

Appendix B: PCCV Model Material Properties

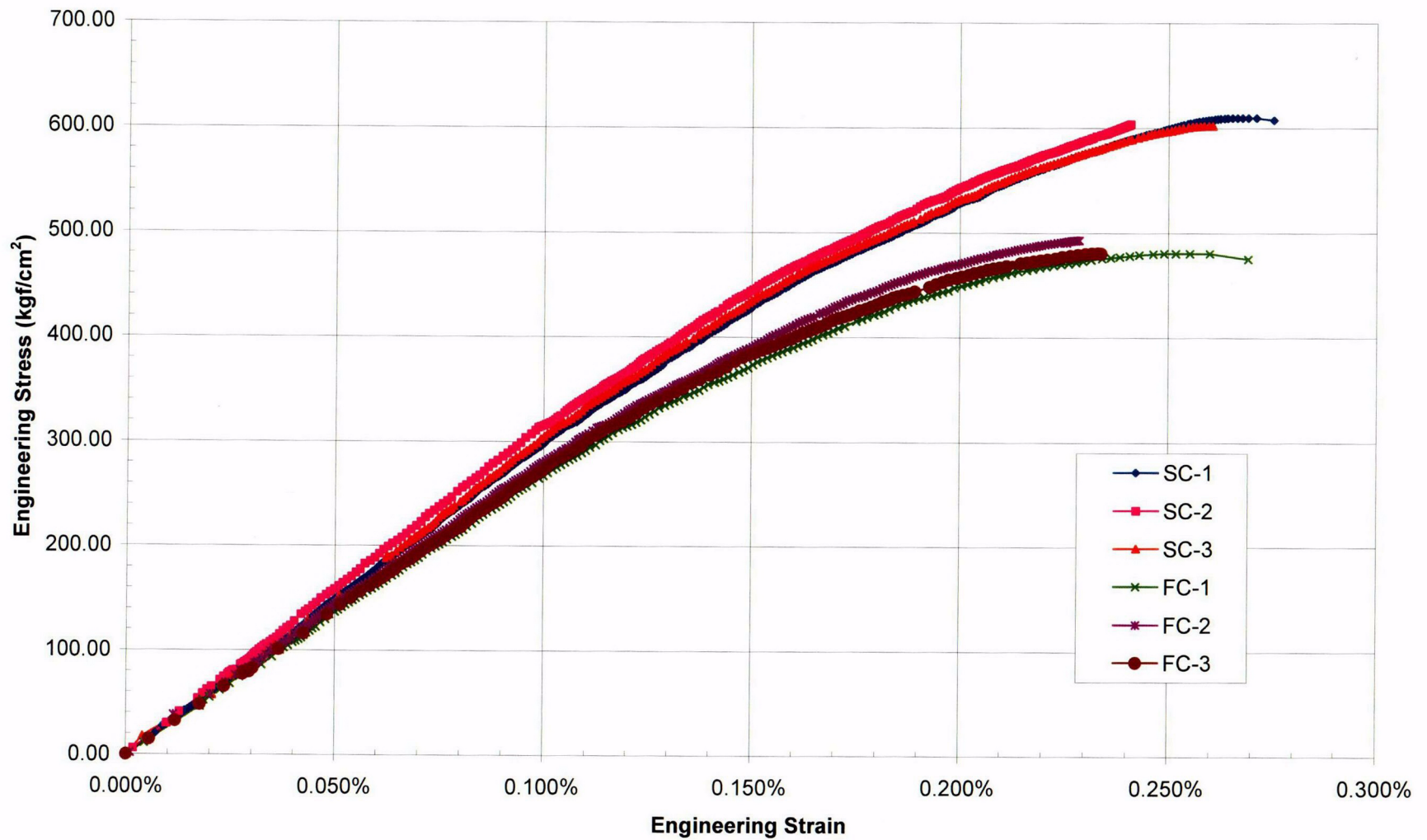
Section i. Trial Mix Concrete

*For test A, stress-strain results were obtained up to about 40% of the maximum stress

Trial Concrete Mixture Test (ENGLISH)														
Procedures & Specifications														
JPN-14-T-1-6, Trial Concrete Mixture, Procedure, Rev. 1; 5/14/96														
Data & Test Reports														
(A) JPN-22-T-1, Ancillary Test Report, October 3, 1997														
(B) JPN-22-T-1(Rev.1), Ancillary Test Report, March 9, 1998														
(C) MH-K10-39, Concrete Creep Coeff. & Drying Shrinkage Test Report														
Test Items														
Fresh Concrete														
			4300 psi		6400 psi									
Slump w/o superplasticizers (in)	ASTM C143-90a	(A)	6.6		4.3									
		(B)	3.6		3.5									
Slump w/ superplasticizers (cm)		(A)	7.6		8.1									
		(B)	6.4		7.4									
Air Content (%)	ASTM C231-91b	(A)	4.50		4.85									
		(B)	5.50		5.00									
Quantity of Chloride (%)	ASTM C1152-90	(A)	0.001		0.002									
		(B)	0.003		0.002									
Hardened Concrete														
			4300 psi		6400 psi		4300 psi		6400 psi		4300 psi		6400 psi	
Specimens	ASTM C31-91		SC	FC	SC	FC	SC	FC	SC	FC	SC	FC	SC	FC
			1 week				4 weeks				13 weeks			
Compressive Strength (psi)	ASTM C39-86 or -94(?)	(A)	4877	4266	5674	5944	5844	4849	7210	6996	7451	6044	8731	7082
		(B)	-	-	-	-	6882	6058	7750	7736	8546	6826	9343	8959
Split Tensile Strength (psi)	ASTM C496-90	(A)									570	489	610	501
		(B)									577	577	647	557
Flexural Strength (psi)	ASTM C-78-84	(A)									779	580	809	799
		(B)									816	856	836	637
Young's Modulus (psi x 10 ⁶)	ASTM C469-87	(A)									4.2	4.1	4.6	3.9
		(B)									4.3	3.9	4.3	4.2
Poisson's Ratio	ASTM C469-87	(A)									0.20	0.18	0.20	0.18
		(B)									0.22	0.23	0.23	0.23
Unit Weight (pcf)	weight of cylinders	(A)									140	138	141	137
	nominal volume	(B)									140	139	140	139
Stress-Strain Relation	TTP-08, Rev. 1, 9/19/97	(A)*												
	using strain gages	(B)									X(B)	X(B)	X(B)	X(B)
Creep Coefficient	ASTM C512-87	(loaded at 2500 psi)											X(C)	
Drying Shrinkage	ASTM C512-87	(w/o loading)											X(C)	

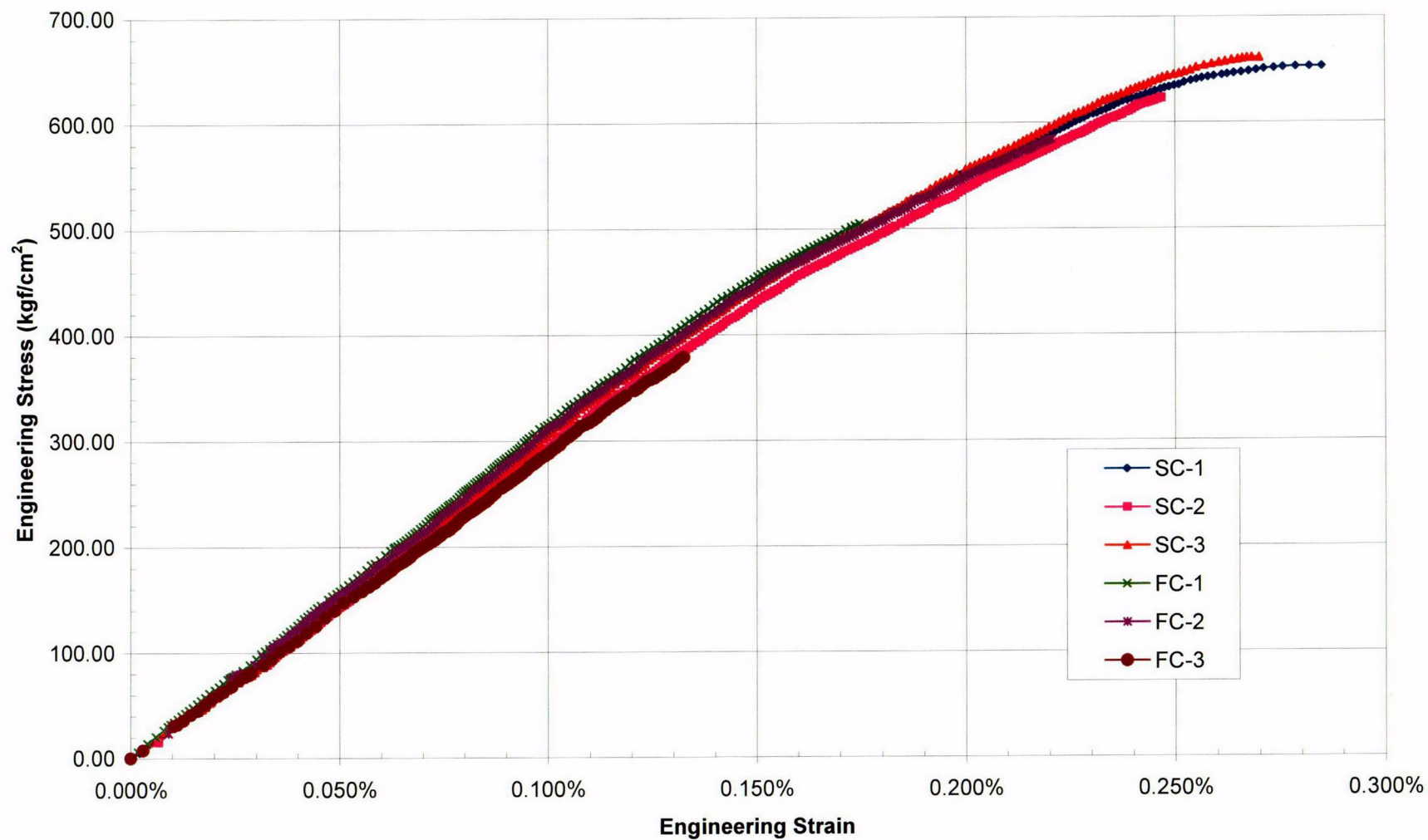
*For test A, stress-strain results were obtained up to about 40% of the maximum stress

Trial Concrete Mix Stress-Strain @ 13 weeks (300 kgf/cm^2) - Series B



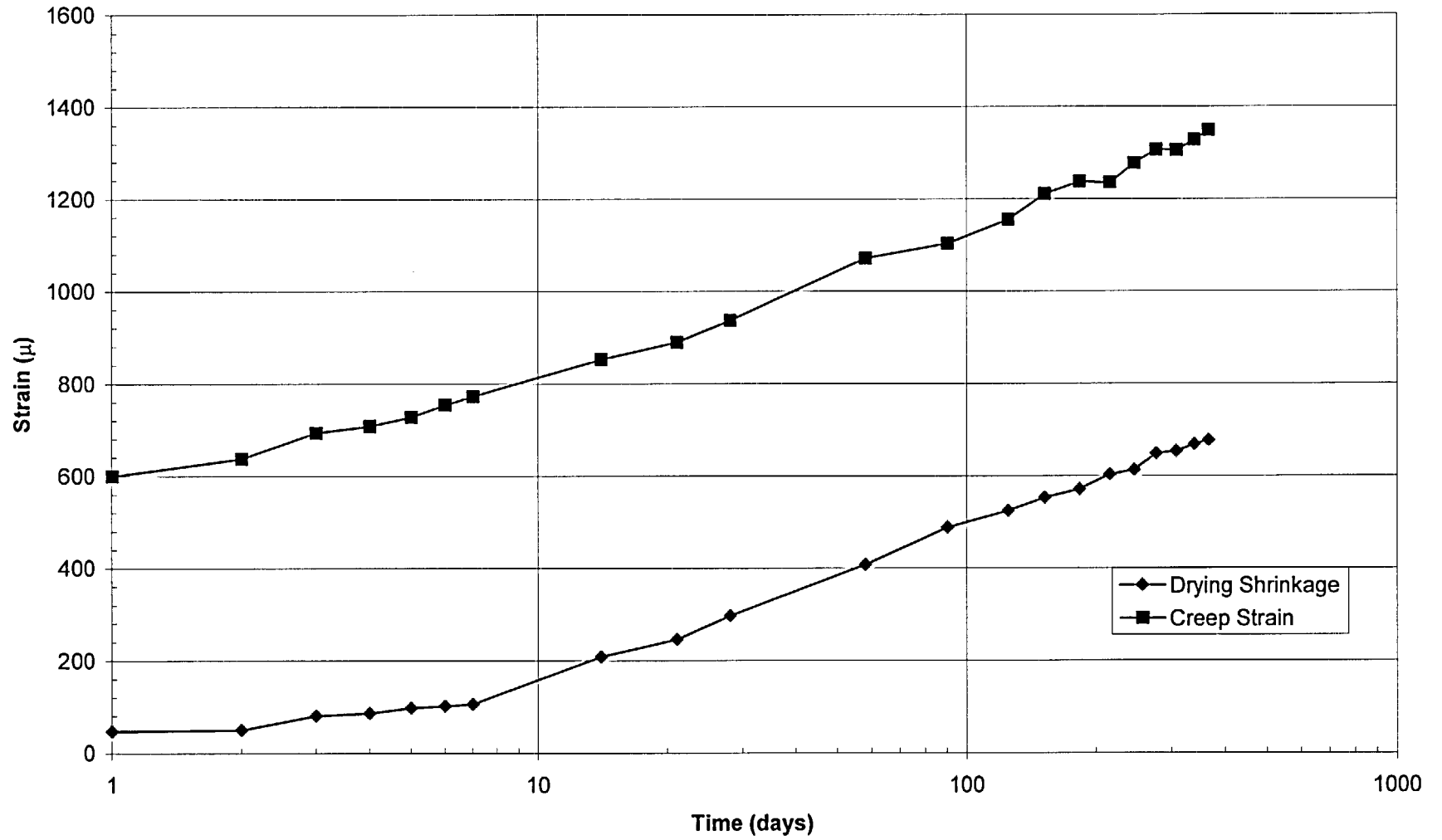
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Trial Concrete Mix Stress-Strain @ 13 weeks (450 kgf/cm²) - Series B



Concrete Creep and Shrinkage Strain

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Section ii. Model Concrete

PCCV Model Concrete Tests (METRIC)																
Procedures & Specifications																
Spec.-T-03-1(E) Specification for Concrete Work; Rev.2																
JPN-14-T-1-8; Concrete Material Test Procedure; Rev. 1; 6/14/96																
Submittal : T-03-1 (E) 2.17.0; Revised 10/30/97																
Data & Test Reports																
(A)* AGRA Reports of Compression Test Results, *NUPEC to issue Test Report																
(B) JPN-22-T-1 (Rev.1), Ancillary Test Report, 9 March 1998																
(C) "Strength and Creep Testing of Concrete in PCCV", ATR/UNM, 31 Jan. 2000																
(D) MH-K11-37: PCCV Stress-Strain Tests, CTL, 15 Feb 2000																
(E) "Mechanical Property Evaluation of Concrete Used in the NUPEC/NRC PCCV: Prestress and Limit State Test Results", Lenke & Gerstle, ATR Institute/UNM, 30 June 2001.																
(F)Draft "Standard Test Method for Determination of Direct Tension Properties of Hardened Concrete using the Stiff Tensile Test (STT) Apparatus", Feb. 2000																
	Specification	Lift:	F1	F2	F3a	F3b	F4	C1	C2	C3	C4	D1	D2	D3	F5	F6
			300	300	300	450	450	450	450	450	450	450	450	450	300	450
Quality Control Tests																
Specimens	ASTM C31-91															
At Placement			X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			02/12/97	02/28/97	05/08/97	05/08/97	07/02/97	11/11/98	12/10/98	01/05/99	01/28/99	03/03/99	04/12/99	04/15/99	05/24/00	06/09/00
Slump (cm)	ASTM C143-90a		14.5	16.8	18.3	14.2	16.5	18.3	23.5	21.4	21.9	21.7	24.6	10.8	9.7	9.7
Air Content (%)	ASTM C231-91b		6.5	7.2	6.0	5.7	6.4	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.0	3.6
Unit Weight (kgf/m ³)			2159.5	2206.0	2196.3	2178.7	2159.5	2212.4	2216.2	2235.3	2244.9	2232.7	2215.6	2214.8		
Temperature (C)			22.2	21.1	27.2	28.3	28.9	22.2	20.4	22.3	17.4	23.6	23.9	21.4	27.7	27.8
1 Week			X(B)	X(B)	X(B)	X(B)	X(B)				X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			02/19/97	03/07/97		05/15/97					02/03/99	03/10/99	04/19/99	04/22/99	05/31/00	06/16/00
Compressive Strength (kgf/cm ²)	ASTM C39-86	SC	347	320	-	404	-					370	363	400	334	365
		FC	-	-	-	-	-				378					
		FC*									430	353	360	386		
4 Weeks			X(B)	X(B)	X(B)	X(B)	X(B)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			03/05/97	03/28/97	06/05/97	06/05/97	07/30/97	12/09/98	01/07/99	02/02/99	02/24/99	03/31/99	05/10/99	05/13/99	06/21/00	07/07/00
Compressive Strength (kgf/cm ²)	ASTM C39-86	SC	392	404	401	490	370	372	386	419	488	474	451	483	407	460
		FC	389	461	342	438	496	339	336	395	423					
		FC*									460	459	435	499	422	459
13 Weeks			X(B)	X(B)	X(B)	X(B)	X(B)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)		
Date (M/D/Y)				05/30/97	08/07/97	08/07/97	10/01/97	02/10/99	03/11/99	04/06/99	04/28/99	06/02/99	07/12/99	07/15/99		
Compressive Strength (kgf/cm ²)	ASTM C39-86	SC	479	480	488	560	449	480	498	496	545	553	489	629		
		FC	395	438	391	483	516	389	436	450	484					
		FC*									516	577	529	629		
Mean Comp. Strength (kgf/cm ²)	ASTM C469-87	FC						X(C)	X(C)							
Young's Modulus (kgf/cm ² x 10 ⁵)	ASTM C469-87	FC						2.05	2.30							
Stress-Strain	ASTM C469-87	FC						X(C)	X(C)							
Poisson's Ratio	ASTM C469-87	FC						0.19	0.22							
Creep Test Data																
Creep Coefficient	ASTM C512-87			FC					X(C)							
Specific Creep (in/in/psi)	(loaded to 61.5 kgf/cm ² @ 28 days)			FC					X(C)							
Drying Shrinkage strain (in/in)	(relative to 28 days)			FC					X(C)							

PCCV Model Concrete Tests (METRIC)																
Procedures & Specifications																
Spec.-T-03-1(E) Specification for Concrete Work; Rev.2																
JPN-14-T-1-8; Concrete Material Test Procedure; Rev. 1; 6/14/96																
Submittal : T-03-1 (E) 2.17.0; Revised 10/30/97																
Data & Test Reports																
(A)* AGRA Reports of Compression Test Results, *NUPEC to issue Test Report																
(B) JPN-22-T-1 (Rev.1), Ancillary Test Report, 9 March 1998																
(C) "Strength and Creep Testing of Concrete in PCCV", ATR/UNM, 31 Jan. 2000																
(D) MH-K11-37: PCCV Stress-Strain Tests, CTL, 15 Feb 2000																
(E) "Mechanical Property Evaluation of Concrete Used in the NUPEC/NRC PCCV: Prestress and Limit State Test Results", Lenke & Gerstle, ATR Institute/UNM, 30 June 2001.																
(F) Draft "Standard Test Method for Determination of Direct Tension Properties of Hardened Concrete using the Stiff Tensile Test (STT) Apparatus", Feb. 2000																
	Specification	Lift:	F1	F2	F3a	F3b	F4	C1	C2	C3	C4	D1	D2	D3	F5	F6
			300	300	300	450	450	450	450	450	450	450	450	450	300	450
Design Data Tests																
@ Prestressing																
Date (M/D/Y)			01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00		
Compressive Strength (kgf/cm ²)	ASTM C39-96	FC	532	553	421	606	672	621	581	516						
		FC*									630	727	517	581		
			X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)		
Date (M/D/Y)			03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00		
Compressive Strength (kgf/cm ²)	ASTM C39-86	FC	600	558	551	553	629	553	534	528						
		FC*									730	665	624	700		
			X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)		
Young's Modulus (kgf/cm ² x 10 ⁵)	ASTM C39-96		2.66	2.92	2.27	2.87	3.03	2.77	2.86	2.53	2.98	3.12	2.43	2.41		
Young's Modulus (GPa)			26.1	28.6	22.3	28.1	29.7	27.2	28.0	24.8	29.2	30.6	23.8	23.6		
Poisson's Ratio			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Unit Weight			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
@ Limit State Test																
Unit Weight (kgf/m ³)			2167.5	2194.7	2170.7	2185.1	2181.9	2111.4	2095.4	2175.5	2186.7	2214.0	2181.9	2231.6	2210.8	2199.5
Date (M/D/Y)								08/24/00	08/24/00	08/24/00		08/24/00	08/24/00	08/24/00		09/28/00
Mean Comp. Strength (kgf/cm ²)	ASTM C39-86	FC						499	481	598						
		FC*										626	578	649		581
Date (M/D/Y)			10/05/00	10/07/00	10/09/00	10/12/00	10/12/00	10/09/00	10/09/00	10/10/00	10/10/00	10/11/00	10/11/00	10/11/00	10/11/00	10/11/00
Mean Comp. Strength (kgf/cm ²)	ASTM C469-87	FC	574	575	538	659	662	573	572	610						
		FC*									665	734	676	760	592	665
Young's Modulus (kgf/cm ² x 10 ⁵)	ASTM C469-87		2.86	2.97	2.62	2.89	2.78	2.51	2.55	2.60	2.83	2.94	2.78	2.96	2.64	2.59
Young's Modulus (GPa)			28.0	29.2	25.7	28.3	27.2	24.6	25.0	25.5	27.8	28.8	27.2	29.0	25.9	25.4
Poisson's Ratio	ASTM C469-87		0.22	0.22	0.20	0.22	0.22	0.21	0.22	0.22	0.22	0.22	0.21	0.22	0.21	0.22
Stress-Strain																
Date (M/D/Y)			08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	09/27/00	08/23/00	08/24/00	08/24/00	09/28/00	09/27/00
Split Tensile Strength (kgf/cm ²)	ASTM C496-90		35	34	35	33	41	34	31	37	40	38	35	37	35	40
Date (M/D/Y)						10/12/00		10/18/00	10/20/00	10/23/00	10/23/00	10/25/00				
Direct Tension (kgf/cm ²)	Draft ASTM Standard (F)					29		21	17	22	24	22				
Date (M/D/Y)						08/22/00		08/21/00	08/21/00	08/21/00	08/21/00	08/22/00	08/22/00	08/22/00		09/28/00
Modulus of Rupture (kgf/cm ²)	ASTM C-78-84					41		37	41	38	43	44	44	45		41

PCCV Model Concrete Tests (ENGLISH)																
Procedures & Specifications																
Spec.-T-03-1(E) Specification for Concrete Work; Rev.2																
JPN-14-T-1-8; Concrete Material Test Procedure; Rev. 1; 6/14/96																
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(F) Draft "Standard Test Method for Determination of Direct Tension Properties of Hardened Concrete using the Stiff Tensile Test (STT) Apparatus", Feb. 2000																
	Specification	Lift:	F1	F2	F3a	F3b	F4	C1	C2	C3	C4	D1	D2	D3	F5	F6
			4300	4300	4300	6400	6400	6400	6400	6400	6400	6400	6400	6400	4300	6400
Quality Control Tests																
Specimens	ASTM C31-91															
At Placement			X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			02/12/97	02/28/97	05/08/97	05/08/97	07/02/97	11/11/98	12/10/98	01/05/99	01/28/99	03/03/99	04/12/99	04/15/99	05/24/00	06/09/00
Slump (cm)	ASTM C143-90a		14.5	16.8	18.3	14.2	16.5	18.3	23.5	21.4	21.9	21.7	24.6	10.8	9.7	9.7
Air Content (%)	ASTM C231-91b		6.5	7.2	6.0	5.7	6.4	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.0	3.6
Unit Weight (pcf)			134.8	137.7	137.1	136.0	134.8	138.1	138.3	139.5	140.1	139.4	138.3	138.3		
Temperature (°F)			72.0	70.0	81.0	83.0	84.0	72.0	68.8	72.2	63.3	74.4	75.0	70.5	81.9	82.0
1 Week			X(B)	X(B)	X(B)	X(B)	X(B)				X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			02/19/97	03/07/97		05/15/97					02/03/99	03/10/99	04/19/99	04/22/99	05/31/00	06/16/00
Compressive Strength (psi)	ASTM C39-86	SC	4934	4550	-	5745	-					5266	5166	5688	4746	5184
		FC	-	-	-	-	-				5377					
		FC*									6111	5022	5121	5485		
4 Weeks			X(B)	X(B)	X(B)	X(B)	X(B)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)
Date (M/D/Y)			03/05/97	03/28/97	06/05/97	06/05/97	07/30/97	12/09/98	01/07/99	02/02/99	02/24/99	03/31/99	05/10/99	05/13/99	06/21/00	07/07/00
Compressive Strength (psi)	ASTM C39-86	SC	5568	5739	5702	6963	5259	5296	5491	5965	6941	6746	6419	6868	5785	6536
		FC	5537	6562	4861	6234	7058	4820	4776	5621	6009					
		FC*									6547	6530	6181	7090	6001	6524
13 Weeks			X(B)	X(B)	X(B)	X(B)	X(B)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)	X(A)		
Date (M/D/Y)				05/30/97	08/07/97	08/07/97	10/01/97	02/10/99	03/11/99	04/06/99	04/28/99	06/02/99	07/12/99	07/15/99		
Compressive Strength (psi)	ASTM C39-86	SC	6815	6822	6940	7957	6386	6823	7076	7053	7750	7865	6949	8942		
		FC	5613	6234	5560	6865	7342	5527	6200	6403	6887					
		FC*									7335	8210	7519	8944		
Mean Comp. Strength (psi)	ASTM C469-87	FC						X(C)	X(C)							
Young's Modulus (psi * 10 ⁶)	ASTM C469-87	FC						2.91	3.28							
Stress-Strain	ASTM C469-87	FC						X(C)	X(C)							
Poisson's Ratio	ASTM C469-87	FC						0.19	0.22							
Creep Test Data																
Creep Coefficient	ASTM C512-87			FC					X(C)							
Specific Creep (in/in/psi)	(loaded to 875 psi @ 28 days)			FC					X(C)							
Drying Shrinkage strain (in/in)	(relative to 28 days)			FC					X(C)							

PCCV Model Concrete Tests (ENGLISH)**Procedures & Specifications**

Spec.-T-03-1(E) Specification for Concrete Work; Rev.2

JPN-14-T-1-8; Concrete Material Test Procedure; Rev. 1; 6/14/96

Submittal : T-03-1 (E) 2.17.0; Revised 10/30/97

Data & Test Reports

(A)* AGRA Reports of Compression Test Results, *NUPEC to issue Test Report

(B) JPN-22-T-1 (Rev.1), Ancillary Test Report, 9 March 1998

(C) "Strength and Creep Testing of Concrete in PCCV", ATR/UNM, 31 Jan. 2000

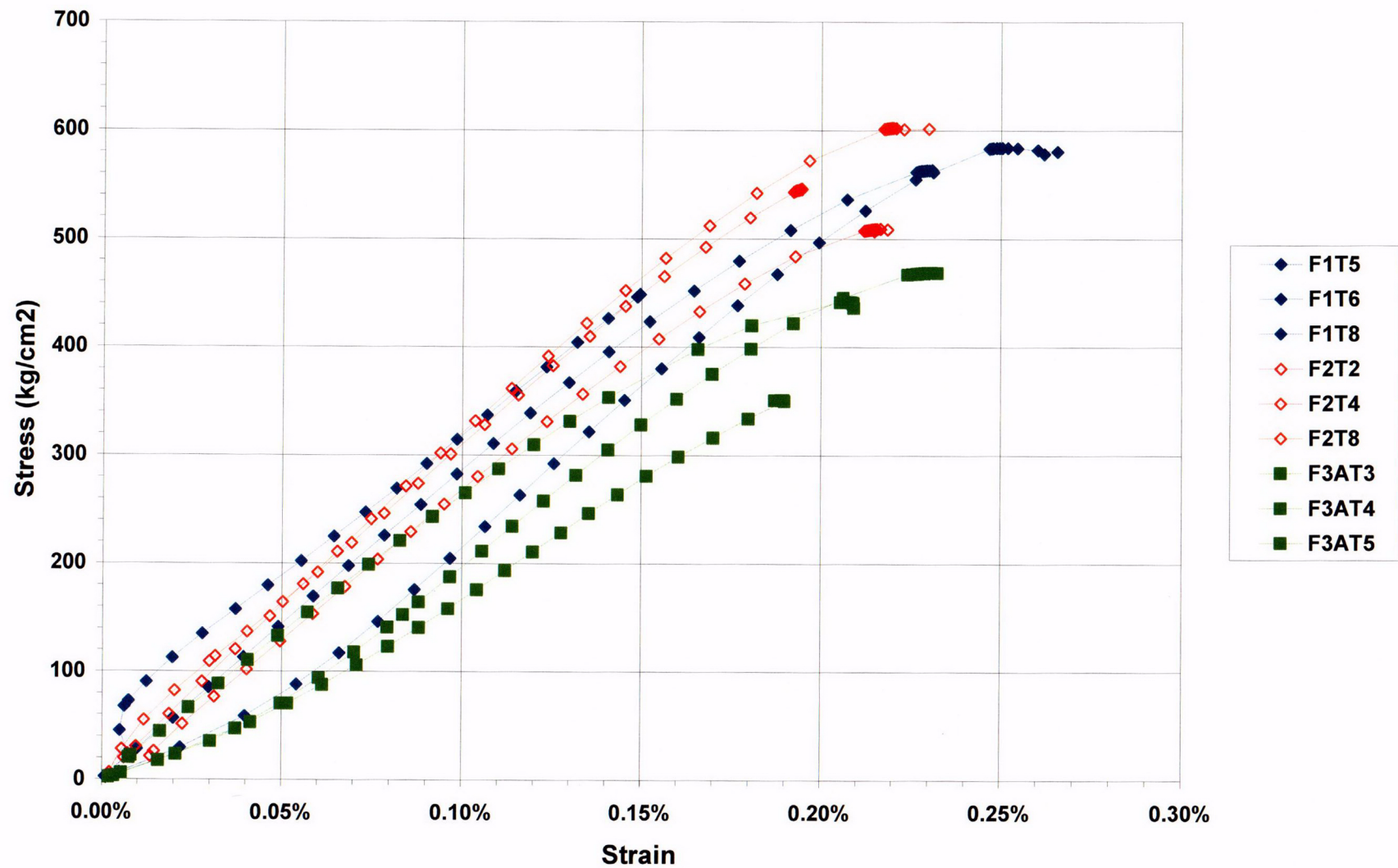
(D) MH-K11-37: PCCV Stress-Strain Tests, CTL, 15 Feb 2000

(E) "Mechanical Property Evaluation of Concrete Used in the NUPEC/NRC PCCV: Prestress and Limit State Test Results", Lenke & Gerstle, ATR Institute/UNM, 30 June 2001.

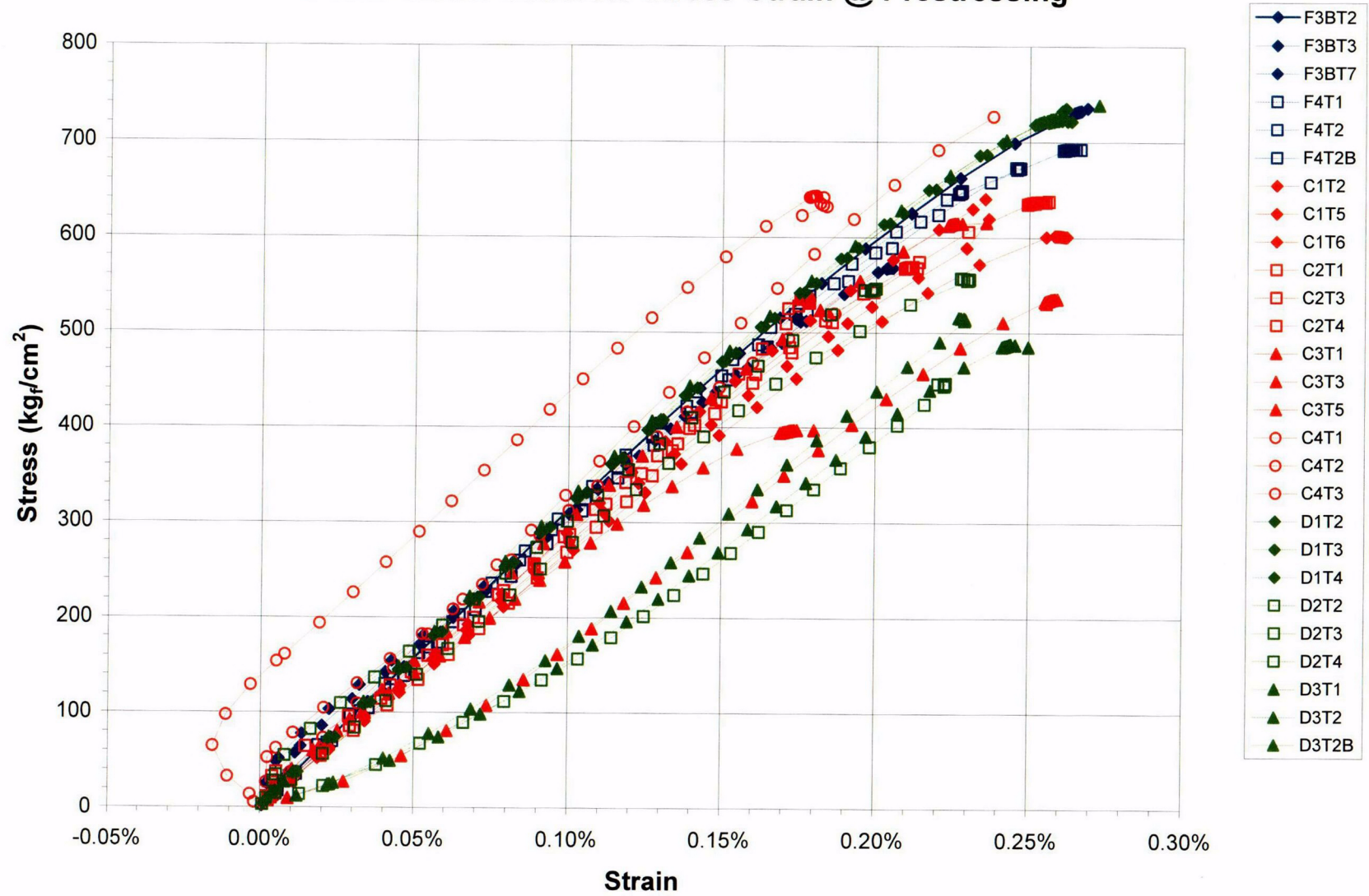
(F) Draft "Standard Test Method for Determination of Direct Tension Properties of Hardened Concrete using the Stiff Tensile Test (STT) Apparatus", Feb. 2000

	Specification	Lift:	F1	F2	F3a	F3b	F4	C1	C2	C3	C4	D1	D2	D3	F5	F6
			4300	4300	4300	6400	6400	6400	6400	6400	6400	6400	6400	6400	4300	6400
Design Data Tests																
@ Prestressing																
Date (M/D/Y)			01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00	01/31/00		
Compressive Strength (psi)	ASTM C39-96	FC	7566	7857	5980	8617	9549	8825	8263	7339						
		FC*									630	727	517	581		
			X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)		
Date (M/D/Y)			03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00	03/08/00		
Compressive Strength (psi)	ASTM C39-86	FC	8525	7940	7840	7870	8950	7860	7590	7510						
		FC*									10380	9455	8875	9950		
			X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)	X(D)		
Young's Modulus (psi x 10 ⁵)	ASTM C39-96		3.78	4.15	3.23	4.08	4.31	3.94	4.06	3.60	4.24	4.43	3.45	3.42		
Poisson's Ratio			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Unit Weight			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
@ Limit State Test			X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)	X(E)
Unit Weight (pcf)			135.3	137.0	135.5	136.4	136.2	131.8	130.8	135.8	136.5	138.2	136.2	139.3	138.0	137.3
Date (M/D/Y)								08/24/00	08/24/00	08/24/00		08/24/00	08/24/00	08/24/00		09/28/00
Mean Comp. Strength (psi)	ASTM C39-86	FC						7097	6840	8507						
		FC*										8895	8217	9230		8260
Date (M/D/Y)			10/05/00	10/07/00	10/09/00	10/12/00	10/12/00	10/09/00	10/09/00	10/10/00	10/10/00	10/11/00	10/11/00	10/11/00	10/11/00	10/11/00
Mean Comp. Strength (psi)	ASTM C469-87	FC	8160	8183	7650	9367	9420	8148	8137	8680						
		FC*									9461	10433	9613	10805	8420	9453
Young's Modulus (psi x 10 ⁵)	ASTM C469-87		4.06	4.23	3.72	4.11	3.95	3.57	3.63	3.70	4.03	4.18	3.95	4.21	3.76	3.68
Poisson's Ratio	ASTM C469-87		0.22	0.22	0.20	0.22	0.22	0.21	0.22	0.22	0.22	0.22	0.21	0.22	0.21	0.22
Stress-Strain																
Date (M/D/Y)			08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	08/23/00	09/27/00	08/23/00	08/24/00	08/24/00	09/28/00	09/27/00
Split Tensile Strength (psi)	ASTM C496-90		498	485	500	468	585	483	435	527	568	537	492	525	503	565
Date (M/D/Y)						10/12/00		10/18/00	10/20/00	10/23/00	10/23/00	10/23/00	10/25/00			
Direct Tension (kgf/cm2)	Draft ASTM Standard (F)					409		303	235	318	337	316				
Date (M/D/Y)						08/22/00		08/21/00	08/21/00	08/21/00	08/21/00	08/22/00	08/22/00	08/22/00		09/28/00
Modulus of Rupture (kgf/cm2)	ASTM C-78-84					590		532	587	543	613	628	628	638		590

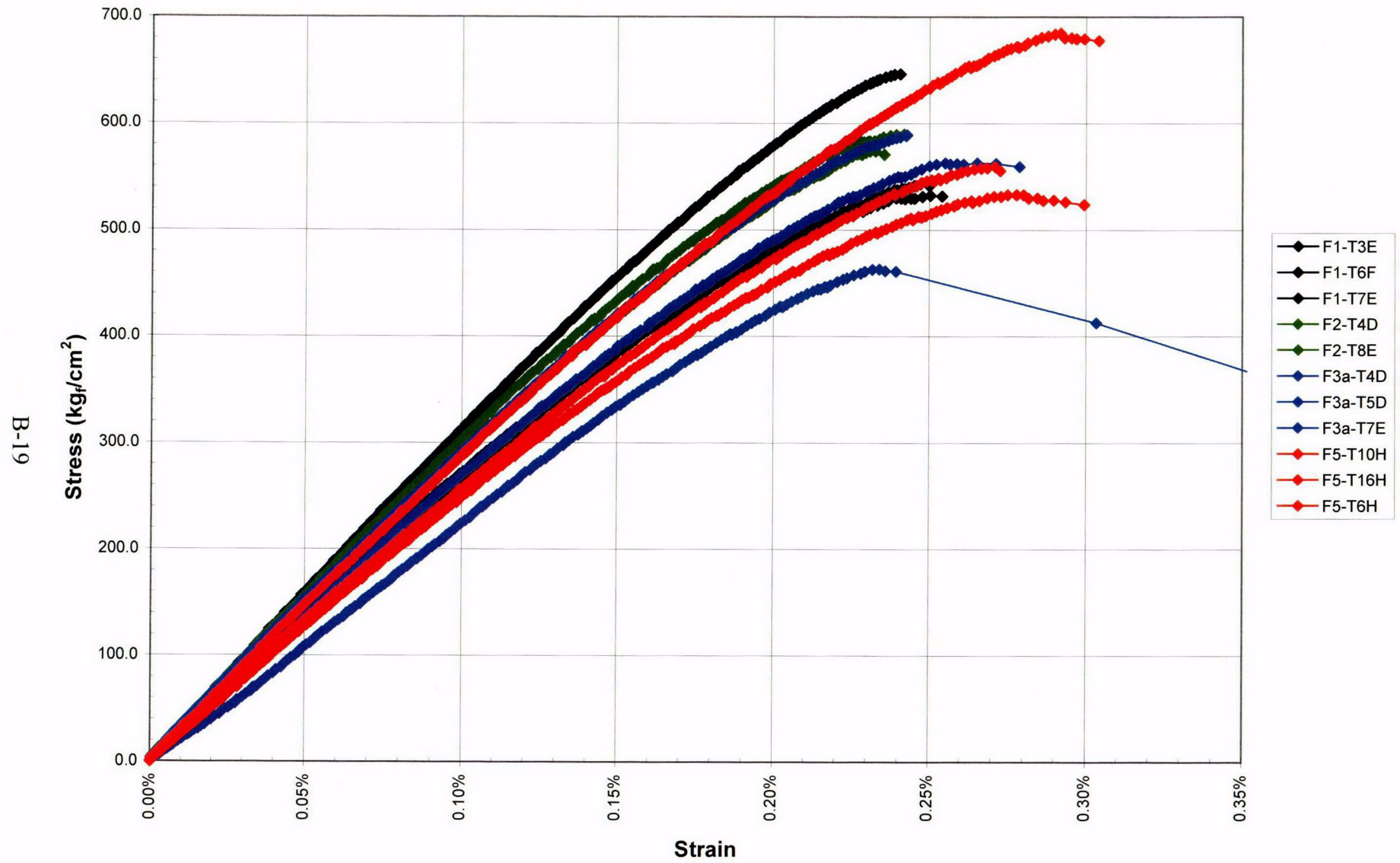
PCCV Model Concrete Stress-Strain @ Prestressing



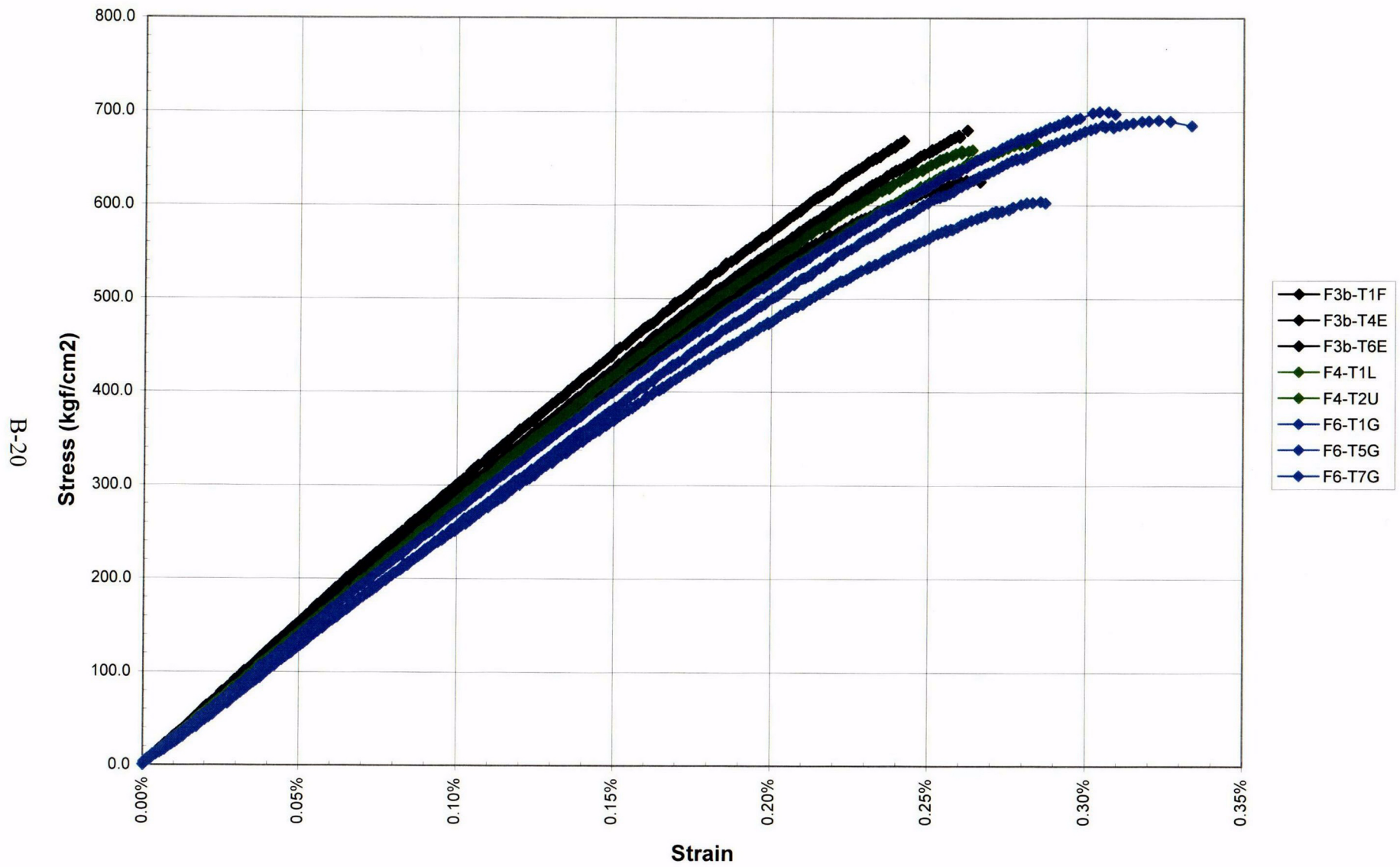
PCCV Model Concrete Stress-Strain @ Prestressing



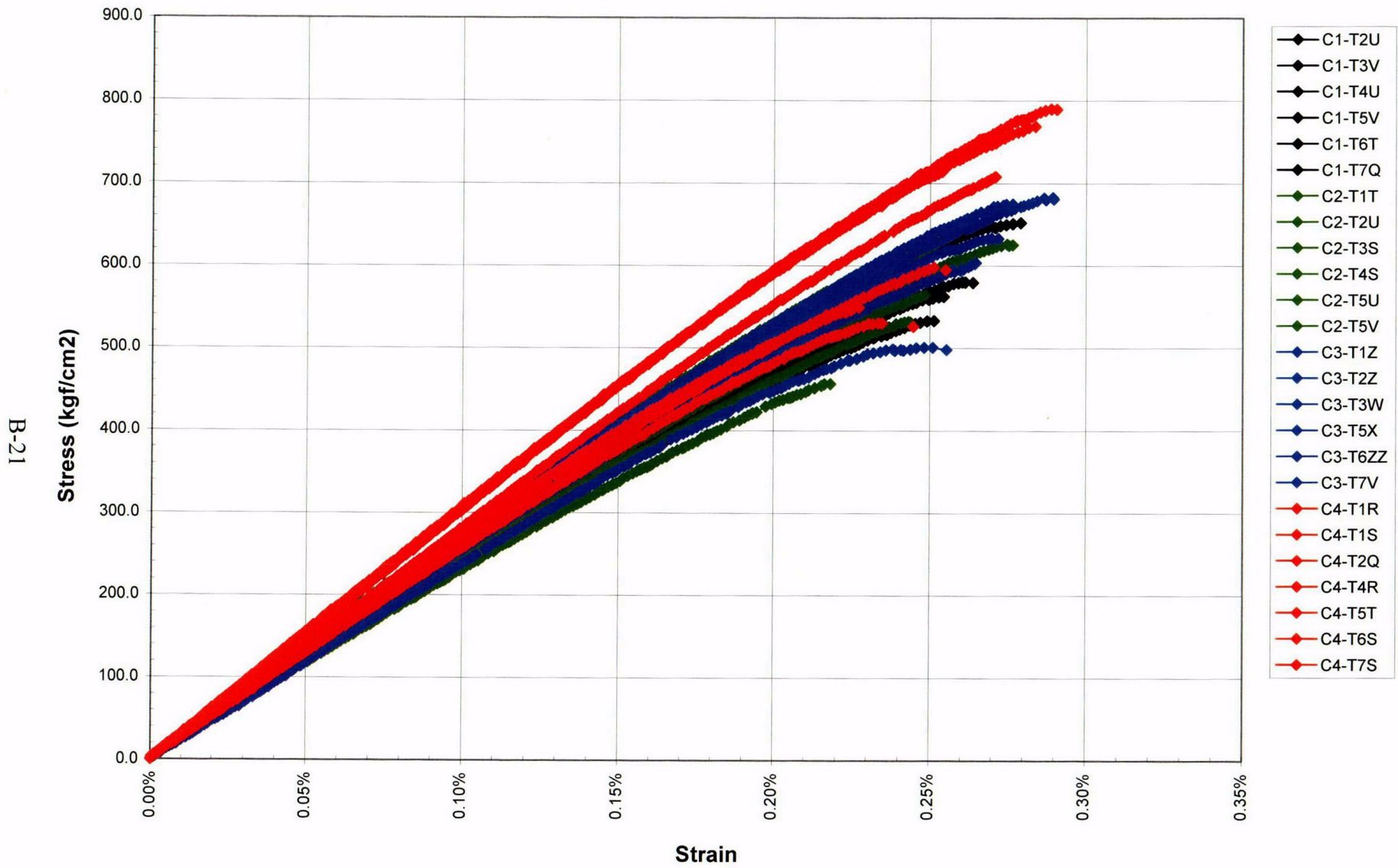
PCCV Concrete Properties @ Limit State Test



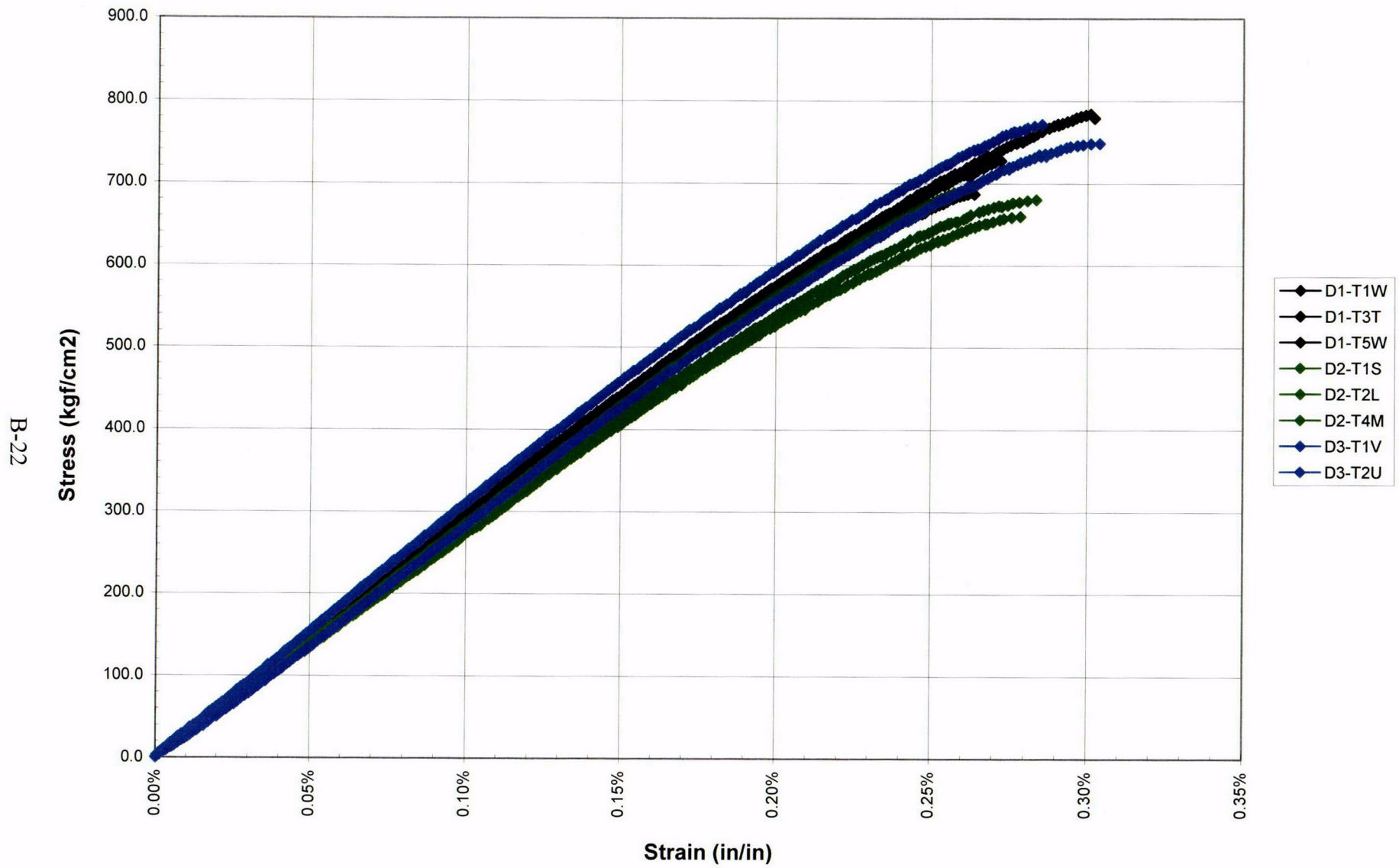
PCCV Concrete Properties @ Limit State Test



PCCV Concrete Properties @ Limit State Test

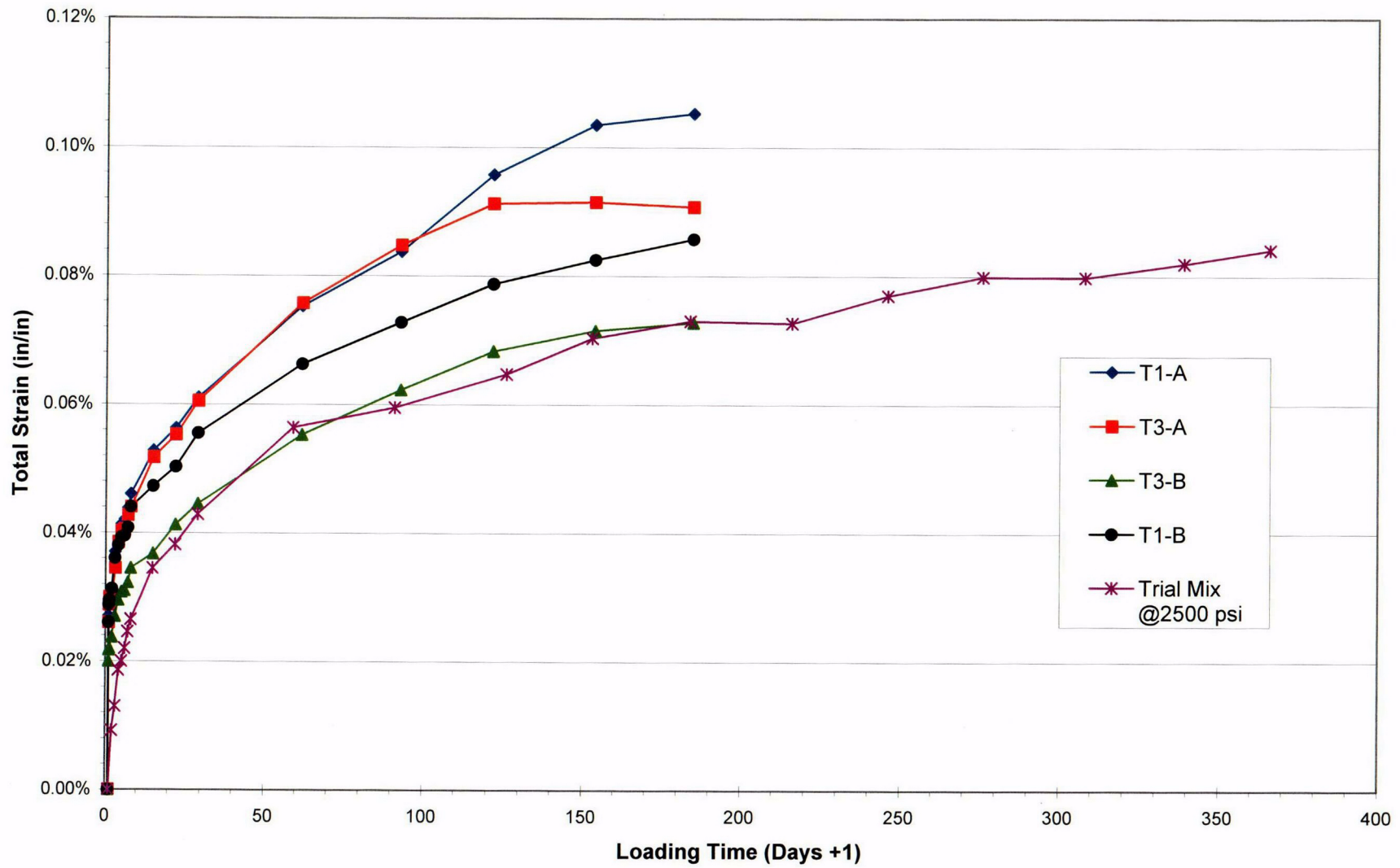


PCCV Concrete Properties @ Limit State Test



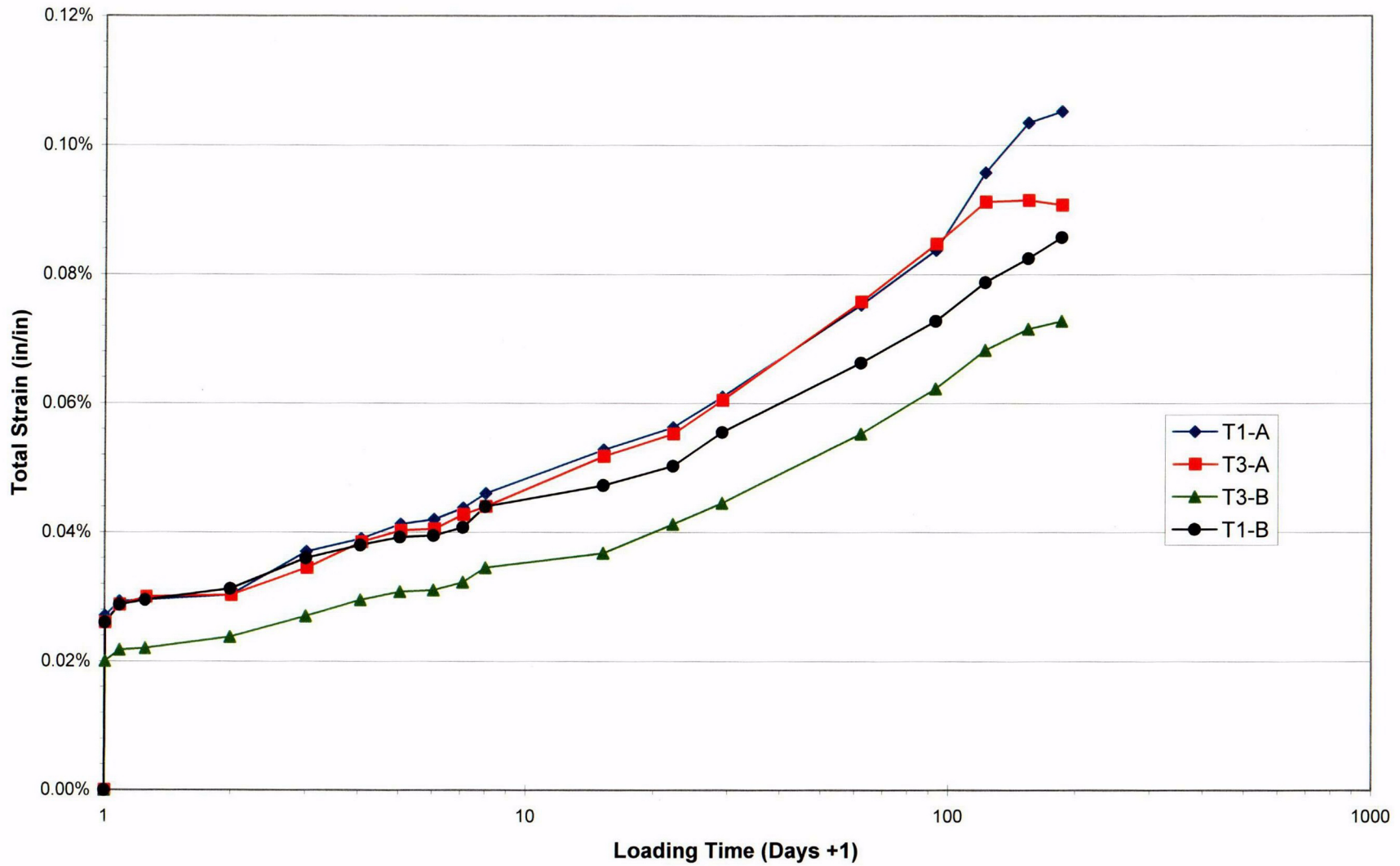
PCCV Model Concrete Creep
Lift C2 (loaded to ~850 psi @ 104 days)

B-23

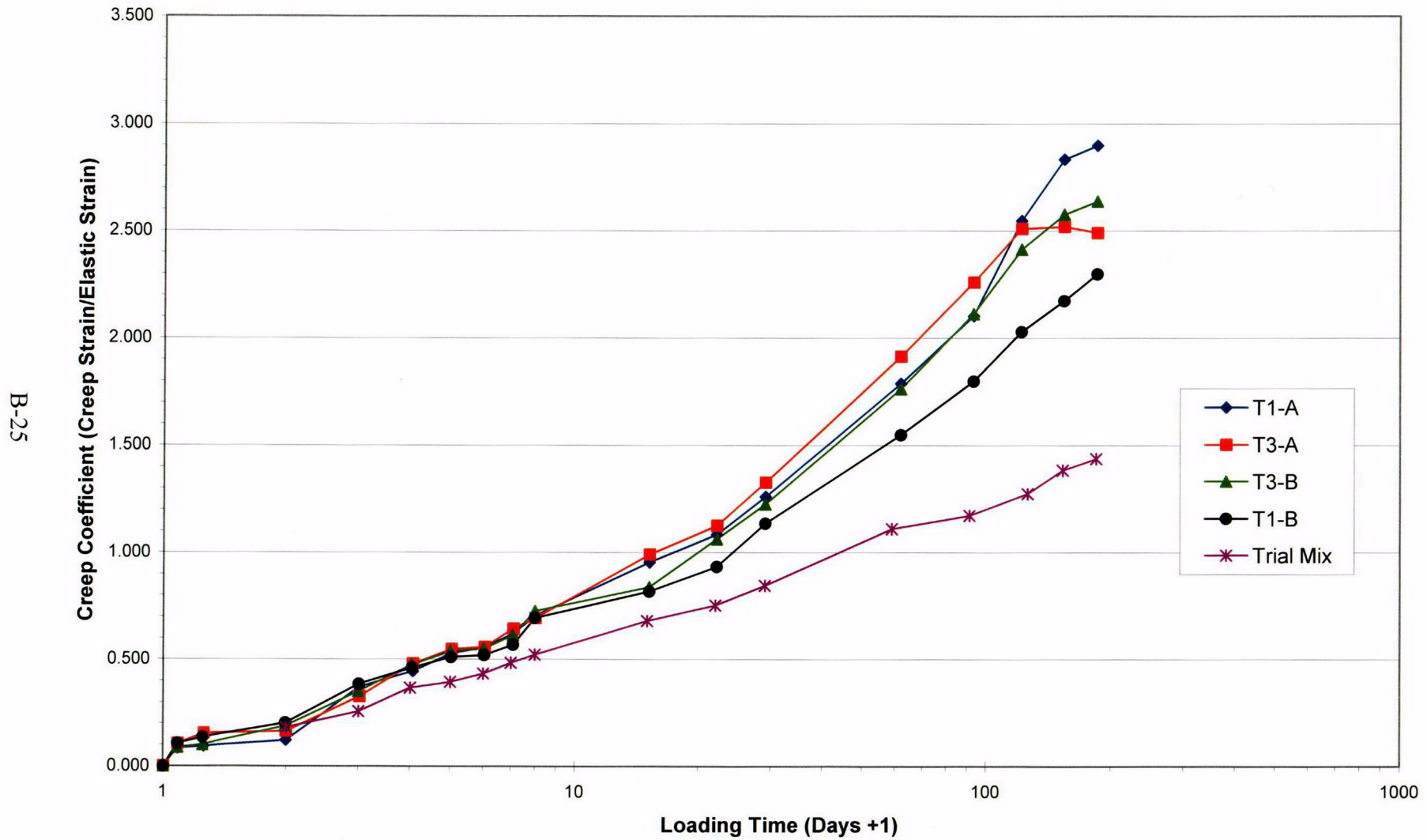


PCCV Model Concrete Creep
Lift C2 (loaded to ~850 psi @ 104 days)

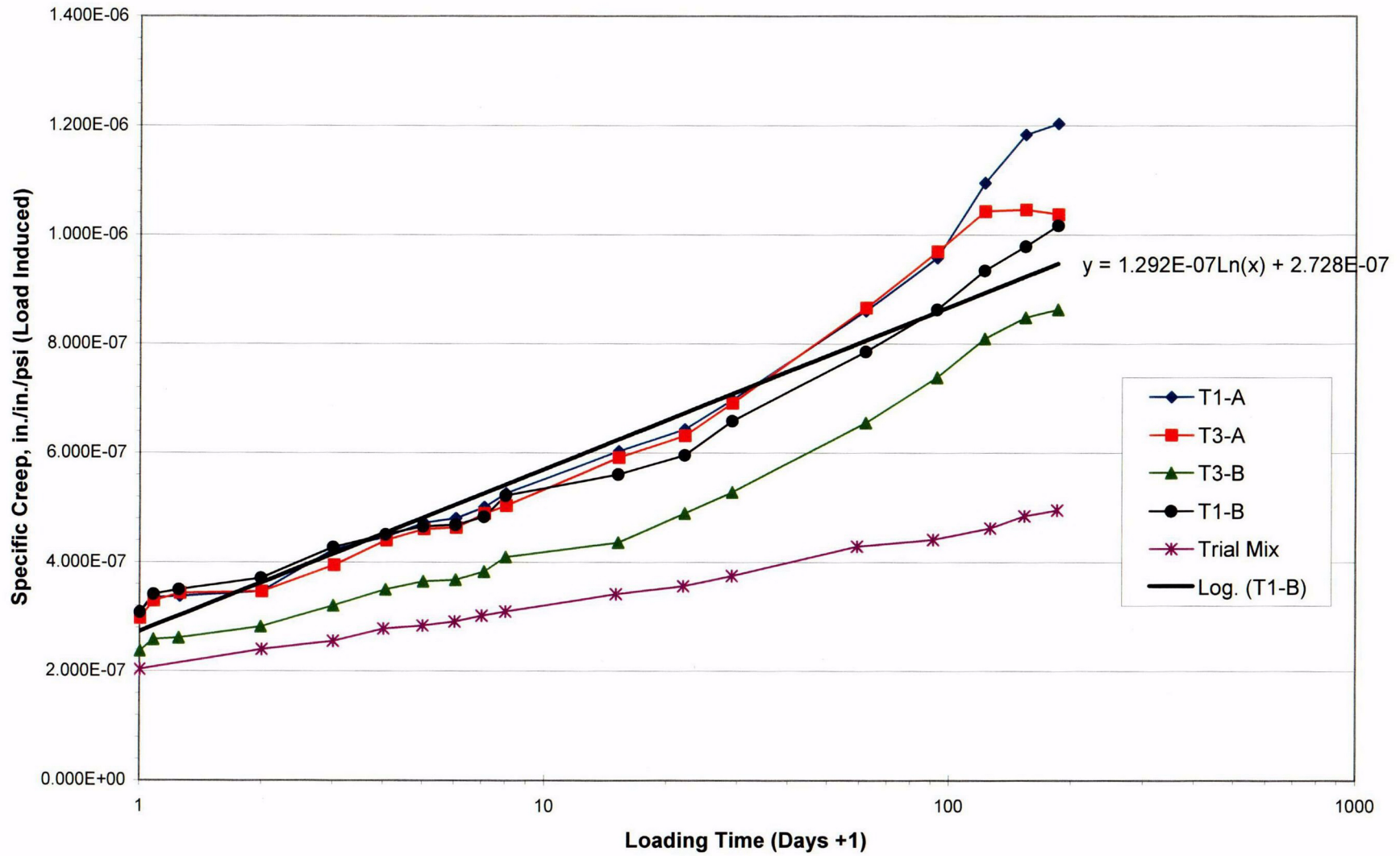
B-24



PCCV Model Concrete Creep
Lift C2 (loaded to ~850 psi @ 104 days)



PCCV Model Concrete Creep
Lift C2 (loaded to ~850 psi @ 104 days)



Section iii. Liner

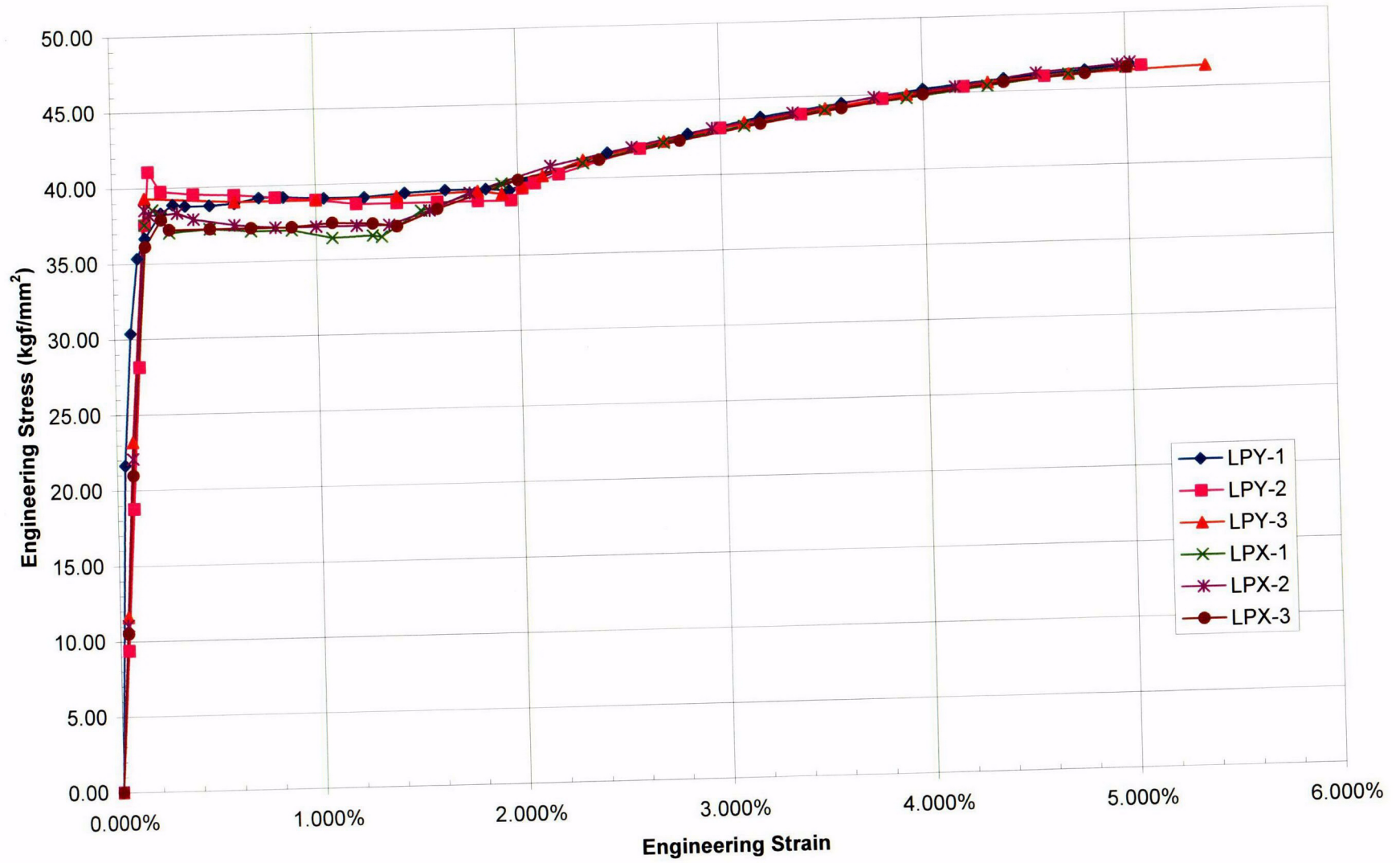
PCCV Liner Material Tests (METRIC)						
Procedures & Specifications						
PCCV Liner Construction Procedure, MH-K9-25A, Rev. 1, Apr. 25, 1997						
Dimension Tolerance for PCCV Liner Installation, MH-K9-26A, Rev. 2, 5/29/97						
Liner Dimension Measurement Procedure, MH-K9-31, Rev. 1						
Procedure for Nondestructive Examinations (RT and PT) and Leak Testing, UGS-L9-970200A, Rev. 2, Apr. 16, 1997						
Repairing Procedure for 5-9 Liner Panel, MH-K9-36, Rev. 0						
Liner Welding Re-Confirmation Test, MH-K9-37, Rev. 1						
Alteration of RT Acceptance Criteria, MH-K9-39						
JIS-Carbon Steel Plates for Pressure Vessels for Intermediate and Moderate Temperature Service, JIS G 3118, 1987						
JIS-Rolled Steels for General Structure, JIS G 3101, 1995						
Data & Test Reports						
(A) Results of Liner Material (SGV410) Test; MH-K9-45, February 1998						
(B) Welded Joint Tensile Test Results; MH-K9-43; 9/12						
(C) JPN-16-M-1; Ancillary Test/Liner Material Test, September 1995						
(D) Liner Anchor Test Report; JPN-15-M-2, March 1995						
(E) Results of Liner Welding Re-Confirmation Test, MH-K9-38						
(F) The Repair of 5-9 Liner Panel, MH-K9-41						
(G) Liner Dimensional Inspection Record, MH-K9-46						
	Mat'l Spec.	Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
Liner Plate	SGV410	kgf/mm ²	kgf/mm ²		kgf/mm ²	
Nominal (JIS G 3118-1987)	min.	22.9	41.8	21.0%		
	max.		50.0			
Test (JIS Z 2241)		X(A)	X(A)	X(A)	X(A)	X(A)
(T*W*G=25.1*1.84*50mm)						
Meridional	LPY-1	38.9	50.5	33.8%	2.21E+04	
	LPY-2	41.1	50.8	33.0%	2.23E+04	
	LPY-3	39.3	50.7	33.6%	2.29E+04	
	Average	39.8	50.7	33.5%	2.24E+04	
Hoop	LPX-1	38.5	50.9	33.0%	2.17E+04	
	LPX-2	38.5	51.0	33.0%	2.32E+04	
	LPX-3	37.8	50.7	33.0%	2.19E+04	
	Average	38.3	50.9	33.0%	2.23E+04	

PCCV Liner Material Tests (METRIC)						
Procedures & Specifications						
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Dimension Tolerance for PCCV Liner Installation, MH-K9-26A, Rev. 2, 5/29/97						
Liner Dimension Measurement Procedure, MH-K9-31, Rev. 1						
Procedure for Nondestructive Examinations (RT and PT) and Leak Testing, UGS-L9-970200A, Rev. 2, Apr. 16, 1997						
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(C)JPN-16-M-1; Ancillary Test/Liner Material Test, September 1995						
(D)Liner Anchor Test Report; JPN-15-M-2, March 1995						
(E)Results of Liner Welding Re-Confirmation Test, MH-K9-38						
(F)The Repair of 5-9 Liner Panel, MH-K9-41						
(G)Liner Dimensional Inspection Record, MH-K9-46						
		Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
		kgf/mm ²	kgf/mm ²		kgf/mm ²	
Welded (SMAW) Liner Plate						
(JIS Z 3121, Test Piece 1A)		X(B)	X(B)	X(B)		X(B)
	As-welded (avg.)	39.4	51.7	19.1%		
	Repaired (avg.)	37.9	51.4	18.4%		
	w/o Back-up bar (avg.)	39.2	51.7	17.9%		
	w/ Back-up bar (avg.)	38.1	51.4	19.7%		
	Mat'l Spec.	Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
	SS400	kgf/mm ²	kgf/mm ²		kgf/mm ²	
Liner Anchor						
Nominal						
	JIS G 3101-1995	min.	25.0	40.8	21.0%	
		max.		52.0		
Test						
		X(C)	X(C)	X(C)	X(C)	
	vertical	29.5	46.5	33.0%	2.12E+04	
	horizontal	31.5	45.3	38.0%	2.20E+04	
		fc'	Max. Load	Max. Disp.	Initial Stiffness	Force-Deflection
		kgf/cm ²	kgf	mm	kgf/mm	
Liner Anchor Force-Deflection		X(D)	X(D)	X(D)	X(D)	X(D)
	Tension, prestressed	410	4,433	0.100	127,333	
	Tension, non-prestressed	410	3,20	0.129	52,667	
	Shear, prestressed	410	14,700	2.865	59,267	
	Shear, non-prestressed	410	11,100	1.155	39,667	

PCCV Liner Material Tests (ENGLISH)						
Procedures & Specifications						
PCCV Liner Construction Procedure, MH-K9-25A, Rev. 1, Apr. 25, 1997						
Dimension Tolerance for PCCV Liner Installation, MH-K9-26A, Rev. 2, 5/29/97						
Liner Dimension Measurement Procedure, MH-K9-31, Rev. 1						
Procedure for Nondestructive Examinations (RT and PT) and Leak Testing, UGS-L9-970200A, Rev. 2, Apr. 16, 1997						
Repairing Procedure for 5-9 Liner Panel, MH-K9-36, Rev. 0						
Liner Welding Re-Confirmation Test, MH-K9-37, Rev. 1						
Alteration of RT Acceptance Criteria; MH-K9-39						
JIS-Carbon Steel Plates for Pressure Vessels for Intermediate and Moderate Temperature Service, JIS G 3118, 1987						
JIS-Rolled Steels for General Structure, JIS G 3101, 1995						
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(C)JPN-16-M-1; Ancillary Test/Liner Material Test, September 1995						
(D)Liner Anchor Test Report; JPN-15-M-2, March 1995						
(E)Results of Liner Welding Re-Confirmation Test, MH-K9-38						
(F)The Repair of 5-9 Liner Panel, MH-K9-41						
(G)Liner Dimensional Inspection Record, MH-K9-46						
	Mat'l Spec.	Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
Liner Plate	SGV410	psi	psi		psi	
Nominal (JIS G 3118-1987)	min.	32,626	59,451	21.0%		
	max.		71,052			
Test (JIS Z 2241)		X(A)	X(A)	X(A)	X(A)	X(A)
(T*W*G=25.1*1.84*50mm)						
Meridonal	LPY-1	55,316	71,811	33.8%	3.143E+07	
	LPY-2	58,444	72,238	33.0%	3.171E+07	
	LPY-3	55,885	72,095	33.6%	3.256E+07	
	Average	56,548	72,048	33.5%	3.190E+07	
Hoop	LPX-1	54,747	72,380	33.0%	3.086E+07	
	LPX-2	54,747	72,522	33.0%	3.299E+07	
	LPX-3	53,752	72,095	33.0%	3.114E+07	
	Average	54,415	72,332	33.0%	3.166E+07	

PCCV Liner Material Tests (ENGLISH)						
Procedures & Specifications						
PCCV Liner Construction Procedure, MH-K9-25A, Rev. 1, Apr. 25, 1997						
Dimension Tolerance for PCCV Liner Installation, MH-K9-26A, Rev. 2, 5/29/97						
Liner Dimension Measurement Procedure, MH-K9-31, Rev. 1						
Procedure for Nondestructive Examinations (RT and PT) and Leak Testing, UGS-L9-970200A, Rev. 2, Apr. 16, 1997						
Repairing Procedure for 5-9 Liner Panel, MH-K9-36, Rev. 0						
Liner Welding Re-Confirmation Test, MH-K9-37, Rev. 1						
Alteration of RT Acceptance Criteria, MH-K9-39						
JIS-Carbon Steel Plates for Pressure Vessels for Intermediate and Moderate Temperature Service, JIS G 3118, 1987						
JIS-Rolled Steels for General Structure, JIS G 3101, 1995						
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(A)Results of Liner Material (SGV410) Test; MH-K9-45, February 1998						
(B)Welded Joint Tensile Test Results; MH-K9-43;9/12						
(C)JPN-16-M-1; Ancillary Test/Liner Material Test, September 1995						
(D)Liner Anchor Test Report; JPN-15-M-2, March 1995						
(E)Results of Liner Welding Re-Confirmation Test, MH-K9-38						
(F)The Repair of 5-9 Liner Panel, MH-K9-41						
(G)Liner Dimensional Inspection Record, MH-K9-46						
		Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
		psi	psi		psi	
Welded (SMAW) Liner Plate		X(B)	X(B)	X(B)		X(B)
(JIS Z 3121, Test Piece 1A)						
	As-welded (avg.)	55,971	73,517	19.1%		
	Repaired (avg.)	53,941	73,082	18.4%		
	w/o Back-up bar (avg.)	55,681	73,517	17.9%		
	w/ Back-up bar (avg.)	54,231	73,082	19.7%		
	Mat'l Spec.	Yield Stress	Ultimate Stress	Elongation	Elastic Modulus	Stress-Strain
Liner Anchor	SS400	psi	psi		psi	
Nominal						
	JIS G 3101-1995	min.	35,526	58,001	21.0%	
		max.	-	73,952		
Test		X(C)	X(C)	X(C)	X(C)	
	vertical	41,906	66,122	33.0%	3.016E+07	
	horizontal	44,806	64,382	38.0%	3.132E+07	
		fc'	Max. Load	Max. Disp.	Initial Stiffness	Force-Deflection
		psi	lbs	in.	lb/in.	
Liner Anchor Force-Deflection		X(D)	X(D)	X(D)	X(D)	X(D)
	Tension, prestressed	5835	9,774	0.004	7,130,375	
	Tension, non-prestressed	5835	7,070	0.005	2,949,213	
	Shear, prestressed	5835	32,408	0.113	3,318,797	
	Shear, non-prestressed	5835	24,471	0.045	2,221,242	

Liner Stress-Strain



Section iv. Rebar and Couplers

PCCV Rebar/Coupler Material Tests (METRIC)												
Procedures & Specifications												
JPN-14-T-1-3; Rebar Material Test Procedure; 6/14/96												
JPN-14-T-1-4; Rebar Connection Test Procedure; 6/14/96												
Spec.-T-04-2(E) Rev. 2; Specification for Reinforcement Material												
Spec.-T-04-3(E) Rev. 2; Specification for Mechanical Joint												
Data & Test Reports												
(A)JPN-21-T-5, Ancillary Test Report, Rebar Joint Test, May 20, 1997												
(B) TAP 9702; Material Property data for a mechanical model used in pre/post analyses, 4/21/97												
(C) JPN-21-T-4, Ancillary Test Report, Rebar Material Test, May 20, 1997												
(D) MH-K10-37, Tensile Test Result for #3 Position Threaded Coupler												
(E) MH-K10-38, Tensile Test Result for #6 Position Threaded Coupler												
(F) SNL Rebar Calibration Tests, February, 1999												
Component		Design Data Tests										
Mat'l Spec.												
Reinforcing Steel			Diameter	Area	Yield Stress	Ultimate Stress	Gage Length	Elongation ¹	Elastic Modulus	Stress-Strain ²		
			(mm)	(mm ²)	(kN)	(MPa)	(kN)	(MPa)	Initial	Final	(%)	(N/mm ²)
Nominal (JIS G 3112)	SD345											
	min.				345.0	490.0					18.0%	
	max.				390.0							
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D6	1	6.35	31.67	12.1	382.1	15.5	489.4	47.7	62.5	31.0%	1.68E+05
	(G=8D, Grip=10D)	2	6.35	31.67	11.5	363.1	15.5	489.4	47.7	62.0	30.0%	1.71E+05
		3	6.35	31.67	11.5	363.1	15.5	489.4	47.8	62.2	30.1%	1.67E+05
	mean		6.35	31.67	11.7	369.4	15.5	489.4	47.7	62.2	30.4%	1.69E+05
	D10	1	9.53	71.33	26.3	368.7	39.2	549.6	79.7	97.5	22.3%	1.82E+05
	(G=8D, Grip=10D)	2	9.53	71.33	26.6	372.9	39.9	559.4	80.0	98.6	23.3%	1.85E+05
		3	9.53	71.33	26.5	371.5	39.2	549.6	80.0	100.7	25.9%	1.80E+05
	mean		9.53	71.33	26.5	371.0	39.4	552.8	79.9	98.9	23.8%	1.82E+05
		¹ Elongation @ ultimate load based on gage length of broken bars.										
		² Stress-Strain relationship measured by 2 dia. opposed strain gages located @ center of gage length.										
		JIS Z 2441 references use of extensometer for strain measurement.										

Reinforcing Steel			Diameter	Area	Yield Stress		Ultimate Stress		Gage Length		Elongation ¹	Elastic Modulus	Stress-Strain ²
			(mm)	(mm2)	(kN)	(MPa)	(kN)	(MPa)	Initial	Final	(%)	(N/mm2)	
Nominal (JIS G 3112)	SD390												
	min.				390.0		539.0				16.0%		
	max.				490.0								
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D10	1	9.53	71.33	33.2	465.4	46.7	654.7	80.2	94.1	17.3%	1.83E+05	
	(G=8D, Grip=10D)	2	9.53	71.33	34.4	482.3	47.0	658.9	79.5	97.7	22.9%	1.85E+05	
		3	9.53	71.33	33.6	471.1	46.0	644.9	79.7	96.6	21.2%	1.82E+05	
		mean	9.53	71.33	33.7	472.9	46.6	652.8	79.8	96.1	20.5%	1.83E+05	
	D13	1	12.7	126.7	53.4	421.5	77.2	609.3	104.0	129.4	24.4%	1.83E+05	
	(G=8D, Grip=10D)	2	12.7	126.7	55.8	440.4	77.5	611.7	103.9	128.4	23.6%	1.83E+05	
		3	12.7	126.7	55.1	434.9	77.4	610.9	104.0	129.6	24.6%	1.84E+05	
		mean	12.7	126.7	54.8	432.3	77.4	610.6	104.0	129.1	24.2%	1.83E+05	
	D16	1	15.9	198.6	90.9	457.7	122.5	616.8	128.0	146.6	19.4%	1.82E+05	
	(G=8D, Grip=10D)	2	15.9	198.6	91.3	459.7	123.0	619.3	128.2	147.4	24.1%	1.84E+05	
		3	15.9	198.6	90.4	455.2	121.8	613.3	127.9	146.5	22.7%	1.84E+05	
		mean	15.9	198.6	90.9	457.5	122.4	616.5	128.0	146.8	22.1%	1.83E+05	
	D16	1	12.5	122.7	66.0	537.9	87.8	715.6	49.7	63.5	27.8%	2.09E+05	
	(dumbbell)	2	12.5	122.7	63.8	520.0	88.2	718.8	50.0	63.0	26.0%	2.09E+05	
	(D x G = 12.5 x 50)	3	12.5	122.7	63.4	516.7	87.8	715.6	50.0	63.7	27.4%	2.09E+05	
		mean	12.5	122.7	64.4	524.9	87.9	716.7	49.9	63.4	27.1%	2.09E+05	
	D19	1	19.1	286.5	135.2	471.9	188.2	656.9	152.2	181.5	19.3%	1.83E+05	
	(G=8D, Grip=10D)	2	19.1	286.5	135.6	473.3	188.8	659.0	152.2	183.9	20.8%	1.83E+05	
		3	19.1	286.5	135.8	474.0	188.8	659.0	151.9	187.2	23.2%	1.86E+05	
		mean	19.1	286.5	135.5	473.1	188.6	658.3	152.1	184.2	21.1%	1.84E+05	
	D22	1	22.2	387.1	176.6	456.2	263.7	681.2	176.0	200.3	16.8%	1.90E+05	
	(G=8D, Grip=10D)	2	22.2	387.1	177.9	459.6	263.9	681.7	176.0	202.3	20.0%	1.91E+05	
		3	22.2	387.1	178.5	461.1	263.0	679.4	176.1	202.1	19.1%	1.92E+05	
		mean	22.2	387.1	177.7	459.0	263.5	680.8	176.0	201.6	18.7%	1.91E+05	
	D22	1	14	153.9	73.0	474.5	113.7	739.0	50.8	63.7	25.4%	2.10E+05	
	(dumbbell)	2	14	153.9	73.4	476.8	112.0	728.0	50.6	63.8	26.1%	2.08E+05	
	(D x G = 14 x 50)	3	14	153.9	70.8	460.2	115.0	747.0	51.3	64.8	26.3%	2.08E+05	
		mean	14	153.9	72.4	470.5	113.6	738.0	50.9	64.1	25.9%	2.09E+05	
		¹ Elongation @ ultimate load based on gage length of broken bars.											
		² Stress-Strain relationship measured by 2 dia.oppoosed strain gages located @ center of gage length.											
		JIS Z 2441 references use of extensometer for strain measurement.											

Reinforcing Steel			Diameter	Area	Yield Stress		Ultimate Stress		Gage Length		Elongation ¹	Elastic Modulus	Stress-Strain ²
			(mm)	(mm ²)	(kN)	(MPa)	(kN)	(MPa)	Initial	Final	(%)	(N/mm ²)	
Nominal (JIS G 3112)	SD490												
	min.					490.0		618.0			12.0%		
	max.					620.0							
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D10	1	9.53	71.33	35.1	492.1	47.6	667.3	79.7	97.9	22.8%	1.86E+05	
(G=8D, Grip=10D)		2	9.53	71.33	35.0	490.7	47.2	661.7	79.8	95.5	19.7%	1.87E+05	
		3	9.53	71.33	35.0	490.7	47.7	668.7	80.0	97.4	21.8%	1.87E+05	
		mean	9.53	71.33	35.0	491.1	47.5	665.9	79.8	96.9	21.4%	1.87E+05	
D13		1	12.7	126.7	69.2	546.2	94.8	748.2	104.0	122.7	18.0%	1.83E+05	
(G=8D, Grip=10D)		2	12.7	126.7	69.2	546.2	95.1	750.6	103.9	121.5	16.9%	1.85E+05	
		3	12.7	126.7	70.0	552.5	95.7	755.3	104.0	119.0	14.4%	1.85E+05	
		mean	12.7	126.7	69.5	548.3	95.2	751.4	104.0	121.1	16.4%	1.84E+05	
D16		1	15.9	198.6	96.2	544.9	134.3	676.2	128.2	143.3	17.0%	1.84E+05	
(G=8D, Grip=10D)		2	15.9	198.6	102.3	544.9	138.9	699.4	128.0	143.1	15.2%	1.86E+05	
		3	15.9	198.6	99.3	551.2	136.9	689.3	128.0	144.6	19.0%	1.84E+05	
		mean	15.9	198.6	99.3	547.0	136.7	688.3	128.1	143.7	17.1%	1.85E+05	
D16		1	12.5	122.7	69.2	544.9	97.3	793.0	49.6	62.1	25.2%	2.12E+05	
(dumbbell)		2	12.5	122.7	67.4	544.9	96.8	788.9	50.2	62.1	23.7%	2.10E+05	
(D x G = 12.5 x 50)		3	12.5	122.7	68.3	551.2	95.7	780.0	49.9	62.2	24.6%	2.09E+05	
		mean	12.5	122.7	68.3	547.0	96.6	787.3	49.9	62.1	24.5%	2.10E+05	
D19		1	19.1	286.5	146.4	511.0	203.4	709.9	151.7	178.6	17.7%	1.85E+05	
(G=8D, Grip=10D)		2	19.1	286.5	147.2	513.8	202.8	707.9	151.9	177.5	16.9%	1.87E+05	
		3	19.1	286.5	146.6	511.7	203.8	711.3	151.8	180.2	18.7%	1.86E+05	
		mean	19.1	286.5	146.7	512.2	203.3	709.7	151.8	178.8	17.8%	1.86E+05	
		¹ Elongation @ ultimate load based on gage length of broken bars.											
		² Stress-Strain relationship measured by 2 dia.opossed strain gages located @ center of gage length.											
		JIS Z 2441 references use of extensometer for strain measurement.											

[illegible]

PCCV Rebar/Coupler Material Tests (ENGLISH)												
Procedures & Specifications												
JPN-14-T-1-3; Rebar Material Test Procedure; 6/14/96												
JPN-14-T-1-4; Rebar Connection Test Procedure; 6/14/96												
Spec.-T-04-2(E) Rev. 2; Specification for Reinforcement Material												
Spec.-T-04-3(E) Rev. 2; Specification for Mechanical Joint												
Data & Test Reports												
(A)JPN-21-T-5, Ancillary Test Report, Rebar Joint Test, May 20, 1997												
(B) TAP 9702; Material Property data for a mechanical model used in pre/post analyses, 4/21/97												
(C) JPN-21-T-4, Ancillary Test Report, Rebar Material Test, May 20, 1997												
(D) MH-K10-37, Tensile Test Result for #3 Position Threaded Coupler												
(E) MH-K10-38, Tensile Test Result for #6 Position Threaded Coupler												
(F) SNL Rebar Calibration Tests, February, 1999												
Component		Design Data Tests										
Mat'l Spec.												
Reinforcing Steel			Diameter	Area	Yield Stress	Ultimate Stress		Gage Length		Elongation¹	Elastic Modulus	Stress-Strain²
			(in.)	(in ²)	(kips)	(ksi)	(kips)	(ksi)	Initial	Final	(%)	(psi)
Nominal (JIS G 3112)	SD345											
	min.				50.03		71.05				18.0%	
	max.				56.55							
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D6	0.250	0.049	2.72	55.40	3.48	70.96	1.878	2.461	31.0%	2.44E+07	1.68E+05
	(G=8D, Grip=10D)	2	0.250	0.049	2.59	52.65	3.48	70.96	1.878	2.441	30.0%	2.48E+07
		3	0.250	0.049	2.59	52.65	3.48	70.96	1.882	2.449	30.1%	2.42E+07
	mean		0.250	0.049	2.63	53.56	3.48	70.96	1.878	2.449	30.4%	2.45E+07
	D10	1	0.375	0.111	5.91	53.46	8.81	79.69	3.138	3.839	22.3%	2.64E+07
	(G=8D, Grip=10D)	2	0.375	0.111	5.98	54.07	8.97	81.11	3.150	3.882	23.3%	2.68E+07
		3	0.375	0.111	5.96	53.87	8.81	79.69	3.150	3.965	25.9%	2.61E+07
	mean		0.375	0.111	5.95	53.80	8.86	80.16	3.146	3.894	23.8%	2.64E+07
		¹ Elongation @ ultimate load based on gage length of broken bars.										
		² Stress-Strain relationship measured by 2 dia. opposed strain gages located @ center of gage length.										
		JIS Z 2441 references use of extensometer for strain measurement.										

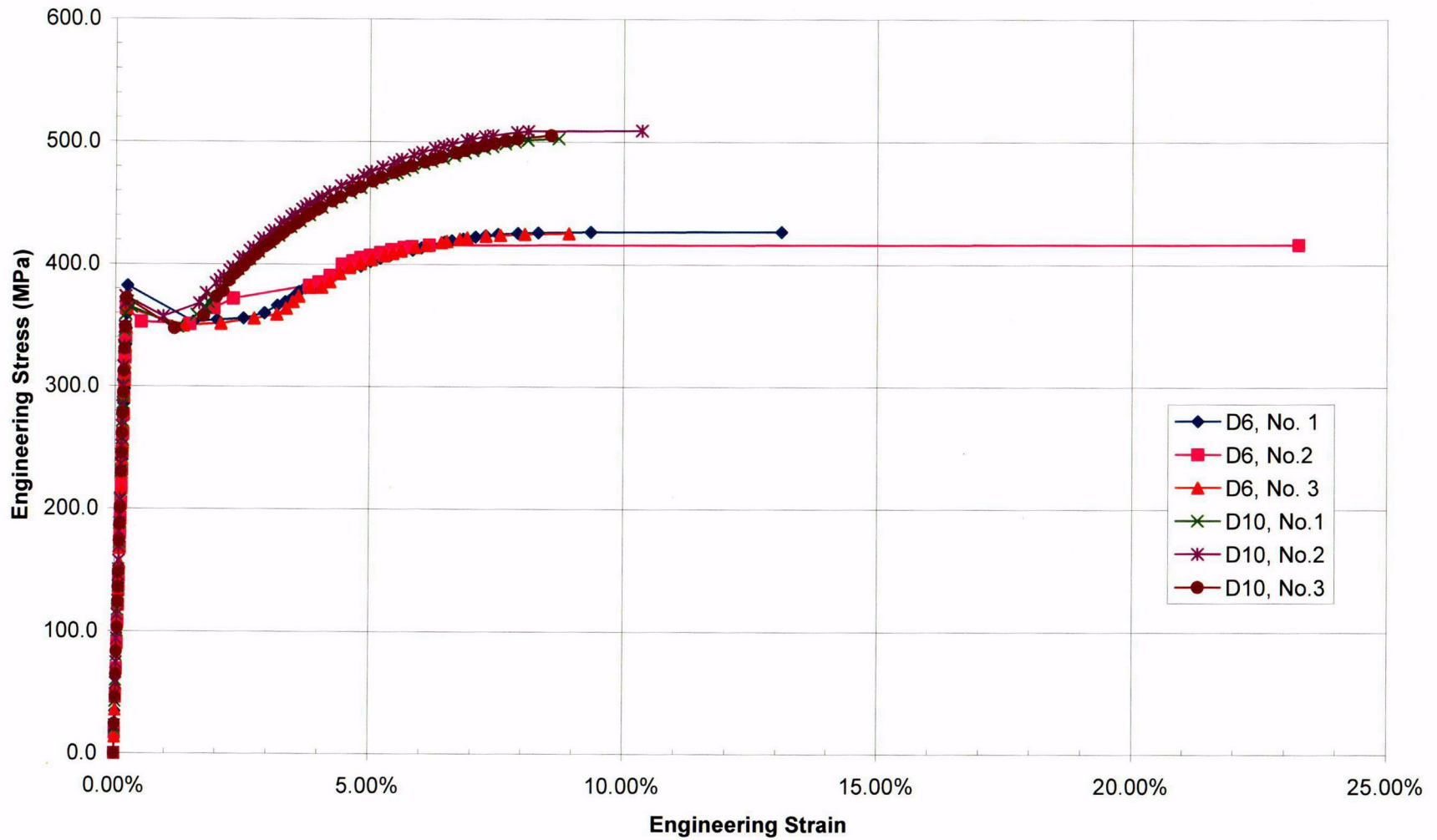
Reinforcing Steel			Diameter	Area	Yield Stress		Ultimate Stress		Gage Length		Elongation ¹	Elastic Modulus	Stress-Strain ²
			(in.)	(in ²)	(kips)	(ksi)	(kips)	(ksi)	Initial	Final	(%)	(psi)	
Nominal (JIS G 3112)	SD390												
min.						56.55		78.16			16.0%		
	max.				71.05								
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D10	0.375	0.111	7.46	67.48	10.50	94.93	3.157	3.705	17.3%	2.65E+07	1.83E+05	
(G=8D, Grip=10D)		2	0.375	0.111	7.73	69.93	10.57	95.54	3.130	3.846	22.9%	2.68E+07	
		3	0.375	0.111	7.55	68.31	10.34	93.51	3.138	3.803	21.2%	2.64E+07	
		mean	0.375	0.111	7.58	68.57	10.47	94.66	3.142	3.783	20.5%	2.65E+07	
D13 (#4)		1	0.500	0.196	12.00	61.12	17.35	88.35	4.094	5.094	24.4%	2.65E+07	
(G=8D, Grip=10D)		2	0.500	0.196	12.54	63.86	17.42	88.70	4.091	5.055	23.6%	2.65E+07	
		3	0.500	0.196	12.39	63.06	17.40	88.58	4.094	5.102	24.6%	2.67E+07	
		mean	0.500	0.196	12.31	62.68	17.39	88.54	4.094	5.083	24.2%	2.65E+07	
D16 (#5)		1	0.626	0.308	20.43	66.37	27.54	89.44	5.039	5.772	19.4%	2.64E+07	
(G=8D, Grip=10D)		2	0.626	0.308	20.52	66.66	27.65	89.80	5.047	5.803	24.1%	2.67E+07	
		3	0.626	0.308	20.32	66.00	27.38	88.93	5.035	5.768	22.7%	2.67E+07	
		mean	0.626	0.308	20.43	66.34	27.52	89.39	5.039	5.780	22.1%	2.65E+07	
D16 (#5)		1	0.492	0.190	14.84	78.00	19.74	103.76	1.957	2.500	27.8%	3.03E+07	
(dumbbell)		2	0.492	0.190	14.34	75.40	19.83	104.23	1.969	2.480	26.0%	3.03E+07	
(D x G = 0.5 x 2.0)		3	0.492	0.190	14.25	74.92	19.74	103.76	1.969	2.508	27.4%	3.03E+07	
		mean	0.492	0.190	14.48	76.11	19.77	103.92	1.965	2.496	27.1%	3.03E+07	
D19 (#6)		1	0.752	0.444	30.39	68.43	42.31	95.25	5.992	7.146	19.3%	2.65E+07	
(G=8D, Grip=10D)		2	0.752	0.444	30.48	68.63	42.44	95.56	5.992	7.240	20.8%	2.65E+07	
		3	0.752	0.444	30.53	68.73	42.44	95.56	5.980	7.370	23.2%	2.70E+07	
		mean	0.752	0.444	30.46	68.60	42.40	95.45	5.988	7.252	21.1%	2.67E+07	
D22 (#7)		1	0.874	0.600	39.70	66.15	59.28	98.77	6.929	7.886	16.8%	2.76E+07	
(G=8D, Grip=10D)		2	0.874	0.600	39.99	66.64	59.32	98.85	6.929	7.965	20.0%	2.77E+07	
		3	0.874	0.600	40.13	66.86	59.12	98.51	6.933	7.957	19.1%	2.78E+07	
		mean	0.874	0.600	39.95	66.56	59.23	98.72	6.929	7.937	18.7%	2.77E+07	
D22 (#7)		1	0.551	0.239	16.41	68.80	25.56	107.16	2.000	2.508	25.4%	3.05E+07	
(dumbbell)		2	0.551	0.239	16.50	69.14	25.18	105.56	1.992	2.512	26.1%	3.02E+07	
(D x G = 0.5 x 2.0)		3	0.551	0.239	15.92	66.73	25.85	108.32	2.020	2.551	26.3%	3.02E+07	
		mean	0.551	0.239	16.28	68.22	25.54	107.01	2.004	2.524	25.9%	3.03E+07	
		¹ Elongation @ ultimate load based on gage length of broken bars.											
		² Stress-Strain relationship measured by 2 dia.opossed strain gages located @ center of gage length.											
		JIS Z 2441 references use of extensometer for strain measurement.											

Reinforcing Steel			Diameter	Area	Yield Stress		Ultimate Stress		Gage Length		Elongation ¹	Elastic Modulus	Stress-Strain ²
			(in.)	(in ²)	(kips)	(ksi)	(kips)	(ksi)	Initial	Final	(%)	(psi)	
Nominal (JIS G 3112)	SD490												
	min.				71.05		89.61				12.0%		
	max.				89.90								
Test (JIS Z 2241)			X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)	X(B)
(ASTM E8M-93)	D10	0.375	0.111	7.89	71.35	10.70	96.76	3.138	3.854	22.8%	2.70E+07	1.86E+05	
(G=8D, Grip=10D)		2	0.375	0.111	7.87	71.15	10.61	95.95	3.142	3.760	19.7%	2.71E+07	
		3	0.375	0.111	7.87	71.15	10.72	96.96	3.150	3.835	21.8%	2.71E+07	
		mean	0.375	0.111	7.87	71.21	10.68	96.56	3.142	3.815	21.4%	2.71E+07	
D13		1	0.500	0.196	15.56	79.20	21.31	108.49	4.094	4.831	18.0%	2.65E+07	
(G=8D, Grip=10D)		2	0.500	0.196	15.56	79.20	21.38	108.84	4.091	4.783	16.9%	2.68E+07	
		3	0.500	0.196	15.74	80.11	21.51	109.52	4.094	4.685	14.4%	2.68E+07	
		mean	0.500	0.196	15.62	79.50	21.40	108.95	4.094	4.768	16.4%	2.67E+07	
D16		1	0.626	0.308	21.63	79.01	30.19	98.05	5.047	5.642	17.0%	2.67E+07	
(G=8D, Grip=10D)		2	0.626	0.308	23.00	79.01	31.22	101.41	5.039	5.634	15.2%	2.70E+07	
		3	0.626	0.308	22.32	79.92	30.78	99.95	5.039	5.693	19.0%	2.67E+07	
		mean	0.626	0.308	22.32	79.32	30.73	99.80	5.043	5.657	17.1%	2.68E+07	
D16		1	0.492	0.190	15.56	79.01	21.87	114.99	1.953	2.445	25.2%	3.07E+07	
(dumbbell)		2	0.492	0.190	15.15	79.01	21.76	114.39	1.976	2.445	23.7%	3.05E+07	
(D x G = 12.5 x 50)		3	0.492	0.190	15.35	79.92	21.51	113.10	1.965	2.449	24.6%	3.03E+07	
		mean	0.492	0.190	15.35	79.32	21.72	114.16	1.965	2.445	24.5%	3.05E+07	
D19		1	0.752	0.444	32.91	74.10	45.72	102.94	5.972	7.031	17.7%	2.68E+07	
(G=8D, Grip=10D)		2	0.752	0.444	33.09	74.50	45.59	102.65	5.980	6.988	16.9%	2.71E+07	
		3	0.752	0.444	32.96	74.20	45.81	103.14	5.976	7.094	18.7%	2.70E+07	
		mean	0.752	0.444	32.98	74.27	45.70	102.91	5.976	7.039	17.8%	2.70E+07	
			¹ Elongation @ ultimate load based on gage length of broken bars.										
			² Stress-Strain relationship measured by 2 dia. opposed strain gages located @ center of gage length.										
			JIS Z 2441 references use of extensometer for strain measurement.										

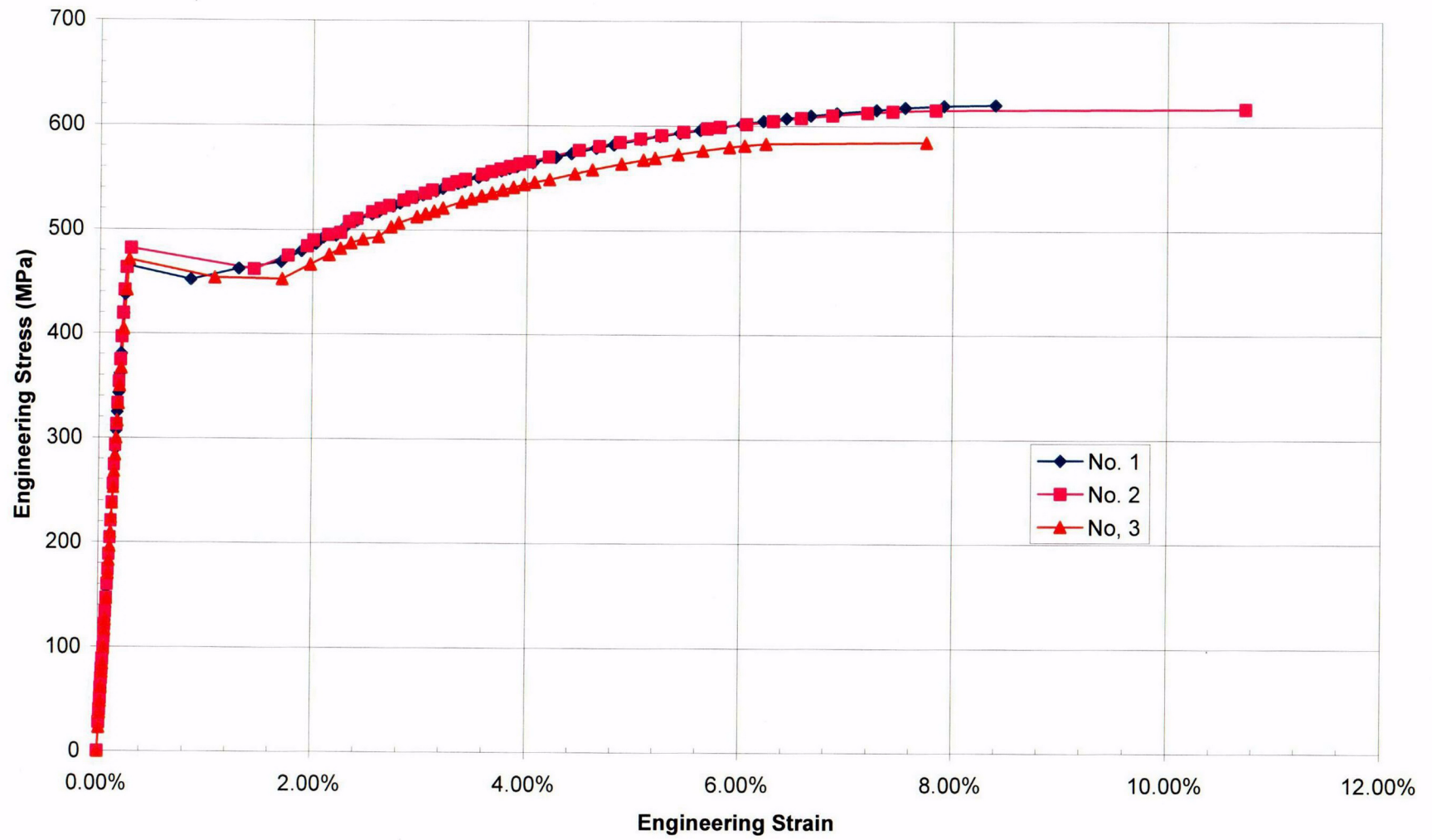
Rebar/Couplers	Slip*		Yield Stress		Fracture		Gage Length		Elongation	Elastic Modulus	Stress-Strain
	(IN)		(kips)	(ksi)	Loc.	(ksi)	Initial	Final	(%)	(psi)	Stress-Stroke
SD390	min.	max.									
min.		0.30			Rebar				2.0%		
									>10e _y		
Test (ASTM E8M-92)	X(B)	X(B)				X(B)	X(B)		X(B)		X(B)
Threaded Couplers											
D10	0.00039	0.00079				106.72			8.05%		
D13	0.00433	0.00669				110.49			7.93%		
D16	0.00354	0.00551				100.92			9.69%		
D19	0.00551	0.00630				106.58			8.76%		
D10-D13	0.00039	0.00079				110.06			6.59%		
D10-D16	0.00039	0.00079				117.02			5.73%		
D13-D16	0.00079	0.00157				110.49			7.20%		
D13-D19	0.00079	0.00157				112.38			6.29%		
D16-D19	0.00197	0.00433				103.10			6.83%		
Position Threaded Couplers											
D10	0.00157	0.00276				106.87			7.87%		
D13	0.00118	0.00433				109.19			7.18%		
D16	0.00630	0.00709				101.79			8.69%		
D19	0.00512	0.00906				106.14			7.71%		
D22	0.00630	0.00748				110.20			8.77%		
D10-D13	0.00079	0.00276				105.27			5.99%		
D13-D16	0.00276	0.00276				109.33			6.68%		
D13-D19	0.00118	0.00197				108.03			5.89%		
D16-D19	0.00551	0.01063				102.37			6.28%		
SD490	min.	max.									
min.		0.30			Rebar				2.0%		
									>10e _y		
Threaded Couplers											
D13	0.00433	0.00630				114.41			9.75%		
D16	0.00315	0.00551				114.84			9.59%		
D19	0.00118	0.00354				115.42			6.69%		
D16-D19	0.00630	0.00866				110.49			9.52%		
Position Threaded Couplers											
D13	0.00276	0.00472				115.28			8.45%		
D16	0.00591	0.00827				115.57			9.76%		
D19	0.00197	0.00630				115.86			7.11%		
D16-D19	0.00197	0.01063				110.78			9.11%		

*Slip = difference between final and initial strain @ 20.7 N/mm2 after loading to 207N/mm2

SD345, D6 (#2) & D10 (#3) Stress-Strain

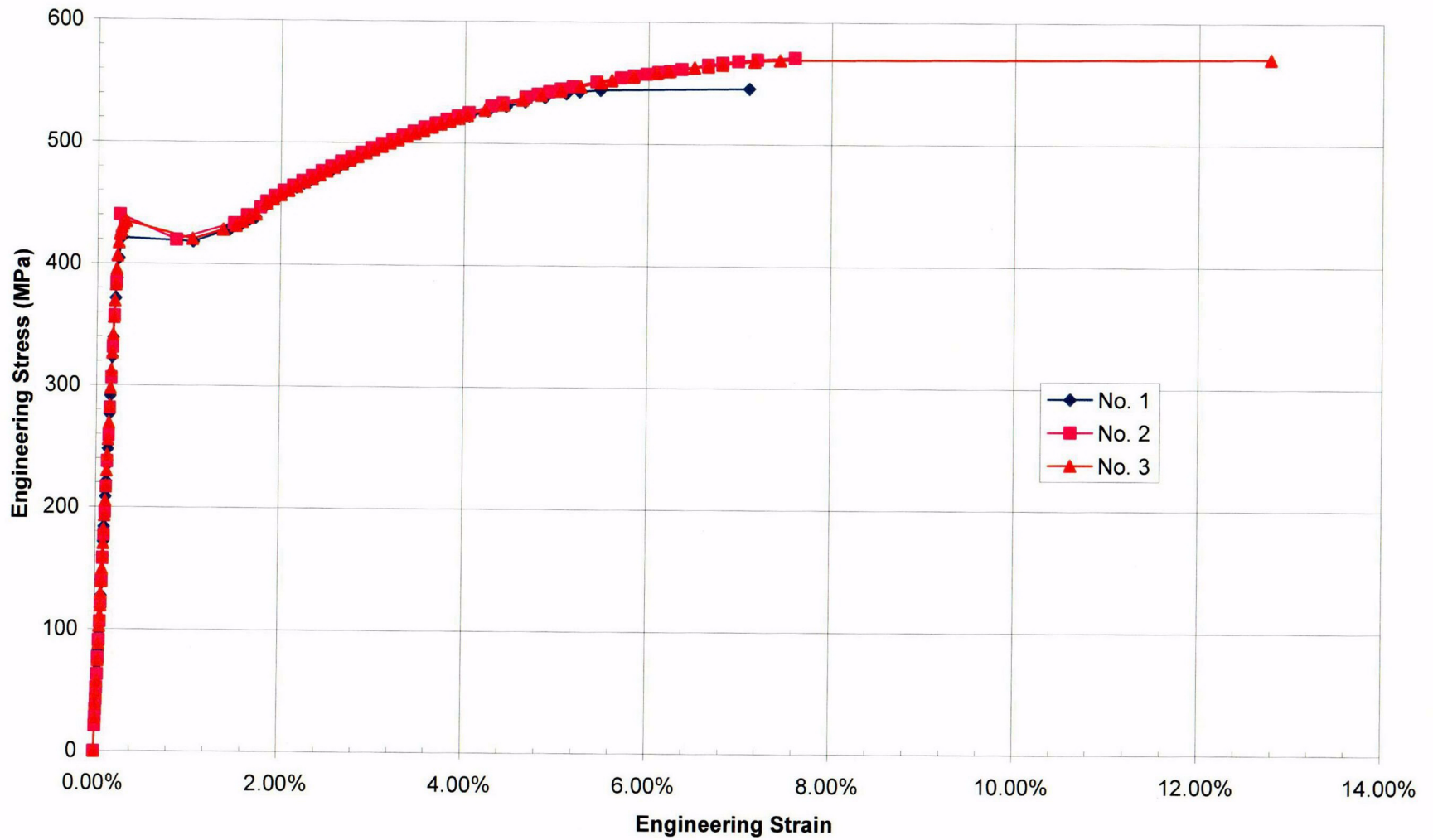


SD390, D10 (#3) Stress-Strain



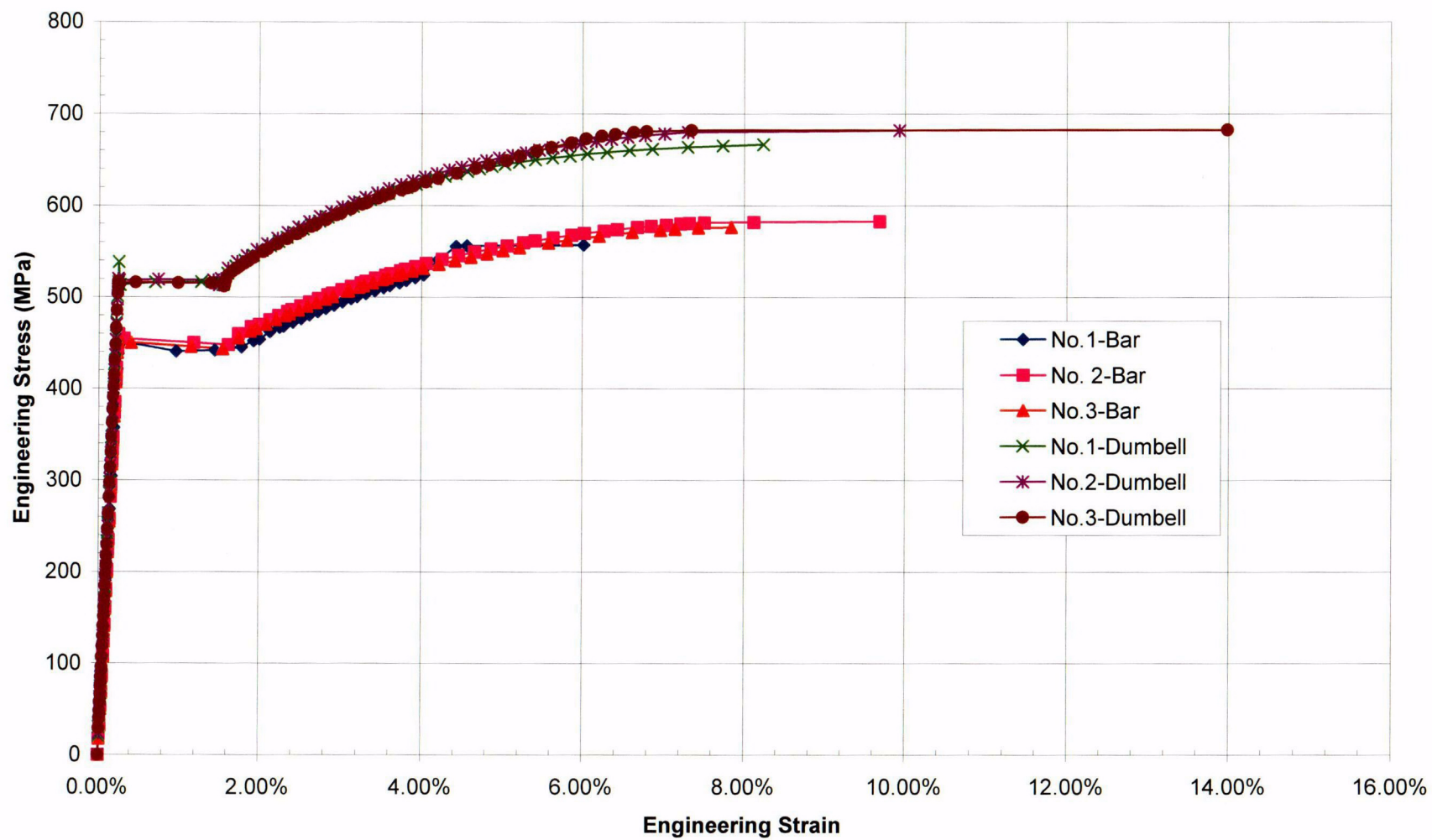
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SD390, D13 (#4) Stress-Strain

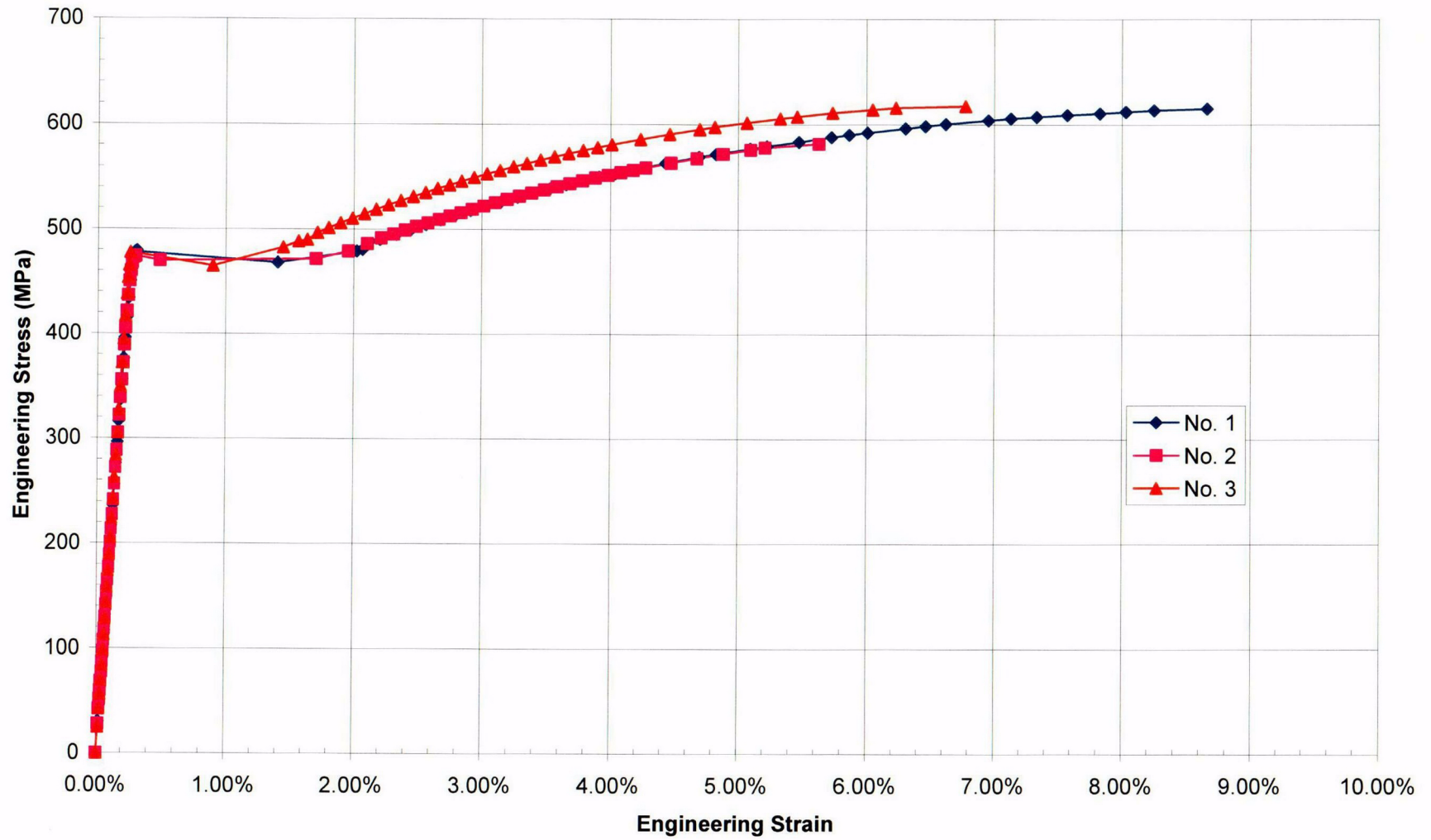


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SD390, D16 (#5) Stress-Strain



SD390, D19 (#6) Stress-Strain



SD390, D22 (#7) Stress-Strain

