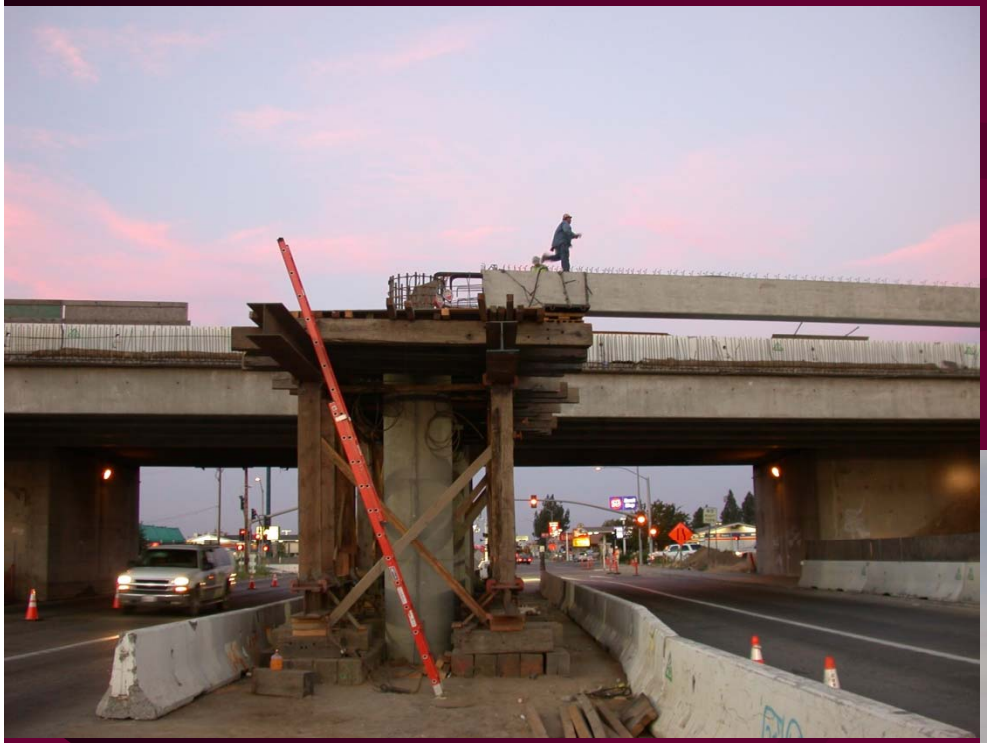
California Precast Girder Bridge Span Capacity

- Typical Precast Girder: 30’-180’
- Post-Tensioned Spliced Precast Girder: 100’-300’
- Segmental Precast Girder: 200’-450’



Two Methods for Post-Tensioned Spliced Precast Girders

Method 1: Splicing Girders Supported on Limited Falsework



Two Methods for Post-Tensioned Spliced Precast Girders

Method 2: Splicing Girders on the Ground (Without Falsework)

PT Spliced Precast Girder Advantages

- ✓ Very limited falsework or no falsework
- ✓ Longer spans
- ✓ Maximize vertical clearance
- ✓ Rapid construction
- ✓ Continuous superstructure with no joints
- ✓ Integral system between superstructure, bent cap and columns
- ✓ Seismic resistance connection
- ✓ Could be pinned at column bottom
- ✓ Smaller footing size
- ✓ Aesthetic pleasant
- ✓ Low construction cost