Appendix A-1: Concrete mix data

Table A-1. 1-Standard concrete mix design

(“Pinners Point” f_{ci}=5800 psi, f'_c=8400 psi)

Materials	SSD weights (lb/yd^3)
Portland Cement	510
Slag Cement	340
Coarse Aggregate	1950
Fine Aggregate	988
Water	252
AEA (Daravair)	15 (oz/yd^3)
WR (Hycol)	27 (oz/yd^3)
HRWR (Adva)	175 (oz/yd^3)
C.I. Or Accel (DCI)	4 (gal/yd^3)

Table A-1. 2: Mortar Cube mix

Materials	SSD weights (lb)
Portland Cement	3.49
Slag Cement	2.32
Fine Aggregate	13.33
Water	1.74*
AEA (Daravair)	3.1 ml
WR (Hycol)	5.4 ml
HRWR (Adva)	35 ml
C.I. Or Accel (DCI)	104 ml

Mix design for 18 two inch cubes

*w/c=0.3 not reduced by Admixture liquid volumes

Appendix A-2: Maturity Rate Constant Data

Table A-2. 1 Mortar cube strength data for Type III mix (Batch C)

	Warm	Cold	Hot
DTG Batch was Made:	3JAN1623	5JAN0803	7JAN1206

Bath Temp, °C	DTG broken	f'c,avg (psi)	Age (hr)	1/Strength	1/Age
50	8JAN0836	1650	20.5	6.06E-04	4.88E-02
50	8JAN1300	3530	25	2.83E-04	4.00E-02
50	8JAN1923	5440	31.3	1.84E-04	3.19E-02
50	10JAN0930	*8880*	69.4	1.13E-04	1.44E-02
50	12JAN1130	*9880*	119.5	1.01E-04	8.37E-03
50	18JAN1516	*12130*	291	8.24E-05	3.44E-03
t=69.4 not within 10% of AVG (11.3%); t=119.5 and 291 only one good cube					
30	4JAN0345	929	11.3	1.08E-03	8.85E-02
30	4JAN1353	3640	21.5	2.75E-04	4.65E-02
30	5JAN0840	5970	40.3	1.68E-04	2.48E-02
30	7JAN1126	9830	91	1.02E-04	1.10E-02
30	11JAN1123	12000	187	8.33E-05	5.35E-03
30	18JAN1516	13380	359	7.47E-05	2.79E-03
10	6JAN1330	829	29.3	1.21E-03	3.41E-02
10	7JAN2215	3730	62.2	2.68E-04	1.61E-02
10	10JAN0935	6580	121.5	1.52E-04	8.23E-03
10	15JAN1418	8330	246.25	1.20E-04	4.06E-03
10	25JAN1330	9790	486	1.02E-04	2.06E-03
10	12FEB1330	12100	918	8.26E-05	1.09E-03

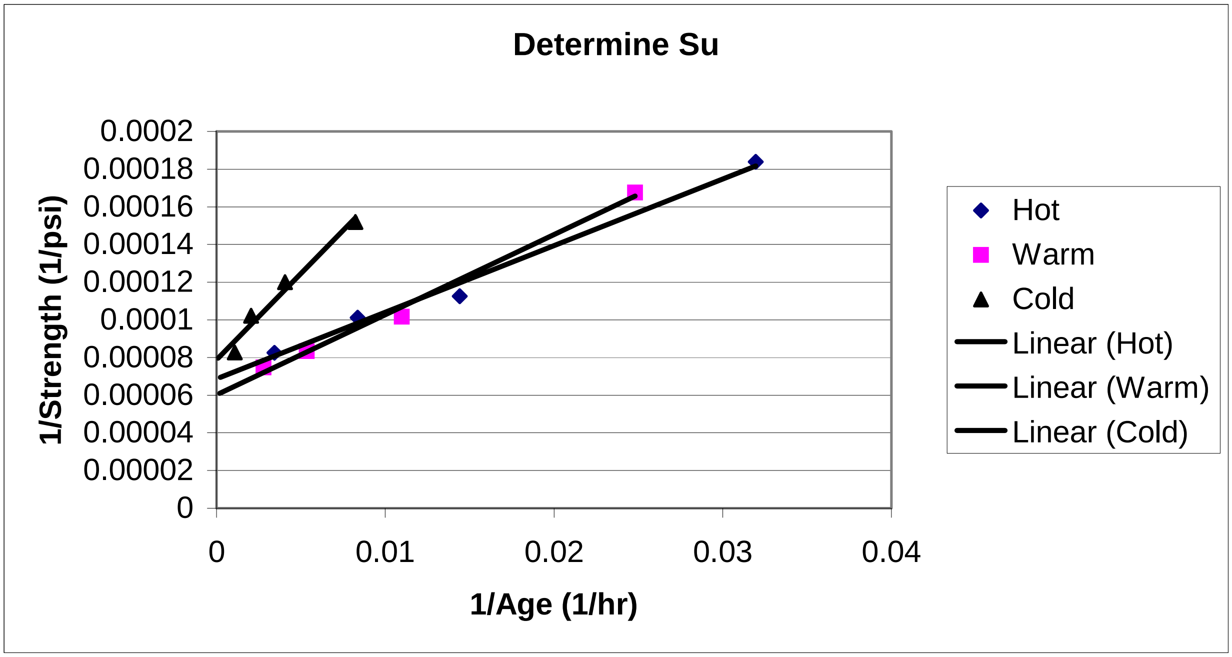

Figure A-2. 1 Determination of Su for Type III mix

Table A-2. 2 A-values for Type III mix (S=test strength, S_u is 1/y-intercept Fig. A-2.1)

FIND: A=S/(Su-S) (Use 4 earliest strengths, S)

Bath Temp= 50°C S_u=14600 psi			Bath Temp= 30°C S_u=16600 psi			Bath Temp= 10°C S_u=12700 psi		
Age (hr)	S (psi)	A	Age (hr)	S (psi)	A	Age (hr)	S (psi)	A
20.5	1650	0.13	11.3	929	0.06	29.3	829	0.07
25	3530	0.32	21.5	3640	0.28	62.2	3730	0.42
31.3	5440	0.59	40.3	5970	0.56	121.5	6580	1.08
69.4	8880	1.55	91	9830	1.45	246.25	8330	1.91

Table A-2. 3 K-values for Type III mix

Temp (^oC)	K (1/hr)
50	0.0281
30	0.0173
10	0.00841

K=Slope of Age vs A (Figure A-2.2) for each temperature

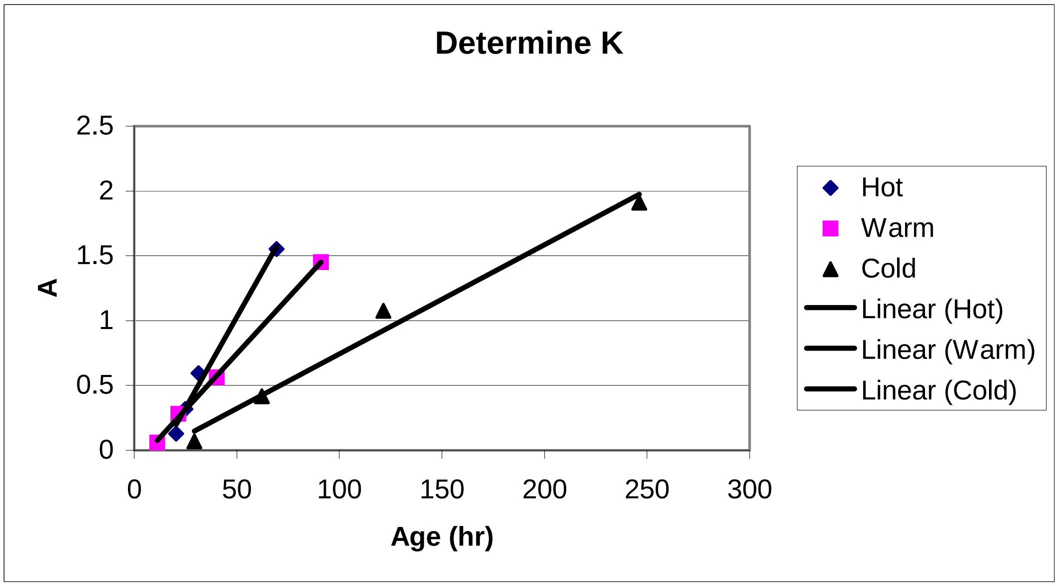

Figure A-2. 2 Determination of K for Type III mix

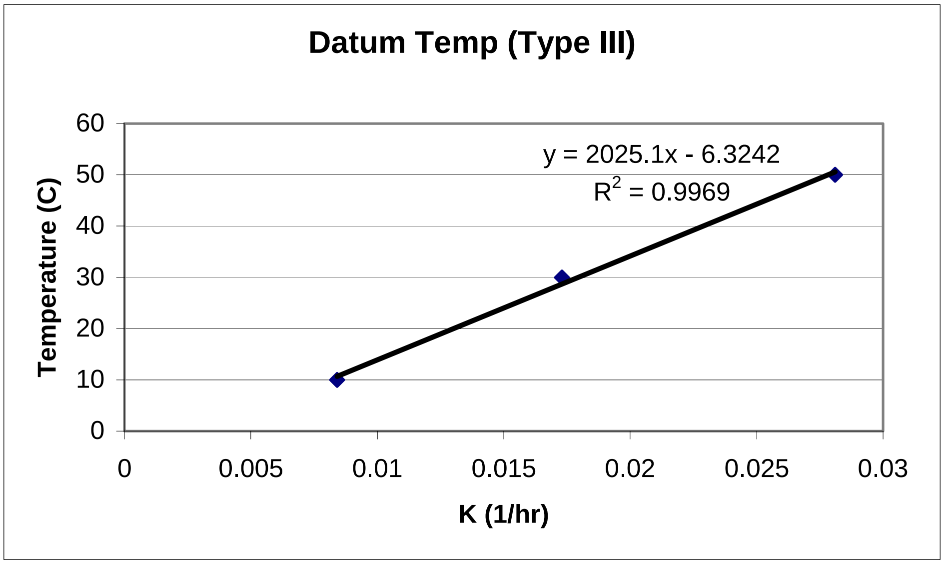

Figure A-2. 3 Datum temperature T_o=-6^{o}C (T_o= y-intercept)

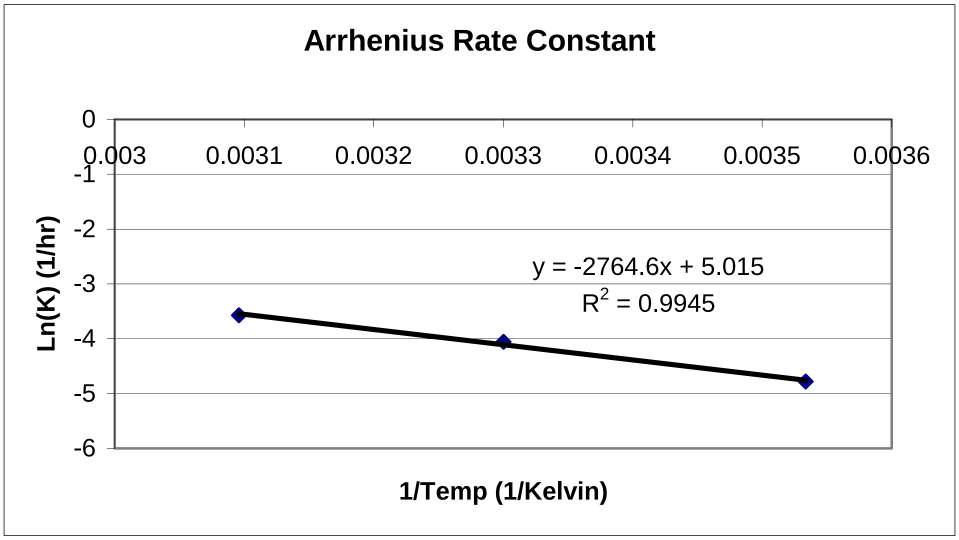

Figure A-2. 4 Q=2760 (Q=Slope) (Type III mix)

Table A-2. 4 Mortar cube data for Type II mix (Batch A)

DTG Batch was Made:	25-Sep	25-Sep	25-Sep

Bath Temp, °C	DTG broken	f'c,avg (psi)	Age (hr)	1/Strength	1/Age
51	26SEP0900	262	21.5	3.82E-03	4.65E-02
51	27SEP0800	4815	44.5	2.08E-04	2.25E-02
51	29SEP1245	7688	98	1.30E-04	1.02E-02
51	1OCT1230	*8505*	146	1.18E-04	6.85E-03
51	4OCT1730	9800	222	1.02E-04	4.50E-03
51	9OCT1500	12050	340	8.30E-05	2.94E-03
t=146 modified linear interp actual 6667					
31	26SEP0900	167	21.5	5.99E-03	4.65E-02
31	27SEP1230	3405	49	2.94E-04	2.04E-02
31	29SEP1245	6450	98	1.55E-04	1.02E-02
31	1OCT1230	6900	146	1.45E-04	6.85E-03
31	5OCT1730	11500	237	8.70E-05	4.22E-03
31	17OCT1230	*12100*	530	8.26E-05	1.89E-03
t=530 modified: Projected, actual test 7700 psi					
11	26SEP0900	75	21.5	1.33E-02	4.65E-02
11	27SEP1600	121	52	8.26E-03	1.92E-02
11	2OCT1500	3038	172	3.29E-04	5.81E-03
11	9OCT1500	7100	340	1.41E-04	2.94E-03
11	24OCT1900	12000	680	8.33E-05	1.47E-03
11	21DEC1900	12300	2100	8.13E-05	4.76E-04

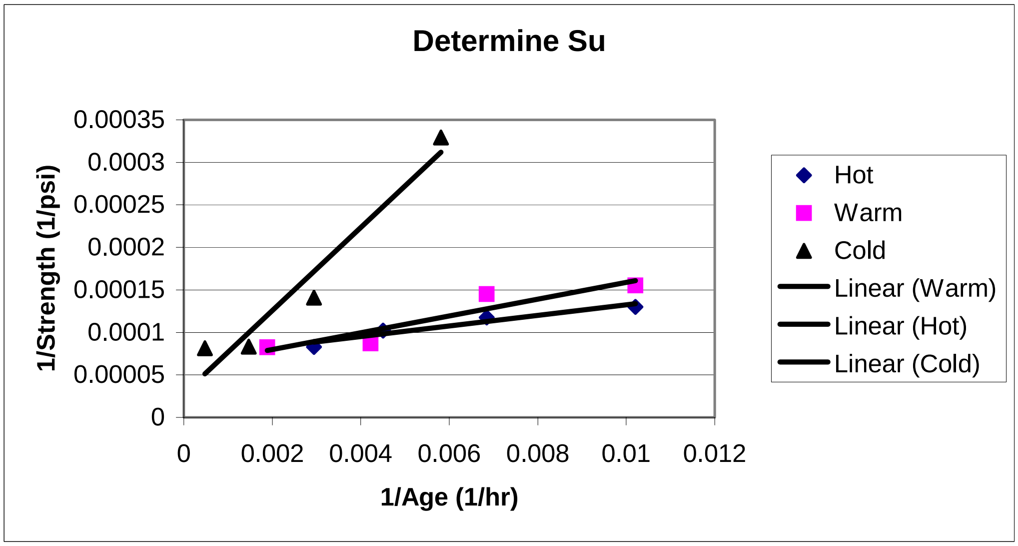

Figure A-2. 5 Determination of Su for Type II mix

Table A-2. 5 Ultimate strength for Type II mix

Bath Temp(°C)	Su(psi) graphical	Su(psi) final values
51	14290	12050
31	16640	12100
11	35600	12300

Used final values to calculate A due to high value of cold cure cubes

Table A-2. 6 A values for Type II mix (S=test strength, S_u is 1/y-intercept Fig. A-2.5)

FIND: A=S/(Su-S) (Use 4 earliest strengths, S)

Bath Temp= 51°C Su=12050 psi			Bath Temp= 31°C Su=12100 psi			Bath Temp= 11°C Su=12300 psi		
Age (hr)	S (psi)	A	Age (hr)	S (psi)	A	Age (hr)	S (psi)	A
21.5	262	0.02	21.5	167	0.01	21.5	75	0.01
44.5	4815	0.67	49	3405	0.39	52	121	0.01
98	7688	1.76	98	6450	1.14	172	3038	0.33
146	8505	2.40	146	6900	1.33	340	7100	1.37

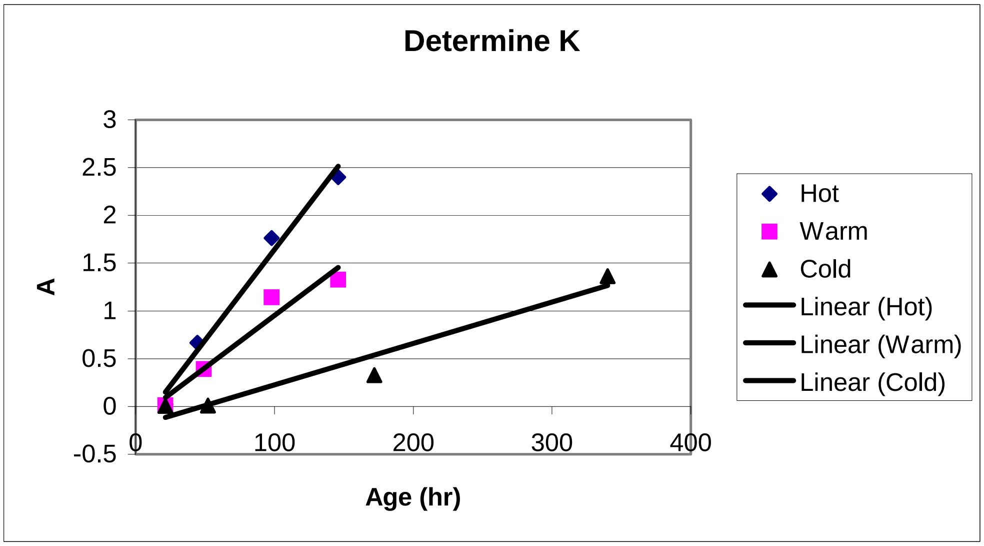

Figure A-2. 6 Determination of K for Type II mix

Table A-2. 7 K-values for Type II mix

Temp (^{o}C)	K (1/hr)
50	0.019
30	0.0109
10	0.0043

K=Slope of Age vs A (Figure A-1.2) for each temperature

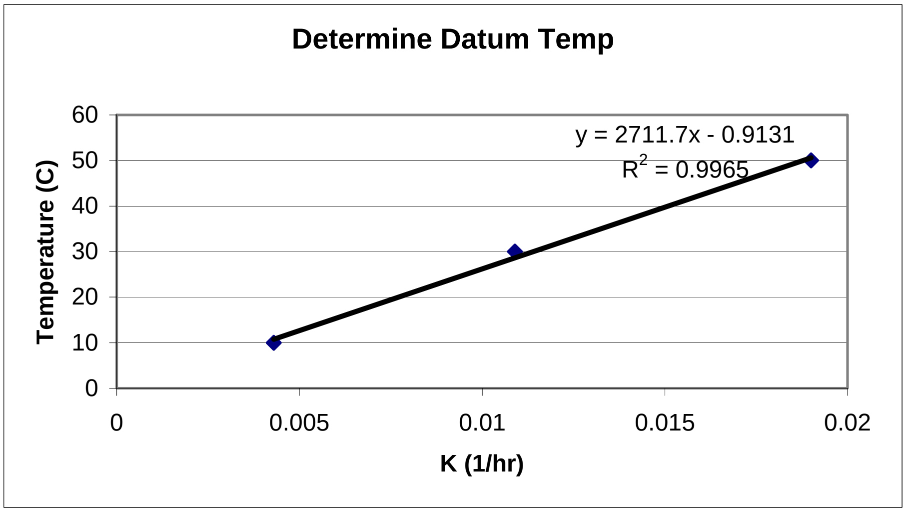

Figure A-2. 8 Datum Temperature T_o=-1^{o}C (y-intercept)

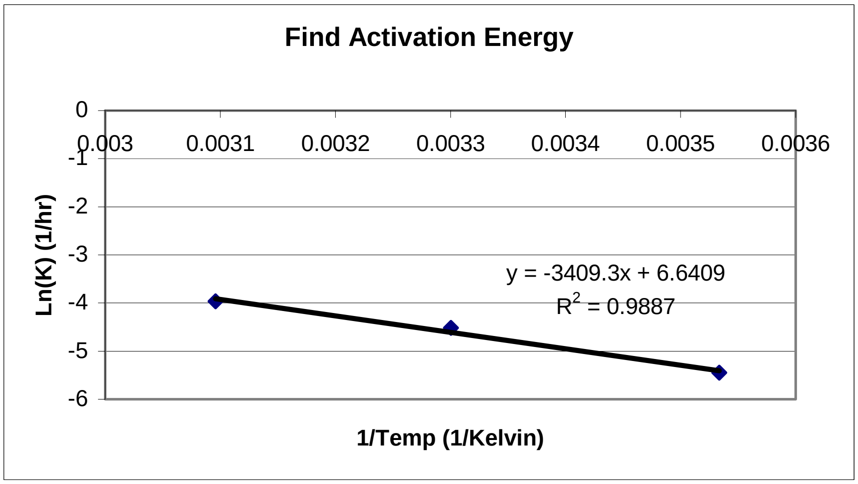

Figure A-2. 9 Q=3410 (Q=negative slope of above plot)

Table A-2. 8: Summary of Maturity Rate Constants

	T_o(°C)	Q(Kelvin)
Type II	-1	3410
Type III	-6	2760

Rate Constants (Ref: Figures A-2.3, 2.4, 2.8, 2.9)

Appendix A-3 Cylinder test data for maturity curves

Table A-3. 1: Cylinder test data Type II mix

VPI-0 Moist Cure Type II   To=-1   Q=3410

Time	Maturity(oC-hr)	t_e (hr)	Avg Strength (psi)	Ecalc1 (ksi)	Etest (ksi)	Ecalc2
64	1707	63	2430	3170	3800	3317
72	1937	72	3560	3836	4410	3779
80	2169	80	4880	4492	4730	4234
89	2422	90	5730	4867	5190	4495
96	2619	97	6410	5148	5390	4690
133	3640	135	8410	5897	5970	5210
329	8892	330	12000	7043	6670	6006
app 620	16710	619	12800	7274	6840	6166

VPI-1 Moist Cure Type II   To=-1   Q=3410

Time	Maturity(oC-hr)	t_e (hr)	Avg Strength (psi)	Ecalc1 (ksi)	Etest (ksi)	Ecalc2 (ksi)
76.5	1870	76.3	4720	4417	4540	4183
98.7	2350	98.6	6270	5091	5640	4651
146.8	3523	146.9	8400	5893		5207

VPI-1 **High** / Variable Temp CureType II   To=-1   Q=3410

Time	Maturity(oC-hr)	t_e (hr)	Avg Strength (psi)	Ecalc1 (ksi)	Etest (ksi)	Ecalc2
39	1930	95.1	4340	3908		
39.5	1960	96.2	4620	3972	4690	3874
49	2440	120	6850	4793	5180	4444
56	2790	138	7170	5232	5440	4748
48.2	2400	118	6490	4736		4404
48hr	1669	75.6	3400	3240		3366
49.5	2237	108	5330	4485		4230
98.5	3415	147	6800	5832		5165
98.5	3709	171	7750	6060	5660	5323
57	2659	129	6060	5005	5400	4591

Ecalc1 refers to equation 2.2, Ecalc2 refers to equation 2.3

Table A-3. 2: Cylinder test data Type III mix

VPI-2 Moist Cure Type III   To=-6; Q=2760

Time	Maturity(oC-hr)	t_e (hr)	Avg Strength (psi)	Ecalc1 (ksi)	Etest (ksi)	Ecalc2 (ksi)
24	756	28	3190	3632		3637
72	2117	78	7520	5576	5070	4987
93	2661	98	7830	5690	5480	5066
116	3246	120	8520	5935	5730	5236
190	5183	192	9870	6388	6060	5551
336.5	9211	341	10390	6554	6690	5666
674	18155	673	12600	7217	6370	6127

BAY-**1**/2 Match Cure Type III **12/17/2004** ; 01/05/2005

Time	Maturity(oC-hr)	t_e (hr)	Avg Strength (psi)	Ecalc1 (ksi)	Etest (ksi)	Ecalc2 (ksi)
16hr	**695**	**28**	**4590**	**4356**		4140
24h	**1097**	**44**	**6000**	**4981**		4574
64h	**2906**	**116**	**9060**	**6120**		5365
139h	**3756**	**162**	**8840**	**6045**		5313
17h	1206	59	6918	5348		4829
163h	3720	159	8314	5863		5186

Ecalc1 refers to equation 2.2, Ecalc2 refers to equation 2.3. Strength tests conducted at Bayshore Concrete Plant, Cape Charles, VA. Tests performed by QC technicians.

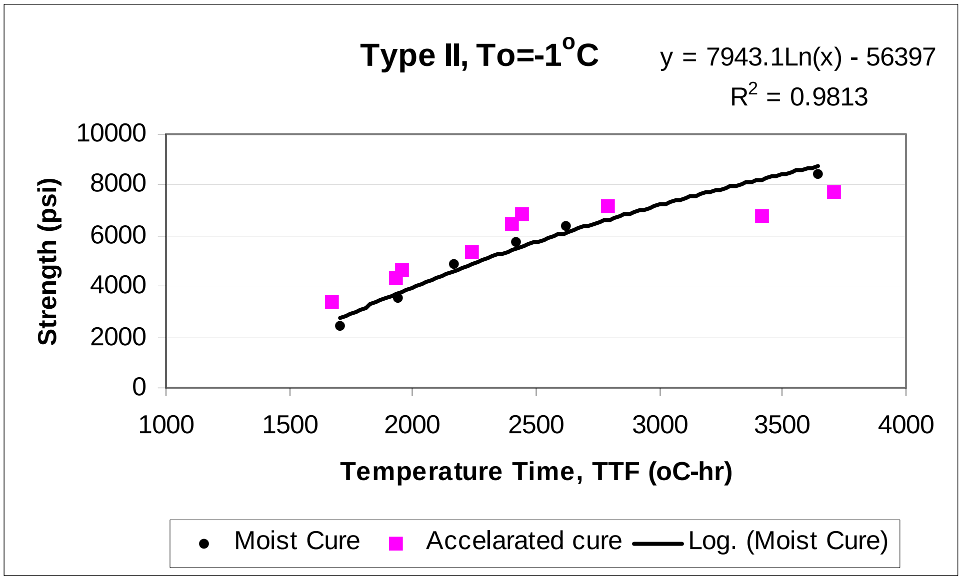

Figure A-3. 1: Accuracy of Logarithmic TTF model

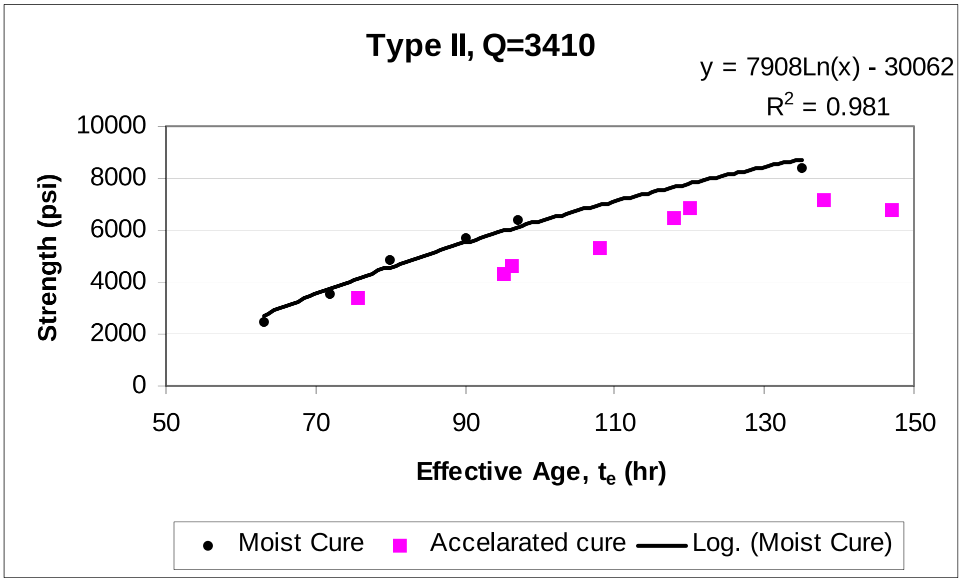

Figure A-3. 2: Accuracy of Logarithmic effective age model

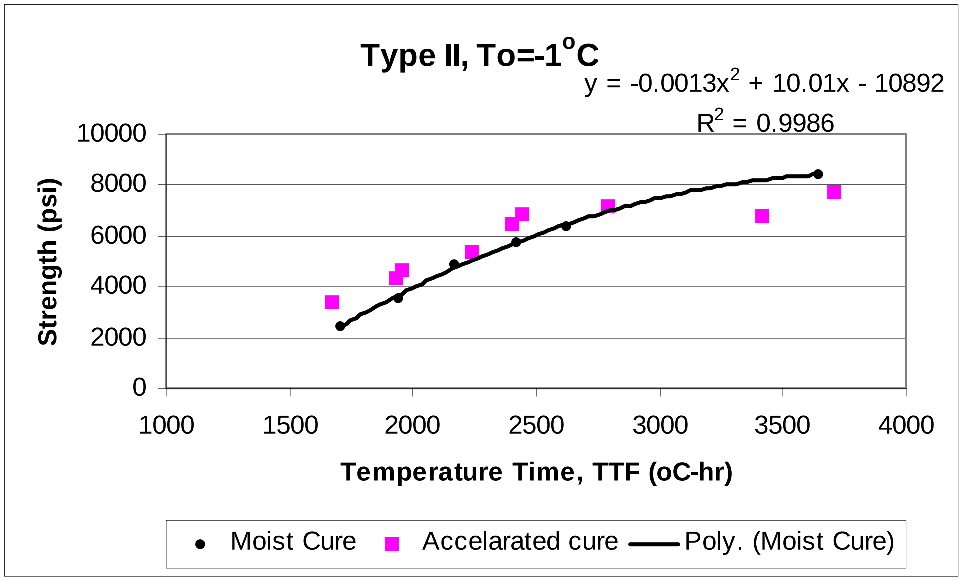

Figure A-3. 3: Analysis of Quadratic TTF model

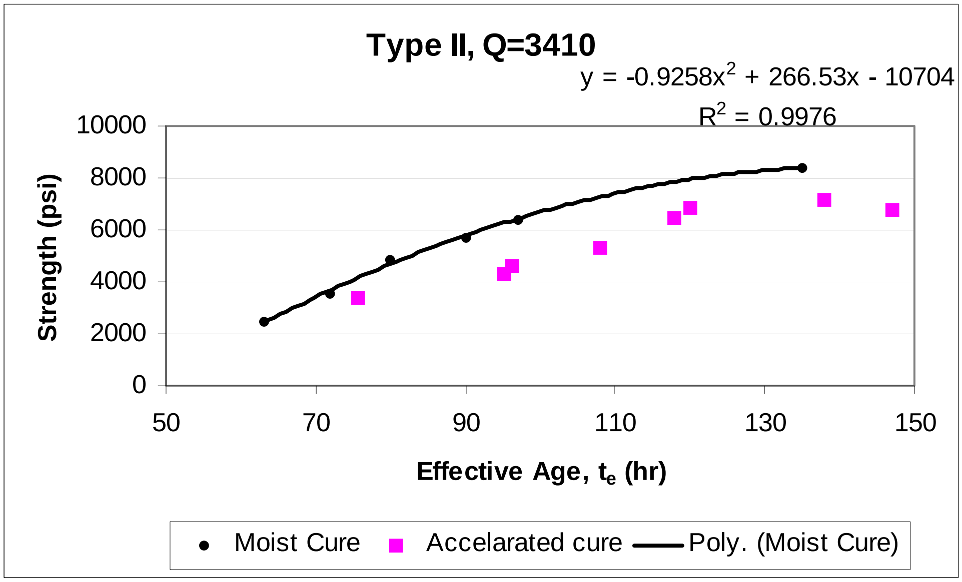

Figure A-3. 4: Analysis of Quadratic Effective Age model

Table A-3. 3: Square Root of the Sum of Squares for Type II

TYPE II MIX		LN Function Strength					
TTF	te	S(TTF)	S(t_e)	dS(TTF)	dS(t_e)	dS^2 (TTF)	dS^2 (t_e)
1930	95.1	3694	5958	646	-1618	417340	2619148
1960	96.2	3816	6049	804	-1429	645615	2042965
2440	120	5556	7797	1294	-947	1673296	897727
2790	138	6621	8903	549	-1733	301238	3002326
2400	118	5425	7665	1065	-1175	1133909	1379624
1669	75.6	2540	4144	860	-744	739771	553102
2237	108	4866	6964	464	-1634	214839	2670916
3415	147	8227	9402	-1427	-2602	2035513	6772178
3709	171	8883	10598	-1133	-2848	1282976	8112673
2659	129	6239	8369	-179	-2309	32098	5333312
					SRSS=	2911	5778

Quadratic Function Strength							
TTF	te	S(TTF)	S(t_e)	dS(TTF)	dS(t_e)	dS^2 (TTF)	dS^2 (t_e)
1930	95.1	3558	6317	782	-1977	612103	3908318
1960	96.2	3706	6416	914	-1796	835542	3224857
2440	120	5760	8006	1090	-1156	1187403	1335411
2790	138	6881	8511	289	-1341	83712	1798968
2400	118	5612	7912	878	-1422	770884	2023153
1669	75.6	2169	4193	1231	-793	1515926	628495
2237	108	4965	7335	365	-2005	133532	4020570
3415	147	8089	8539	-1289	-1739	1661798	3024351
3709	171	8306	7880	-556	-130	309486	16857
2659	129	6499	8333	-439	-2273	192400	5168502
					SRSS=	2702	5015

Measure of accuracy between calculated values of strength using logarithmic and exponential functions and actual field cured cylinder strength values. (Ref: Figures A-3.2 and A-3.4)

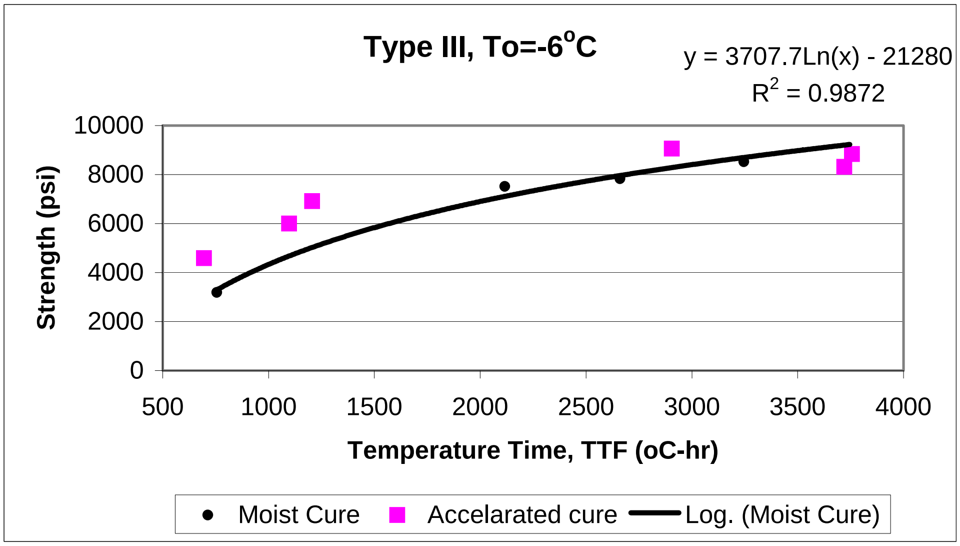

Figure A-3. 5: Analysis of Logarithmic TTF model

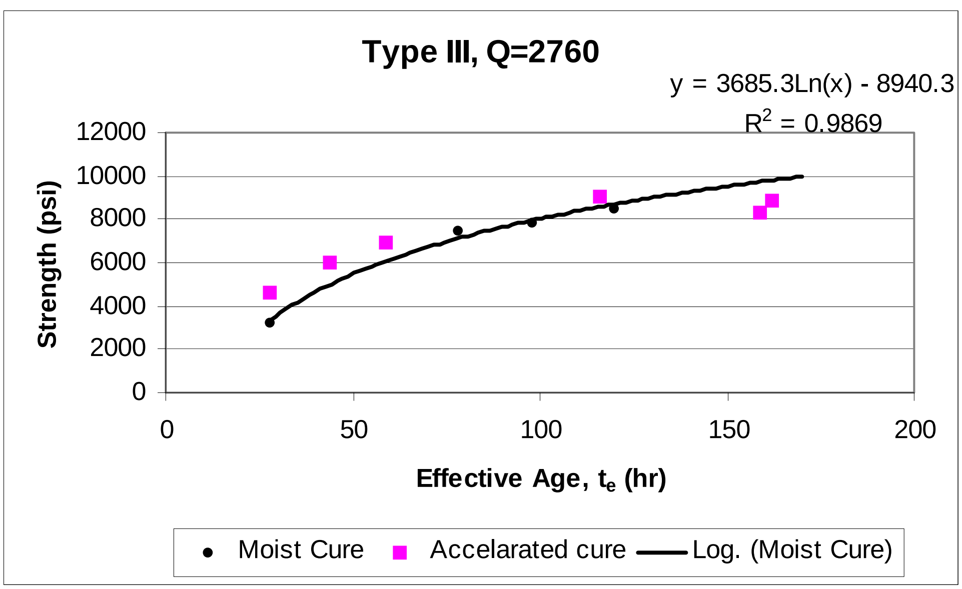

Figure A-3. 6: Analysis of Logarithmic Effective Age model

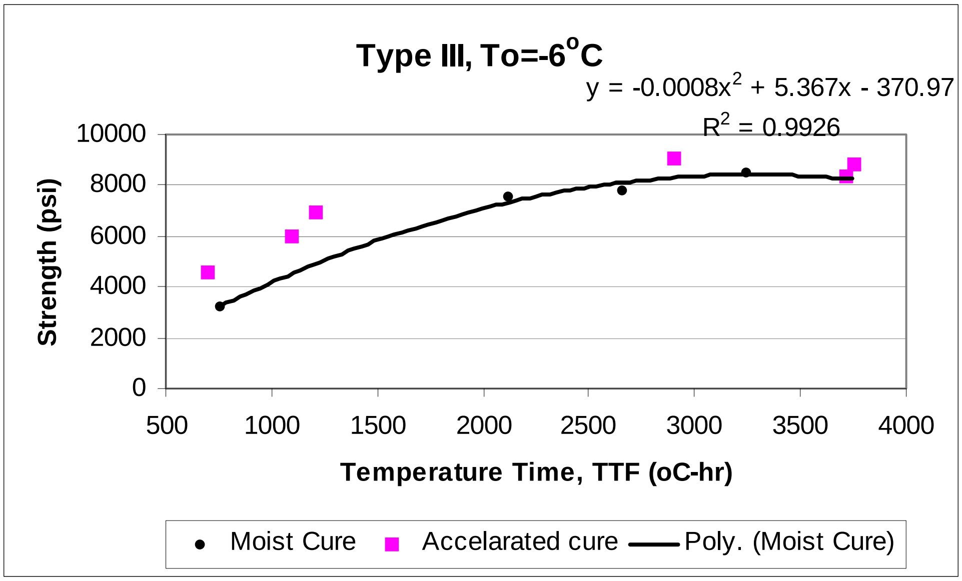

Figure A-3. 7: Analysis of Quadratic TTF model

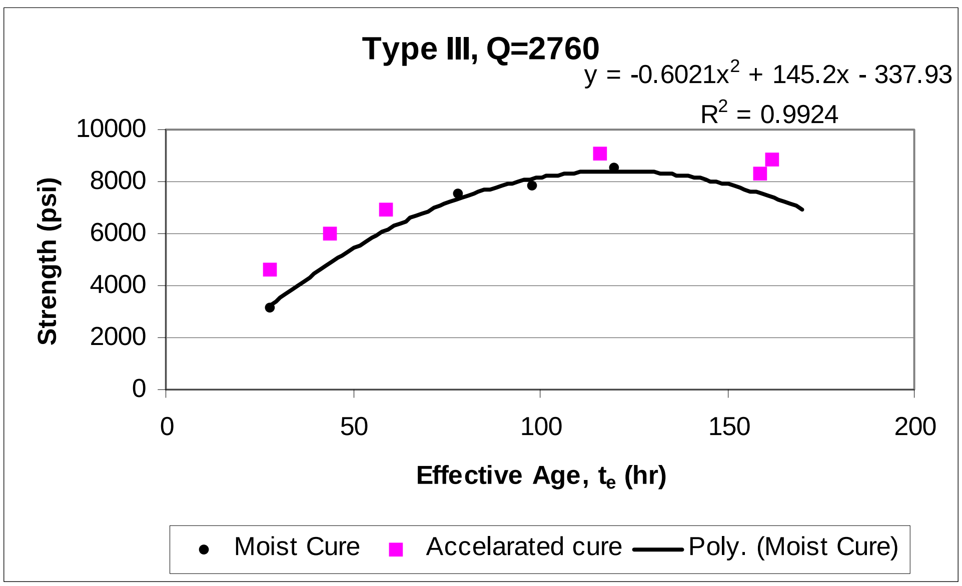

Figure A-3. 8: Analysis of Quadratic Effective Age model

Note: Downward trend, only use for ages < 125hr

Table A-3. 4: Square Root of the Sum of Squares for Type III

TYPE III MIX		LN Function Strength					
TTF	te	S(TTF)	$S(t_e)$	dS(TTF)	$dS(t_e)$	dS^2 (TTF)	dS^2 (t_e)
695	27.8	2985	3313	1605	1277	2576586	1631348
1097	43.8	4677	4988	1323	1012	1749694	1024244
2906	116	8290	8577	770	483	593566	233308
3756	162	9241	9808	-401	-968	160765	936622
1206	58.7	5028	6067	1890	851	3570215	724302
3720	159	9205	9739	-891	-1425	794316	2030374
					SRSS=	3073	2565

Quadratic Function Strength							
TTF	te	S(TTF)	$S(t_e)$	dS(TTF)	$dS(t_e)$	dS^2 (TTF)	dS^2 (t_e)
695	27.8	2975	3228	1615	1362	2609097	1855724
1097	43.8	4557	4858	1443	1142	2081779	1303938
2906	116.0	8478	8381	582	679	338315	460379
3756	162.0	8513	7353	327	1487	107131	2210836
1206	58.7	4942	6099	1976	819	3905876	670442
3720	159.0	8535	7498	-221	816	48700	666120
					SRSS=	3015	2677

Measure of accuracy between calculated values of strength using logarithmic and exponential functions and actual field cured cylinder strength values. (Ref: Figures A-3.6 and A-3.8)

Table A-3. 5: Summary of SRSS results for Strength

S.R.S.S.		TTF	te
Type II	LN	2910	5780
	Quadratic	2700	5010
Type III	LN	3070	2570
	Quadratic	3020	2680

Strength model accuracy analysis by SRSS method

Table A-3. 6: Summary of R^2 values for Strength

	R^2	TTF	te
Type II	LN	0.981	0.981
	Quadratic	0.999	0.998
Type III	LN	0.987	0.987
	Quadratic	0.993	0.992

Analysis of model Precision: Results of R^2 analysis of logarithmic and quadratic models for "standard" moist cure strength vs. maturity.

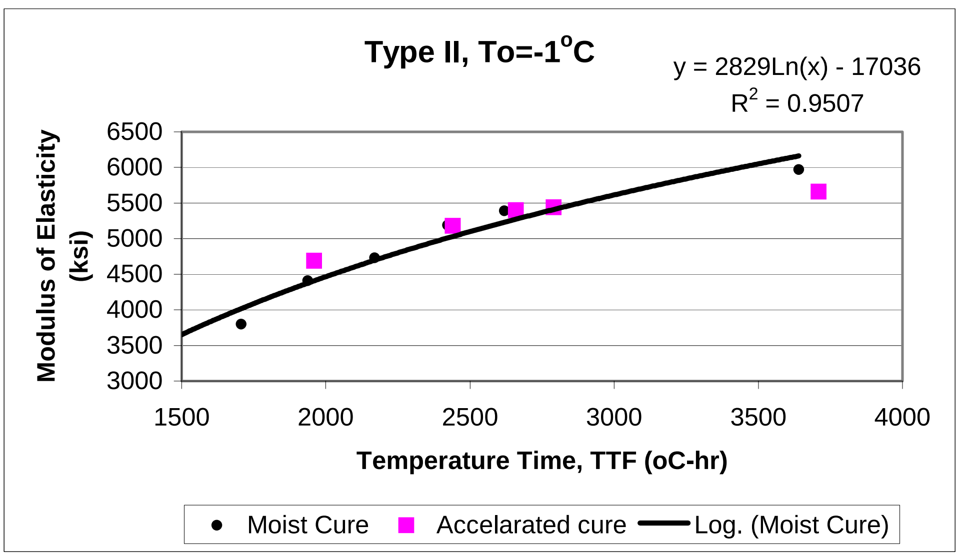

Figure A-3. 9: Analysis of Logarithmic TTF model

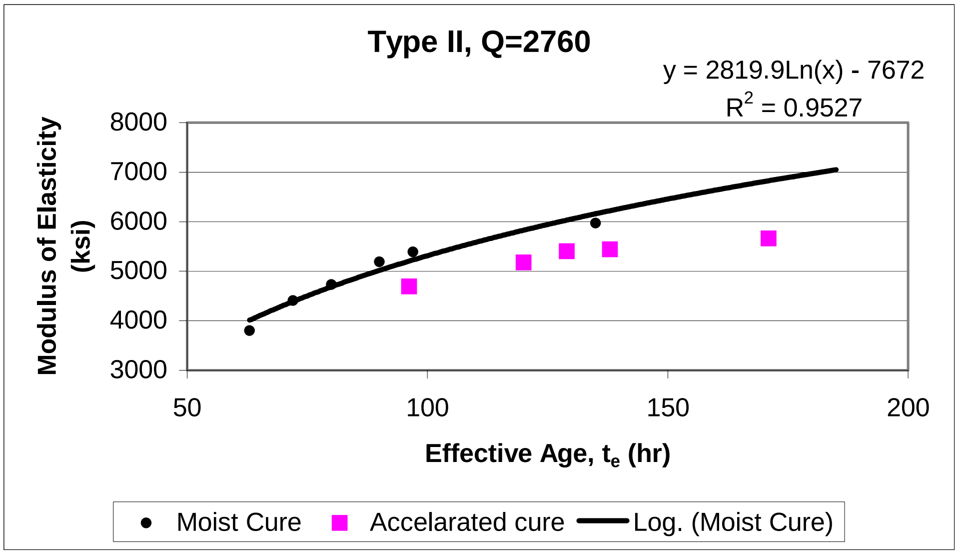

Figure A-3. 10: Analysis of Logarithmic Effective Age model

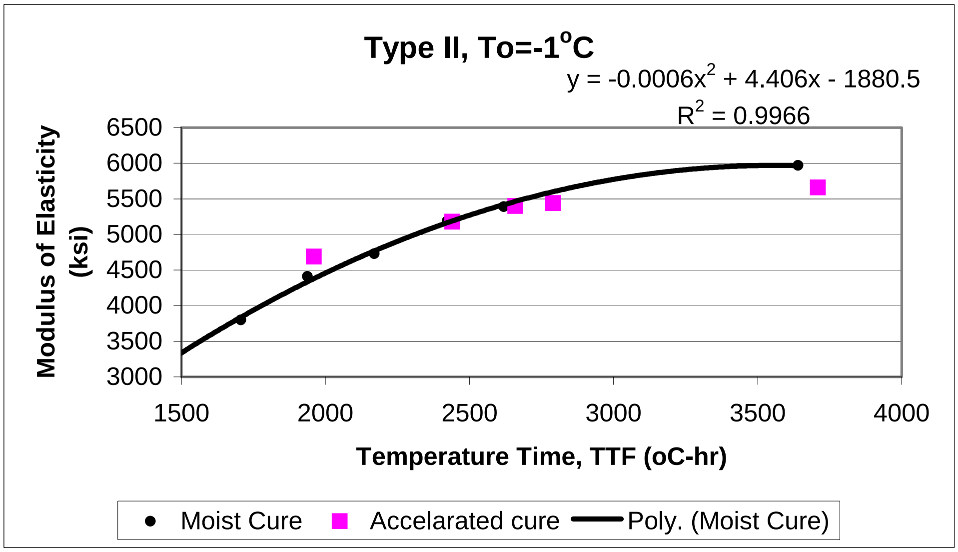

Figure A-3. 11: Analysis of Quadratic TTF model

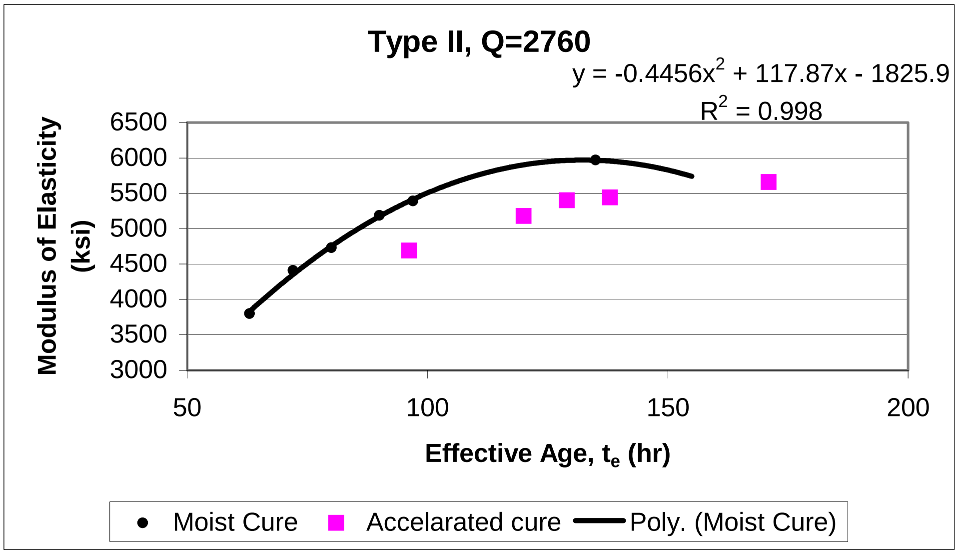

Figure A-3. 12: Analysis of Quadratic Effective Age model

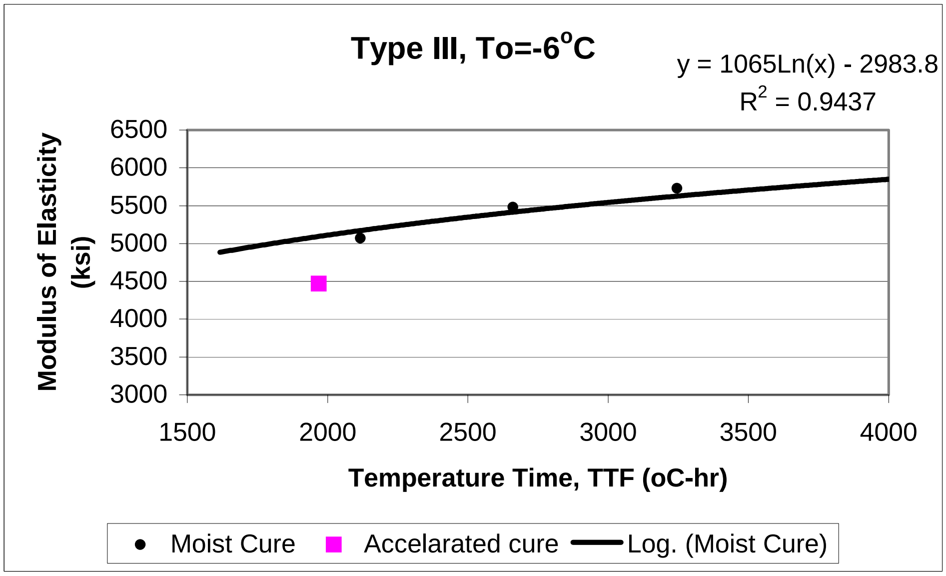

Figure A-3. 13: Analysis of Logarithmic TTF model

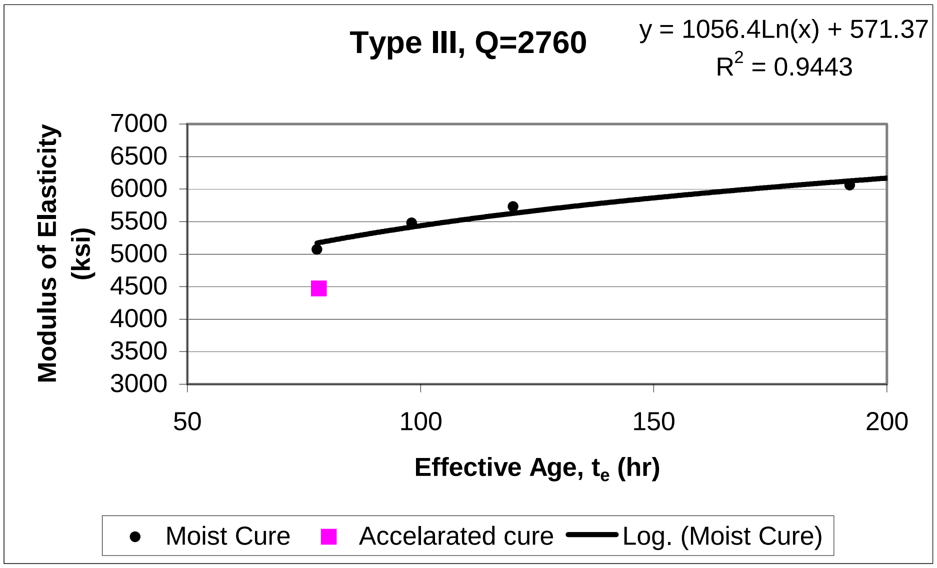

Figure A-3. 14: Analysis of Logarithmic Effective Age model

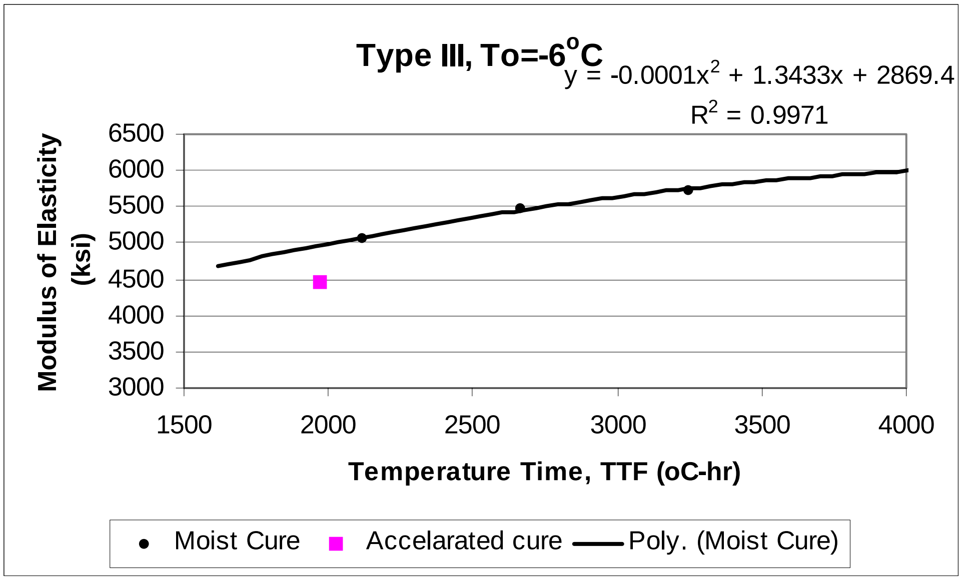

Figure A-3. 15: Analysis of Quadratic TTF model

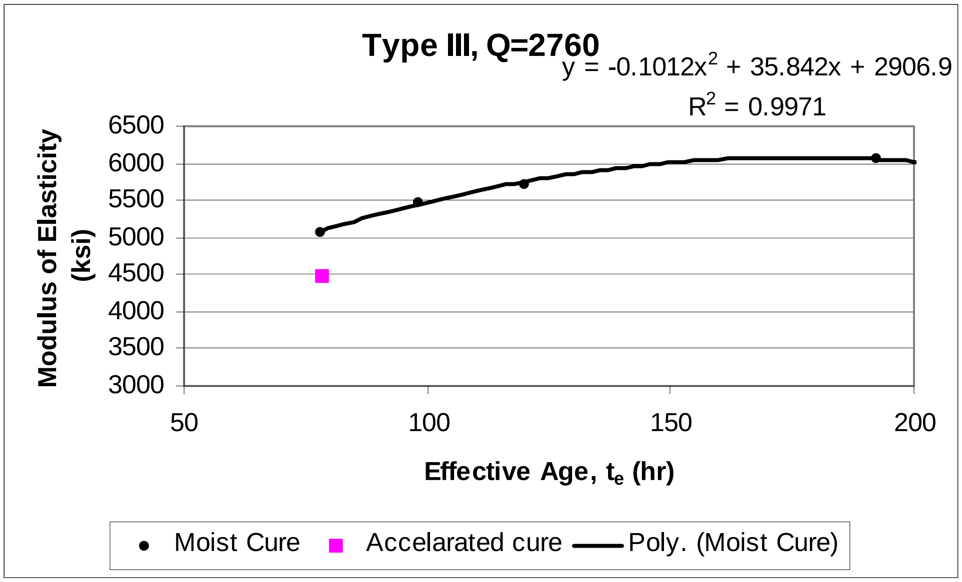

Figure A-3. 16: Analysis of Quadratic Effective Age model

Table A-3. 7: Summary of R^2 values for Modulus

	R^2	TTF	te
Type II	LN	0.951	0.953
	Quadratic	0.997	0.998
Type III	LN	0.944	0.944
	Quadratic	0.997	0.997

Table A-3. 8: Square Root of the Sum of Squares for Type II

TYPE II MIX		LN Function Modulus					
TTF	te	E(TTF)	E(t_e)	dE(TTF)	dE(t_e)	dE^2 (TTF)	dE^2 (t_e)
1960	96.2	4410	5205	280	-515	78512	265566
2440	120	5030	5829	150	-649	22650	420846
2790	138	5409	6223	31	-783	979	612863
3709	171	6214	6827	-554	-1167	307122	1363036
2659	129	5273	6033	127	-633	16215	400273
					SRSS=	652	1750

		Quadratic Function Modulus					
TTF	te	E(TTF)	E(t_e)	dE(TTF)	dE(t_e)	dE^2 (TTF)	dE^2 (t_e)
1960	96.2	4458	5398	232	-708	53991	501434
2440	120	5307	5912	-127	-732	16190	535239
2790	138	5752	5964	-312	-524	97619	274970
3709	171	6222	5311	-562	349	315486	122140
2659	129	5603	5974	-203	-574	41218	329607
					SRSS=	724	1328

Measure of accuracy between calculated values of modulus using logarithmic and exponential functions and actual field cured cylinder modulus values.

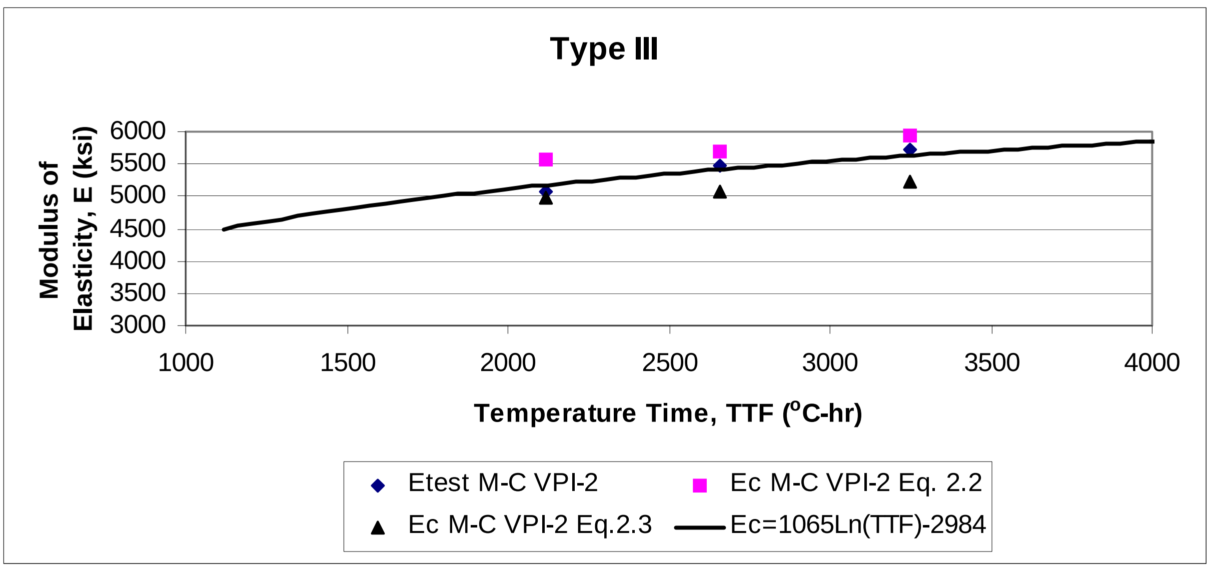

Figure A-3. 17: Comparing E(Maturity) to E(f'c) Moist Cure

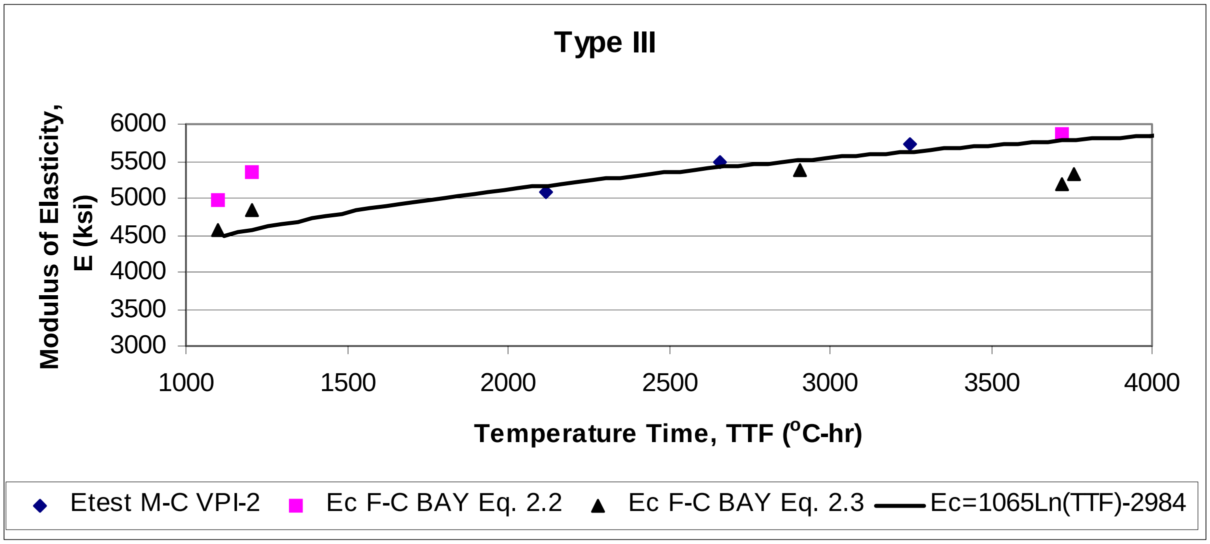

Figure A-3. 18: Comparing E(Maturity) Moist Cure to E(f'c) Steam Cure

Table A-3. 9: Summary of SRSS results for Modulus

S.R.S.S.		TTF	te
Type II	LN	652	1750
	Quadratic	724	1328
Type III	LN	624	705
	Quadratic	649	620

Type III errors are for only one data point and insufficient to adequately determine accuracy

Appendix A-4 Girder test data

Table A-4. 1: Girder Data listed by pour date and location of temperature recording device

	To=-6		fc= 8840	8840						
12/17/2004	Girder Maturity (oC-hr)		Eq 2.2 Cyl. Strength		Maturity Strength		Eq 2.2 Maturity Strength		From Maturity v E curve	
Location	North	South	En	Es	fc,n	fc,s	En	Es	En	Es
Mid-Bulb	4248	4032	5987	5987	8004	8275	5697	5793	6771	6659
Mid-Mid		3504	5987	5987		8623		5913		6348
end-Bulb		3768	5987	5987		8505		5873		6511

	To=-6		fc= 7002	6108						
1/5/2005	Girder Maturity (oC-hr)		Eq 2.2 Cyl. Strength		Maturity Strength		Eq 2.2 Maturity Strength		From Maturity v E curve	
Location	North	South	En	Es	fc,n	fc,s	En	Es	En	Es
Mid-Bulb	1170	1210	5329	4977	4817	4955	4420	4483	4304	4348
Mid-Top		1210	5329	4977		4955		4483		4348

	To=-6		fc= 7161	7031						
2/16/2005	Girder Maturity (oC-hr)		Eq 2.2 Cyl. Strength		Maturity Strength		Eq 2.2 Maturity Strength		From Maturity v E curve	
Location	North	South	En	Es	fc,n	fc,s	En	Es	En	Es
Mid-Bulb	1274	1276	5389	5340	5172	5179	4580	4583	4418	4420
end-Bulb		1140	5389	5340		4711		4371		4270

	To=-6		fc=	6108						
4/11/2005	Girder Maturity (oC-hr)		Calculated by Cyl. Strength		Maturity Strength		Eq 2.2 Maturity Strength		From Maturity v E curve	
Location	North	South	En	Es	fc,n	fc,s	En	Es	En	Es
end-Bulb		1080		4977		4495		4270		4203

	To=-6		fc= 8840	8840				
12/17/2004	Girder Maturity (oC-hr)		Eq 2.3 Cyl. Strength		Maturity Strength		Eq 2.3 Maturity Strength	
Location	North	South	En	Es	fc,n	fc,s	En	Es
Mid-Bulb	4248	4032	5237	5237	8004	8275	5037	5103
Mid-Mid		3504				8623		5186
end-Bulb		3768				8505		5158

	To=-6		fc= 7002	6108				
1/5/2005	Girder Maturity (oC-hr)		Eq 2.3 Cyl. Strength		Maturity Strength		Eq 2.3 Maturity Strength	
Location	North	South	En	Es	fc,n	fc,s	En	Es
Mid-Bulb	1170	1210	4782	4539	4817	4955	4154	4197
Mid-Top		1210				4955		4197

	To=-6		fc= 7161	7031				
2/16/2005	Girder Maturity (oC-hr)		Eq 2.3 Cyl. Strength		Maturity Strength		Eq 2.3 Maturity Strength	
Location	North	South	En	Es	fc,n	fc,s	En	Es
Mid-Bulb	1274	1276	4823	4789	5172	5179	4264	4266
end-Bulb		1140				4711		4120

	To=-6		fc=	6108				
4/11/2005	Girder Maturity (oC-hr)		Eq 2.3 Cyl. Strength		Maturity Strength		Eq 2.3 Maturity Strength	
Location	North	South	En	Es	fc,n	fc,s	En	Es
end-Bulb		1080		4539		4495		4050

Table A-4.2: Camber Calculations

I (in.^{4})= 847000
c1 (in.)= 39.33
c2 (in.)= 37.67
w (k/in)= 0.09
include +3 p/in for steel

	Span-Beam	P (k)	L (in.)	emid (in.)	eend (in.)	alpha (in.)	E_c(ksi)	d_p (in.)	A_c (in.^{2})	d_a (in.)	M_a (in-k)	Camber (in.)
E1A Eq 2.2 Using Cylinder Strength	Pour 1 (12/17) North	1630	1720	33.07	23.4	663	5990	3.70	971	2.02	33300	-1.68
	Pour 1 (12/17) South	1630	1720	33.07	23.4	663	5990	3.70	971	2.02	33300	-1.68
	Pour 2 (1/5) South	1380	1726	33.42	22.0	666	4980	3.79	971	2.47	33500	-1.33
	Pour 2 (1/5) North	1390	1646	33.42	22.0	626	5330	3.25	971	1.91	30500	-1.35
	Pour 3 (2/16) North	1610	1720	33.07	23.4	663	5390	4.06	971	2.25	33300	-1.82
	Pour 3 (2/16) South	1610	1720	33.07	23.4	663	5340	4.10	971	2.27	33300	-1.83
	Pour 4 (4/11) South	1600	1720	33.07	23.4	663	4980	4.37	971	2.43	33300	-1.94
E1B Eq 2.3 Using Cylinder Strength	Pour 1 (12/17) North	1610	1720	33.07	23.4	663	5240	4.18	971	2.31	33300	-1.87
	Pour 1 (12/17) South	1610	1720	33.07	23.4	663	5240	4.18	971	2.31	33300	-1.87
	Pour 2 (1/5) South	1370	1726	33.42	22.0	666	4540	4.13	971	2.70	33500	-1.43
	Pour 2 (1/5) North	1380	1646	33.42	22.0	626	4780	3.60	971	2.12	30500	-1.48
	Pour 3 (2/16) North	1590	1720	33.07	23.4	663	4820	4.49	971	2.51	33300	-1.97
	Pour 3 (2/16) South	1590	1720	33.07	23.4	663	4790	4.51	971	2.53	33300	-1.99
	Pour 4 (4/11) South	1580	1720	33.07	23.4	663	4540	4.73	971	2.67	33300	-2.07
E1B Eq 2.2 Using Maturity Strength	Pour 1 (12/17) North	1620	1720	33.07	23.4	663	5700	3.87	971	2.12	33300	-1.74
	Pour 1 (12/17) South	1620	1720	33.07	23.4	663	5790	3.80	971	2.09	33300	-1.71
	Pour 2 (1/5) South	1370	1726	33.42	22.0	666	4480	4.19	971	2.74	33500	-1.45
	Pour 2 (1/5) North	1360	1646	33.42	22.0	626	4420	3.84	971	2.30	30500	-1.54
	Pour 3 (2/16) North	1580	1720	33.07	23.4	663	4580	4.69	971	2.64	33300	-2.05
	Pour 3 (2/16) South	1580	1720	33.07	23.4	663	4580	4.69	971	2.64	33300	-2.05
	Pour 4 (4/11) South	1570	1720	33.07	23.4	663	4270	5.00	971	2.84	33300	-2.16
E2B Eq 2.3 Using Maturity Strength	Pour 1 (12/17) North	1600	1720	33.07	23.4	663	5040	4.32	971	2.40	33300	-1.91
	Pour 1 (12/17) South	1600	1720	33.07	23.4	663	5100	4.27	971	2.37	33300	-1.89
	Pour 2 (1/5) South	1360	1726	33.42	22.0	666	4200	4.43	971	2.92	33500	-1.51
	Pour 2 (1/5) North	1360	1646	33.42	22.0	626	4150	4.09	971	2.45	30500	-1.64
	Pour 3 (2/16) North	1570	1720	33.07	23.4	663	4260	5.01	971	2.84	33300	-2.17
	Pour 3 (2/16) South	1570	1720	33.07	23.4	663	4270	5.00	971	2.84	33300	-2.16
	Pour 4 (4/11) South	1560	1720	33.07	23.4	663	4050	5.24	971	2.99	33300	-2.25
E3	Pour 1 (12/17) North	1650	1720	33.07	23.4	663	6770	3.31	971	1.79	33300	-1.53
	Pour 1 (12/17) South	1640	1720	33.07	23.4	663	6660	3.35	971	1.82	33300	-1.53
	Pour 2 (1/5) South	1360	1726	33.42	22.0	666	4350	4.28	971	2.82	33500	-1.46
	Pour 2 (1/5) North	1360	1646	33.42	22.0	626	4300	3.95	971	2.36	30500	-1.59
	Pour 3 (2/16) North	1580	1720	33.07	23.4	663	4420	4.86	971	2.74	33300	-2.12
	Pour 3 (2/16) South	1580	1720	33.07	23.4	663	4420	4.86	971	2.74	33300	-2.12
	Pour 4 (4/11) South	1570	1720	33.07	23.4	663	4200	5.08	971	2.88	33300	-2.20

Table A-4. 3: Calculation of prestress losses due to elastic shortening

Span-Beam	x (ft)	L (ft)	Pj (k)	ES (ksi)	ES loss (%)	Pe (k)	Aps	Ec(t)	n	f_{cir} (ksi)	e (in)
E1A fn($f'_{c,cyl}$) Eq 2.2											
mid 12/17 North	71.7	143.33	1772	-16.6	-8.1%	1629	8.6	5990	4.5	-3.69	33.1
mid 12/17 South	71.7	143.33	1772	-16.6	-8.1%	1629	8.6	5990	4.5	-3.69	33.1
mid 1/5 South	71.9	143.8	1506	-17.2	-8.3%	1381	7.31	4980	5.4	-3.17	33.4
mid 1/5 North	68.6	137.2	1506	-16.0	-7.8%	1389	7.31	5330	5.1	-3.17	33.4
mid 2/16 North	71.7	143.33	1772	-18.5	-9.0%	1613	8.6	5390	5.0	-3.69	33.1
mid 2/16 South	71.7	143.33	1772	-18.7	-9.1%	1612	8.6	5340	5.1	-3.69	33.1
mid 4/11 South	71.7	143.33	1772	-20.0	-9.7%	1600	8.6	4980	5.4	-3.69	33.1
E1B fn($f'_{c,cyl}$) Eq 2.3											
mid 12/17 North	71.7	143.33	1772	-19.0	-9.2%	1608	8.6	5240	5.2	-3.69	33.1
mid 12/17 South	71.7	143.33	1772	-19.0	-9.2%	1608	8.6	5240	5.2	-3.69	33.1
mid 1/5 South	71.9	143.8	1506	-18.8	-9.1%	1368	7.31	4540	5.9	-3.17	33.4
mid 1/5 North	68.6	137.2	1506	-17.9	-8.7%	1375	7.31	4780	5.6	-3.17	33.4
mid 2/16 North	71.7	143.33	1772	-20.7	-10.0%	1594	8.6	4820	5.6	-3.69	33.1
mid 2/16 South	71.7	143.33	1772	-20.8	-10.1%	1593	8.6	4790	5.6	-3.69	33.1
mid 4/11 South	71.7	143.33	1772	-21.9	-10.7%	1583	8.6	4540	5.9	-3.69	33.1
E2A fn($f'_{c,mat}$) Eq 2.2											
mid 12/17 North	71.7	143.33	1772	-17.5	-8.5%	1622	8.6	5700	4.7	-3.69	33.1
mid 12/17 South	71.7	143.33	1772	-17.2	-8.4%	1624	8.6	5790	4.7	-3.69	33.1
mid 1/5 South	71.9	143.8	1506	-19.1	-9.3%	1367	7.31	4480	6.0	-3.17	33.4
mid 1/5 North	68.6	137.2	1506	-19.3	-9.4%	1365	7.31	4420	6.1	-3.17	33.4
mid 2/16 North	71.7	143.33	1772	-21.8	-10.6%	1585	8.6	4580	5.9	-3.69	33.1
mid 2/16 South	71.7	143.33	1772	-21.8	-10.6%	1585	8.6	4580	5.9	-3.69	33.1
mid 4/11 South	71.7	143.33	1772	-23.3	-11.3%	1571	8.6	4270	6.3	-3.69	33.1

Elastic Shortening calculations: E1A refers to Equation 2.2 using cylinder strength, E1B refers to Equation 2.3 using cylinder strength, E2A refers to Equation 2.2 using strength as a function of maturity, E2B refers to Equation 2.3 using strength as a function of maturity, E3 refers to Modulus as a function of maturity. x is location from support, L is girder length, Pj is jacking force, ES is prestress loss due to elastic shortening, ES loss is change in stress as a %, Aps is area of prestress, Ec is modulus measured by maturity, n is modular ratio, fcir is stress in concrete at the centroid of the prestress strand assuming 90% of jacking force, e is eccentricity of strand.

Table A-4. 3 cont…: Calculation of prestress losses due to elastic shortening

Span-Beam	x (ft)	L (ft)	Pj (k)	ES (ksi)	ES loss (%)	Pe (k)	Aps	Ec(t)	n	f_{cir} (ksi)	e (in)
E2B fn($f_{c,TTF}$) Eq 2.3											
mid 12/17 North	71.7	143.33	1772	-19.8	-9.6%	1602	8.6	5040	5.4	-3.69	33.1
mid 12/17 South	71.7	143.33	1772	-19.5	-9.5%	1604	8.6	5100	5.3	-3.69	33.1
mid 1/5 South	71.9	143.8	1506	-20.4	-9.9%	1357	7.31	4200	6.4	-3.17	33.4
mid 1/5 North	68.6	137.2	1506	-20.6	-10.0%	1355	7.31	4150	6.5	-3.17	33.4
mid 2/16 North	71.7	143.33	1772	-23.4	-11.4%	1571	8.6	4260	6.3	-3.69	33.1
mid 2/16 South	71.7	143.33	1772	-23.3	-11.3%	1571	8.6	4270	6.3	-3.69	33.1
mid 4/11 South	71.7	143.33	1772	-24.6	-11.9%	1560	8.6	4050	6.7	-3.69	33.1
E3 fn(TTF)											
mid 12/17 North	71.7	143.33	1772	-14.7	-7.1%	1645	8.6	6770	4.0	-3.69	33.1
mid 12/17 South	71.7	143.33	1772	-15.0	-7.3%	1643	8.6	6660	4.1	-3.69	33.1
mid 1/5 South	71.9	143.8	1506	-19.6	-9.5%	1362	7.31	4350	6.2	-3.17	33.4
mid 1/5 North	68.6	137.2	1506	-19.9	-9.7%	1361	7.31	4300	6.3	-3.17	33.4
mid 2/16 North	71.7	143.33	1772	-22.5	-10.9%	1578	8.6	4420	6.1	-3.69	33.1
mid 2/16 South	71.7	143.33	1772	-22.5	-10.9%	1578	8.6	4420	6.1	-3.69	33.1
mid 4/11 South	71.7	143.33	1772	-23.7	-11.5%	1568	8.6	4200	6.4	-3.69	33.1

Elastic Shortening calculations: E1A refers to Equation 2.2 using cylinder strength, E1B refers to Equation 2.3 using cylinder strength, E2A refers to Equation 2.2 using strength as a function of maturity, E2B refers to Equation 2.3 using strength as a function of maturity, E3 refers to Modulus as a function of maturity. x is location from support, L is girder length, Pj is jacking force, ES is prestress loss due to elastic shortening, ES loss is change in stress as a %, Aps is area of prestress, Ec is modulus measured by maturity, n is modular ratio, fcir is stress in concrete at the centroid of the prestress strand assuming 90% of jacking force, e is eccentricity of strand.

Table A-4. 4: Summary of camber and Modulus calculations

	N. 12/17/04	S. 12/17/04	N. 1/05/05	S. 1/05/05	N. 2/16/05	S. 2/16/05	S. 4/11/05
Maturity TTF ^{o}C-hr	4250	4030	1170	1210	1270	1280	1080
E1A= *fn* ($f_{c,cyl}$) Eq 2.2	5990	5990	5330	4980	5390	5340	4980
E1B= *fn* ($f_{c,cyl}$) Eq 2.3	5240	5240	4780	4540	4820	4790	4540
E2A= *fn* ($f_{c,Mat}$) Eq 2.2	5700	5790	4420	4480	4580	4580	4270
E2B= *fn* ($f_{c,Mat}$) Eq 2.3	5040	5100	4150	4200	4260	4270	4050
E3= *fn* (Mat)	6770	6660	4300	4350	4420	4420	4200
Camber *fn* (E1A)	1 5/8	1 5/8	1 3/8	1 3/8	1 7/8	1 7/8	2
Camber *fn* (E1B)	1 7/8	1 7/8	1 1/2	1 3/8	2	2	2
Camber *fn* (E2A)	1 3/4	1 3/4	1 1/2	1 1/2	2	2	2 1/8
Camber *fn* (E2B)	2	1 7/8	1 1/2	1 5/8	2 1/8	2 1/8	2 1/4
Camber *fn* (E3)	1 1/2	1 1/2	1 1/2	1 5/8	2 1/8	2 1/8	2 1/4
Camber Measured	1 3/8	1 1/2	2 7/8	3 3/8	2	2 1/8	2 1/2

E1A refers to Equation 2.2 using cylinder strength, E1B refers to Equation 2.3 using cylinder strength, E2A refers to Equation 2.2 using strength as a function of maturity, E2B refers to Equation 2.3 using strength as a function of maturity, E3 refers to Modulus as a function of maturity. E is in ksi and camber is in inches.

Appendix B: Girder shop drawing (metric)