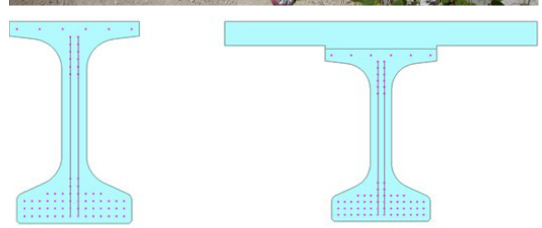
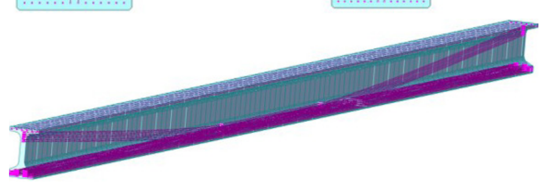
Improving the Accuracy of Camber Predictions for Precast Pretensioned Concrete Beams

BRIDGE ENGINEERING CENTER

Final Report Appendices
July 2015





IOWA STATE UNIVERSITY
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About the Bridge Engineering Center

The mission of the Bridge Engineering Center (BEC) at Iowa State University is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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16. Abstract

The discrepancies between the designed and measured camber of precast pretensioned concrete beams (PPCBs) observed by the Iowa DOT have created challenges in the field during bridge construction, causing construction delays and additional costs. This study was undertaken to systematically identify the potential sources of discrepancies between the designed and measured camber from release to time of erection and improve the accuracy of camber estimations in order to minimize the associated problems in the field.

To successfully accomplish the project objectives, engineering properties, including creep and shrinkage, of three normal concrete and four high-performance concrete mix designs were characterized. In parallel, another task focused on identifying the instantaneous camber and the variables affecting the instantaneous camber and evaluated the corresponding impact of this factor using more than 100 PPCBs. Using a combination of finite element analyses and the time-step method, the long-term camber was estimated for 66 PPCBs, with due consideration given to creep and shrinkage of concrete, changes in support location and prestress force, and the thermal effects.

Utilizing the outcomes of the project, suitable long-term camber multipliers were developed that account for the time-dependent behavior, including the thermal effects. It is shown that by using the recommended practice for the camber measurements together with the proposed multipliers, the accuracy of camber prediction will be greatly improved. Consequently, it is expected that future bridge projects in Iowa can minimize construction challenges resulting from large discrepancies between the designed and actual camber of PPCBs during construction.

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IMPROVING THE ACCURACY OF CAMBER PREDICTIONS FOR PRECAST PRETENSIONED CONCRETE BEAMS

Final Report Appendices
July 2015

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APPENDIX A. MEASURED AND PREDICTED CREEP AND SHRINKAGE

A comparison between the measured results of the creep and shrinkage tests and those obtained from five different models is presented in this appendix.

Table A.1. HPC 1 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.05	0.05	0.31	0.31	0.81	1.08
2	0.10	0.10	0.45	0.45	0.84	1.12
3	0.13	0.15	0.55	0.54	0.87	1.16
7	0.21	0.31	0.83	0.80	0.97	1.28
14	0.30	0.53	1.12	1.05	1.09	1.44
21	0.36	0.70	1.31	1.21	1.19	1.57
28	0.42	0.83	1.45	1.32	1.27	1.68
60	0.60	1.17	1.84	1.63	1.51	2.03
90	0.63	1.33	2.05	1.78	1.65	2.24
120	0.65	1.43	2.19	1.88	1.75	2.40
150	0.66	1.49	2.29	1.95	1.83	2.52
180	0.68	1.54	2.37	2.01	1.90	2.61
210	0.71	1.57	2.44	2.06	1.95	2.69
240	0.72	1.60	2.49	2.10	2.00	2.75
270	0.74	1.62	2.54	2.13	2.03	2.80
300	0.79	1.64	2.58	2.16	2.07	2.84
330	0.79	1.66	2.62	2.18	2.10	2.87
360	0.79	1.67	2.65	2.20	2.12	2.90

Table A.2. HPC 1 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.17	0.03	0.09	0.10	0.28	0.85
2	0.20	0.05	0.14	0.14	0.29	0.88
3	0.26	0.07	0.17	0.17	0.30	0.90
7	0.38	0.16	0.25	0.24	0.33	0.98
14	0.48	0.27	0.34	0.32	0.38	1.08
21	0.52	0.35	0.40	0.37	0.41	1.14
28	0.56	0.41	0.44	0.40	0.44	1.19
60	0.77	0.58	0.56	0.50	0.53	1.35
90	0.84	0.66	0.62	0.54	0.59	1.43
120	0.89	0.71	0.67	0.57	0.64	1.49
150	0.92	0.74	0.70	0.60	0.68	1.54
180	0.94	0.76	0.72	0.61	0.71	1.58
210	0.95	0.78	0.74	0.63	0.74	1.62
240	0.96	0.79	0.76	0.64	0.77	1.65
270	0.95	0.81	0.77	0.65	0.79	1.68
300	0.98	0.81	0.79	0.66	0.81	1.70
330	1.00	0.82	0.80	0.66	0.83	1.72
360	1.03	0.83	0.81	0.67	0.85	1.74

Table A.3. HPC 1 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	98	15	8	15	147	152
2	163	30	17	29	156	162
3	166	43	24	41	165	172
7	219	91	53	84	194	207
14	276	155	96	136	232	255
21	285	203	131	171	262	292
28	295	239	159	197	285	322
60	319	338	247	260	353	414
90	353	384	293	287	390	462
120	373	413	324	302	414	493
150	392	432	346	312	431	513
180	414	445	362	319	444	528
210	433	456	374	325	455	538
240	443	464	384	329	463	546
270	453	470	393	332	469	551
300	500	475	399	335	475	556
330	538	480	405	337	480	559
360	576	484	410	339	484	562

Table A.4. HPC 1 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	31	5	\	\	\	23
2	62	10	\	\	\	24
3	59	15	\	\	\	26
7	74	32	\	\	\	31
14	101	54	\	\	\	38
21	115	71	\	\	\	43
28	129	84	\	\	\	47
60	151	118	\	\	\	59
90	171	134	\	\	\	65
120	180	144	\	\	\	68
150	187	151	\	\	\	70
180	188	156	\	\	\	72
210	192	159	\	\	\	73
240	197	162	\	\	\	73
270	205	164	\	\	\	74
300	213	166	\	\	\	74
330	214	168	\	\	\	75
360	214	169	\	\	\	75

Table A.5. HPC 2 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.11	0.05	0.31	0.31	0.85	0.86
2	0.14	0.10	0.45	0.45	0.88	0.89
3	0.21	0.15	0.55	0.55	0.91	0.93
7	0.36	0.32	0.83	0.81	1.02	1.03
14	0.58	0.55	1.12	1.06	1.15	1.16
21	0.72	0.72	1.31	1.23	1.25	1.26
28	0.80	0.86	1.45	1.35	1.33	1.35
60	0.86	1.23	1.84	1.67	1.58	1.63
90	0.89	1.40	2.05	1.83	1.73	1.80
120	0.93	1.51	2.19	1.94	1.84	1.92
150	0.97	1.58	2.29	2.02	1.92	2.02
180	1.00	1.64	2.37	2.08	1.99	2.09
210	1.04	1.68	2.44	2.13	2.05	2.15
240	1.08	1.71	2.49	2.17	2.10	2.20
270	1.11	1.73	2.54	2.20	2.14	2.24
300	1.17	1.75	2.58	2.23	2.17	2.27
330	1.21	1.77	2.62	2.26	2.20	2.30
360	1.26	1.78	2.65	2.28	2.23	2.33

Table A.6. HPC 2 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.21	0.03	0.09	0.10	0.29	0.70
3	0.27	0.05	0.14	0.14	0.30	0.72
7	0.43	0.07	0.17	0.17	0.31	0.75
14	0.55	0.16	0.25	0.25	0.35	0.82
21	0.72	0.27	0.34	0.32	0.40	0.90
28	0.83	0.36	0.40	0.37	0.43	0.96
60	0.89	0.43	0.44	0.41	0.46	1.01
90	1.00	0.61	0.56	0.51	0.56	1.14
120	1.03	0.70	0.62	0.56	0.62	1.22
150	1.05	0.75	0.67	0.59	0.67	1.28
180	1.07	0.79	0.70	0.61	0.71	1.32
210	1.08	0.81	0.72	0.63	0.75	1.36
240	1.10	0.83	0.74	0.65	0.78	1.39
270	1.12	0.85	0.76	0.66	0.80	1.42
300	1.14	0.86	0.77	0.67	0.83	1.44
330	1.13	0.87	0.79	0.68	0.85	1.46
360	1.15	0.88	0.80	0.69	0.87	1.48

Table A.7. HPC 2 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	51	15	10	17	163	162
2	76	30	19	32	174	174
3	125	44	28	47	183	185
7	132	92	61	95	216	222
14	142	159	110	156	259	273
21	150	209	150	199	291	312
28	157	249	183	230	317	345
60	216	355	284	308	393	442
90	254	406	338	341	434	494
120	287	437	373	361	461	527
150	319	458	398	374	480	549
180	344	474	417	383	494	564
210	366	485	431	390	506	576
240	383	494	442	395	515	584
270	396	501	452	400	522	590
300	404	507	460	403	529	594
330	418	512	466	406	534	598
360	429	517	472	408	539	601

Table A.8. HPC 2 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	20	5	\	\	\	24
2	30	10	\	\	\	26
3	46	15	\	\	\	28
7	50	32	\	\	\	33
14	54	56	\	\	\	40
21	61	73	\	\	\	46
28	68	87	\	\	\	50
60	131	124	\	\	\	63
90	185	142	\	\	\	69
120	216	153	\	\	\	73
150	245	160	\	\	\	75
180	260	166	\	\	\	77
210	269	170	\	\	\	78
240	279	173	\	\	\	79
270	290	175	\	\	\	79
300	302	177	\	\	\	79
330	313	179	\	\	\	80
360	324	181	\	\	\	80

Table A.9. HPC 3 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.07	0.05	0.31	0.31	0.91	1.00
3	0.30	0.11	0.45	0.45	0.95	1.03
7	0.31	0.16	0.55	0.55	0.98	1.07
14	0.35	0.33	0.83	0.81	1.09	1.18
21	0.35	0.58	1.12	1.08	1.23	1.33
28	0.35	0.77	1.31	1.25	1.34	1.44
60	0.35	0.92	1.45	1.38	1.43	1.54
90	0.36	1.34	1.84	1.72	1.70	1.86
120	0.38	1.54	2.05	1.89	1.86	2.06
150	0.38	1.67	2.19	2.01	1.98	2.20
180	0.38	1.76	2.29	2.10	2.07	2.31
210	0.38	1.82	2.37	2.16	2.14	2.39
240	0.38	1.87	2.44	2.22	2.20	2.46
270	0.41	1.90	2.49	2.26	2.25	2.51
300	0.43	1.93	2.54	2.30	2.30	2.55
330	0.45	1.96	2.58	2.33	2.34	2.59
360	0.47	1.98	2.62	2.36	2.37	2.62

Table A.10. HPC 3 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.16	0.03	0.09	0.09	0.31	0.78
2	0.36	0.05	0.14	0.14	0.32	0.80
3	0.39	0.08	0.17	0.17	0.34	0.82
7	0.54	0.17	0.25	0.25	0.37	0.89
14	0.56	0.29	0.34	0.33	0.42	0.97
21	0.59	0.38	0.40	0.38	0.46	1.03
28	0.63	0.46	0.44	0.42	0.50	1.08
60	0.68	0.66	0.56	0.52	0.60	1.21
90	0.74	0.77	0.62	0.58	0.67	1.28
120	0.75	0.83	0.67	0.61	0.72	1.33
150	0.78	0.87	0.70	0.64	0.77	1.38
180	0.82	0.90	0.72	0.66	0.80	1.41
210	0.84	0.93	0.74	0.68	0.84	1.44
240	0.84	0.95	0.76	0.69	0.87	1.47
270	0.87	0.96	0.77	0.70	0.89	1.49
300	0.88	0.97	0.79	0.71	0.91	1.51
330	0.91	0.98	0.80	0.72	0.94	1.53
360	0.92	0.99	0.81	0.73	0.96	1.55

Table A.11. HPC 3 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	105	16	8	14	185	172
2	147	31	17	27	197	184
3	164	45	24	39	208	195
7	265	97	53	81	245	234
14	277	168	96	135	293	288
21	295	223	130	174	330	329
28	317	267	159	202	360	363
60	351	388	246	276	446	464
90	404	447	293	308	492	517
120	418	483	323	328	522	550
150	445	508	345	341	544	572
180	465	527	361	350	561	587
210	478	541	373	357	574	598
240	486	551	383	362	584	606
270	500	560	392	366	592	612
300	509	567	398	369	600	617
330	522	573	404	372	606	620
360	533	579	409	375	611	623

Table A.12. HPC 3 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	36	6	\	\	\	26
2	73	11	\	\	\	28
3	90	16	\	\	\	29
7	195	34	\	\	\	35
14	214	59	\	\	\	43
21	242	78	\	\	\	48
28	277	93	\	\	\	53
60	311	136	\	\	\	66
90	344	156	\	\	\	72
120	352	169	\	\	\	76
150	365	178	\	\	\	78
180	373	184	\	\	\	80
210	381	189	\	\	\	81
240	389	193	\	\	\	81
270	392	196	\	\	\	82
300	399	198	\	\	\	82
330	404	201	\	\	\	83
360	410	202	\	\	\	83

Table A.13. HPC 4 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.20	0.05	0.31	0.31	0.82	1.06
2	0.22	0.10	0.45	0.45	0.86	1.10
3	0.25	0.15	0.55	0.55	0.89	1.14
7	0.38	0.31	0.83	0.80	0.99	1.26
14	0.49	0.54	1.12	1.06	1.11	1.42
21	0.57	0.71	1.31	1.22	1.21	1.55
28	0.61	0.83	1.45	1.33	1.29	1.66
60	0.71	1.18	1.84	1.64	1.54	2.02
90	0.78	1.35	2.05	1.80	1.68	2.24
120	0.82	1.45	2.19	1.90	1.79	2.40
150	0.83	1.51	2.29	1.98	1.87	2.53
180	0.84	1.56	2.37	2.04	1.93	2.62
210	0.84	1.60	2.44	2.09	1.99	2.70
240	0.86	1.63	2.49	2.13	2.03	2.76
270	0.89	1.65	2.54	2.16	2.07	2.81
300	0.90	1.67	2.58	2.19	2.11	2.85
330	0.92	1.69	2.62	2.21	2.14	2.88
360	0.93	1.70	2.65	2.23	2.16	2.91

Table A.14. HPC 4 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.21	0.03	0.09	0.10	0.28	0.82
2	0.24	0.05	0.14	0.14	0.29	0.84
3	0.26	0.07	0.17	0.17	0.30	0.87
7	0.36	0.16	0.25	0.24	0.34	0.94
14	0.55	0.27	0.34	0.32	0.38	1.03
21	0.61	0.35	0.40	0.37	0.42	1.10
28	0.64	0.41	0.44	0.41	0.45	1.15
60	0.75	0.59	0.56	0.50	0.54	1.29
90	0.82	0.67	0.62	0.55	0.61	1.38
120	0.86	0.72	0.67	0.58	0.65	1.44
150	0.88	0.75	0.70	0.60	0.69	1.48
180	0.89	0.78	0.72	0.62	0.73	1.52
210	0.89	0.79	0.74	0.64	0.76	1.56
240	0.93	0.81	0.76	0.65	0.78	1.59
270	0.98	0.82	0.77	0.66	0.80	1.61
300	1.01	0.83	0.79	0.67	0.83	1.63
330	1.03	0.84	0.80	0.67	0.84	1.66
360	1.07	0.84	0.81	0.68	0.86	1.67

Table A.15. HPC 4 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	22	15	10	17	153	152
2	33	30	19	32	163	162
3	51	43	28	46	172	172
7	133	91	60	94	203	207
14	229	156	108	153	243	255
21	286	204	147	194	274	292
28	293	242	180	223	298	322
60	296	342	278	296	369	413
90	306	390	330	327	407	461
120	312	419	365	346	433	492
150	319	438	389	357	451	512
180	330	452	408	366	465	526
210	341	463	422	372	475	537
240	344	471	433	377	484	544
270	342	478	442	381	491	550
300	345	484	450	384	497	554
330	351	488	456	386	502	558
360	353	492	462	389	506	560

Table A.16. HPC 4 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	17	5	\	\	\	23
2	26	10	\	\	\	24
3	40	15	\	\	\	26
7	103	32	\	\	\	31
14	160	54	\	\	\	38
21	212	71	\	\	\	43
28	220	85	\	\	\	47
60	225	120	\	\	\	59
90	229	136	\	\	\	65
120	235	146	\	\	\	68
150	244	153	\	\	\	70
180	251	158	\	\	\	72
210	259	162	\	\	\	73
240	260	165	\	\	\	73
270	257	167	\	\	\	74
300	259	169	\	\	\	74
330	262	171	\	\	\	74
360	263	172	\	\	\	75

Table A.17. NC 1 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.06	0.05	0.34	0.31	0.81	1.19
2	0.10	0.10	0.50	0.45	0.84	1.24
3	0.13	0.15	0.61	0.55	0.87	1.28
7	0.22	0.31	0.92	0.81	0.97	1.44
14	0.26	0.51	1.24	1.06	1.09	1.64
21	0.29	0.65	1.45	1.22	1.19	1.79
28	0.31	0.75	1.60	1.34	1.27	1.92
60	0.50	1.01	2.03	1.64	1.51	2.32
90	0.59	1.12	2.26	1.80	1.65	2.57
120	0.70	1.19	2.41	1.90	1.75	2.75
150	0.77	1.23	2.52	1.97	1.83	2.88
180	0.81	1.26	2.61	2.03	1.90	2.99
210	0.83	1.28	2.69	2.08	1.95	3.07
240	0.84	1.30	2.75	2.11	2.00	3.14
270	0.84	1.31	2.80	2.15	2.03	3.20
300	0.85	1.32	2.84	2.17	2.07	3.25
330	0.86	1.33	2.88	2.20	2.10	3.29
360	0.86	1.34	2.92	2.22	2.12	3.32

Table A.18. NC 1 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.04	0.03	0.10	0.10	0.28	0.96
2	0.09	0.05	0.15	0.14	0.29	0.99
3	0.14	0.08	0.19	0.17	0.30	1.03
7	0.27	0.15	0.28	0.25	0.33	1.13
14	0.34	0.25	0.38	0.32	0.38	1.26
21	0.36	0.32	0.44	0.37	0.41	1.36
28	0.38	0.37	0.49	0.41	0.44	1.43
60	0.52	0.50	0.62	0.50	0.53	1.63
90	0.55	0.56	0.69	0.55	0.59	1.75
120	0.56	0.59	0.73	0.58	0.64	1.84
150	0.57	0.61	0.77	0.60	0.68	1.90
180	0.58	0.62	0.80	0.62	0.71	1.96
210	0.59	0.64	0.82	0.63	0.74	2.01
240	0.60	0.64	0.84	0.64	0.77	2.05
270	0.60	0.65	0.85	0.65	0.79	2.08
300	0.61	0.66	0.87	0.66	0.81	2.12
330	0.62	0.66	0.88	0.67	0.83	2.15
360	0.63	0.67	0.89	0.68	0.85	2.17

Table A.19. NC 1 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	0	16	8	14	117	156
2	40	30	17	26	124	167
3	68	44	25	38	131	178
7	150	90	53	76	154	213
14	185	148	96	123	185	262
21	193	188	131	155	208	300
28	199	218	160	179	227	330
60	253	292	247	236	281	421
90	287	324	294	260	310	468
120	328	343	325	274	330	498
150	369	356	347	283	343	518
180	391	364	363	289	354	531
210	397	371	375	294	362	541
240	406	376	385	298	369	548
270	417	380	394	301	374	553
300	426	383	400	303	378	557
330	434	386	406	305	382	560
360	443	389	411	307	386	562

Table A.20. NC 1 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	0	6	\	\	\	24
2	30	11	\	\	\	25
3	59	15	\	\	\	27
7	130	31	\	\	\	32
14	161	52	\	\	\	39
21	167	66	\	\	\	44
28	171	76	\	\	\	48
60	216	102	\	\	\	60
90	246	113	\	\	\	65
120	278	120	\	\	\	69
150	312	124	\	\	\	71
180	333	127	\	\	\	72
210	338	130	\	\	\	73
240	339	132	\	\	\	74
270	338	133	\	\	\	74
300	340	134	\	\	\	74
330	343	135	\	\	\	75
360	344	136	\	\	\	75

Table A.21. NC 2 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.01	0.05	0.31	0.31	0.87	1.26
2	0.02	0.10	0.45	0.45	0.90	1.30
3	0.09	0.15	0.55	0.55	0.94	1.34
7	0.15	0.32	0.83	0.81	1.04	1.47
14	0.25	0.54	1.12	1.07	1.18	1.65
21	0.30	0.71	1.31	1.24	1.28	1.79
28	0.34	0.84	1.45	1.36	1.36	1.90
60	0.44	1.19	1.84	1.69	1.62	2.27
90	0.48	1.36	2.05	1.85	1.78	2.50
120	0.50	1.46	2.19	1.96	1.89	2.66
150	0.53	1.53	2.29	2.05	1.97	2.79
180	0.56	1.58	2.37	2.11	2.04	2.88
210	0.60	1.62	2.44	2.16	2.10	2.96
240	0.63	1.65	2.49	2.20	2.15	3.02
270	0.66	1.67	2.54	2.24	2.19	3.08
300	0.69	1.69	2.58	2.27	2.23	3.12
330	0.71	1.70	2.62	2.30	2.26	3.16
360	0.73	1.72	2.65	2.32	2.29	3.19

Table A.22. NC 2 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.01	0.03	0.09	0.10	0.30	1.02
2	0.07	0.05	0.14	0.14	0.31	1.05
3	0.21	0.07	0.17	0.17	0.32	1.08
7	0.26	0.16	0.25	0.25	0.36	1.17
14	0.34	0.27	0.34	0.33	0.41	1.27
21	0.36	0.35	0.40	0.38	0.44	1.35
28	0.41	0.42	0.44	0.41	0.47	1.40
60	0.52	0.59	0.56	0.51	0.57	1.57
90	0.58	0.67	0.62	0.56	0.64	1.67
120	0.63	0.73	0.67	0.60	0.69	1.73
150	0.70	0.76	0.70	0.62	0.73	1.79
180	0.71	0.78	0.72	0.64	0.77	1.83
210	0.75	0.80	0.74	0.66	0.80	1.87
240	0.79	0.82	0.76	0.67	0.83	1.91
270	0.81	0.83	0.77	0.68	0.85	1.94
300	0.84	0.84	0.79	0.69	0.87	1.96
330	0.87	0.85	0.80	0.70	0.89	1.99
360	0.88	0.85	0.81	0.71	0.91	2.01

Table A.23. NC 2 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	130	21	13	21	171	177
2	161	40	25	41	182	190
3	225	58	36	59	192	202
7	236	118	79	122	226	242
14	259	194	142	201	271	298
21	271	247	193	257	305	341
28	279	286	236	298	333	376
60	299	383	365	401	412	481
90	315	426	435	446	455	536
120	330	450	480	473	483	571
150	352	467	512	491	503	595
180	358	478	536	503	519	611
210	373	487	555	512	531	623
240	387	493	570	519	540	631
270	396	499	582	525	548	638
300	408	503	592	530	555	642
330	419	507	600	534	560	646
360	425	510	607	537	565	649

Table A.24. NC 2 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	70	7	\	\	\	27
2	73	14	\	\	\	29
3	77	20	\	\	\	30
7	91	41	\	\	\	36
14	122	68	\	\	\	44
21	139	86	\	\	\	50
28	141	100	\	\	\	55
60	150	134	\	\	\	69
90	157	149	\	\	\	75
120	161	157	\	\	\	79
150	165	163	\	\	\	81
180	172	167	\	\	\	83
210	218	170	\	\	\	84
240	265	173	\	\	\	85
270	286	174	\	\	\	85
300	325	176	\	\	\	86
330	354	177	\	\	\	86
360	360	178	\	\	\	86

Table A.25. NC 3 measured unsealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.01	0.06	0.31	0.36	0.72	1.45
2	0.02	0.11	0.45	0.52	0.75	1.50
3	0.02	0.16	0.55	0.63	0.77	1.54
7	0.05	0.32	0.83	0.91	0.86	1.69
14	0.14	0.51	1.12	1.19	0.97	1.88
21	0.17	0.65	1.31	1.36	1.06	2.03
28	0.27	0.74	1.45	1.48	1.13	2.15
60	0.31	0.97	1.84	1.80	1.34	2.54
90	0.34	1.06	2.05	1.96	1.47	2.78
120	0.37	1.12	2.19	2.07	1.56	2.95
150	0.39	1.15	2.29	2.14	1.63	3.07
180	0.40	1.18	2.37	2.20	1.69	3.17
210	0.41	1.20	2.44	2.25	1.74	3.25
240	0.45	1.21	2.49	2.29	1.78	3.31
270	0.48	1.22	2.54	2.32	1.81	3.37
300	0.50	1.23	2.58	2.35	1.84	3.41
330	0.53	1.24	2.62	2.37	1.87	3.45
360	0.54	1.25	2.65	2.39	1.89	3.49

Table A.26. NC 3 measured sealed creep coefficient compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.07	0.03	0.09	0.11	0.25	1.23
2	0.11	0.05	0.14	0.16	0.26	1.27
3	0.15	0.08	0.17	0.19	0.26	1.30
7	0.21	0.16	0.25	0.28	0.30	1.41
14	0.29	0.26	0.34	0.36	0.34	1.54
21	0.31	0.32	0.40	0.41	0.37	1.63
28	0.40	0.37	0.44	0.45	0.39	1.70
60	0.47	0.48	0.56	0.55	0.48	1.90
90	0.53	0.53	0.62	0.60	0.53	2.02
120	0.60	0.55	0.67	0.63	0.57	2.10
150	0.68	0.57	0.70	0.65	0.61	2.17
180	0.73	0.59	0.72	0.67	0.63	2.22
210	0.74	0.59	0.74	0.68	0.66	2.27
240	0.83	0.60	0.76	0.70	0.68	2.31
270	0.88	0.61	0.77	0.71	0.70	2.34
300	0.93	0.61	0.79	0.71	0.72	2.38
330	0.98	0.62	0.80	0.72	0.74	2.41
360	1.01	0.62	0.81	0.73	0.75	2.43

Table A.27. NC 3 measured unsealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	0	0	0	0
1	14	17	10	17	100	166
2	28	32	20	32	107	177
3	42	46	29	47	113	188
7	67	92	64	96	133	226
14	104	149	116	158	159	277
21	126	187	157	202	179	316
28	204	215	192	235	195	348
60	252	280	297	317	242	442
90	278	308	353	352	267	490
120	315	324	390	373	283	520
150	353	334	417	387	295	539
180	375	341	436	397	304	552
210	383	347	451	404	311	562
240	387	351	463	410	317	568
270	383	354	473	414	321	573
300	391	357	481	418	325	577
330	392	359	488	421	329	580
360	395	361	494	424	331	582

Table A.28. NC 3 measured sealed shrinkage compared to the five models

Time after Loading, (days)	Measured Creep Coefficient	AASHTO LRFD 2010	ACI 209R-1990	ACI 209R-Modified by Huo	CEB-FIP 90	Bazant B3
0	0	0	\	\	\	0
1	9	6	\	\	\	25
2	18	11	\	\	\	27
3	27	16	\	\	\	28
7	48	32	\	\	\	34
14	88	52	\	\	\	41
21	99	65	\	\	\	46
28	140	75	\	\	\	51
60	180	98	\	\	\	63
90	204	108	\	\	\	68
120	233	113	\	\	\	71
150	261	117	\	\	\	73
180	277	119	\	\	\	75
210	281	121	\	\	\	76
240	282	123	\	\	\	76
270	280	124	\	\	\	77
300	283	125	\	\	\	77
330	283	126	\	\	\	77
360	285	126	\	\	\	77

APPENDIX B. STRING POTENTIOMETER DATA

String potentiometers were used along the length of the PPCB and on the precasting bed. Using these devices to record the time versus displacement allowed researchers to investigate the behavior of the PPCBs during the transfer of the prestress and to verify laser level measurements. Additionally, recording the time during significant events allowed researchers to justify the vertical displacement by what was happening at specific times of the release.

The abbreviations used for events in the graphs that show the transfer of prestress on various PPCBs are as follows:

BSRB = bottom strands, release began
BSRC = bottom strands, release completed
HSRB = harped strands, release began
HSRC = harped strands, release completed
LB = lifted PPCB
TSRB = top strands, release began
TSRC = top strands, release completed
VHRB = vertical hold-down, release began
VHRC = vertical hold-down, release completed

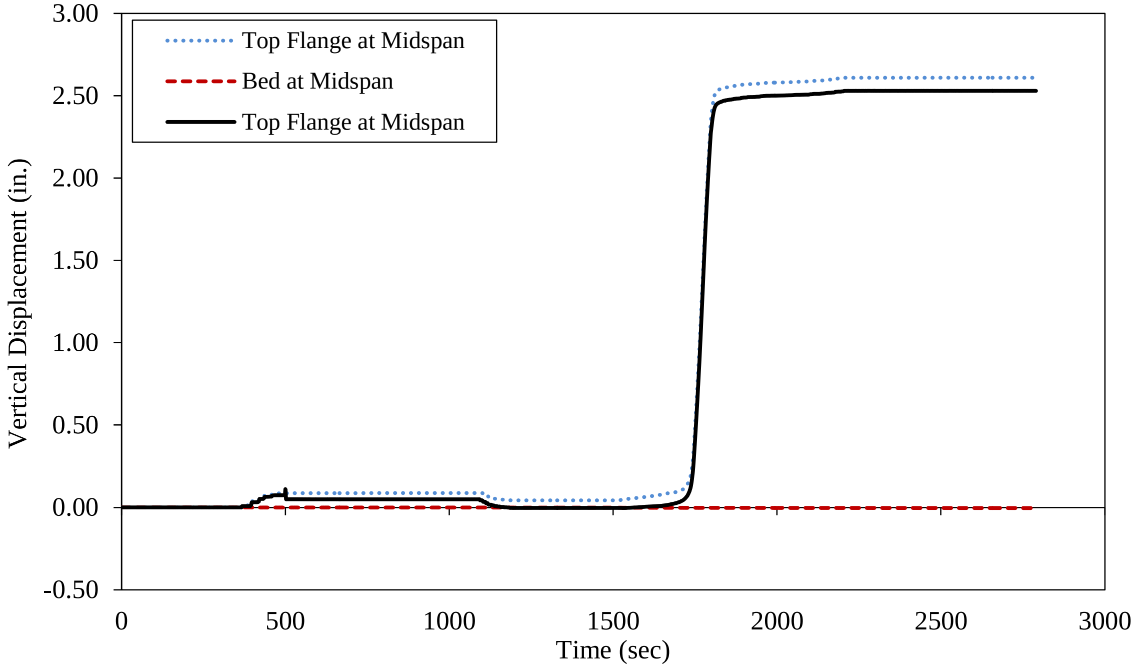


Figure B.1. Time versus vertical displacement for first BTE 155 PPCB

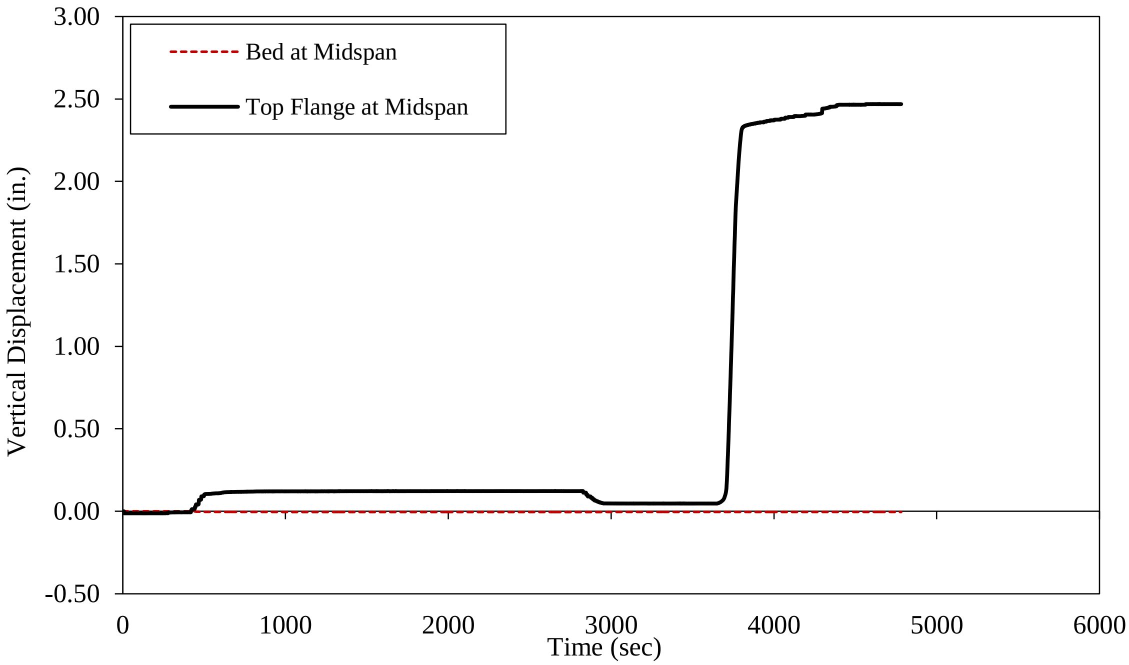


Figure B.2. Time versus vertical displacement for second BTE 155 PPCB

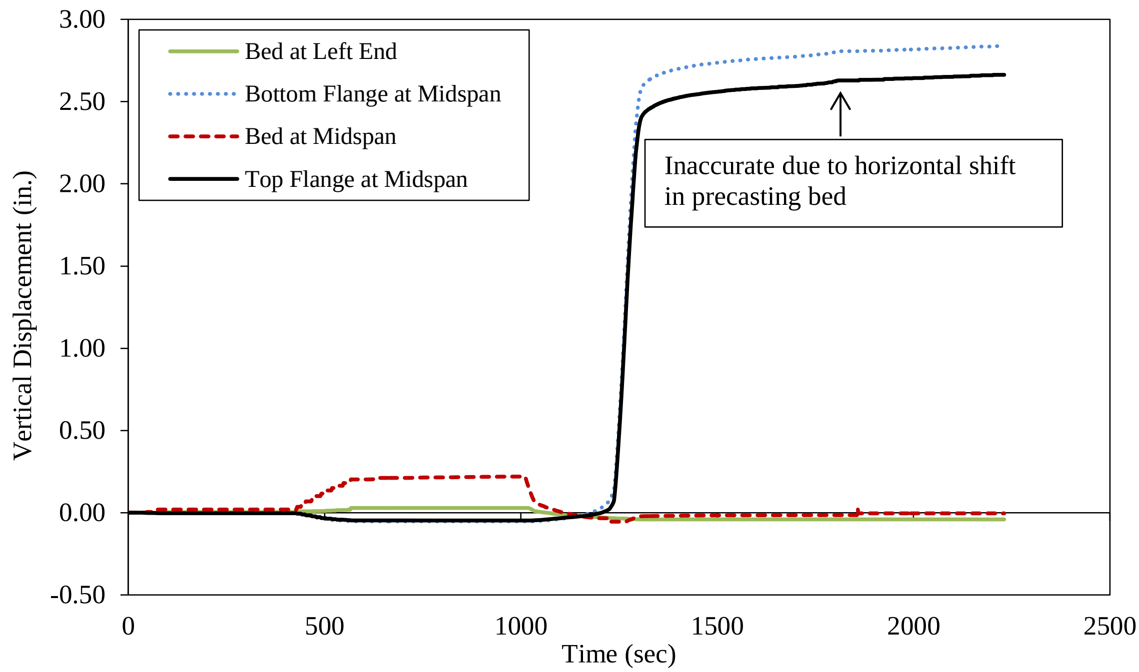
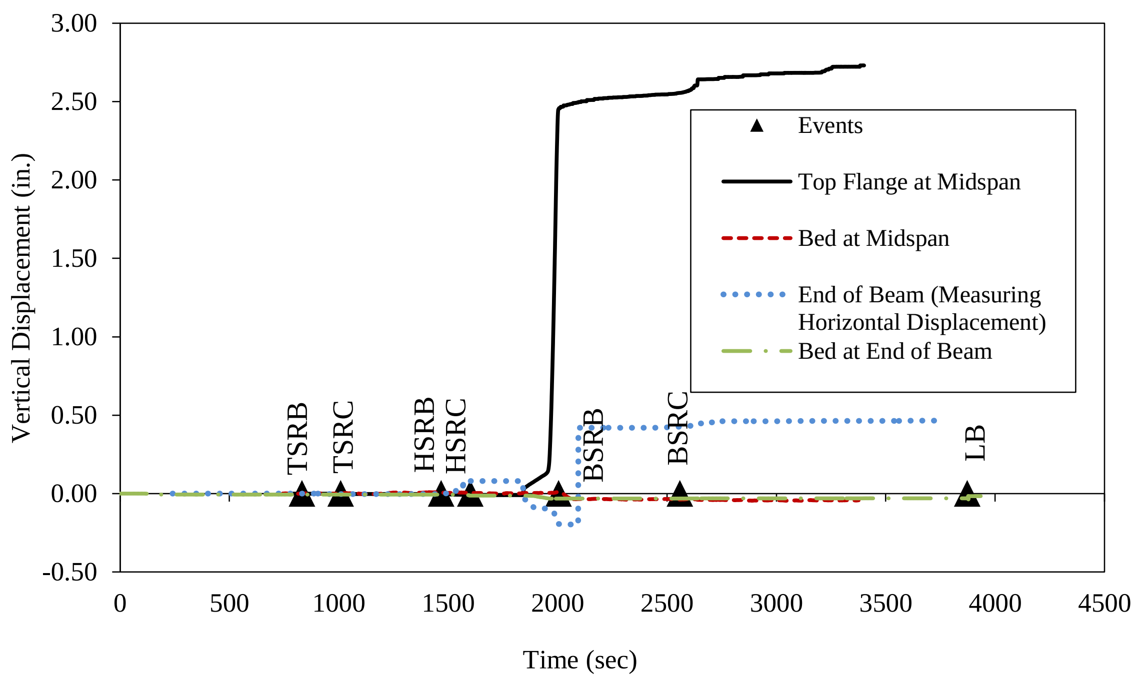
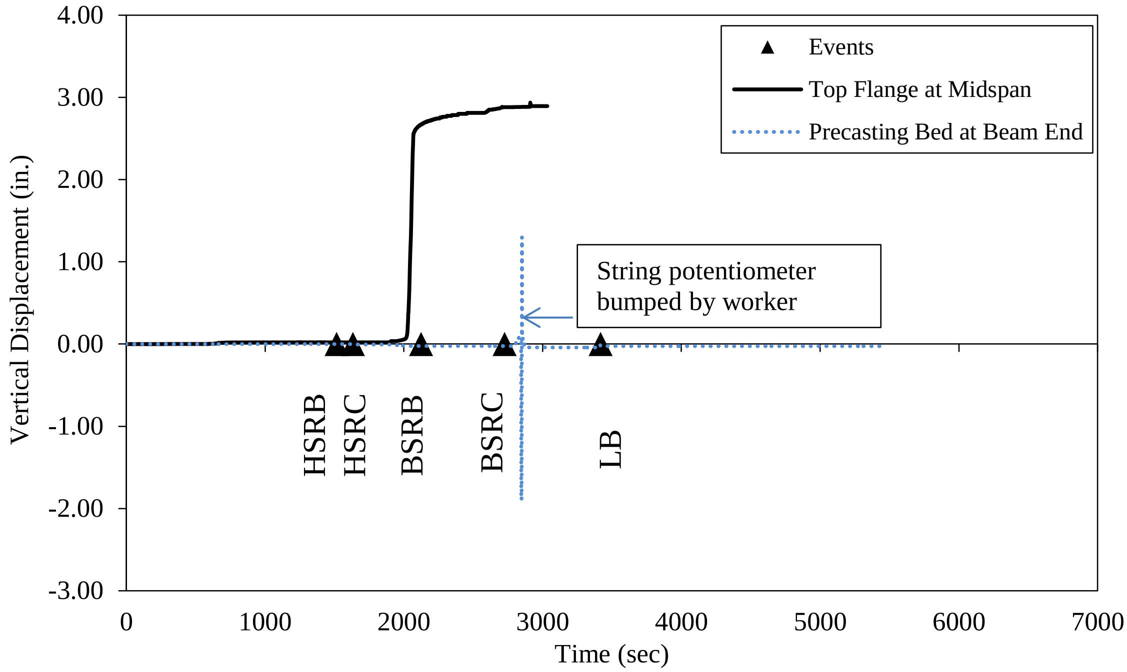


Figure B.3. Time versus vertical displacement for third BTE 155 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; LB = lifted PPCB; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.4. Time versus vertical displacement for first BTE 145 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; LB = lifted PPCB

Figure B.5. Time versus vertical displacement for second BTE 145 PPCB

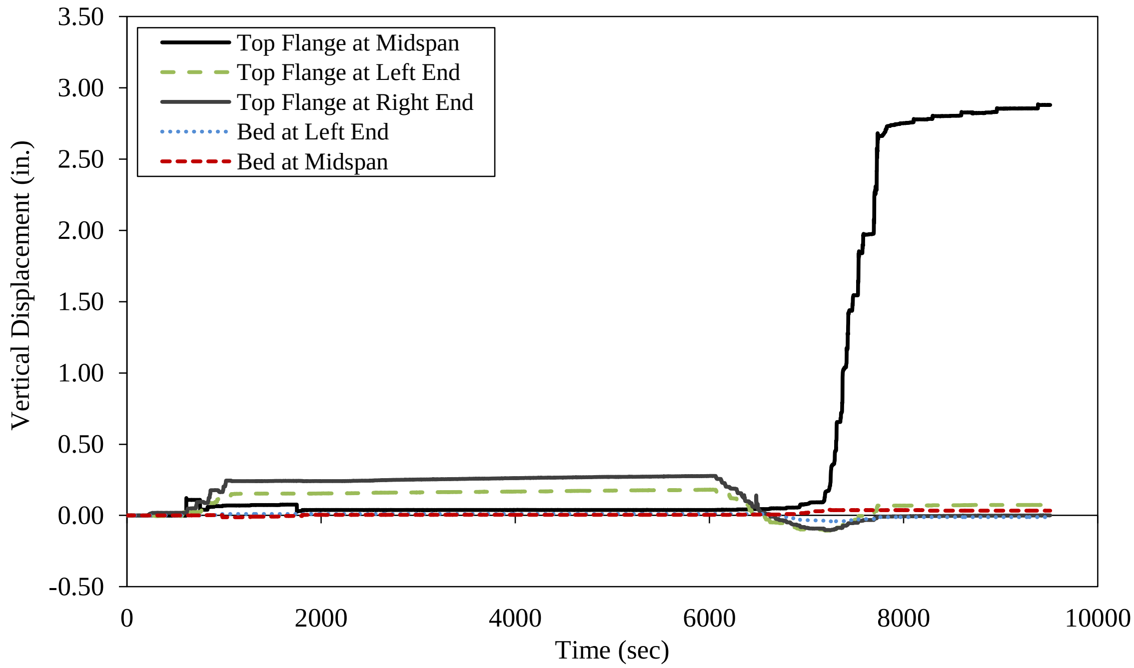
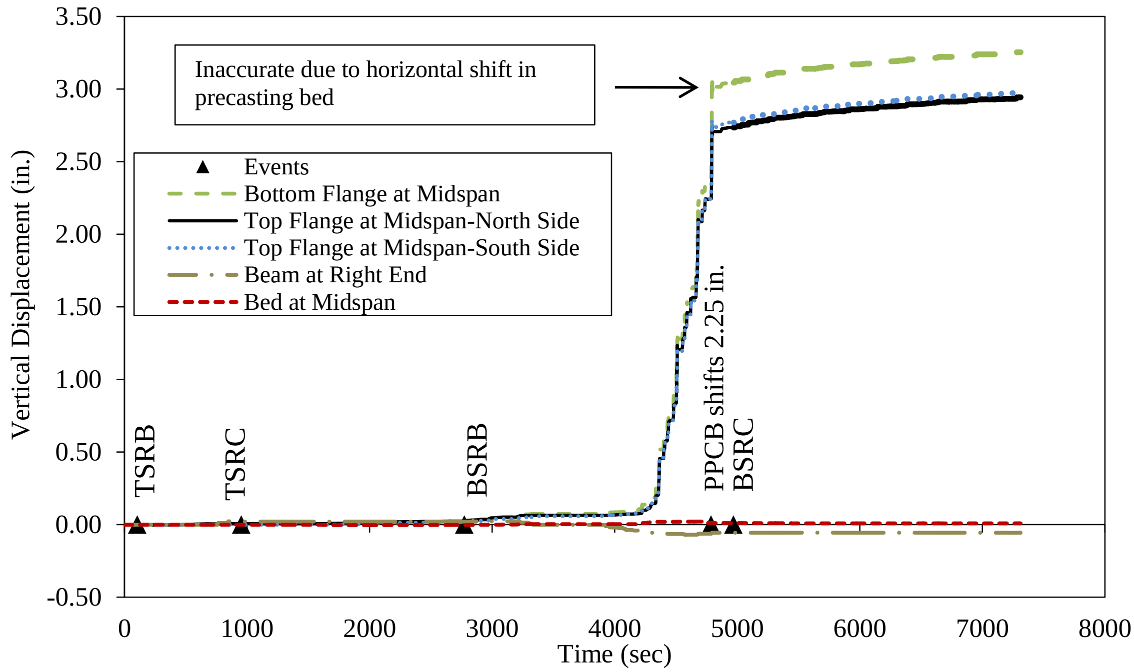


Figure B.6. Time versus vertical displacement for a BTC 130 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.7. Time versus vertical displacement for first BTC 120 PPCB

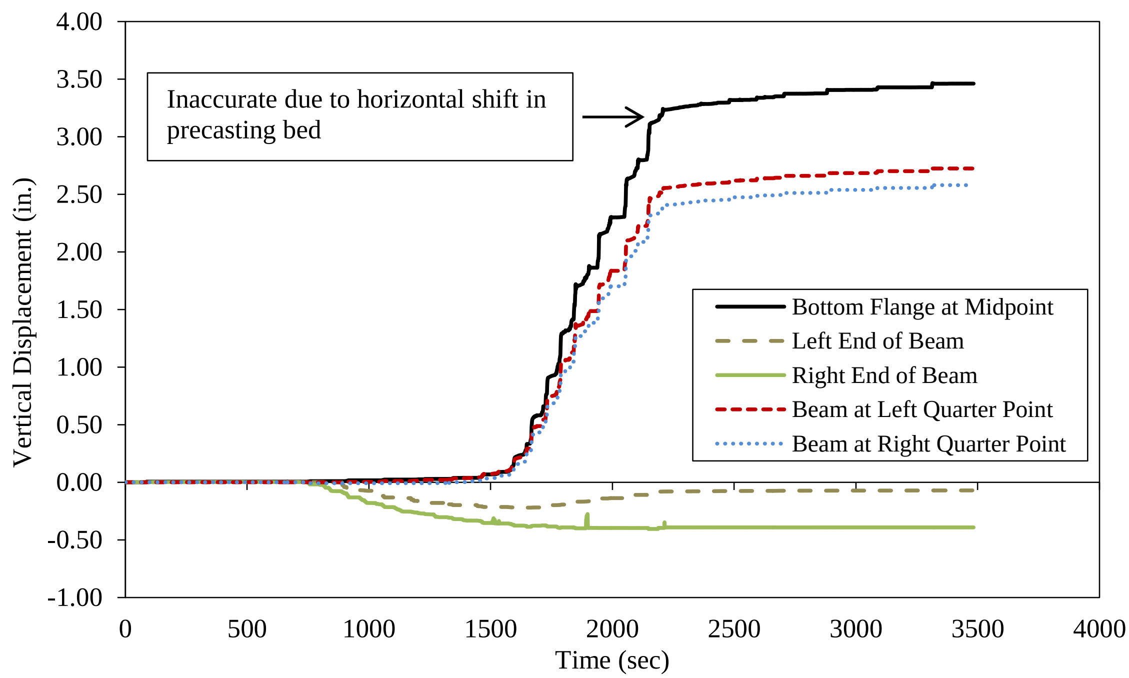
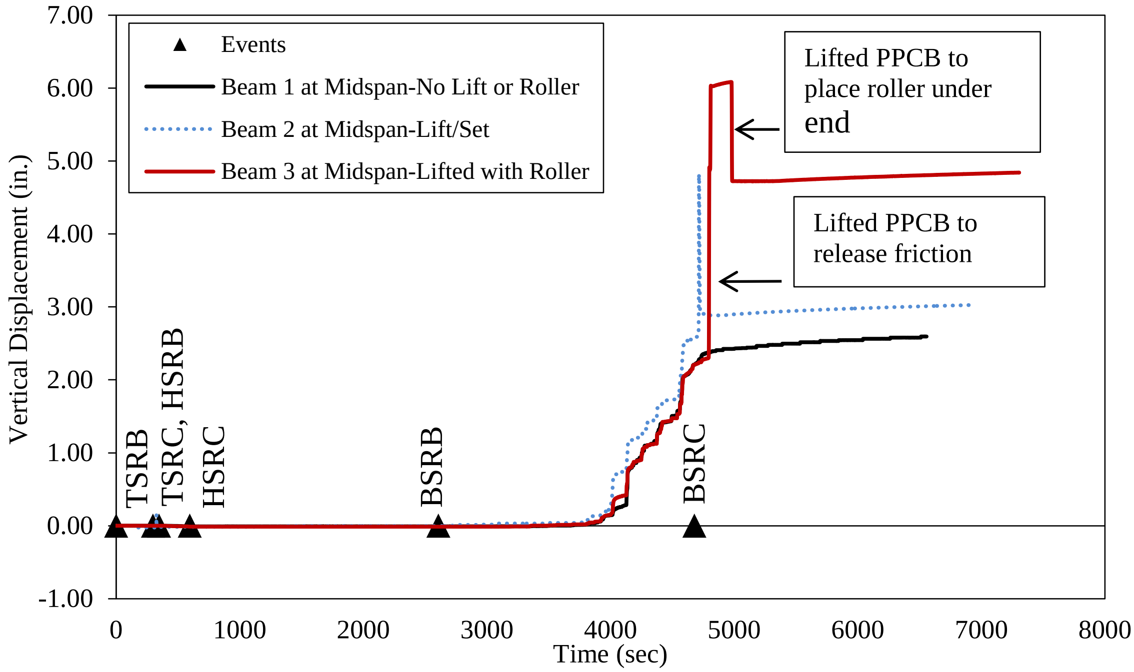
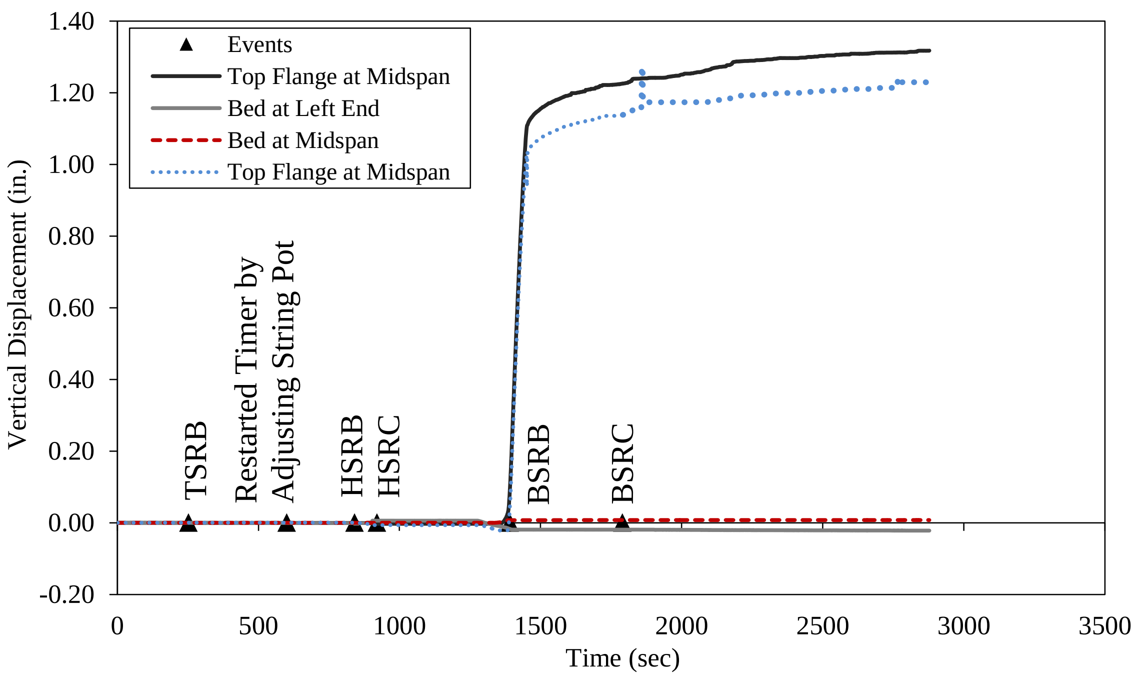


Figure B.8. Time versus vertical displacement for second BTC 120 PPCB



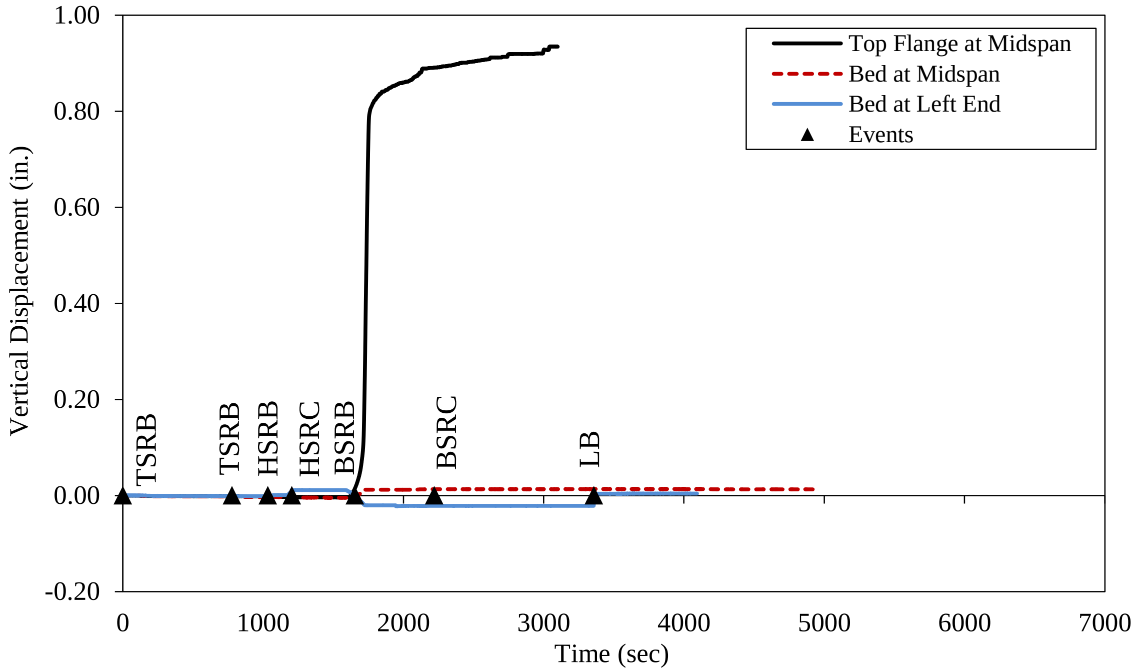
BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.9. Time versus vertical displacement after the transfer of prestress for three D110 PPCBs with different support conditions



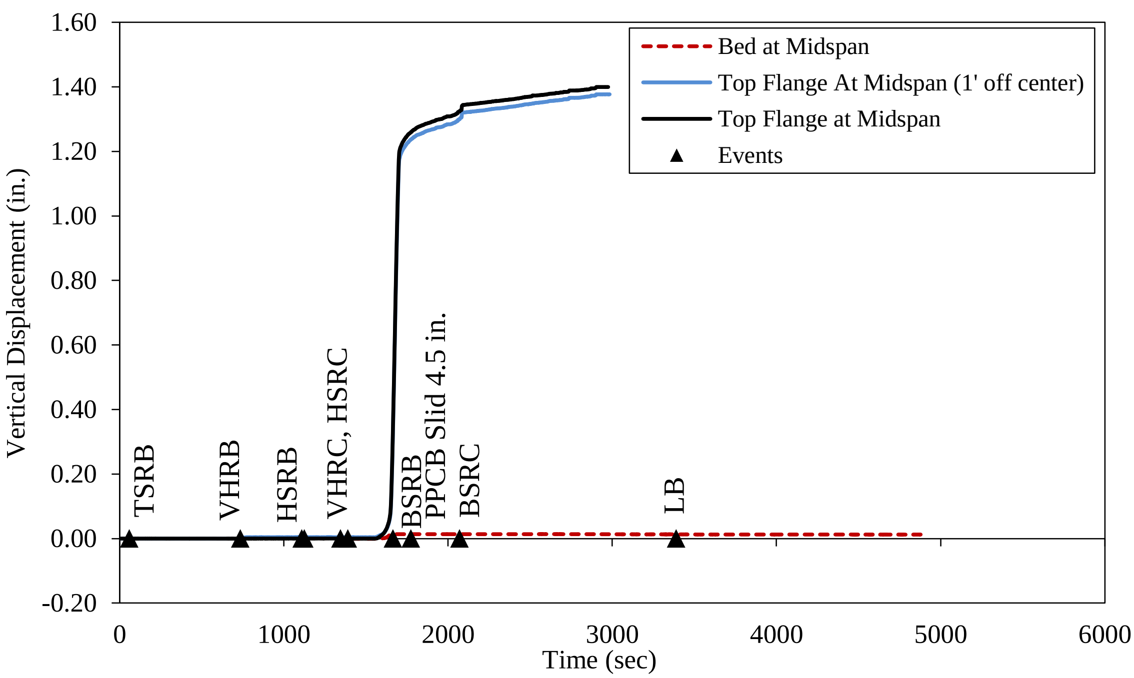
BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; TSRB = top strands

Figure B.10. Time versus vertical displacement for first BTE 110 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; LB = lifted PPCB; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.11. Time versus vertical displacement for second BTE 110 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; LB = lifted PPCB; TSRB = top strands, release began; VHRB = vertical hold-down, release began; VHRC = vertical hold-down, release completed

Figure B.12. Time versus vertical displacement for third BTE 110 PPCB

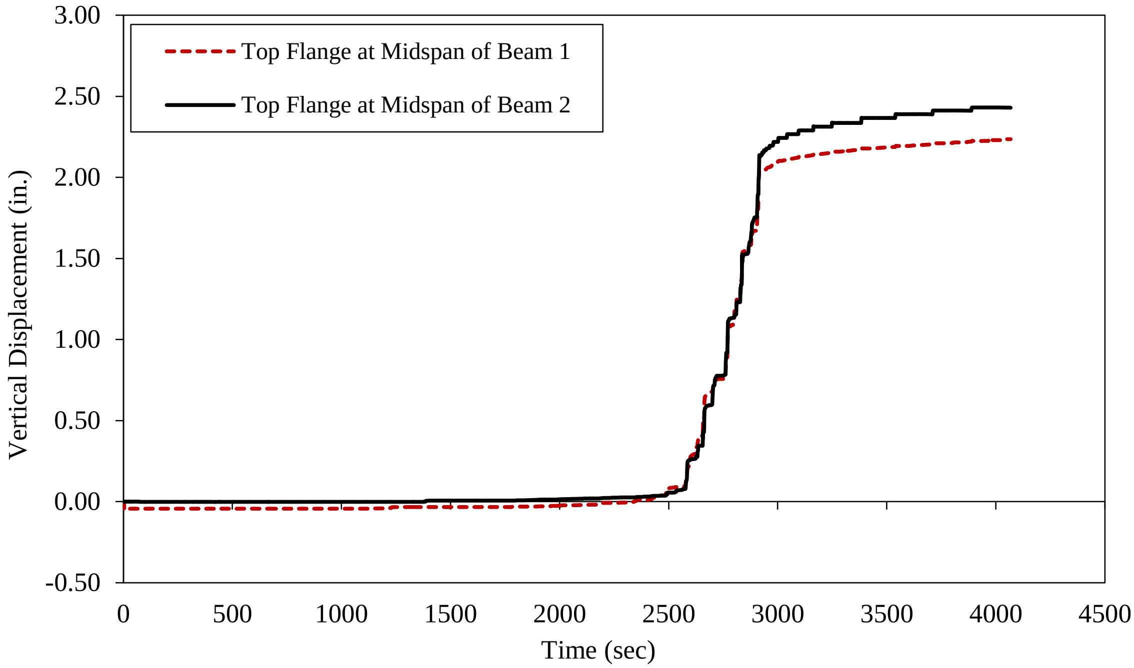


Figure B.13. Time versus vertical displacement for first D 110 PPCB

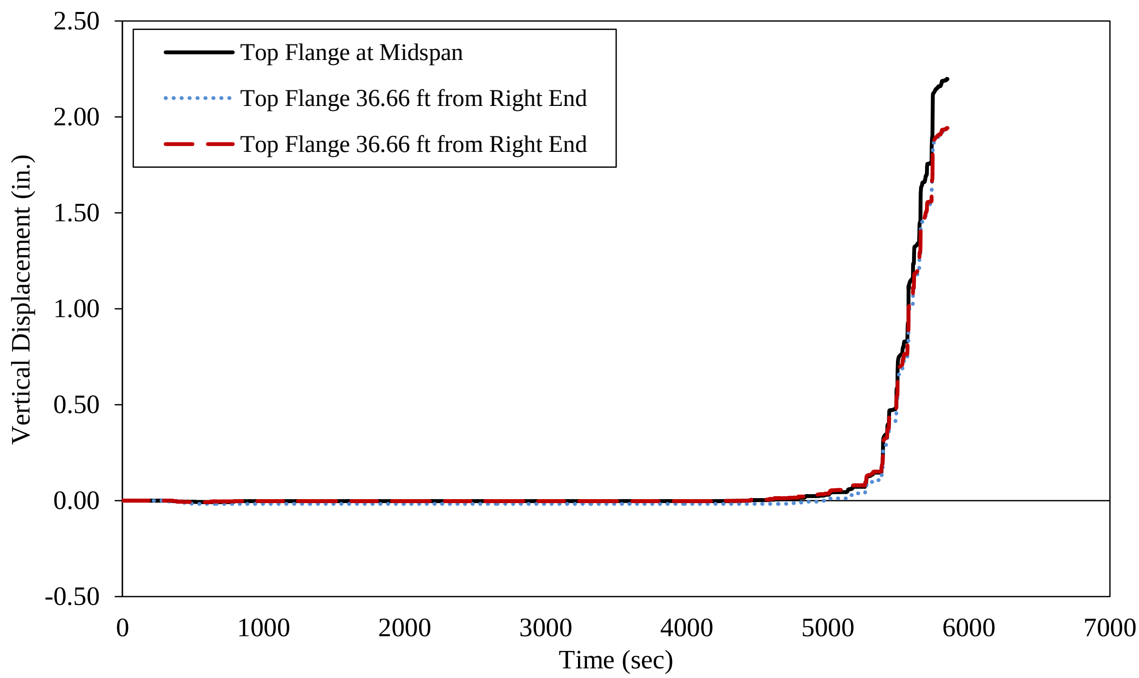


Figure B.14. Time versus vertical displacement for second D 110 PPCB

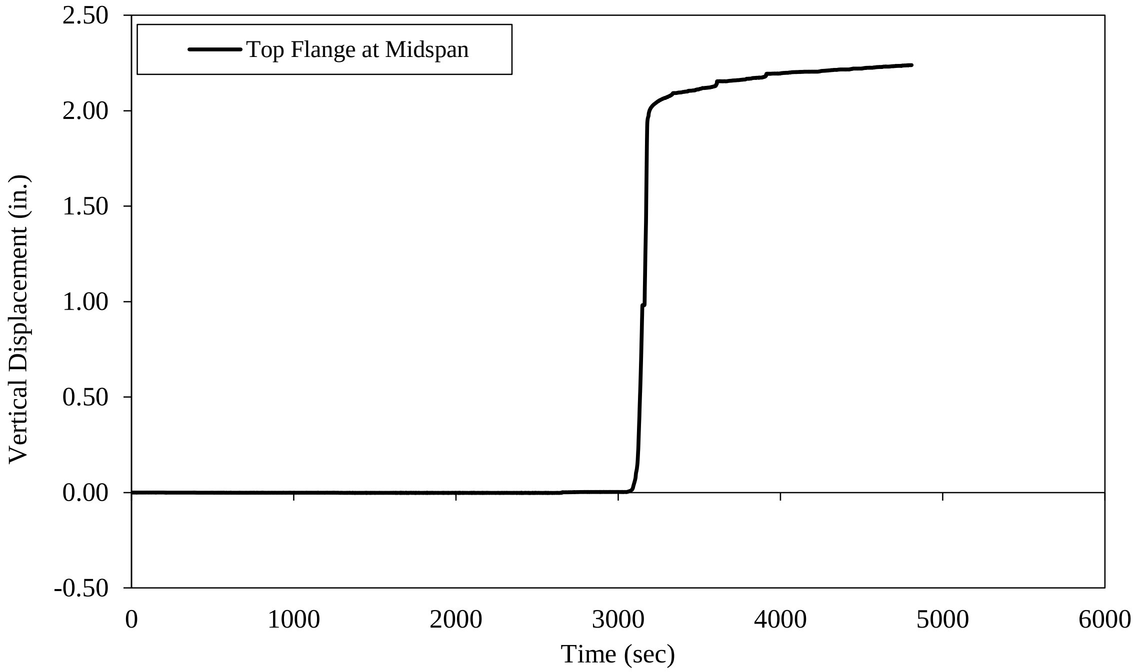
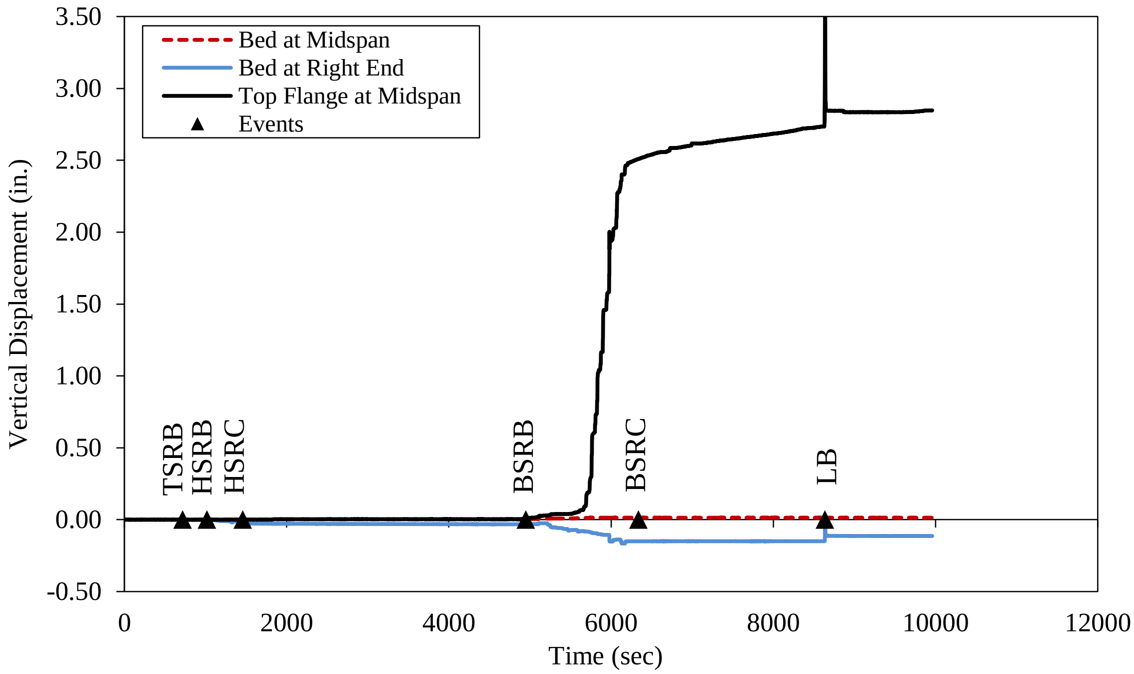
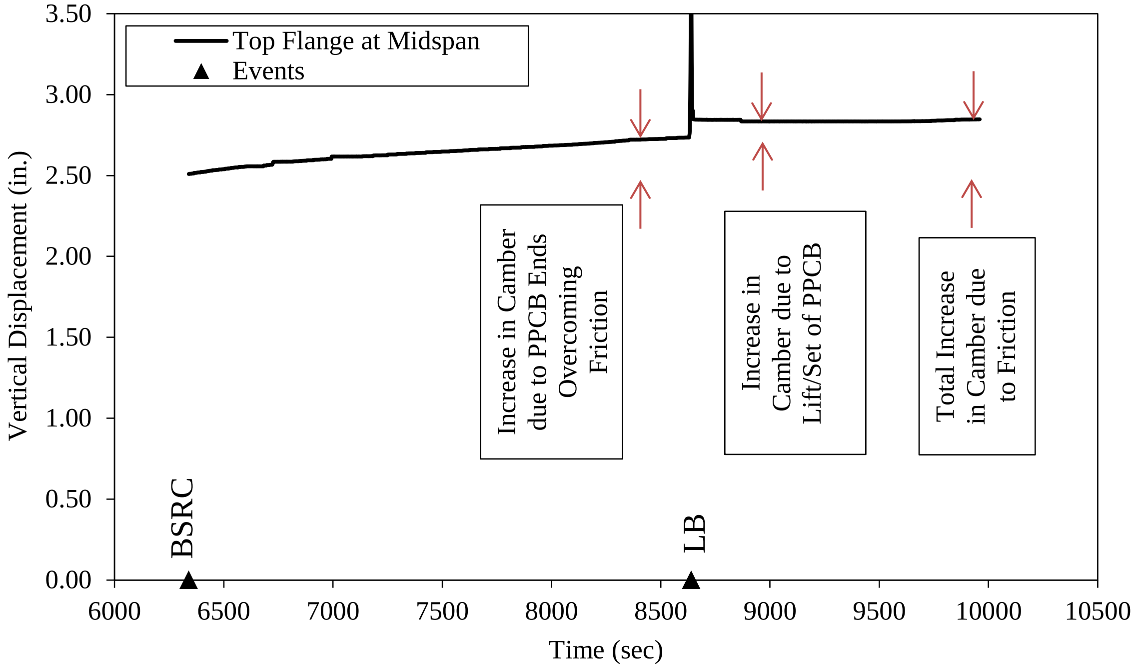


Figure B.15. Time versus vertical displacement for third D 105 PPCB



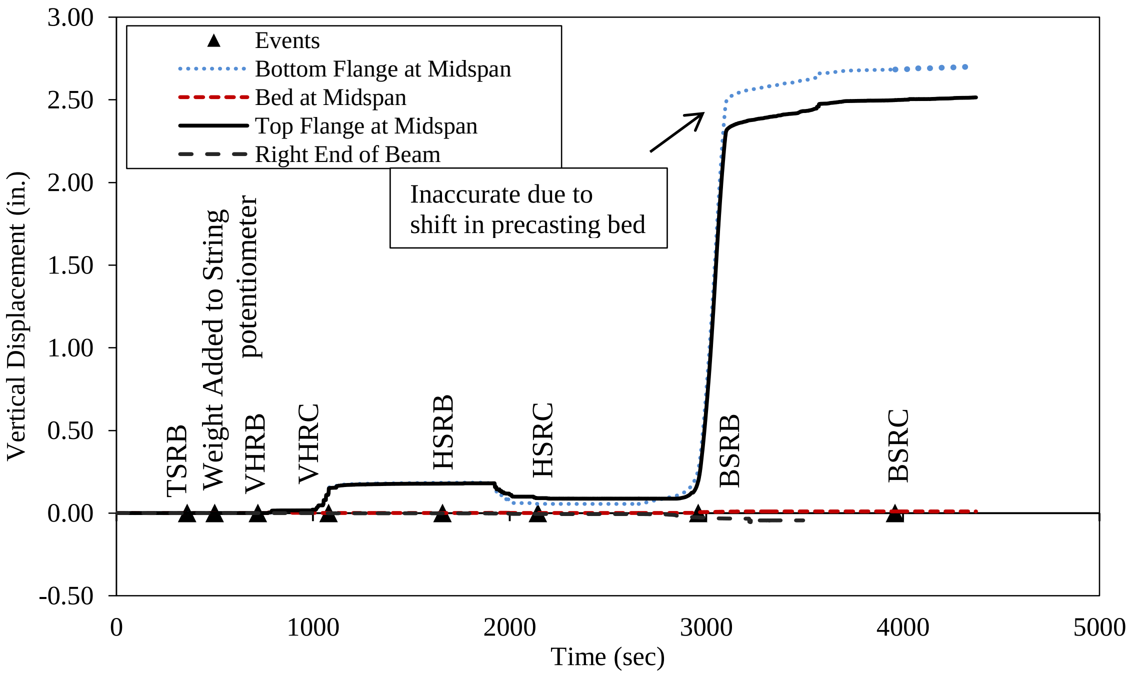
BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; LB = lifted PPCB; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.16. Time versus vertical displacement for a BTB 100 PPCB



BSRC = bottom strands, release completed; LB = lifted PPCB

Figure B.17. Time versus vertical displacement after the release of prestressing strands for a BTB 100



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; TSRB = top strands, release began; VHRB = vertical hold-down, release began; VHRC = vertical hold-down, release completed

Figure B.18. Time versus vertical displacement for a BTB 95 PPCB

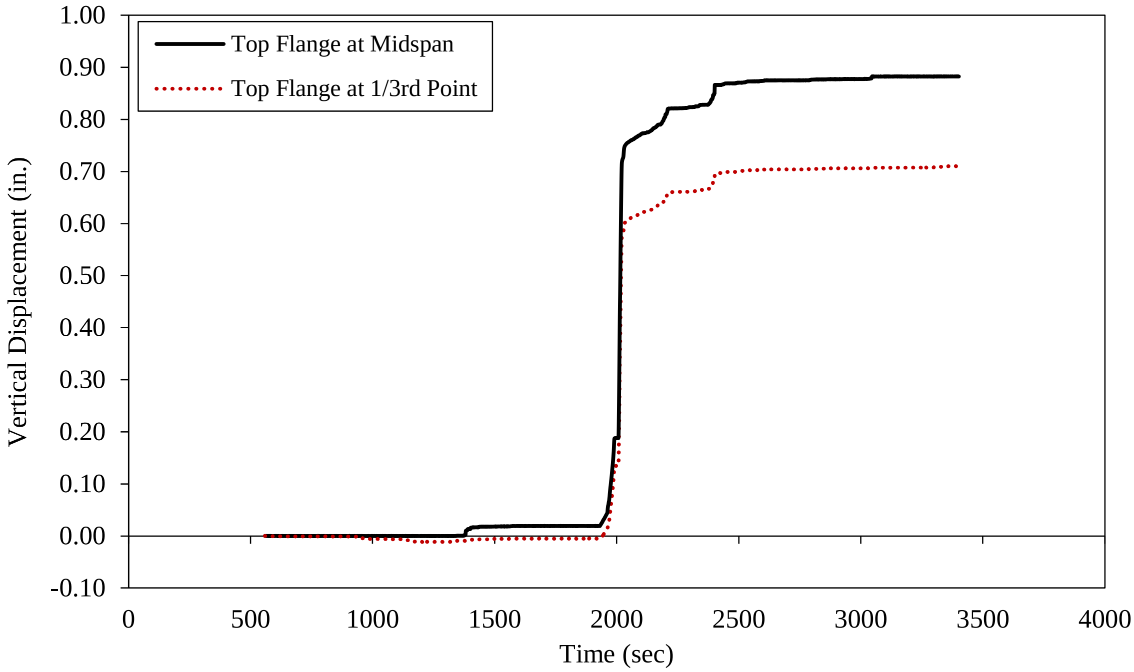


Figure B.19. Time versus vertical displacement for first D 90 PPCB

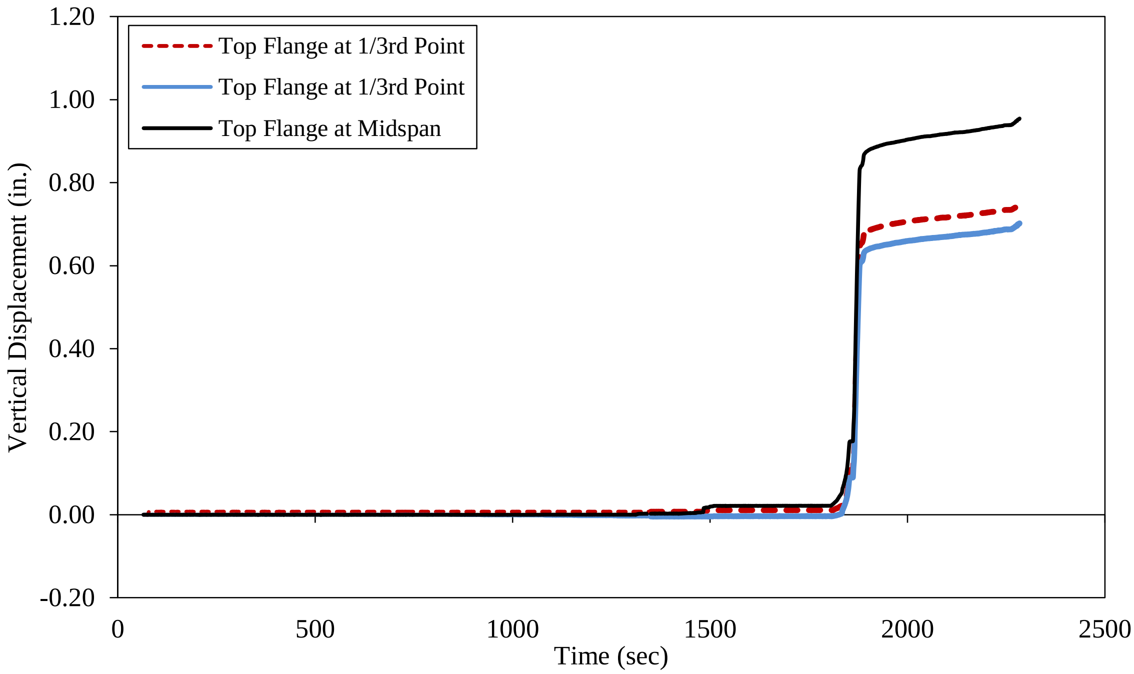


Figure B.20. Time versus vertical displacement for second D 90 PPCB

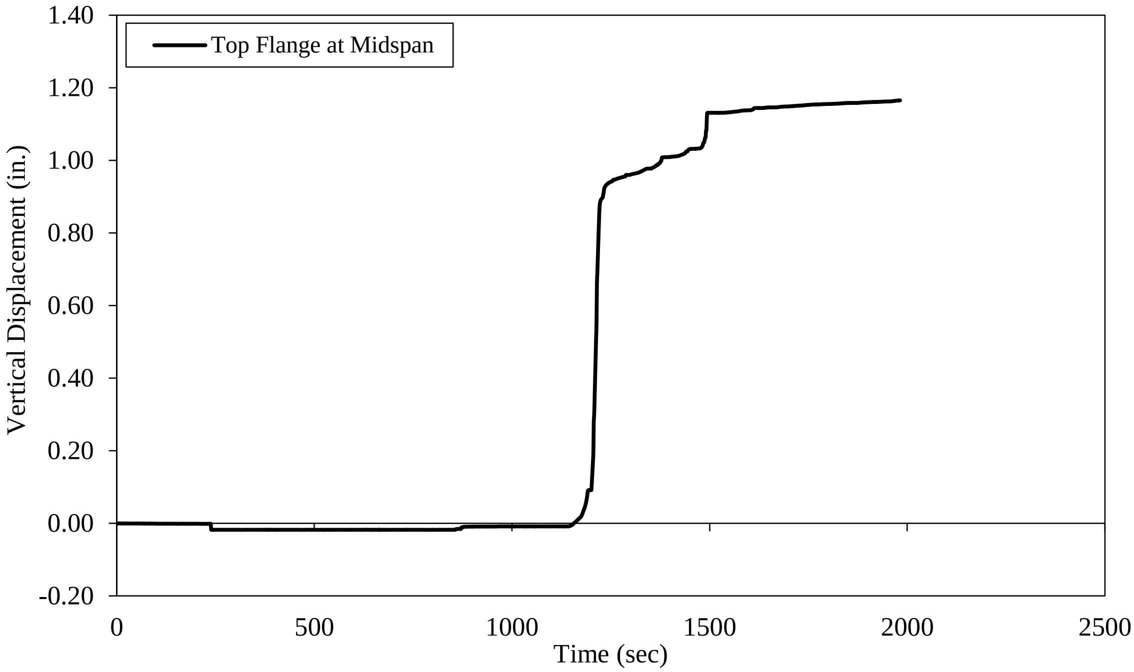


Figure B.21. Time versus vertical displacement for first D 90 PPCB

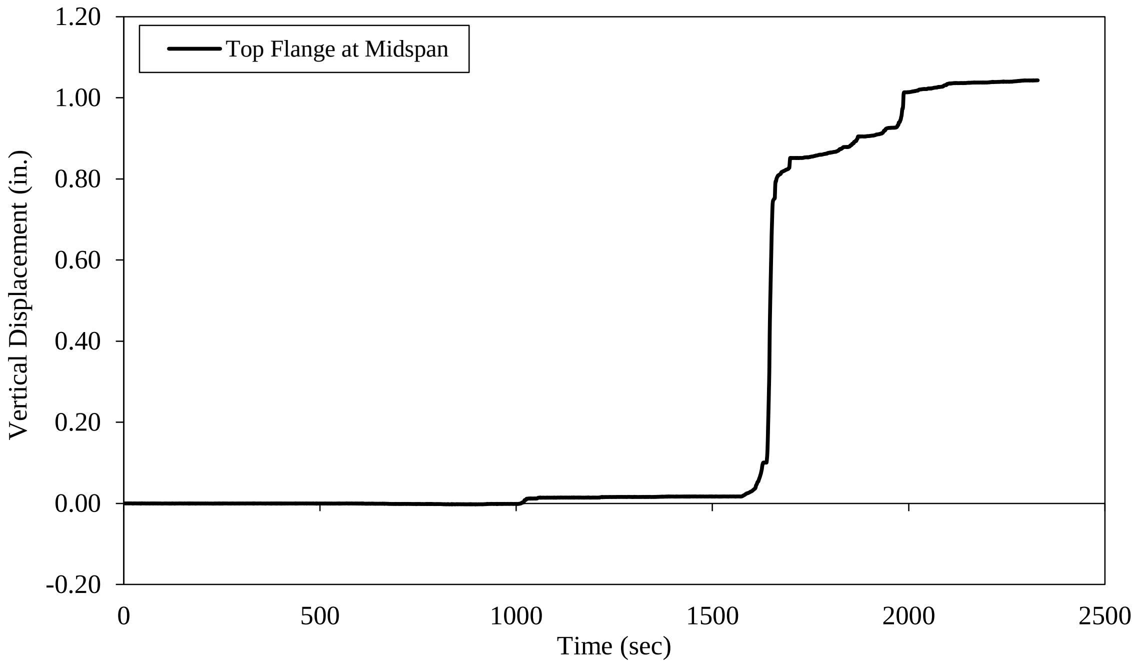
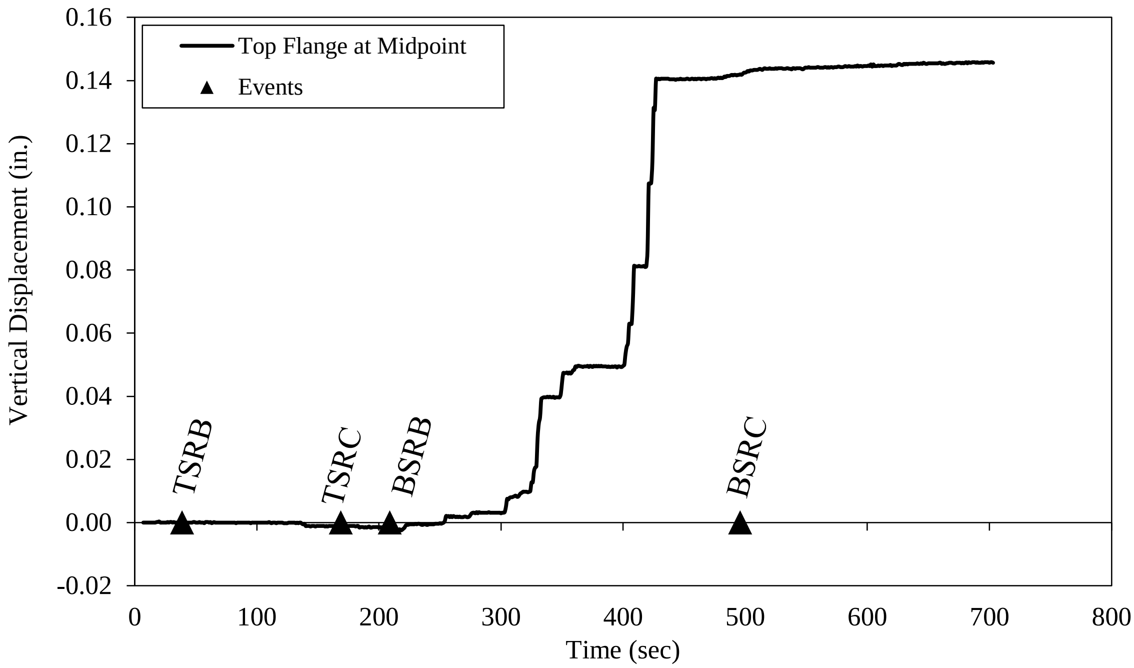
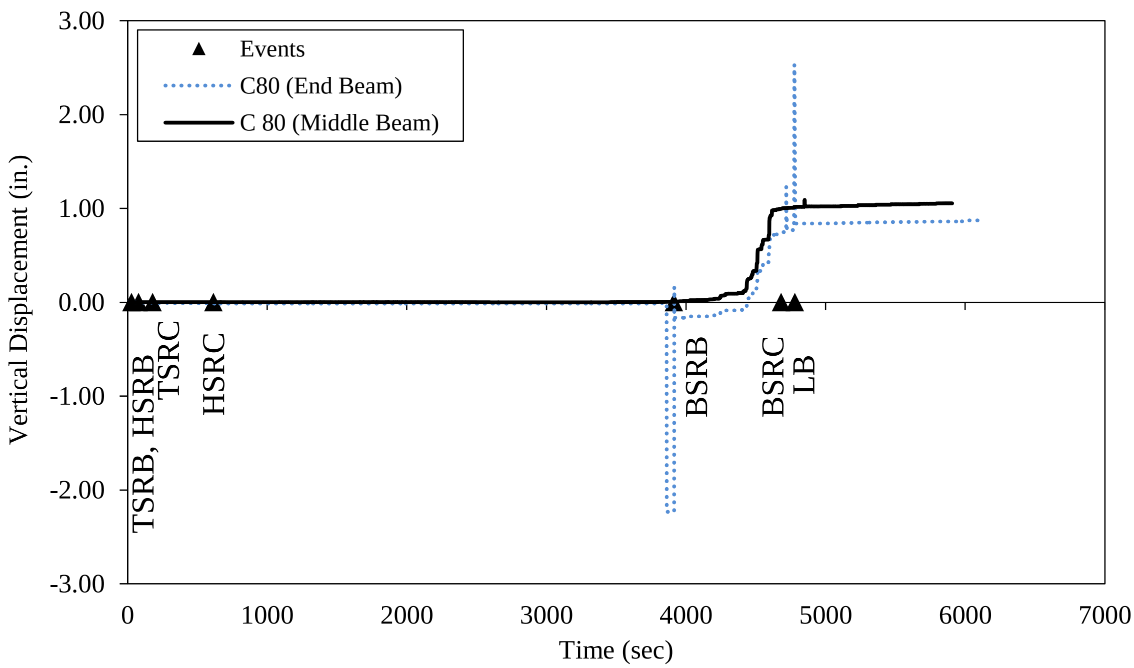


Figure B.22. Time versus vertical displacement for second D 90 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.23. Time versus vertical displacement for a BTC 45 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; LB = lifted PPCB; HSRB = harped strands, release began; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.24. Time versus vertical displacement for first C 80 PPCB

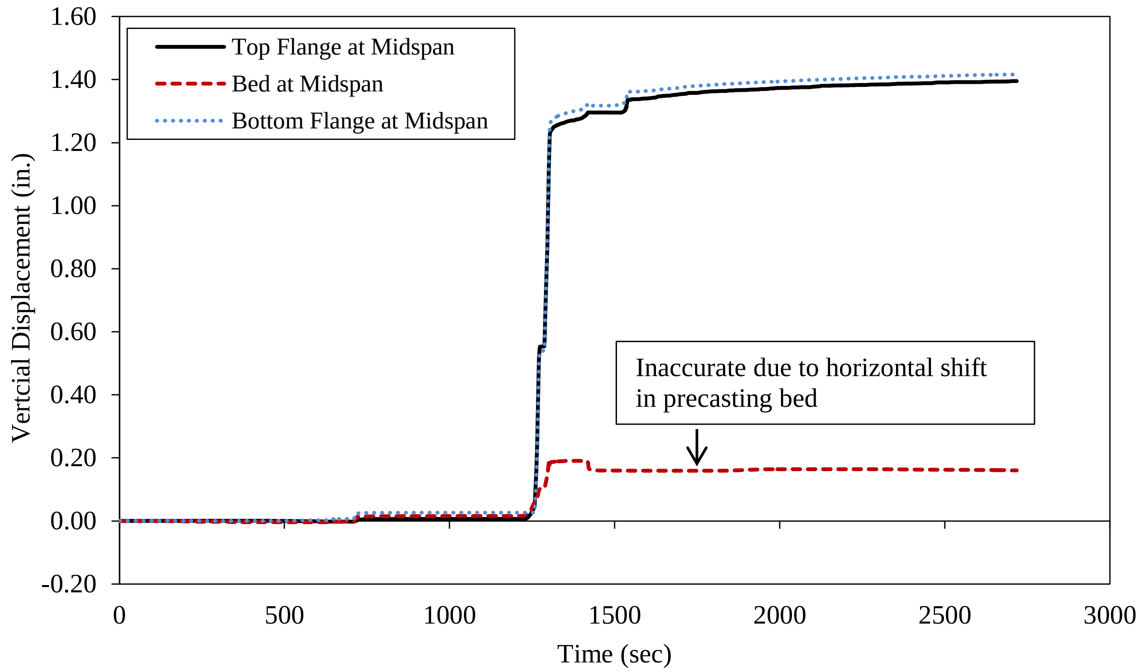


Figure B.25. Time versus vertical displacement for second C 80 PPCB

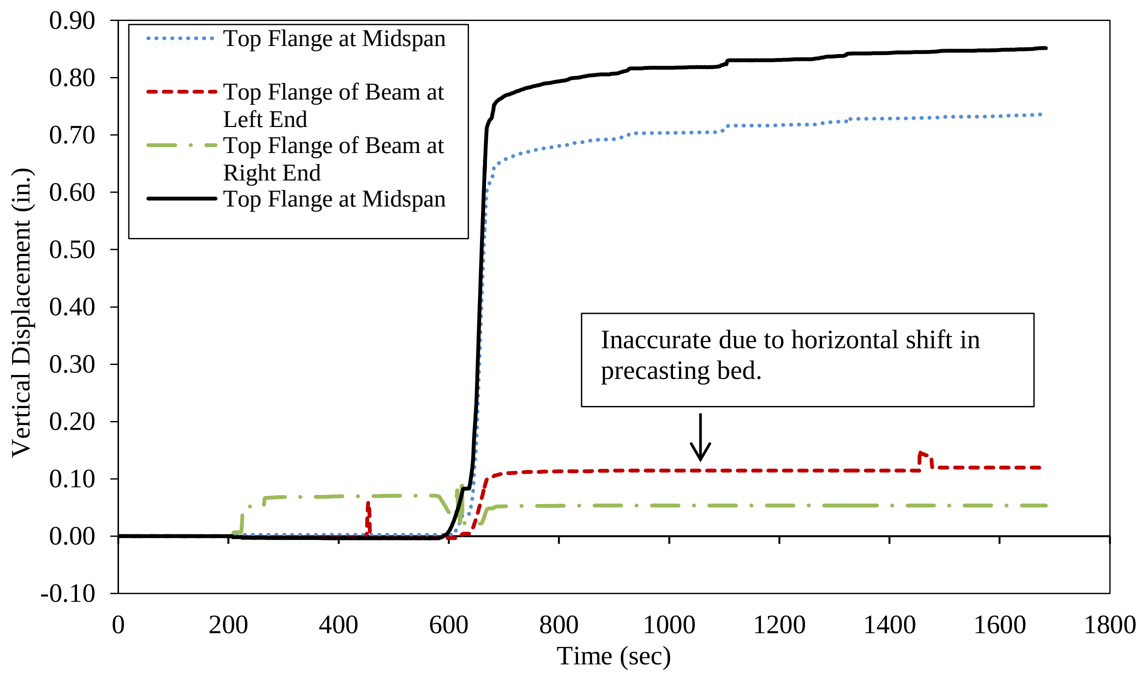


Figure B.26. Time versus vertical displacement for a C 67 PPCB

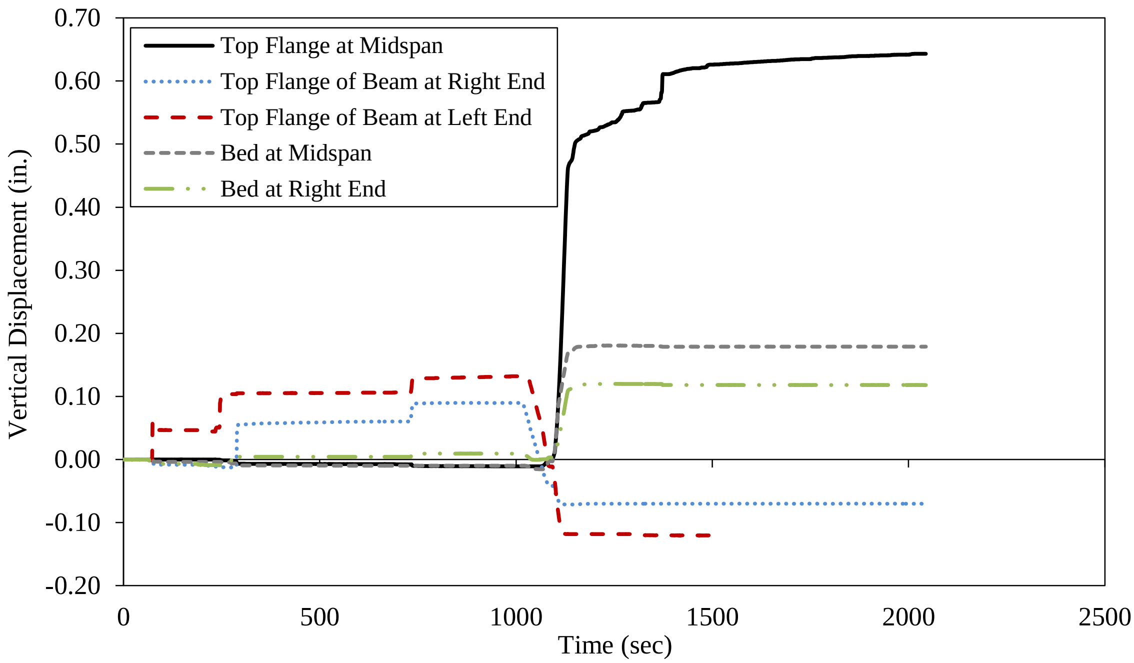


Figure B.27. Time versus vertical displacement for a C 67 PPCB

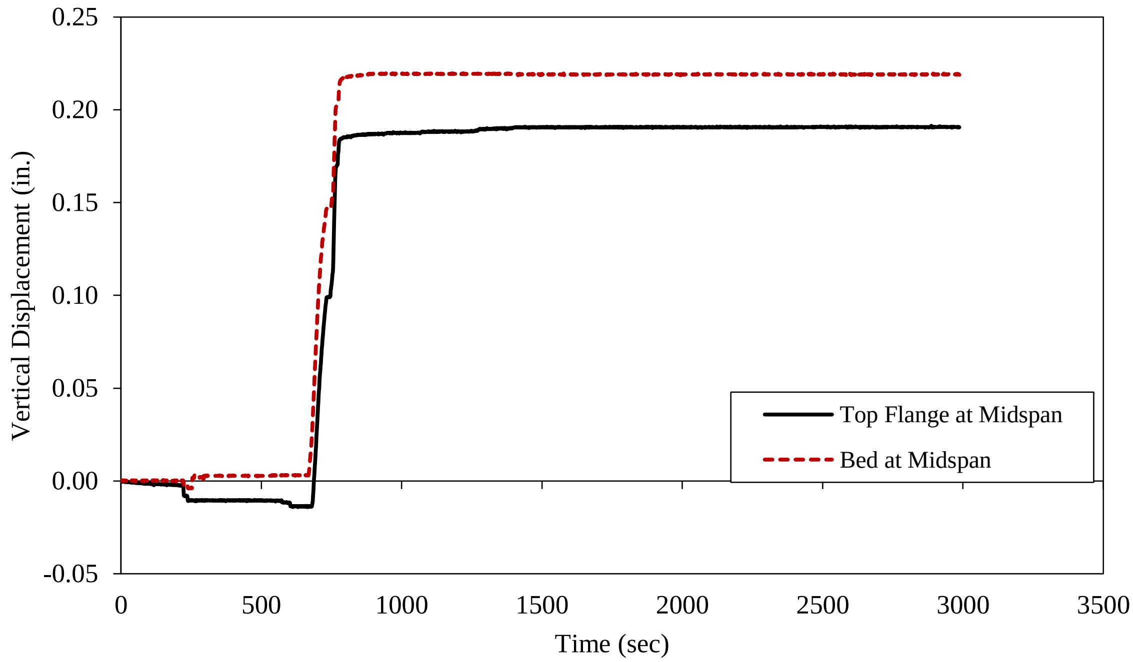


Figure B.28. Time versus vertical displacement for a D 55 PPCB

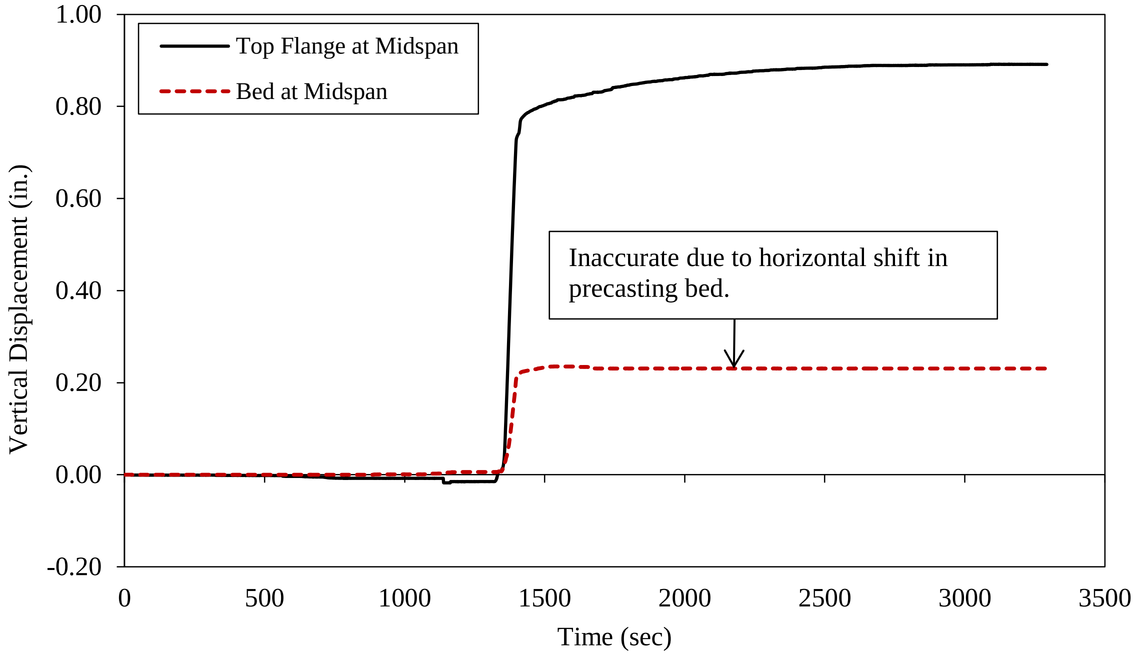


Figure B.29. Time versus vertical displacement for first B 55 PPCB

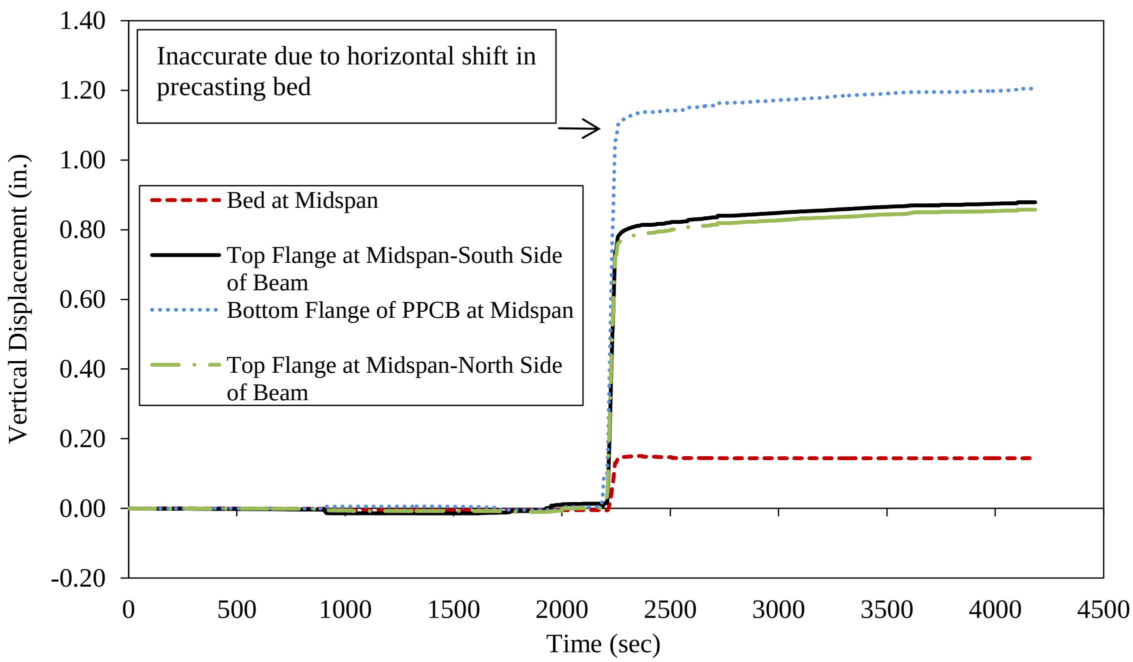
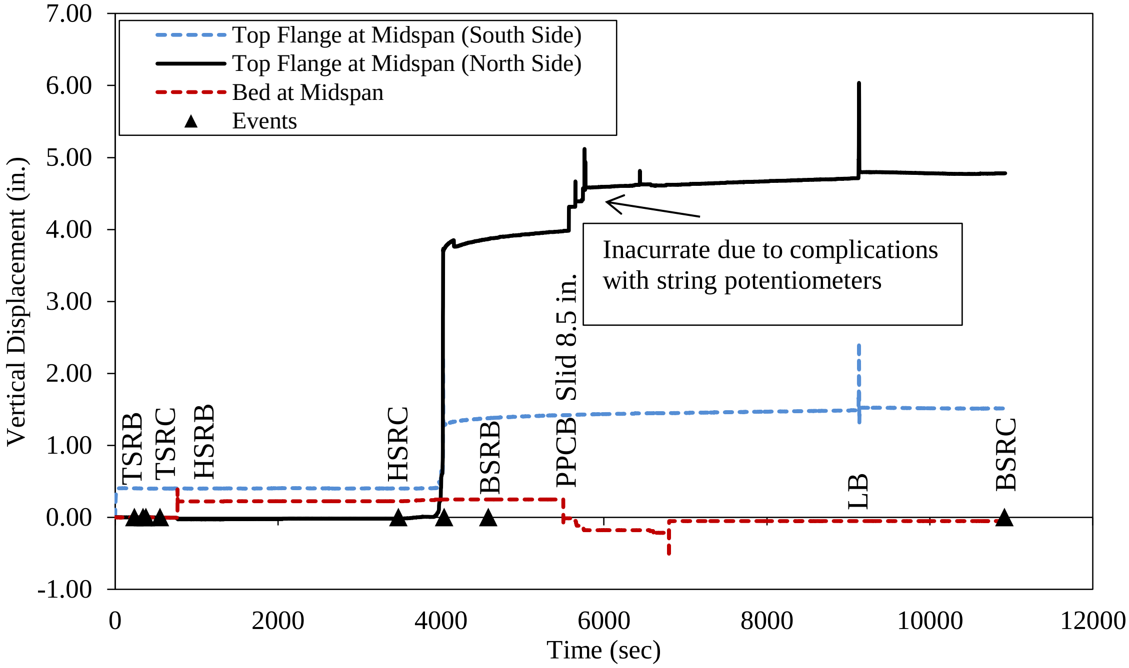
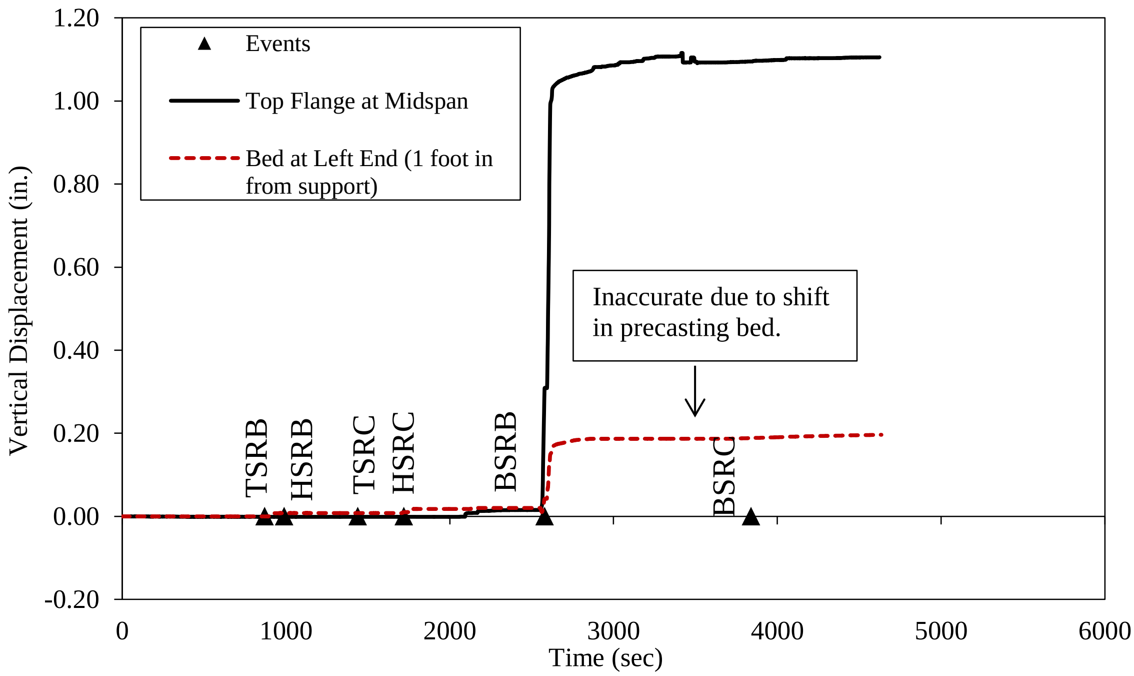


Figure B.30. Time versus vertical displacement for second B 55 PPCB



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; LB = lifted PPCB; HSRB = harped strands, release began; HSRC = harped strands, release completed; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.31. Time versus vertical displacement for a SBTD 135



BSRB = bottom strands, release began; BSRC = bottom strands, release completed; HSRB = harped strands, release began; HSRC = harped strands, release completed; TSRB = top strands, release began; TSRC = top strands, release completed

Figure B.32. Time versus vertical displacement for a C 80 PPCB

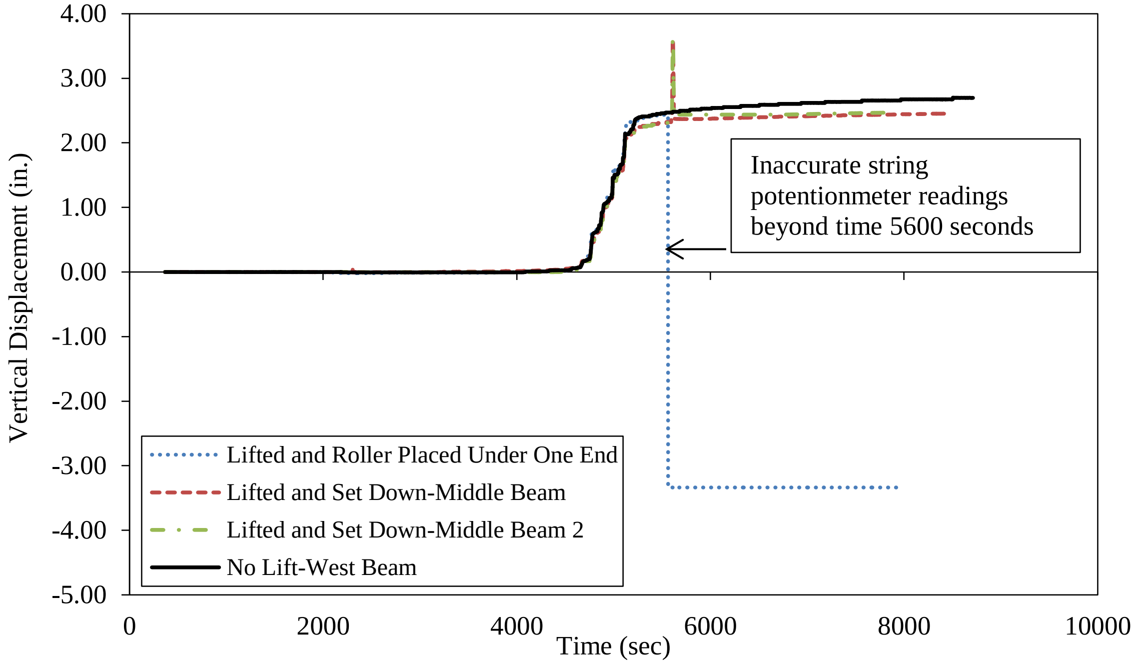


Figure B.33. Time versus vertical displacement after the transfer of prestress for three D 110 PPCBs with different support conditions

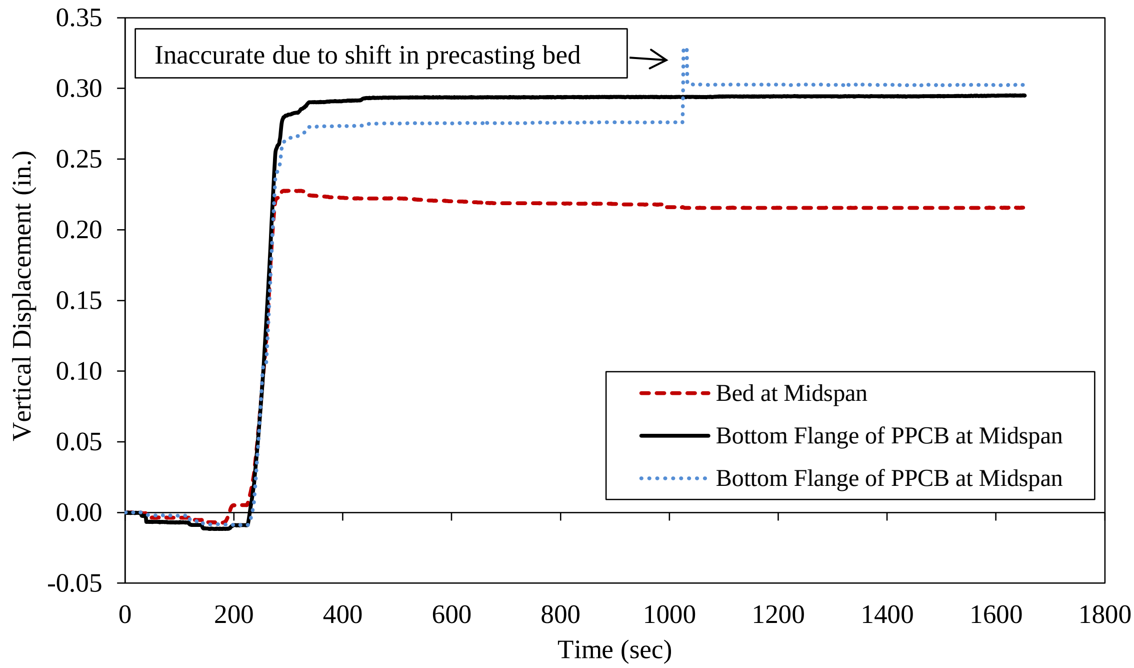


Figure B.34. Time versus vertical displacement for a D 60 PPCB

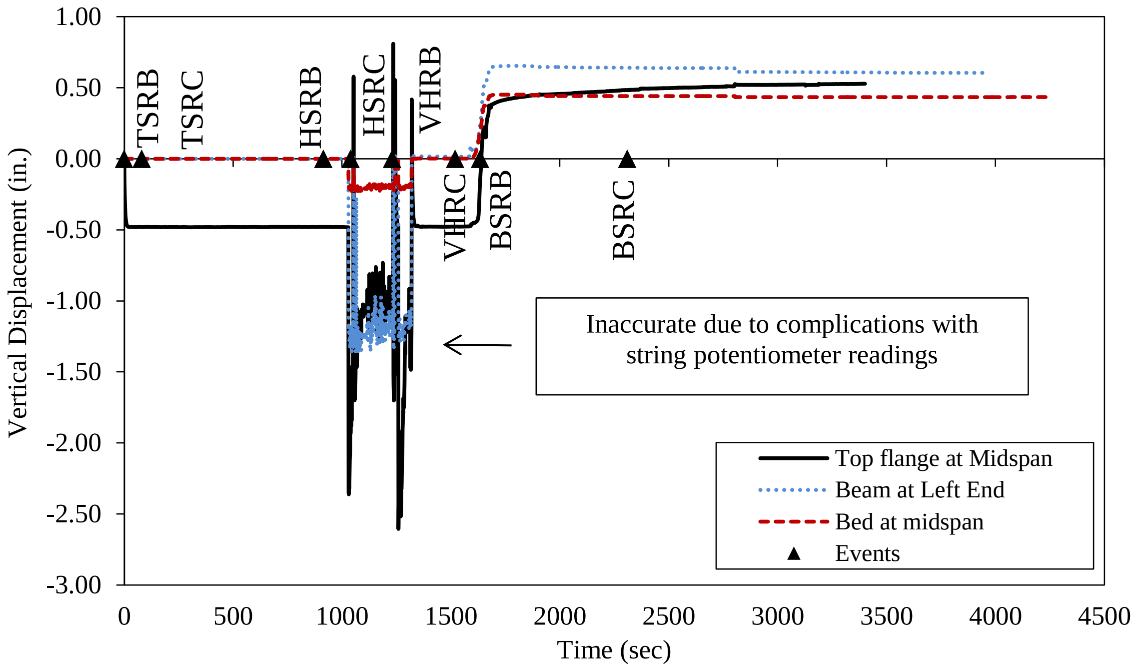


Figure B.35. Time versus vertical displacement for a BTD 135 PPCB

APPENDIX C. LONG-TERM CAMBER MEASUREMENTS

This appendix presents the raw data collected for the long-term camber of 66 PPCBs from release to when erected on-site. Also, the average and standard deviation of the entire data are shown in the graphs and compared to the current Iowa DOT long-term camber prediction.

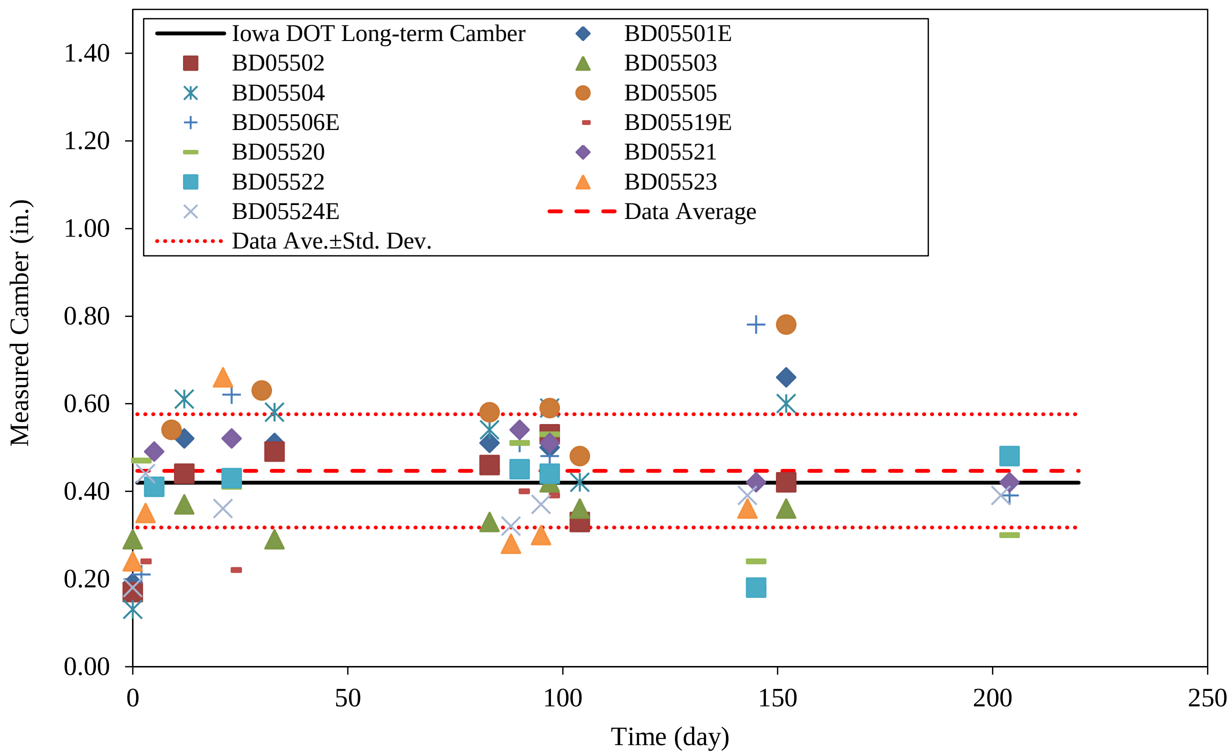


Figure C.1. Measured camber for all D 55 PPCBs

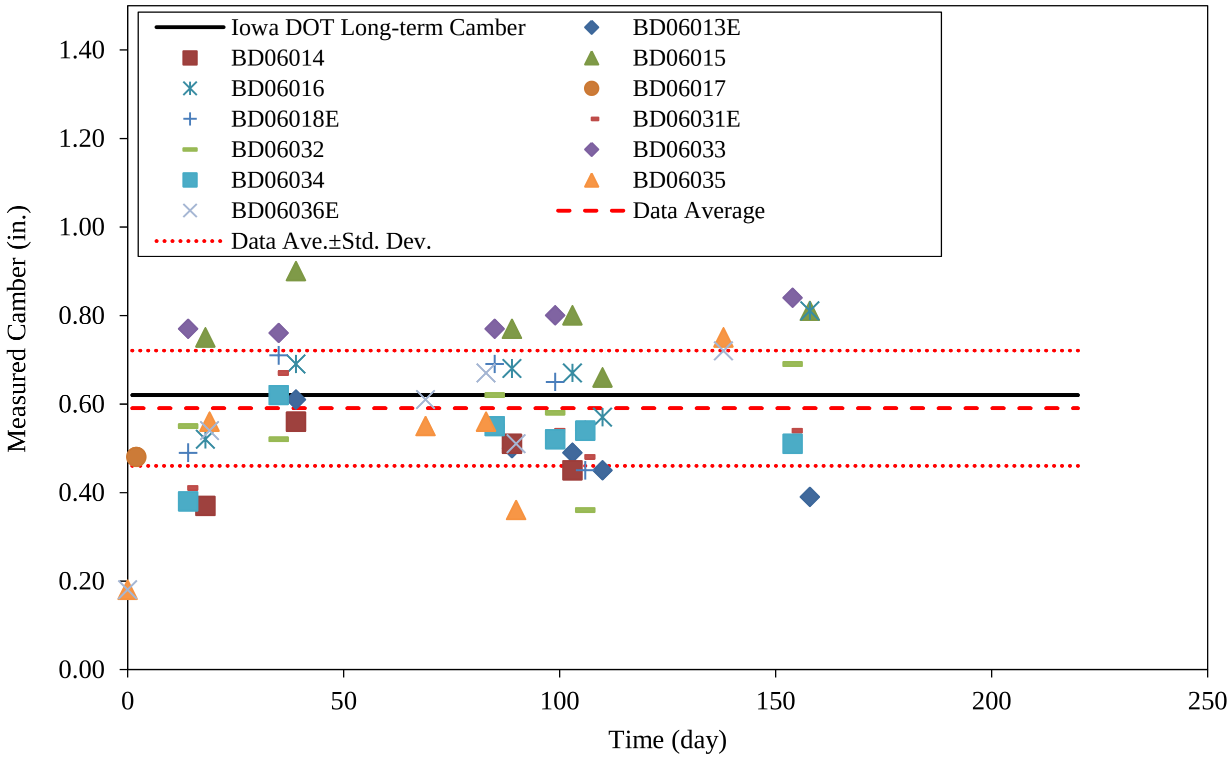


Figure C.2. Measured camber for all D 60 PPCBs

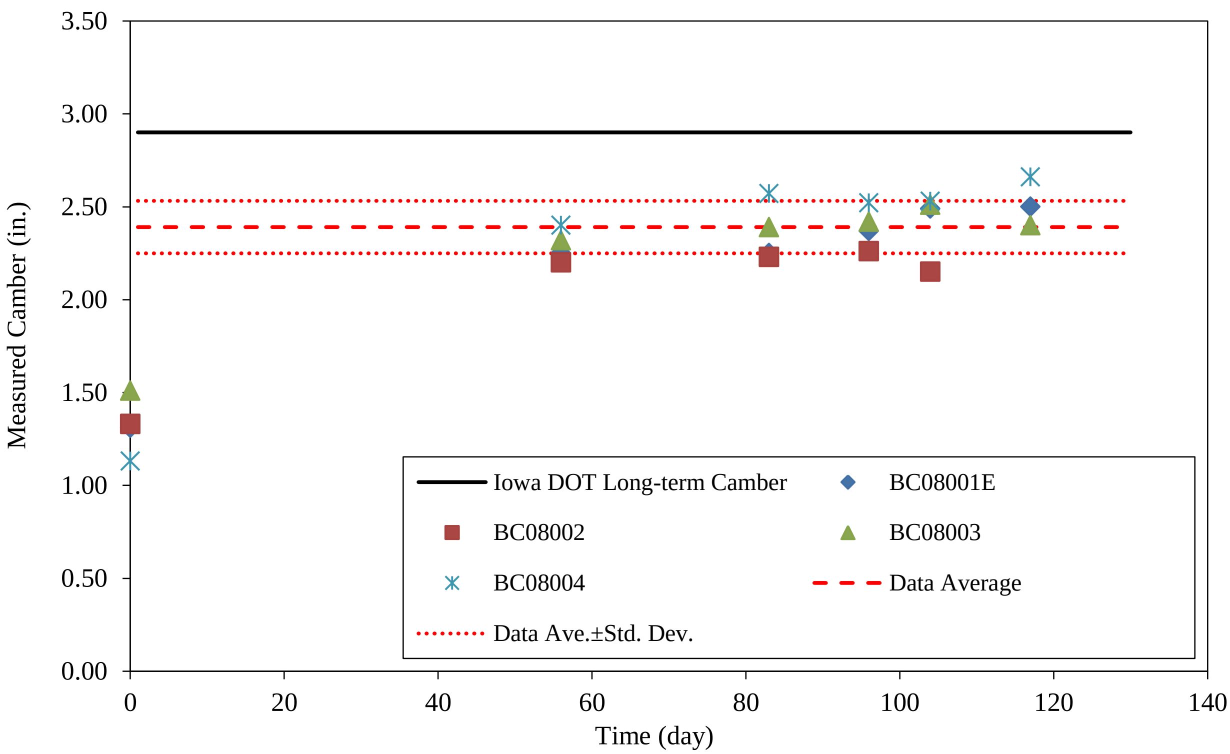


Figure C.3. Measured camber for all C 80 PPCBs

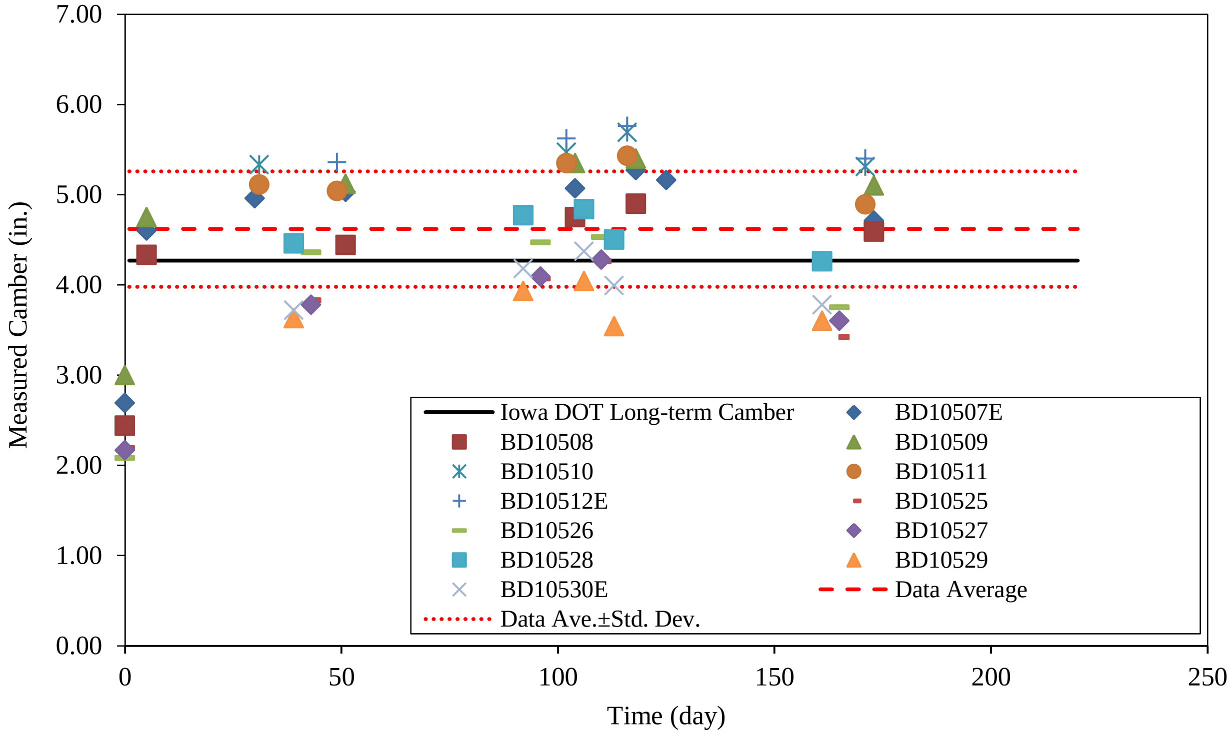


Figure C.4. Measured camber for all D 105 PPCBs

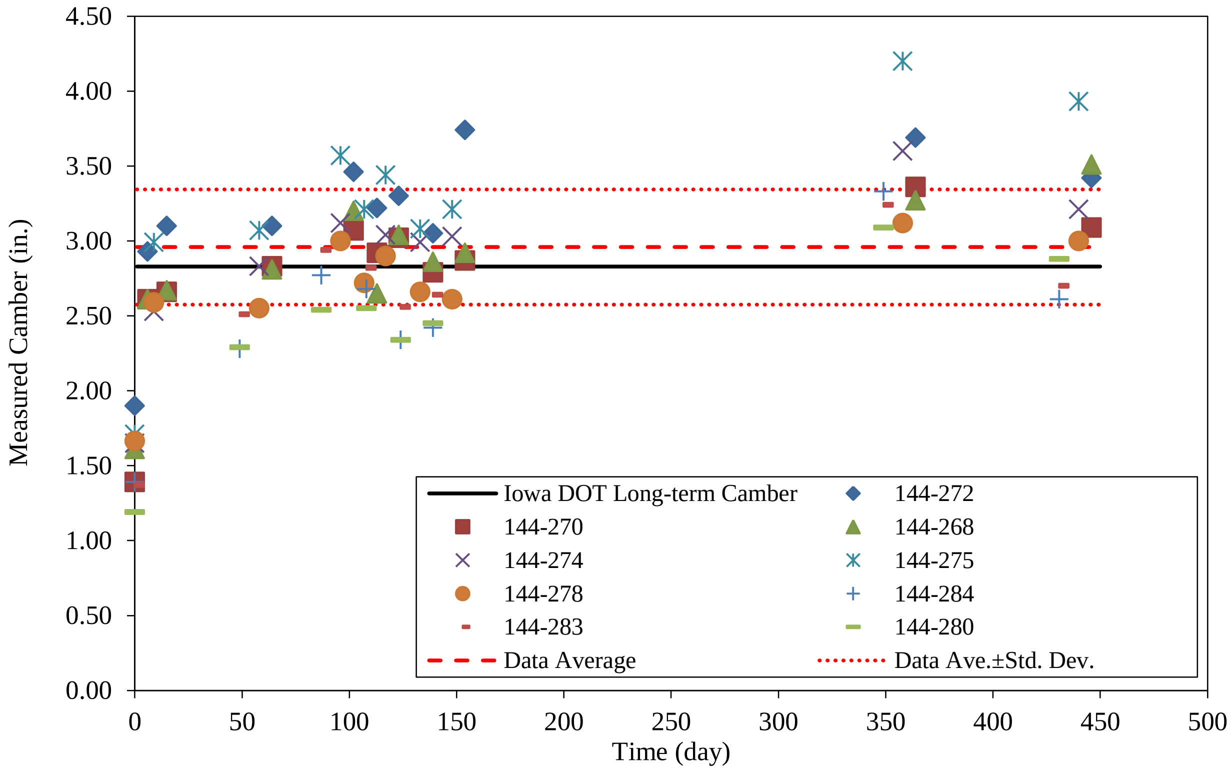


Figure C.5. Measured camber for all BTE 110 PPCBs

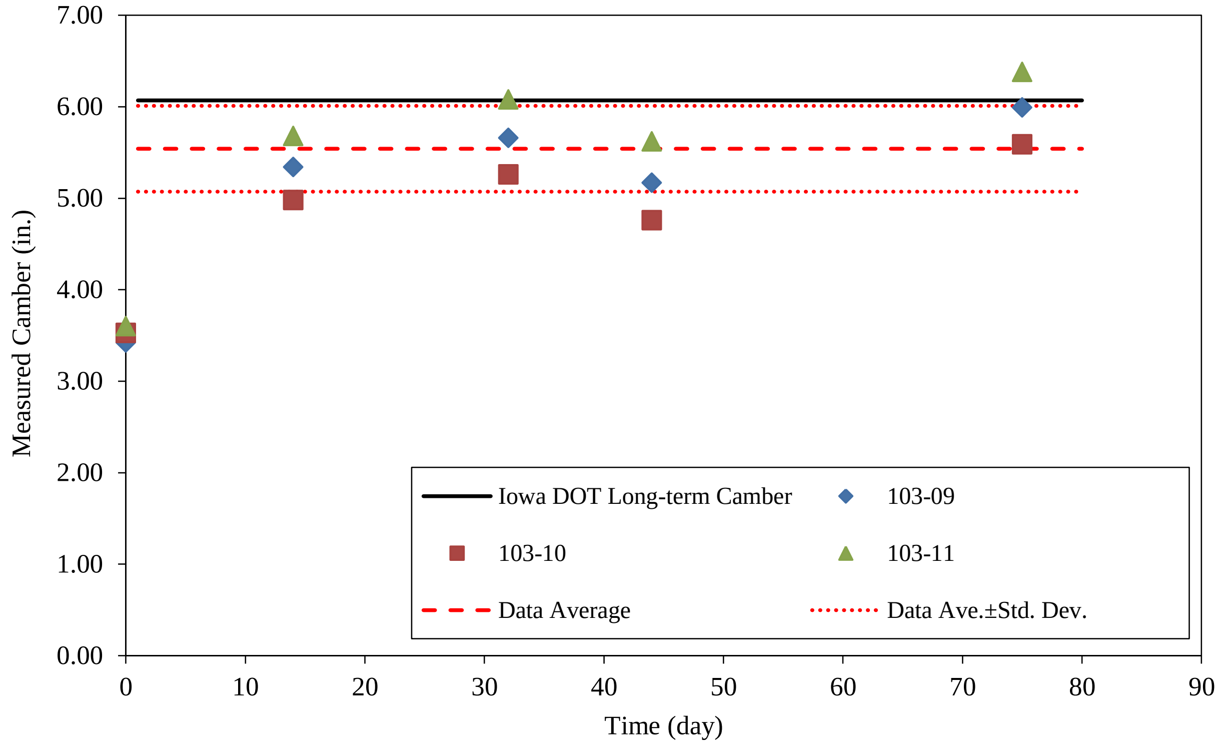


Figure C.6. Measured camber for all BTC 120 PPCBs

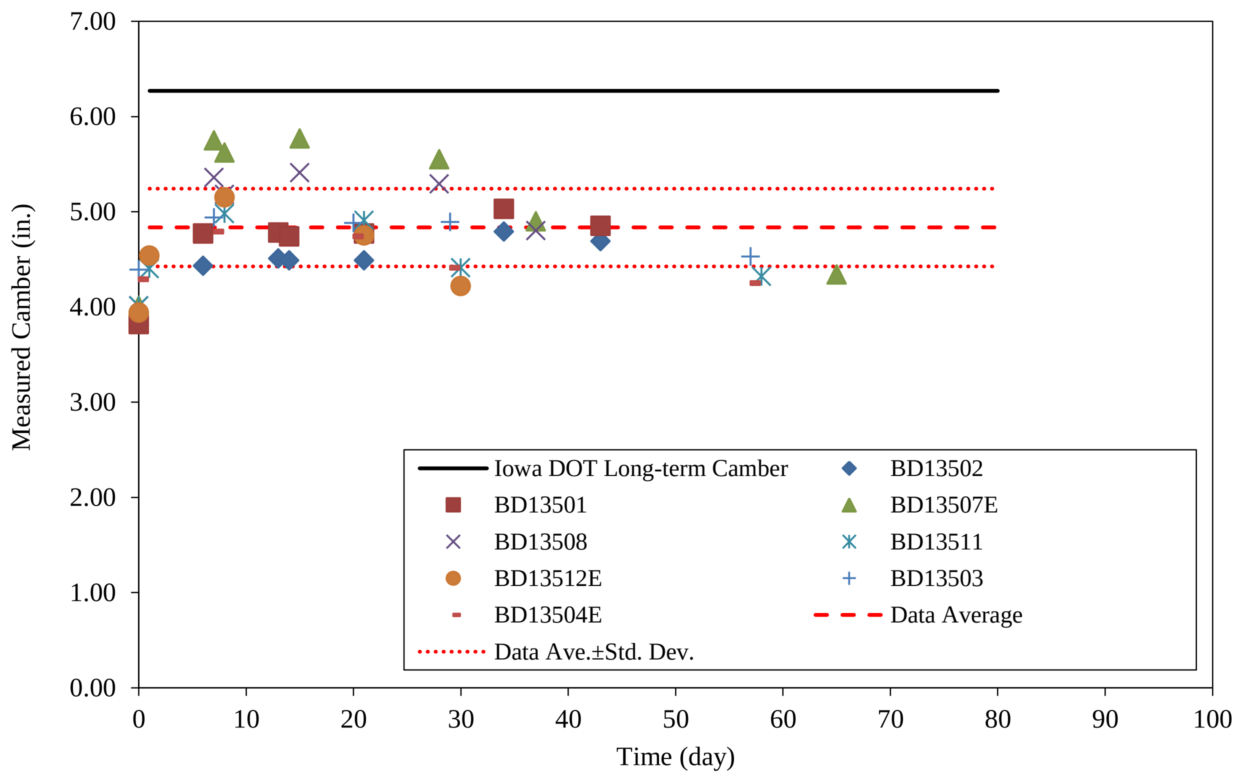


Figure C.7. Measured camber for all BTD 135 PPCBs

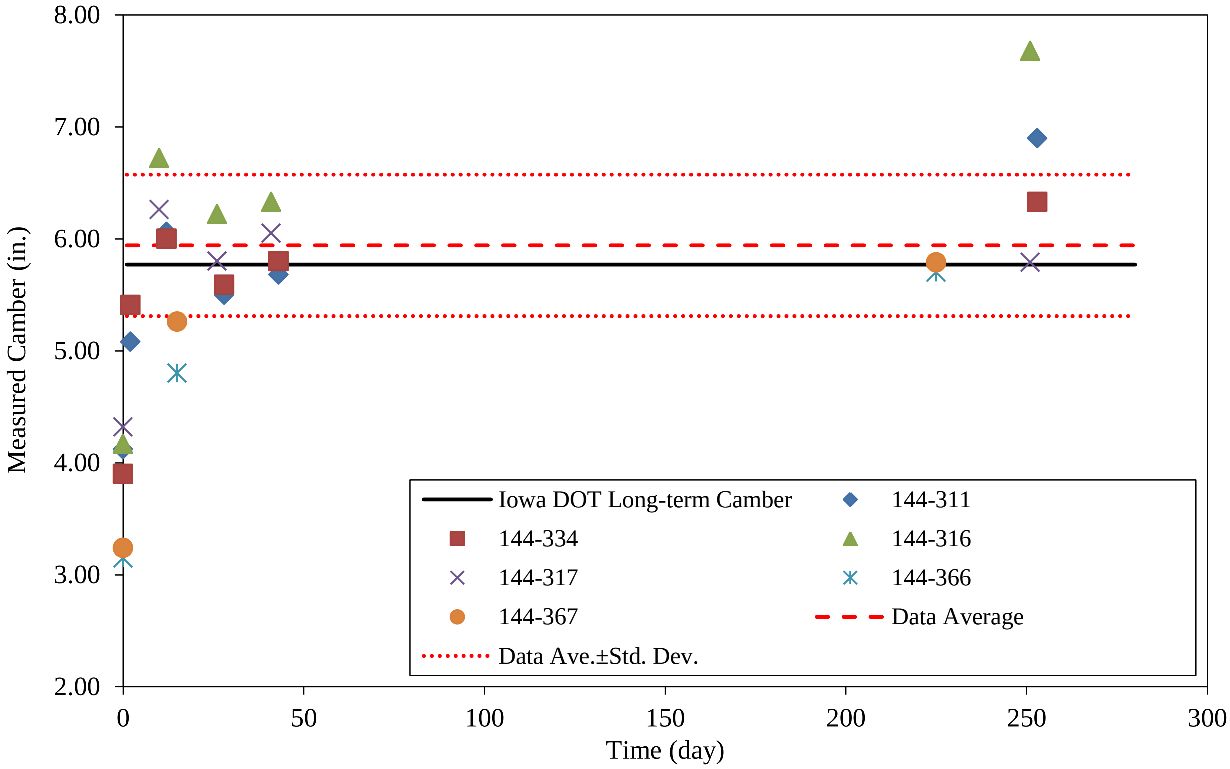


Figure C.8. Measured camber for all BTE 145 PPCBs

APPENDIX D. INVESTIGATION OF THERMAL EFFECTS

The variations of the thermal deflections and the temperature difference with time for various instrumented PPCBs in different seasons are shown in this appendix.

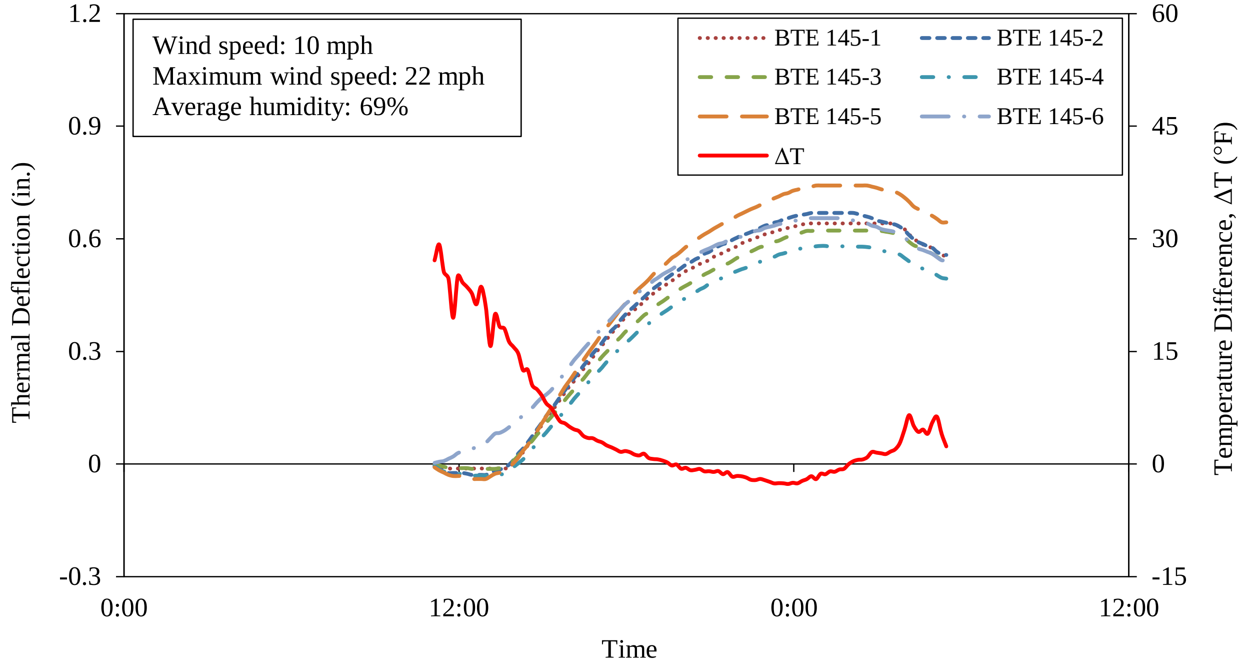


Figure D.1. Thermal deflection and temperature difference variation versus time for BTE 145 PPCBs in summer (June)

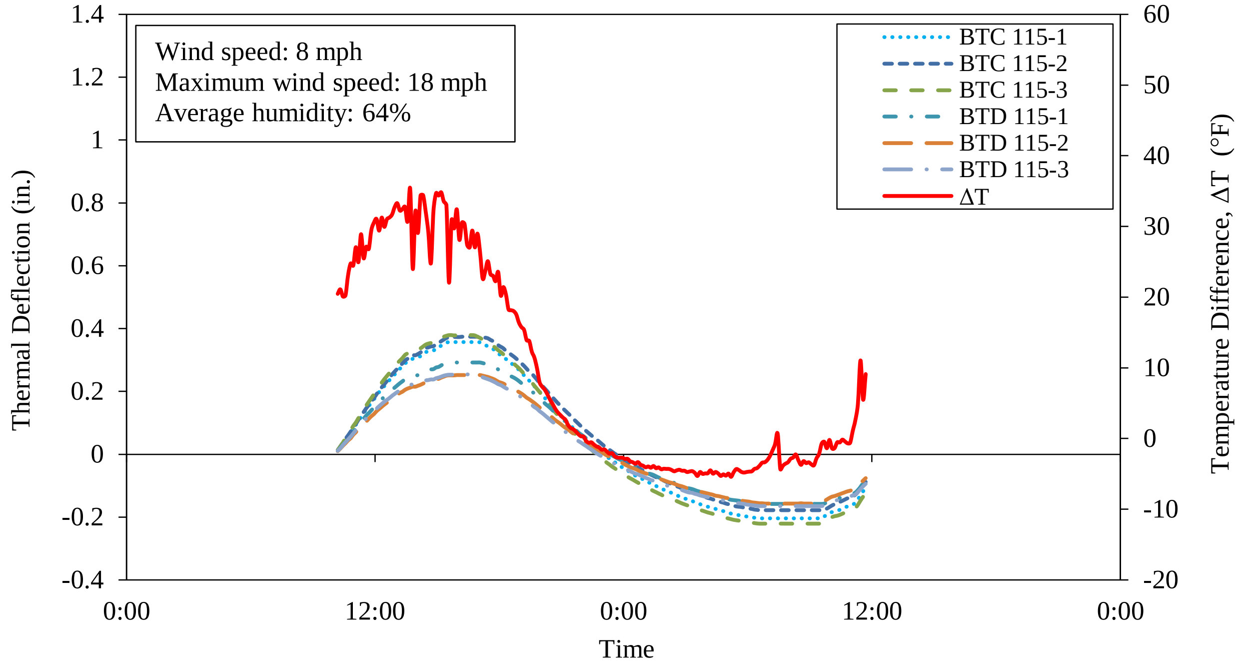


Figure D.2. Thermal deflection and temperature difference variation versus time for BTC 115 and BTD 115 PPCBs in summer (July)

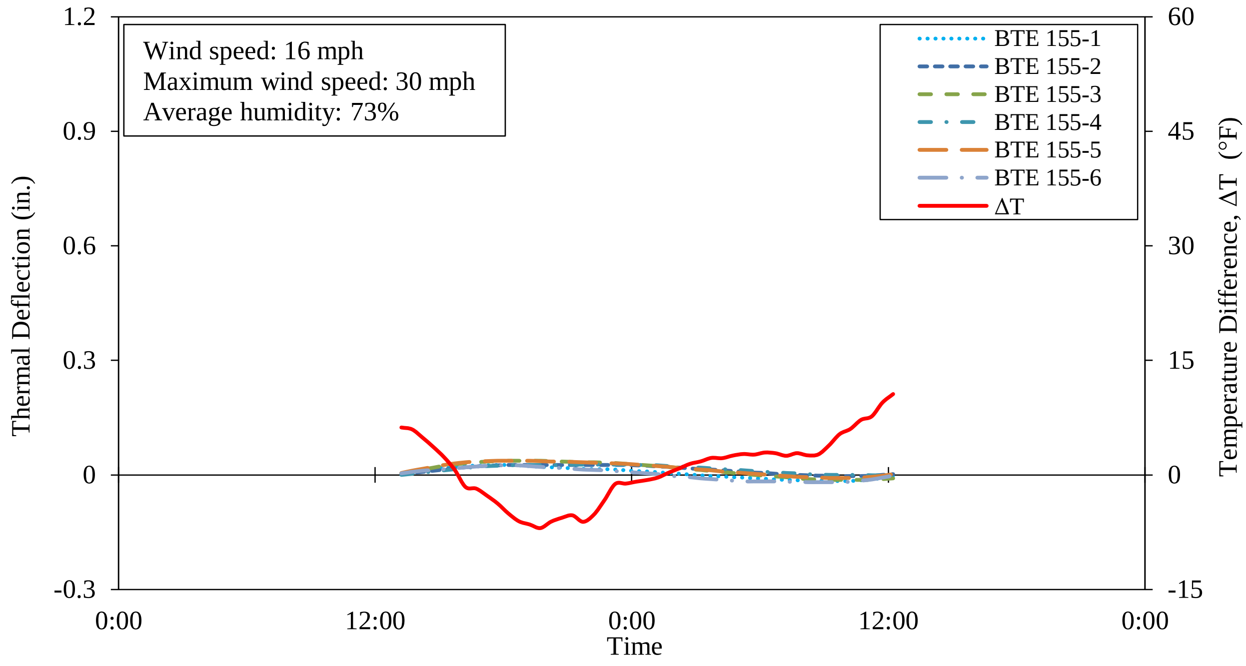


Figure D.3. Thermal deflection and temperature difference variation versus time for BTE 155 PPCBs in winter (February)

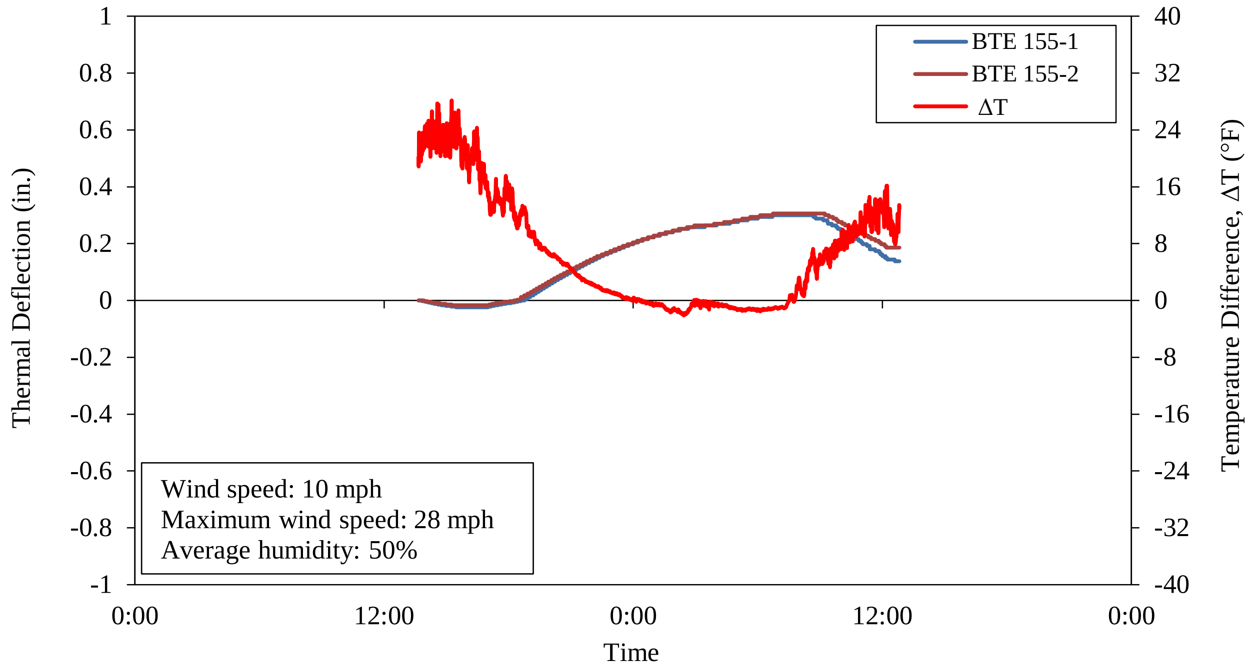


Figure D.4. Thermal deflection and temperature difference variation versus time for BTE 155 PPCBs in spring (April)

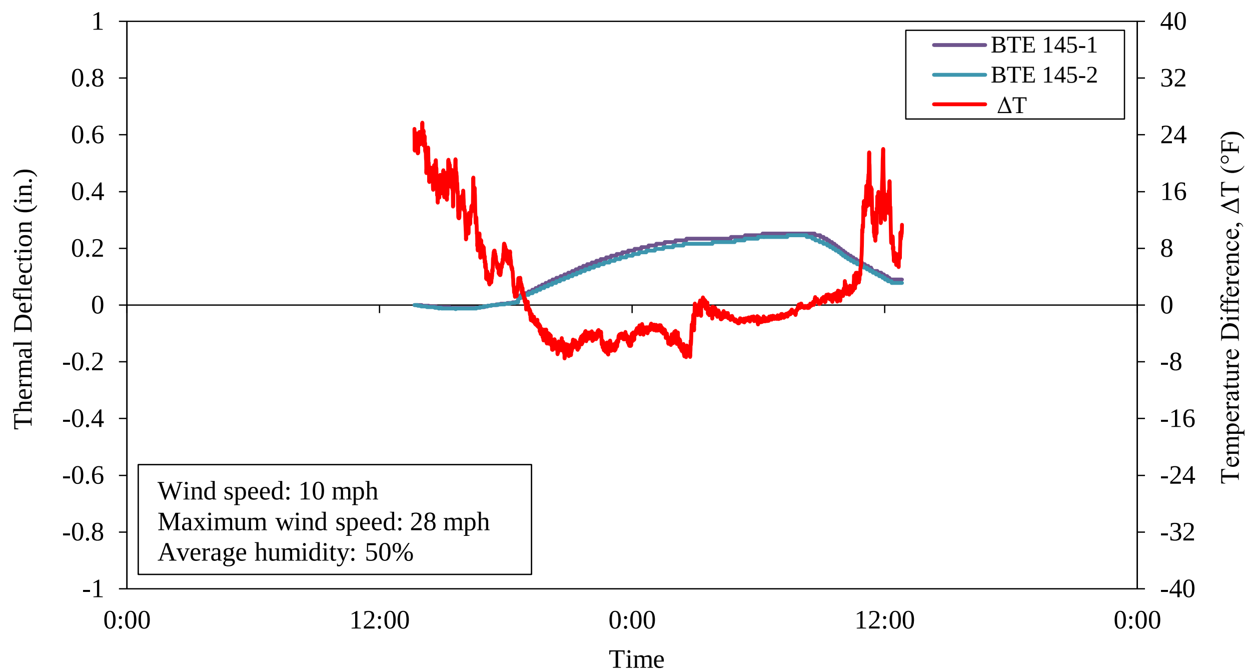


Figure D.5. Thermal deflection and temperature difference variation versus time for BTE 145 PPCBs in spring (April)

APPENDIX E. INSTANTANEOUS CAMBER PREDICTION

The results listed in Appendix E are a combination of the calculated camber data using the moment area method, the comparison of material properties obtained from specifications and as-built values, and the additional data that were found as a result of analytically calculating the camber data.

E.1. Release Strength

The release strengths that were measured from various PPCBs at three different precast plants are listed below. Additionally, the designed and measured release strengths are compared to one another.

Table E.1. Measured release strengths

Plant	PPCB Type	Date of Casting	Date of Release	Target f'_{ci} (psi)	Average of Measured f'_{ci} (psi)	Target f'_{ci}/Measured f'_{ci}	Percent Difference of Target and Measured f'_{ci}
Plant C	D90	9/13/2011	9/14/2011	4500	8000	0.56	77.78
Plant C	D90	9/13/2011	9/14/2011	4500	8000	0.56	77.78
Plant C	D90	9/13/2011	9/14/2011	4500	8000	0.56	77.78
Plant C	D90	9/15/2011	9/16/2011	4500	6823	0.66	51.63
Plant C	D90	9/15/2011	9/16/2011	4500	6823	0.66	51.63
Plant C	D90	9/15/2011	9/16/2011	4500	6823	0.66	51.63
Plant A	D110	9/16/2011	9/17/2011	6500	7171	0.91	10.32
Plant A	D110	9/16/2011	9/17/2011	6500	7171	0.91	10.32
Plant A	D110	9/16/2011	9/17/2011	6500	7171	0.91	10.32
Plant A	D110	9/15/2011	9/17/2011	6500	7171	0.91	10.32
Plant C	D90	9/19/2011	9/20/2011	4500	5927	0.76	31.70
Plant C	D90	9/19/2011	9/20/2011	4500	5927	0.76	31.70
Plant C	D90	9/19/2011	9/20/2011	4500	5927	0.76	31.70
Plant C	D90	9/20/2011	9/21/2011	4500	5630	0.80	25.11
Plant C	D90	9/20/2011	9/21/2011	4500	5630	0.80	25.11
Plant C	D90	9/20/2011	9/21/2011	4500	5630	0.80	25.11
Plant A	D110	9/23/2011	9/24/2011	6500	7414	0.88	14.06
Plant A	D110	9/23/2011	9/24/2011	6500	7414	0.88	14.06
Plant A	D110	9/23/2011	9/24/2011	6500	7414	0.88	14.06
Plant A	D110	9/22/2011	9/24/2011	6500	7414	0.88	14.06
Plant A	BTC45	10/7/2011	10/8/2011	4500	6937	0.65	54.15
Plant A	BTC45	10/7/2011	10/8/2011	4500	6937	0.65	54.15
Plant A	BTC120	10/21/2011	10/24/2011	8000	8505	0.94	6.31
Plant A	BTC120	10/21/2011	10/24/2011	8000	8505	0.94	6.31

Plant	PPCB Type	Date of Casting	Date of Release	Target f'_{ci} (psi)	Average of Measured f'_{ci} (psi)	Target f'_{ci}/Measured f'_{ci}	Percent Difference of Target and Measured f'_{ci}
Plant A	BTD130	10/28/2011	10/31/2011	8000	8220	0.97	2.75
Plant A	BTD130	10/29/2011	10/31/2011	8000	7755	1.03	-3.06
Plant C	C67	10/31/2011	11/1/2011	4500	6152	0.73	36.70
Plant C	C67	10/31/2011	11/1/2011	4500	6152	0.73	36.70
Plant C	C67	10/31/2011	11/1/2011	4500	6152	0.73	36.70
Plant C	C67	11/3/2011	11/4/2011	4500	4893	0.92	8.74
Plant C	C67	11/3/2011	11/4/2011	4500	4893	0.92	8.74
Plant C	C67	11/3/2011	11/4/2011	4500	4893	0.92	8.74
Plant A	BTE135	11/8/2011	11/12/2011	7000	7450	0.94	6.43
Plant A	BTE135	11/9/2011	11/12/2011	7000	7450	0.94	6.43
Plant C	D105	11/29/2011	11/30/2011	6000	6422	0.93	7.03
Plant C	D105	11/29/2011	11/30/2011	6000	6422	0.93	7.03
Plant C	D105	11/29/2011	11/30/2011	6000	6422	0.93	7.03
Plant C	D105	12/6/2011	12/8/2011	6000	8643	0.69	44.06
Plant C	D105	12/6/2011	12/8/2011	6000	8643	0.69	44.06
Plant C	D105	12/6/2011	12/8/2011	6000	8643	0.69	44.06
Plant C	D55	12/20/2011	12/21/2011	4500	6528	0.69	45.07
Plant C	D55	12/20/2011	12/21/2011	4500	6528	0.69	45.07
Plant C	D55	12/20/2011	12/21/2011	4500	6528	0.69	45.07
Plant C	D55	12/20/2011	12/21/2011	4500	6528	0.69	45.07
Plant C	D55	12/20/2011	12/21/2011	4500	6528	0.69	45.07
Plant C	D55	12/29/2011	12/30/2011	4500	6832	0.66	51.81
Plant C	D55	12/29/2011	12/30/2011	4500	6832	0.66	51.81
Plant C	D60	1/3/2011	1/4/2011	4500	5348	0.84	18.85
Plant C	D60	1/3/2011	1/4/2011	4500	5348	0.84	18.85
Plant C	D105	-	-	6000	6240	0.96	4.00
Plant C	D105	-	-	6000	6240	0.96	4.00
Plant C	D105	-	-	6000	6240	0.96	4.00
Plant C	D105	-	-	6000	9623	0.62	60.39
Plant C	D105	-	-	6000	9623	0.62	60.39
Plant C	D105	-	-	6000	9623	0.62	60.39
Plant C	D60	-	-	4500	7683	0.59	70.74
Plant C	D60	-	-	4500	7683	0.59	70.74
Plant C	D60	-	-	4500	7683	0.59	70.74
Plant C	D60	-	12/13/2011	4500	7683	0.59	70.74
Plant C	D60	-	12/13/2011	4500	7683	0.59	70.74
Plant C	D60	-	-	4500	9057	0.50	101.26
Plant C	D60	-	-	4500	9057	0.50	101.26

Plant	PPCB Type	Date of Casting	Date of Release	Target f'_{ci} (psi)	Average of Measured f'_{ci} (psi)	Target f'_{ci}/Measured f'_{ci}	Percent Difference of Target and Measured f'_{ci}
Plant C	D60	-	-	4500	9057	0.50	101.26
Plant C	D60	-	-	4500	9057	0.50	101.26
Plant C	D60	-	-	4500	9057	0.50	101.26
Plant C	D55	-	-	4500	6158	0.73	36.85
Plant C	D55	-	-	4500	6158	0.73	36.85
Plant C	D55	-	-	4500	6158	0.73	36.85
Plant C	D55	-	-	4500	6158	0.73	36.85
Plant C	D55	-	-	4500	6158	0.73	36.85
Plant C	C80	1/18/2012	1/23/2012	5000			
Plant C	C80	1/18/2012	1/23/2012	5000			
Plant C	C80	1/18/2012	1/23/2012	5000			
Plant B	BTE155	1/28/2012	1/30/2012	8000	9633	0.83	20.42
Plant B	BTE155	1/28/2012	1/30/2012	8000	9633	0.83	20.42
Plant B	BTE155	2/1/2012	2/2/2012	8000	8121	0.99	1.51
Plant B	BTE155	2/1/2012	2/2/2012	8000	8121	0.99	1.51
Plant B	BTE155	2/3/2012	2/6/2012	8000	10358	0.77	29.47
Plant B	BTE155	2/3/2012	2/6/2012	8000	10358	0.77	29.47
Plant C	B55	2/9/2012	2/10/2012	6000	6480	0.93	8.00
Plant C	B55	2/9/2012	2/10/2012	6000	6480	0.93	8.00
Plant C	B55	2/9/2012	2/10/2012	6000	6480	0.93	8.00
Plant C	B55	2/9/2012	2/10/2012	6000	6480	0.93	8.00
Plant C	B55	2/13/2012	2/14/2012	6000	6392	0.94	6.53
Plant C	B55	2/13/2012	2/14/2012	6000	6392	0.94	6.53
Plant C	B55	2/13/2012	2/14/2012	6000	6392	0.94	6.53
Plant C	B55	2/13/2012	2/14/2012	6000	6392	0.94	6.53
Plant A	BTC120	2/23/2012	2/25/2012	8000	8610	0.93	7.63
Plant A	BTC120	2/23/2012	2/25/2012	8000	8610	0.93	7.63
Plant A	BTC120	2/24/2012	2/25/2012	8000	8610	0.93	7.63
Plant B	BTB95	2/25/2012	2/27/2012	8000	9082	0.88	13.52
Plant B	BTB95	2/24/2012	2/27/2012	8000	9082	0.88	13.52
Plant B	BTE 110	3/7/2012	3/8/2012	5000	6090	0.82	21.79
Plant B	BTE 110	3/7/2012	3/8/2012	5000	6090	0.82	21.79
Plant B	BTE 110	3/7/2012	3/8/2012	5000	6090	0.82	21.79
Plant B	BTE 110	3/13/2012	3/14/2012	5000	5598	0.89	11.97
Plant B	BTE 110	3/13/2012	3/14/2012	5000	5598	0.89	11.97
Plant B	BTE 110	3/13/2012	3/14/2012	5000	5598	0.89	11.97
Plant B	BTE 110	3/22/2012	3/23/2012	5000	6550	0.76	31.00
Plant B	BTE 110	3/22/2012	3/23/2012	5000	6550	0.76	31.00

Plant	PPCB Type	Date of Casting	Date of Release	Target f'_{ci} (psi)	Average of Measured f'_{ci} (psi)	Target f'_{ci}/Measured f'_{ci}	Percent Difference of Target and Measured f'_{ci}
Plant B	BTE 110	3/22/2012	3/23/2012	5000	6550	0.76	31.00
Plant A	BTB 100	3/28/2012	4/2/2012	8000	10324	0.77	29.05
Plant A	BTB 100	3/29/2012	4/2/2012	8000	10324	0.77	29.05
Plant A	BTB 100	3/30/2012	4/2/2012	8000	10324	0.77	29.05
Plant A	BTB 100	3/31/2012	4/2/2012	8000	10324	0.77	29.05
Plant C	C 80	4/11/2012	4/13/2012	5000	9885	0.51	97.70
Plant C	C 80	4/11/2012	4/13/2012	5000	9885	0.51	97.70
Plant C	C 80	4/11/2012	4/13/2012	5000	9885	0.51	97.70
Plant C	C 80	4/11/2012	4/13/2012	5000	9885	0.51	97.70
Plant B	BTE 90	4/16/2012	4/17/2012	5000	5013	1.00	0.27
Plant B	BTE 90	4/16/2012	4/17/2012	5000	5013	1.00	0.27
Plant B	BTE 90	4/16/2012	4/17/2012	5000	5013	1.00	0.27
Plant A	C 80	5/9/2012	5/10/2012	5000	7373	0.68	47.47
Plant A	C 80	5/9/2012	5/10/2012	5000	7373	0.68	47.47
Plant A	C 80	5/9/2012	5/10/2012	5000	7373	0.68	47.47
Plant A	SBTD135	5/31/2012	6/4/2012	8000	8237	0.97	2.96
Plant A	SBTD135	6/1/2012	6/4/2012	8000	8237	0.97	2.96
Plant A	SBTD135	6/1/2012	6/4/2012	8000	8237	0.97	2.96
Plant B	BTE 145	6/26/2012	6/27/2012	7500	8066	0.93	7.54
Plant B	BTE 145	6/26/2012	6/27/2012	7500	8066	0.93	7.54
Plant B	BTE 145	6/28/2012	6/29/2012	7500	7750	0.97	3.33
Plant B	BTE 145	6/28/2012	6/29/2012	7500	7750	0.97	3.33
Plant C	BTD 135	7/3/2012	7/5/2012	8000	9674	0.83	20.93
Plant C	BTD 135	7/3/2012	7/5/2012	8000	9674	0.83	20.93
Plant C	BTD 135	7/10/2012	7/11/2012	8000	8218	0.97	2.73
Plant C	BTD 135	7/10/2012	7/11/2012	8000	8218	0.97	2.73
Plant C	BTD 135	7/16/2012	7/18/2012	8000	8992	0.89	12.40
Plant C	BTD 135	7/16/2012	7/18/2012	8000	8992	0.89	12.40
Plant C	BTD 135	7/18/2012	7/19/2012	8000	8118	0.99	1.48
Plant C	BTD 135	7/18/2012	7/19/2012	8000	8118	0.99	1.48
Plant B	BTE 145	7/24/2012	7/25/2012	7500	8121	0.92	8.28
Plant B	BTE 145	7/24/2012	7/25/2012	7500	8121	0.92	8.28

E.2. Effect of Compressive Strength Variability on Camber

The camber is affected by the concrete modulus of elasticity. When calculating the camber using the AASHTO LRFD method, the release strength affects the modulus of elasticity. Determining the effect of increasing the release strength on the camber was accomplished using the data in the following table.

Table E.2. Effect of E_{ci} on calculated camber

PPCB	I_{tr} (in.^{4})	Design f'_{ci} (psi)	Design E_{ci} (ksi)	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)
BTE 145	439193	7500	5035	7.47	3.82	3.65
BTE 145	439193	sample of ACI 363 for modulus	4464	8.42	4.30	4.12
BTE 110	430402	5000	3961	3.57	1.62	1.95
BTB 95-2days	102330	8000	5200	6.06	2.33	3.73
BTE 90	426254	5000	3961	1.70	0.74	0.96
BTE 155-1 day	439864	8000	5200	9.00	4.81	4.19
BTD 135	295328	8000	5266	7.62	3.82	3.79
B 55	62696.5	6000	4560	1.03	0.30	0.73
D 55	217262	4500	3949	0.38	0.17	0.22
D 60	218225	4500	3949	0.56	0.24	0.32
D 90	218999	4500	3949	2.60	1.16	1.43
D 105	222751	6000	4560	4.42	1.82	2.60
C 67	119744	4500	3949	1.47	0.60	0.86
C 80-Polk County	117952	5000	4163	2.81	1.14	1.68
BTC 45	179599	4500	4167	0.34	0.10	0.23
BTD 130	294584	8000	5556	6.92	3.24	3.68
BTB 100-2 days	102227	8000	5556	6.17	2.79	3.38
D 110	222411	6500	5008	4.67	2.07	2.59
BTE 135-3 days	433871	7000	5197	5.95	2.95	3.00
SBTD 135-3 days	294841	8000	5556	7.51	3.61	3.90
BTC 120-1 day	184299	8000	5556	7.30	3.49	3.81
C80-Plant A	119027	5000	4392	2.66	1.11	1.56
sample of ACI 363 for modulus	439193	sample of ACI 363 for modulus	4464	8.42	4.30	4.12

5% Increase in f'_{ci}	5% Increase in E_{ci}	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)	Percent of Design Release Camber
7875	5159	7.30	3.72	3.57	97.82
	4549	8.27	4.22	4.05	98.36
5250	4058	3.49	1.58	1.91	97.79
8400	5328	5.92	2.27	3.64	97.77
5250	4058	1.66	0.72	0.94	97.74
8400	5328	8.79	4.69	4.10	97.83
8400	5396	7.44	3.73	3.71	97.82
6300	4673	1.01	0.30	0.71	97.72
4725	4047	0.38	0.16	0.21	97.82
4725	4047	0.54	0.23	0.31	97.84
4725	4047	2.54	1.14	1.40	97.75
6300	4673	4.32	1.78	2.54	97.81
4725	4047	1.43	0.59	0.84	97.91
5250	4266	2.75	1.11	1.64	97.74
4725	4270	0.33	0.10	0.23	97.71
8400	5693	6.76	3.16	3.60	97.79
8400	5693	6.03	2.73	3.30	97.78
6825	5132	4.56	2.02	2.54	97.81
7350	5325	5.81	2.88	2.93	97.80
8400	5693	7.33	3.52	3.81	97.80
8400	5693	7.13	3.40	3.72	97.80
5250	4501	2.60	1.08	1.52	97.76
	4549	8.27	4.22	4.05	98.36
				Average	**97.82**

10% Increase in f'_{ci}	**10% Increase in E_{ci}**	**Deflection Due to Prestress (in.)**	**Deflection Due to the PPCB Self-Weight (in.)**	**Camber Value (in.)**	**Percent of Design Release Camber**
8250	5281	7.14	3.64	3.50	95.77
	4633	8.13	4.15	3.99	96.78
5500	4154	3.41	1.54	1.87	95.72
8800	5454	5.79	2.22	3.57	95.68
5500	4154	1.63	0.71	0.92	95.63
8800	5454	8.60	4.58	4.02	95.80
8800	5523	7.28	3.64	3.63	95.78
6600	4783	0.98	0.29	0.70	95.58
4950	4142	0.37	0.16	0.21	95.77
4950	4142	0.53	0.22	0.31	95.81
4950	4142	2.48	1.11	1.37	95.65
6600	4783	4.22	1.74	2.48	95.76
4950	4142	1.40	0.58	0.83	95.95
5500	4366	2.69	1.08	1.60	95.62
4950	4370	0.32	0.10	0.22	95.57
8800	5827	6.62	3.09	3.52	95.73
8800	5827	5.89	2.66	3.23	95.70
7150	5252	4.46	1.98	2.48	95.77
7700	5451	5.68	2.81	2.87	95.74
8800	5827	7.17	3.44	3.73	95.75
8800	5827	6.97	3.33	3.65	95.74
5500	4607	2.54	1.06	1.49	95.66
	4633	8.13	4.15	3.99	96.78
				Average	**95.77**

15% Increase in f'_{ci}	15% Increase in E'_{ci}	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)	Percent of Design Release Camber
8625	5399	6.99	3.56	3.43	93.86
	4715	8.00	4.07	3.92	95.29
5750	4247	3.34	1.51	1.83	93.78
9200	5576	5.67	2.17	3.49	93.72
5750	4247	1.59	0.69	0.90	93.65
9200	5576	8.42	4.48	3.94	93.89
9200	5647	7.13	3.56	3.56	93.86
6900	4891	0.96	0.28	0.68	93.59
5175	4235	0.36	0.16	0.20	93.86
5175	4235	0.52	0.22	0.30	93.91
5175	4235	2.43	1.09	1.34	93.68
6900	4891	4.14	1.70	2.44	93.83
5175	4235	1.37	0.56	0.81	94.10
5750	4464	2.63	1.06	1.57	93.64
5175	4468	0.31	0.09	0.22	93.57
9200	5958	6.48	3.02	3.45	93.80
9200	5958	5.77	2.60	3.16	93.76
7475	5370	4.37	1.93	2.43	93.85
8050	5573	5.56	2.75	2.82	93.82
9200	5958	7.02	3.36	3.66	93.82
9200	5958	6.82	3.25	3.57	93.81
5750	4710	2.49	1.03	1.46	93.70
	4715	8.00	4.07	3.92	95.29
				Average	**93.85**

20% Increase in f'_{ci}	20% Increase in E_{ci}	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)	Percent of Design Release Camber
9000	5515	6.84	3.48	3.36	92.06
	4795	7.87	4.01	3.87	93.88
6000	4339	3.27	1.48	1.79	91.96
9600	5696	5.55	2.13	3.43	91.88
6000	4339	1.56	0.68	0.88	91.80
9600	5696	8.25	4.39	3.86	92.10
9600	5769	6.98	3.49	3.49	92.06
7200	4996	0.94	0.28	0.67	91.71
5400	4326	0.35	0.15	0.20	92.05
5400	4326	0.51	0.22	0.30	92.13
5400	4326	2.38	1.06	1.32	91.83
7200	4996	4.05	1.67	2.39	92.03
5400	4326	1.35	0.55	0.80	92.37
6000	4560	2.58	1.04	1.54	91.79
5400	4565	0.31	0.09	0.21	91.69
9600	6086	6.35	2.96	3.39	91.98
9600	6086	5.65	2.55	3.10	91.93
7800	5486	4.28	1.89	2.39	92.04
8400	5693	5.45	2.69	2.76	92.00
9600	6086	6.88	3.29	3.59	92.01
9600	6086	6.69	3.18	3.50	91.99
6000	4812	2.44	1.01	1.43	91.85
	4795	7.87	4.01	3.87	93.88
				Average	**92.05**

30% Increase in f'_{ci}	30% Increase in E_{ci}	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)	Percent of Design Release Camber
9750	5741	6.59	3.35	3.24	88.75
	4950	7.64	3.88	3.76	91.26
6500	4516	3.15	1.42	1.73	88.62
10400	5929	5.34	2.04	3.30	88.52
6500	4516	1.50	0.65	0.85	88.40
10400	5929	7.94	4.21	3.72	88.81
10400	6004	6.72	3.35	3.37	88.76
7800	5200	0.91	0.27	0.64	88.29
5850	4503	0.34	0.15	0.19	88.75
5850	4503	0.49	0.21	0.28	88.85
5850	4503	2.29	1.02	1.27	88.45
7800	5200	3.90	1.60	2.30	88.71
5850	4503	1.30	0.53	0.77	89.18
6500	4747	2.48	1.00	1.48	88.38
5850	4751	0.30	0.09	0.21	88.26
10400	6335	6.11	2.84	3.26	88.64
10400	6335	5.44	2.45	2.99	88.57
8450	5710	4.12	1.82	2.30	88.74
9100	5926	5.25	2.58	2.66	88.68
10400	6335	6.62	3.16	3.46	88.69
10400	6335	6.44	3.06	3.38	88.66
6500	5008	2.35	0.97	1.38	88.48
	4950	7.64	3.88	3.76	91.26
				Average	**88.75**

40% Increase in f'_{ci}	40% Increase in E_{ci}	Deflection Due to Prestress (in.)	Deflection Due to the PPCB Self-Weight (in.)	Camber Value (in.)	Percent of Design Release Camber
10500	5957	6.36	3.23	3.13	85.79
	5099	7.43	3.77	3.66	88.86
7000	4686	3.04	1.37	1.67	85.63
11200	6153	5.16	1.97	3.19	85.50
7000	4686	1.45	0.63	0.82	85.36
11200	6153	7.66	4.06	3.60	85.86
11200	6231	6.49	3.23	3.26	85.79
8400	5396	0.88	0.26	0.62	85.22
6300	4673		0.14		
6300	4673	0.47	0.20	0.28	85.90
6300	4673	2.21	0.98	1.22	85.42
8400	5396	3.77	1.54	2.22	85.74
6300	4673	1.25	0.51	0.74	86.31
7000	4926	2.39	0.96	1.43	85.34
6300	4930	0.29	0.09	0.20	85.19
11200	6574	5.89	2.74	3.15	85.66
11200	6574	5.25	2.36	2.89	85.57
9100	5926	3.98	1.75	2.22	85.77
9800	6149	5.06	2.49	2.57	85.70
11200	6574	6.39	3.05	3.34	85.72
11200	6574	6.21	2.95	3.26	85.68
7000	5197	2.26	0.94	1.33	85.45
	5099	7.43	3.77	3.66	88.86
				Average	**85.78**

E.3. Moment of Inertia

The researchers calculated the camber using different moment of inertia values for five different PPCBs. The calculated camber, the percent difference, and the error associated with the moment of inertia were evaluated using a parametric study.

Table E.3. Calculated camber (in.) for different moments of inertia

PPCB	I_{tr} along the length of the PPCB	I_{tr} at Midspan	I_{tr} at End	I_g
B55	0.74	0.73	0.73	0.76
C80	1.43	1.41	1.40	1.47
BTE 110	1.55	1.52	1.50	1.60
BTD 135	4.04	3.94	3.88	4.19
BTE 145	3.49	3.40	3.33	3.60

Table E.4. Percent difference with I_{tr} along the length of the PPCB

PPCB	I_{tr} at Midspan	I_{tr} at End	I_g	Error with I_{tr} at Midspan	Error with I_{tr} at end	Error with I_g
55	-1.44	-1.54	2.21	98.58	98.47	102.24
C80	-1.68	-2.39	2.52	98.34	97.63	102.55
BTE 110	-2.4	-3.18	3.14	97.63	96.87	103.19
BTD 135	-2.57	-4.13	3.69	97.46	98.45	108.13
BTE 145	-2.57	-4.67	2.91	97.46	95.43	102.96

E.4. Prestress Force

The applied prestress force was recorded by the precasters and obtained from tensioning sheets. The Iowa DOT also specifies the design stresses to be applied to the PPCBs immediately before the transfer of the prestress. Comparing the designed and as-built prestress force values allowed the researchers to compare the accuracy of applied prestress. For identical PPCBs listed below, the as-built prestressing force or the measured release strengths that affect the modulus of elasticity may be different.

Table E.5. Effect of initial prestress force on analytical camber

PPCBs	Iowa DOT Designed Prestress (kip)	Applied Prestress (kip)	Difference (kip)	Ratio (Applied Prestress/Designed Prestress)
BTE 145	2213	2190	23	0.99
BTE 145	2213	2202	11	0.99
BTE 145	2213	2180	33	0.98
BTE 110	1276	1273	3	1.00
BTD 135	2297	2257	40	0.98
BTD 135	2297	2281	16	0.99
BTD 135	2297	2281	16	0.99
BTD 135	2297	2294	3	1.00
B 55	468	505	-37	1.08
B 55	468	510	-42	1.09
C 80	936	927	9	0.99
C 80	936	936	0	1.00
BTE 90	851	857	-6	1.01
BTE 155-1 Day Curing	2468	2467	1	1.00
BTE 155-2 Days Curing	2468	2532	-64	1.03
BTE 155-3 Days Curing	2468	2482	-14	1.01
BTB 95-2 Days Curing	1786	1834	-48	1.03
BTB 95-3 Days Curing	1786	1831	-45	1.03
D 55	510	516	-6	1.01
D 60	596	610	-14	1.02
D 90	936	909	27	0.97
D 90	936	901	35	0.96
D 105	1362	1382	-20	1.01
D 105	1362	1379	-17	1.01
C 67	766	782	-16	1.02
BTC 45	425	425	0	1.00
BTD 130-2 Days Curing	2212	2300	-88	1.04

PPCBs	Iowa DOT Designed Prestress (kip)	Applied Prestress (kip)	Difference (kip)	Ratio (Applied Prestress/Designed Prestress)
BTD 130-3 Days Curing	2212	2297	-85	1.04
BTB 100-2 Days Curing	1871	1848	23	0.99
BTB 100-3 Days Curing	1871	1847	24	0.99
BTB 100-4 Days Curing	1871	1846	25	0.99
BTB 100-5 Days Curing	1871	1845	26	0.99
D110-1 Day Curing	1446	1455	-9	1.01
D110-2 Days Curing	1446	1452	-6	1.00
D110-1 Day Curing	1446	1443	3	1.00
D110-2 Days Curing	1446	1441	5	1.00
BTE 135-3 Days Curing	1958	1995	-37	1.02
BTE 135-4 Days Curing	1958	1993	-35	1.02
BTC 120-1 Day Curing	2127	2194	-67	1.03
BTC 120-2 Days Curing	2127	2189	-62	1.03
BTC 120-3 Days Curing	2127	2186	-59	1.03
		Average	**-11**	**1.01**
		Standard Deviation	**34**	**0.03**
		Maximum	**40**	**1.09**
		Minimum	**-88**	**0.96**
		Plant A	**-20**	**1.01**
		Plant B	**-11**	**1.01**
		Plant C	**-1**	**1.01**

E.5. Prestress Losses

The prestress losses will reduce the applied prestress force and affect the calculated camber. Comparing the effect the prestress losses have on the camber was possible by conducting a parametric study. The calculated camber with and without prestress losses is listed in the following table. For identical PPCBs, the as-built prestressing force or the measured release strengths that affect the modulus of elasticity may be different.

Table E.6. Effect of instantaneous prestress losses on analytical instantaneous camber

PPCBs	Prestress Force Before Losses (kips)	Prestress Force After Losses (kip)	Difference in Prestress without and with losses (kip)	((Prestress with Losses/Prestress without Losses)-1)×100	Camber with Losses (inches)	Camber without Losses (in.)	Difference in Camber without and with losses (in.)	Percent Difference	((Camber with Losses/Camber without Losses)-1)×100
BTE 145	2223	2043	180	8.82	3.33	3.88	0.55	15.17	-14.10
BTE 145	2234	2062	172	8.32	3.44	4.00	0.56	15.05	-13.99
BTE 145	2212	2040	171	8.39	3.43	4.00	0.57	15.30	-14.21
BTE 110	1293	1200	93	7.76	1.77	1.99	0.22	11.92	-11.25
BTD 135	2295	2126	169	7.96	3.36	3.91	0.55	15.26	-14.18
BTD 135	2319	2141	178	8.3	3.68	4.31	0.63	15.85	-14.69
BTD 135	2319	2142	177	8.26	3.66	4.29	0.63	15.78	-14.63
BTD 135	2333	2155	178	8.25	3.56	4.16	0.60	15.63	-14.50
B 55	514	486	28	5.79	0.76	0.81	0.06	7.41	-7.15
B 55	519	491	29	5.85	0.77	0.83	0.06	7.47	-7.20
C 80	943	894	48	5.41	1.19	1.29	0.10	7.91	-7.61
C 80	951	902	48	5.34	1.32	1.44	0.12	8.83	-8.46
BTE 90	870	817	53	6.52	0.90	0.99	0.09	9.31	-8.90
BTE 155-1 Day Curing	2506	2311	194	8.41	3.95	4.64	0.70	16.19	-14.97
BTE 155-2 Days Curing	2579	2383	196	8.24	3.91	4.57	0.66	15.55	-14.43
BTE 155-3 Days Curing	2530	2341	189	8.06	3.64	4.25	0.61	15.45	-14.34
BTB 95-2 Days Curing	1868	1720	147	8.56	3.47	3.96	0.49	13.21	-12.39
BTB 95-3 Days Curing	1868	1722	146	8.47	3.36	3.83	0.47	13.09	-12.28
D 55	524	499	25	4.95	0.19	0.20	0.02	8.20	-7.88

PPCBs	Prestress Force Before Losses (kips)	Prestress Force After Losses (kip)	Difference in Prestress without and with losses (kip)	((Prestress with Losses/Prestress without Losses)-1)×100	Camber with Losses (inches)	Camber without Losses (in.)	Difference in Camber without and with losses (in.)	Percent Difference	((Camber with Losses/Camber without Losses)-1)×100
D 60	621	586	35	5.92	0.30	0.33	0.03	9.55	-9.12
D 90	924	876	48	5.48	1.24	1.36	0.12	9.38	-8.96
D 90	915	867	48	5.53	1.25	1.37	0.13	9.53	-9.10
D 105	1406	1308	98	7.5	2.20	2.48	0.28	12.15	-11.45
D 105	1406	1301	105	8.07	2.50	2.85	0.35	13.13	-12.33
C 67	796	740	55	7.47	0.75	0.85	0.09	11.66	-11.02
BTC 45	431	413	19	4.55	0.20	0.20	0.01	2.56	-2.53
BTD 130-2 Days Curing	2338	2162	176	8.15	3.75	4.33	0.59	14.48	-13.50
BTD 130-3 Days Curing	2338	2162	176	8.12	3.56	4.13	0.57	14.77	-13.75
BTB 100-2 Days Curing	1881	1800	81	4.51	3.03	3.43	0.40	12.40	-11.67
BTB 100-3 Days Curing	1881	1771	110	6.2	2.95	3.35	0.40	12.61	-11.86
BTB 100-4 Days Curing	1881	1751	130	7.43	2.86	3.25	0.39	12.69	-11.93
BTB 100-5 Days Curing	1881	1750	131	7.5	2.86	3.25	0.39	12.80	-12.03
D110-1 Day Curing	1477	1372	105	7.69	2.44	2.78	0.34	13.01	-12.22
D110-2 Days Curing	1477	1368	109	7.99	2.42	2.78	0.35	13.55	-12.69
D110-1 Day Curing	1466	1362	104	7.65	2.37	2.70	0.33	13.02	-12.23
D110-2 Days Curing	1466	1359	107	7.86	2.36	2.70	0.34	13.39	-12.55
BTE 135-3	2032	1876	156	8.31	2.86	3.32	0.46	15.01	-13.96

PPCBs	Prestress Force Before Losses (kips)	Prestress Force After Losses (kip)	Difference in Prestress without and with losses (kip)	((Prestress with Losses/Prestress without Losses)-1)×100	Camber with Losses (inches)	Camber without Losses (in.)	Difference in Camber without and with losses (in.)	Percent Difference	((Camber with Losses/Camber without Losses)-1)×100
Days Curing									
BTE 135-4 Days Curing	2032	1874	158	8.41	2.85	3.32	0.47	15.19	-14.12
SBTD 135-3 Days Curing	2328	2158	169	7.85	3.55	4.13	0.58	15.16	-14.09
SBTD 135-4 Days Curing	2328	2156	171	7.94	3.54	4.13	0.59	15.32	-14.23
BTC 120-1 Day Curing	2229	2070	159	7.68	3.61	4.16	0.56	14.34	-13.38
BTC 120-2 Days Curing	2229	2066	163	7.91	3.59	4.16	0.57	14.77	-13.76
BTC 120-3 Days Curing	2229	2063	166	8.04	3.60	4.19	0.59	15.03	-13.98
Average				**7.34**				**12.75**	**-11.94**
Maximum				**8.82**				**16.19**	**-2.53**
Minimum				**4.51**				**2.56**	**-14.97**
Plant A				**7.28**				**13.01**	**-12.18**
Plant B				**8.16**				**14.02**	**-13.09**
Plant C				**6.77**				**11.35**	**-10.70**

E.6. Transfer Length

The effect of the transfer length will decrease the calculated camber. Comparing the effect the transfer length has on the camber was possible by conducting a parametric study. The calculated camber with and without a three-foot transfer length is listed in the following table. For identical PPCBs, the prestressing force or the modulus of elasticity may be different.

Table E.7. Effect of transfer length on analytical camber

PPCBs	Calculated Camber with Transfer Length (in.)	Calculated Camber without Transfer Length (in.)	Transfer Length using E_{ci} from creep frames (with transfer length/without transfer length)×100	Difference (in.)	Difference (%)
BTE 145	3.33	3.37	98.82	-0.04	-1.19
BTE 145	3.44	3.48	98.84	-0.04	-1.16
BTE 145	3.43	3.47	98.83	-0.04	-1.18
BTE 110	1.77	1.79	98.95	-0.02	-1.05
BTE 110	1.66	1.67	98.96	-0.02	-1.04
BTE 110	1.71	1.73	98.96	-0.02	-1.05
BTD 135	3.36	3.41	98.55	-0.05	-1.46
BTD 135	3.68	3.73	98.54	-0.05	-1.47
BTD 135	3.66	3.72	98.54	-0.05	-1.47
BTD 135	3.56	3.61	98.56	-0.05	-1.45
B 55	0.70	0.72	96.74	-0.02	-3.31
B 55	0.71	0.74	96.76	-0.02	-3.30
B 55	0.76	0.78	96.95	-0.02	-3.10
B 55	0.77	0.80	96.96	-0.02	-3.08
C 80	1.19	1.22	97.63	-0.03	-2.40
C 80	1.32	1.35	97.68	-0.03	-2.34
BTE 90	0.90	0.91	98.92	-0.01	-1.09
BTE 155-1 day curing	3.95	4.00	98.73	-0.05	-1.28
BTE 155-2 days curing	3.91	3.96	98.79	-0.05	-1.22
BTE 155-3 days curing	3.64	3.69	98.77	-0.05	-1.23
BTB 95-2 days curing	3.47	3.52	98.47	-0.05	-1.54
BTB 95-3 days curing	3.36	3.41	98.48	-0.05	-1.53
D 55	0.19	0.19	99.34	0.00	-0.66
D 55	0.18	0.18	99.34	0.00	-0.66
D 60	0.30	0.30	99.45	0.00	-0.55

PPCBs	Calculated Camber with Transfer Length (in.)	Calculated Camber without Transfer Length (in.)	Transfer Length using E_{ci} from creep frames (with transfer length/without transfer length)×100	Difference (in.)	Difference (%)
D 90	1.24	1.27	97.79	-0.03	-2.23
D 90	1.25	1.28	97.77	-0.03	-2.25
D 105	2.20	2.23	98.57	-0.03	-1.44
D 105	2.50	2.53	98.54	-0.04	-1.47
C 67	0.75	0.76	99.58	0.00	-0.42
C 67	0.68	0.68	99.56	0.00	-0.44
BTC 45	0.20	0.20	99.22	0.00	-0.78
BTD 130-2 days curing	3.75	3.80	98.71	-0.05	-1.30
BTD 130-3 days curing	3.56	3.61	98.68	-0.05	-1.33
BTB 100-2 days curing	3.03	3.08	98.36	-0.05	-1.65
BTB 100-3 days curing	2.95	3.00	98.37	-0.05	-1.65
BTB 100-4 days curing	2.86	2.91	98.30	-0.05	-1.71
BTB 100-5 days curing	2.86	2.91	98.30	-0.05	-1.71
D110 1 day curing	2.44	2.47	98.70	-0.03	-1.31
D110 2 days curing	2.42	2.46	98.69	-0.03	-1.31
D110 1 day curing	2.37	2.40	98.69	-0.03	-1.32
D110 2 days curing	2.36	2.39	98.69	-0.03	-1.32
BTE 135-3 days curing	2.86	2.89	98.91	-0.03	-1.10
BTE 135-4 days curing	2.85	2.89	98.91	-0.03	-1.10
SBTD 135-3 days curing	3.55	3.60	98.57	-0.05	-1.44
SBTD 135-4 days curing	3.54	3.60	98.57	-0.05	-1.44
BTC 120-1 day curing	3.61	3.66	98.55	-0.05	-1.46
BTC 120-2 days curing	3.59	3.64	98.54	-0.05	-1.47
BTC 120-3 days curing	3.60	3.66	98.54	-0.05	-1.47

PPCBs	Calculated Camber with Transfer Length (in.)	Calculated Camber without Transfer Length (in.)	Transfer Length using E_{ci} from creep frames (with transfer length/without transfer length)×100	Difference (in.)	Difference (%)
Average	**2.24**	**2.27**	**98.52**	**-0.03**	**-1.50**
Minimum	**0.18**	**0.18**	**96.74**	**-0.05**	**-3.31**
Maximum	**3.95**	**4.00**	**99.58**	**0.00**	**-0.42**
Plant A	**2.46**	**2.49**	**98.59**	**-0.04**	**-1.42**
Plant B	**2.68**	**2.72**	**98.78**	**-0.03**	**-1.23**
Plant C	**1.76**	**1.79**	**98.33**	**-0.03**	**-1.69**

E.7. Analytical, Measured, and Designed Camber

The analytical camber was calculated for various PPCBs based on material properties and the prestress force. Using three different moduli of elasticity allowed researchers to determine which method gave the best agreement with the measured values. The design camber that was specified by the Iowa DOT was calculated using the moment area method from CONSPAN and is listed in the following table. The measured camber value was taken by a rotary laser level. Certain PPCBs measured friction, while others estimated the friction values. Additionally, the analytical camber was calculated by using the as-built tensioning values and by adjusting the modulus of elasticity by ±20% to determine the upper and lower bounds.

Table E.8. Analytical, measured, and designed camber

Plant	PPCB Type	Date of Release	Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
			(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on -20% increase in Modulus
Plant C	D90	9/14/2011	1.15	1.24	1.18	1.4	1.4		0.99	1.54	1.08
Plant C	D90	9/14/2011	1.15	1.24	1.18	1.4	1.4		1.11	1.54	1.08
Plant C	D90	9/14/2011	1.15	1.24	1.18	1.4	1.4		1.24	1.54	1.08
Plant C	D90	9/16/2011	1.15	1.24	1.18	1.4	1.4		1.51	1.54	1.08
Plant C	D90	9/16/2011	1.15	1.24	1.18	1.4	1.4		1.41	1.54	1.08
Plant C	D90	9/16/2011	1.15	1.24	1.18	1.4	1.4		1.05	1.54	1.08
Plant A	D110	9/17/2011	3.01	2.44	2.49	2.83	2.83		2.42	3.18	2.20
Plant A	D110	9/17/2011	3.01	2.44	2.49	2.83	2.83		2.35	3.18	2.20
Plant A	D110	9/17/2011	3.01	2.44	2.49	2.83	2.83		2.72	3.18	2.20
Plant A	D110	9/17/2011	3.00	2.42	2.48	2.83	2.83		2.44	3.18	2.20
Plant C	D90	9/20/2011	1.15	1.24	1.18	1.4	1.4		1.46	1.54	1.08
Plant C	D90	9/20/2011	1.15	1.24	1.18	1.4	1.4		1.20	1.54	1.08
Plant C	D90	9/20/2011	1.15	1.24	1.18	1.4	1.4		1.37	1.54	1.08
Plant C	D90	9/21/2011	1.13	1.25	1.16	1.4	1.4		1.52	1.54	1.08
Plant C	D90	9/21/2011	1.13	1.25	1.16	1.4	1.4		1.37	1.54	1.08
Plant C	D90	9/21/2011	1.13	1.25	1.16	1.4	1.4		1.32	1.54	1.08
Plant A	D110	9/24/2011	2.97	2.37	2.45	2.83	2.83		2.57	3.18	2.20
Plant A	D110	9/24/2011	2.97	2.37	2.45	2.83	2.83		2.44	3.18	2.20
Plant A	D110	9/24/2011	2.97	2.37	2.45	2.83	2.83		2.56	3.18	2.20

Plant	PPCB Type	Date of Release	Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
			(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on -20% increase in Modulus
Plant A	D110	9/24/2011	2.96	2.36	2.44	2.83	2.83		2.50	3.18	2.20
Plant A	BTC45	10/8/2011	0.26	0.20	0.20	0.26	0.23		0.31	0.24	0.16
Plant A	BTC45	10/8/2011	0.26	0.20	0.20	0.26	0.23		0.23	0.24	0.16
Plant A	BTC120	10/24/2011	4.70	3.60	3.93	3.82	3.45		3.54	4.51	3.11
Plant A	BTC120	10/24/2011	4.70	3.60	3.93	3.82	3.45		3.39	4.51	3.11
Plant A	BTD130	10/31/2011	4.61	3.75	3.84	3.91	3.33		3.15	4.45	3.07
Plant A	BTD130	10/31/2011	4.60	3.56	3.83	3.91	3.33		2.73	4.45	3.07
Plant C	C67	11/1/2011	0.71	0.75	0.73	0.92	0.92		0.87	0.91	0.65
Plant C	C67	11/1/2011	0.71	0.75	0.73	0.92	0.92		0.89	0.91	0.65
Plant C	C67	11/1/2011	0.71	0.75	0.73	0.92	0.92		1.03	0.91	0.65
Plant C	C67	11/4/2011	0.71	0.75	0.73	0.92	0.92		1.07	0.91	0.65
Plant C	C67	11/4/2011	0.71	0.75	0.73	0.92	0.92		1.15	0.91	0.65
Plant C	C67	11/4/2011	0.71	0.75	0.73	0.92	0.92		0.98	0.91	0.65
Plant A	BTE135	11/12/2011	3.56	2.86	2.96	3.2	2.83		2.87	3.58	2.48
Plant A	BTE135	11/12/2011	3.57	2.85	2.96	3.2	2.83		3.03	3.58	2.48
Plant C	D105	11/30/2011	2.40	2.50	2.45	2.42	2.42		2.95	2.68	1.90
Plant C	D105	11/30/2011	2.40	2.50	2.45	2.42	2.42		2.70	2.68	1.90
Plant C	D105	11/30/2011	2.40	2.50	2.45	2.42	2.42		3.09	2.68	1.90
Plant C	D105	12/8/2011	2.39	2.20	2.44	2.42	2.42		2.37	2.68	1.90
Plant C	D105	12/8/2011	2.39	2.20	2.44	2.42	2.42		2.37	2.68	1.90

Plant	PPCB Type	Date of Release	Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
			(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on -20% increase in Modulus
Plant C	D105	12/8/2011	2.39	2.20	2.44	2.42	2.42		2.63	2.68	1.90
Plant C	D55	12/21/2011	0.18	0.19	0.18	0.24	0.24		0.38	0.22	0.15
Plant C	D55	12/21/2011	0.18	0.19	0.18	0.24	0.24		0.36	0.22	0.15
Plant C	D55	12/21/2011	0.18	0.19	0.18	0.24	0.24		0.48	0.22	0.15
Plant C	D55	12/21/2011	0.18	0.19	0.18	0.24	0.24		0.34	0.22	0.15
Plant C	D55	12/21/2011	0.18	0.19	0.18	0.24	0.24		0.32	0.22	0.15
Plant C	D55	12/30/2011	0.18	0.18	0.18	0.24	0.24		0.37	0.22	0.15
Plant C	D55	12/30/2011	0.18	0.18	0.18	0.24	0.24		0.43	0.22	0.15
Plant C	D60	1/4/2011	0.26	0.30	0.27	0.35	0.35		0.67	0.36	0.25
Plant C	D60	1/4/2011	0.26	0.30	0.27	0.35	0.35		0.69	0.36	0.25
Plant C	D105	-	2.40	2.50	2.45	2.42	2.42			2.68	1.90
Plant C	D105	-	2.40	2.50	2.45	2.42	2.42			2.68	1.90
Plant C	D105	-	2.40	2.50	2.45	2.42	2.42			2.68	1.90
Plant C	D105	-	2.39	2.20	2.44	2.42	2.42			2.68	1.90
Plant C	D105	-	2.39	2.20	2.44	2.42	2.42			2.68	1.90
Plant C	D105	-	2.39	2.20	2.44	2.42	2.42			2.68	1.90
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	12/13/2011	0.26	0.30	0.27	0.35	0.35			0.36	0.25

			Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
Plant	**PPCB Type**	**Date of Release**	**(E_{ci} found from creep frames using plant cylinders)**	**(E_{ci} found from AASHTO using plant f'ci values)**	**(E_{ci} found from AASHTO using ISU's lab f'ci values)**	**Iowa DOT**	**Iowa DOT (Adjusted)**	**Instantaneous Camber (supports accounted for)**	**Camber based on Estimated friction value from Non-linear analysis**	**Upper Bound Camber based on +20% increase in Modulus**	**Upper Bound Camber based on - 20% increase in Modulus**
Plant C	D60	12/13/2011	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D60	-	0.26	0.30	0.27	0.35	0.35			0.36	0.25
Plant C	D55	-	0.18	0.19	0.18	0.24	0.24			0.22	0.15
Plant C	D55	-	0.18	0.18	0.18	0.24	0.24			0.22	0.15
Plant C	D55	-	0.18	0.19	0.18	0.24	0.24			0.22	0.15
Plant C	D55	-	0.18	0.18	0.18	0.24	0.24			0.22	0.15
Plant C	D55	-	0.18	0.18	0.18	0.24	0.24			0.22	0.15
Plant C	C80	1/23/2012				1.64	1.64		1.44		
Plant C	C80	1/23/2012				1.64	1.64		1.53		
Plant C	C80	1/23/2012				1.64	1.64		1.64		
Plant B	BTE155	1/30/2012	5.03	3.91	4.28	4.16	3.72		3.80	4.80	3.49
Plant B	BTE155	1/30/2012	5.03	3.91	4.28	4.16	3.72		3.98	4.80	3.49
Plant B	BTE155	2/2/2012	4.75	3.95	4.05	4.16	3.72		3.96	4.80	3.53
Plant B	BTE155	2/2/2012	4.75	3.95	4.05	4.16	3.72		4.07	4.80	3.53
Plant B	BTE155	2/6/2012	4.82	3.64	4.10	4.16	3.72		3.36	4.45	3.23
Plant B	BTE155	2/6/2012	4.82	3.64	4.10	4.16	3.72		4.06	4.45	3.23

			Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
Plant	PPCB Type	Date of Release	(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on -20% increase in Modulus
Plant C	B55	2/10/2012	0.73	0.76	0.74	0.85	0.85	1.10		0.86	0.59
Plant C	B55	2/10/2012	0.73	0.76	0.74	0.85	0.85	1.30		0.86	0.59
Plant C	B55	2/10/2012	0.73	0.76	0.74	0.85	0.85	1.12		0.86	0.59
Plant C	B55	2/10/2012	0.73	0.76	0.74	0.85	0.85	1.05		0.86	0.59
Plant C	B55	2/14/2012	0.74	0.77	0.75	0.85	0.85	0.93		0.86	0.59
Plant C	B55	2/14/2012	0.74	0.77	0.75	0.85	0.85	0.88		0.86	0.59
Plant C	B55	2/14/2012	0.74	0.77	0.75	0.85	0.85	0.89		0.86	0.59
Plant C	B55	2/14/2012	0.74	0.77	0.75	0.85	0.85	0.93		0.86	0.59
Plant A	BTC120	2/25/2012	4.71	3.59	3.94	3.82	3.45		2.99	4.51	3.11
Plant A	BTC120	2/25/2012	4.71	3.59	3.94	3.82	3.45		3.09	4.51	3.11
Plant A	BTC120	2/25/2012	4.73	3.61	3.95	3.82	3.45		3.16	4.51	3.11
Plant B	BTB95	2/27/2012	4.33	3.47	3.63	3.61	3.07	2.76		4.28	3.05
Plant B	BTB95	2/27/2012	4.32	3.36	3.62	3.61	3.07	2.29		4.15	2.95
Plant B	BTE 110	3/8/2012	1.53	1.65	1.54	1.9	1.61	1.78		2.10	1.48
Plant B	BTE 110	3/8/2012	1.53	1.65	1.54	1.9	1.61	1.33		2.10	1.48
Plant B	BTE 110	3/8/2012	1.53	1.65	1.54	1.9	1.61	1.49		2.10	1.48
Plant B	BTE 110	3/14/2012	1.53	1.77	1.54	1.9	1.61	1.53		2.10	1.48
Plant B	BTE 110	3/14/2012	1.53	1.77	1.54	1.9	1.61	1.59		2.10	1.48
Plant B	BTE 110	3/14/2012	1.53	1.77	1.54	1.9	1.61	1.55		2.10	1.48
Plant B	BTE 110	3/23/2012	1.53	1.71	1.54	1.9	1.61	1.33		2.10	1.48

Plant	PPCB Type	Date of Release	Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
			(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on -20% increase in Modulus
Plant B	BTE 110	3/23/2012	1.53	1.71	1.54	1.9	1.61	1.31		2.10	1.48
Plant B	BTE 110	3/23/2012	1.53	1.71	1.54	1.9	1.61	1.13		2.10	1.48
Plant A	BTB 100	4/2/2012	4.06	2.86	3.38	3.19	3.19	2.88		3.73	2.55
Plant A	BTB 100	4/2/2012	4.07	2.86	3.38	3.19	3.19	2.74		3.73	2.55
Plant A	BTB 100	4/2/2012	4.20	2.95	3.49	3.19	3.19	2.70		3.73	2.55
Plant A	BTB 100	4/2/2012	4.31	3.03	3.58	3.19	3.19	2.83		3.73	2.55
Plant C	C 80	4/13/2012	1.39	1.20	1.42	1.64	1.64	1.32		1.50	1.04
Plant C	C 80	4/13/2012	1.39	1.20	1.42	1.64	1.64	1.34		1.50	1.04
Plant C	C 80	4/13/2012	1.39	1.20	1.42	1.64	1.64	1.51		1.50	1.04
Plant C	C 80	4/13/2012	1.39	1.20	1.42	1.64	1.64	1.13		1.50	1.04
Plant B	BTE 90	4/17/2012	0.73	0.90	0.74	0.92	0.78	0.82		1.12	0.78
Plant B	BTE 90	4/17/2012	0.73	0.90	0.74	0.92	0.78	0.73		1.12	0.78
Plant B	BTE 90	4/17/2012	0.73	0.90	0.74	0.92	0.78	0.84		1.12	0.78
Plant A	C 80	5/10/2012	1.73	1.32	1.40	1.64	1.64	1.11			
Plant A	C 80	5/10/2012	1.73	1.32	1.40	1.64	1.64	1.12			
Plant A	C 80	5/10/2012	1.73	1.32	1.40	1.64	1.64	1.18			
Plant A	SBTD135	6/4/2012	4.55	3.54	3.81	4.2	3.57	3.43		4.70	3.25
Plant A	SBTD135	6/4/2012	4.56	3.55	3.81	4.2	3.57	3.48		4.70	3.25
Plant A	SBTD135	6/4/2012	4.56	3.55	3.81	4.2	3.57	2.94		4.70	3.25
Plant B	BTE 145	6/27/2012	4.17	3.44	3.57	3.7	3.29	3.80		4.15	3.02

Plant	PPCB Type	Date of Release	Analytical Camber (in.)			Designed Camber (in.)		Measured Camber (in.)		Analytical Camber (in.)	
			(E_{ci} found from creep frames using plant cylinders)	(E_{ci} found from AASHTO using plant f'ci values)	(E_{ci} found from AASHTO using ISU's lab f'ci values)	Iowa DOT	Iowa DOT (Adjusted)	Instantaneous Camber (supports accounted for)	Camber based on Estimated friction value from Non-linear analysis	Upper Bound Camber based on +20% increase in Modulus	Upper Bound Camber based on - 20% increase in Modulus
Plant B	BTE 145	6/27/2012	4.17	3.44	3.57	3.7	3.29	3.58		4.15	3.02
Plant B	BTE 145	6/29/2012	4.09	3.43	3.50	3.7	3.29	3.53		4.22	3.07
Plant B	BTE 145	6/29/2012	4.09	3.43	3.50	3.7	3.29	3.68		4.22	3.07
Plant C	BTD 135	7/5/2012	3.78	3.36	3.86	4.2	3.57	3.82		4.09	2.99
Plant C	BTD 135	7/5/2012	3.78	3.36	3.86	4.2	3.57	3.83		4.09	2.99
Plant C	BTD 135	7/11/2012	3.87	3.66	3.95	4.2	3.57	4.01		4.09	2.99
Plant C	BTD 135	7/11/2012	3.87	3.66	3.95	4.2	3.57	4.02		4.09	2.99
Plant C	BTD 135	7/18/2012	3.90	3.56	3.98	4.2	3.57	4.02		4.09	2.99
Plant C	BTD 135	7/18/2012	3.90	3.56	3.98	4.2	3.57	3.94		4.09	2.99
Plant C	BTD 135	7/19/2012	3.87	3.68	3.95	4.2	3.57	4.39		4.09	2.99
Plant C	BTD 135	7/19/2012	3.87	3.68	3.95	4.2	3.57	4.29		4.09	2.99
Plant B	BTE 145	7/25/2012	4.10	3.33	3.46	3.7	3.29	2.99		4.14	3.01
Plant B	BTE 145	7/25/2012	4.10	3.33	3.46	3.7	3.29	3.08		4.14	3.01

APPENDIX F. DETAILS OF THE MEASURED PPCBS FOR LONG-TERM CAMBER

The nomenclatures and the related details for the long-term camber of all the measured PPCBS are presented in the following tables in this appendix.

Table F.1. Details of the measured D 55 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
D 55	Small Camber PPCBs	Set 1	BD05501E BD05502 BD05503 BD05504 BD05505	12/20/2011	12/21/2011	Plant C	Sac County
		Set 2	BD05506E BD05519E BD05520 BD05521 BD05522	12/27/2011	12/28/2011		
		Set 3	BD05523 BD05524E	12/29//2011	12/30/2011		

Table F.2. Details of the measured D 60 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
D 60	Small Camber PPCBs	Set 1	BD06013E BD06014 BD06015 BD06016 BD06017	12/13/2011	12/15/2011	Plant C	Sac County
		Set 2	BD06018E BD06031E BD06032 BD06033 BD06034	12/16/2011	12/19/2011		
		Set 3	BD06035 BD06036E	1/3/2012	1/4/2012		

Table F.3. Details of the measured C 80 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
C 80	Large Camber PPCBs	Set 1	BC08001E BC08002 BC08003 BC08004	4/11/2012	4/13/2012	Plant C	Polk County

Table F.4. Details of the measured D 105 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
D 105	Large Camber PPCBs	Set 1	BD10507E BD10508 BD10509	11/29/2011	11/30/2011	Plant C	Sac County
		Set 2	BD10525 BD10526 BD10527	12/6/2011	12/8/2011		
		Set 3	BD10510 BD10511 BD10512E	12/1/2011	12/2/2011		
		Set 4	BD10528 BD10529 BD10530E	12/9/2011	12/12/2011		

Table F.5. Details of the measured BTE 110 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
BTE 110	Large Camber PPCBs	Set 1	144-272 144-270 144-268	3/7/2012	3/8/2012	Plant B	Mills County
		Set 2	144-274 144-275 144-278	3/13/2012	3/14/2012		
		Set 3	144-284 144-283 144-280	3/22/2012	3/23/2012		

Table F.6. Details of the measured BTC 120 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
BTC 120	Large Camber PPCBs	Set 1	103-09 103-10 103-11	2/23/2012	2/25/2012	Plant A	NA*

*NA= Not Available

Table F.7. Details of the measured BTD 135 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
BTD 135	Large Camber PPCBs	Set 1	BD13502 BD13501	7/3/2012	7/5/2012	Plant C	Dallas County
		Set 2	BD13503 BD13504E	7/18/2012	7/19/2012		
		Set 3	BD13507E BD13508	7/10/2012	7/11/2012		
		Set 4	BD13511 BD13512E	7/16/2012	7/18/2012		

Table F.8. Details of the measured BTE 145 PPCBs

PPCB Type	Group	Set Number	PPCB Number	Cast Date	Release Date	Plant	Bridge Project
BTE 145	Large Camber PPCBs	Set 1	144-311 144-334	6/26/2012	6/27/2012	Plant B	Mills County
		Set 2	144-316 144-317	6/28/2012	6/29/2012		
		Set 3	144-366 144-367	7/24/2012	7/25/2012		

APPENDIX G. SIMPLIFIED LONG-TERM CAMBER PREDICTIONS USING AVERAGE SEALED CREEP AND SHRINKAGE

A comparison of the cambers for different types of PPCBs using three methods, the gross section properties, the transformed section properties, the average sealed creep coefficient, and the sealed shrinkage data are presented in this appendix.

Table G.1. Camber prediction (in.) of BTC 120 Set 1 PPCBs with overhang using the three methods and two types of section properties at Plant A

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.56	4.61	4.56	3.99	4.00	3.99
0	4.43	4.48	4.44	3.70	3.95	3.89
1	5.07	5.13	5.23	4.25	4.54	4.58
2	5.28	5.35	5.56	4.43	4.75	4.87
3	5.44	5.52	5.83	4.58	4.91	5.11
7	5.66	5.75	6.34	4.79	5.14	5.55
14	5.87	5.98	6.83	4.99	5.36	5.99
21	5.95	6.06	7.07	5.07	5.45	6.20
28	6.01	6.12	7.24	5.13	5.51	6.34
60	6.22	6.35	7.73	5.32	5.73	6.78
90	6.32	6.45	7.96	5.41	5.83	6.98
120	6.37	6.50	8.08	5.45	5.88	7.09
150	6.41	6.55	8.18	5.49	5.92	7.18
180	6.44	6.58	8.26	5.52	5.96	7.24
210	6.46	6.61	8.32	5.54	5.98	7.30
240	6.49	6.64	8.38	5.57	6.01	7.35
270	6.54	6.69	8.48	5.61	6.06	7.43
300	6.57	6.72	8.54	5.64	6.09	7.49
330	6.62	6.77	8.63	5.68	6.14	7.57
360	6.66	6.82	8.71	5.71	6.18	7.64

Table G.2. Camber prediction (in.) of BTC 120 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant A

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.10	4.15	4.10	3.56	3.57	3.56
0	3.97	4.01	4.00	3.43	3.51	3.46
1	4.53	4.59	4.71	3.94	4.03	4.08
2	4.71	4.78	5.00	4.11	4.21	4.34
3	4.86	4.93	5.25	4.25	4.35	4.55
7	5.05	5.13	5.70	4.44	4.55	4.95
14	5.23	5.32	6.15	4.62	4.75	5.34
21	5.29	5.40	6.36	4.69	4.82	5.53
28	5.34	5.44	6.51	4.74	4.87	5.66
60	5.52	5.64	6.96	4.92	5.06	6.05
90	5.60	5.73	7.17	5.00	5.15	6.23
120	5.64	5.77	7.27	5.04	5.19	6.32
150	5.67	5.80	7.36	5.07	5.22	6.40
180	5.70	5.83	7.43	5.10	5.25	6.46
210	5.72	5.86	7.49	5.12	5.27	6.51
240	5.74	5.88	7.54	5.14	5.30	6.56
270	5.78	5.93	7.63	5.18	5.34	6.63
300	5.81	5.95	7.68	5.20	5.37	6.68
330	5.85	6.00	7.76	5.24	5.41	6.75
360	5.88	6.03	7.84	5.27	5.44	6.81

Table G.3. Camber prediction (in.) of BTE 110 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.11	2.13	2.11	1.90	1.91	1.90
0	2.05	2.07	2.04	1.84	1.87	1.84
1	2.35	2.38	2.41	2.12	2.15	2.17
2	2.45	2.48	2.56	2.22	2.25	2.31
3	2.53	2.56	2.68	2.30	2.33	2.42
7	2.64	2.68	2.92	2.41	2.45	2.63
14	2.75	2.79	3.15	2.51	2.56	2.84
21	2.79	2.83	3.26	2.55	2.60	2.94
28	2.82	2.87	3.33	2.58	2.63	3.00
60	2.93	2.98	3.56	2.69	2.75	3.21
90	2.98	3.03	3.67	2.74	2.80	3.31
120	3.00	3.06	3.72	2.77	2.82	3.36
150	3.02	3.08	3.77	2.79	2.85	3.40
180	3.04	3.10	3.80	2.80	2.86	3.43
210	3.05	3.12	3.83	2.82	2.88	3.46
240	3.07	3.13	3.86	2.83	2.89	3.48
270	3.09	3.16	3.90	2.85	2.92	3.52
300	3.11	3.17	3.93	2.87	2.93	3.55
330	3.13	3.20	3.97	2.89	2.96	3.59
360	3.15	3.22	4.01	2.91	2.98	3.62

Table G.4. Camber prediction (in.) of BTE 110 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.74	1.76	1.74	1.55	1.56	1.55
0	1.68	1.70	1.69	1.50	1.52	1.50
1	1.92	1.95	1.99	1.72	1.75	1.77
2	2.00	2.03	2.12	1.80	1.83	1.89
3	2.07	2.10	2.22	1.86	1.89	1.98
7	2.15	2.19	2.41	1.94	1.98	2.15
14	2.23	2.28	2.60	2.02	2.07	2.32
21	2.26	2.31	2.69	2.05	2.11	2.40
28	2.28	2.33	2.75	2.08	2.13	2.46
60	2.37	2.42	2.94	2.16	2.22	2.63
90	2.40	2.46	3.03	2.19	2.26	2.71
120	2.42	2.48	3.08	2.21	2.28	2.75
150	2.44	2.50	3.12	2.23	2.29	2.78
180	2.45	2.51	3.15	2.24	2.30	2.81
210	2.46	2.52	3.17	2.25	2.32	2.83
240	2.47	2.53	3.19	2.26	2.33	2.85
270	2.49	2.55	3.23	2.28	2.35	2.88
300	2.50	2.57	3.25	2.29	2.36	2.90
330	2.52	2.58	3.29	2.30	2.38	2.94
360	2.54	2.60	3.32	2.32	2.39	2.96

Table G.5. Camber prediction (in.) of BTE 110 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.19	2.21	2.19	1.96	1.97	1.96
0	2.13	2.15	2.12	1.91	1.93	1.90
1	2.44	2.47	2.50	2.19	2.23	2.24
2	2.55	2.58	2.66	2.29	2.33	2.38
3	2.63	2.66	2.79	2.37	2.41	2.50
7	2.74	2.78	3.03	2.49	2.53	2.72
14	2.85	2.90	3.27	2.60	2.65	2.93
21	2.89	2.94	3.38	2.64	2.69	3.03
28	2.92	2.97	3.46	2.67	2.72	3.10
60	3.03	3.09	3.69	2.78	2.84	3.32
90	3.09	3.15	3.81	2.83	2.89	3.42
120	3.11	3.17	3.86	2.85	2.92	3.47
150	3.13	3.20	3.91	2.88	2.94	3.51
180	3.15	3.22	3.95	2.89	2.96	3.55
210	3.16	3.23	3.98	2.91	2.97	3.57
240	3.18	3.25	4.00	2.92	2.99	3.60
270	3.21	3.27	4.05	2.95	3.02	3.64
300	3.22	3.29	4.08	2.96	3.03	3.66
330	3.24	3.32	4.12	2.98	3.06	3.70
360	3.27	3.34	4.16	3.00	3.08	3.74

Table G.6. Camber prediction (in.) of BTE 110 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.81	1.83	1.81	1.60	1.61	1.60
0	1.75	1.77	1.75	1.55	1.57	1.55
1	2.00	2.03	2.07	1.78	1.81	1.83
2	2.08	2.11	2.20	1.85	1.89	1.95
3	2.15	2.18	2.30	1.92	1.96	2.04
7	2.23	2.27	2.50	2.00	2.05	2.22
14	2.32	2.36	2.70	2.09	2.14	2.40
21	2.35	2.40	2.79	2.12	2.18	2.48
28	2.37	2.42	2.86	2.14	2.20	2.54
60	2.45	2.51	3.05	2.23	2.29	2.71
90	2.49	2.55	3.15	2.26	2.33	2.80
120	2.51	2.57	3.19	2.28	2.35	2.84
150	2.52	2.59	3.23	2.30	2.37	2.87
180	2.54	2.60	3.26	2.31	2.38	2.90
210	2.55	2.61	3.29	2.32	2.39	2.92
240	2.56	2.62	3.31	2.33	2.40	2.94
270	2.58	2.65	3.35	2.35	2.42	2.98
300	2.59	2.66	3.37	2.36	2.43	3.00
330	2.61	2.68	3.41	2.37	2.45	3.03
360	2.62	2.70	3.44	2.39	2.47	3.06

Table G.7. Camber prediction (in.) of BTE 110 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.04	2.06	2.04	1.84	1.85	1.84
0	1.98	2.00	1.98	1.79	1.81	1.79
1	2.27	2.30	2.33	2.06	2.09	2.11
2	2.37	2.40	2.48	2.16	2.19	2.24
3	2.45	2.48	2.60	2.23	2.27	2.35
7	2.56	2.59	2.82	2.34	2.38	2.56
14	2.66	2.70	3.05	2.44	2.48	2.76
21	2.70	2.74	3.15	2.48	2.53	2.85
28	2.73	2.77	3.22	2.51	2.56	2.92
60	2.84	2.89	3.45	2.62	2.67	3.12
90	2.89	2.94	3.55	2.67	2.72	3.22
120	2.91	2.96	3.60	2.69	2.74	3.26
150	2.93	2.99	3.65	2.71	2.77	3.30
180	2.95	3.00	3.68	2.73	2.78	3.34
210	2.96	3.02	3.71	2.74	2.80	3.36
240	2.98	3.03	3.74	2.75	2.81	3.38
270	3.00	3.06	3.78	2.78	2.84	3.42
300	3.02	3.08	3.81	2.79	2.85	3.45
330	3.04	3.10	3.85	2.81	2.87	3.49
360	3.06	3.12	3.88	2.83	2.90	3.52

Table G.8. Camber prediction (in.) of BTE 110 Set 3 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.68	1.70	1.68	1.51	1.52	1.51
0	1.63	1.64	1.63	1.45	1.48	1.46
1	1.86	1.89	1.93	1.67	1.70	1.72
2	1.94	1.97	2.05	1.75	1.78	1.83
3	2.00	2.03	2.15	1.80	1.84	1.93
7	2.09	2.12	2.33	1.89	1.93	2.09
14	2.16	2.20	2.52	1.97	2.01	2.26
21	2.19	2.24	2.61	2.00	2.05	2.34
28	2.21	2.26	2.67	2.02	2.07	2.39
60	2.30	2.35	2.85	2.10	2.16	2.56
90	2.33	2.38	2.94	2.14	2.19	2.63
120	2.35	2.40	2.98	2.15	2.21	2.67
150	2.36	2.42	3.02	2.17	2.23	2.71
180	2.38	2.43	3.05	2.18	2.24	2.73
210	2.39	2.44	3.07	2.19	2.25	2.75
240	2.40	2.45	3.09	2.20	2.26	2.77
270	2.42	2.48	3.13	2.22	2.28	2.80
300	2.43	2.49	3.15	2.23	2.29	2.83
330	2.45	2.51	3.18	2.24	2.31	2.86
360	2.46	2.52	3.21	2.26	2.33	2.88

Table G.9. Camber prediction (in.) of BTE 145 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	5.04	5.09	5.04	4.39	4.41	4.39
0	4.89	4.94	4.90	4.26	4.34	4.27
1	5.59	5.66	5.77	4.89	4.99	5.03
2	5.82	5.90	6.13	5.10	5.22	5.34
3	6.00	6.09	6.42	5.27	5.39	5.60
7	6.24	6.34	6.97	5.52	5.64	6.09
14	6.47	6.58	7.52	5.75	5.89	6.56
21	6.56	6.68	7.78	5.84	5.98	6.79
28	6.61	6.74	7.95	5.91	6.05	6.95
60	6.85	6.99	8.50	6.14	6.29	7.42
90	6.95	7.10	8.75	6.24	6.40	7.65
120	7.00	7.16	8.88	6.29	6.46	7.76
150	7.04	7.20	8.99	6.33	6.50	7.86
180	7.08	7.24	9.07	6.37	6.54	7.93
210	7.11	7.27	9.14	6.40	6.57	7.99
240	7.14	7.30	9.20	6.42	6.60	8.05
270	7.19	7.36	9.31	6.48	6.65	8.14
300	7.22	7.40	9.38	6.50	6.69	8.20
330	7.27	7.45	9.47	6.55	6.74	8.28
360	7.32	7.50	9.56	6.60	6.78	8.36

Table G.10. Camber prediction (in.) of BTE 145 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.70	3.76	3.70	3.13	3.15	3.13
0	3.54	3.60	3.60	2.99	3.08	3.05
1	4.06	4.14	4.27	3.44	3.55	3.62
2	4.19	4.28	4.52	3.57	3.69	3.83
3	4.27	4.37	4.69	3.65	3.77	3.98
7	4.44	4.54	5.10	3.82	3.95	4.33
14	4.56	4.68	5.49	3.95	4.09	4.66
21	4.63	4.76	5.72	4.02	4.17	4.86
28	4.68	4.82	5.88	4.07	4.23	4.99
60	4.79	4.95	6.26	4.19	4.36	5.32
90	4.85	5.01	6.44	4.24	4.42	5.47
120	4.88	5.04	6.54	4.27	4.46	5.56
150	4.90	5.07	6.61	4.29	4.48	5.62
180	4.91	5.08	6.66	4.31	4.50	5.66
210	4.92	5.09	6.70	4.32	4.51	5.69
240	4.93	5.10	6.73	4.32	4.52	5.72
270	4.93	5.11	6.75	4.33	4.52	5.74
300	4.94	5.12	6.77	4.33	4.53	5.75
330	4.94	5.12	6.79	4.34	4.53	5.77
360	4.94	5.12	6.80	4.34	4.54	5.78

Table G.11. Camber prediction (in.) of BTE 145 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	5.05	5.11	5.05	4.39	4.40	4.39
0	4.90	4.96	4.92	4.25	4.34	4.27
1	5.60	5.67	5.78	4.88	4.99	5.02
2	5.83	5.91	6.14	5.10	5.21	5.34
3	6.01	6.10	6.44	5.27	5.39	5.60
7	6.25	6.35	6.99	5.51	5.64	6.08
14	6.48	6.59	7.53	5.74	5.88	6.55
21	6.56	6.68	7.79	5.83	5.97	6.78
28	6.62	6.75	7.97	5.89	6.04	6.94
60	6.85	6.99	8.51	6.12	6.28	7.41
90	6.95	7.11	8.77	6.22	6.39	7.64
120	7.00	7.16	8.90	6.27	6.44	7.75
150	7.04	7.20	9.00	6.31	6.49	7.84
180	7.08	7.24	9.09	6.35	6.52	7.92
210	7.10	7.27	9.15	6.37	6.55	7.98
240	7.13	7.31	9.22	6.40	6.58	8.03
270	7.19	7.36	9.32	6.45	6.64	8.12
300	7.22	7.40	9.39	6.48	6.67	8.18
330	7.27	7.45	9.49	6.53	6.72	8.27
360	7.31	7.50	9.58	6.57	6.77	8.35

Table G.12. Camber prediction (in.) of BTE 145 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.68	3.75	3.68	3.11	3.13	3.11
0	3.53	3.59	3.58	2.97	3.05	3.02
1	4.04	4.12	4.26	3.41	3.52	3.59
2	4.17	4.26	4.50	3.53	3.65	3.80
3	4.25	4.35	4.67	3.61	3.74	3.94
7	4.41	4.52	5.08	3.77	3.91	4.29
14	4.53	4.66	5.47	3.90	4.05	4.62
21	4.60	4.73	5.69	3.98	4.13	4.81
28	4.64	4.79	5.85	4.02	4.19	4.95
60	4.76	4.92	6.24	4.14	4.32	5.27
90	4.80	4.97	6.41	4.19	4.38	5.42
120	4.83	5.01	6.51	4.22	4.41	5.51
150	4.85	5.03	6.58	4.24	4.43	5.57
180	4.87	5.05	6.63	4.25	4.45	5.61
210	4.87	5.06	6.67	4.26	4.46	5.64
240	4.88	5.07	6.70	4.27	4.47	5.67
270	4.89	5.07	6.72	4.27	4.47	5.69
300	4.89	5.08	6.74	4.28	4.48	5.70
330	4.89	5.08	6.76	4.28	4.48	5.72
360	4.90	5.08	6.77	4.28	4.49	5.73

Table G.13. Camber prediction (in.) of BTE 145 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.95	5.00	4.95	4.31	4.33	4.31
0	4.80	4.85	4.82	4.18	4.27	4.19
1	5.49	5.56	5.66	4.80	4.90	4.94
2	5.71	5.79	6.02	5.01	5.12	5.25
3	5.89	5.97	6.31	5.18	5.29	5.50
7	6.13	6.22	6.85	5.42	5.54	5.98
14	6.35	6.46	7.38	5.65	5.78	6.45
21	6.43	6.55	7.64	5.74	5.87	6.67
28	6.49	6.61	7.81	5.80	5.94	6.82
60	6.72	6.86	8.34	6.02	6.18	7.29
90	6.82	6.97	8.59	6.12	6.28	7.51
120	6.87	7.02	8.72	6.17	6.34	7.62
150	6.91	7.07	8.83	6.21	6.38	7.72
180	6.95	7.11	8.91	6.25	6.42	7.79
210	6.97	7.14	8.97	6.27	6.44	7.85
240	7.00	7.17	9.04	6.30	6.48	7.90
270	7.05	7.22	9.14	6.35	6.53	7.99
300	7.08	7.26	9.21	6.38	6.56	8.05
330	7.13	7.31	9.30	6.43	6.61	8.13
360	7.18	7.36	9.39	6.47	6.66	8.21

Table G.14. Camber prediction (in.) of BTE 145 Set 3 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.61	3.67	3.61	3.06	3.08	3.06
0	3.46	3.51	3.51	2.92	3.00	2.97
1	3.93	4.00	4.13	3.33	3.44	3.50
2	4.08	4.16	4.39	3.47	3.58	3.72
3	4.19	4.29	4.61	3.58	3.70	3.91
7	4.33	4.44	5.00	3.72	3.86	4.24
14	4.47	4.59	5.39	3.87	4.01	4.58
21	4.51	4.64	5.58	3.92	4.07	4.74
28	4.54	4.68	5.71	3.95	4.10	4.85
60	4.67	4.83	6.10	4.08	4.25	5.18
90	4.73	4.89	6.28	4.14	4.31	5.34
120	4.75	4.92	6.38	4.16	4.34	5.42
150	4.77	4.94	6.45	4.18	4.37	5.48
180	4.79	4.96	6.51	4.20	4.39	5.53
210	4.80	4.98	6.56	4.21	4.40	5.57
240	4.82	5.00	6.61	4.23	4.42	5.61
270	4.85	5.03	6.68	4.25	4.45	5.68
300	4.87	5.05	6.73	4.27	4.47	5.72
330	4.89	5.08	6.80	4.30	4.50	5.78
360	4.92	5.11	6.87	4.32	4.53	5.83

Table G.15. Camber prediction (in.) of BTD 135 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.27	4.32	4.27	3.71	3.73	3.71
0	4.12	4.17	4.15	3.58	3.66	3.61
1	4.71	4.77	4.89	4.11	4.20	4.25
2	4.90	4.98	5.20	4.29	4.39	4.53
3	5.05	5.13	5.45	4.43	4.54	4.75
7	5.25	5.34	5.92	4.63	4.75	5.16
14	5.44	5.55	6.39	4.83	4.95	5.57
21	5.51	5.62	6.61	4.90	5.03	5.76
28	5.56	5.68	6.76	4.95	5.08	5.89
60	5.75	5.88	7.23	5.14	5.28	6.30
90	5.84	5.98	7.45	5.22	5.37	6.49
120	5.88	6.02	7.56	5.26	5.42	6.59
150	5.91	6.06	7.65	5.30	5.45	6.67
180	5.94	6.09	7.72	5.33	5.48	6.73
210	5.96	6.11	7.78	5.35	5.51	6.78
240	5.99	6.14	7.84	5.37	5.53	6.83
270	6.03	6.19	7.92	5.41	5.58	6.91
300	6.06	6.22	7.98	5.44	5.60	6.96
330	6.10	6.26	8.07	5.47	5.65	7.03
360	6.14	6.30	8.14	5.51	5.68	7.10

Table G.16. Camber prediction (in.) of BTD 135 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.04	4.11	4.04	3.42	3.44	3.42
0	3.88	3.94	3.93	3.28	3.37	3.33
1	4.42	4.50	4.63	3.75	3.86	3.92
2	4.59	4.68	4.92	3.91	4.03	4.17
3	4.73	4.82	5.16	4.03	4.16	4.37
7	4.90	5.00	5.61	4.21	4.34	4.75
14	5.06	5.18	6.04	4.37	4.52	5.12
21	5.11	5.24	6.26	4.43	4.59	5.30
28	5.15	5.28	6.40	4.48	4.63	5.43
60	5.31	5.46	6.84	4.63	4.81	5.80
90	5.38	5.54	7.04	4.70	4.88	5.97
120	5.41	5.57	7.15	4.73	4.92	6.06
150	5.43	5.60	7.23	4.76	4.94	6.14
180	5.46	5.63	7.30	4.78	4.97	6.20
210	5.47	5.65	7.36	4.79	4.99	6.24
240	5.49	5.67	7.41	4.81	5.01	6.29
270	5.53	5.71	7.49	4.85	5.05	6.36
300	5.55	5.73	7.55	4.87	5.07	6.41
330	5.58	5.77	7.63	4.90	5.10	6.47
360	5.61	5.81	7.70	4.93	5.14	6.53

Table G.17. Camber prediction (in.) of BTD 135 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.27	4.33	4.27	3.63	3.65	3.63
0	4.29	4.17	4.16	3.66	3.58	3.53
1	4.90	4.76	4.89	4.19	4.11	4.16
2	5.09	4.95	5.20	4.37	4.28	4.42
3	5.25	5.11	5.45	4.52	4.43	4.64
7	5.44	5.30	5.92	4.72	4.62	5.04
14	5.63	5.50	6.38	4.91	4.82	5.44
21	5.70	5.56	6.61	4.99	4.89	5.63
28	5.75	5.61	6.76	5.04	4.94	5.76
60	5.94	5.80	7.22	5.22	5.13	6.15
90	6.02	5.89	7.44	5.30	5.21	6.34
120	6.06	5.93	7.55	5.34	5.25	6.43
150	6.09	5.96	7.64	5.37	5.28	6.51
180	6.12	5.99	7.71	5.40	5.31	6.57
210	6.14	6.01	7.77	5.42	5.33	6.62
240	6.16	6.03	7.82	5.44	5.35	6.67
270	6.21	6.08	7.91	5.49	5.39	6.75
300	6.23	6.10	7.97	5.51	5.41	6.80
330	6.27	6.14	8.05	5.55	5.45	6.87
360	6.31	6.18	8.13	5.58	5.49	6.93

Table G.18. Camber prediction (in.) of BTD 135 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.12	4.19	4.12	3.49	3.51	3.49
0	3.96	4.02	4.01	3.35	3.44	3.40
1	4.51	4.59	4.72	3.83	3.94	4.00
2	4.69	4.77	5.02	3.99	4.12	4.26
3	4.83	4.92	5.26	4.12	4.25	4.46
7	5.00	5.11	5.72	4.30	4.44	4.85
14	5.17	5.29	6.16	4.47	4.62	5.23
21	5.22	5.35	6.38	4.53	4.69	5.41
28	5.26	5.40	6.52	4.58	4.73	5.54
60	5.43	5.58	6.97	4.74	4.91	5.92
90	5.49	5.65	7.18	4.81	4.99	6.10
120	5.53	5.69	7.29	4.84	5.03	6.19
150	5.55	5.72	7.38	4.87	5.06	6.27
180	5.58	5.75	7.45	4.89	5.08	6.32
210	5.59	5.77	7.50	4.91	5.10	6.37
240	5.61	5.79	7.56	4.93	5.12	6.42
270	5.65	5.83	7.64	4.96	5.16	6.49
300	5.67	5.86	7.70	4.98	5.18	6.54
330	5.71	5.90	7.78	5.01	5.22	6.61
360	5.74	5.93	7.85	5.04	5.25	6.67

Table G.19. Camber prediction (in.) of BTD 135 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.66	4.73	4.66	4.01	4.02	4.01
0	4.51	4.57	4.54	3.86	3.96	3.90
1	5.14	5.22	5.34	4.43	4.54	4.59
2	5.35	5.44	5.68	4.63	4.75	4.88
3	5.52	5.61	5.95	4.78	4.91	5.12
7	5.73	5.84	6.46	4.99	5.13	5.56
14	5.93	6.06	6.97	5.20	5.35	6.00
21	6.01	6.14	7.21	5.28	5.43	6.21
28	6.06	6.19	7.38	5.34	5.49	6.35
60	6.26	6.41	7.88	5.54	5.71	6.79
90	6.35	6.51	8.12	5.63	5.80	6.99
120	6.39	6.56	8.24	5.67	5.85	7.10
150	6.43	6.60	8.34	5.70	5.89	7.18
180	6.46	6.63	8.42	5.73	5.92	7.25
210	6.48	6.66	8.48	5.76	5.94	7.30
240	6.51	6.69	8.54	5.78	5.97	7.36
270	6.56	6.74	8.64	5.83	6.02	7.44
300	6.58	6.77	8.70	5.85	6.05	7.50
330	6.63	6.82	8.79	5.89	6.09	7.57
360	6.67	6.86	8.88	5.93	6.13	7.65

Table G.20. Camber prediction (in.) of BTD 135 Set 3 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.10	4.16	4.10	3.48	3.49	3.48
0	3.94	4.00	3.99	3.33	3.43	3.38
1	4.49	4.56	4.70	3.81	3.93	3.98
2	4.66	4.75	4.99	3.98	4.10	4.24
3	4.80	4.89	5.24	4.11	4.23	4.44
7	4.97	5.08	5.69	4.28	4.42	4.83
14	5.14	5.26	6.13	4.45	4.60	5.21
21	5.20	5.32	6.35	4.52	4.67	5.39
28	5.24	5.37	6.49	4.56	4.71	5.52
60	5.40	5.55	6.94	4.72	4.89	5.89
90	5.47	5.63	7.14	4.79	4.97	6.07
120	5.50	5.66	7.25	4.82	5.00	6.16
150	5.53	5.69	7.34	4.85	5.03	6.24
180	5.55	5.72	7.41	4.87	5.06	6.30
210	5.57	5.74	7.46	4.89	5.08	6.35
240	5.59	5.76	7.52	4.91	5.10	6.39
270	5.63	5.81	7.60	4.94	5.14	6.46
300	5.65	5.83	7.66	4.96	5.16	6.51
330	5.68	5.87	7.74	4.99	5.20	6.58
360	5.72	5.90	7.81	5.02	5.23	6.64

Table G.21. Camber prediction (in.) of BTD 135 Set 4 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.01	4.07	4.01	3.44	3.45	3.44
0	4.03	3.91	3.90	3.46	3.38	3.34
1	4.60	4.47	4.59	3.96	3.88	3.94
2	4.78	4.65	4.88	4.14	4.05	4.19
3	4.93	4.79	5.12	4.27	4.18	4.39
7	5.12	4.98	5.56	4.47	4.37	4.77
14	5.30	5.16	6.00	4.65	4.55	5.15
21	5.36	5.23	6.21	4.72	4.62	5.33
28	5.41	5.27	6.35	4.77	4.67	5.45
60	5.59	5.45	6.79	4.95	4.85	5.83
90	5.67	5.53	6.99	5.02	4.92	6.01
120	5.70	5.57	7.10	5.06	4.96	6.10
150	5.73	5.60	7.18	5.09	4.99	6.17
180	5.76	5.63	7.25	5.12	5.02	6.23
210	5.78	5.65	7.30	5.14	5.04	6.27
240	5.80	5.67	7.36	5.16	5.06	6.32
270	5.85	5.71	7.44	5.20	5.10	6.39
300	5.87	5.74	7.49	5.22	5.12	6.44
330	5.91	5.78	7.57	5.26	5.16	6.51
360	5.95	5.81	7.64	5.29	5.19	6.57

Table G.22. Camber prediction (in.) of BTD 135 Set 4 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.86	3.91	3.86	3.29	3.31	3.29
0	3.70	3.75	3.75	3.15	3.24	3.20
1	4.22	4.28	4.42	3.61	3.71	3.77
2	4.38	4.46	4.70	3.76	3.87	4.01
3	4.51	4.60	4.92	3.88	4.00	4.21
7	4.67	4.77	5.35	4.05	4.18	4.57
14	4.83	4.94	5.77	4.21	4.35	4.93
21	4.89	5.00	5.97	4.27	4.41	5.11
28	4.92	5.04	6.11	4.31	4.45	5.22
60	5.08	5.22	6.53	4.47	4.62	5.58
90	5.14	5.29	6.72	4.53	4.69	5.75
120	5.18	5.32	6.82	4.56	4.73	5.84
150	5.20	5.35	6.91	4.59	4.76	5.91
180	5.22	5.38	6.97	4.61	4.78	5.97
210	5.24	5.40	7.02	4.62	4.80	6.01
240	5.26	5.42	7.07	4.64	4.82	6.06
270	5.30	5.46	7.15	4.68	4.86	6.12
300	5.31	5.48	7.21	4.69	4.88	6.17
330	5.35	5.52	7.28	4.72	4.91	6.23
360	5.38	5.55	7.35	4.75	4.94	6.29

APPENDIX H. SIMPLIFIED LONG-TERM CAMBER PREDICTIONS USING SPECIFIED SEALED CREEP AND SHRINKAGE

A comparison of the cambers for different types of PPCBs using three methods, the gross section properties, the transformed section properties, the specified sealed creep coefficient, and the sealed shrinkage data are presented in this appendix.

Table H.1. Camber prediction (in.) of BTC 120 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant A

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.56	4.61	4.56	3.99	4.00	3.99
0	4.43	4.48	4.44	3.70	3.95	3.89
1	5.00	5.06	5.16	4.19	4.48	4.51
2	5.02	5.08	5.27	4.21	4.51	4.61
3	5.17	5.24	5.51	4.35	4.65	4.82
7	5.44	5.52	6.03	4.60	4.93	5.28
14	5.60	5.69	6.45	4.76	5.10	5.65
21	5.63	5.72	6.60	4.80	5.14	5.78
28	5.69	5.78	6.74	4.85	5.20	5.91
60	6.19	6.31	7.63	5.30	5.70	6.68
90	6.35	6.48	7.93	5.44	5.85	6.96
120	6.44	6.58	8.13	5.52	5.95	7.13
150	6.52	6.67	8.28	5.60	6.03	7.26
180	6.56	6.70	8.35	5.63	6.07	7.32
210	6.58	6.73	8.40	5.65	6.09	7.37
240	6.58	6.72	8.41	5.64	6.09	7.37
270	6.56	6.70	8.39	5.63	6.07	7.36
300	6.62	6.77	8.50	5.68	6.13	7.46
330	6.67	6.82	8.60	5.73	6.18	7.54
360	6.73	6.88	8.69	5.78	6.24	7.62

Table H.2. Camber prediction (in.) of BTC 120 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant A

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.10	4.15	4.10	3.56	3.57	3.56
0	3.97	4.01	4.00	3.43	3.51	3.46
1	4.47	4.53	4.64	3.89	3.98	4.03
2	4.48	4.54	4.74	3.91	4.00	4.11
3	4.61	4.68	4.95	4.03	4.13	4.30
7	4.85	4.93	5.43	4.26	4.37	4.71
14	4.99	5.08	5.80	4.41	4.52	5.04
21	5.01	5.10	5.93	4.44	4.56	5.15
28	5.06	5.15	6.07	4.49	4.60	5.27
60	5.50	5.61	6.86	4.90	5.04	5.96
90	5.63	5.75	7.14	5.03	5.17	6.20
120	5.71	5.84	7.31	5.11	5.26	6.36
150	5.78	5.92	7.45	5.17	5.33	6.47
180	5.81	5.95	7.51	5.20	5.35	6.53
210	5.83	5.97	7.56	5.22	5.38	6.57
240	5.82	5.96	7.56	5.21	5.37	6.57
270	5.80	5.94	7.55	5.20	5.36	6.56
300	5.86	6.00	7.65	5.24	5.41	6.65
330	5.90	6.05	7.74	5.29	5.45	6.72
360	5.95	6.10	7.82	5.33	5.50	6.80

Table H.3. Camber prediction (in.) of BTE 110 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.11	2.13	2.11	1.90	1.91	1.90
0	2.05	2.07	2.04	1.84	1.87	1.84
1	2.39	2.42	2.45	2.16	2.19	2.21
2	2.44	2.47	2.54	2.21	2.24	2.29
3	2.56	2.59	2.71	2.32	2.36	2.45
7	2.65	2.69	2.92	2.41	2.45	2.63
14	2.84	2.89	3.26	2.60	2.65	2.94
21	2.92	2.97	3.43	2.67	2.73	3.09
28	2.95	3.00	3.51	2.71	2.76	3.16
60	3.04	3.10	3.72	2.80	2.86	3.35
90	3.08	3.14	3.81	2.84	2.90	3.44
120	3.10	3.16	3.86	2.86	2.92	3.49
150	3.11	3.17	3.89	2.87	2.93	3.51
180	3.12	3.18	3.91	2.87	2.94	3.53
210	3.13	3.19	3.93	2.88	2.95	3.55
240	3.16	3.22	3.99	2.91	2.98	3.60
270	3.19	3.26	4.05	2.95	3.02	3.66
300	3.20	3.27	4.07	2.96	3.03	3.68
330	3.23	3.30	4.11	2.98	3.05	3.71
360	3.25	3.32	4.15	3.00	3.07	3.75

Table H.4. Camber prediction (in.) of BTE 110 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.74	1.76	1.74	1.55	1.56	1.55
0	1.68	1.70	1.69	1.50	1.52	1.50
1	1.96	1.99	2.03	1.75	1.78	1.81
2	1.99	2.02	2.10	1.79	1.82	1.87
3	2.09	2.12	2.24	1.88	1.91	2.00
7	2.16	2.20	2.41	1.95	1.99	2.15
14	2.31	2.36	2.70	2.09	2.15	2.41
21	2.37	2.42	2.83	2.15	2.21	2.53
28	2.39	2.45	2.90	2.18	2.24	2.59
60	2.46	2.52	3.07	2.24	2.31	2.74
90	2.49	2.55	3.15	2.27	2.34	2.82
120	2.50	2.56	3.19	2.29	2.35	2.85
150	2.51	2.57	3.22	2.29	2.36	2.87
180	2.51	2.57	3.24	2.30	2.37	2.89
210	2.52	2.58	3.25	2.30	2.37	2.91
240	2.54	2.61	3.30	2.32	2.40	2.95
270	2.57	2.64	3.35	2.35	2.42	2.99
300	2.58	2.65	3.37	2.36	2.43	3.01
330	2.59	2.66	3.40	2.37	2.45	3.04
360	2.61	2.68	3.43	2.39	2.46	3.07

Table H.5. Camber prediction (in.) of BTE 110 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.19	2.21	2.19	1.96	1.97	1.96
0	2.13	2.15	2.12	1.91	1.93	1.90
1	2.49	2.51	2.55	2.23	2.27	2.29
2	2.53	2.56	2.64	2.28	2.32	2.37
3	2.66	2.69	2.82	2.40	2.44	2.53
7	2.75	2.79	3.03	2.49	2.54	2.72
14	2.95	3.00	3.39	2.69	2.74	3.04
21	3.03	3.08	3.56	2.76	2.82	3.19
28	3.06	3.12	3.64	2.80	2.86	3.27
60	3.15	3.21	3.86	2.89	2.95	3.46
90	3.19	3.26	3.96	2.93	3.00	3.55
120	3.21	3.28	4.01	2.95	3.02	3.60
150	3.22	3.29	4.04	2.96	3.03	3.63
180	3.23	3.30	4.06	2.97	3.04	3.65
210	3.24	3.31	4.08	2.97	3.05	3.67
240	3.27	3.34	4.14	3.00	3.08	3.72
270	3.31	3.38	4.20	3.04	3.12	3.78
300	3.32	3.39	4.23	3.05	3.13	3.80
330	3.34	3.42	4.27	3.07	3.15	3.83
360	3.36	3.44	4.31	3.09	3.17	3.87

Table H.6. Camber prediction (in.) of BTE 110 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.68	1.70	1.68	1.51	1.52	1.51
0	1.63	1.64	1.63	1.45	1.48	1.46
1	1.90	1.92	1.96	1.70	1.73	1.76
2	1.93	1.96	2.03	1.74	1.77	1.82
3	2.02	2.05	2.17	1.82	1.86	1.95
7	2.09	2.13	2.34	1.89	1.93	2.09
14	2.24	2.28	2.61	2.04	2.09	2.34
21	2.30	2.34	2.74	2.09	2.14	2.46
28	2.32	2.37	2.81	2.12	2.17	2.52
60	2.39	2.44	2.98	2.18	2.24	2.67
90	2.42	2.47	3.05	2.21	2.28	2.74
120	2.43	2.49	3.09	2.23	2.29	2.78
150	2.43	2.49	3.12	2.23	2.29	2.80
180	2.44	2.50	3.13	2.23	2.30	2.81
210	2.44	2.50	3.15	2.24	2.31	2.83
240	2.47	2.53	3.19	2.26	2.33	2.87
270	2.49	2.56	3.24	2.29	2.36	2.91
300	2.50	2.57	3.26	2.30	2.37	2.93
330	2.52	2.58	3.29	2.31	2.38	2.96
360	2.53	2.60	3.32	2.33	2.40	2.98

Table H.7. Camber prediction (in.) of BTE 110 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	2.04	2.06	2.04	1.84	1.85	1.84
0	1.98	2.00	1.98	1.79	1.81	1.79
1	2.32	2.34	2.37	2.10	2.13	2.15
2	2.36	2.39	2.46	2.14	2.18	2.23
3	2.48	2.51	2.63	2.25	2.29	2.38
7	2.56	2.60	2.83	2.34	2.38	2.56
14	2.75	2.80	3.16	2.53	2.57	2.86
21	2.83	2.87	3.32	2.60	2.65	3.00
28	2.86	2.91	3.40	2.63	2.69	3.08
60	2.95	3.00	3.60	2.72	2.78	3.26
90	2.99	3.05	3.69	2.76	2.82	3.34
120	3.01	3.07	3.74	2.78	2.84	3.39
150	3.02	3.07	3.77	2.79	2.85	3.41
180	3.02	3.08	3.79	2.80	2.86	3.43
210	3.03	3.09	3.81	2.80	2.87	3.45
240	3.06	3.12	3.86	2.83	2.90	3.50
270	3.10	3.16	3.92	2.87	2.93	3.55
300	3.11	3.17	3.94	2.88	2.94	3.57
330	3.13	3.19	3.98	2.90	2.96	3.61
360	3.15	3.22	4.02	2.92	2.98	3.64

Table H.8. Camber prediction (in.) of BTE 110 Set 3 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	1.81	1.83	1.81	1.60	1.61	1.60
0	1.75	1.77	1.75	1.55	1.57	1.55
1	2.03	2.06	2.11	1.81	1.84	1.87
2	2.07	2.10	2.18	1.85	1.88	1.94
3	2.17	2.20	2.33	1.94	1.98	2.07
7	2.24	2.28	2.50	2.01	2.06	2.22
14	2.40	2.44	2.80	2.16	2.22	2.49
21	2.45	2.51	2.94	2.22	2.28	2.61
28	2.48	2.54	3.01	2.25	2.31	2.67
60	2.55	2.61	3.19	2.31	2.38	2.83
90	2.58	2.64	3.27	2.34	2.42	2.91
120	2.59	2.66	3.31	2.36	2.43	2.95
150	2.59	2.66	3.34	2.36	2.44	2.97
180	2.60	2.67	3.36	2.37	2.44	2.98
210	2.61	2.67	3.38	2.37	2.45	3.00
240	2.63	2.70	3.42	2.39	2.47	3.04
270	2.66	2.73	3.47	2.42	2.50	3.09
300	2.67	2.74	3.49	2.43	2.51	3.11
330	2.68	2.76	3.53	2.44	2.53	3.14
360	2.70	2.78	3.56	2.46	2.54	3.16

Table H.9. Camber prediction (in.) of BTE 145 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	5.04	5.09	5.04	4.39	4.41	4.39
0	4.89	4.94	4.90	4.26	4.34	4.27
1	5.71	5.78	5.90	4.99	5.10	5.14
2	5.73	5.80	6.01	5.02	5.13	5.24
3	5.74	5.81	6.10	5.04	5.15	5.32
7	5.88	5.96	6.51	5.19	5.30	5.68
14	6.34	6.45	7.35	5.63	5.76	6.42
21	6.40	6.52	7.61	5.71	5.84	6.65
28	6.43	6.55	7.74	5.74	5.88	6.76
60	6.66	6.80	8.24	5.97	6.12	7.20
90	6.84	6.98	8.57	6.14	6.29	7.49
120	6.94	7.09	8.76	6.23	6.39	7.66
150	6.97	7.12	8.85	6.26	6.42	7.73
180	6.98	7.13	8.89	6.27	6.44	7.77
210	6.97	7.13	8.90	6.27	6.44	7.78
240	7.07	7.23	9.06	6.36	6.53	7.92
270	7.21	7.38	9.29	6.49	6.67	8.12
300	7.28	7.46	9.43	6.56	6.74	8.24
330	7.35	7.52	9.54	6.62	6.80	8.34
360	7.44	7.62	9.70	6.70	6.90	8.48

Table H.10. Camber prediction (in.) of BTE 145 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.70	3.76	3.70	3.13	3.15	3.13
0	3.54	3.60	3.60	2.99	3.08	3.05
1	4.11	4.19	4.33	3.49	3.60	3.67
2	4.12	4.20	4.41	3.51	3.62	3.74
3	4.12	4.21	4.48	3.52	3.63	3.80
7	4.19	4.29	4.78	3.60	3.72	4.06
14	4.48	4.60	5.40	3.88	4.02	4.59
21	4.51	4.63	5.59	3.91	4.06	4.75
28	4.52	4.65	5.69	3.93	4.08	4.83
60	4.67	4.81	6.06	4.08	4.24	5.14
90	4.78	4.93	6.30	4.18	4.35	5.35
120	4.84	5.00	6.44	4.24	4.42	5.47
150	4.86	5.02	6.50	4.26	4.44	5.52
180	4.86	5.02	6.53	4.26	4.44	5.55
210	4.85	5.02	6.54	4.25	4.44	5.56
240	4.91	5.08	6.66	4.31	4.50	5.66
270	5.00	5.18	6.83	4.39	4.59	5.81
300	5.05	5.24	6.93	4.44	4.64	5.89
330	5.09	5.28	7.01	4.47	4.68	5.96
360	5.15	5.34	7.13	4.52	4.74	6.06

Table H.11. Camber prediction (in.) BTE 145 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	5.05	5.11	5.05	4.39	4.40	4.39
0	4.90	4.96	4.92	4.25	4.34	4.27
1	5.72	5.79	5.91	4.98	5.10	5.14
2	5.74	5.82	6.03	5.01	5.13	5.24
3	5.75	5.83	6.11	5.03	5.14	5.31
7	5.89	5.97	6.52	5.18	5.30	5.67
14	6.34	6.45	7.37	5.62	5.75	6.41
21	6.41	6.53	7.62	5.69	5.83	6.64
28	6.44	6.56	7.75	5.73	5.87	6.75
60	6.66	6.80	8.26	5.96	6.11	7.19
90	6.84	6.99	8.59	6.12	6.28	7.48
120	6.93	7.09	8.78	6.21	6.38	7.65
150	6.96	7.12	8.86	6.24	6.41	7.72
180	6.97	7.14	8.90	6.25	6.42	7.75
210	6.97	7.13	8.92	6.25	6.42	7.77
240	7.06	7.23	9.08	6.34	6.51	7.91
270	7.20	7.38	9.31	6.47	6.65	8.11
300	7.28	7.46	9.44	6.54	6.73	8.23
330	7.34	7.53	9.56	6.60	6.79	8.33
360	7.43	7.62	9.72	6.68	6.88	8.47

Table H.12. Camber prediction (in.) of BTE 145 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.68	3.75	3.68	3.11	3.13	3.11
0	3.53	3.59	3.58	2.97	3.05	3.02
1	4.09	4.17	4.31	3.46	3.57	3.64
2	4.10	4.19	4.40	3.48	3.59	3.71
3	4.10	4.19	4.46	3.48	3.60	3.77
7	4.17	4.27	4.76	3.57	3.69	4.02
14	4.45	4.58	5.38	3.84	3.98	4.55
21	4.47	4.60	5.57	3.86	4.02	4.71
28	4.49	4.62	5.66	3.89	4.04	4.79
60	4.63	4.78	6.03	4.03	4.20	5.10
90	4.74	4.90	6.27	4.13	4.31	5.30
120	4.80	4.97	6.41	4.19	4.37	5.42
150	4.81	4.98	6.47	4.20	4.39	5.48
180	4.82	4.99	6.50	4.21	4.39	5.50
210	4.81	4.98	6.51	4.20	4.39	5.51
240	4.87	5.05	6.63	4.25	4.45	5.61
270	4.96	5.15	6.80	4.34	4.54	5.75
300	5.00	5.20	6.90	4.38	4.59	5.84
330	5.04	5.24	6.98	4.41	4.63	5.91
360	5.10	5.30	7.10	4.46	4.69	6.01

Table H.13. Camber prediction (in.) of BTE 145 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.95	5.00	4.95	4.31	4.33	4.31
0	4.80	4.85	4.82	4.18	4.27	4.19
1	5.60	5.67	5.79	4.90	5.01	5.05
2	5.62	5.70	5.90	4.93	5.04	5.15
3	5.63	5.71	5.99	4.95	5.05	5.23
7	5.77	5.85	6.39	5.10	5.21	5.58
14	6.22	6.33	7.22	5.53	5.65	6.31
21	6.28	6.40	7.47	5.60	5.73	6.53
28	6.31	6.43	7.60	5.64	5.77	6.64
60	6.54	6.67	8.09	5.86	6.00	7.07
90	6.71	6.85	8.42	6.02	6.18	7.36
120	6.80	6.95	8.60	6.11	6.27	7.52
150	6.84	6.99	8.69	6.14	6.30	7.59
180	6.85	7.00	8.73	6.15	6.32	7.63
210	6.84	7.00	8.74	6.15	6.32	7.64
240	6.93	7.09	8.90	6.24	6.41	7.78
270	7.07	7.24	9.13	6.37	6.54	7.98
300	7.15	7.32	9.26	6.44	6.62	8.10
330	7.21	7.38	9.37	6.49	6.68	8.19
360	7.30	7.48	9.53	6.58	6.77	8.33

Table H.14. Camber prediction (in.) of BTE 145 Set 3 PPCBs without an overhang using the three methods and two types of section properties at Plant B

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.61	3.67	3.61	3.06	3.08	3.06
0	3.46	3.51	3.51	2.92	3.00	2.97
1	4.01	4.09	4.23	3.40	3.51	3.58
2	4.02	4.10	4.31	3.42	3.53	3.65
3	4.02	4.10	4.37	3.43	3.54	3.71
7	4.09	4.18	4.67	3.51	3.63	3.96
14	4.37	4.49	5.28	3.78	3.92	4.48
21	4.39	4.52	5.46	3.81	3.95	4.63
28	4.41	4.54	5.55	3.83	3.98	4.71
60	4.55	4.69	5.91	3.97	4.13	5.02
90	4.66	4.81	6.15	4.07	4.24	5.22
120	4.71	4.87	6.29	4.13	4.30	5.34
150	4.73	4.89	6.35	4.14	4.32	5.39
180	4.73	4.90	6.38	4.15	4.33	5.42
210	4.73	4.89	6.39	4.14	4.32	5.43
240	4.78	4.96	6.51	4.19	4.38	5.53
270	4.87	5.05	6.67	4.28	4.47	5.67
300	4.92	5.11	6.77	4.32	4.52	5.75
330	4.96	5.15	6.85	4.35	4.56	5.82
360	5.01	5.21	6.97	4.40	4.62	5.92

Table H.15. Camber prediction (in.) of BTD 135 Set 1 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.27	4.32	4.27	3.71	3.73	3.71
0	4.12	4.17	4.15	3.58	3.66	3.61
1	4.60	4.66	4.77	4.01	4.10	4.15
2	5.18	5.27	5.55	4.54	4.65	4.83
3	5.19	5.28	5.64	4.55	4.67	4.91
7	5.41	5.51	6.20	4.77	4.90	5.40
14	5.31	5.41	6.28	4.70	4.83	5.47
21	5.29	5.40	6.38	4.70	4.82	5.56
28	5.31	5.42	6.51	4.73	4.85	5.67
60	5.33	5.44	6.70	4.76	4.88	5.84
90	5.40	5.52	6.89	4.82	4.95	6.00
120	5.41	5.54	6.95	4.84	4.97	6.06
150	5.46	5.59	7.06	4.89	5.02	6.16
180	5.53	5.66	7.20	4.95	5.09	6.27
210	5.57	5.71	7.29	4.99	5.13	6.35
240	5.57	5.70	7.29	4.98	5.13	6.35
270	5.63	5.77	7.41	5.04	5.19	6.46
300	5.64	5.78	7.44	5.05	5.20	6.49
330	5.69	5.83	7.53	5.10	5.25	6.57
360	5.72	5.86	7.60	5.13	5.28	6.62

Table H.16. Camber prediction (in.) of BTD 135 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.04	4.11	4.04	3.42	3.44	3.42
0	3.88	3.94	3.93	3.28	3.37	3.33
1	4.32	4.39	4.52	3.66	3.77	3.82
2	4.85	4.94	5.25	4.12	4.26	4.45
3	4.85	4.95	5.34	4.14	4.28	4.53
7	5.02	5.14	5.87	4.31	4.46	4.97
14	4.92	5.04	5.94	4.25	4.40	5.03
21	4.90	5.02	6.03	4.24	4.39	5.12
28	4.91	5.04	6.16	4.26	4.41	5.22
60	4.91	5.04	6.34	4.28	4.43	5.37
90	4.96	5.10	6.52	4.33	4.49	5.53
120	4.97	5.12	6.57	4.34	4.51	5.58
150	5.01	5.16	6.68	4.38	4.55	5.67
180	5.07	5.23	6.81	4.43	4.61	5.78
210	5.11	5.26	6.89	4.47	4.64	5.85
240	5.10	5.25	6.89	4.46	4.63	5.85
270	5.15	5.31	7.01	4.51	4.69	5.95
300	5.16	5.32	7.04	4.52	4.70	5.97
330	5.20	5.37	7.12	4.55	4.74	6.04
360	5.22	5.39	7.18	4.57	4.76	6.09

Table H.17. Camber prediction (in.) of BTD 135 Set 2 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.27	4.33	4.27	3.63	3.65	3.63
0	4.29	4.17	4.16	3.66	3.58	3.53
1	4.78	4.65	4.77	4.09	4.01	4.06
2	5.38	5.24	5.55	4.62	4.53	4.72
3	5.39	5.25	5.64	4.64	4.55	4.80
7	5.60	5.46	6.20	4.85	4.76	5.28
14	5.49	5.35	6.27	4.79	4.69	5.34
21	5.47	5.34	6.37	4.78	4.68	5.43
28	5.49	5.36	6.50	4.81	4.71	5.54
60	5.50	5.37	6.69	4.83	4.73	5.70
90	5.57	5.43	6.88	4.90	4.80	5.86
120	5.58	5.45	6.94	4.91	4.81	5.91
150	5.63	5.50	7.05	4.96	4.86	6.01
180	5.70	5.57	7.19	5.02	4.92	6.13
210	5.74	5.61	7.28	5.06	4.96	6.20
240	5.73	5.60	7.28	5.05	4.95	6.21
270	5.80	5.66	7.40	5.11	5.02	6.31
300	5.81	5.68	7.43	5.12	5.03	6.34
330	5.85	5.72	7.52	5.17	5.07	6.41
360	5.88	5.75	7.59	5.19	5.10	6.47

Table H.18. Camber prediction (in.) of BTD 135 Set 2 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.12	4.19	4.12	3.49	3.51	3.49
0	3.96	4.02	4.01	3.35	3.44	3.40
1	4.41	4.48	4.61	3.74	3.85	3.90
2	4.95	5.04	5.36	4.22	4.35	4.54
3	4.95	5.05	5.45	4.23	4.37	4.62
7	5.13	5.25	5.98	4.41	4.56	5.08
14	5.03	5.15	6.06	4.35	4.50	5.14
21	5.01	5.13	6.15	4.34	4.49	5.22
28	5.02	5.15	6.28	4.36	4.51	5.33
60	5.02	5.15	6.46	4.38	4.53	5.49
90	5.08	5.22	6.65	4.43	4.59	5.64
120	5.09	5.23	6.70	4.45	4.61	5.69
150	5.13	5.28	6.81	4.48	4.65	5.78
180	5.19	5.34	6.94	4.54	4.71	5.90
210	5.22	5.38	7.03	4.57	4.75	5.97
240	5.21	5.37	7.03	4.56	4.74	5.97
270	5.27	5.43	7.15	4.62	4.80	6.07
300	5.28	5.44	7.18	4.62	4.81	6.10
330	5.32	5.49	7.27	4.66	4.85	6.17
360	5.35	5.51	7.33	4.68	4.87	6.22

Table H.19. Camber prediction (in.) of BTD 135 Set 3 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.66	4.73	4.66	4.01	4.02	4.01
0	4.51	4.57	4.54	3.86	3.96	3.90
1	5.03	5.10	5.21	4.33	4.44	4.48
2	5.66	5.76	6.06	4.89	5.03	5.21
3	5.67	5.77	6.16	4.91	5.05	5.30
7	5.90	6.02	6.77	5.14	5.29	5.82
14	5.79	5.91	6.85	5.07	5.22	5.89
21	5.77	5.89	6.96	5.07	5.21	5.99
28	5.79	5.92	7.10	5.10	5.25	6.11
60	5.81	5.94	7.31	5.13	5.28	6.29
90	5.88	6.02	7.51	5.20	5.35	6.47
120	5.90	6.04	7.58	5.22	5.37	6.53
150	5.95	6.10	7.70	5.27	5.43	6.63
180	6.02	6.18	7.85	5.34	5.50	6.76
210	6.07	6.23	7.95	5.38	5.55	6.84
240	6.06	6.22	7.95	5.37	5.54	6.85
270	6.13	6.29	8.08	5.44	5.61	6.96
300	6.14	6.31	8.12	5.45	5.62	6.99
330	6.19	6.36	8.22	5.49	5.67	7.07
360	6.22	6.39	8.28	5.52	5.70	7.13

Table H.20. Camber prediction (in.) of BTD 135 Set 1 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.10	4.16	4.10	3.48	3.49	3.48
0	3.94	4.00	3.99	3.33	3.43	3.38
1	4.39	4.46	4.58	3.73	3.83	3.89
2	4.92	5.02	5.33	4.20	4.33	4.52
3	4.93	5.03	5.42	4.21	4.35	4.60
7	5.10	5.22	5.95	4.39	4.54	5.06
14	5.00	5.12	6.02	4.33	4.48	5.12
21	4.98	5.10	6.12	4.32	4.47	5.20
28	4.99	5.12	6.25	4.34	4.49	5.31
60	5.00	5.13	6.43	4.36	4.51	5.46
90	5.05	5.19	6.61	4.41	4.57	5.62
120	5.06	5.20	6.67	4.43	4.59	5.67
150	5.10	5.25	6.78	4.47	4.63	5.76
180	5.16	5.32	6.91	4.52	4.69	5.87
210	5.20	5.35	6.99	4.55	4.73	5.94
240	5.19	5.34	7.00	4.55	4.72	5.95
270	5.25	5.41	7.11	4.60	4.78	6.04
300	5.26	5.42	7.14	4.61	4.79	6.07
330	5.30	5.46	7.23	4.64	4.83	6.15
360	5.32	5.49	7.29	4.67	4.85	6.20

Table H.21. Camber prediction (in.) of BTD 135 Set 4 PPCBs with an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	4.01	4.07	4.01	3.44	3.45	3.44
0	4.03	3.91	3.90	3.46	3.38	3.34
1	4.49	4.36	4.48	3.87	3.79	3.84
2	5.05	4.92	5.21	4.38	4.28	4.47
3	5.06	4.92	5.30	4.39	4.30	4.55
7	5.26	5.12	5.82	4.59	4.50	5.00
14	5.16	5.03	5.89	4.53	4.43	5.06
21	5.14	5.01	5.99	4.52	4.42	5.14
28	5.16	5.03	6.11	4.55	4.45	5.25
60	5.17	5.04	6.29	4.57	4.47	5.40
90	5.23	5.10	6.47	4.63	4.53	5.55
120	5.25	5.12	6.52	4.65	4.55	5.60
150	5.30	5.16	6.63	4.69	4.59	5.70
180	5.36	5.23	6.76	4.75	4.65	5.80
210	5.40	5.27	6.84	4.79	4.69	5.88
240	5.39	5.26	6.84	4.78	4.68	5.88
270	5.45	5.32	6.96	4.84	4.74	5.98
300	5.46	5.33	6.99	4.85	4.75	6.00
330	5.51	5.37	7.07	4.89	4.79	6.08
360	5.53	5.40	7.13	4.92	4.81	6.13

Table H.22. Camber prediction (in.) of BTD 135 Set 4 PPCBs without an overhang using the three methods and two types of section properties at Plant C

Time after Transfer (days)	I_g and Incremental Method	I_g and Naaman Method	I_g and Tadros Method	I_{tr} and Incremental Method	I_{tr} and Naaman Method	I_{tr} and Tadros Method
0	3.86	3.91	3.86	3.29	3.31	3.29
0	3.70	3.75	3.75	3.15	3.24	3.20
1	4.12	4.19	4.31	3.52	3.62	3.68
2	4.62	4.71	5.01	3.97	4.09	4.28
3	4.63	4.72	5.10	3.98	4.11	4.36
7	4.79	4.90	5.60	4.15	4.29	4.79
14	4.70	4.81	5.67	4.09	4.23	4.85
21	4.68	4.79	5.76	4.09	4.22	4.93
28	4.69	4.81	5.88	4.10	4.24	5.03
60	4.70	4.82	6.05	4.12	4.26	5.17
90	4.75	4.87	6.22	4.17	4.32	5.32
120	4.76	4.89	6.27	4.18	4.33	5.37
150	4.80	4.93	6.38	4.22	4.37	5.46
180	4.85	4.99	6.50	4.27	4.43	5.56
210	4.89	5.03	6.58	4.30	4.46	5.63
240	4.88	5.02	6.58	4.30	4.46	5.63
270	4.93	5.08	6.69	4.35	4.51	5.73
300	4.94	5.09	6.72	4.35	4.52	5.75
330	4.98	5.13	6.80	4.39	4.56	5.82
360	5.00	5.15	6.86	4.41	4.58	5.87

APPENDIX I. LONG-TERM CAMBER PREDICTIONS WITH AND WITHOUT OVERHANG EFFECT USING FEA

The analytical camber curves of different sets of PPCBs with and without overhangs are presented here. These curves were subsequently used to modify the original measured camber to eliminate the overhang effect and to generate the adjusted measured camber with zero overhang length, which are shown in this appendix.

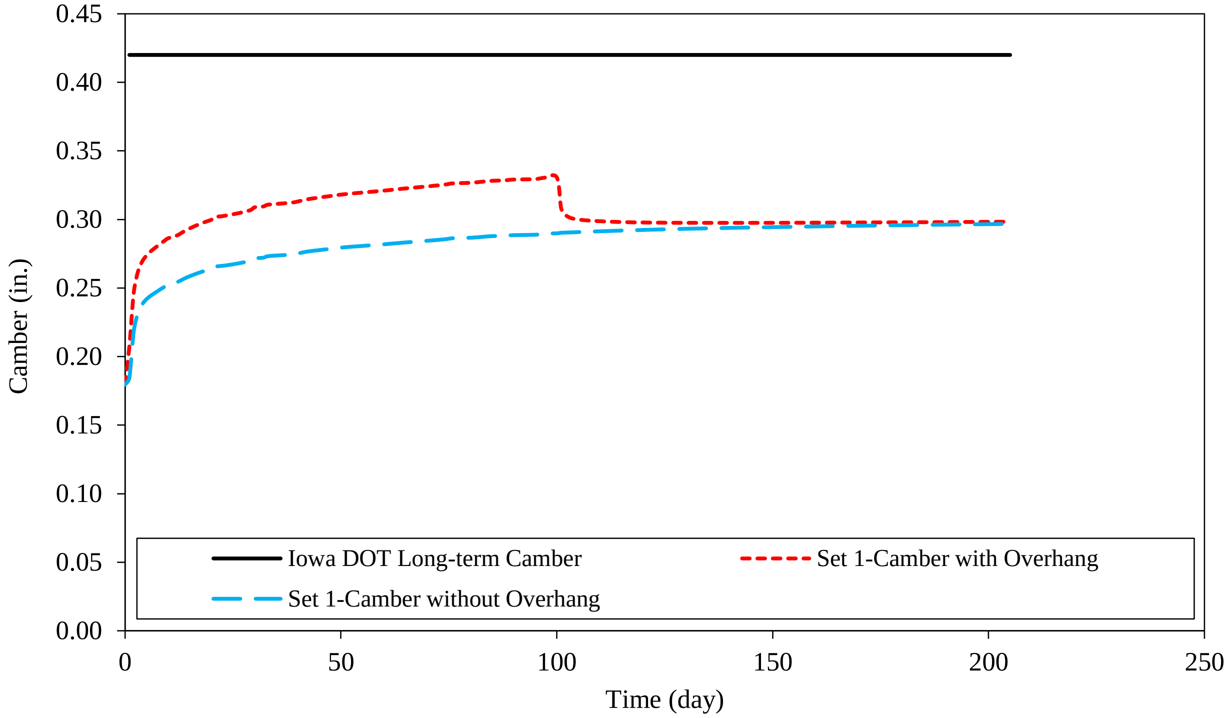


Figure I.1. Analytical camber curves for D 55 Set 1 PPCBs

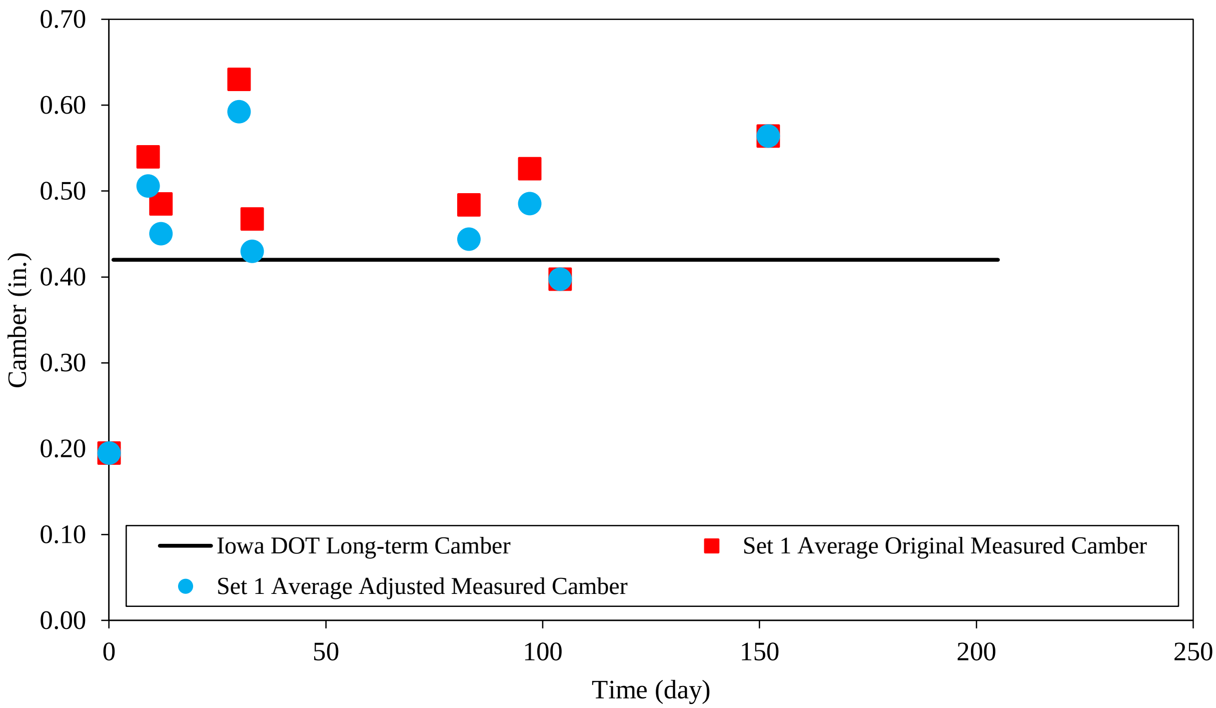


Figure I.2. Measured and adjusted data for D 55 Set 1 PPCBs

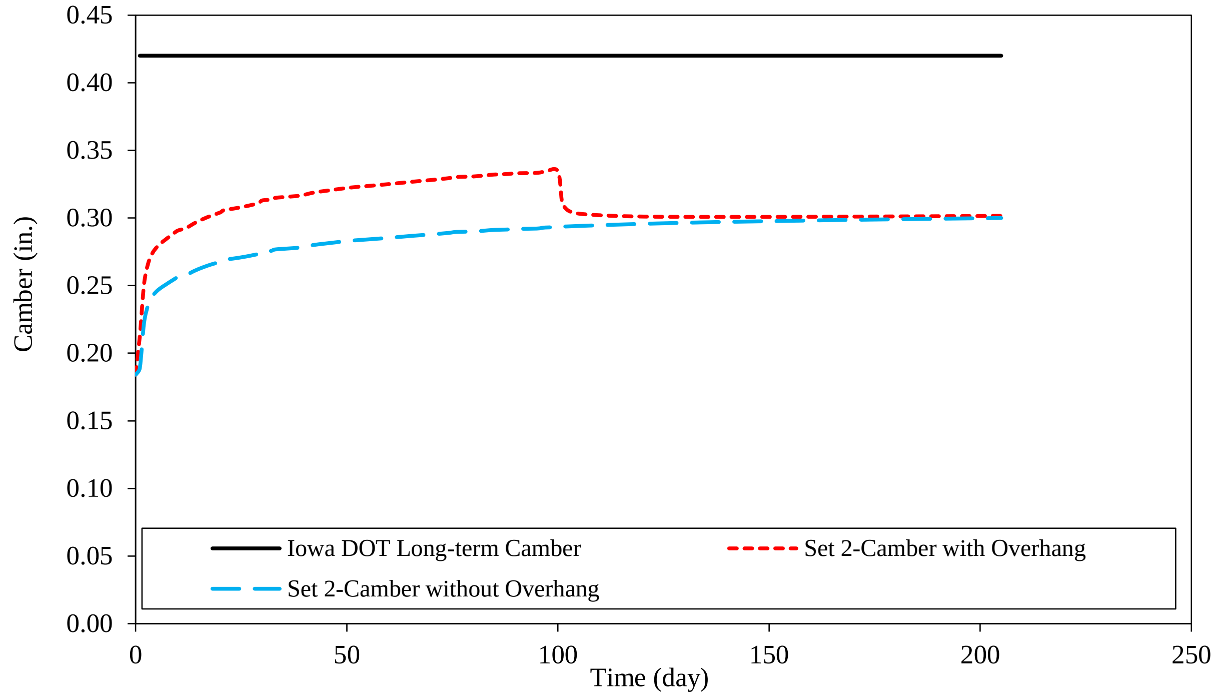


Figure I.3. Analytical camber curves for D 55 Set 2 PPCBs

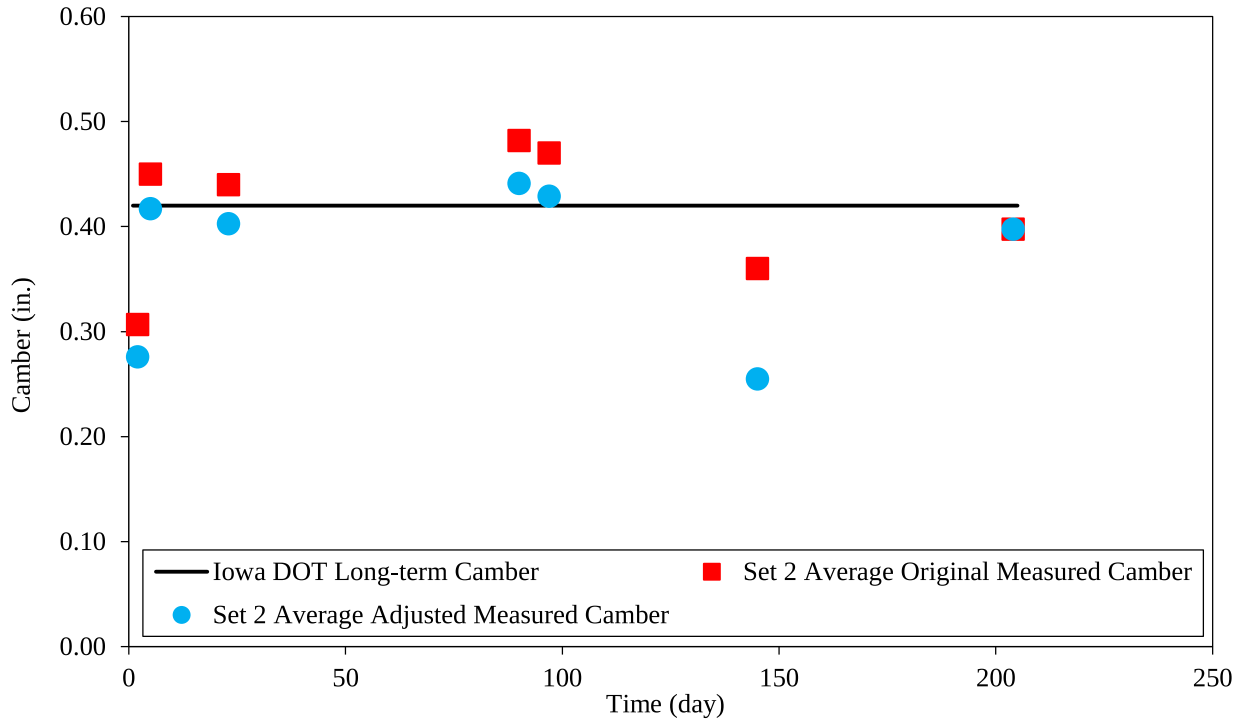


Figure I.4. Measured and adjusted data for D 55 Set 2 PPCBs

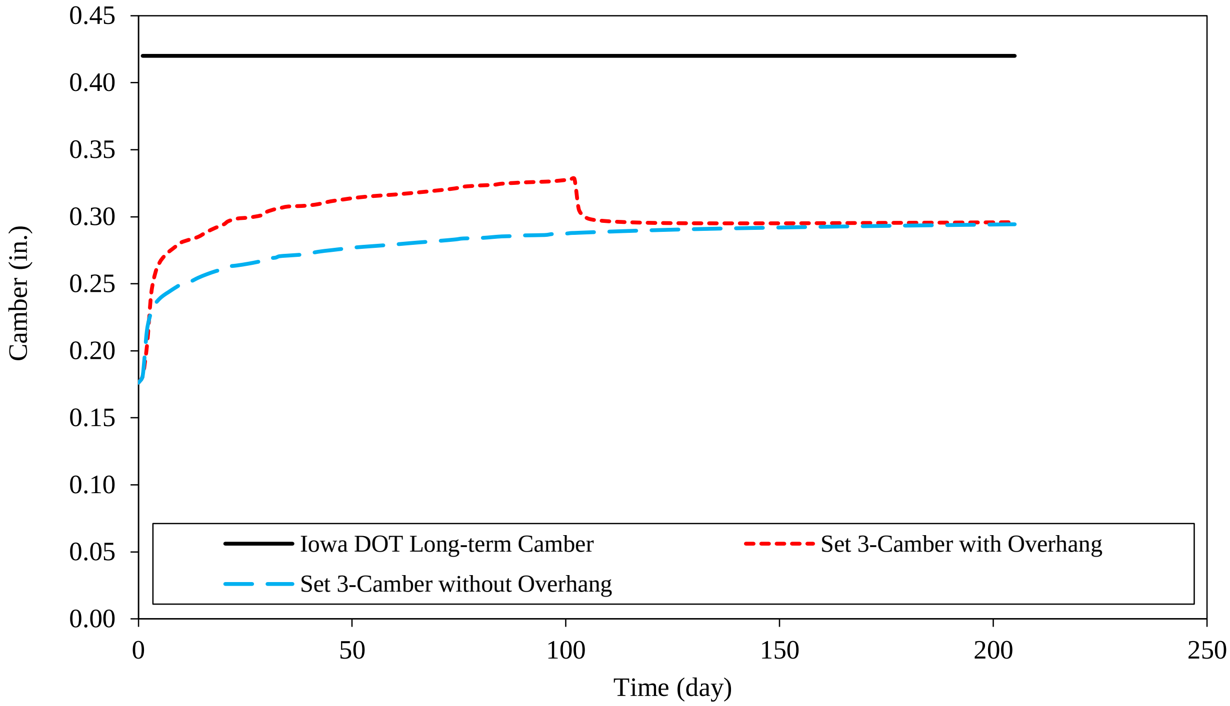


Figure I.5. Analytical camber curves for D 55 Set 3 PPCBs

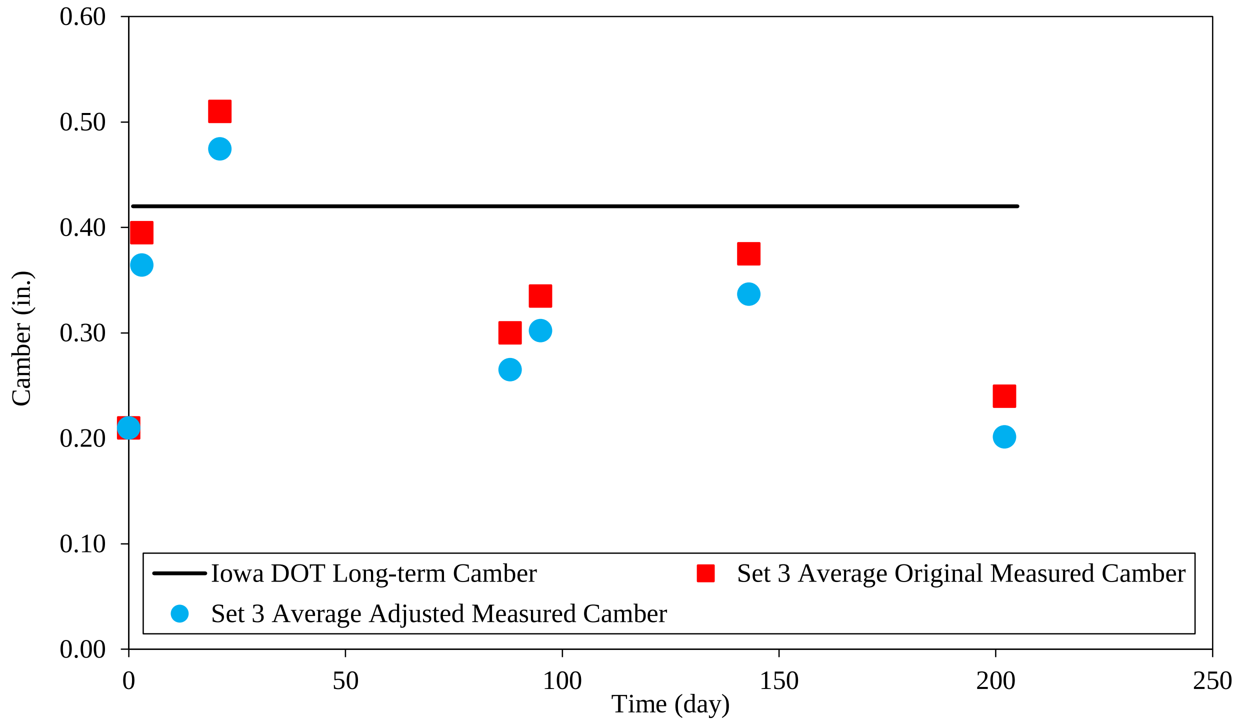


Figure I.6. Measured and adjusted data for D 55 Set 3 PPCBs

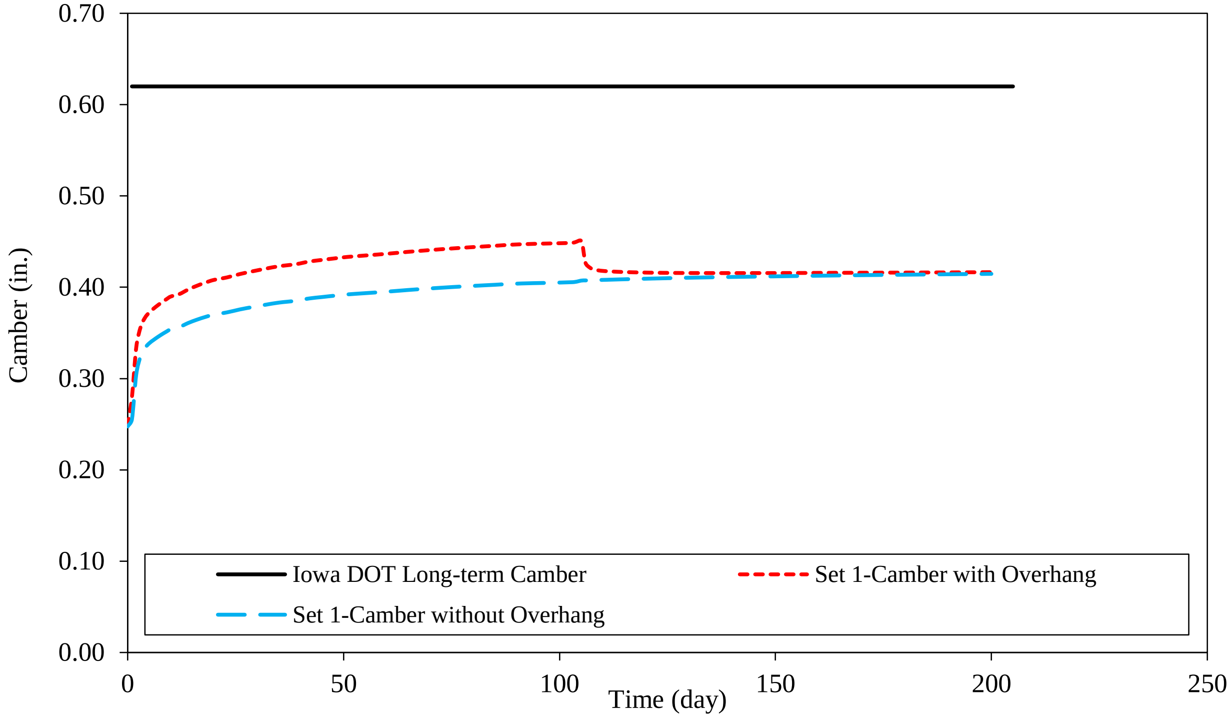


Figure I.7. Analytical camber curves for D 60 Set 1 PPCBs

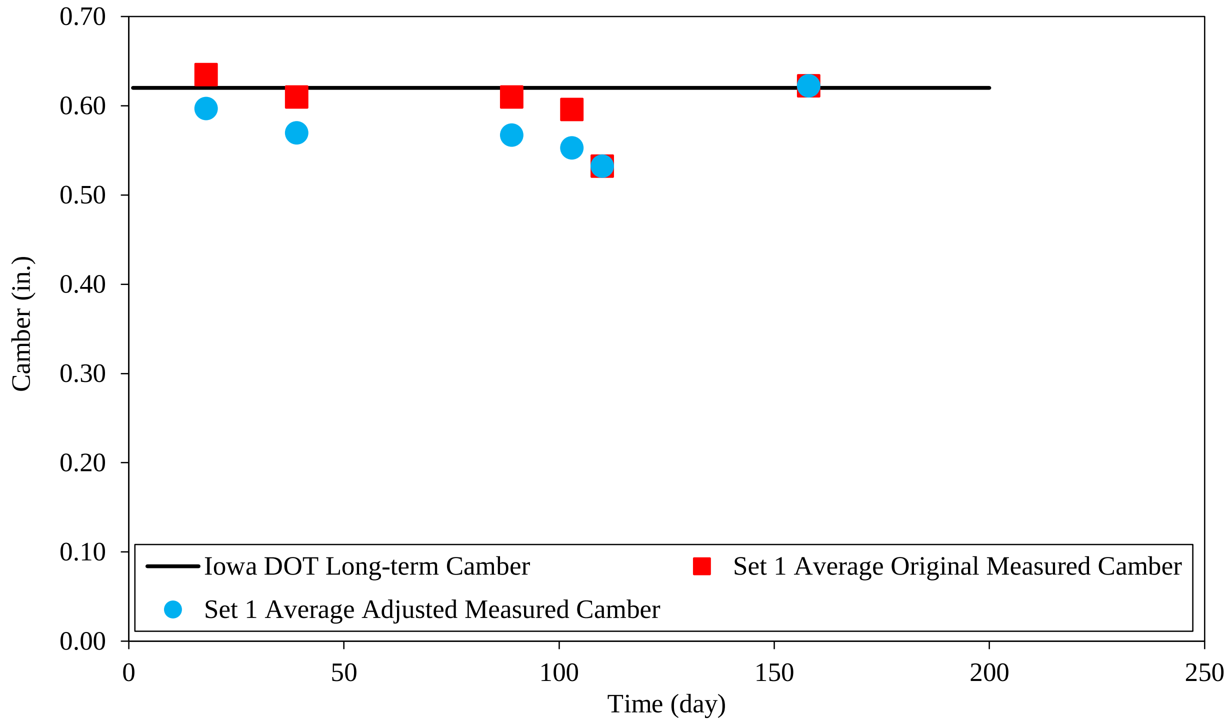


Figure I.8. Measured and adjusted data for D 60 Set 1 PPCBs

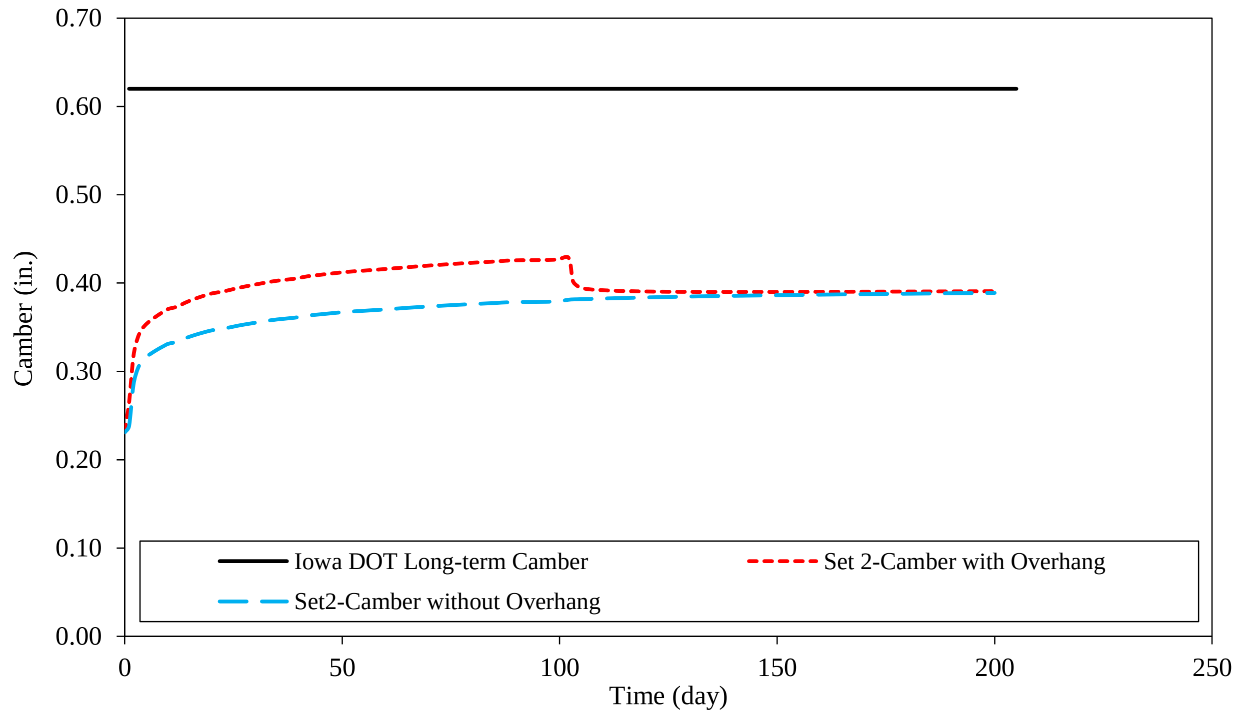


Figure I.9. Analytical camber curves for D 60 Set 2 PPCBs

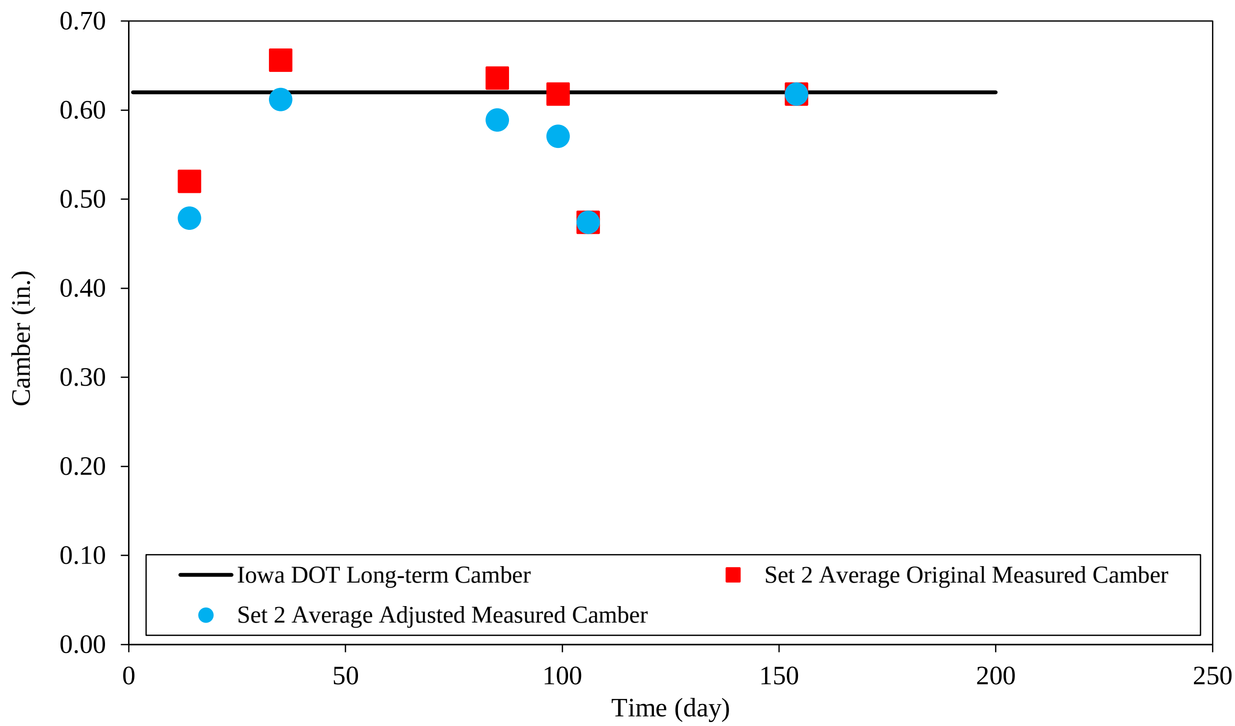


Figure I.10. Measured and adjusted data for D 60 Set 2 PPCBs

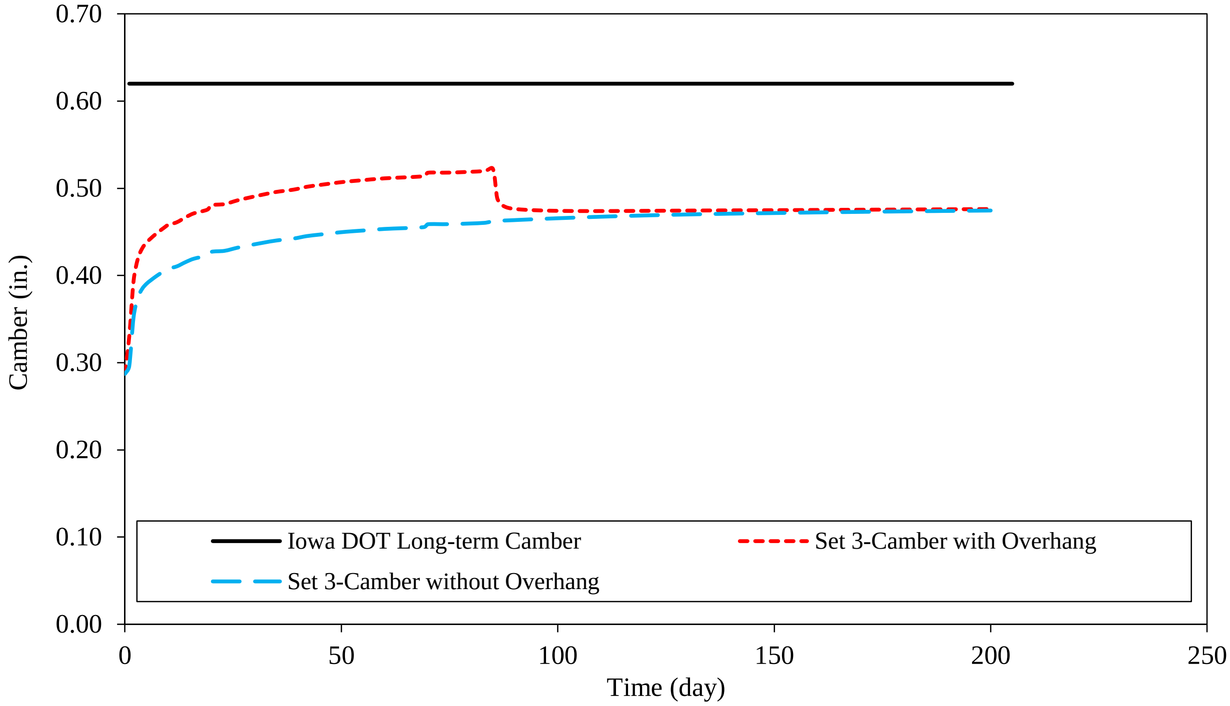


Figure I.11. Analytical camber curves for D 60 Set 3 PPCBs

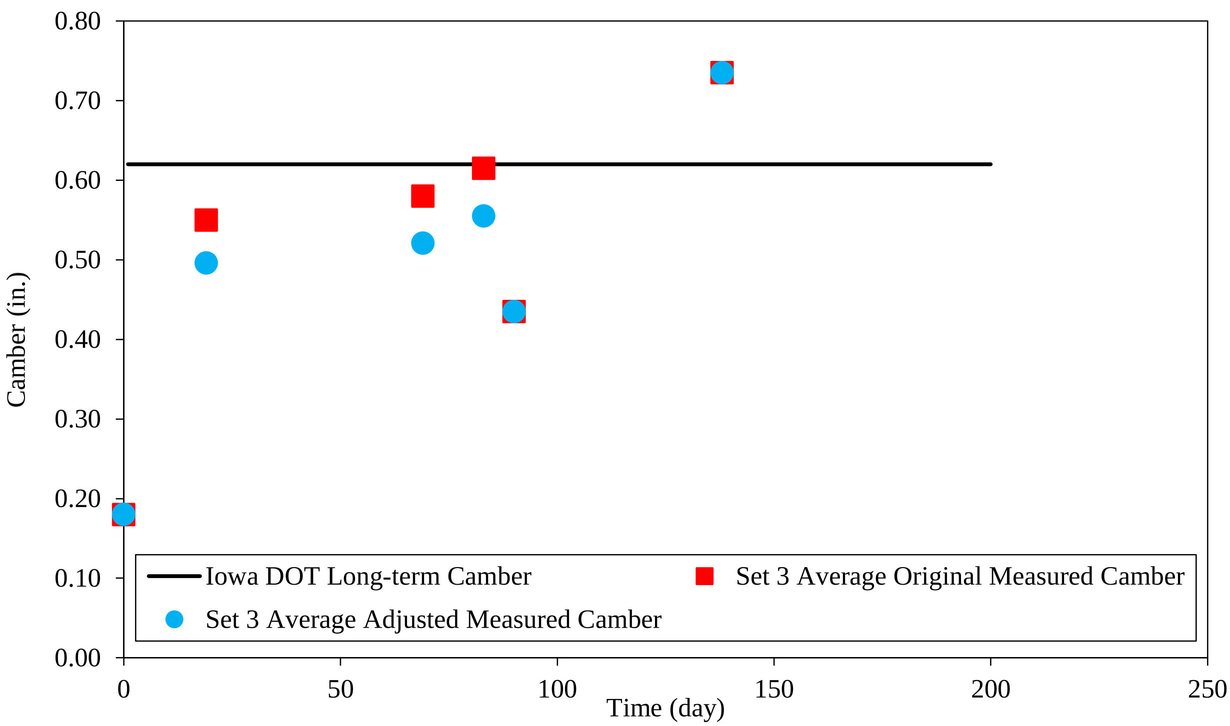


Figure I.12. Measured and adjusted data for D 60 Set 3 PPCBs

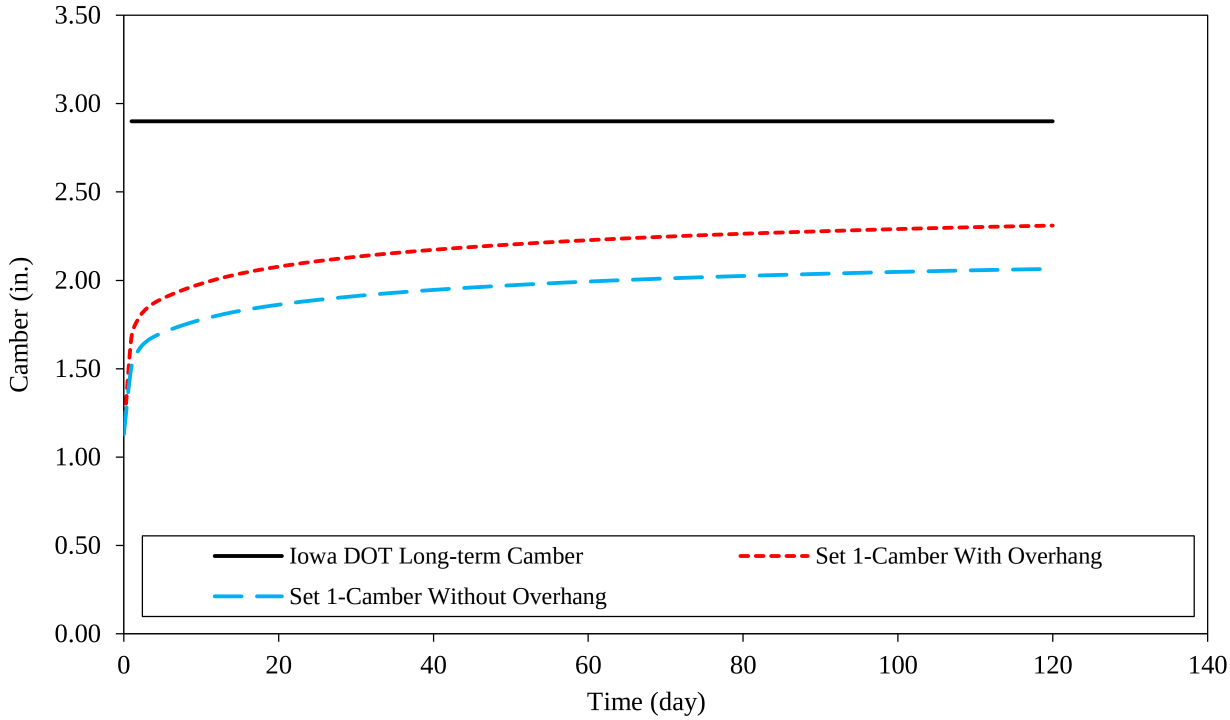


Figure I.13. Analytical camber curves for C 80 Set 1 PPCBs

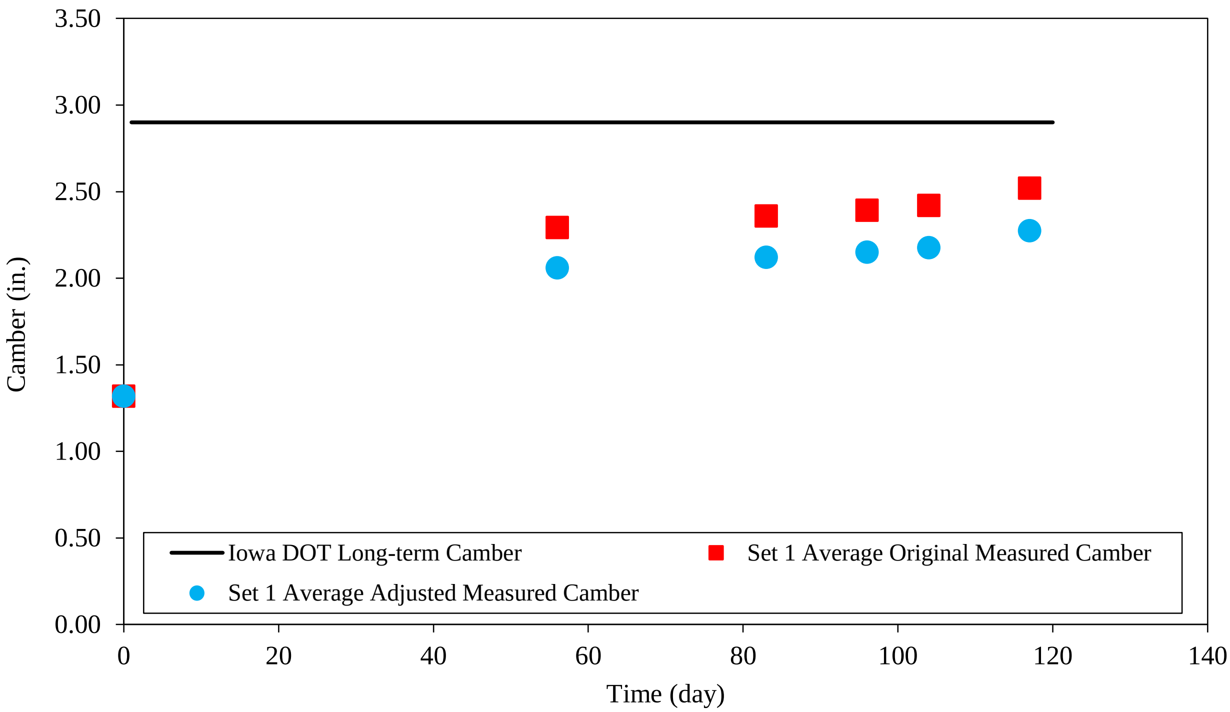


Figure I.14. Measured and adjusted data for C 80 Set 1 PPCBs

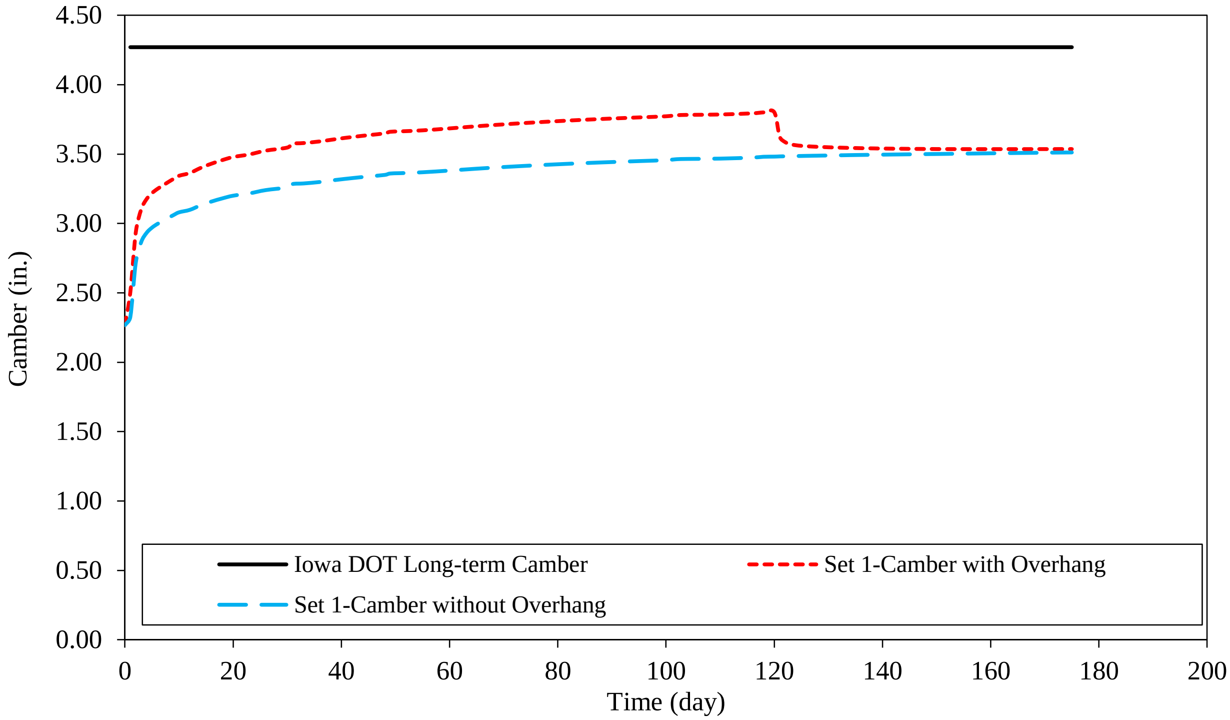


Figure I.15. Analytical camber curves for D 105 Set 1 PPCBs

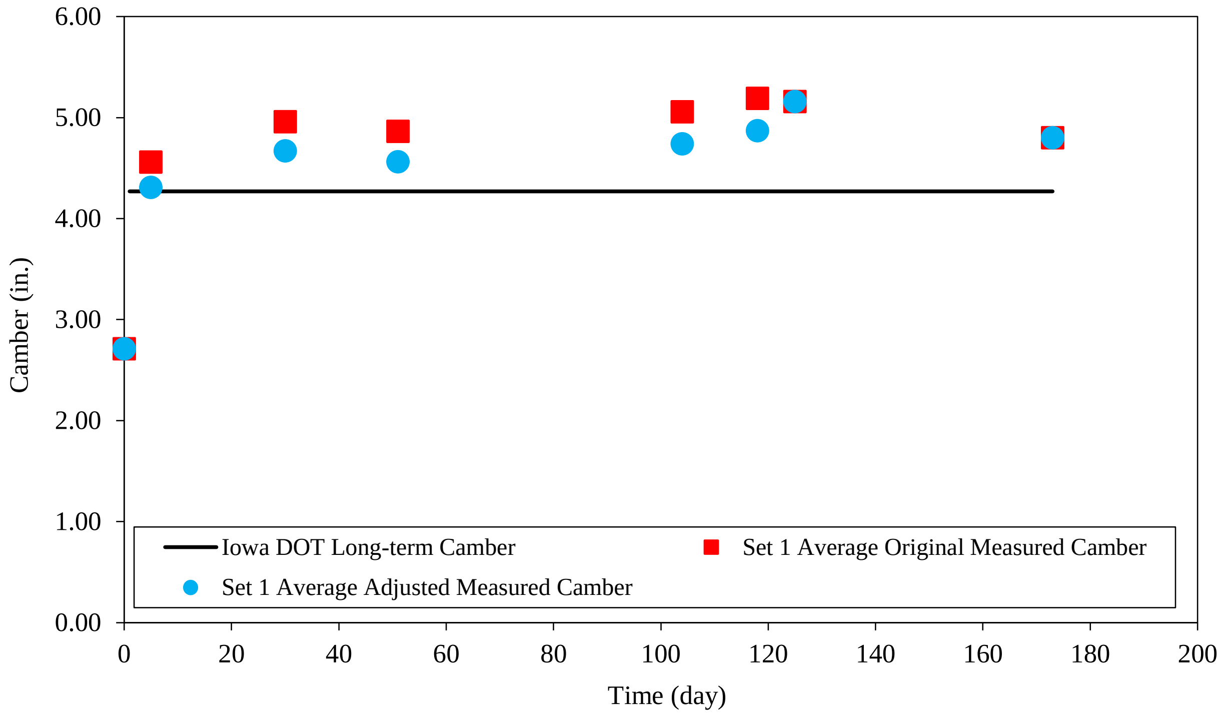


Figure I.16. Measured and adjusted data for D 105 Set 1 PPCBs

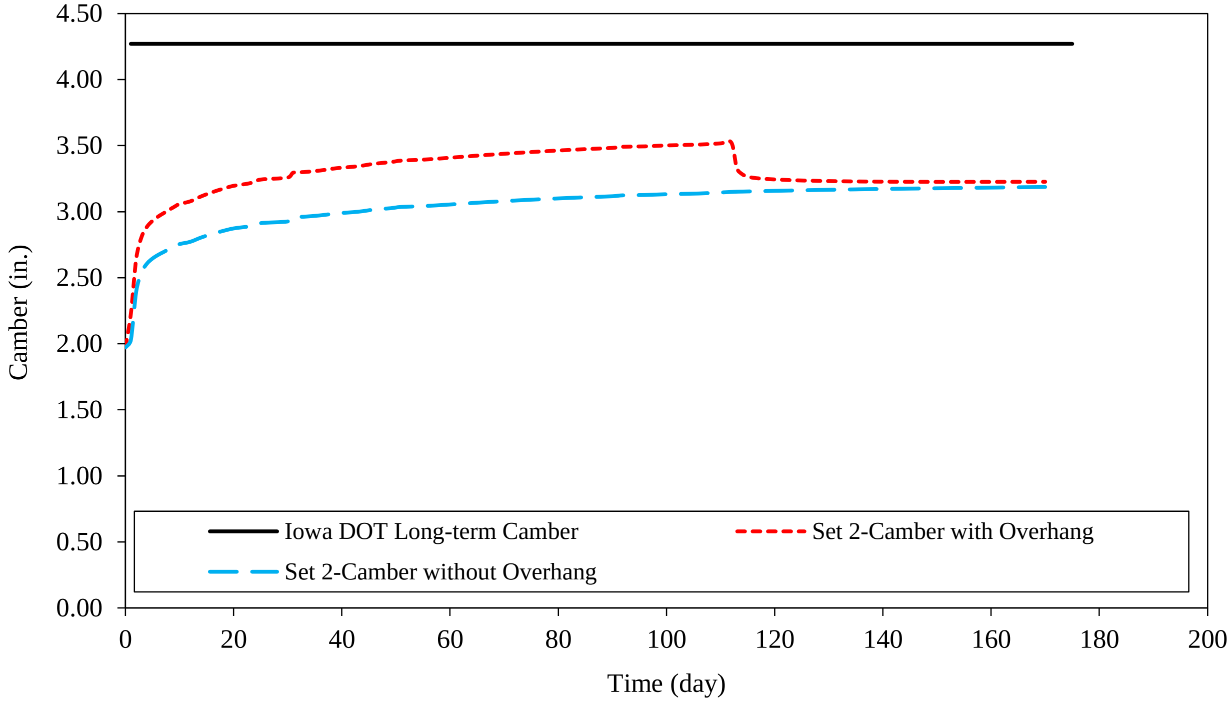


Figure I.17. Analytical camber curves for D 105 Set 2 PPCBs

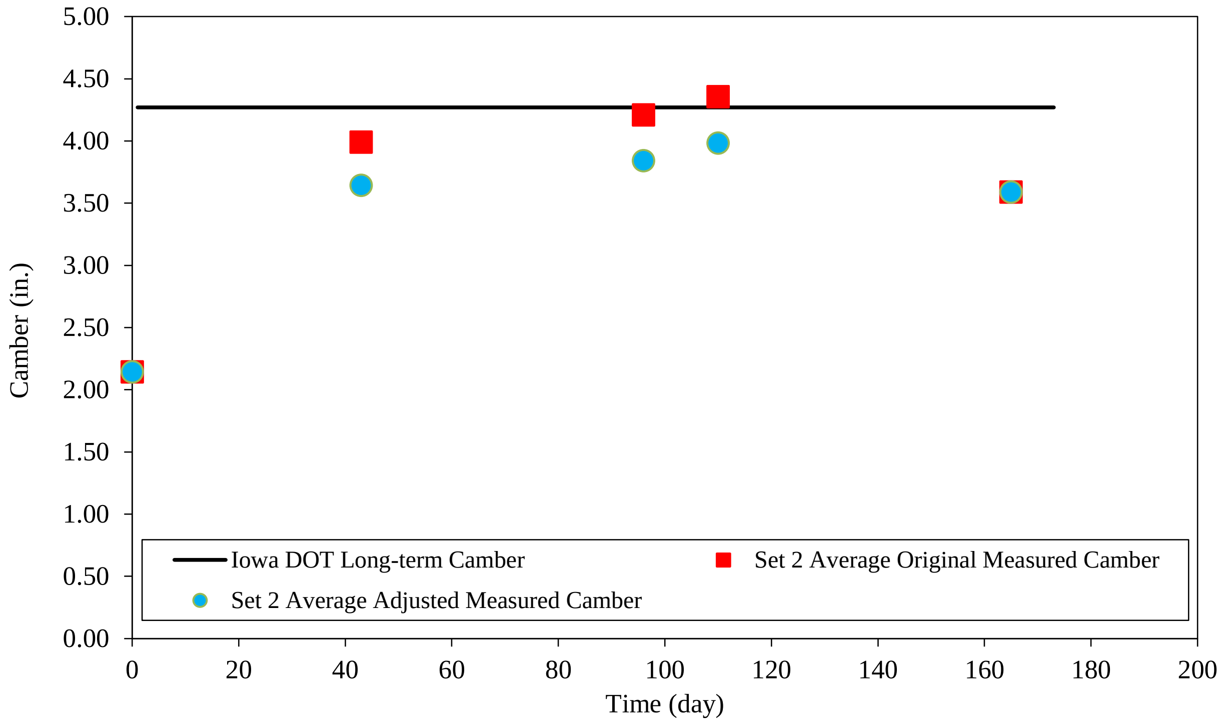


Figure I.18. Measured and adjusted data for D 105 Set 2 PPCBs

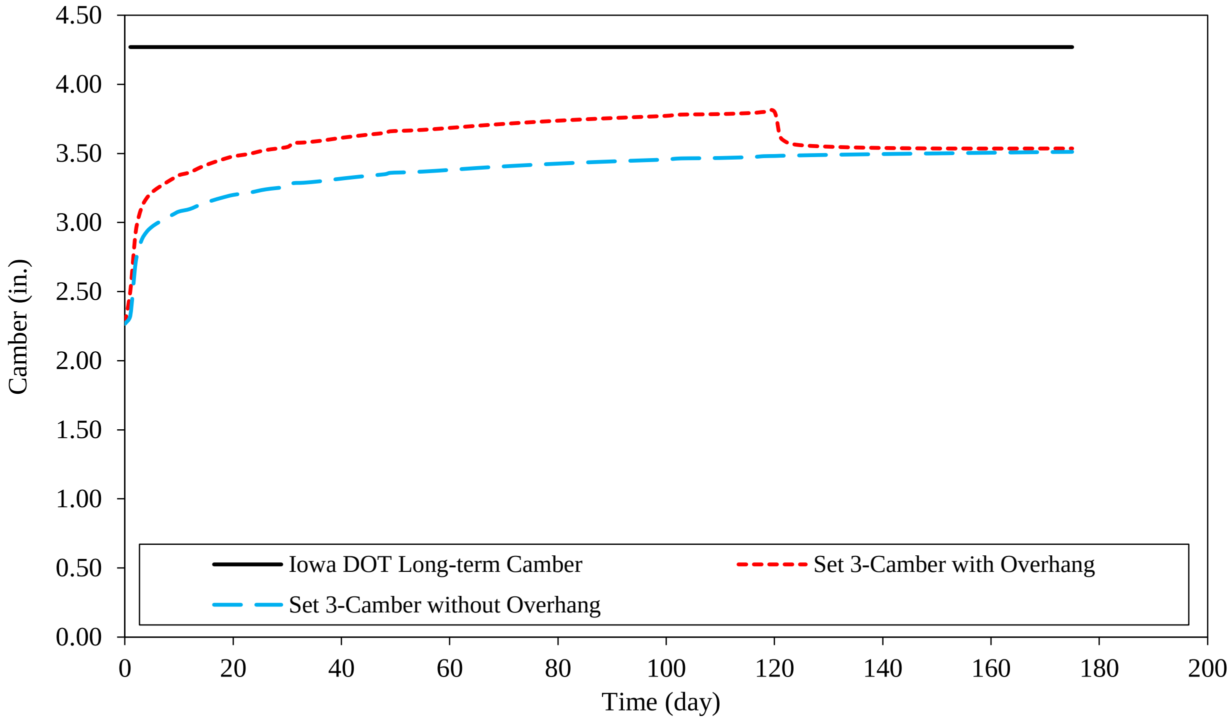


Figure I.19. Analytical camber curves for D 105 Set 3 PPCBs

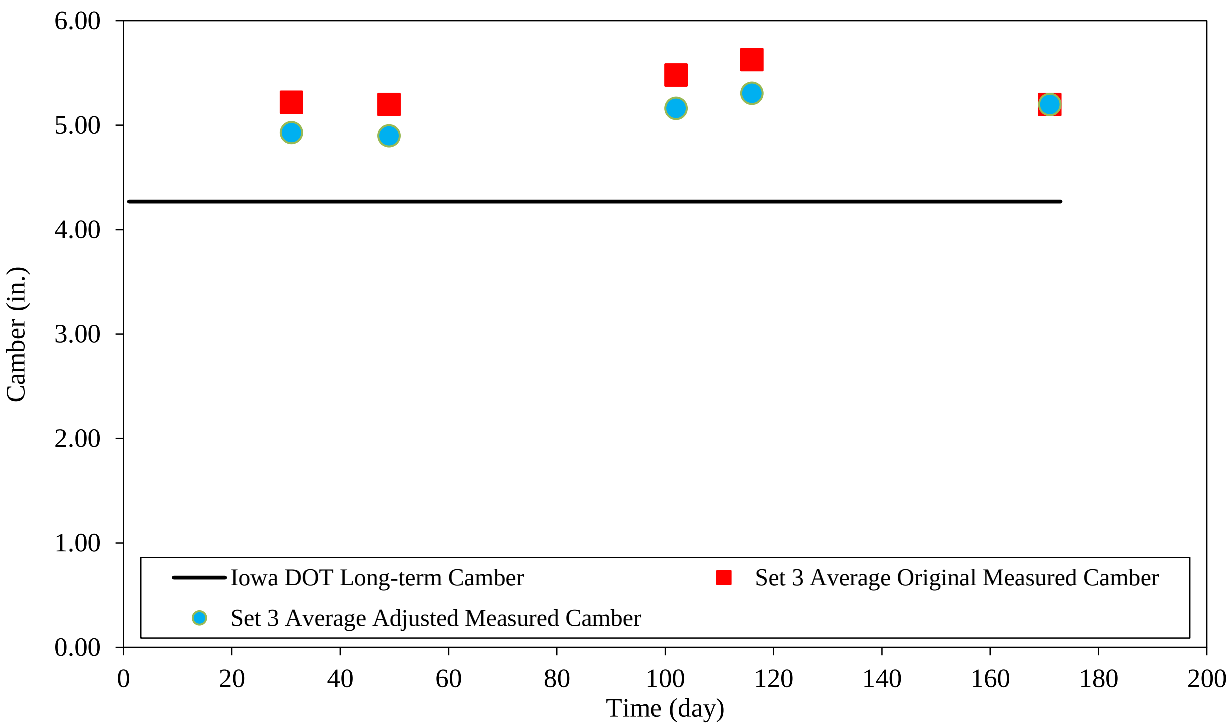


Figure I.20. Measured and adjusted data for D 105 Set 3 PPCBs

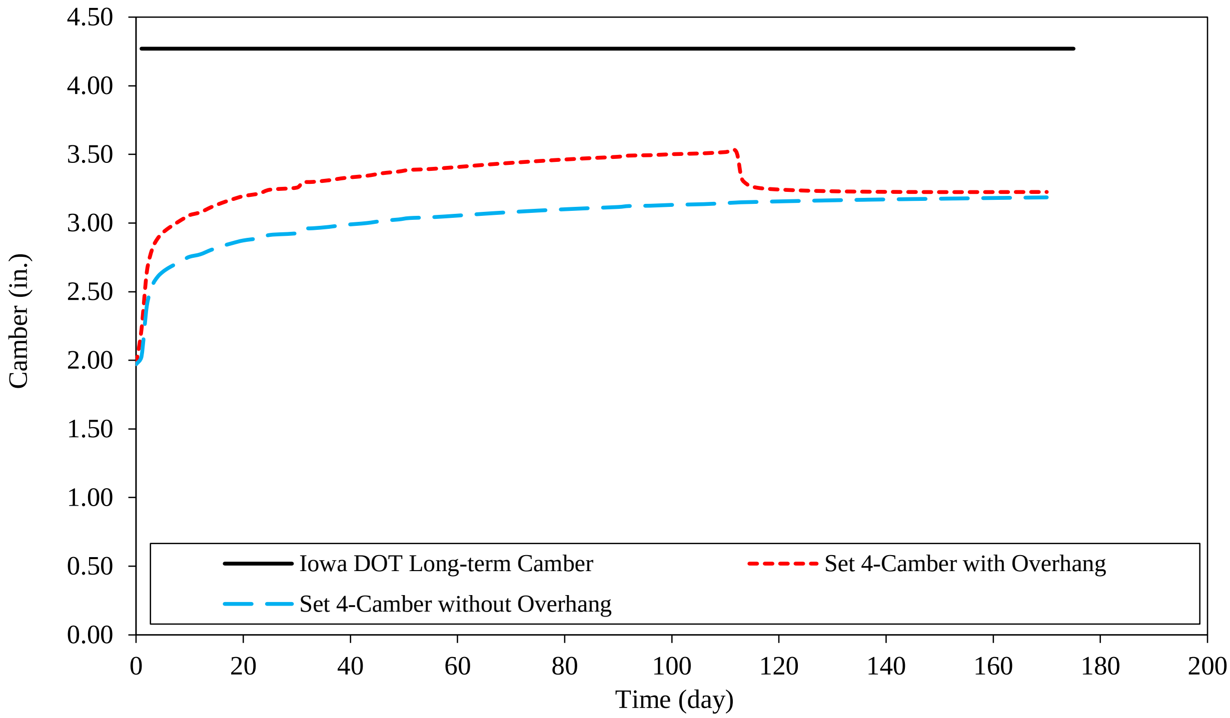


Figure I.21. Analytical camber curves for D 105 Set 4 PPCBs

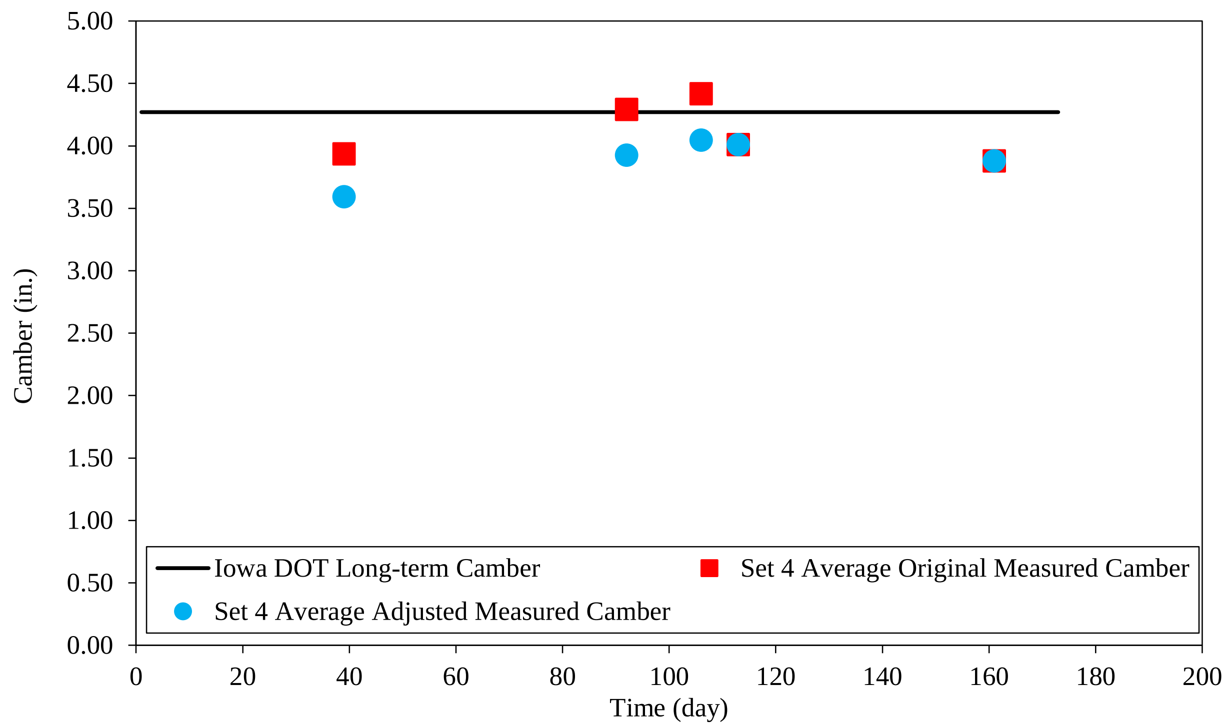


Figure I.22. Measured and adjusted data for D 105 Set 4 PPCBs

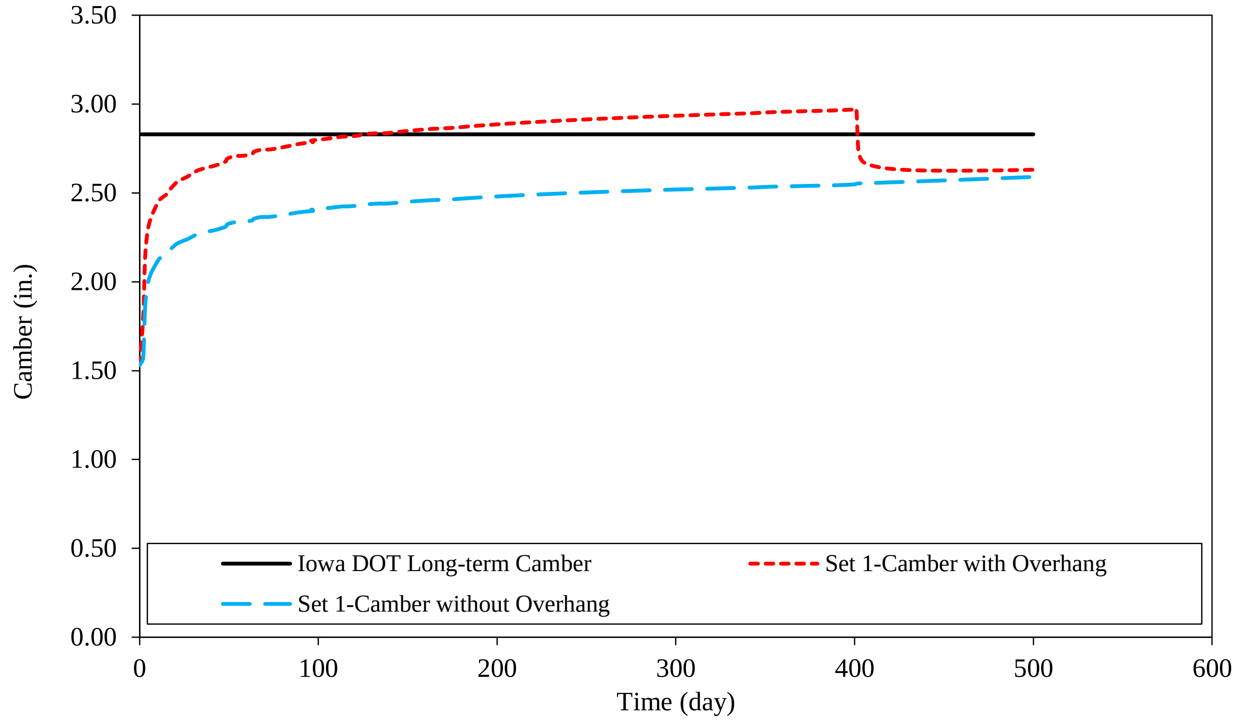


Figure I.23. Analytical camber curves for BTE 110 Set 1 PPCBs

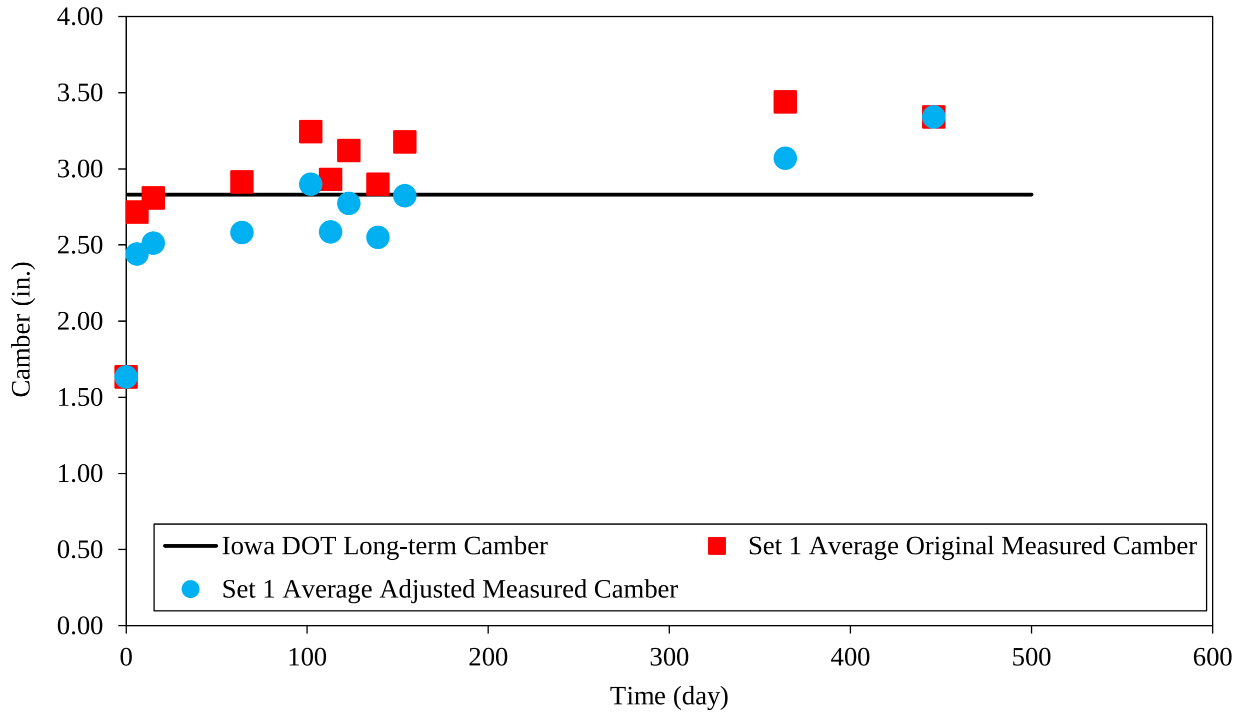


Figure I.24. Measured and adjusted data for BTE 110 Set 1 PPCBs

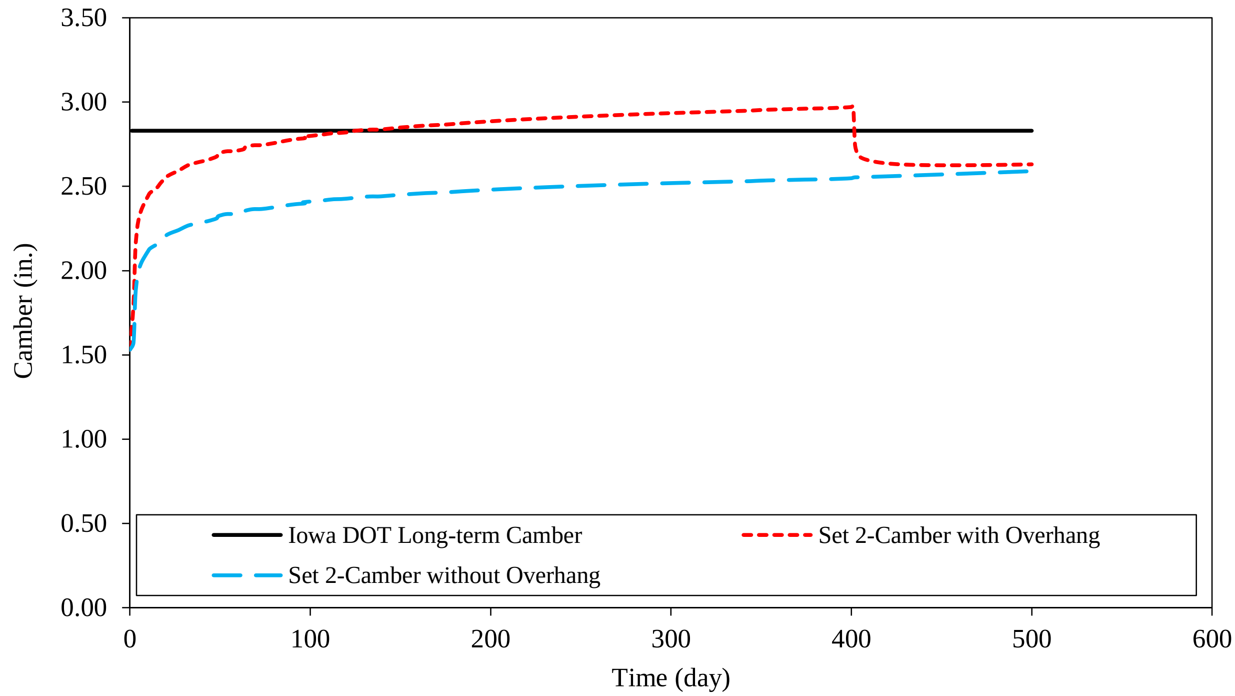


Figure I.25. Analytical camber curves for BTE 110 Set 2 PPCBs

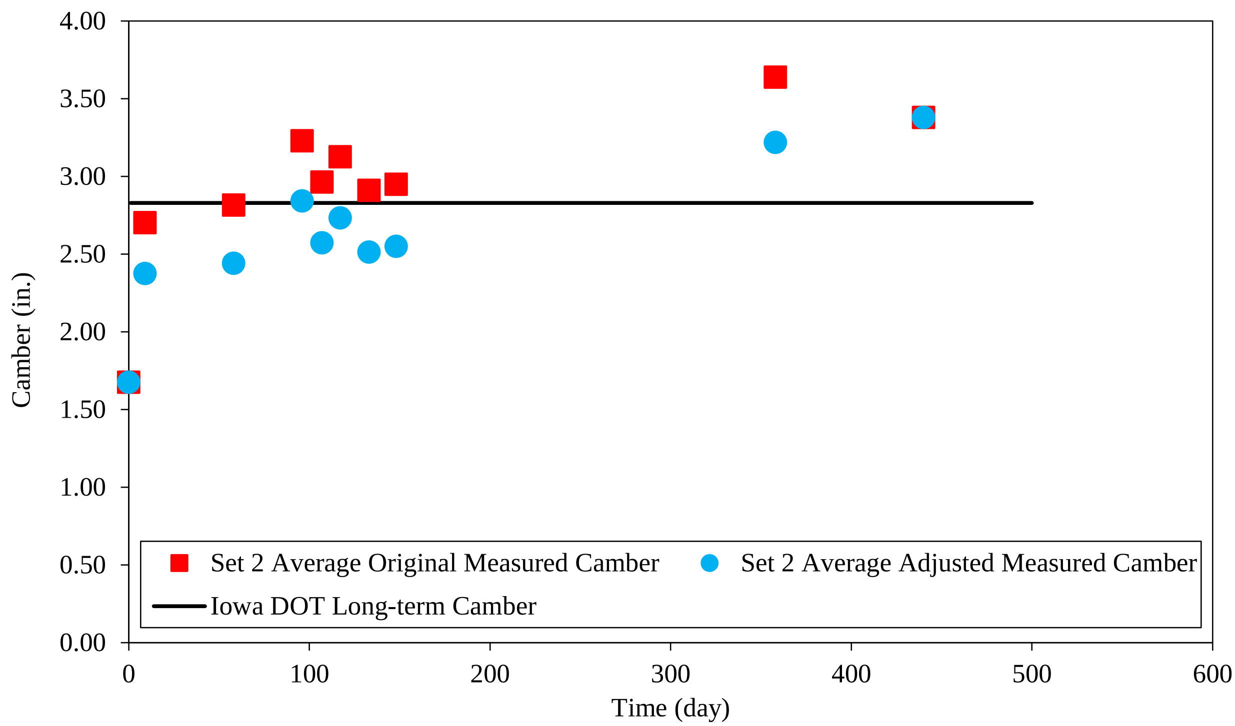


Figure I.26. Measured and adjusted data for BTE 110 Set 2 PPCBs

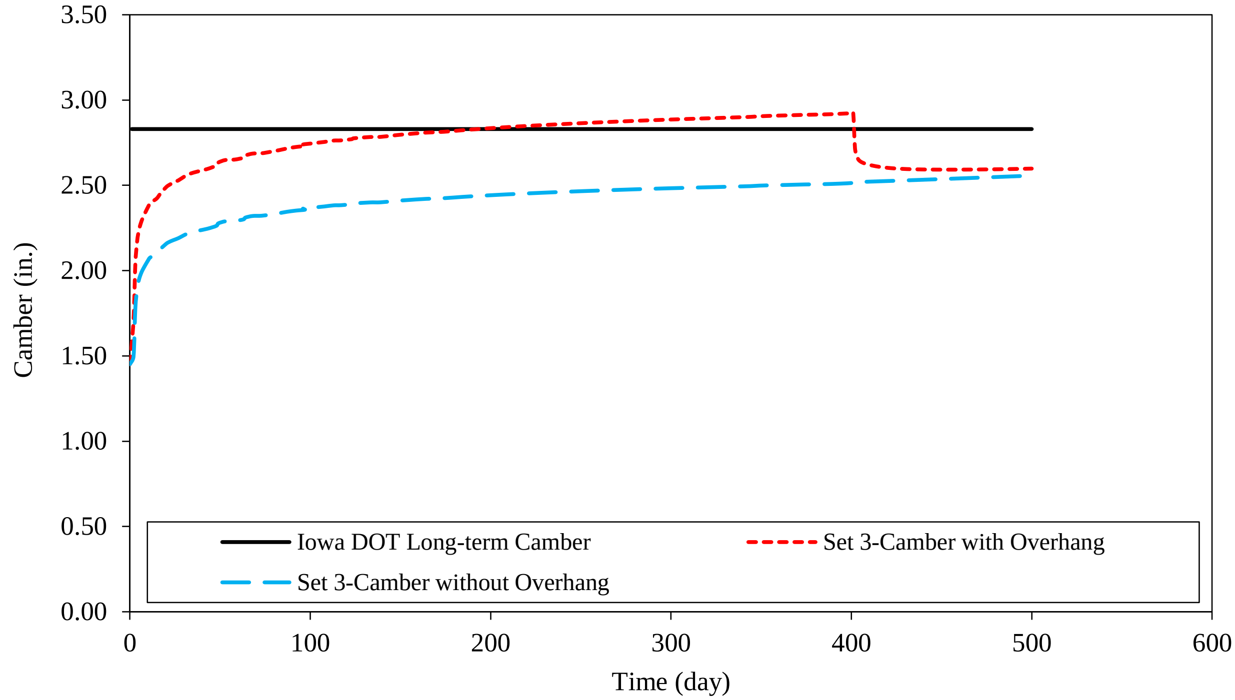


Figure I.27. Analytical camber curves for BTE 110 Set 3 PPCBs

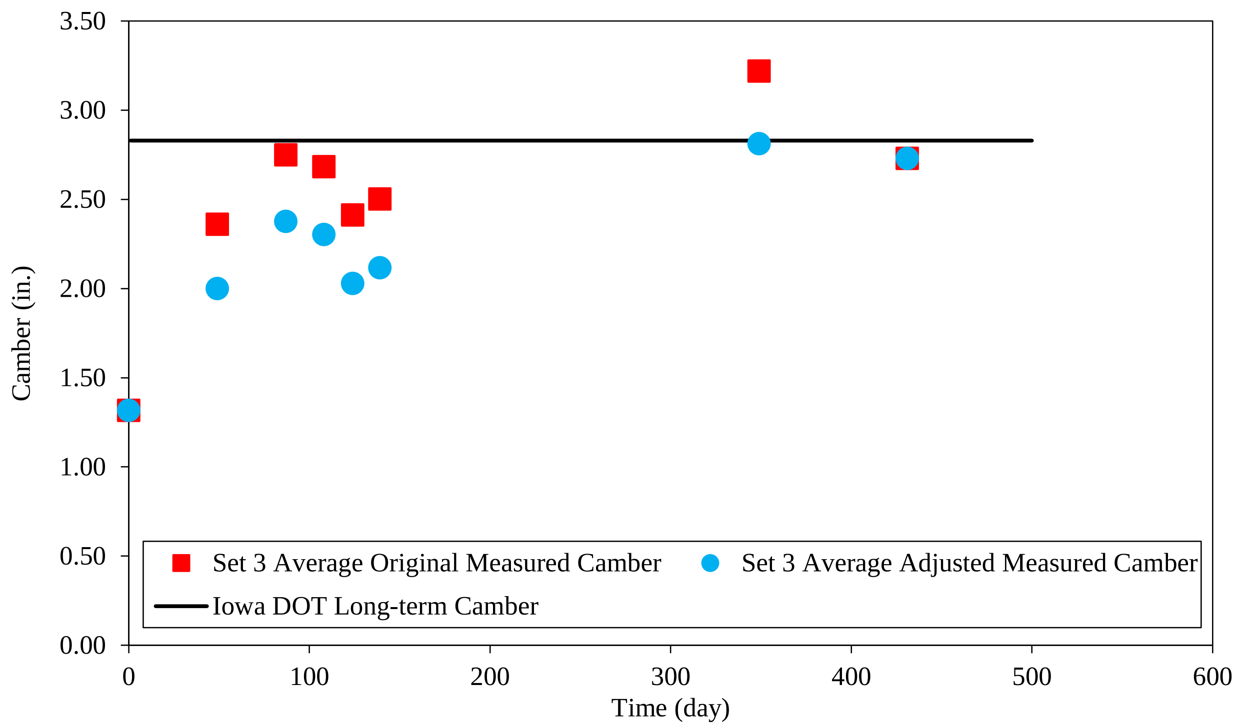


Figure I.28. Measured and adjusted data for BTE 110 Set 3 PPCBs

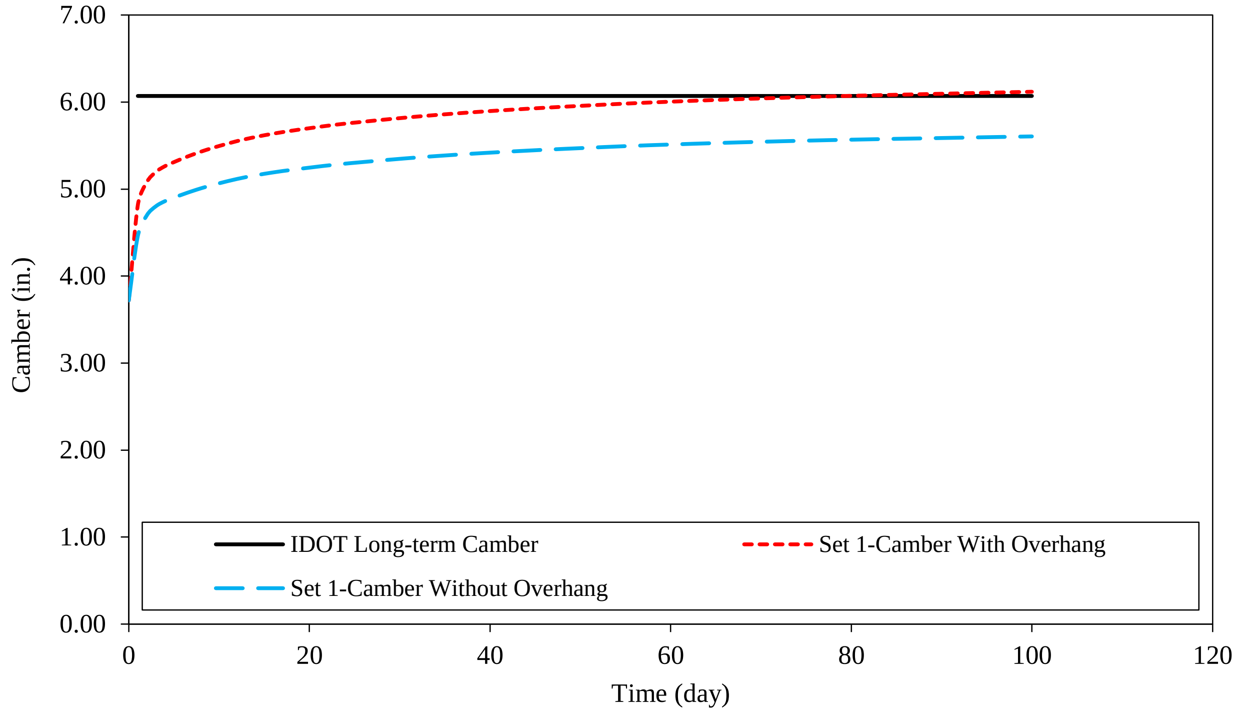


Figure I.29. Analytical camber curves for BTC 120 Set 1 PPCBs

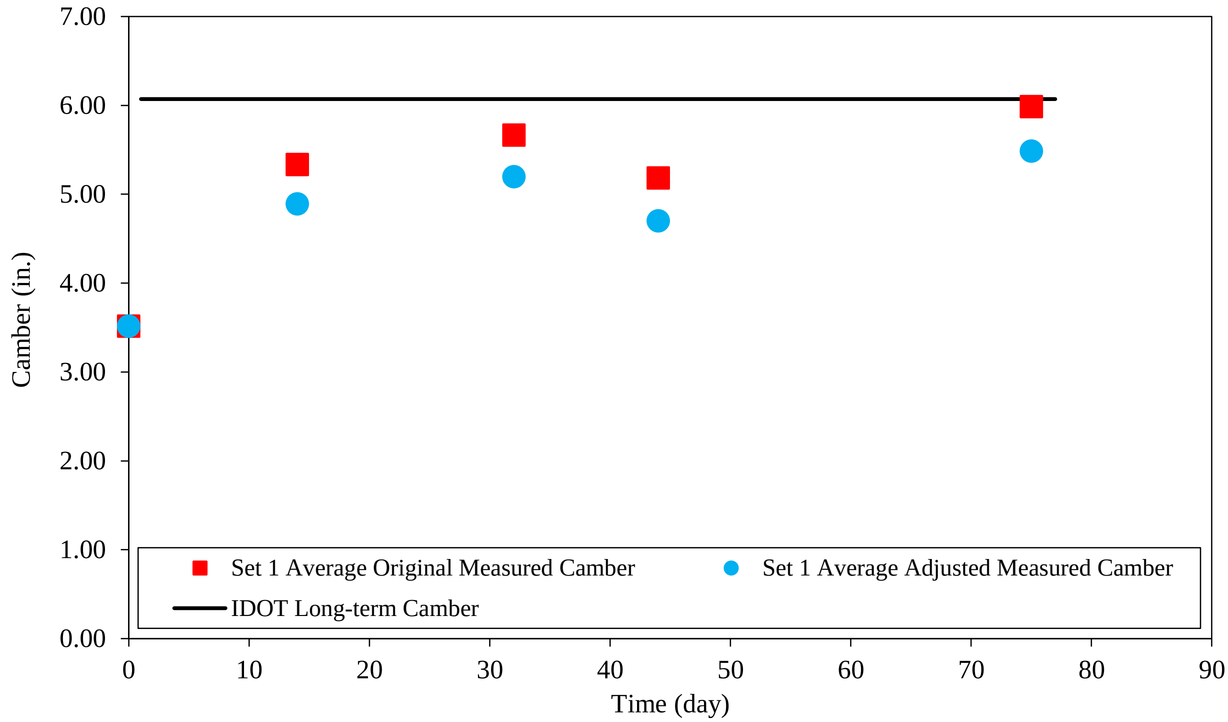


Figure I.30. Measured and adjusted data for BTC 120 Set 1 PPCBs

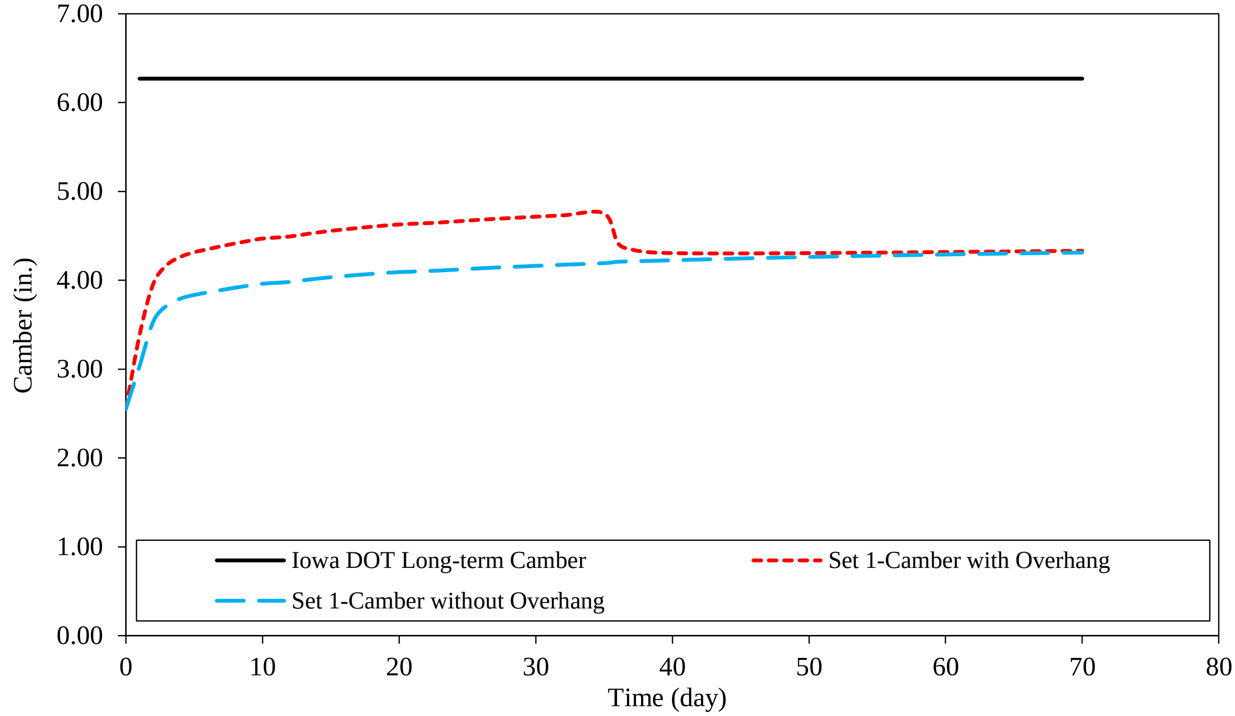


Figure I.31. Analytical camber curves for BTD 135 Set 1 PPCBs

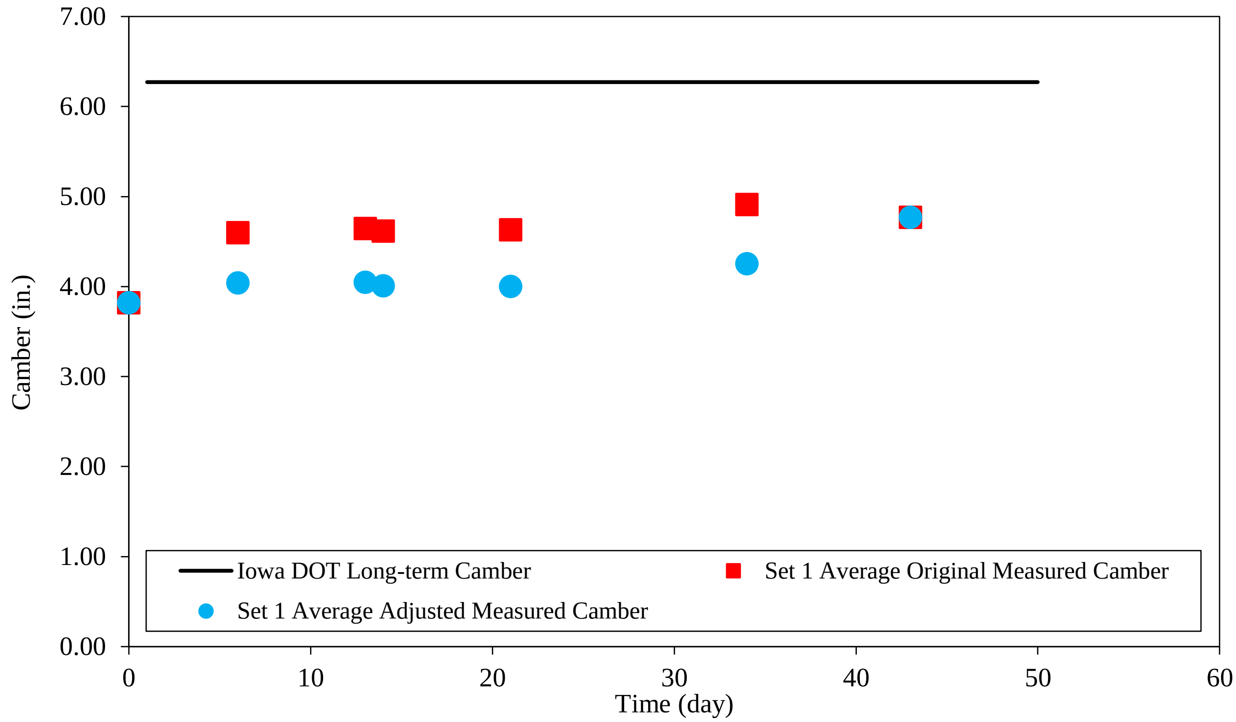


Figure I.32. Measured and adjusted data for BTD 135 Set 1 PPCBs

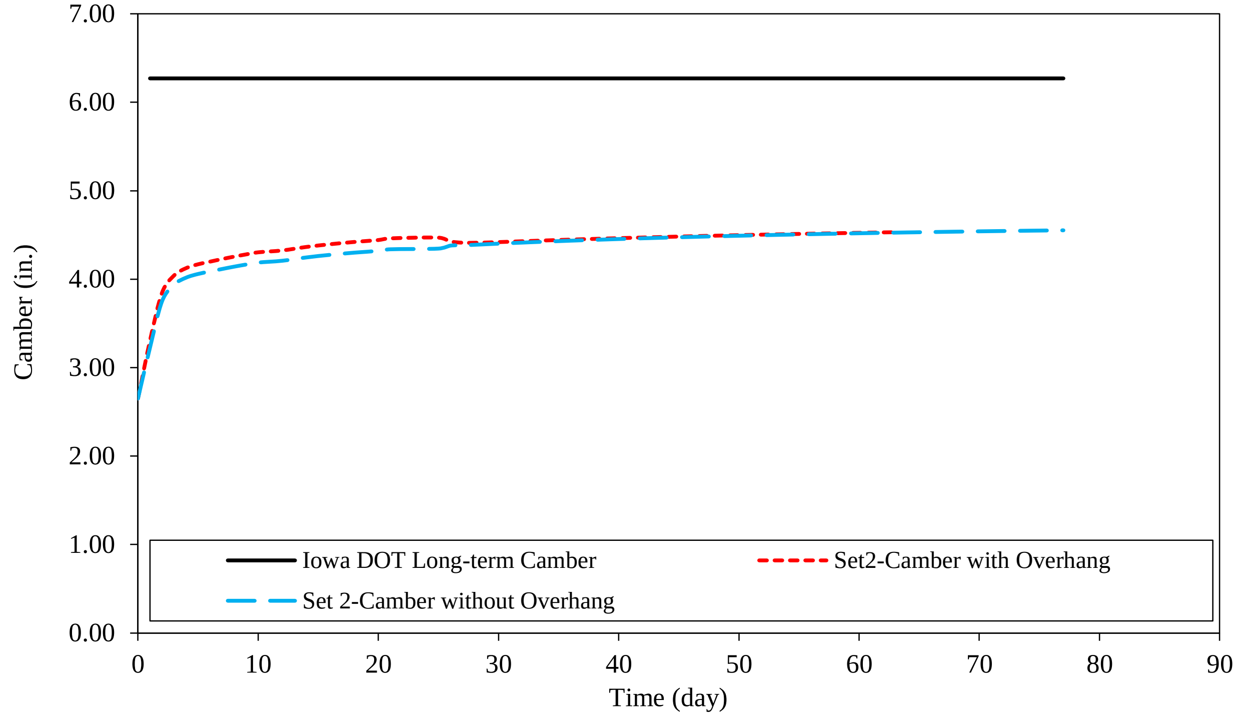


Figure I.33. Analytical camber curves for BTD 135 Set 2 PPCBs

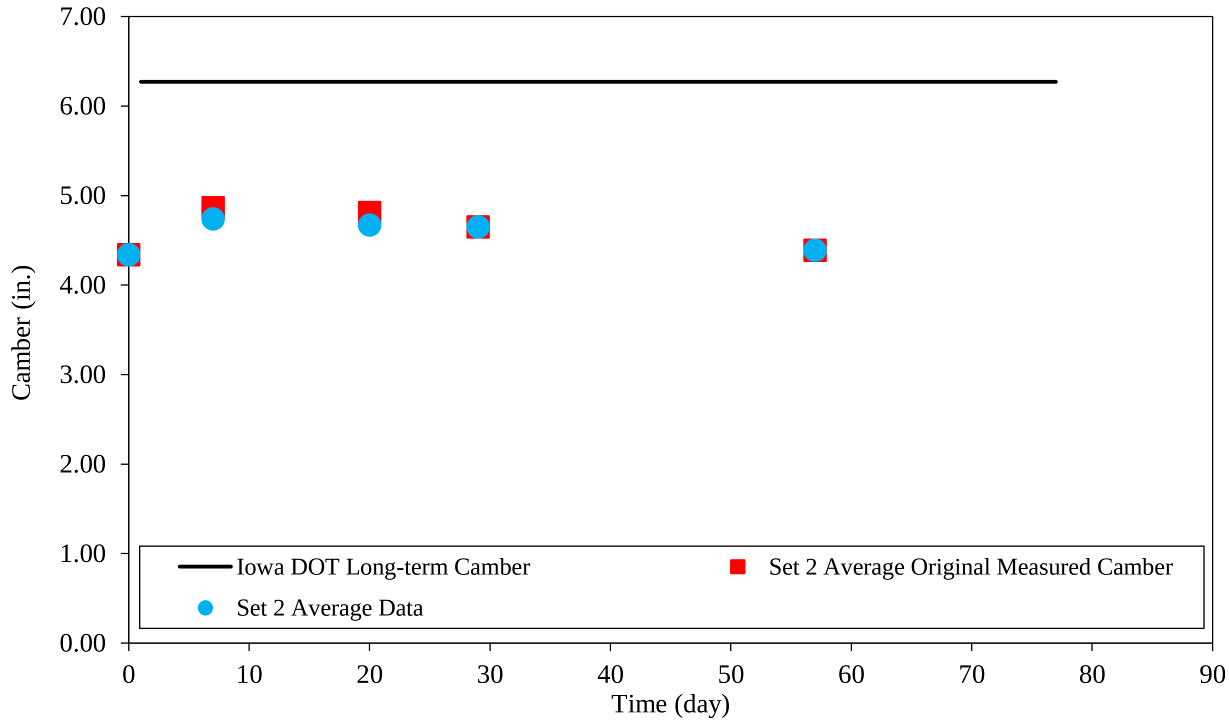


Figure I.34. Measured and adjusted data for BTD 135 Set 2 PPCBs

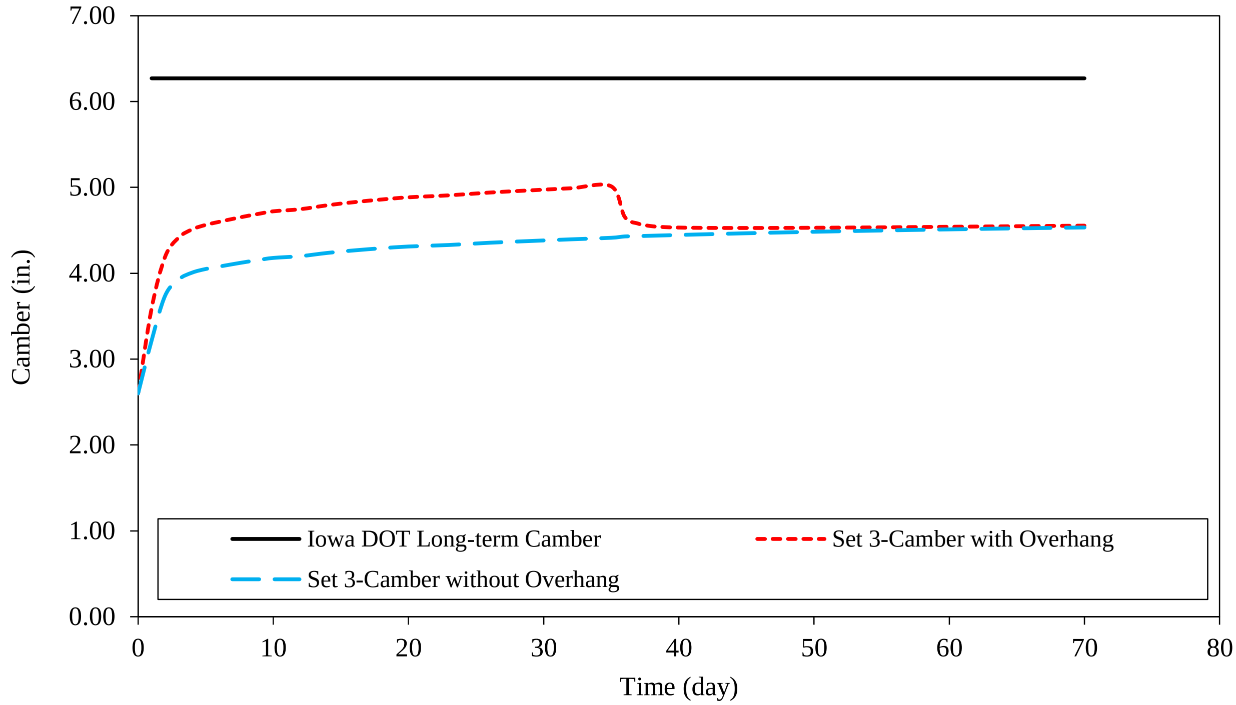


Figure I.35. Analytical camber curves for BTD 135 Set 3 PPCBs

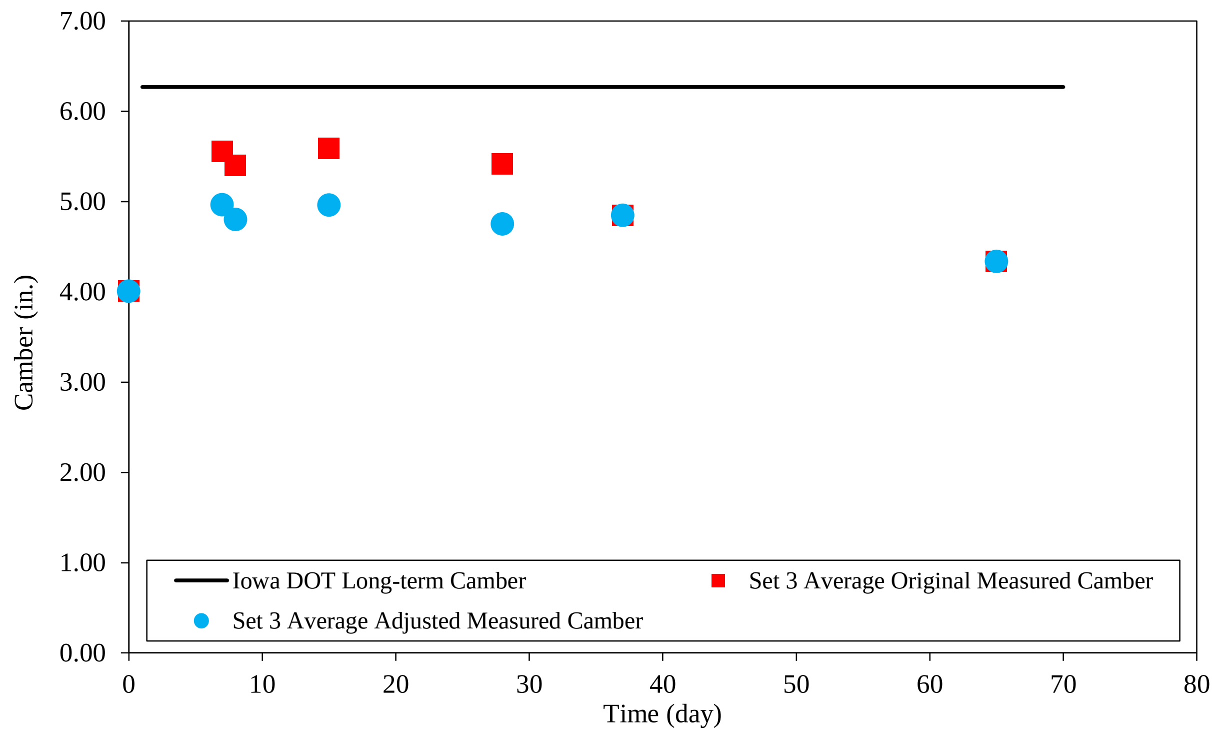


Figure I.36. Measured and adjusted data for BTD 135 Set 3 PPCBs

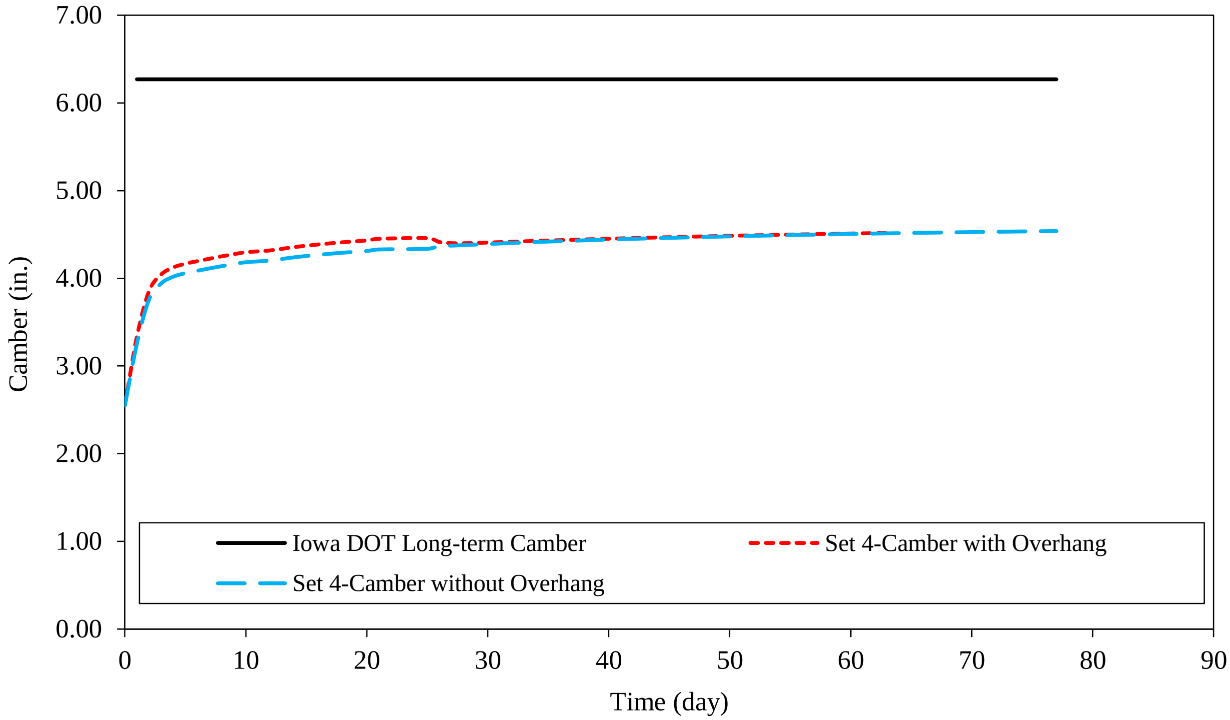


Figure I.37. Analytical camber curves for BTD 135 Set 4 PPCBs

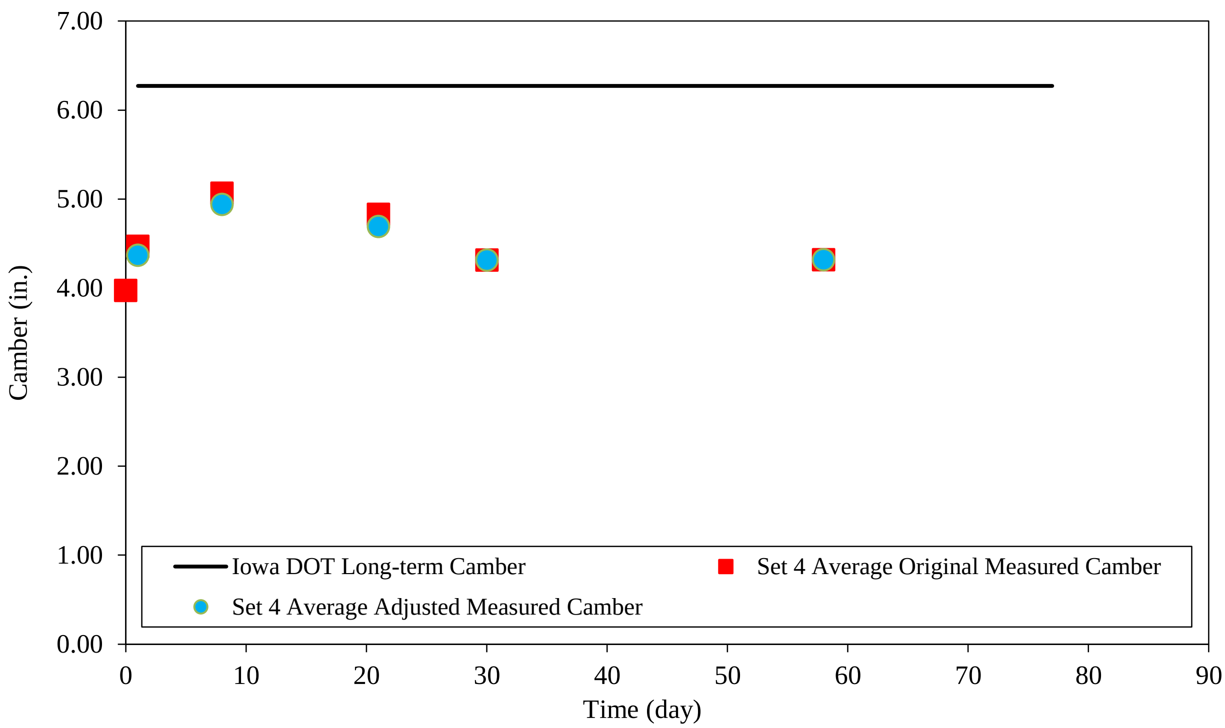


Figure I.38. Measured and adjusted data for BTD 135 Set 4 PPCBs

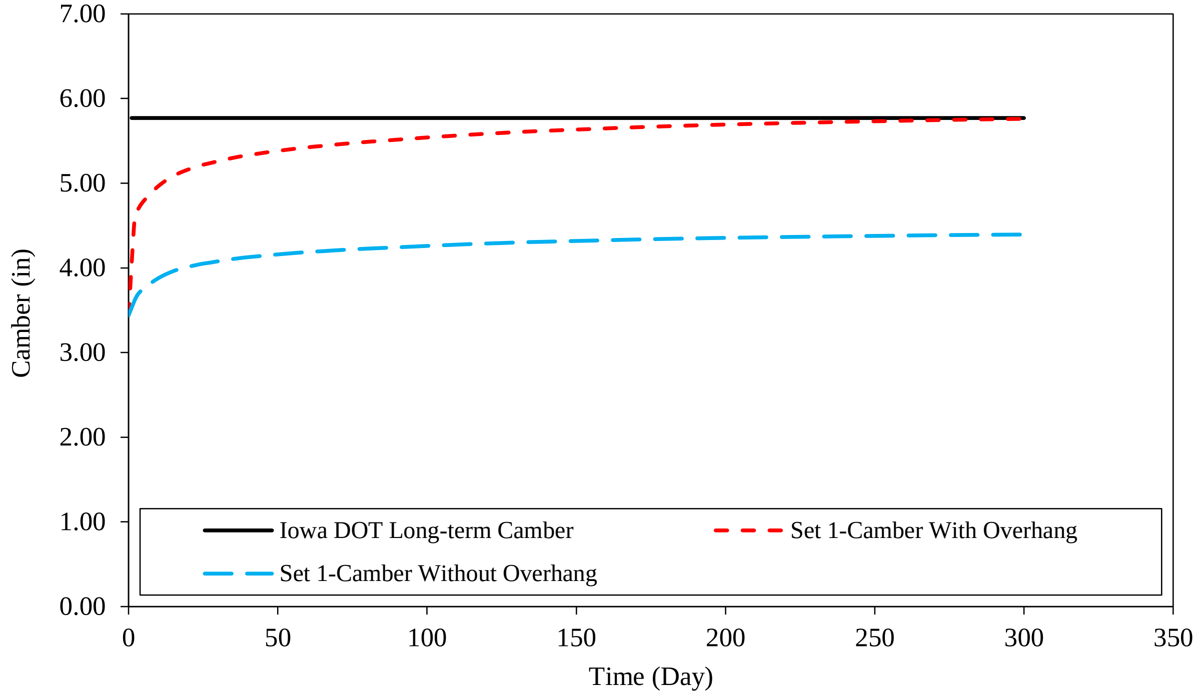


Figure I.39. Analytical camber curves for BTE 145 Set 1 PPCBs

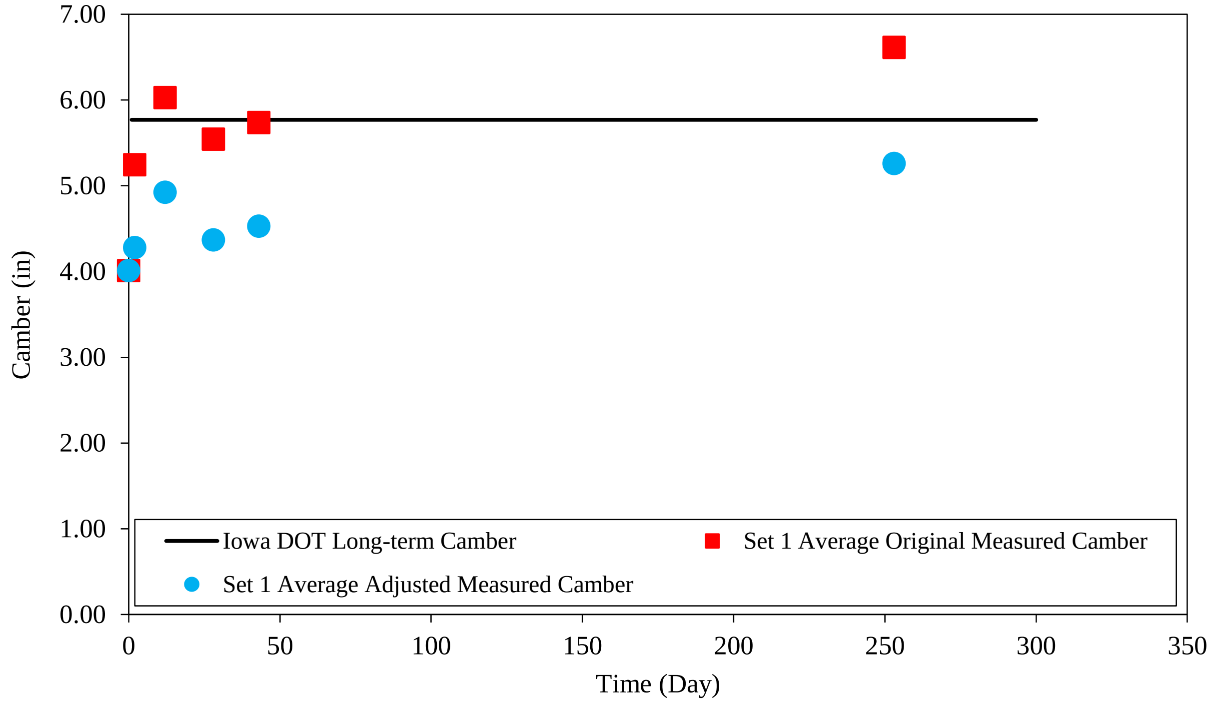


Figure I.40. Measured and adjusted data for BTE 145 Set 1 PPCBs

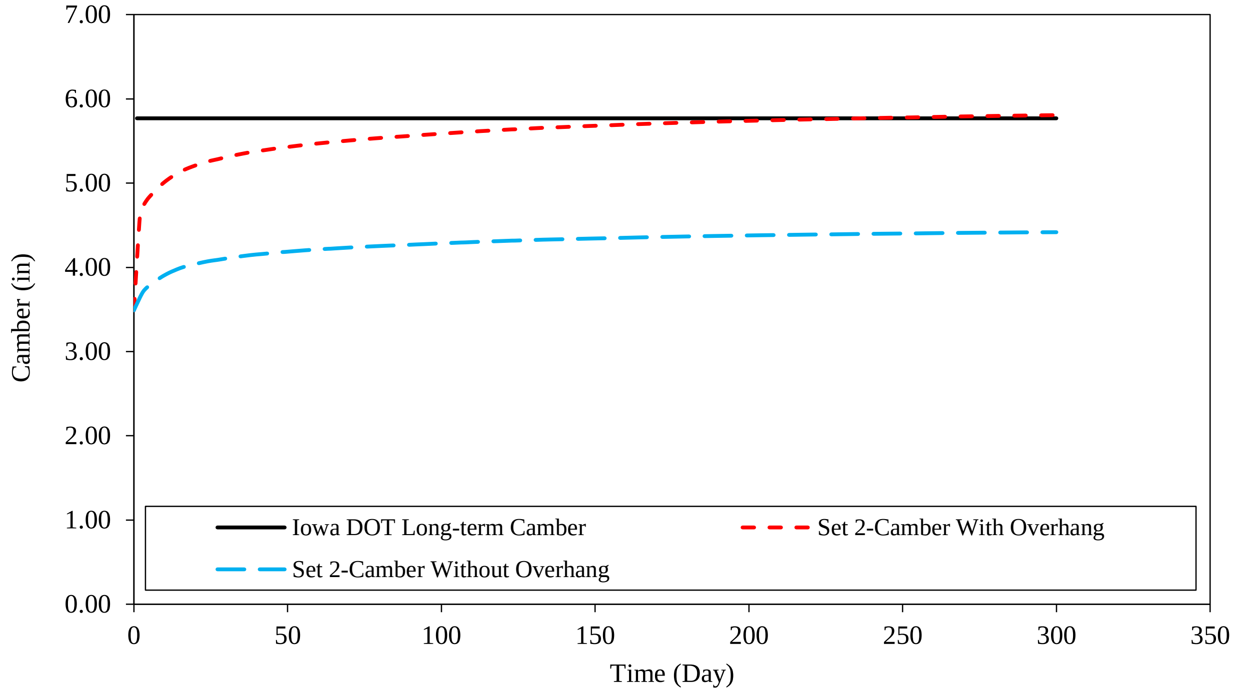


Figure I.41. Analytical camber curves for BTE 145 Set 2 PPCBs

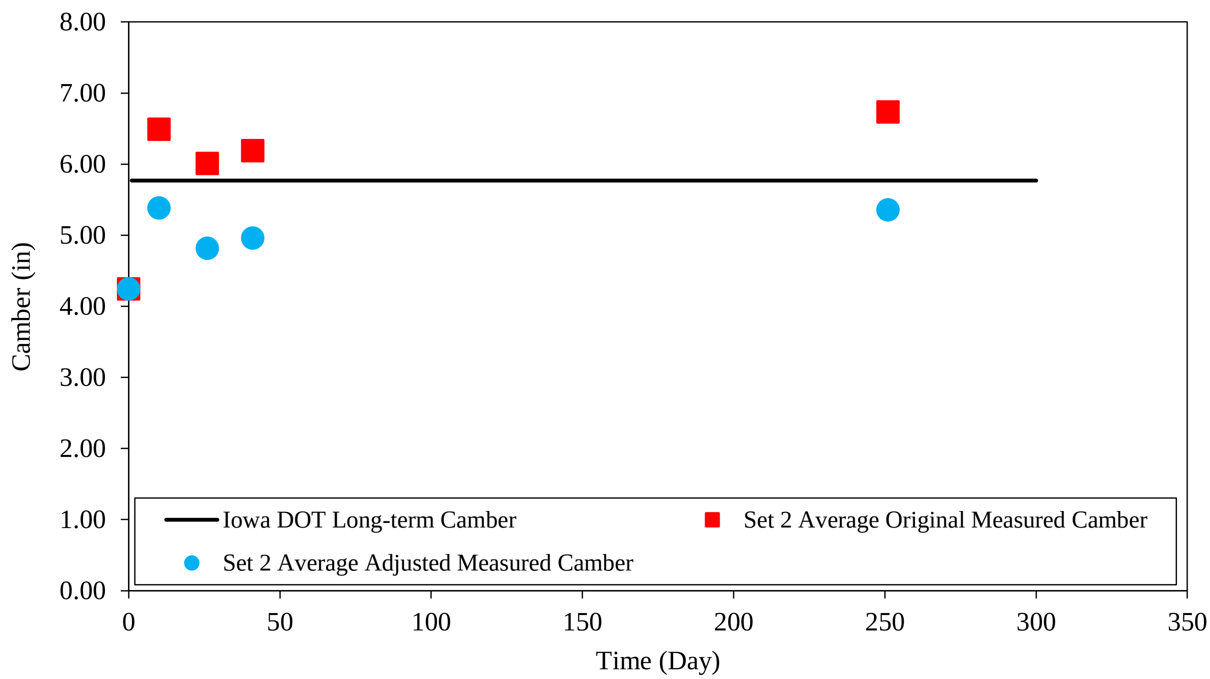


Figure I.42. Measured and adjusted data for BTE 145 Set 2 PPCBs

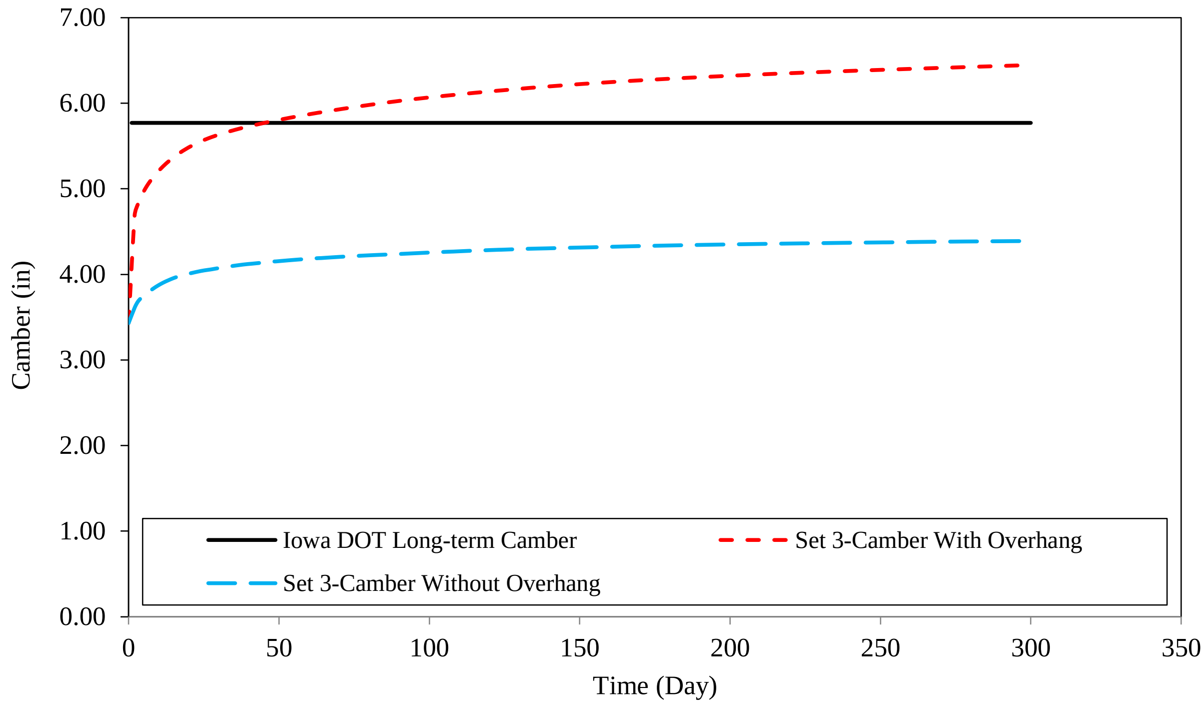


Figure I.43. Analytical camber curves for BTE 145 Set 3 PPCBs

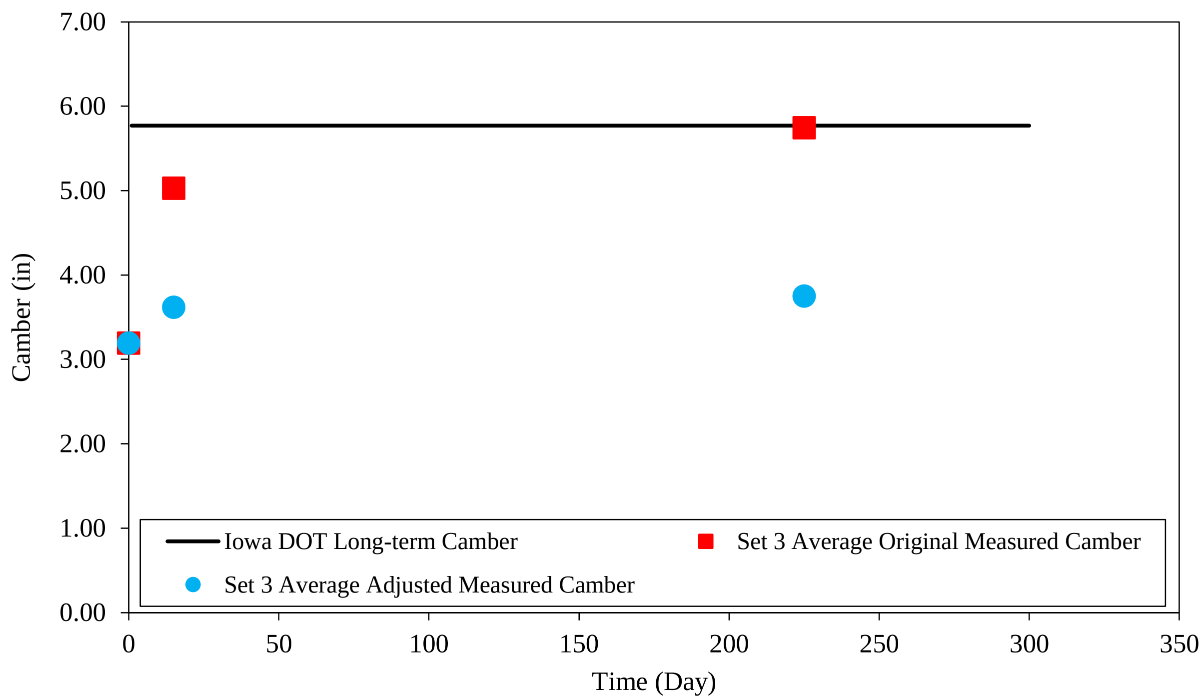


Figure I.44. Measured and adjusted data for BTE 145 Set 3 PPCBs

APPENDIX J. LONG-TERM CAMBER PREDICTIONS WITH THERMAL EFFECTS USING FEA

For the different sets of PPCBs, the analytical camber curves with the temperature differences of zero, 15 °F, and 25 °F for the condition of zero overhang length are compared to the measured long-term camber data and the predicted long-term camber by the Iowa DOT in this appendix.

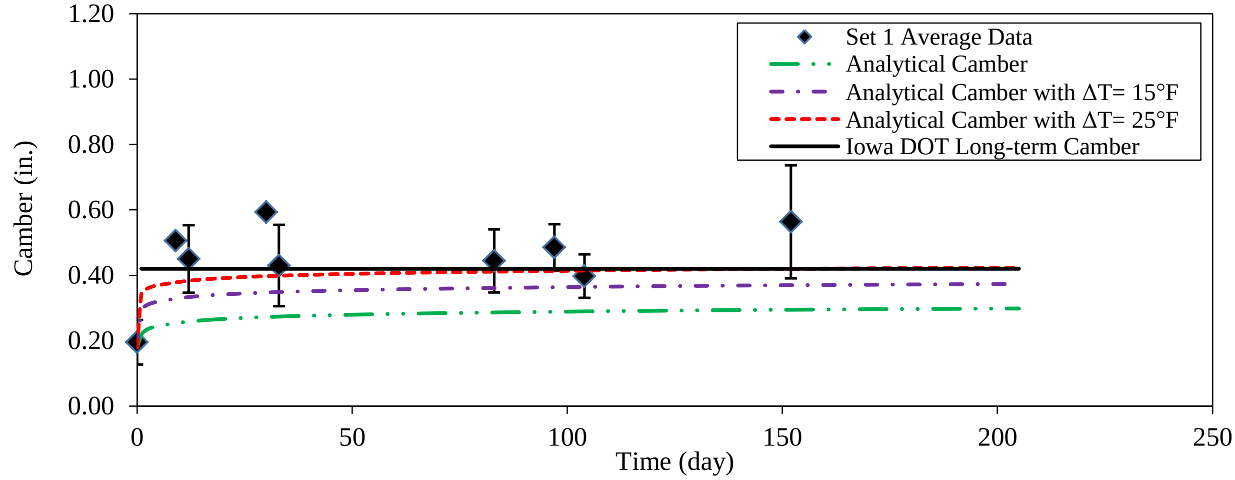


Figure J.1. Prediction of long-term camber for D 55 Set 1 PPCBs

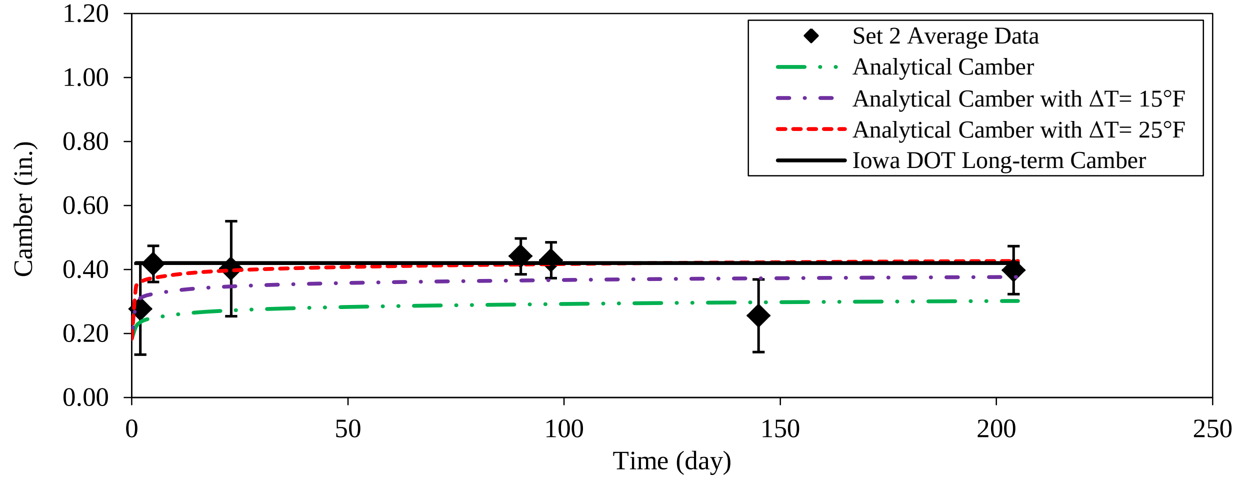


Figure J.2. Prediction of long-term camber for D 55 Set 2 PPCBs

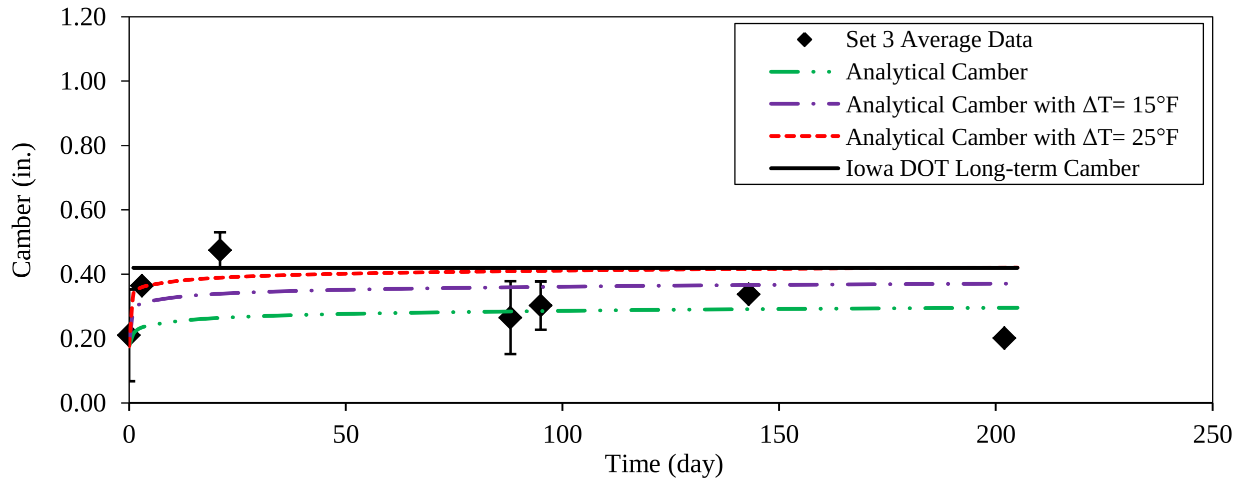


Figure J.3. Prediction of long-term camber for D 55 Set 3 PPCBs

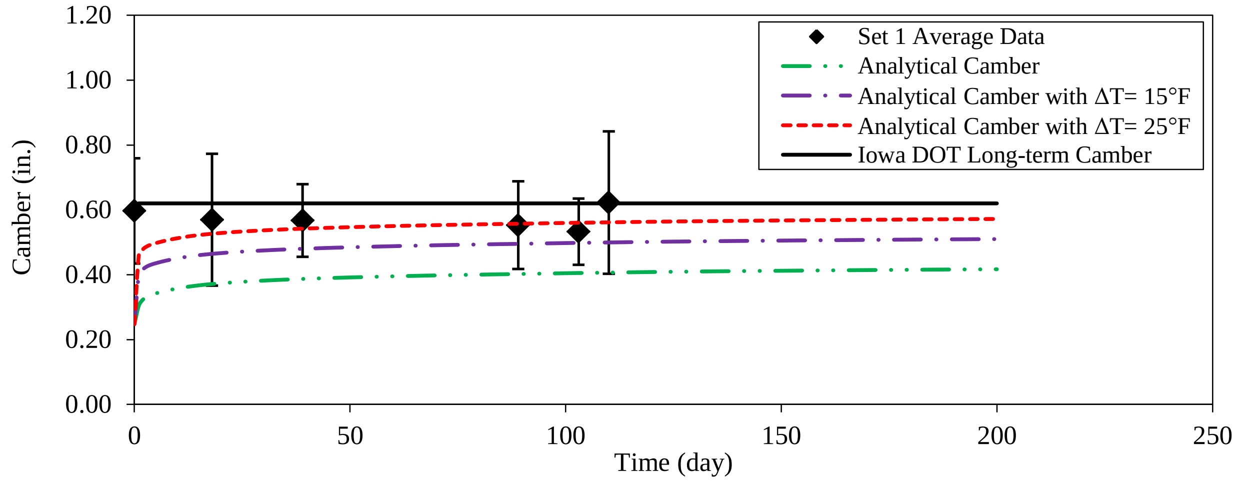


Figure J.4. Prediction of long-term camber for D 60 Set 1 PPCBs

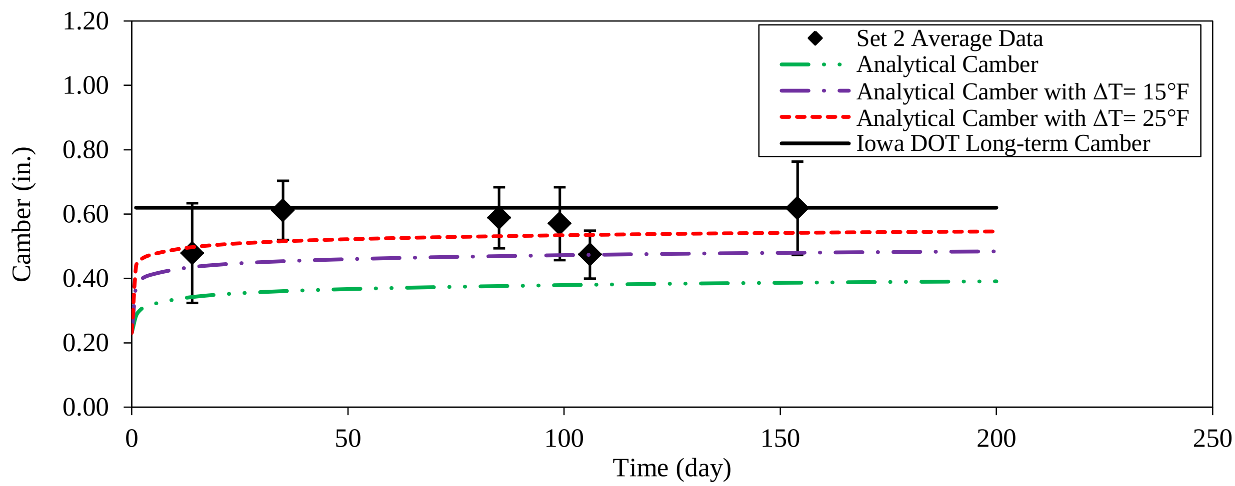


Figure J.5. Prediction of long-term camber for D 60 Set 2 PPCBs

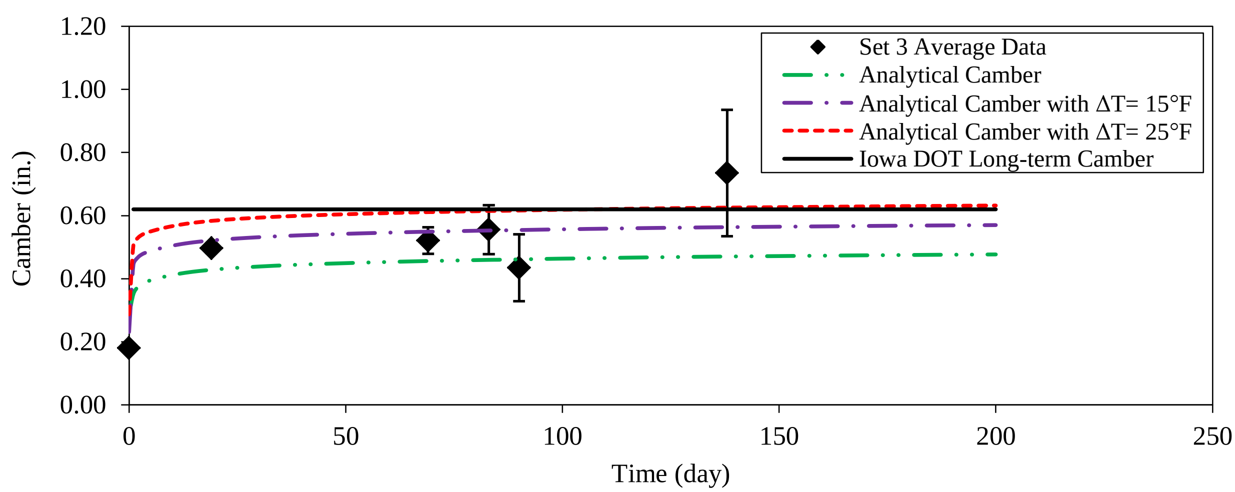


Figure J.6. Prediction of long-term camber for D 60 Set 3 PPCBs

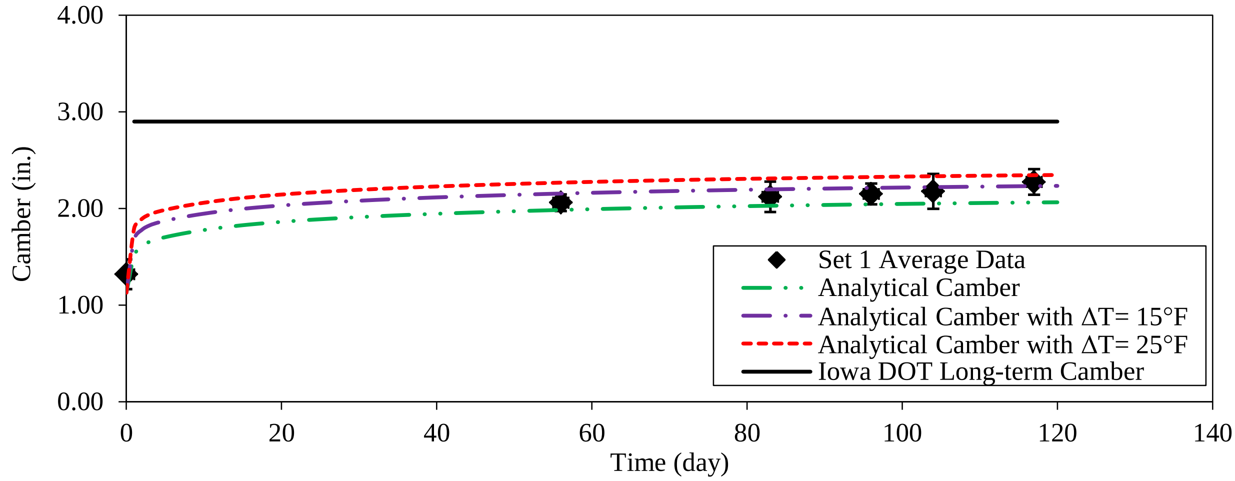


Figure J.7. Prediction of long-term camber for C 80 Set 1 PPCBs

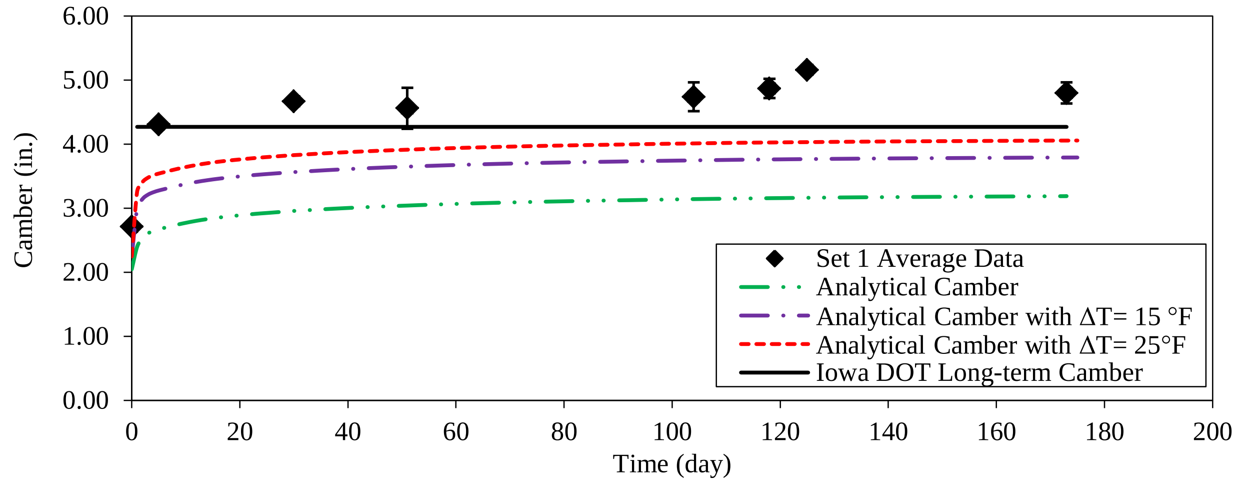


Figure J.8. Prediction of long-term camber for D 105 Set 1 PPCBs

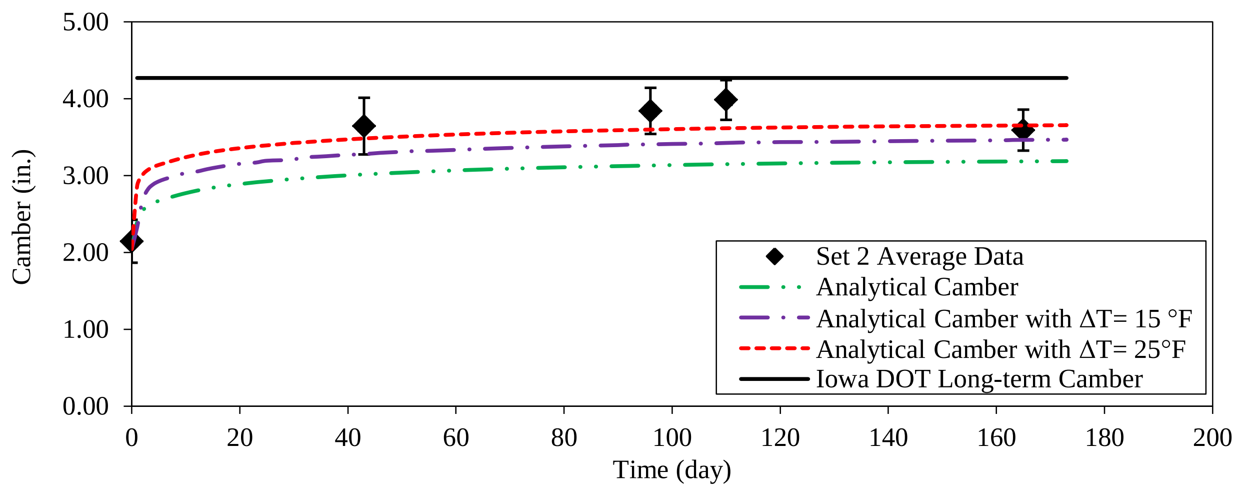


Figure J.9. Prediction of long-term camber for D 105 Set 2 PPCBs

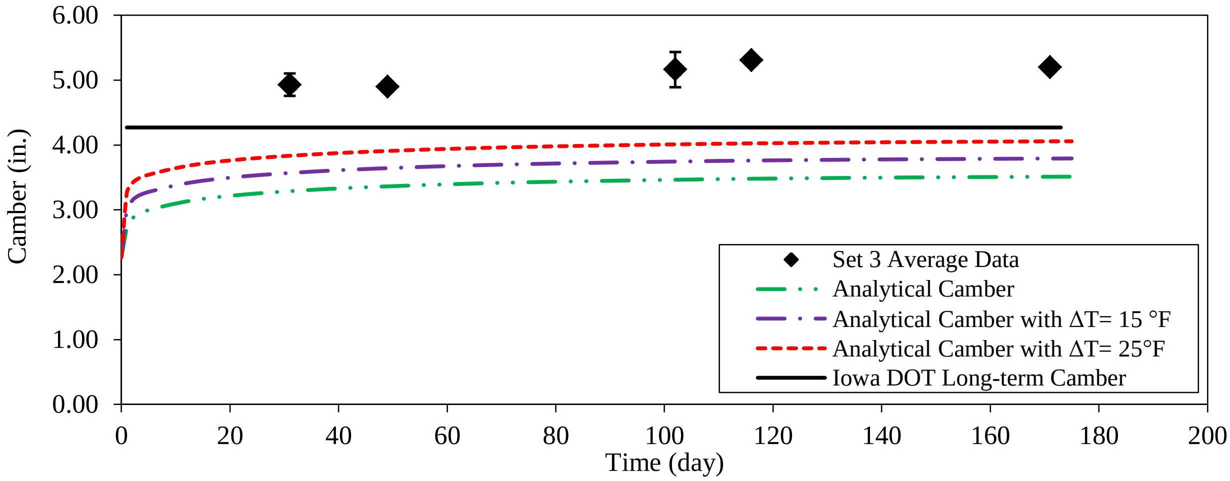


Figure J.10. Prediction of long-term camber for D 105 Set 3 PPCBs

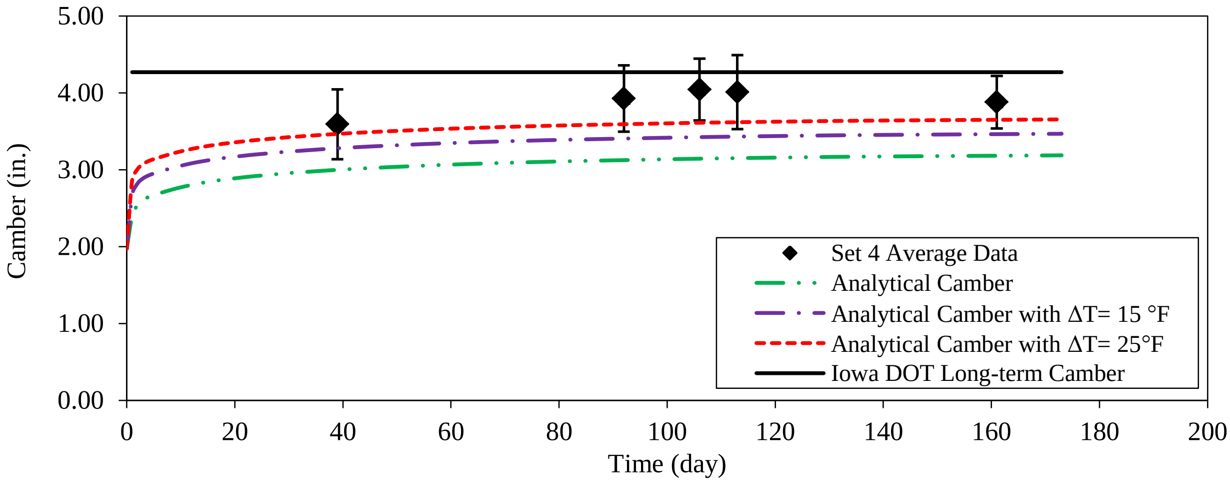


Figure J.11. Prediction of long-term camber for D 105 Set 4 PPCBs

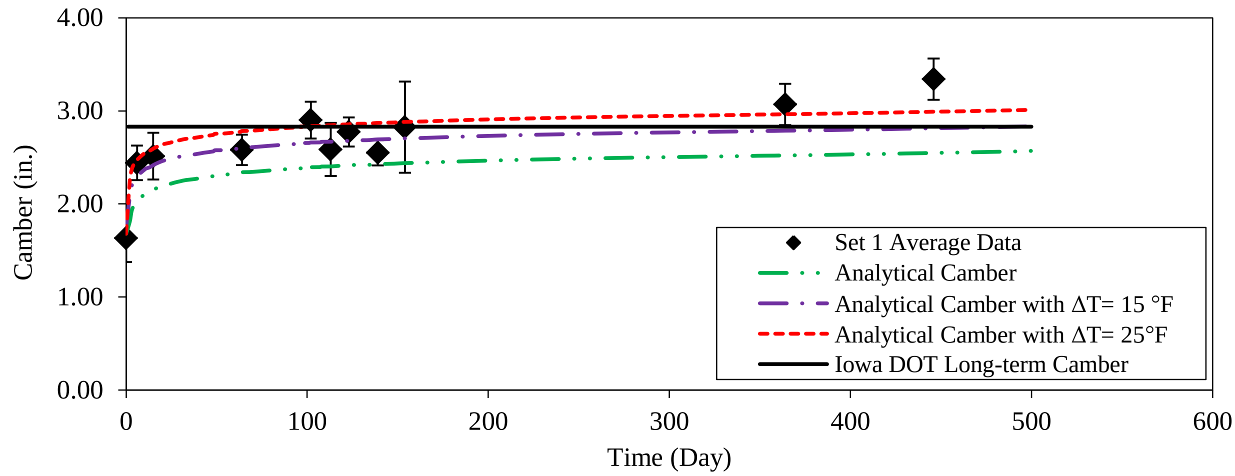


Figure J.12. Prediction of long-term camber for BTE 110 Set 1 PPCBs

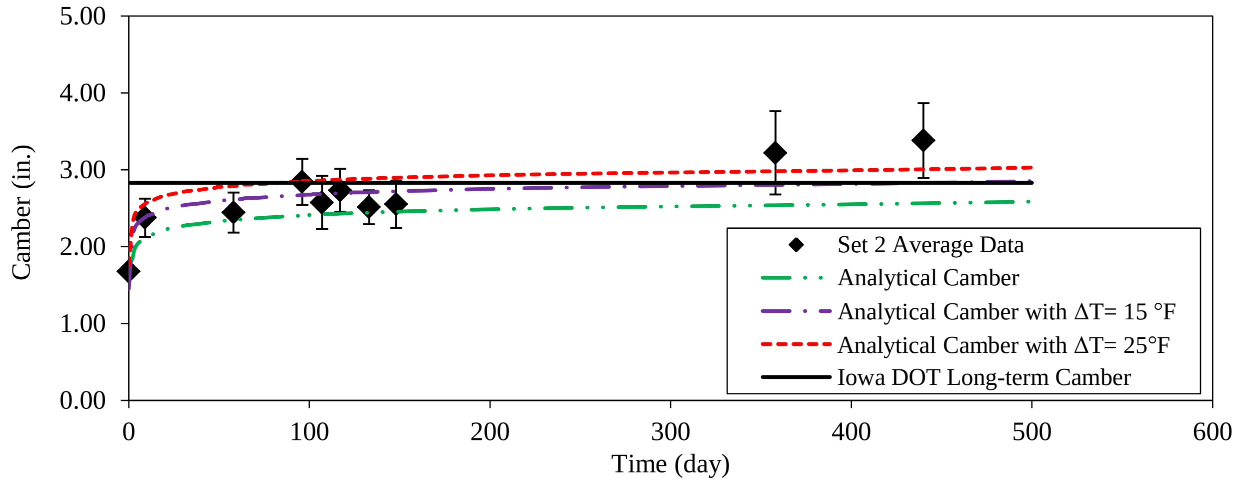


Figure J.13. Prediction of long-term camber for BTE 110 Set 2 PPCBs

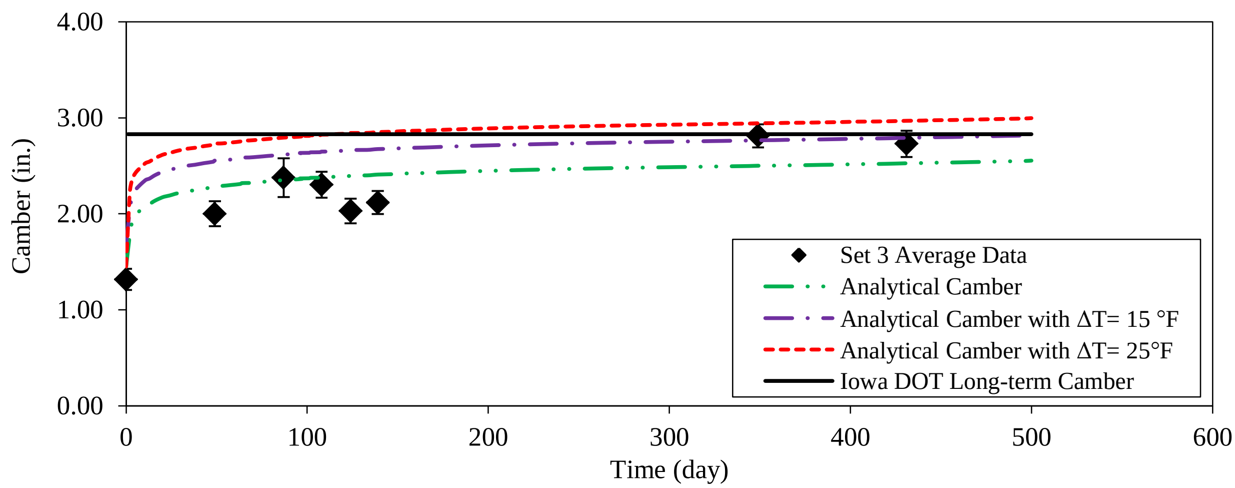


Figure J.14. Prediction of long-term camber for BTE 110 Set 3 PPCBs

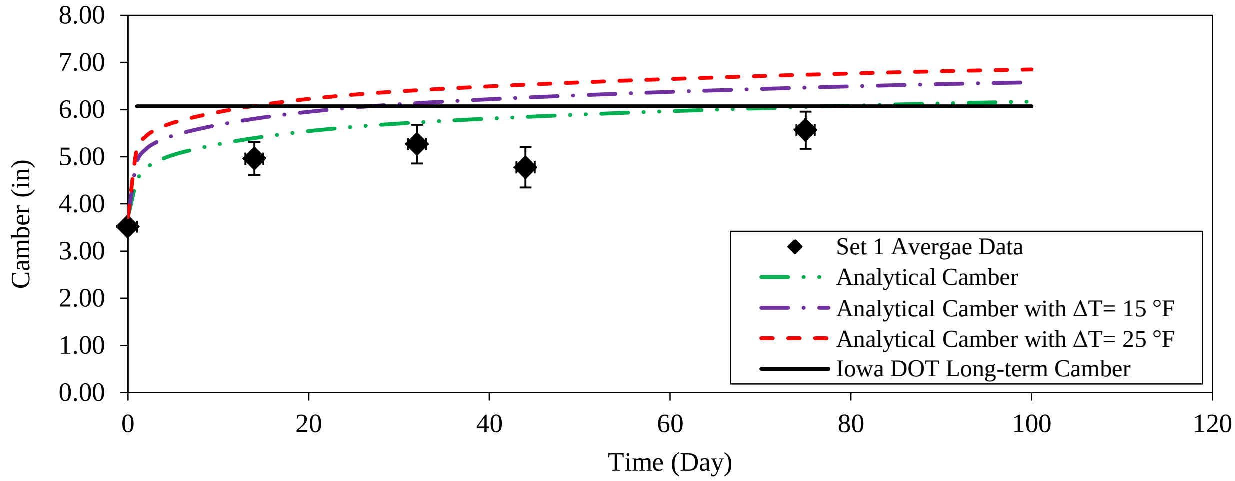


Figure J.15. Prediction of long-term camber for BTC 120 Set 1 PPCBs

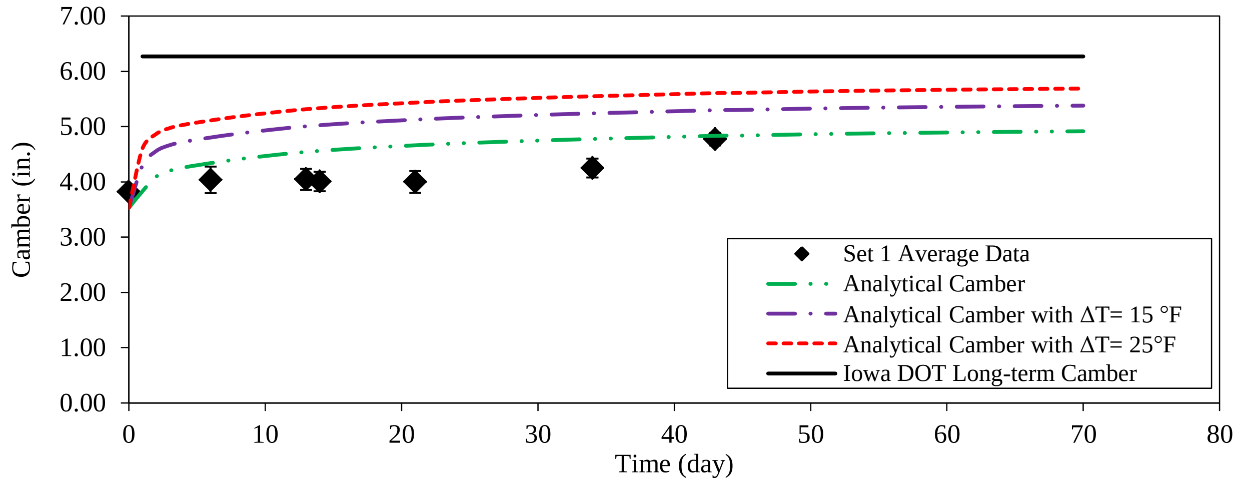


Figure J.16. Prediction of long-term camber for BTD 135 Set 1 PPCBs

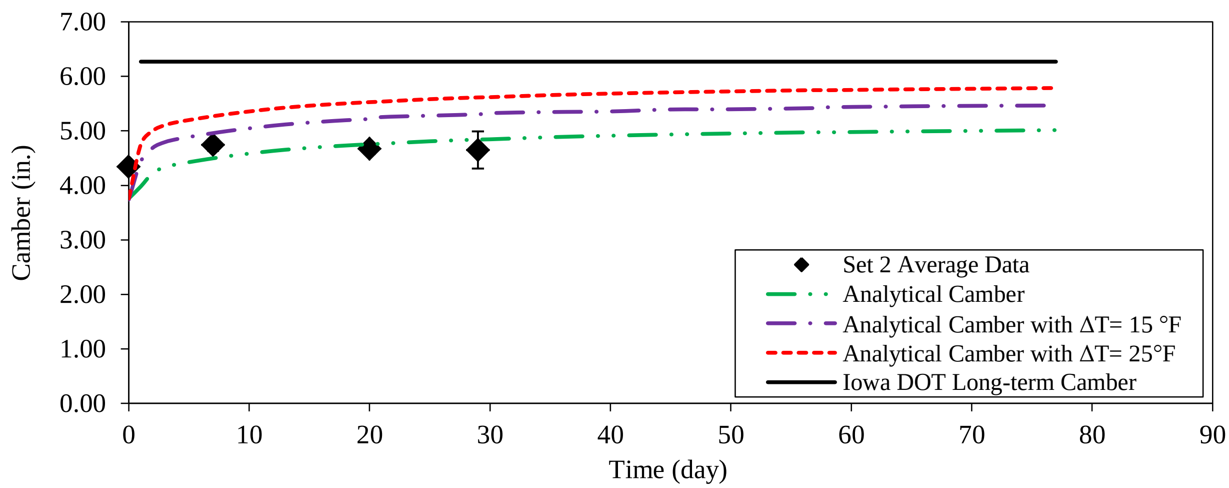


Figure J.17. Prediction of long-term camber for BTD 135 Set 2 PPCBs

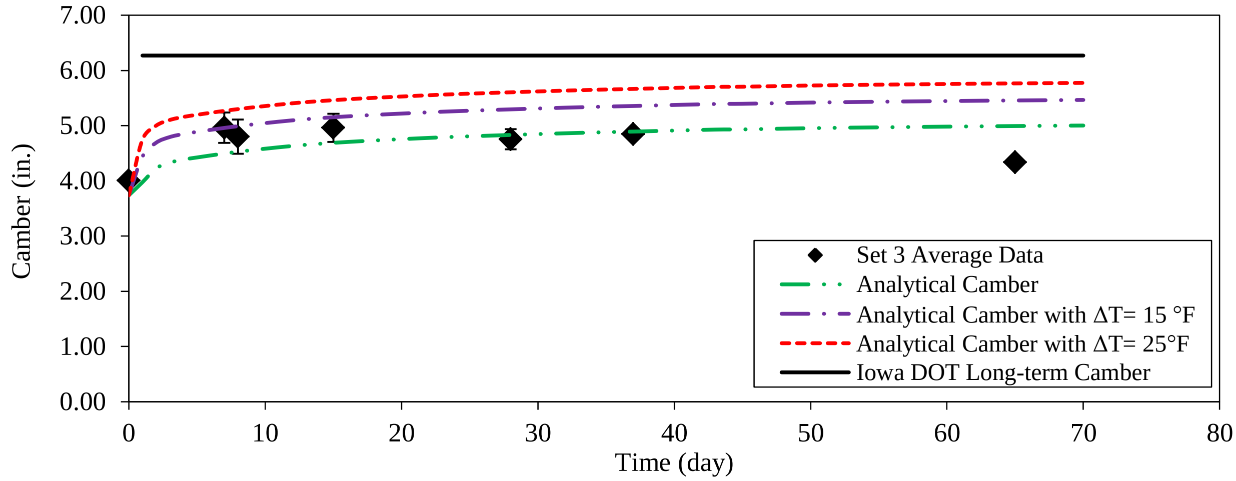


Figure J.18. Prediction of long-term camber for BTD 135 Set 3 PPCBs

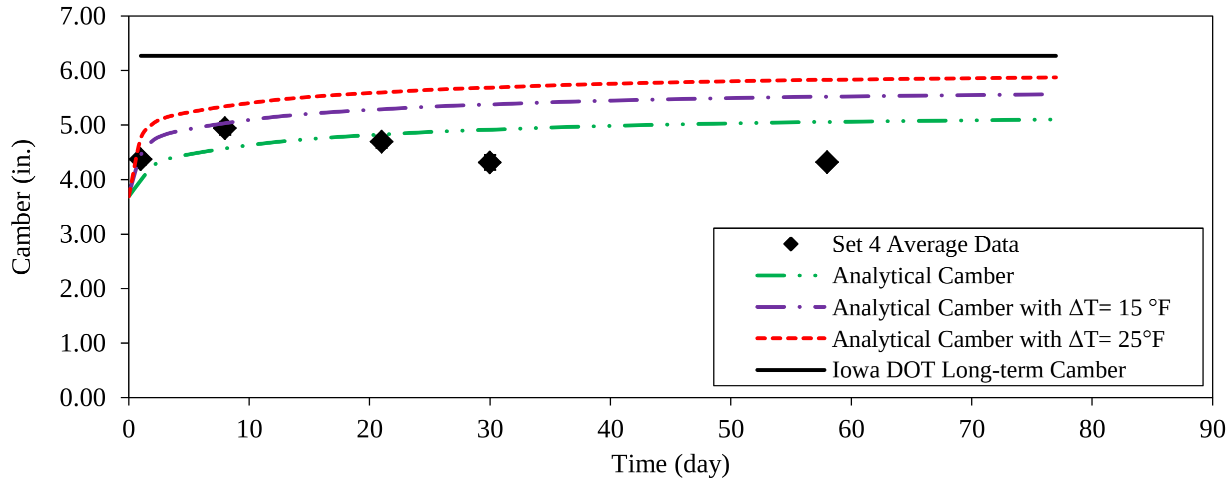


Figure J.19. Prediction of long-term camber for BTD 135 Set 4 PPCBs

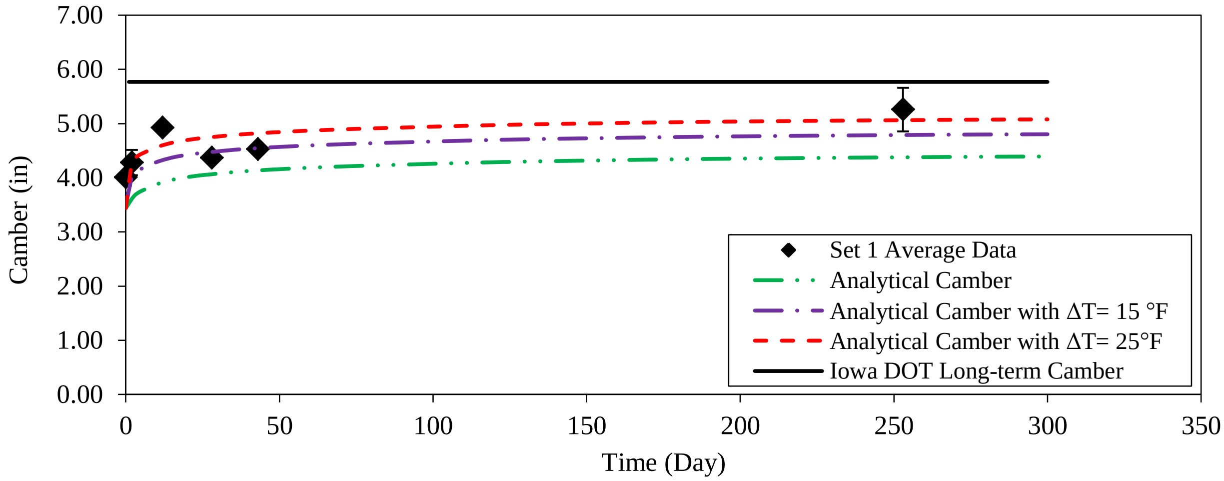


Figure J.20. Prediction of long-term camber for BTE 145 Set 1 PPCBs

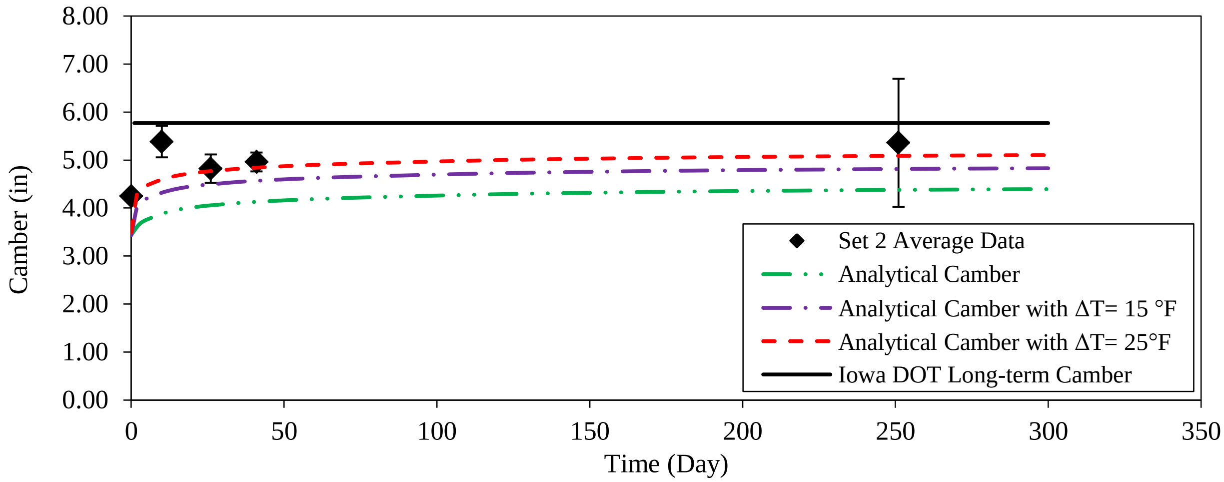


Figure J.21. Prediction of long-term camber for BTE 145 Set 2 PPCBs

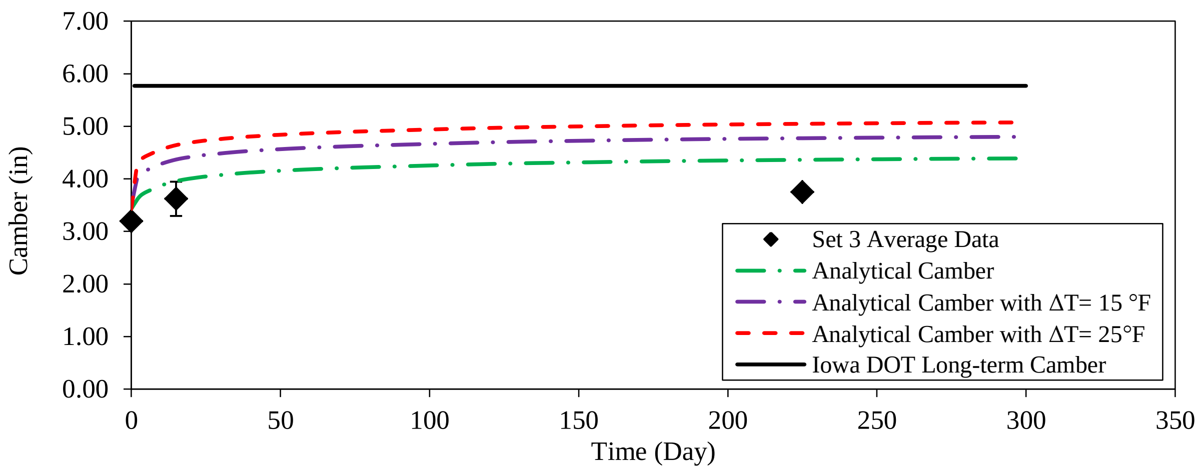


Figure J.22. Prediction of long-term camber for BTE 145 Set 3 PPCBs

APPENDIX K. LONG-TERM CAMBER PREDICTONS USING THE SET OF MULTIPLIERS

In this appendix, the estimated long-term camber using the recommended multipliers as well as the analytical camber curves for the temperature differences of zero and 15 °F for the condition of zero overhang length are compared to the measured long-term camber data and the predicted long-term camber by the Iowa DOT.

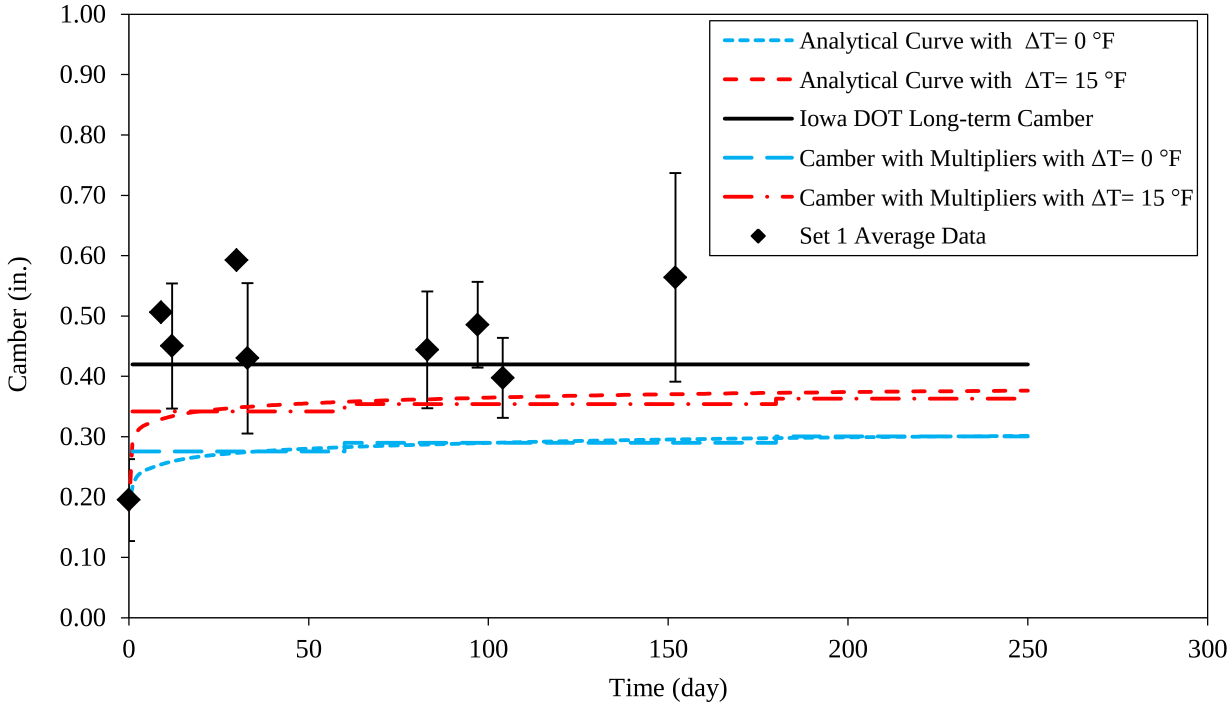


Figure K.1. Measured and estimated long-term cambers for D 55 Set 1 PPCBs

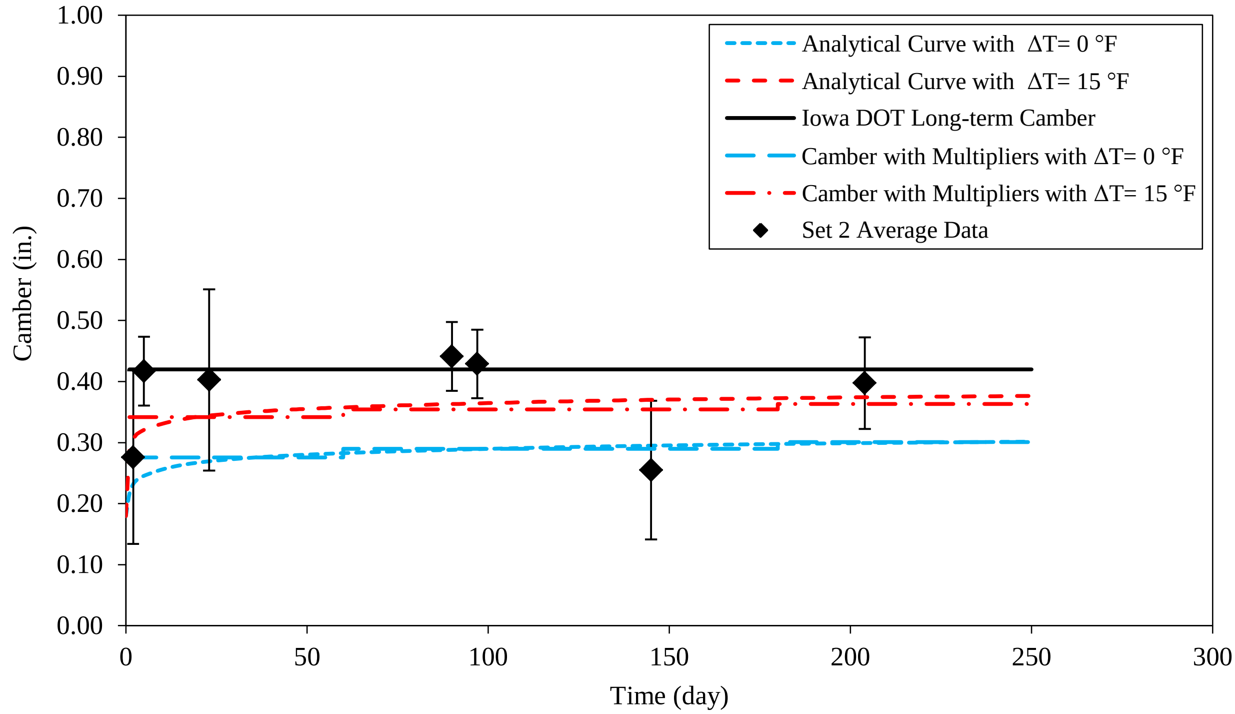


Figure K.2. Measured and estimated long-term cambers for D 55 Set 2 PPCBs

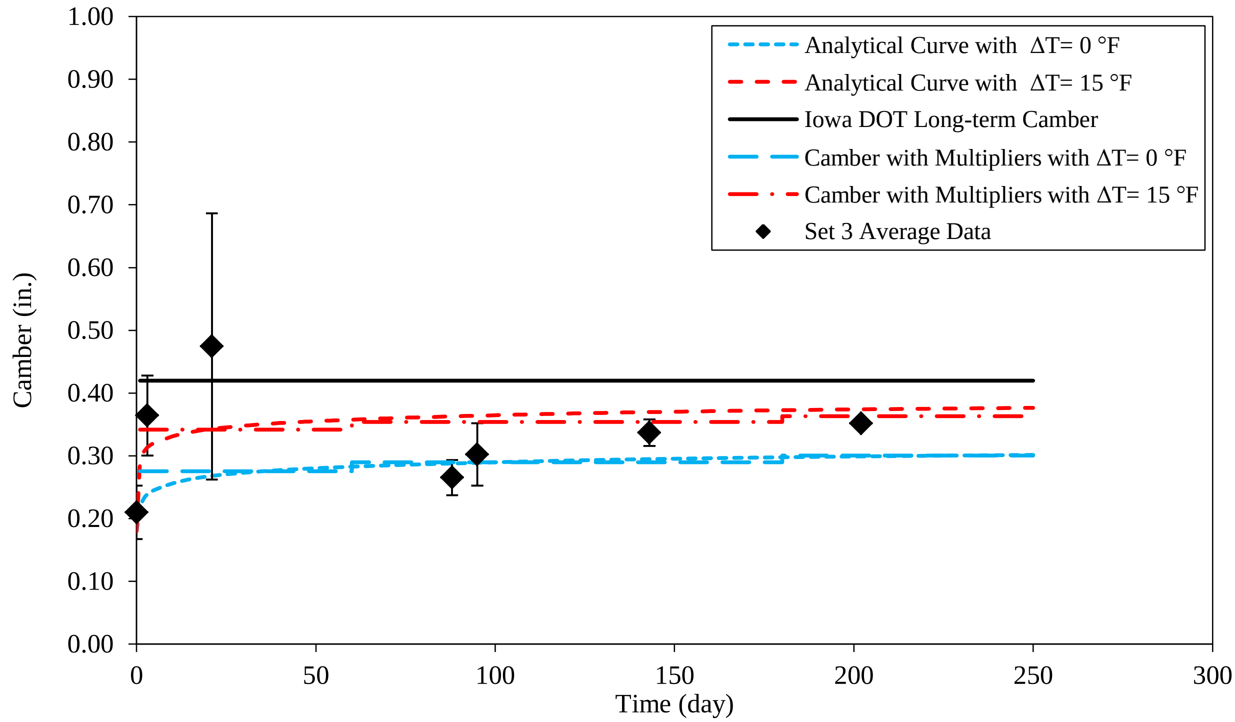


Figure K.3. Measured and estimated long-term cambers for D 55 Set 3 PPCBs

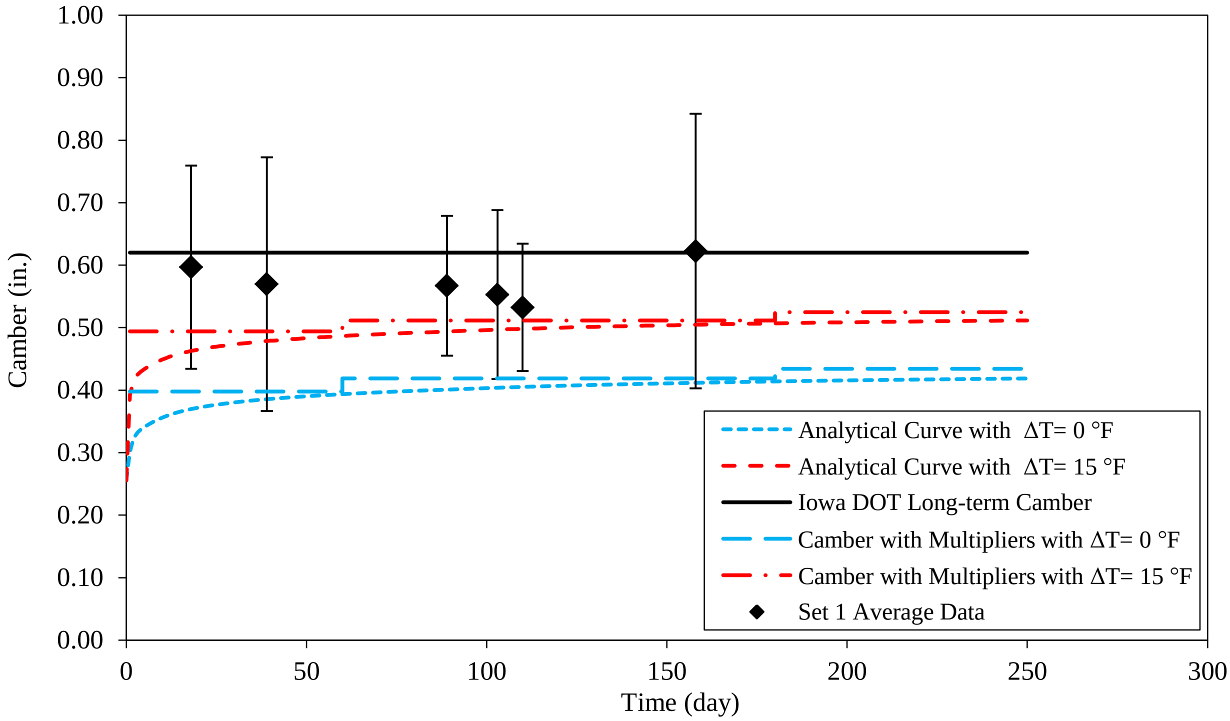


Figure K.4. Measured and estimated long-term cambers for D 60 Set 1 PPCBs

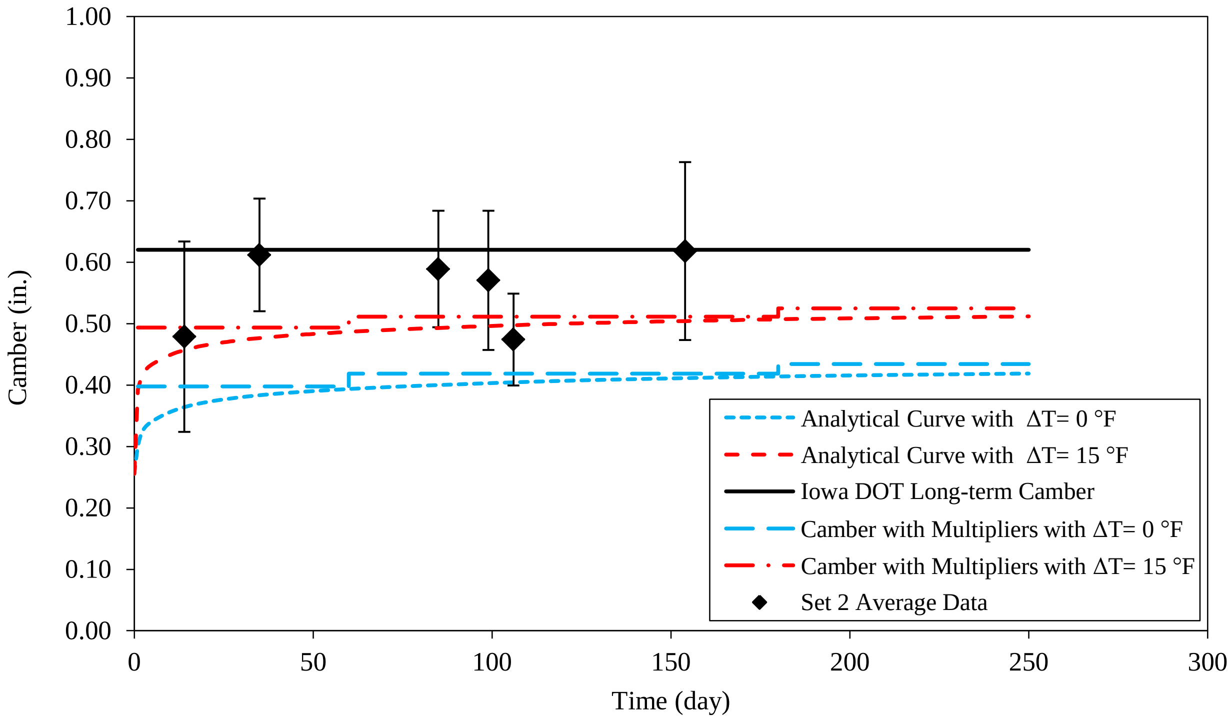


Figure K.5. Measured and estimated long-term cambers for D 60 Set 2 PPCBs

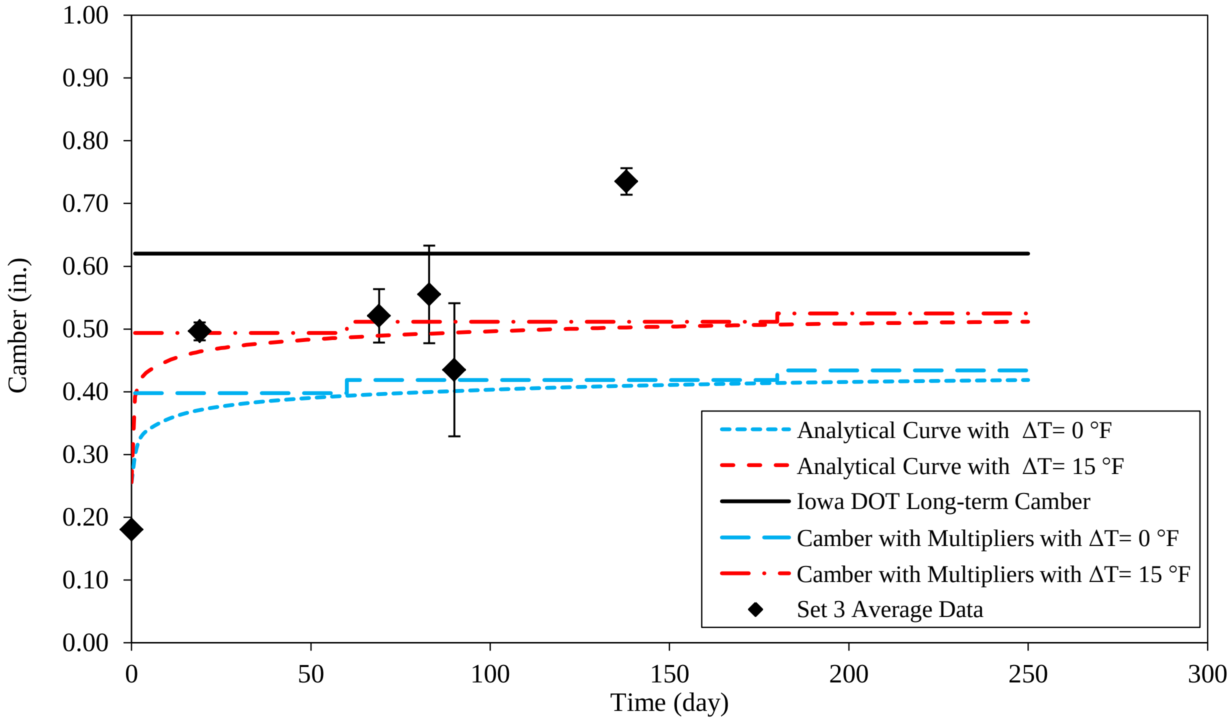


Figure K.6. Measured and estimated long-term cambers for D 60 Set 3 PPCBs

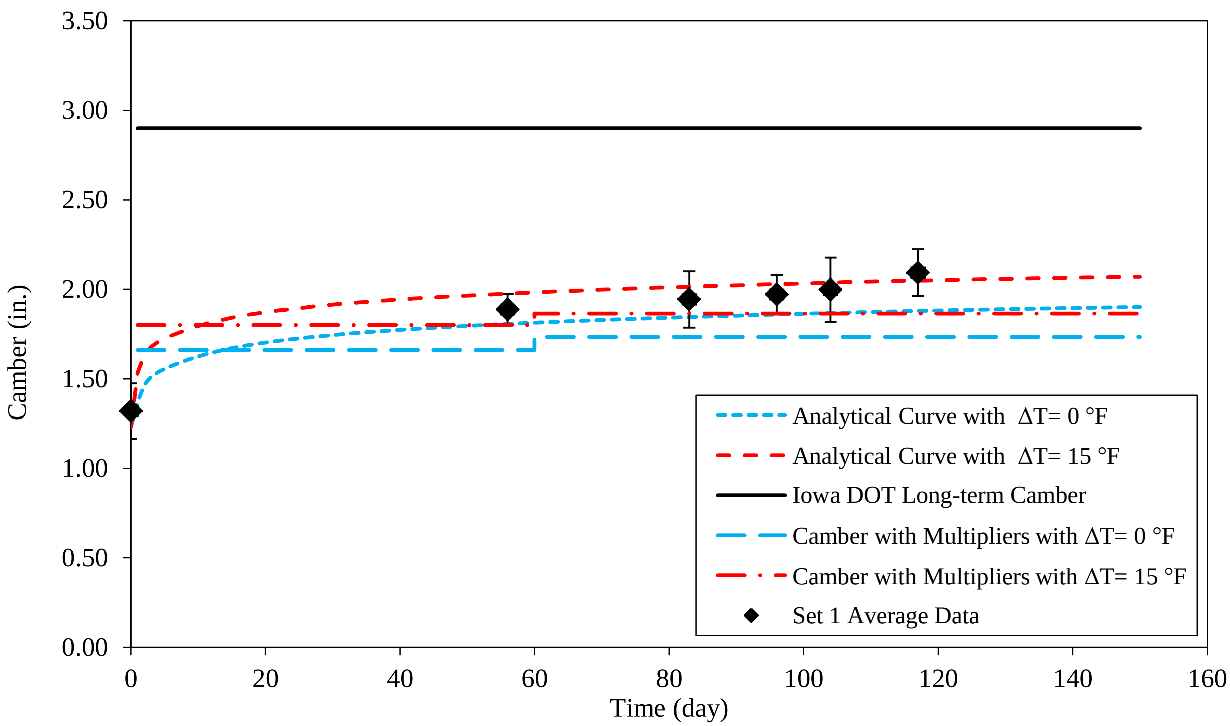


Figure K.7. Measured and estimated long-term cambers for C 80 Set 1 PPCBs

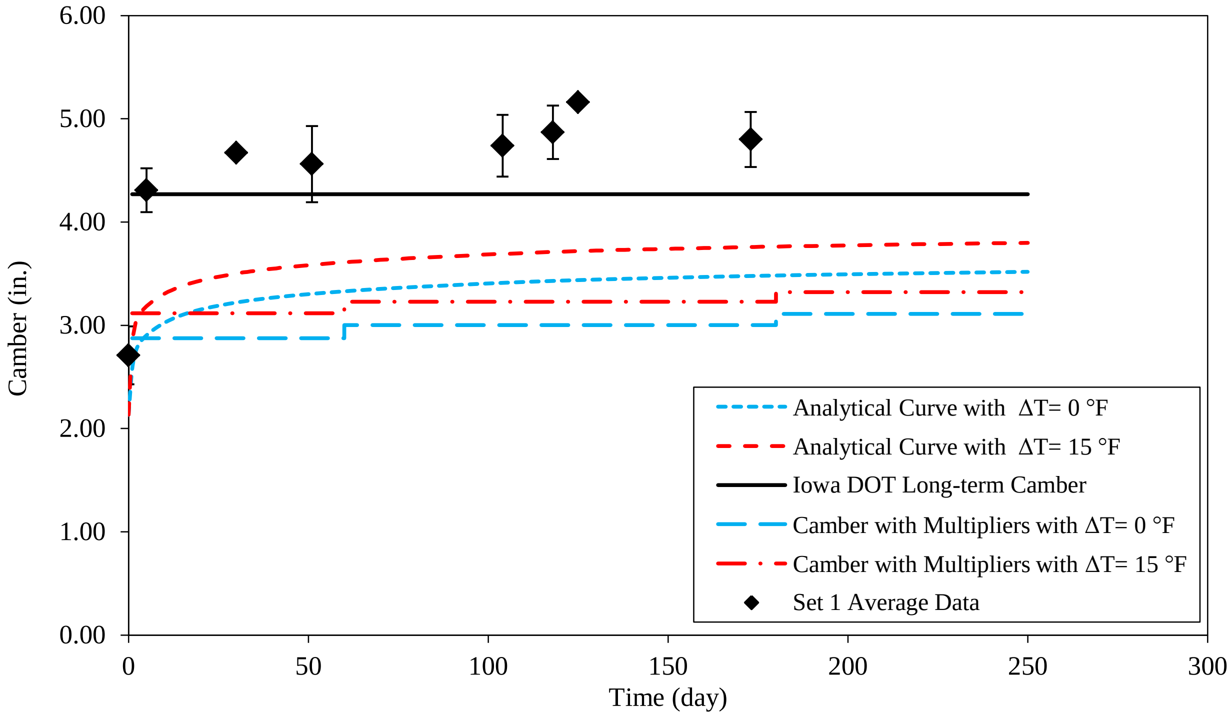


Figure K.8. Measured and estimated long-term cambers for D 105 Set 1 PPCBs

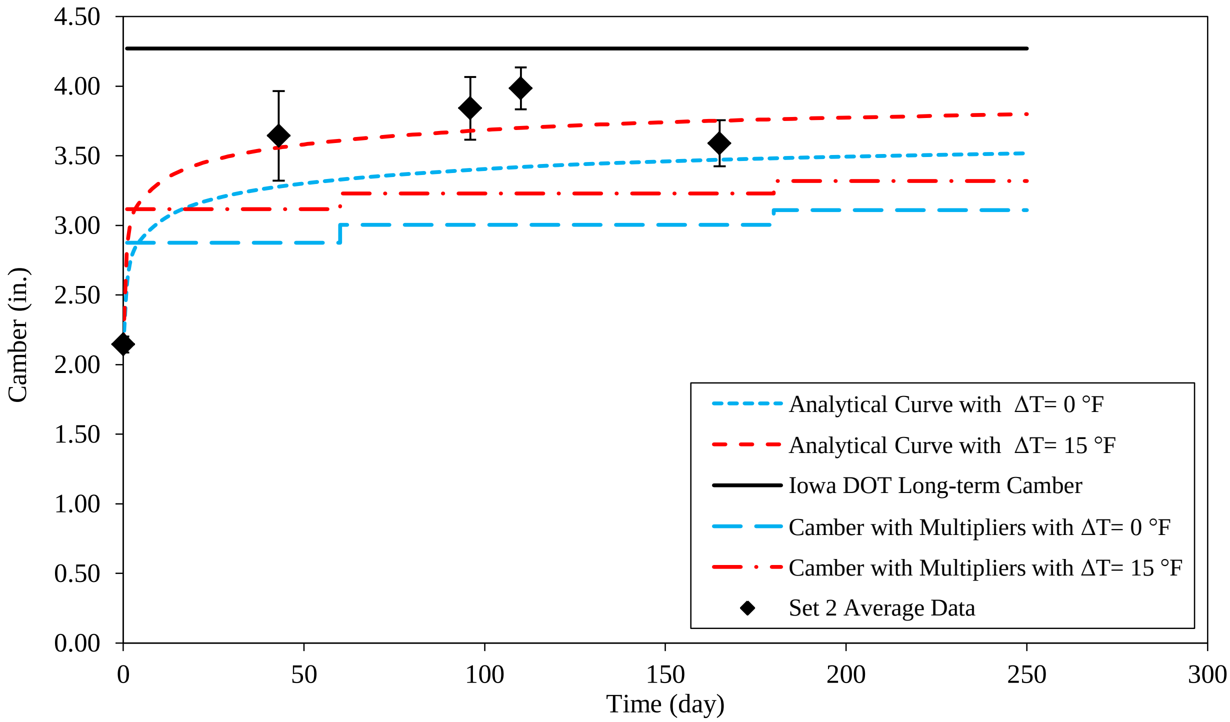


Figure K.9. Measured and estimated long-term cambers for D 105 Set 2 PPCBs

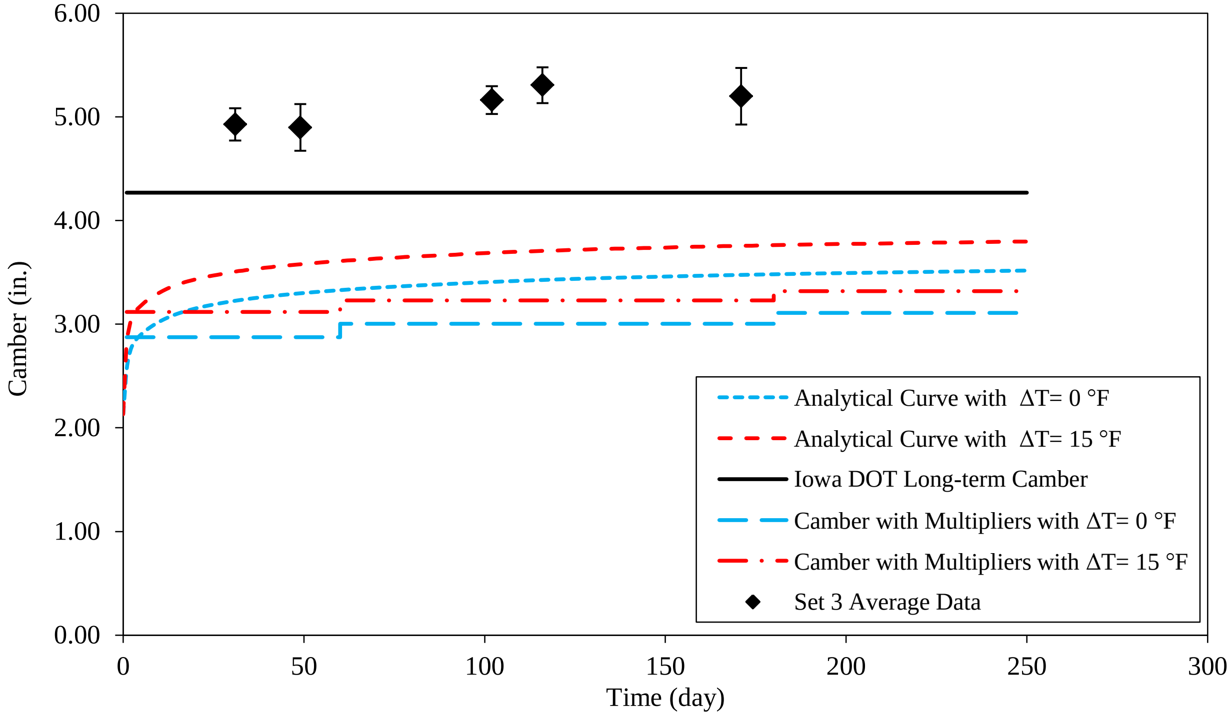


Figure K.10. Measured and estimated long-term cambers for D 105 Set 3 PPCBs

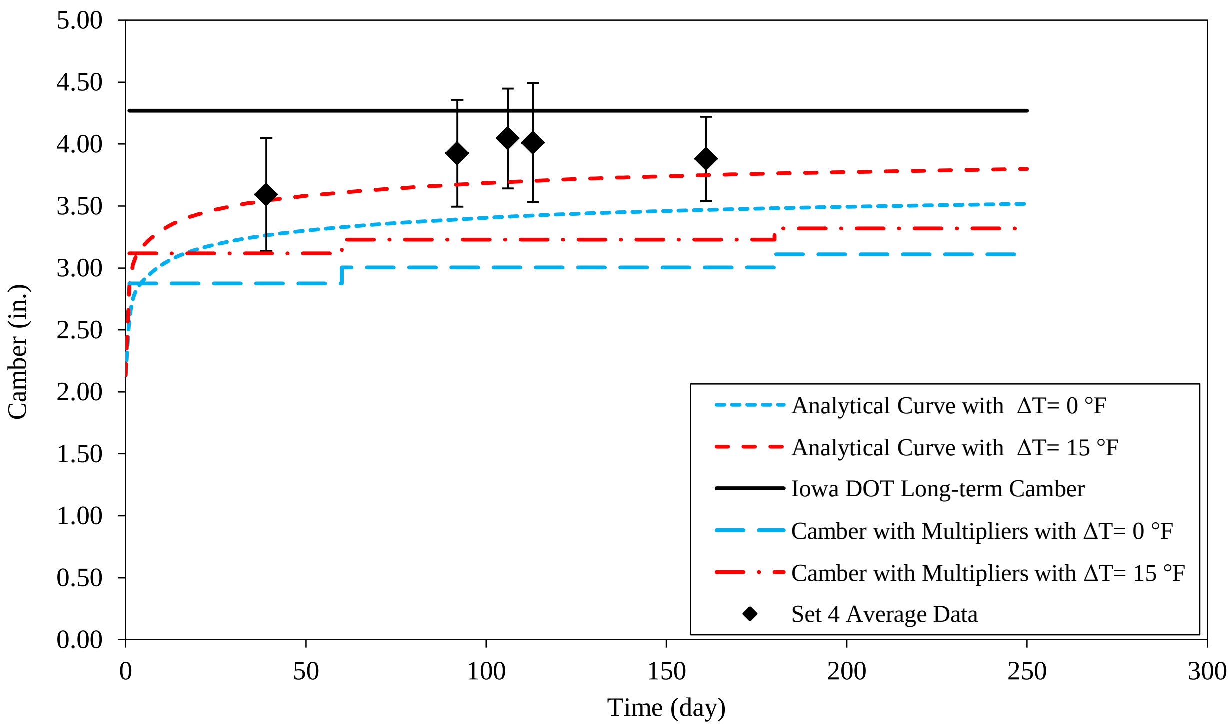


Figure K.11. Measured and estimated long-term cambers for D 105 Set 4 PPCBs

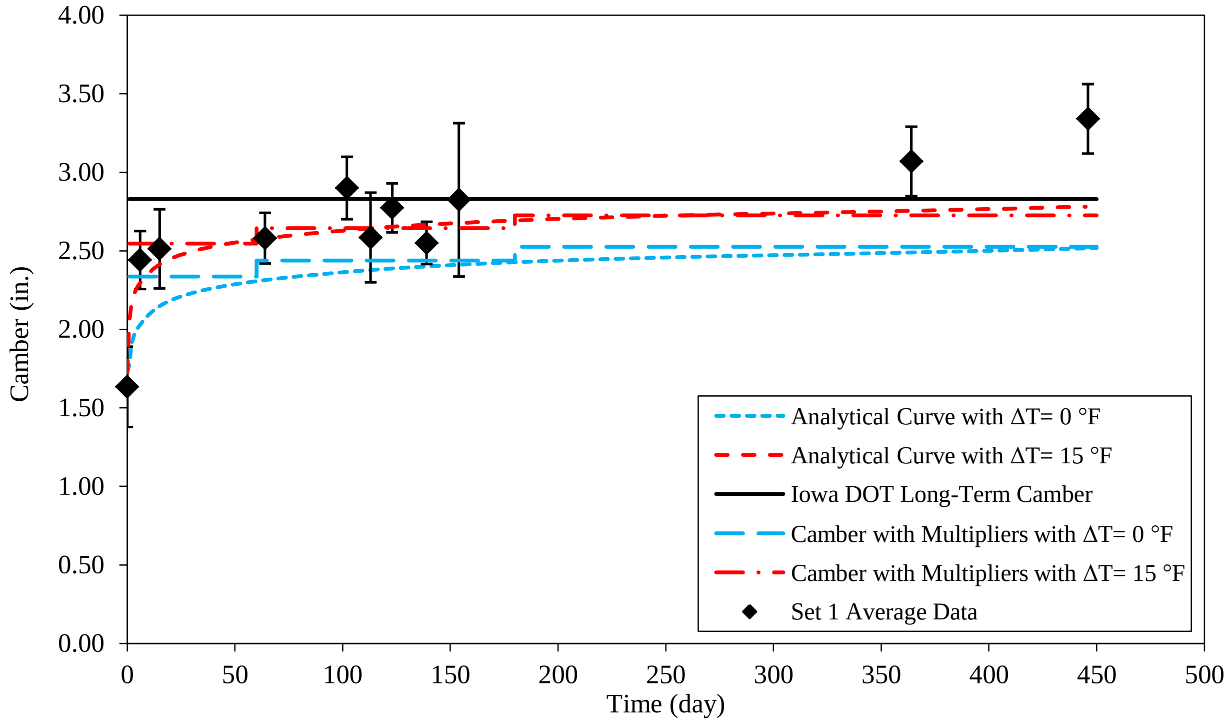


Figure K.12. Measured and estimated long-term cambers for BTE 110 Set 1 PPCBs

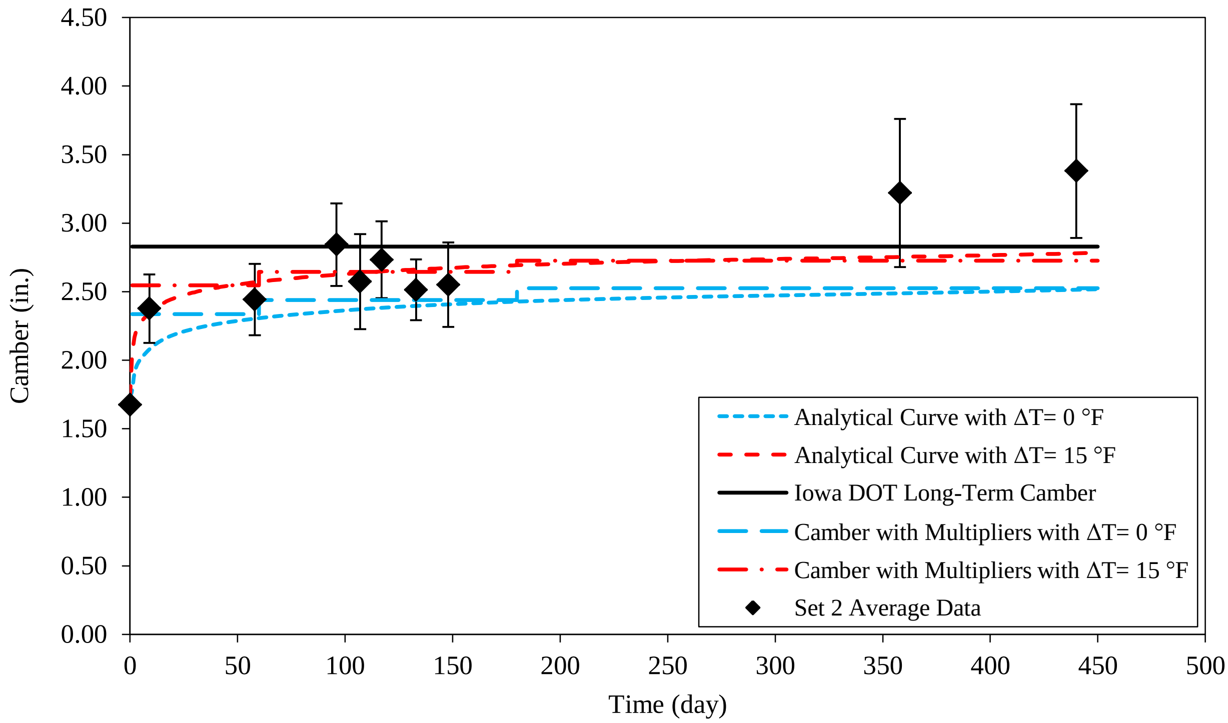


Figure K.13. Measured and estimated long-term cambers for BTE 110 Set 2 PPCBs

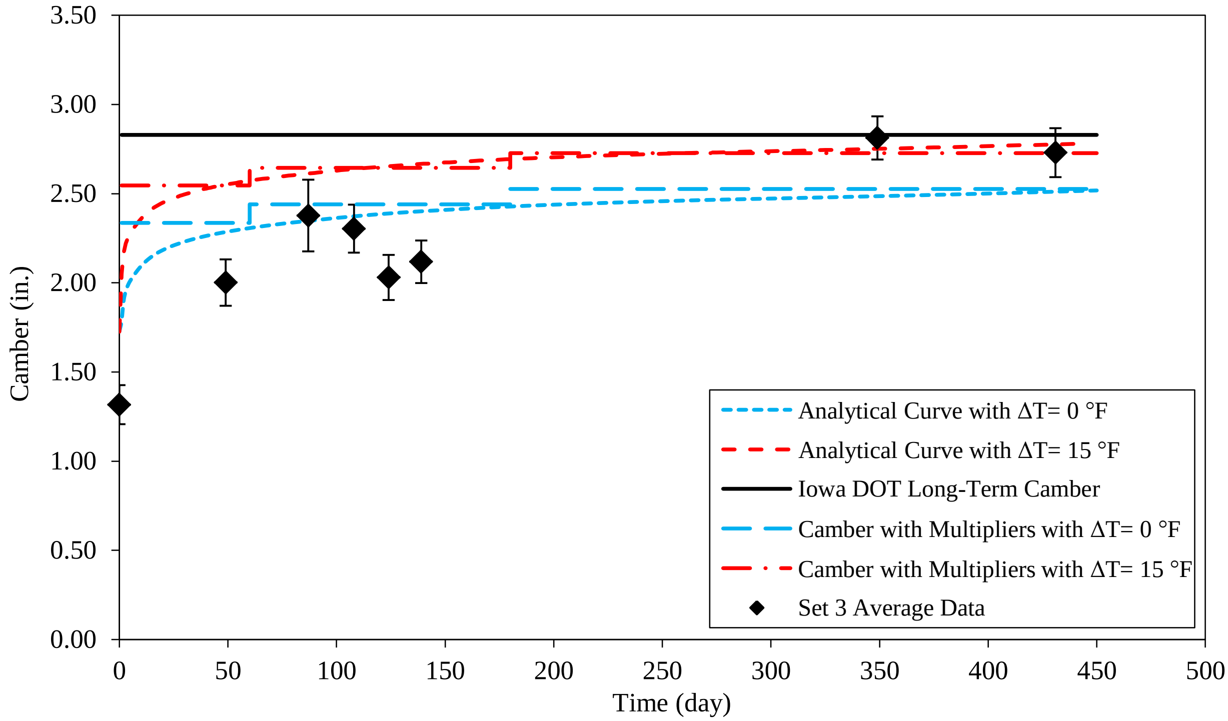


Figure K.14. Measured and estimated long-term cambers for BTE 110 Set 3 PPCBs

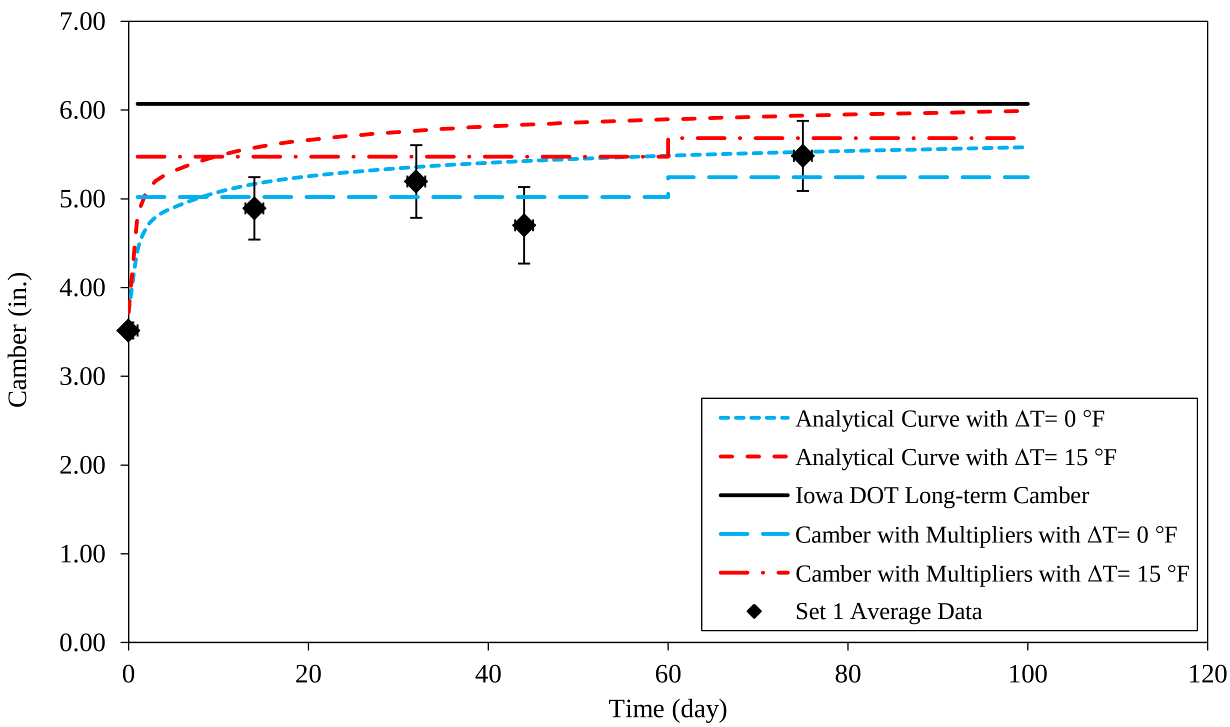


Figure K.15. Measured and estimated long-term cambers for BTC 120 Set 1 PPCBs

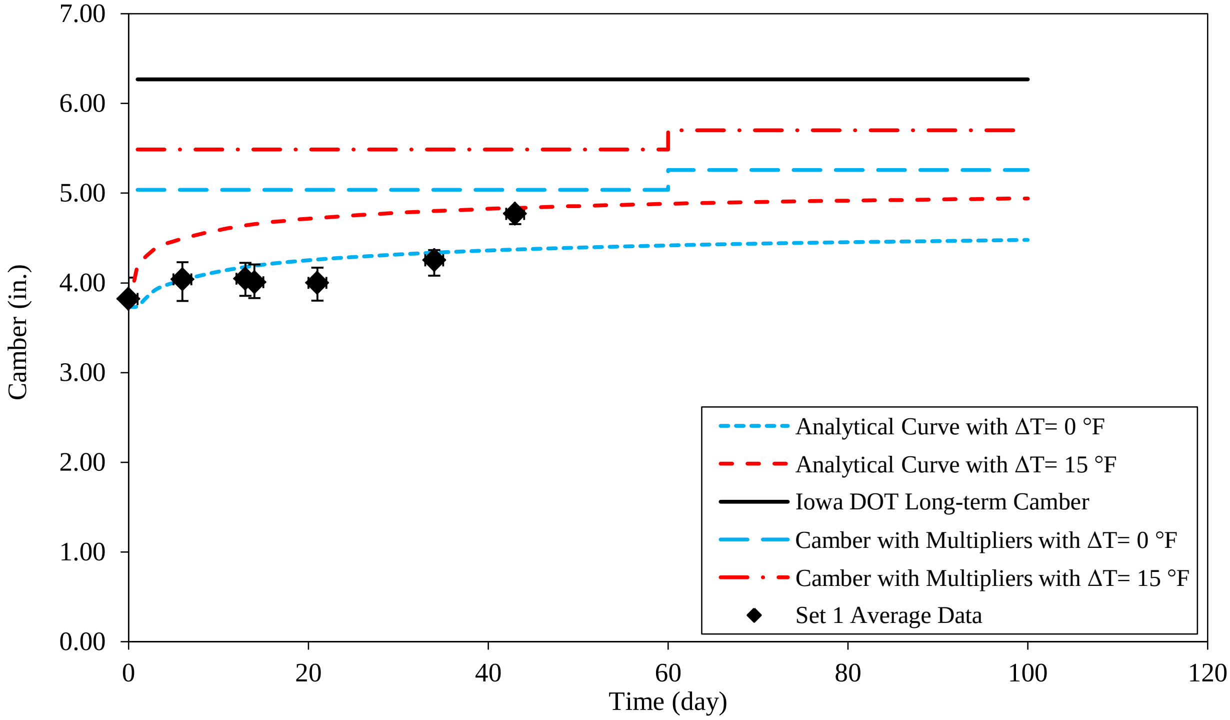


Figure K.16. Measured and estimated long-term cambers for BTD 135 Set 1 PPCBs

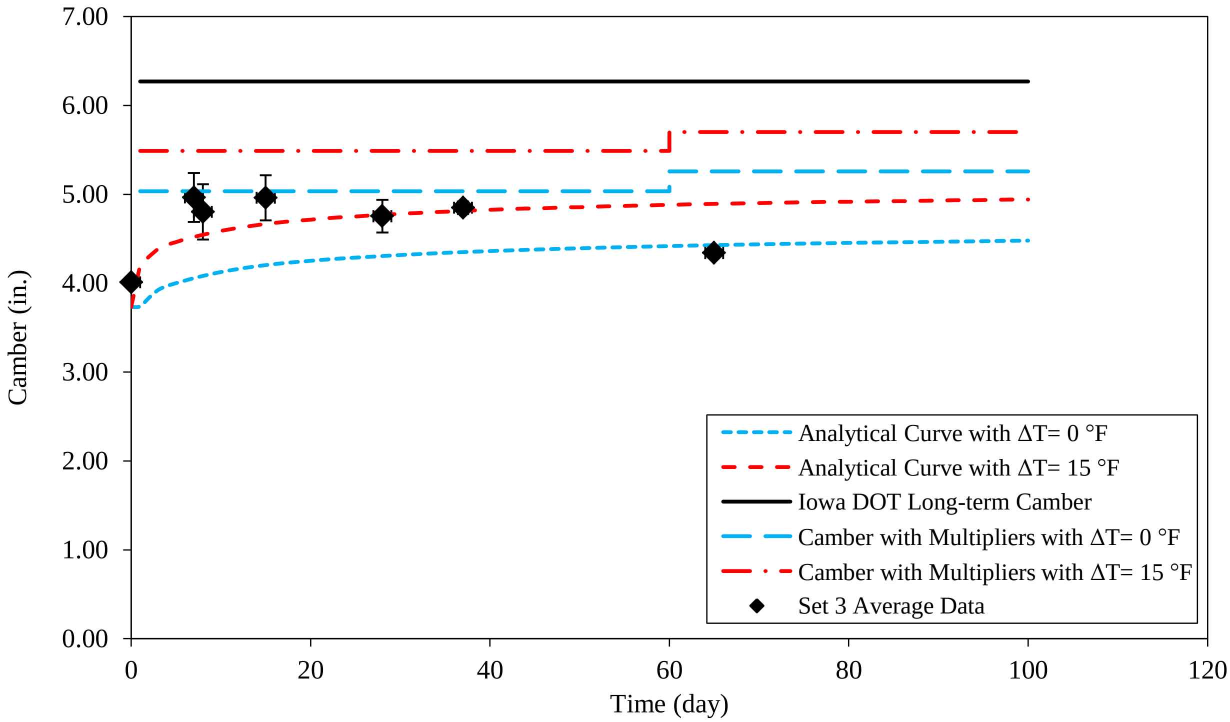


Figure K.17. Measured and estimated long-term cambers for BTD 135 Set 2 PPCBs

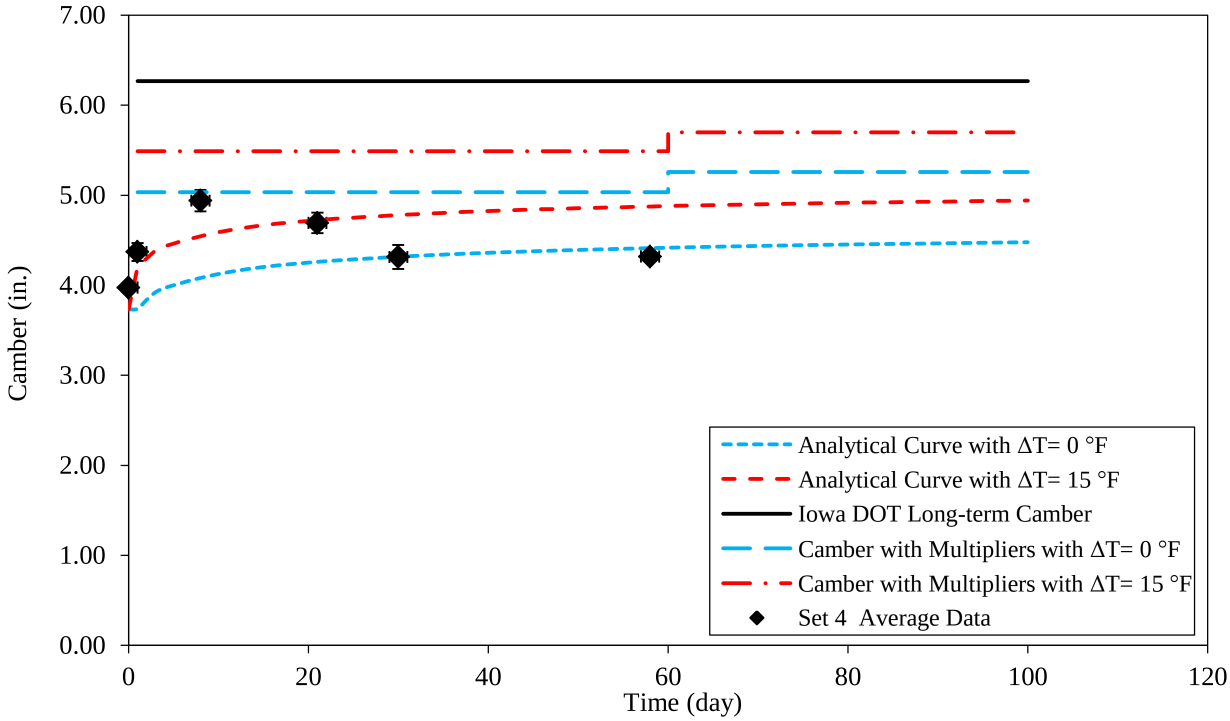


Figure K.18. Measured and estimated long-term cambers for BTD 135 Set 3 PPCBs

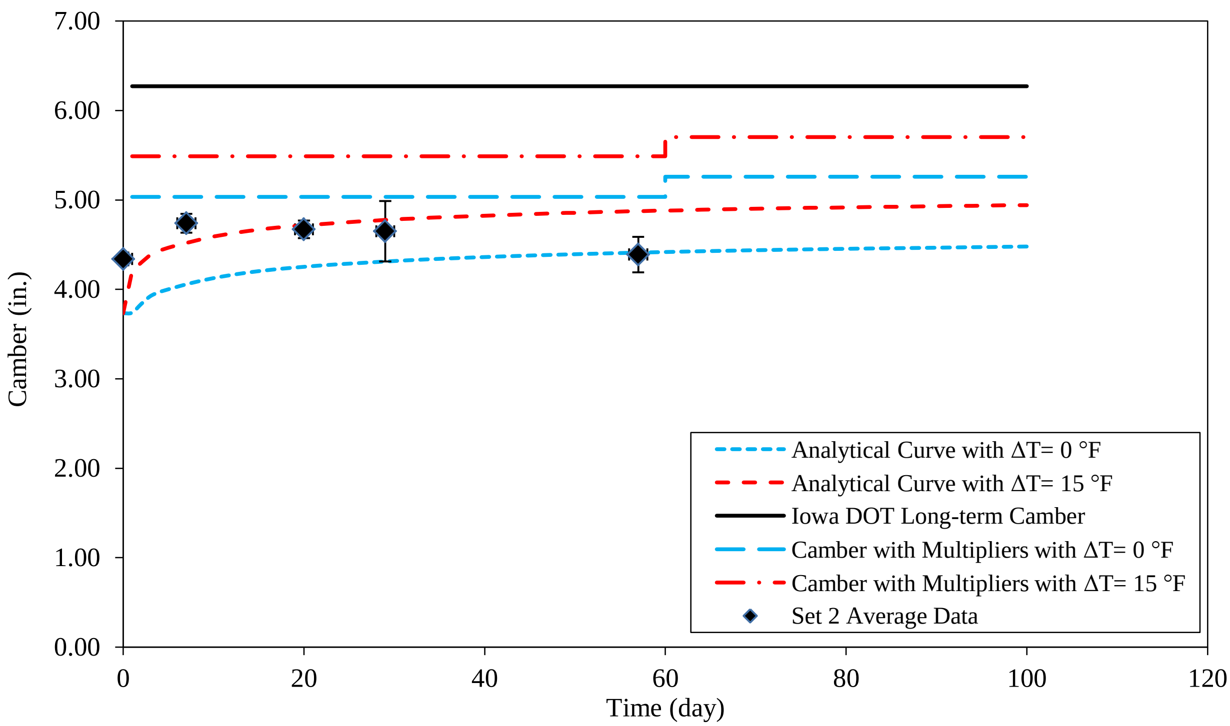


Figure K.19. Measured and estimated long-term cambers for BTD 135 Set 4 PPCBs

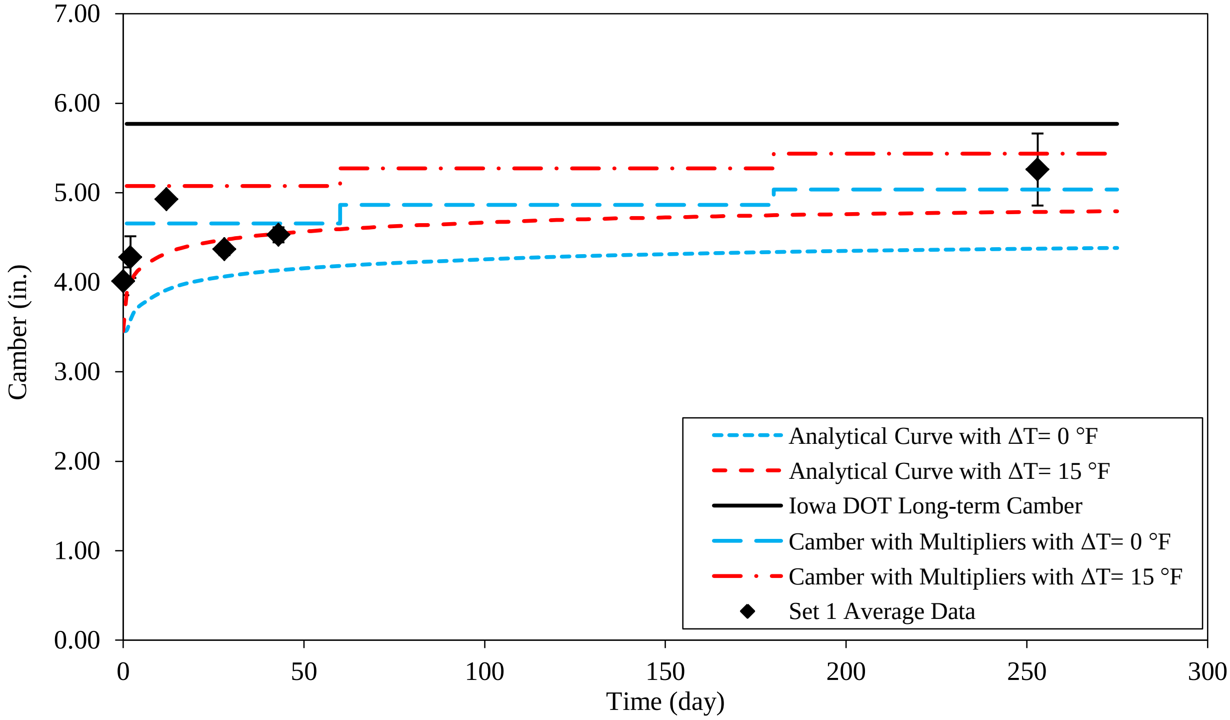


Figure K.20. Measured and estimated long-term cambers for BTE 145 Set 1 PPCBs

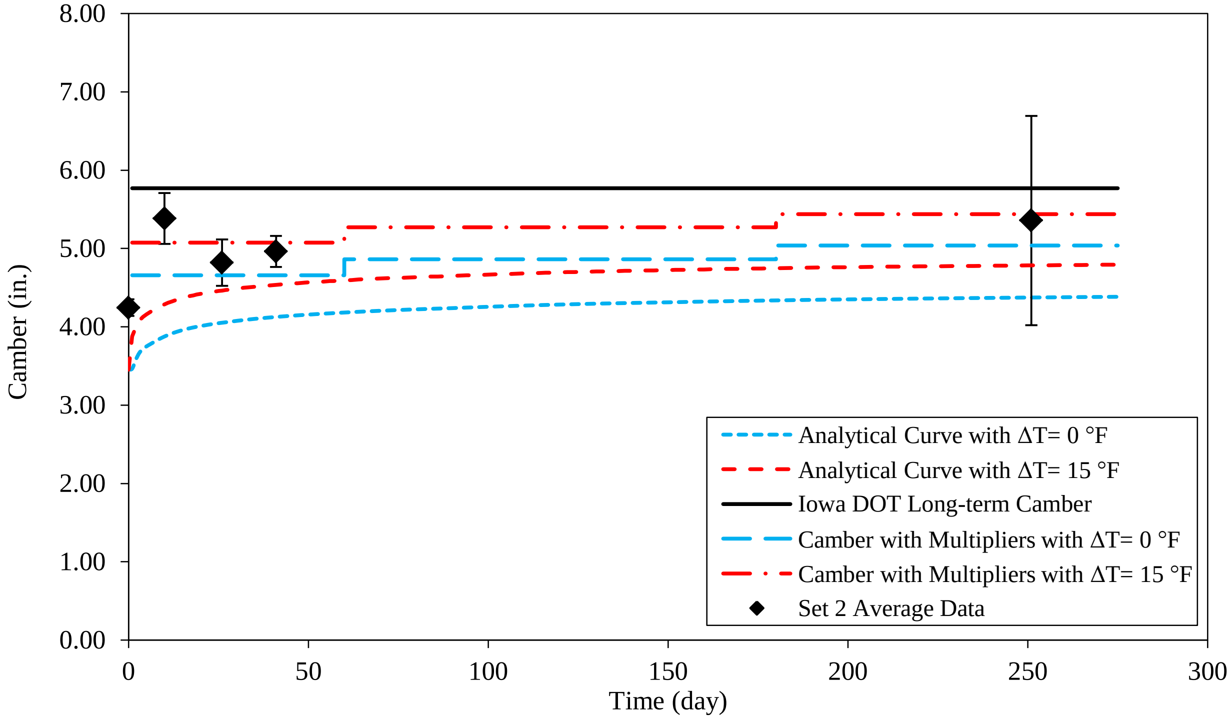


Figure K.21. Measured and estimated long-term cambers for BTE 145 Set 2 PPCBs

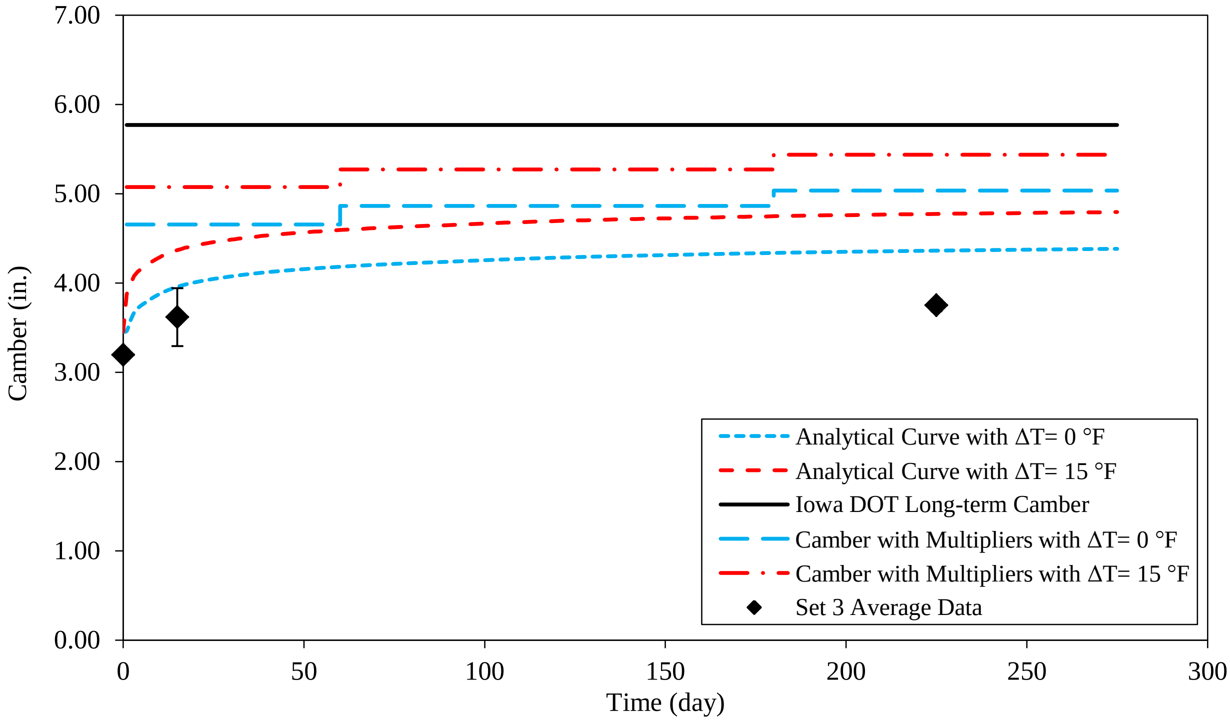


Figure K.22. Measured and estimated long-term cambers for BTE 145 Set 3 PPCBs