Annex A

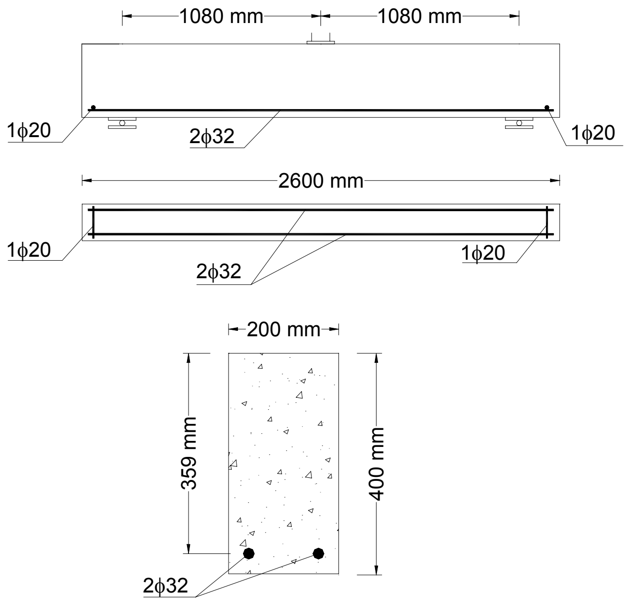
EXPERIMENTAL RESULTS

Specimen H50/1

Concrete properties
f'_c = 49.9 MPa f_{sp} = 3.6 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 ϕ32 bars in one layer

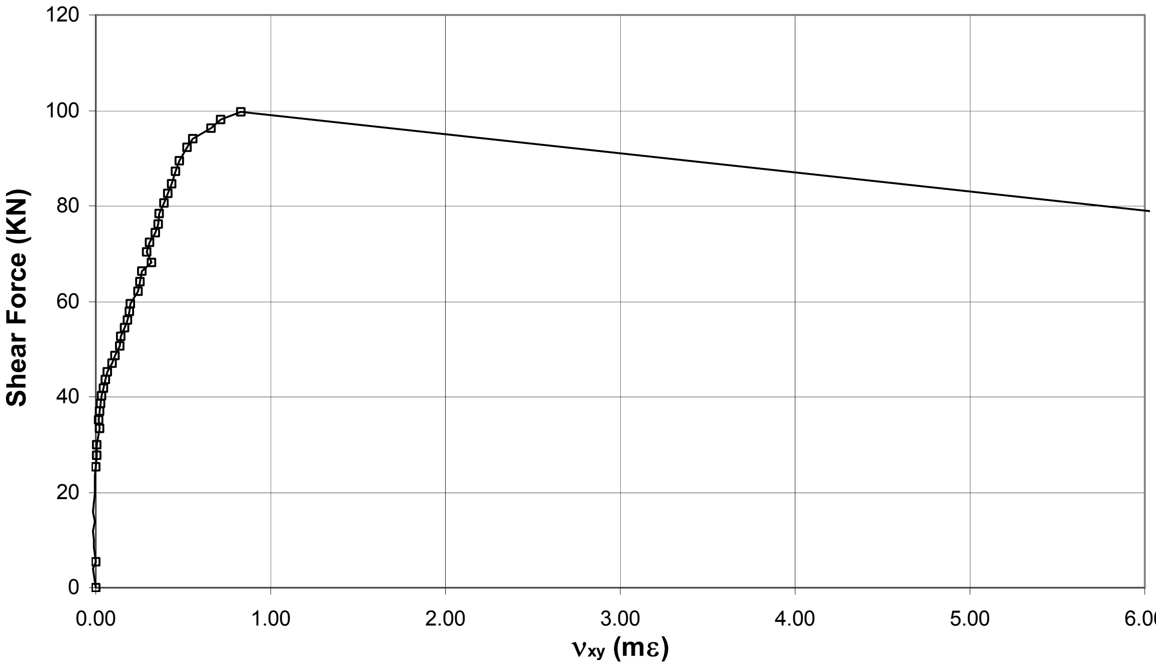
Transversal reinforcement
None



Cast: Jan 11, 2002
Tested: Feb 20, 2002
Test duration: 37 min
Test control: 0.003 mm/s

Summary of Test Observations

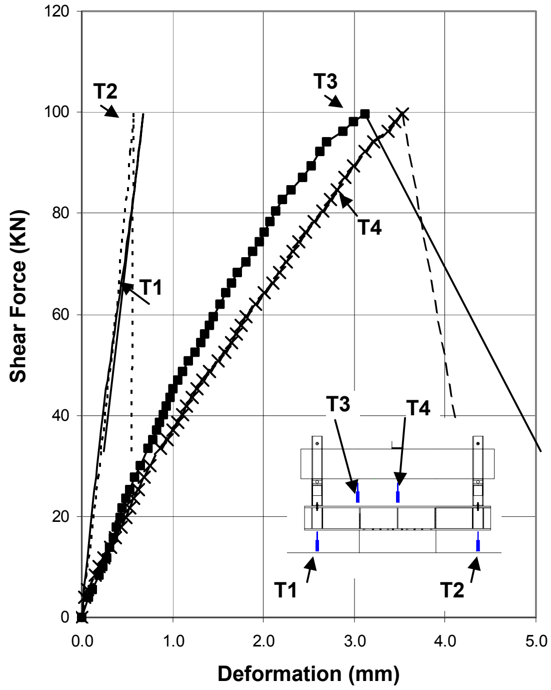
Beam specimen H50/1 did not contain shear reinforcement. For personal safety reasons, as a fragile failure was expected, the crack control was not carried out. However, a shear crack was noticed to appear at V = 95 KN. The beam collapsed at V = 99.69 KN. The longitudinal reinforcement did not reach the yielding strain.

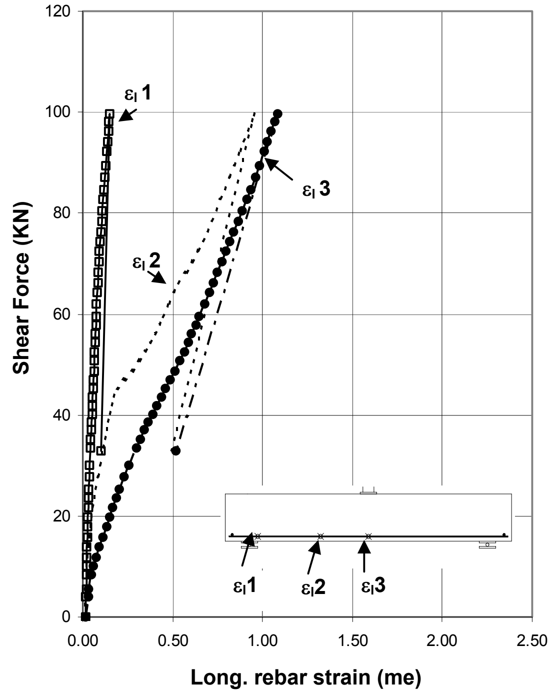


Specimen H50/1

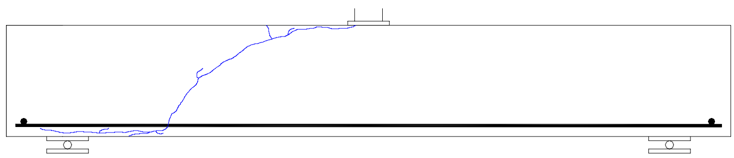
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**
398	3.92	-0.01	0.03	0.02	0.07	0.03	0.00	0.00	0.02	0.01	0.03
450	5.42	0.00	0.04	0.03	0.12	0.06	0.00	0.00	0.02	0.01	0.03
534	8.43	-0.01	0.06	0.04	0.19	0.14	0.00	0.00	0.02	0.02	0.05
576	10.12	-0.01	0.07	0.05	0.24	0.19	0.00	0.00	0.02	0.02	0.06
616	11.81	-0.02	0.08	0.06	0.27	0.25	0.00	0.01	0.02	0.03	0.07
660	13.86	-0.01	0.09	0.07	0.31	0.31	0.00	0.00	0.02	0.03	0.09
700	15.87	-0.02	0.10	0.08	0.35	0.37	0.00	0.01	0.03	0.04	0.11
736	17.80	-0.01	0.12	0.09	0.38	0.43	0.00	0.00	0.03	0.04	0.13
770	19.73	-0.01	0.13	0.11	0.42	0.48	0.00	0.01	0.03	0.05	0.15
804	21.76	0.00	0.14	0.12	0.45	0.53	0.00	0.00	0.03	0.05	0.17
834	23.59	0.00	0.15	0.13	0.49	0.58	0.00	0.01	0.03	0.06	0.18
862	25.35	0.00	0.16	0.14	0.52	0.62	0.00	0.01	0.03	0.07	0.20
900	27.81	0.01	0.18	0.15	0.58	0.68	0.01	0.00	0.03	0.08	0.23
934	30.04	0.01	0.20	0.17	0.64	0.75	0.01	0.00	0.04	0.09	0.25
986	33.45	0.02	0.22	0.19	0.73	0.87	0.01	0.00	0.04	0.11	0.30
1014	35.24	0.02	0.22	0.20	0.78	0.94	0.01	0.00	0.05	0.12	0.32
1042	37.00	0.02	0.24	0.22	0.82	1.00	0.01	0.00	0.05	0.13	0.34
1068	38.68	0.02	0.25	0.22	0.86	1.06	0.02	0.00	0.05	0.14	0.37
1092	40.14	0.03	0.26	0.23	0.90	1.11	0.02	0.01	0.05	0.15	0.39
1118	41.75	0.04	0.27	0.24	0.93	1.16	0.02	0.00	0.05	0.16	0.41
1148	43.63	0.06	0.28	0.26	0.98	1.22	0.03	0.00	0.05	0.17	0.44
1172	45.23	0.07	0.29	0.27	1.01	1.27	0.03	0.00	0.06	0.19	0.46
1202	47.02	0.09	0.30	0.28	1.06	1.34	0.04	0.00	0.06	0.23	0.49
1230	48.62	0.11	0.31	0.30	1.11	1.41	0.05	0.00	0.06	0.28	0.51
1264	50.71	0.14	0.32	0.31	1.18	1.50	0.06	0.00	0.06	0.31	0.54
1294	52.56	0.14	0.33	0.33	1.25	1.58	0.07	0.01	0.07	0.35	0.56
1324	54.48	0.17	0.35	0.34	1.31	1.64	0.08	0.00	0.07	0.37	0.59
1350	56.17	0.18	0.35	0.36	1.36	1.70	0.08	0.01	0.07	0.40	0.61
1378	57.85	0.19	0.36	0.37	1.41	1.75	0.09	0.00	0.07	0.43	0.63
1404	59.51	0.20	0.37	0.38	1.45	1.81	0.09	0.01	0.07	0.45	0.65
1446	62.09	0.24	0.39	0.40	1.52	1.91	0.11	0.00	0.08	0.48	0.68
1482	64.21	0.25	0.40	0.42	1.58	2.01	0.11	0.00	0.08	0.51	0.70
1514	66.27	0.26	0.41	0.44	1.65	2.10	0.12	0.01	0.08	0.53	0.73
1546	68.23	0.32	0.42	0.45	1.72	2.18	0.13	-0.01	0.09	0.57	0.75
1578	70.37	0.29	0.43	0.47	1.80	2.25	0.13	0.01	0.09	0.61	0.77
1610	72.37	0.31	0.44	0.49	1.88	2.32	0.14	0.01	0.09	0.64	0.80
1642	74.38	0.34	0.45	0.50	1.95	2.39	0.15	0.00	0.10	0.67	0.82
1672	76.21	0.35	0.46	0.52	2.01	2.46	0.16	0.01	0.10	0.69	0.84
1706	78.41	0.36	0.47	0.53	2.08	2.55	0.16	0.01	0.10	0.72	0.87
1740	80.51	0.39	0.48	0.55	2.14	2.65	0.17	0.01	0.11	0.74	0.89
1774	82.64	0.41	0.49	0.56	2.21	2.74	0.18	0.01	0.11	0.77	0.91
1808	84.70	0.43	0.50	0.58	2.31	2.82	0.19	0.01	0.12	0.79	0.94
1848	87.19	0.45	0.51	0.59	2.43	2.90	0.20	0.01	0.12	0.82	0.96
1886	89.45	0.48	0.52	0.61	2.52	2.99	0.21	0.01	0.13	0.84	0.98
1934	92.23	0.52	0.53	0.63	2.62	3.12	0.23	0.01	0.13	0.87	1.01
1968	94.15	0.56	0.55	0.64	2.70	3.22	0.24	0.00	0.14	0.89	1.03
2024	96.25	0.66	0.56	0.65	2.88	3.37	0.29	0.01	0.14	0.92	1.05
2058	98.10	0.71	0.57	0.67	3.00	3.44	0.31	0.01	0.15	0.94	1.07
2096	**99.69**	**0.83**	**0.58**	**0.67**	**3.11**	**3.53**	**0.36**	**0.01**	**0.15**	**0.96**	**1.08**
2110	32.91	17.51	0.55	0.24	5.06	4.18	7.36	-0.07	0.10	0.49	0.52

Specimen H50/1





Specimen H50/1 – Cracking control



V_{fail} = 99.69 KN

Test set-up for beam H50/1

Cracking at failure (V = 99.69 KN)

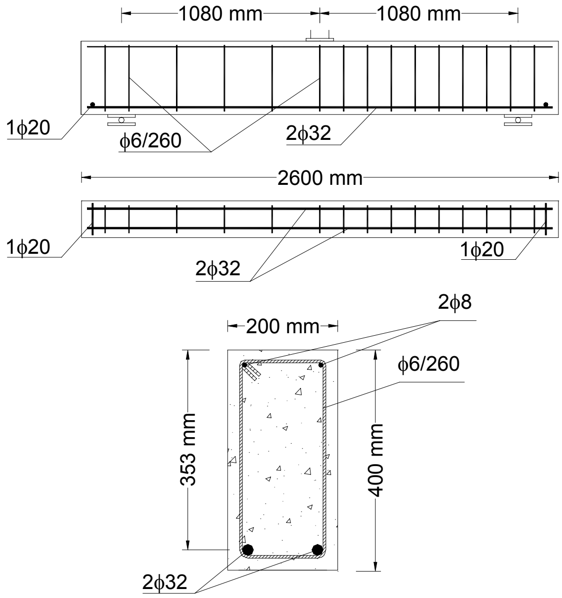
Specimen H50/2

Concrete properties
f'_c = 49.9 MPa f_{sp} = 3.6 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.28%   2 ϕ32 bars in one layer

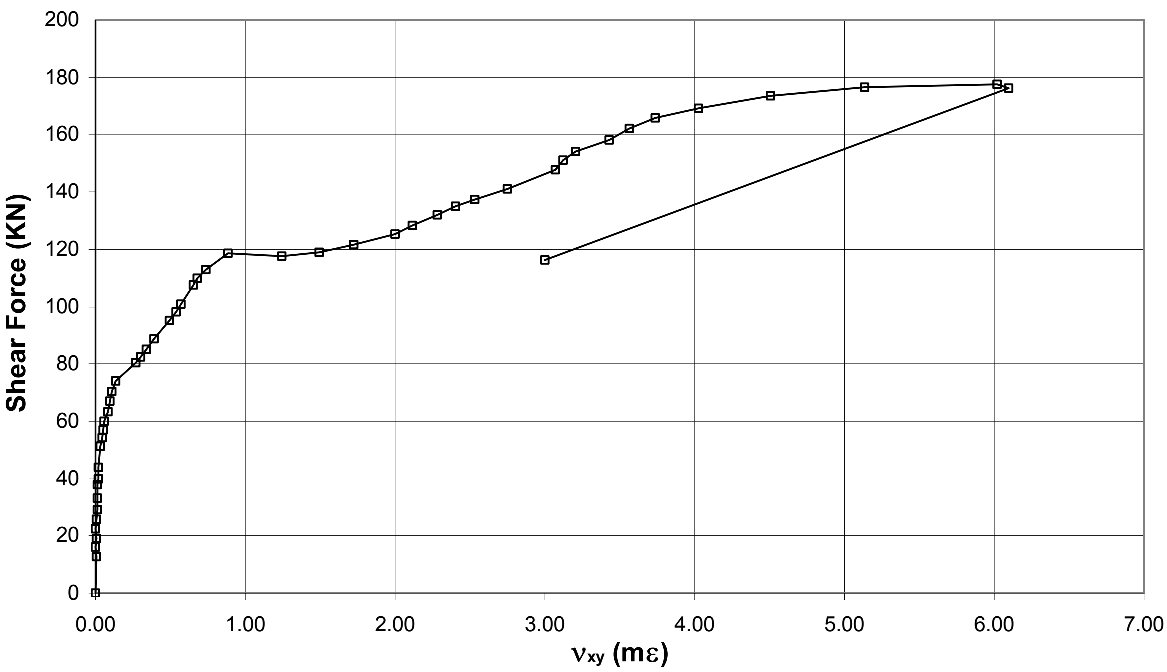
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 0.577 MPa stirrups ϕ6 @ 260 mm

Cast: Jan 11, 2002
Tested: Feb 21, 2002
Test duration: 48 min
Test control: 0.005 mm/s



Summary of Test Observations

Beam specimen H50/2 contained the minimum amount of web reinforcement proposed in this document. At load stage 3, the first shear crack was observed (V = 85 KN). Stirrup 3 yielded suddenly for V = 118 KN, and stirrup 4 for V = 160 KN. The failure took place for a shear strength of 177.64 KN. The longitudinal reinforcement did not reach the yielding strain.



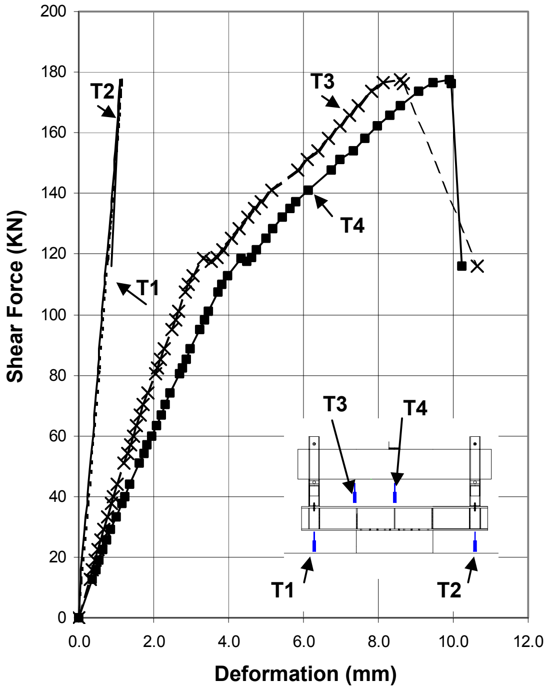
Specimen H50/2

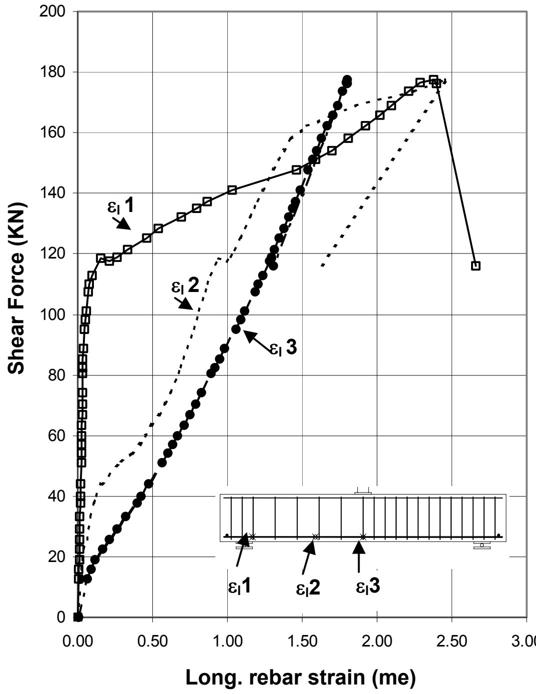
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
339	12.83	0.01	0.08	0.05	0.36	0.30	0.00	0.00	0.01	0.02	0.06
378	15.97	0.00	0.10	0.06	0.46	0.37	0.00	0.00	0.01	0.03	0.09
411	18.93	0.00	0.13	0.09	0.54	0.43	0.00	0.00	0.01	0.03	0.12
450	22.36	0.00	0.15	0.11	0.64	0.51	0.00	0.00	0.01	0.04	0.16
486	25.71	0.01	0.17	0.13	0.74	0.58	0.00	0.00	0.01	0.06	0.21
522	29.16	0.01	0.19	0.16	0.86	0.66	0.00	0.00	0.02	0.07	0.26
564	33.17	0.01	0.22	0.19	1.00	0.76	0.01	0.00	0.02	0.08	0.32
612	37.73	0.01	0.25	0.22	1.15	0.88	0.00	0.00	0.02	0.11	0.40
636	**39.98**	**0.02**	**0.27**	**0.24**	**1.23**	**0.94**	**0.01**	**0.00**	**0.02**	**0.12**	**0.43**
678	44.02	0.02	0.30	0.27	1.36	1.03	0.01	0.00	0.02	0.15	0.47
753	51.11	0.03	0.35	0.32	1.63	1.21	0.01	0.00	0.02	0.29	0.57
786	54.24	0.05	0.37	0.34	1.74	1.30	0.02	0.00	0.02	0.36	0.60
816	57.02	0.05	0.39	0.36	1.83	1.39	0.02	0.00	0.03	0.41	0.64
846	**59.97**	**0.06**	**0.41**	**0.38**	**1.94**	**1.46**	**0.03**	**0.00**	**0.03**	**0.45**	**0.67**
882	63.47	0.08	0.43	0.40	2.07	1.55	0.03	0.00	0.03	0.50	0.71
918	66.93	0.10	0.46	0.42	2.20	1.64	0.04	0.00	0.03	0.54	0.75
951	70.22	0.11	0.48	0.44	2.31	1.72	0.05	0.00	0.03	0.58	0.79
990	74.17	0.14	0.50	0.47	2.44	1.84	0.05	0.00	0.03	0.62	0.83
1056	80.42	0.27	0.54	0.50	2.69	2.05	0.11	0.00	0.03	0.67	0.89
1077	82.44	0.30	0.55	0.52	2.77	2.11	0.13	0.00	0.03	0.69	0.92
1104	**85.21**	**0.34**	**0.57**	**0.53**	**2.86**	**2.18**	**0.14**	**0.00**	**0.04**	**0.71**	**0.95**
1137	88.62	0.39	0.59	0.55	2.97	2.27	0.16	0.00	0.04	0.73	0.98
1203	95.18	0.50	0.63	0.59	3.24	2.48	0.21	0.00	0.05	0.78	1.06
1233	98.23	0.54	0.65	0.61	3.36	2.58	0.22	0.00	0.05	0.79	1.09
1260	100.97	0.57	0.67	0.62	3.46	2.66	0.24	0.00	0.05	0.81	1.12
1326	107.55	0.66	0.71	0.66	3.72	2.86	0.27	-0.01	0.07	0.85	1.18
1350	109.83	0.68	0.72	0.68	3.83	2.94	0.28	0.00	0.08	0.87	1.21
1383	112.91	0.74	0.74	0.70	3.97	3.05	0.31	-0.01	0.09	0.89	1.24
1464	118.58	0.88	0.78	0.74	4.34	3.32	0.37	0.00	0.16	0.94	1.30
1491	117.53	1.25	0.78	0.75	4.49	3.53	0.53	0.00	0.21	0.99	1.28
1515	118.98	1.49	0.78	0.75	4.60	3.68	0.63	0.00	0.26	1.02	1.29
1548	121.51	1.72	0.80	0.77	4.75	3.85	0.75	0.01	0.33	1.04	1.31
1599	125.25	2.00	0.82	0.80	5.00	4.09	0.89	0.04	0.46	1.09	1.35
1638	128.31	2.12	0.84	0.82	5.17	4.27	0.96	0.06	0.54	1.12	1.38
1695	**132.13**	**2.28**	**0.87**	**0.84**	**5.43**	**4.52**	**1.09**	**0.12**	**0.69**	**1.15**	**1.41**
1737	134.97	2.40	0.88	0.86	5.64	4.70	1.20	0.18	0.79	1.18	1.44
1773	137.27	2.53	0.90	0.88	5.79	4.87	1.32	0.24	0.87	1.20	1.46
1839	141.15	2.75	0.93	0.90	6.12	5.16	1.54	0.38	1.03	1.24	1.49
1971	147.81	3.07	0.98	0.94	6.75	5.84	2.04	0.73	1.46	1.31	1.54
2025	151.10	3.12	1.00	0.96	6.99	6.10	2.18	0.86	1.59	1.34	1.57
2097	154.02	3.21	1.02	0.97	7.34	6.38	2.33	0.97	1.70	1.38	1.59
2163	158.11	3.43	1.04	1.00	7.64	6.67	2.54	1.08	1.81	1.43	1.63
2232	162.22	3.57	1.07	1.02	7.98	6.97	2.72	1.21	1.92	1.53	1.67
2298	165.87	3.74	1.09	1.04	8.30	7.24	2.91	1.32	2.02	1.71	1.71
2355	169.04	4.03	1.11	1.06	8.58	7.46	3.12	1.42	2.10	1.86	1.73
2454	173.55	4.51	1.14	1.08	9.08	7.82	3.45	1.53	2.21	2.25	1.77
2529	176.41	5.13	1.15	1.10	9.46	8.13	3.78	1.60	2.29	2.42	1.79
2619	177.64	6.02	1.16	1.11	9.91	8.59	4.25	1.70	2.38	2.45	1.80
2628	176.28	6.10	1.16	1.11	9.96	8.66	4.33	1.74	2.40	2.45	1.80
2631	116.09	3.00	0.78	0.87	10.23	10.64	4.46	3.19	2.66	1.62	1.30

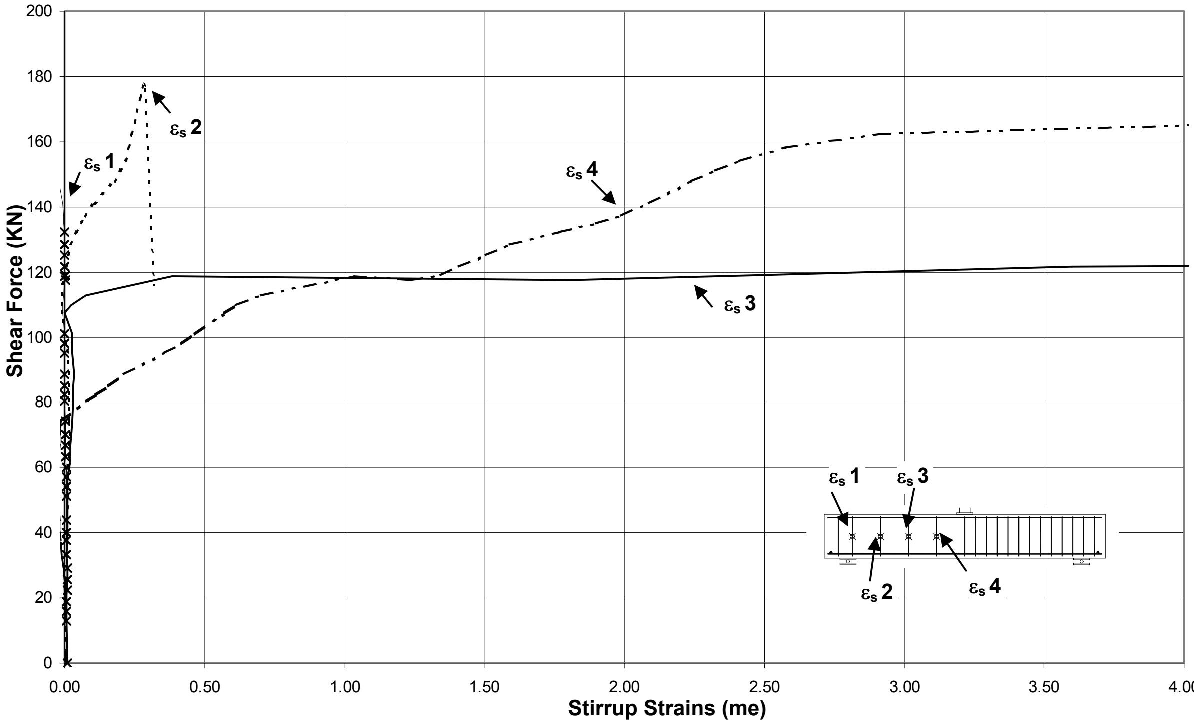
Specimen H50/2 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains				
			ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	me	me	me	me	me	me
0	**0**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	
339	13	0.01	0.01	0.01	0.01	0.00	
378	16	0.00	0.01	0.01	0.01	0.00	
411	19	0.00	0.01	0.01	0.01	0.00	
450	22	0.00	0.01	0.01	0.01	0.00	
486	26	0.01	0.01	0.01	0.01	0.00	
522	29	0.01	0.01	0.01	0.01	0.00	
564	33	0.01	0.01	0.01	0.01	-0.01	
612	38	0.01	0.01	0.01	0.01	-0.01	
636	**40**	**0.02**	**0.01**	**0.01**	**0.01**	**-0.02**	
678	44	0.02	0.01	0.01	0.01	-0.02	
753	51	0.03	0.01	0.01	0.01	-0.02	
786	54	0.05	0.01	0.01	0.01	-0.02	
816	57	0.05	0.01	0.01	0.01	-0.02	
846	**60**	**0.06**	**0.01**	**0.01**	**0.02**	**-0.02**	
882	63	0.08	0.00	0.02	0.02	-0.02	
918	67	0.10	0.00	0.02	0.02	-0.02	
951	70	0.11	0.01	0.02	0.02	-0.02	
990	74	0.14	0.00	0.02	0.03	-0.01	
1056	80	0.27	0.00	0.02	0.03	0.08	
1077	82	0.30	0.00	0.02	0.03	0.11	
1104	**85**	**0.34**	**0.00**	**0.02**	**0.03**	**0.16**	
1137	89	0.39	0.00	0.02	0.03	0.21	
1203	95	0.50	0.00	0.01	0.03	0.36	
1233	98	0.54	0.00	0.01	0.03	0.42	
1260	101	0.57	0.00	0.00	0.03	0.47	
1326	108	0.66	-0.01	-0.01	0.00	0.57	
1350	110	0.68	-0.01	-0.01	0.03	0.62	
1383	113	0.74	0.00	-0.01	0.08	0.70	
1464	119	0.88	0.00	-0.01	0.39	1.04	
1491	118	1.25	0.00	0.00	1.81	1.24	
1515	119	1.49	0.00	0.00	2.46	1.34	
1548	122	1.72	0.00	0.01	3.60	1.41	
1599	125	2.00	0.00	0.01	12.59	1.51	
1638	128	2.12	0.00	0.02	12.81	1.59	
1695	**132**	**2.28**	**0.00**	**0.04**	**12.80**	**1.77**	
1737	135	2.40	0.00	0.06	12.80	1.90	
1773	137	2.53	0.00	0.07	12.79	1.99	
1839	141	2.75	-0.01	0.10	12.79	2.09	
1971	148	3.07	-0.02	0.18	12.79	2.24	
2025	151	3.12	-0.02	0.20	12.79	2.33	
2097	154	3.21	-0.02	0.22	12.79	2.41	
2163	158	3.43	-0.03	0.23	12.79	2.58	
2232	162	3.57	-0.03	0.24	12.79	2.91	
2298	166	3.74	-0.03	0.25	12.79	4.44	
2355	169	4.03	-0.03	0.26	12.79	6.65	
2454	174	4.51	-0.04	0.27	12.79	12.81	
2529	176	5.13	-0.04	0.28	12.79	12.79	
2619	178	6.02	-0.04	0.29	12.79	12.79	
2628	176	6.10	-0.04	0.29	12.79	12.79	
2631	116	3.00	-0.02	0.32	12.79	12.79	

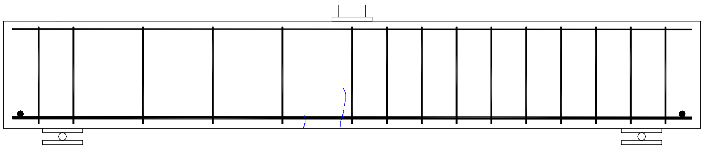
Specimen H50/2



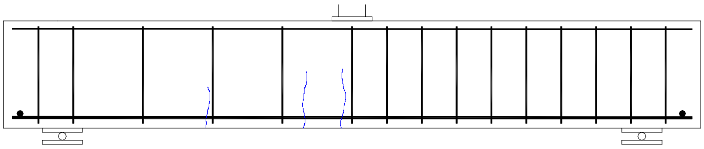




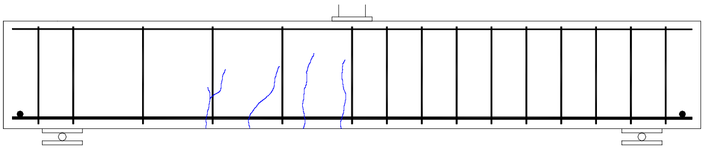
Specimen H50/2 – Cracking control



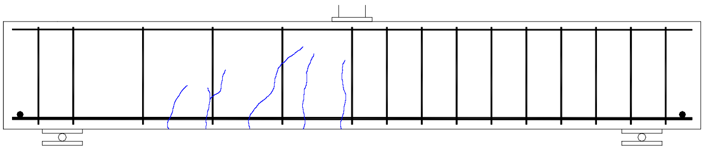
V = 40 KN



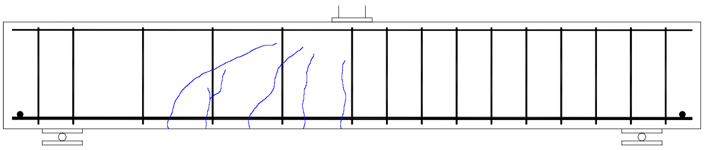
V = 60 KN



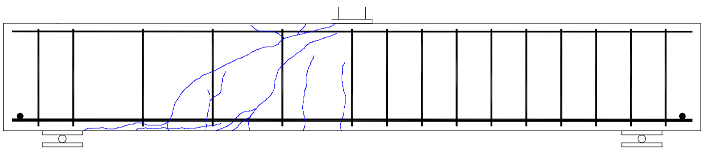
V = 85 KN



V = 110 KN

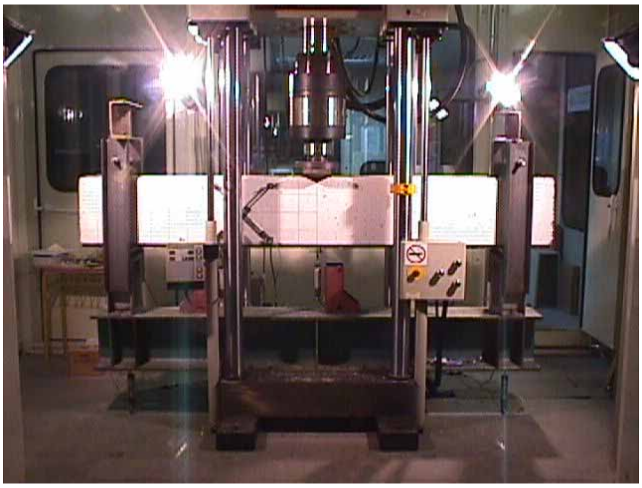


V = 130 KN

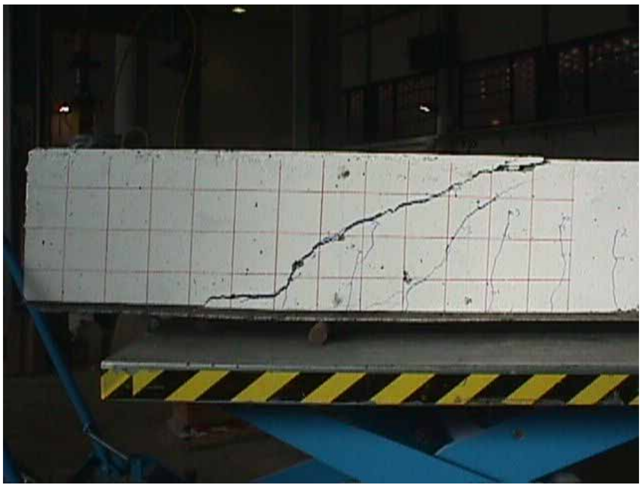


V = 178 KN
failure

Specimen H50/2



Test set-up for beam H50/2



Cracking at failure (V = 178 KN)

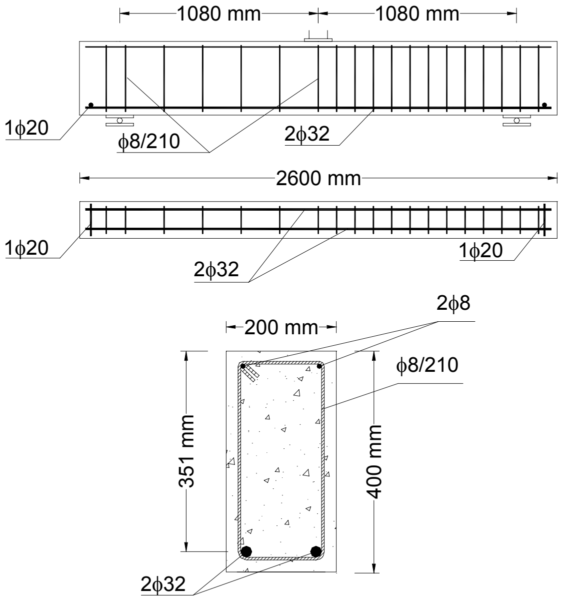
Specimen H50/3

Concrete properties
f'_c = 49.9 MPa f_{sp} = 3.6 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.29% 2 ϕ32 bars in one layer

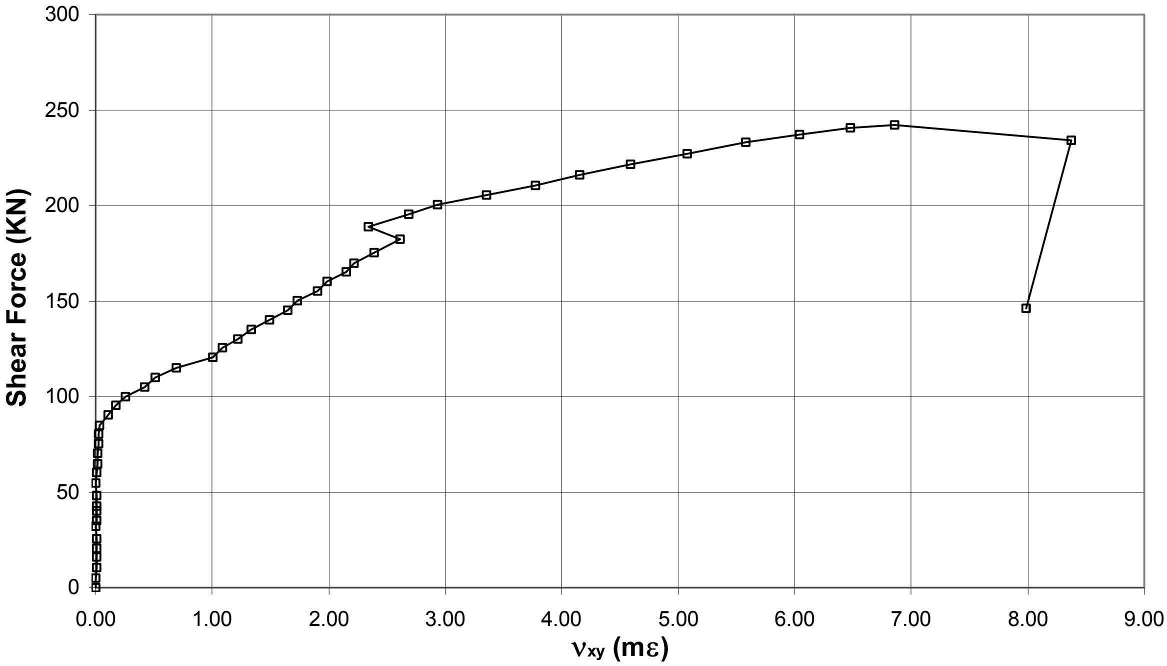
Transversal reinforcement
B-500-S f_y = 540 MPa
ρ_w = 1.29 MPa stirrups ϕ8 @ 210 mm

Cast: Jan 11, 2002
Tested: Feb 25, 2002
Test duration: 55 min
Test control: 0.006 mm/s



Summary of Test Observations

First flexural crack was noticed at load stage 1 (V = 30 KN). For V = 90 KN shear cracks appeared. Stirrup 4 yielded for V = 180 KN. Longitudinal reinforcement did not reach the yielding strain. The specimen failed at V = 242.07 KN.



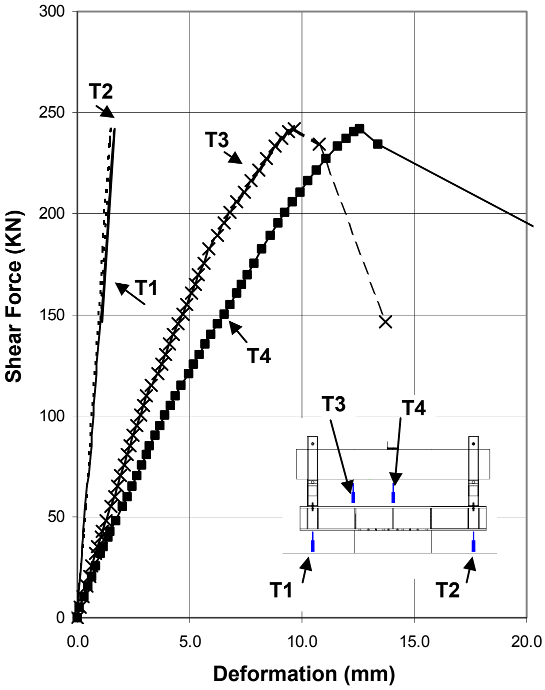
Specimen H50/3

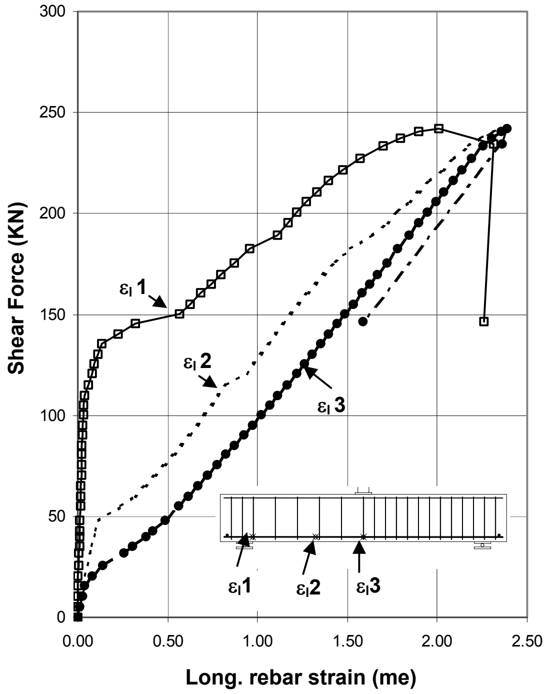
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
270	5.01	0.00	0.02	0.02	0.10	0.12	0.00	0.00	0.00	0.01	0.01
378	10.37	0.01	0.05	0.05	0.29	0.27	0.00	0.00	0.00	0.02	0.02
456	15.91	0.01	0.09	0.09	0.47	0.43	0.00	0.00	0.00	0.03	0.04
510	20.64	0.01	0.13	0.12	0.64	0.55	0.01	0.00	0.00	0.04	0.08
561	25.56	0.01	0.17	0.15	0.81	0.66	0.00	0.00	0.00	0.05	0.14
627	32.03	0.00	0.22	0.19	1.04	0.82	0.00	0.00	0.01	0.07	0.26
657	**35.03**	**0.01**	**0.24**	**0.21**	**1.16**	**0.91**	**0.00**	**0.00**	**0.01**	**0.08**	**0.31**
708	40.02	0.01	0.29	0.25	1.37	1.05	0.00	0.00	0.01	0.09	0.38
735	**42.62**	**0.01**	**0.30**	**0.26**	**1.47**	**1.12**	**0.00**	**0.00**	**0.01**	**0.09**	**0.42**
792	48.13	0.01	0.34	0.29	1.70	1.27	0.00	0.00	0.01	0.12	0.48
864	55.02	0.00	0.38	0.35	2.00	1.49	0.00	0.00	0.01	0.24	0.56
912	**60.13**	**0.01**	**0.41**	**0.39**	**2.21**	**1.65**	**0.00**	**0.00**	**0.02**	**0.32**	**0.62**
960	65.04	0.01	0.44	0.44	2.43	1.78	0.00	0.00	0.02	0.38	0.67
1011	70.18	0.02	0.47	0.49	2.64	1.92	0.00	-0.01	0.02	0.43	0.72
1062	75.51	0.02	0.50	0.54	2.85	2.08	0.00	-0.01	0.02	0.48	0.77
1110	80.60	0.03	0.53	0.59	3.06	2.23	0.00	-0.01	0.02	0.53	0.82
1152	**85.01**	**0.03**	**0.55**	**0.62**	**3.22**	**2.34**	**0.00**	**-0.02**	**0.02**	**0.58**	**0.87**
1203	90.28	0.11	0.58	0.66	3.45	2.48	0.03	-0.02	0.03	0.63	0.92
1254	95.26	0.17	0.61	0.69	3.67	2.64	0.05	-0.02	0.03	0.67	0.97
1308	100.22	0.26	0.64	0.72	3.89	2.81	0.08	-0.03	0.03	0.70	1.02
1365	105.15	0.42	0.68	0.75	4.15	2.95	0.15	-0.03	0.03	0.75	1.07
1416	**109.98**	**0.51**	**0.71**	**0.77**	**4.35**	**3.08**	**0.18**	**-0.04**	**0.04**	**0.78**	**1.11**
1476	115.24	0.70	0.74	0.81	4.62	3.29	0.26	-0.04	0.06	0.83	1.16
1551	120.84	1.01	0.78	0.84	4.96	3.58	0.39	-0.04	0.08	0.94	1.22
1599	125.39	1.09	0.81	0.87	5.19	3.74	0.43	-0.04	0.09	0.98	1.26
1650	**130.23**	**1.22**	**0.84**	**0.90**	**5.43**	**3.92**	**0.48**	**-0.04**	**0.11**	**1.02**	**1.30**
1707	135.31	1.33	0.87	0.94	5.70	4.09	0.53	-0.04	0.14	1.06	1.35
1761	140.27	1.49	0.90	0.98	5.96	4.26	0.59	-0.04	0.22	1.10	1.39
1818	145.34	1.65	0.93	1.02	6.22	4.47	0.66	-0.04	0.32	1.14	1.44
1881	**150.18**	**1.73**	**0.96**	**1.07**	**6.54**	**4.71**	**0.69**	**-0.04**	**0.57**	**1.18**	**1.49**
1938	155.19	1.90	0.98	1.10	6.81	4.89	0.76	-0.04	0.62	1.23	1.53
1995	160.48	1.99	1.01	1.15	7.09	5.09	0.80	-0.04	0.69	1.28	1.58
2046	165.12	2.15	1.03	1.18	7.33	5.24	0.87	-0.05	0.74	1.32	1.62
2097	169.83	2.22	1.06	1.21	7.58	5.40	0.90	-0.04	0.80	1.37	1.67
2160	175.52	2.39	1.08	1.25	7.85	5.63	0.97	-0.05	0.87	1.43	1.72
2238	182.37	2.61	1.12	1.28	8.21	5.87	1.06	-0.05	0.95	1.52	1.78
2328	189.09	2.34	1.16	1.32	8.60	6.22	0.94	-0.05	1.11	1.64	1.84
2412	195.31	2.69	1.18	1.35	8.95	6.54	1.09	-0.05	1.17	1.72	1.90
2478	200.42	2.94	1.21	1.38	9.25	6.81	1.20	-0.05	1.22	1.78	1.95
2553	205.69	3.36	1.25	1.40	9.57	7.09	1.38	-0.05	1.27	1.84	1.99
2625	210.70	3.77	1.28	1.43	9.91	7.41	1.55	-0.05	1.33	1.90	2.04
2700	216.15	4.15	1.32	1.47	10.27	7.72	1.71	-0.05	1.40	1.96	2.09
2778	221.50	4.59	1.35	1.50	10.64	8.06	1.90	-0.05	1.47	2.03	2.14
2859	227.22	5.08	1.39	1.53	11.06	8.40	2.11	-0.05	1.57	2.10	2.19
2955	233.21	5.58	1.43	1.58	11.58	8.80	2.32	-0.05	1.70	2.17	2.25
3024	237.30	6.04	1.45	1.61	11.95	9.12	2.51	-0.05	1.79	2.24	2.30
3087	240.65	6.47	1.47	1.64	12.29	9.39	2.69	-0.05	1.90	2.31	2.36
3135	**242.07**	**6.85**	**1.48**	**1.65**	**12.57**	**9.66**	**2.85**	**-0.06**	**2.01**	**2.35**	**2.39**
3270	234.22	8.37	1.46	1.62	13.39	10.78	3.44	-0.11	2.31	2.18	2.36
3279	146.31	7.99	1.04	1.12	28.31	13.73	3.22	-0.17	2.26		1.58

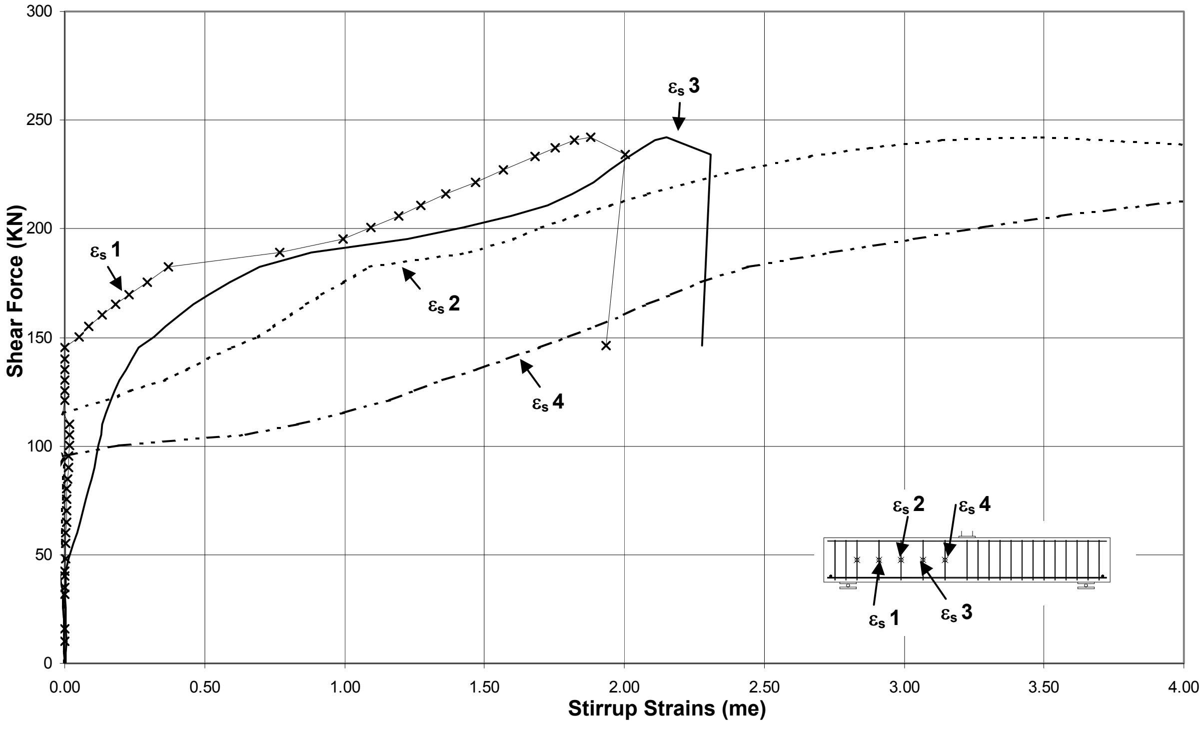
Specimen H50/3 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains			
			ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}
sec	KN	me	me	me	me	me
0	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
270	5.01	0.00	0.00	0.00	0.00	0.00
378	10.37	0.01	0.00	0.00	0.01	0.00
456	15.91	0.01	0.00	0.00	0.01	0.00
510	20.64	0.01	0.00	0.00	0.00	-0.01
561	25.56	0.01	0.00	0.00	0.00	-0.01
627	32.03	0.00	0.00	0.00	0.00	-0.01
657	**35.03**	**0.01**	**0.00**	**0.00**	**0.00**	**-0.01**
708	40.02	0.01	0.00	0.00	0.00	-0.02
735	**42.62**	**0.01**	**0.00**	**0.00**	**0.00**	**-0.02**
792	48.13	0.01	0.00	0.00	0.01	-0.04
864	55.02	0.00	0.00	-0.01	0.03	-0.04
912	**60.13**	**0.01**	**0.00**	**-0.01**	**0.04**	**-0.04**
960	65.04	0.01	0.01	-0.01	0.05	-0.04
1011	70.18	0.02	0.01	-0.01	0.07	-0.04
1062	75.51	0.02	0.01	-0.01	0.08	-0.04
1110	80.60	0.03	0.01	-0.01	0.09	-0.04
1152	**85.01**	**0.03**	**0.01**	**-0.01**	**0.10**	**-0.04**
1203	90.28	0.11	0.01	0.00	0.11	-0.03
1254	95.26	0.17	0.02	-0.01	0.11	0.00
1308	100.22	0.26	0.02	-0.02	0.12	0.20
1365	105.15	0.42	0.02	-0.03	0.13	0.65
1416	**109.98**	**0.51**	**0.02**	**-0.03**	**0.13**	**0.83**
1476	115.24	0.70	-0.01	0.00	0.15	1.00
1551	120.84	1.01	0.00	0.15	0.17	1.16
1599	125.39	1.09	0.00	0.24	0.18	1.25
1650	**130.23**	**1.22**	**0.00**	**0.36**	**0.20**	**1.35**
1707	135.31	1.33	0.00	0.44	0.22	1.48
1761	140.27	1.49	0.00	0.51	0.24	1.58
1818	145.34	1.65	0.00	0.60	0.26	1.70
1881	**150.18**	**1.73**	**0.05**	**0.69**	**0.32**	**1.80**
1938	155.19	1.90	0.09	0.75	0.36	1.90
1995	160.48	1.99	0.13	0.81	0.41	2.00
2046	165.12	2.15	0.18	0.86	0.46	2.08
2097	169.83	2.22	0.23	0.92	0.51	2.17
2160	175.52	2.39	0.30	1.00	0.59	2.28
2238	182.37	2.61	0.37	1.09	0.70	2.44
2328	189.09	2.34	0.77	1.45	0.88	2.74
2412	195.31	2.69	1.00	1.61	1.23	3.04
2478	200.42	2.94	1.10	1.70	1.42	3.28
2553	205.69	3.36	1.19	1.83	1.60	3.56
2625	210.70	3.77	1.27	1.95	1.73	3.87
2700	216.15	4.15	1.36	2.09	1.82	4.24
2778	221.50	4.59	1.47	2.24	1.89	4.66
2859	227.22	5.08	1.57	2.42	1.95	5.10
2955	233.21	5.58	1.68	2.67	2.02	5.64
3024	237.30	6.04	1.75	2.88	2.06	6.11
3087	240.65	6.47	1.82	3.13	2.11	6.60
3135	**242.07**	**6.85**	**1.88**	**3.49**	**2.15**	**7.13**
3270	234.22	8.37	2.00	4.67	2.31	7.65
3279	146.31	7.99	1.93	4.64	2.28	5.49

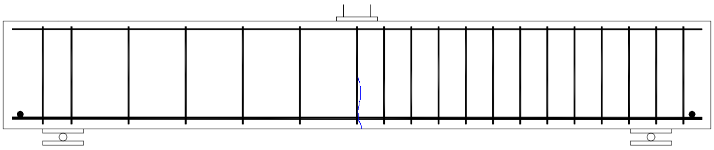
Specimen H50/3



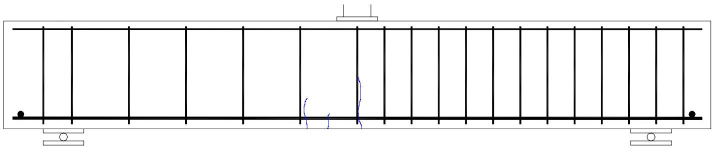




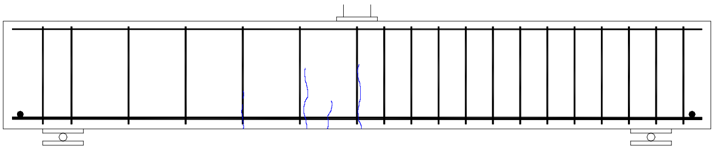
Specimen H50/3 – Cracking control



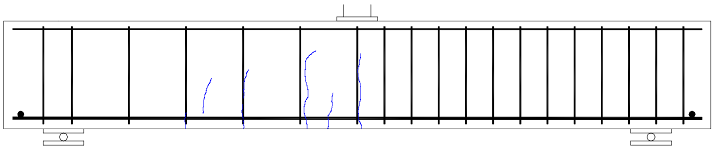
V = 35 KN



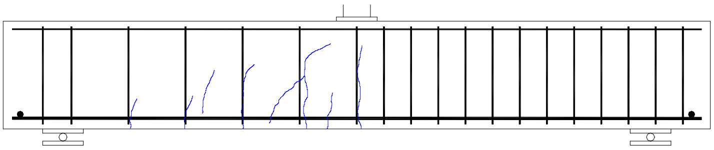
V = 42 KN



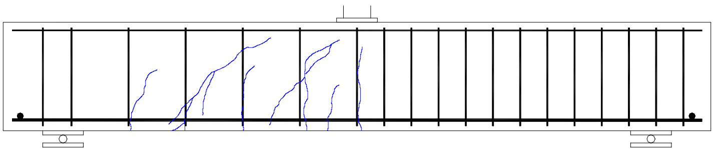
V = 60 KN



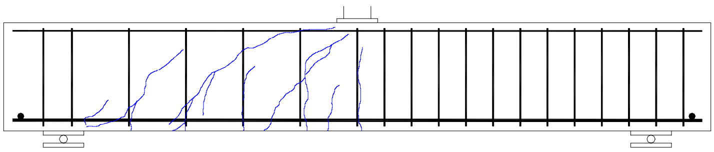
V = 85 KN



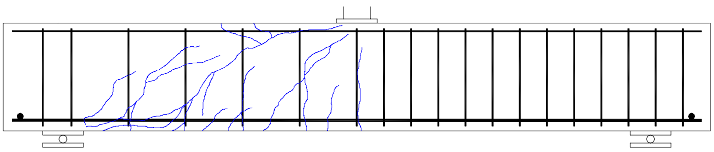
V = 110 KN



V = 130 KN

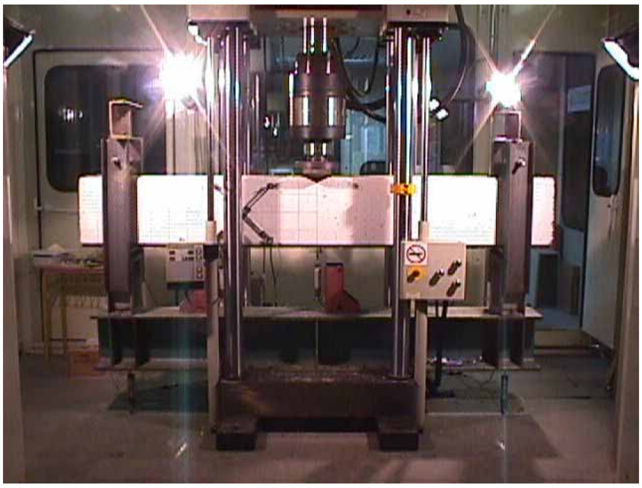


V = 150 KN

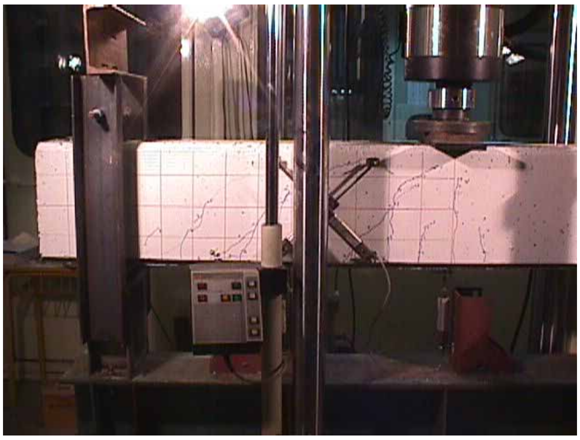


V = 242 KN
failure

Specimen H50/3



Test set-up for beam H50/3



Cracking for V = 130 KN

Cracking at failure (V = 242.07 KN)

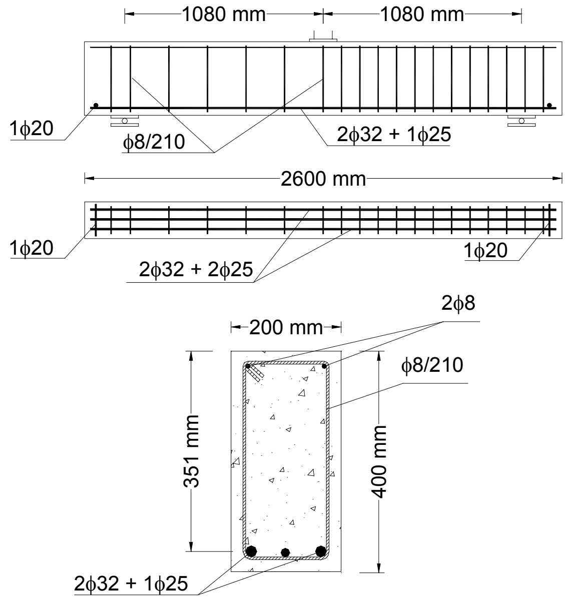
Specimen H50/4

Concrete properties
f'_c = 49.9 MPa f_{sp} = 3.6 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.99%   2 ϕ32 + 1 ϕ25 bars in one layer

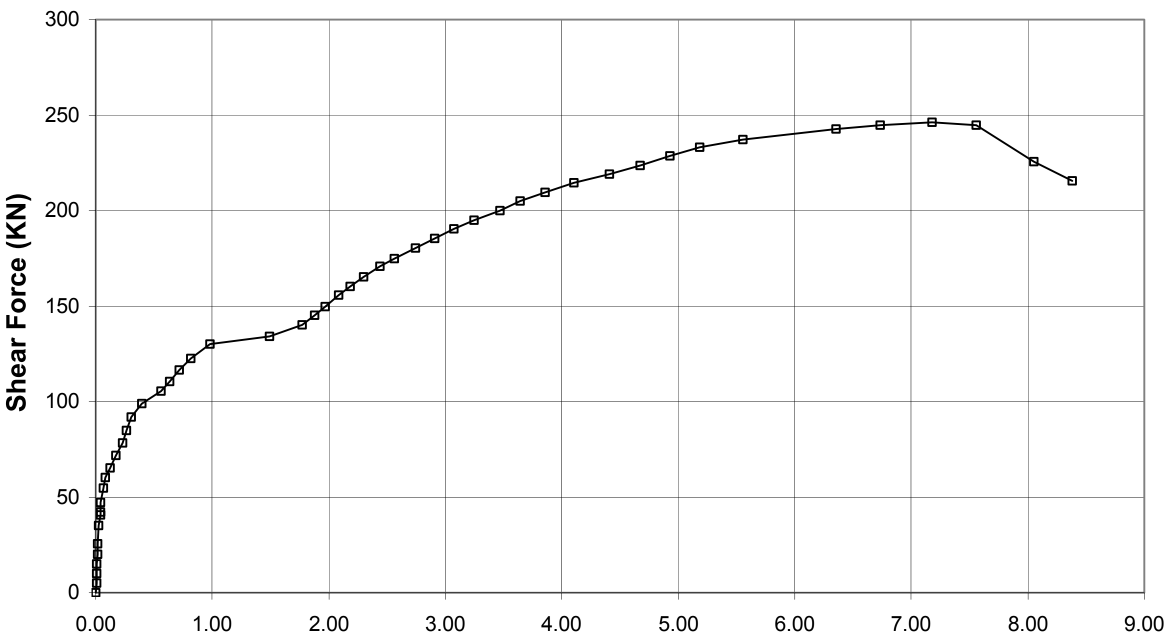
Transversal reinforcement
B-500-S f_y = 540 MPa
ρ_w = 1.291 MPa stirrups ϕ8 @ 210 mm

Cast: Jan 11, 2002
Tested: Feb 26, 2002
Test duration: 54 min
Test control: 0.006 mm/s



Summary of Test Observations

The test was to be stopped before cracking to adjust transducer 2. A flexural crack was noticed at stage 1 (V = 30 KN). For V = 110 KN shear cracks appeared. Longitudinal reinforcement did not reach the yielding strain. The specimen failed at V = 246.34 KN.



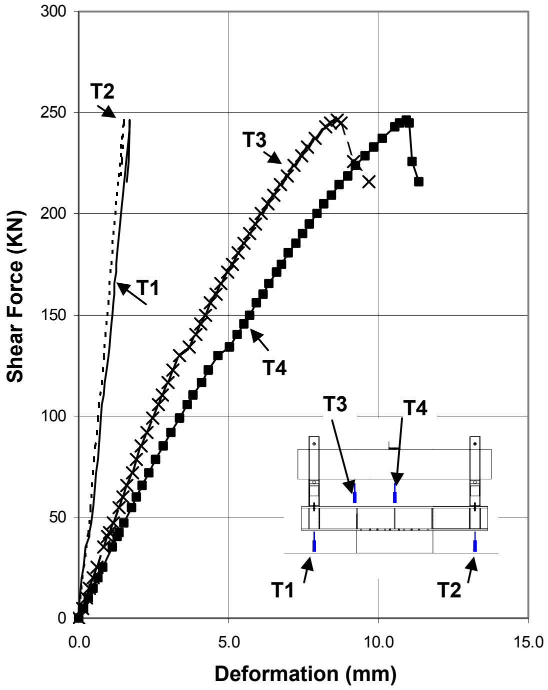
Specimen H50/4

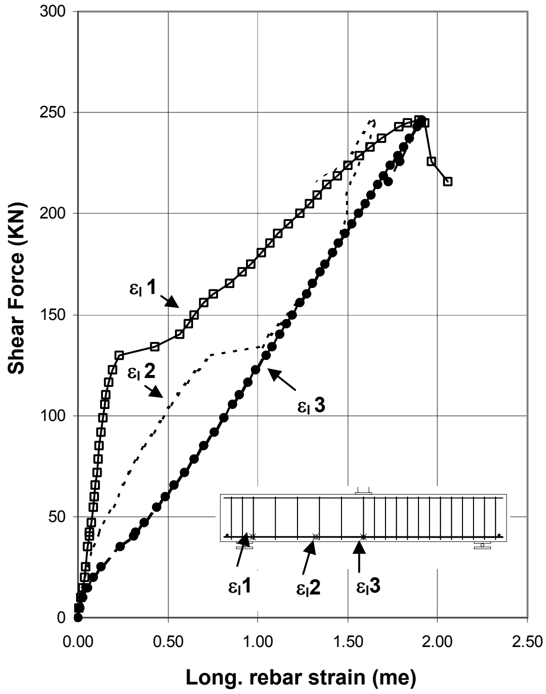
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
195	4.97	0.01	0.03	0.01	0.15	0.13	0.01	0.00	0.01	0.00	0.01
270	10.01	0.00	0.05	0.03	0.31	0.25	0.00	0.00	0.02	0.01	0.03
327	14.85	0.01	0.09	0.07	0.47	0.35	0.00	0.00	0.03	0.02	0.05
381	20.00	0.01	0.13	0.11	0.63	0.49	0.00	0.00	0.04	0.04	0.08
438	25.39	0.02	0.17	0.14	0.79	0.62	0.01	0.00	0.04	0.05	0.13
522	**35.24**	**0.02**	**0.25**	**0.21**	**1.11**	**0.84**	**0.01**	**0.00**	**0.05**	**0.09**	**0.23**
672	40.64	0.04	0.29	0.36	1.29	0.98	0.01	0.00	0.06	0.11	0.31
684	**42.27**	**0.04**	**0.31**	**0.37**	**1.33**	**1.02**	**0.01**	**0.00**	**0.07**	**0.12**	**0.32**
723	47.12	0.04	0.34	0.41	1.50	1.15	0.02	0.00	0.08	0.14	0.37
783	54.56	0.06	0.39	0.47	1.75	1.33	0.02	0.00	0.08	0.20	0.44
828	**60.07**	**0.08**	**0.42**	**0.51**	**1.93**	**1.46**	**0.03**	**-0.01**	**0.09**	**0.22**	**0.49**
873	65.56	0.12	0.45	0.55	2.13	1.61	0.05	0.00	0.10	0.25	0.54
924	72.01	0.17	0.49	0.59	2.35	1.78	0.06	-0.01	0.10	0.29	0.59
975	78.62	0.23	0.52	0.63	2.57	1.93	0.09	-0.01	0.11	0.32	0.65
1029	**85.08**	**0.27**	**0.56**	**0.67**	**2.82**	**2.09**	**0.10**	**-0.01**	**0.12**	**0.37**	**0.70**
1083	91.96	0.31	0.60	0.70	3.06	2.28	0.12	-0.01	0.13	0.42	0.76
1140	99.12	0.40	0.64	0.74	3.35	2.46	0.16	-0.01	0.14	0.47	0.81
1194	105.37	0.56	0.68	0.78	3.61	2.65	0.21	-0.03	0.15	0.52	0.86
1236	**110.34**	**0.64**	**0.72**	**0.82**	**3.83**	**2.80**	**0.24**	**-0.03**	**0.15**	**0.56**	**0.90**
1287	116.44	0.72	0.75	0.87	4.09	2.98	0.27	-0.03	0.17	0.61	0.94
1338	122.56	0.82	0.80	0.93	4.34	3.14	0.32	-0.03	0.19	0.66	0.99
1401	**130.02**	**0.98**	**0.84**	**0.99**	**4.66**	**3.38**	**0.38**	**-0.03**	**0.23**	**0.74**	**1.05**
1467	134.13	1.49	0.88	1.02	5.02	3.67	0.59	-0.04	0.43	1.02	1.08
1521	140.13	1.77	0.91	1.06	5.29	3.92	0.71	-0.04	0.57	1.07	1.12
1566	145.29	1.88	0.94	1.09	5.51	4.08	0.75	-0.04	0.61	1.12	1.16
1608	**149.98**	**1.97**	**0.96**	**1.12**	**5.71**	**4.22**	**0.79**	**-0.04**	**0.65**	**1.17**	**1.19**
1659	155.76	2.09	0.99	1.15	5.94	4.41	0.84	-0.04	0.70	1.22	1.24
1701	160.39	2.18	1.01	1.18	6.14	4.58	0.88	-0.04	0.75	1.27	1.27
1749	165.27	2.30	1.04	1.20	6.36	4.76	0.93	-0.04	0.84	1.31	1.30
1803	171.02	2.44	1.07	1.24	6.59	4.95	0.99	-0.04	0.92	1.35	1.34
1842	175.10	2.57	1.09	1.25	6.78	5.12	1.04	-0.05	0.96	1.38	1.37
1896	180.48	2.74	1.11	1.28	7.00	5.31	1.12	-0.04	1.02	1.41	1.41
1947	185.49	2.91	1.14	1.31	7.25	5.50	1.19	-0.04	1.07	1.44	1.45
1995	190.26	3.08	1.17	1.34	7.47	5.70	1.26	-0.04	1.11	1.46	1.48
2043	**195.16**	**3.25**	**1.19**	**1.37**	**7.69**	**5.89**	**1.33**	**-0.04**	**1.17**	**1.48**	**1.52**
2094	200.19	3.47	1.22	1.40	7.95	6.10	1.42	-0.06	1.23	1.49	1.56
2142	204.91	3.65	1.24	1.44	8.18	6.33	1.49	-0.05	1.29	1.50	1.60
2187	209.31	3.85	1.27	1.47	8.43	6.51	1.58	-0.06	1.33	1.49	1.63
2238	214.35	4.10	1.30	1.51	8.69	6.75	1.69	-0.05	1.38	1.51	1.67
2286	218.90	4.41	1.33	1.55	8.96	6.96	1.80	-0.07	1.44	1.53	1.70
2337	223.80	4.67	1.36	1.58	9.24	7.18	1.91	-0.07	1.50	1.56	1.74
2391	228.80	4.93	1.40	1.61	9.55	7.44	2.02	-0.07	1.56	1.58	1.78
2439	233.07	5.18	1.43	1.64	9.83	7.64	2.13	-0.07	1.62	1.60	1.81
2490	237.36	5.55	1.45	1.66	10.12	7.88	2.27	-0.09	1.69	1.63	1.84
2562	242.85	6.35	1.49	1.70	10.53	8.22	2.50	-0.20	1.78	1.65	1.89
2592	244.80	6.73	1.50	1.70	10.72	8.38	2.58	-0.27	1.83	1.65	1.90
2631	**246.34**	**7.18**	**1.51**	**1.71**	**10.94**	**8.63**	**2.71**	**-0.34**	**1.90**	**1.65**	**1.91**
2646	244.84	7.56	1.51	1.71	11.03	8.75	2.75	-0.46	1.93	1.63	1.90
2649	225.66	8.05	1.45	1.66	11.12	9.16	2.72	-0.70	1.97	1.49	1.79
2679	215.69	8.38	1.39	1.61	11.35	9.68	2.83	-0.73	2.06	1.33	1.72

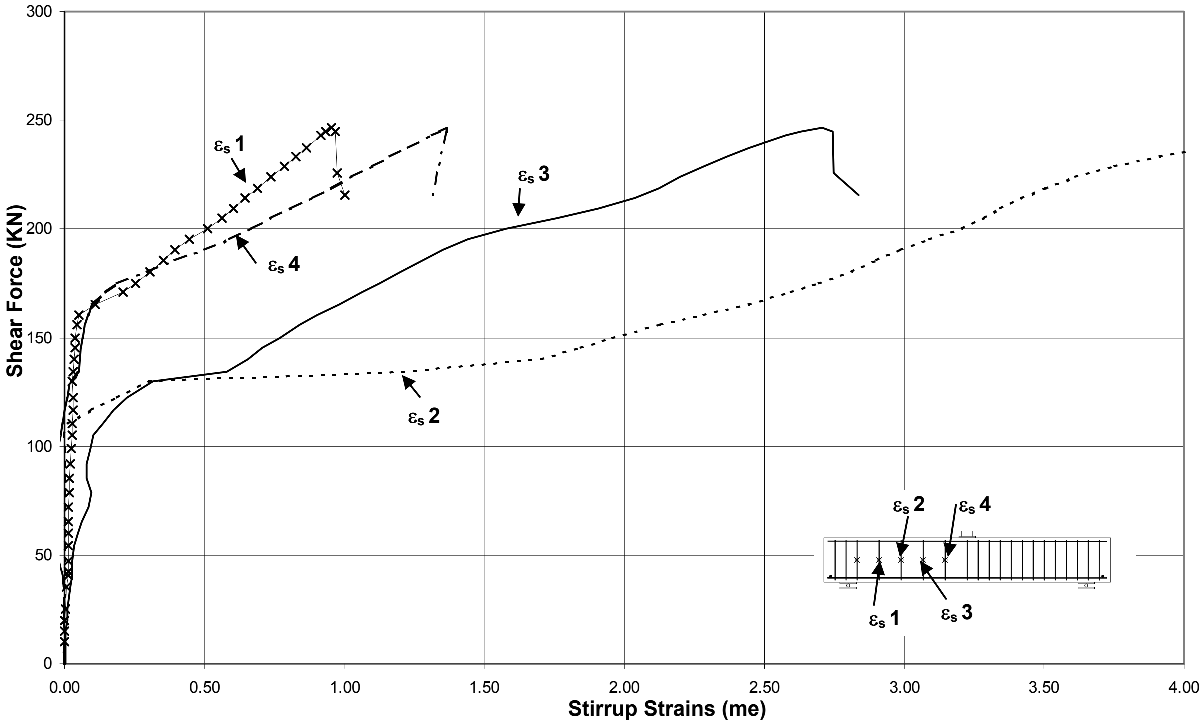
Specimen H50/4 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains			
			ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}
sec	KN	me	me	me	me	me
0	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
195	4.97	0.01	0.00	0.00	0.00	0.00
270	10.01	0.00	0.00	0.00	0.00	0.00
327	14.85	0.01	0.00	0.00	0.00	0.00
381	20.00	0.01	0.00	0.00	0.01	0.00
438	25.39	0.02	0.00	0.00	0.01	0.00
522	**35.24**	**0.02**	**0.01**	**0.00**	**0.02**	**0.00**
672	40.64	0.04	0.01	0.01	0.03	-0.01
684	**42.27**	**0.04**	**0.01**	**0.00**	**0.03**	**-0.01**
723	47.12	0.04	0.01	0.00	0.03	-0.02
783	54.56	0.06	0.01	0.00	0.03	-0.03
828	**60.07**	**0.08**	**0.01**	**0.00**	**0.05**	**-0.04**
873	65.56	0.12	0.01	0.00	0.06	-0.04
924	72.01	0.17	0.02	0.00	0.09	-0.04
975	78.62	0.23	0.02	0.00	0.10	-0.04
1029	**85.08**	**0.27**	**0.02**	**0.00**	**0.08**	**-0.04**
1083	91.96	0.31	0.02	0.00	0.08	-0.03
1140	99.12	0.40	0.02	0.00	0.09	-0.02
1194	105.37	0.56	0.03	-0.01	0.10	-0.01
1236	**110.34**	**0.64**	**0.03**	**0.01**	**0.14**	**-0.01**
1287	116.44	0.72	0.03	0.10	0.18	0.00
1338	122.56	0.82	0.03	0.19	0.22	0.01
1401	**130.02**	**0.98**	**0.03**	**0.30**	**0.31**	**0.02**
1467	134.13	1.49	0.03	1.21	0.58	0.05
1521	140.13	1.77	0.03	1.71	0.66	0.06
1566	145.29	1.88	0.04	1.85	0.71	0.06
1608	**149.98**	**1.97**	**0.04**	**1.96**	**0.77**	**0.06**
1659	155.76	2.09	0.04	2.13	0.84	0.07
1701	160.39	2.18	0.05	2.28	0.90	0.08
1749	165.27	2.30	0.11	2.45	0.98	0.10
1803	171.02	2.44	0.21	2.60	1.06	0.15
1842	175.10	2.57	0.25	2.70	1.12	0.19
1896	180.48	2.74	0.31	2.81	1.20	0.29
1947	185.49	2.91	0.35	2.90	1.28	0.39
1995	190.26	3.08	0.40	2.99	1.35	0.50
2043	**195.16**	**3.25**	**0.45**	**3.09**	**1.44**	**0.59**
2094	200.19	3.47	0.51	3.21	1.58	0.67
2142	204.91	3.65	0.56	3.29	1.76	0.74
2187	209.31	3.85	0.60	3.35	1.91	0.81
2238	214.35	4.10	0.65	3.42	2.04	0.89
2286	218.90	4.41	0.69	3.51	2.12	0.96
2337	223.80	4.67	0.74	3.61	2.20	1.03
2391	228.80	4.93	0.79	3.75	2.28	1.10
2439	233.07	5.18	0.83	3.91	2.37	1.16
2490	237.36	5.55	0.87	4.10	2.45	1.23
2562	242.85	6.35	0.91	4.38	2.58	1.31
2592	244.80	6.73	0.93	4.51	2.63	1.34
2631	**246.34**	**7.18**	**0.95**	**4.70**	**2.71**	**1.37**
2646	244.84	7.56	0.97	4.81	2.74	1.36
2649	225.66	8.05	0.98	5.01	2.75	1.33
2679	215.69	8.38	1.00	5.34	2.84	1.32

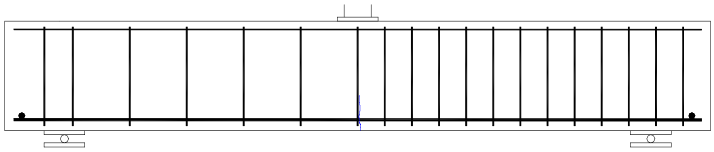
Specimen H50/4



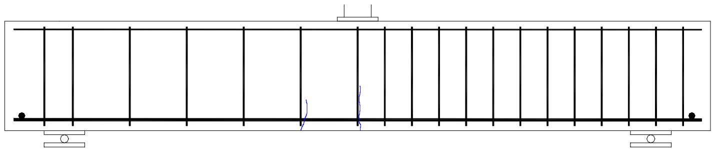




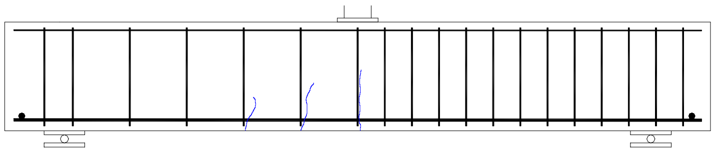
Specimen H50/4 – Cracking control



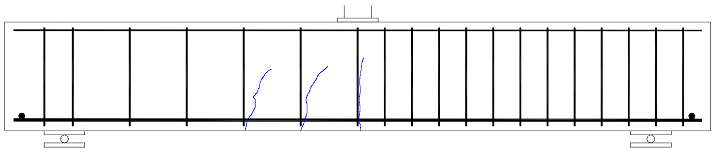
V = 35 KN



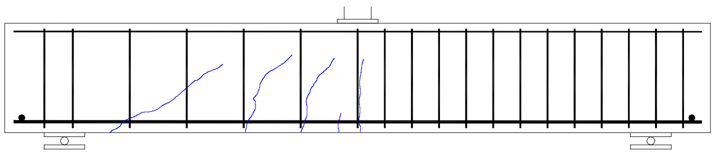
V = 42 KN



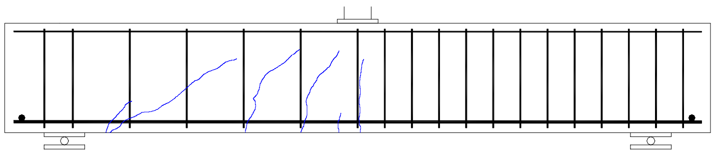
V = 60 KN



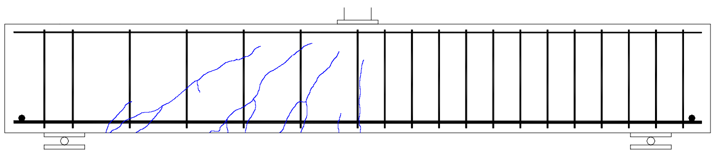
V = 85 KN



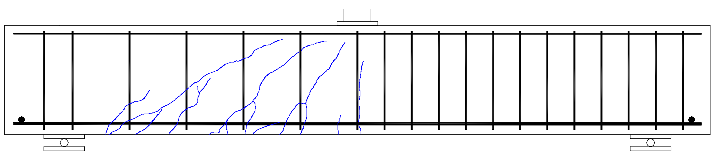
V = 110 KN



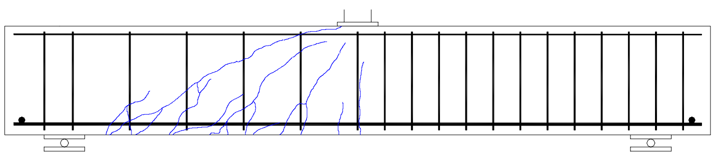
V = 130 KN



V = 150 KN

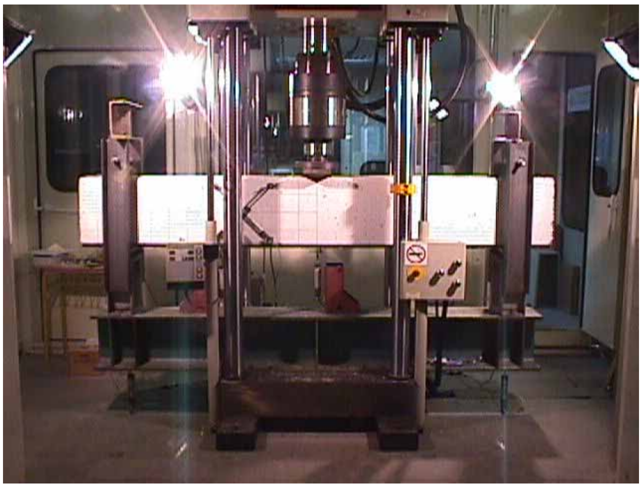


V = 195 KN

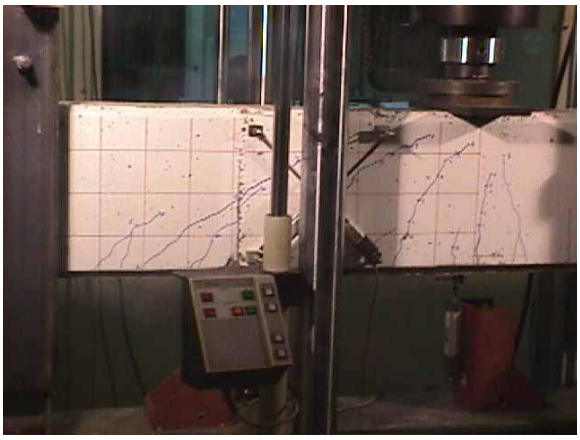


V = 246.3 KN
failure

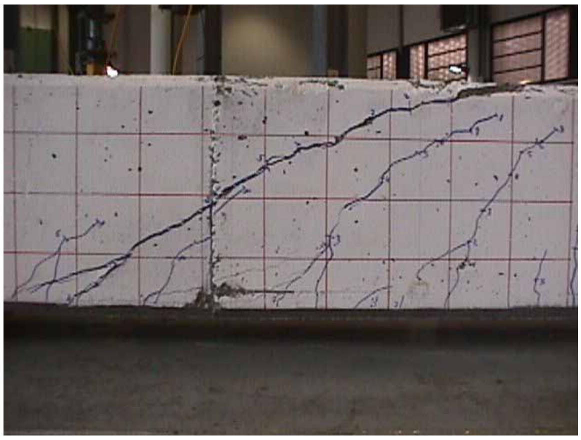
Specimen H50/4



Test set-up for beam H50/4



Cracking for V = 195 KN



Cracking at failure (V = 242.34 KN)

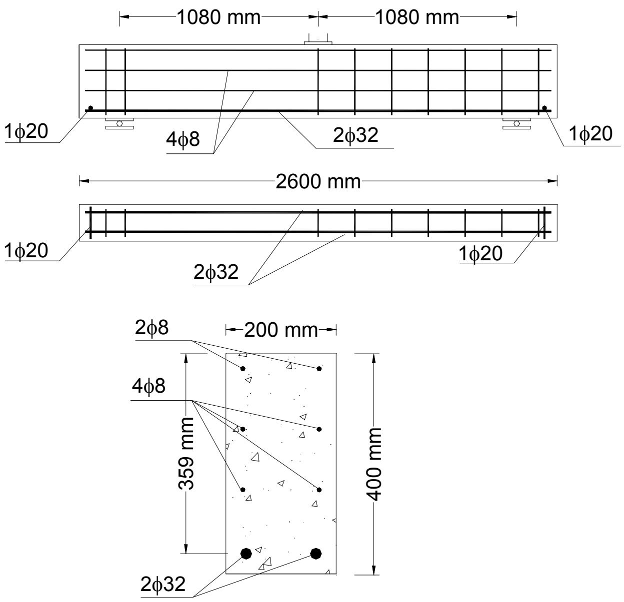
Specimen H50/5

Concrete properties
f'_c = 49.9 MPa f_{sp} = 3.6 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 ϕ32 bars in one layer

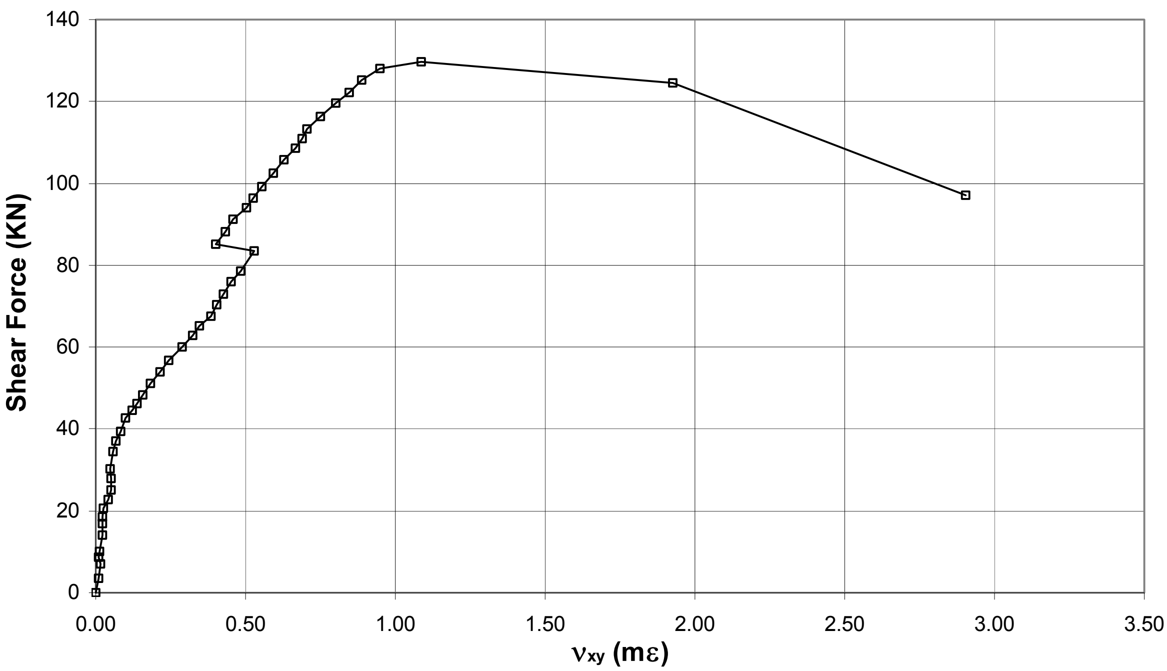
Transversal reinforcement
No stirrups at the tested zone
4 ϕ8 bars distributed along the web

Cast: Jan 11, 2002
Tested: Feb 26, 2002
Test duration: 30 min
Test control: 0.005 mm/s



Summary of Test Observations

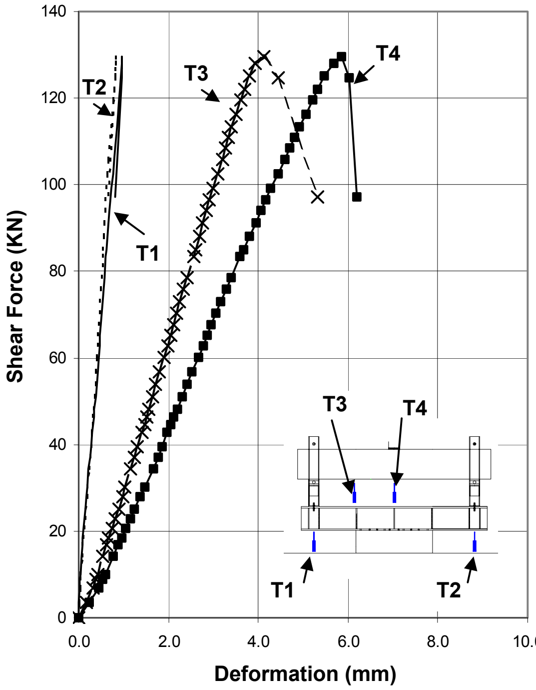
Beam specimen H50/5 did not contain stirrups but longitudinal bars distributed in the web. First flexural crack was reported at V = 25 KN. At load stage 4, a shear crack was observed (V = 85 KN). The beam collapsed briskly under a shear force of V = 129.65 KN.

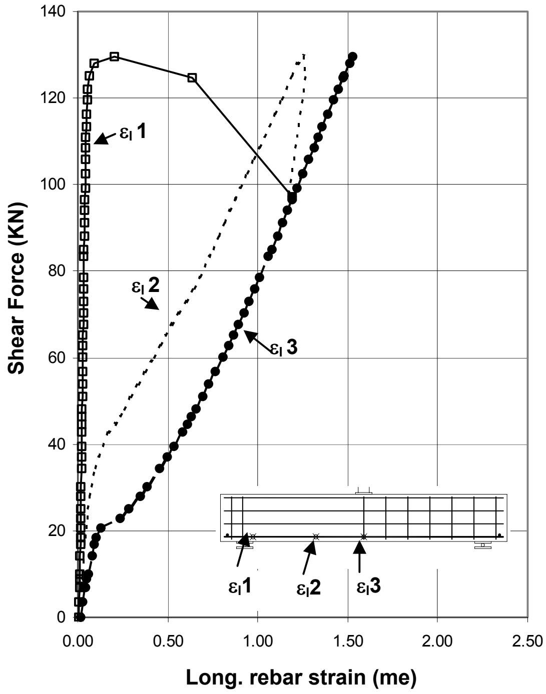


Specimen H50/5

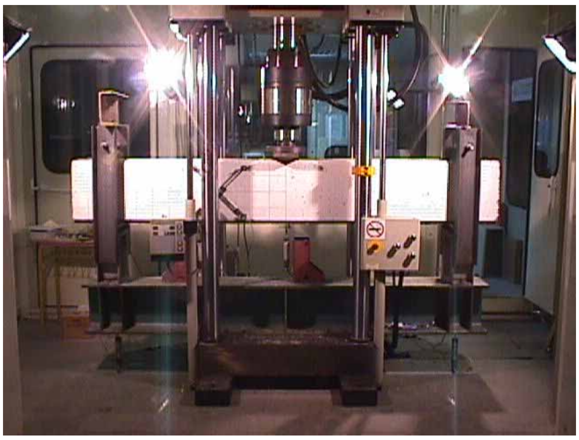
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.02**
348	3.46	0.01	0.02	0.00	0.24	0.17	0.00	0.00	0.01	0.01	0.03
429	6.92	0.02	0.04	0.02	0.45	0.33	0.01	0.00	0.01	0.02	0.04
459	8.77	0.01	0.04	0.03	0.54	0.38	0.00	0.00	0.01	0.02	0.05
483	10.07	0.01	0.05	0.04	0.61	0.43	0.00	0.00	0.01	0.03	0.06
540	14.14	0.02	0.08	0.06	0.78	0.54	0.01	0.00	0.01	0.03	0.08
576	16.83	0.02	0.10	0.08	0.88	0.62	0.01	0.00	0.01	0.04	0.09
597	18.41	0.02	0.11	0.09	0.96	0.67	0.01	0.00	0.01	0.04	0.10
624	20.59	0.02	0.12	0.11	1.06	0.74	0.01	0.00	0.02	0.05	0.13
654	22.83	0.04	0.14	0.12	1.16	0.82	0.01	0.00	0.02	0.05	0.24
681	**25.06**	**0.05**	**0.16**	**0.14**	**1.25**	**0.89**	**0.02**	**0.00**	**0.01**	**0.05**	**0.28**
717	28.01	0.05	0.18	0.17	1.37	0.98	0.02	0.00	0.02	0.06	0.35
741	30.14	0.05	0.20	0.18	1.46	1.03	0.02	0.00	0.02	0.07	0.38
789	34.36	0.06	0.23	0.22	1.66	1.16	0.02	0.00	0.02	0.10	0.45
816	37.02	0.07	0.26	0.25	1.77	1.24	0.03	0.00	0.02	0.12	0.50
840	39.50	0.08	0.27	0.27	1.86	1.31	0.03	0.00	0.02	0.14	0.54
870	42.76	0.10	0.30	0.30	1.97	1.41	0.04	0.00	0.02	0.16	0.58
888	44.66	0.12	0.31	0.32	2.05	1.47	0.05	0.00	0.02	0.21	0.61
903	46.27	0.14	0.32	0.34	2.11	1.51	0.05	0.00	0.02	0.23	0.63
921	**48.20**	**0.16**	**0.34**	**0.35**	**2.19**	**1.56**	**0.06**	**-0.01**	**0.02**	**0.26**	**0.66**
948	51.07	0.18	0.36	0.38	2.31	1.63	0.07	-0.01	0.02	0.29	0.70
975	53.84	0.22	0.38	0.40	2.41	1.71	0.09	0.00	0.02	0.33	0.73
1002	56.77	0.24	0.39	0.42	2.52	1.80	0.10	0.00	0.03	0.37	0.77
1032	**60.14**	**0.29**	**0.41**	**0.44**	**2.66**	**1.90**	**0.12**	**0.00**	**0.03**	**0.42**	**0.81**
1056	62.83	0.32	0.43	0.46	2.77	1.98	0.13	0.00	0.03	0.46	0.84
1077	65.20	0.35	0.44	0.48	2.86	2.04	0.14	0.00	0.03	0.49	0.86
1098	67.60	0.38	0.45	0.50	2.95	2.11	0.16	0.00	0.03	0.52	0.89
1122	70.29	0.40	0.46	0.51	3.05	2.18	0.17	0.00	0.03	0.56	0.92
1146	72.95	0.43	0.48	0.53	3.16	2.24	0.18	0.00	0.03	0.60	0.95
1173	75.94	0.45	0.49	0.56	3.29	2.33	0.19	0.00	0.03	0.64	0.98
1197	78.64	0.48	0.51	0.57	3.41	2.41	0.20	0.00	0.03	0.68	1.01
1239	83.37	0.53	0.53	0.61	3.59	2.56	0.22	0.00	0.03	0.73	1.06
1254	**85.08**	**0.40**	**0.54**	**0.62**	**3.67**	**2.60**	**0.23**	**0.06**	**0.03**	**0.75**	**1.08**
1281	88.17	0.43	0.56	0.64	3.81	2.69	0.25	0.06	0.04	0.79	1.11
1308	91.26	0.46	0.57	0.67	3.95	2.77	0.26	0.06	0.04	0.82	1.14
1332	94.09	0.50	0.60	0.69	4.06	2.84	0.27	0.06	0.04	0.85	1.17
1353	96.43	0.52	0.61	0.71	4.16	2.91	0.28	0.06	0.04	0.88	1.19
1377	99.12	0.55	0.62	0.73	4.28	2.99	0.30	0.06	0.04	0.90	1.22
1407	**102.52**	**0.59**	**0.64**	**0.76**	**4.44**	**3.10**	**0.31**	**0.06**	**0.04**	**0.94**	**1.25**
1437	105.88	0.63	0.67	0.79	4.60	3.20	0.33	0.06	0.04	0.98	1.28
1461	108.59	0.67	0.68	0.82	4.71	3.27	0.34	0.06	0.04	1.01	1.31
1482	110.95	0.69	0.70	0.83	4.81	3.34	0.35	0.06	0.05	1.03	1.34
1503	113.34	0.70	0.72	0.86	4.92	3.40	0.36	0.06	0.05	1.06	1.36
1530	116.27	0.75	0.74	0.88	5.06	3.50	0.38	0.06	0.05	1.10	1.39
1560	119.56	0.80	0.76	0.90	5.21	3.61	0.40	0.06	0.05	1.13	1.42
1584	**122.13**	**0.85**	**0.78**	**0.92**	**5.32**	**3.71**	**0.42**	**0.06**	**0.05**	**1.16**	**1.45**
1614	125.11	0.89	0.80	0.94	5.48	3.81	0.43	0.06	0.06	1.19	1.48
1650	128.00	0.95	0.83	0.96	5.67	3.93	0.46	0.06	0.09	1.22	1.51
1686	**129.65**	**1.09**	**0.84**	**0.97**	**5.85**	**4.13**	**0.51**	**0.05**	**0.20**	**1.25**	**1.53**
1713	124.61	1.93	0.82	0.96	6.03	4.44	0.87	0.06	0.64	1.27	1.48
1716	97.14	2.90	0.66	0.81	6.20	5.31	2.31	1.08	1.19	1.17	1.19

Specimen H50/5

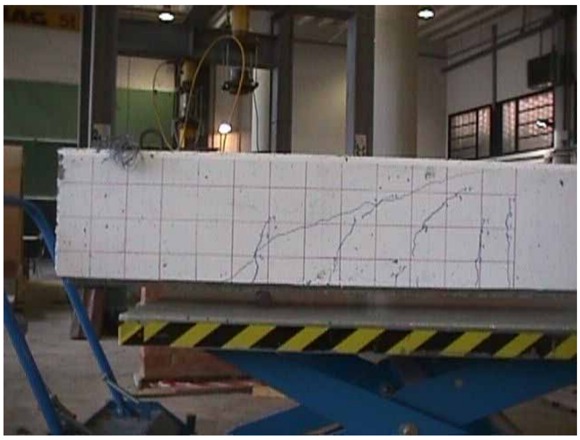




Photographs of the beam specimen

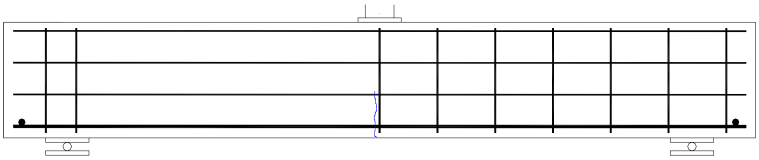


Test set-up for beam H50/5

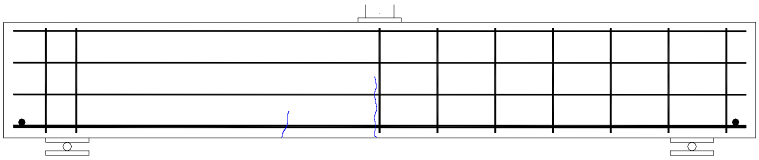


Cracking at failure (V = 129.65 KN)

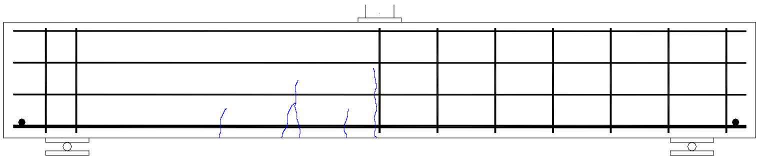
Specimen H50/5 – Cracking control



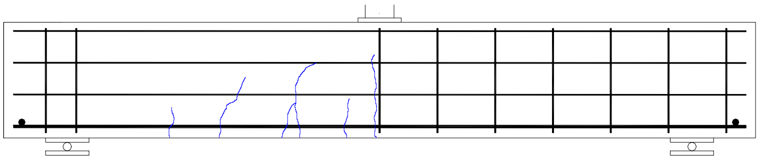
V = 25 KN



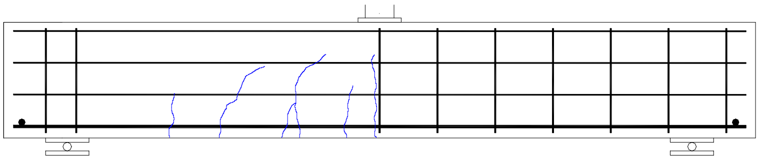
V = 48 KN



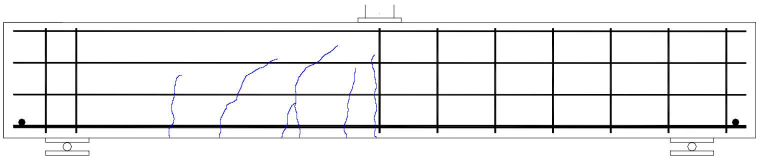
V = 60 KN



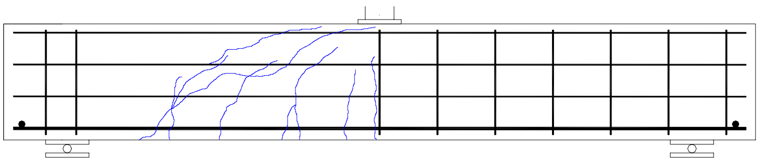
V = 85 KN



V = 102 KN



V = 122 KN



V = 129.7 KN
failure

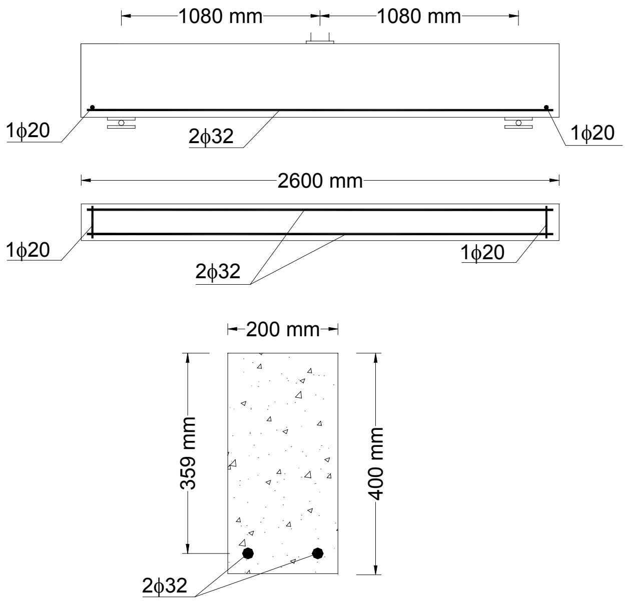
Specimen H60/1

Concrete properties
f'_c = 60.8 MPa f_{sp} = 4.2 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 ϕ32 bars in one layer

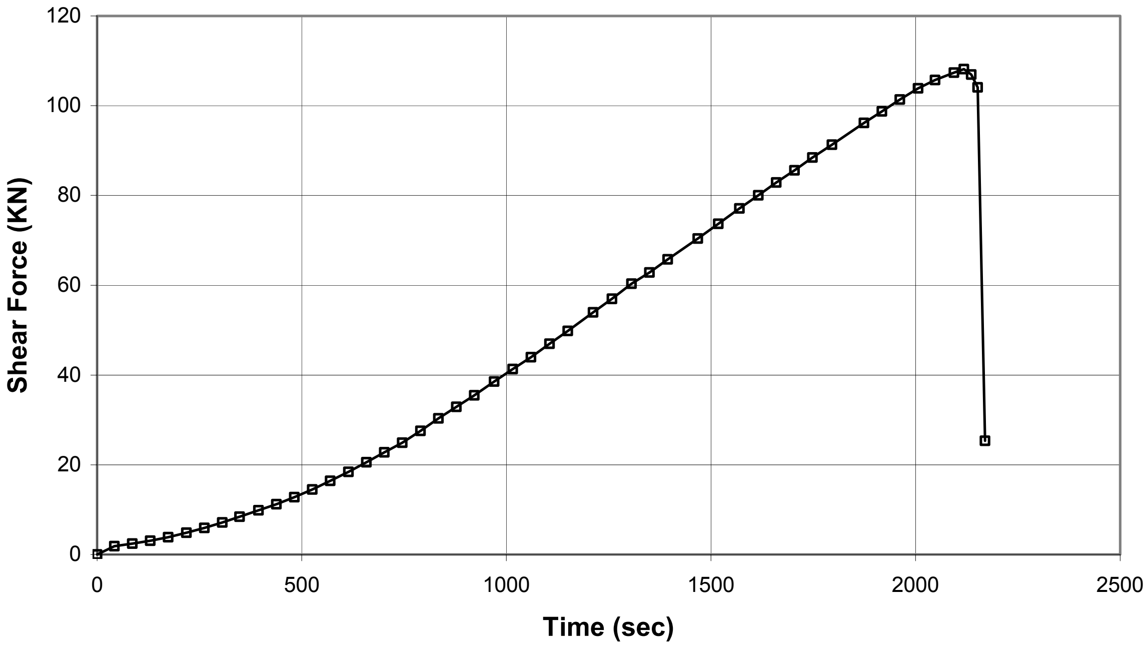
Transversal reinforcement
None

Cast: February 23, 2001
Tested: April 9, 2001
Test duration: 36 min
Test control: 0.003 mm/s



Summary of Test Observations

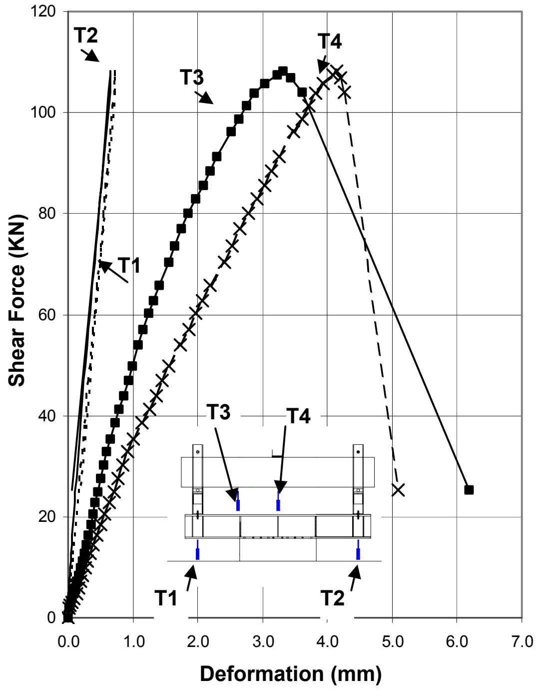
Beam H60/1 did not contain transversal reinforcement. For safety reasons, as a fragile failure was expected, the crack control was not carried out. From the LVDT's readings, flexural cracking was noticed for V = 30 KN. A shear crack was noticed, from the control cubicle, for V = 104 KN. The specimen failed violently at V = 108.14 KN. The strain gauge attached to the longitudinal reinforcement did not measure correctly.



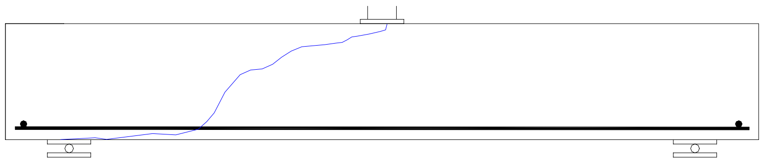
Specimen H60/1

Time	Shear	Deformations				Concrete strains 1			Concrete strains 2		
		T1	T2	T3	T4	ex1	ey1	exy1	ex2	ey2	exy2
sec	KN	mm	mm	mm	mm	me	me	me	me	me	me
0	0.00	0.00	0.00	0.00	0.00	0.00E3	0.00E3	0.00E3	0.00E3	0.00E3	0.00E3
42	1.83	0.00	0.00	0.01	0.02	1.74E-3	-9.78E-3	-2.03E-3	-5.09E-3	-1.30E-3	5.33E-3
86	2.42	0.01	0.00	0.03	0.03	1.58E-3	-9.55E-3	-2.31E-3	-5.15E-3	-2.62E-3	5.81E-3
130	3.10	0.01	0.00	0.04	0.07	1.69E-3	-9.78E-3	-2.80E-3	-5.25E-3	-3.40E-3	6.58E-3
174	3.88	0.02	0.01	0.06	0.09	1.92E-3	-9.20E-3	-3.26E-3	-5.29E-3	1.82E-3	6.86E-3
218	4.82	0.03	0.01	0.09	0.13	2.04E-3	-9.48E-3	-3.70E-3	-5.66E-3	1.88E-3	7.89E-3
262	5.92	0.03	0.01	0.11	0.16	1.87E-3	-9.93E-3	-4.71E-3	-5.83E-3	2.80E-3	8.71E-3
306	7.16	0.04	0.02	0.14	0.20	2.06E-3	-1.02E-3	-5.27E-3	-5.91E-3	4.62E-3	9.57E-3
348	8.40	0.05	0.03	0.16	0.23	1.92E-3	-1.03E-3	-6.01E-3	-6.21E-3	3.93E-3	1.07E-3
394	9.88	0.06	0.03	0.20	0.27	1.62E-3	-1.00E-3	-6.98E-3	-6.20E-3	7.67E-3	1.18E-3
438	11.24	0.07	0.04	0.22	0.30	1.66E-3	-9.93E-3	-7.65E-3	-6.42E-3	6.17E-3	1.29E-3
482	12.78	0.08	0.05	0.25	0.34	1.65E-3	-9.32E-3	-8.83E-3	-6.57E-3	8.77E-3	1.34E-3
526	14.47	0.09	0.06	0.28	0.39	1.36E-3	-9.22E-3	-9.77E-3	-6.63E-3	6.82E-3	1.45E-3
570	16.39	0.10	0.07	0.32	0.44	1.59E-3	-1.07E-3	-1.09E-3	-5.93E-3	6.89E-3	1.60E-3
614	18.45	0.12	0.08	0.35	0.50	1.35E-3	-1.06E-3	-1.21E-3	-6.30E-3	5.36E-3	1.76E-3
658	20.57	0.13	0.09	0.39	0.57	6.71E-3	-5.98E-3	-1.29E-3	-6.08E-3	5.53E-3	1.98E-3
702	22.76	0.15	0.10	0.42	0.64	4.36E-3	-7.48E-3	-1.36E-3	-6.10E-3	5.57E-3	2.04E-3
746	24.94	0.16	0.11	0.46	0.70	1.37E-3	-5.20E-3	-1.42E-3	-5.90E-3	5.30E-3	2.28E-3
790	27.57	0.18	0.13	0.50	0.77	1.87E-3	-4.71E-3	-1.52E-3	-6.05E-3	4.15E-3	2.44E-3
834	30.33	0.20	0.14	0.54	0.85	3.44E-3	-3.96E-3	-1.64E-3	-6.04E-3	1.28E-3	2.63E-3
878	32.94	0.22	0.16	0.60	0.92	1.40E-3	-8.59E-3	-1.97E-3	-5.58E-3	-5.22E-3	2.89E-3
922	35.45	0.23	0.17	0.65	1.01	1.50E-3	-1.11E-3	-2.29E-3	-5.23E-3	-5.22E-3	3.01E-3
970	38.56	0.25	0.19	0.72	1.14	1.45E-3	-1.22E-3	-2.43E-3	-5.06E-3	-8.41E-3	3.18E-3
1016	41.35	0.27	0.21	0.78	1.25	1.33E-3	-1.31E-3	-2.65E-3	-4.75E-3	-9.14E-3	3.31E-3
1060	43.97	0.29	0.22	0.86	1.36	1.32E-3	-1.41E-3	-2.98E-3	-4.97E-3	-7.47E-3	3.46E-3
1106	47.00	0.31	0.24	0.93	1.46	1.28E-3	-1.50E-3	-3.25E-3	-5.28E-3	-1.69E-3	3.68E-3
1150	49.85	0.33	0.26	0.99	1.56	9.88E-3	-1.66E-3	-3.43E-3	-5.26E-3	6.58E-3	3.85E-3
1212	53.99	0.37	0.29	1.08	1.74	8.12E-3	-1.96E-3	-3.81E-3	-4.65E-3	1.12E-3	3.99E-3
1258	56.99	0.39	0.31	1.15	1.86	2.88E-3	-1.45E-3	-4.08E-3	-4.42E-3	7.58E-3	4.20E-3
1306	60.31	0.41	0.34	1.24	1.97	-3.51E-3	-1.91E-3	-4.13E-3	-4.86E-3	6.77E-3	4.35E-3
1350	62.81	0.43	0.35	1.32	2.07	-1.49E-3	-3.44E-3	3.38E-3	-5.55E-3	1.29E-3	4.53E-3
1394	65.78	0.45	0.38	1.41	2.19	-2.50E-3	-3.71E-3	8.69E-3	4.78E-3	-1.93E-3	4.53E-3
1468	70.35	0.48	0.41	1.55	2.41	-3.80E-3	-4.17E-3	5.62E-3	6.88E-3	-7.88E-3	4.44E-3
1518	73.64	0.50	0.43	1.65	2.53	-4.93E-3	-4.25E-3	1.53E-3	6.66E-3	-9.16E-3	4.57E-3
1570	77.06	0.53	0.46	1.75	2.66	-5.92E-3	-4.53E-3	-2.30E-3	4.54E-3	-9.22E-3	4.63E-3
1616	80.04	0.55	0.48	1.86	2.78	-6.79E-3	-4.74E-3	-8.47E-3	-4.23E-3	-8.76E-3	4.64E-3
1660	82.85	0.56	0.49	1.97	2.91	-7.38E-3	-5.03E-3	-1.46E-3	-3.47E-3	-9.11E-3	4.69E-3
1704	85.56	0.58	0.51	2.08	3.03	-7.93E-3	-5.16E-3	-2.29E-3	-8.30E-3	-9.68E-3	4.81E-3
1748	88.46	0.60	0.53	2.19	3.14	-8.48E-3	-5.45E-3	-2.90E-3	-9.69E-3	-1.11E-3	4.93E-3
1796	91.30	0.62	0.55	2.30	3.26	-8.90E-3	-5.71E-3	-4.00E-3	-1.33E-3	-1.14E-3	5.06E-3
1874	96.17	0.65	0.58	2.51	3.48	-9.70E-3	-4.38E-3	-5.93E-3	-1.94E-3	-1.04E-3	5.44E-3
1918	98.73	0.67	0.60	2.64	3.60	-1.01E3	-3.64E-3	-6.69E-3	-2.27E-3	-9.53E-3	5.66E-3
1962	101.37	0.69	0.61	2.75	3.71	-1.03E3	-1.26E-3	-7.47E-3	-2.70E-3	-7.86E-3	5.85E-3
2006	103.84	0.70	0.63	2.88	3.82	-1.05E3	1.91E-3	-7.91E-3	-3.17E-3	-6.64E-3	6.10E-3
2048	105.73	0.72	0.64	3.04	3.94	-1.07E3	3.91E-3	-8.01E-3	-3.52E-3	-5.70E-3	6.30E-3
2094	107.36	0.73	0.65	3.22	4.08	-1.10E3	5.26E-3	-8.10E-3	-3.81E-3	-4.47E-3	6.55E-3
2118	**108.14**	**0.73**	**0.66**	**3.31**	**4.15**	**-1.11E3**	**6.06E-3**	**-8.04E-3**	**-3.99E-3**	**-3.90E-3**	**6.71E-3**
2136	106.94	0.73	0.66	3.43	4.21	-1.11E3	6.59E-3	-7.80E-3	-4.10E-3	-3.41E-3	6.73E-3
2152	104.05	0.72	0.65	3.61	4.26	-1.10E3	6.59E-3	-7.60E-3	-4.06E-3	-3.22E-3	6.60E-3
2170	25.32	0.19	0.06	6.19	5.09	-6.32E-3	2.80E-3	-2.50E-3	-2.39E-3	-4.61E-3	2.40E-3

Specimen H60/1



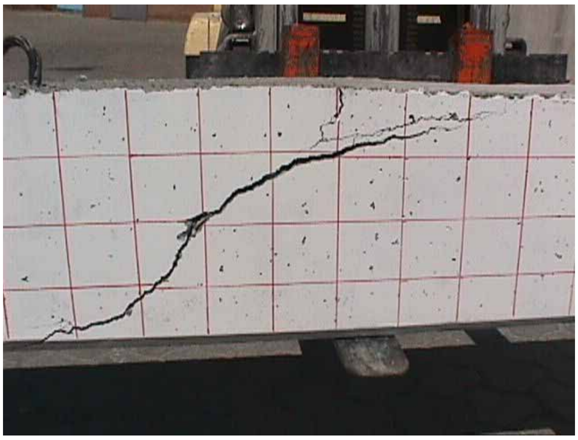
Cracking control



V = 108.1 KN

Photographs of the beam specimen

Test set-up for beam H60/1



Cracking at failure (V = 108.14 KN)

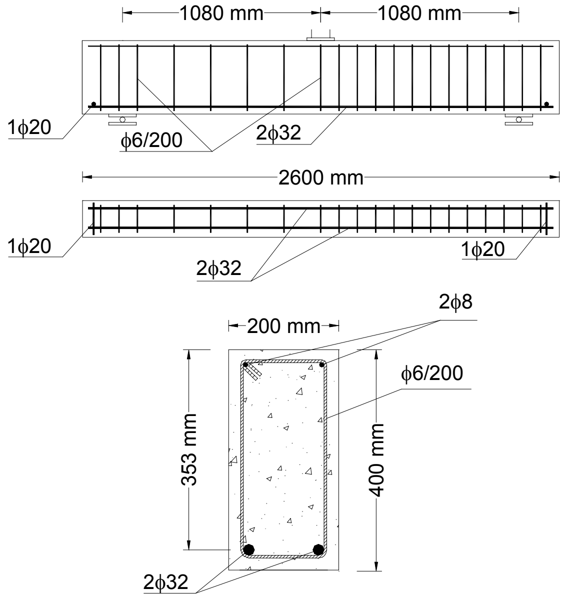
Specimen H60/2

Concrete properties
f'_c = 60.8 MPa f_{sp} = 4.2 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.28%   2 ϕ32 bars in one layer

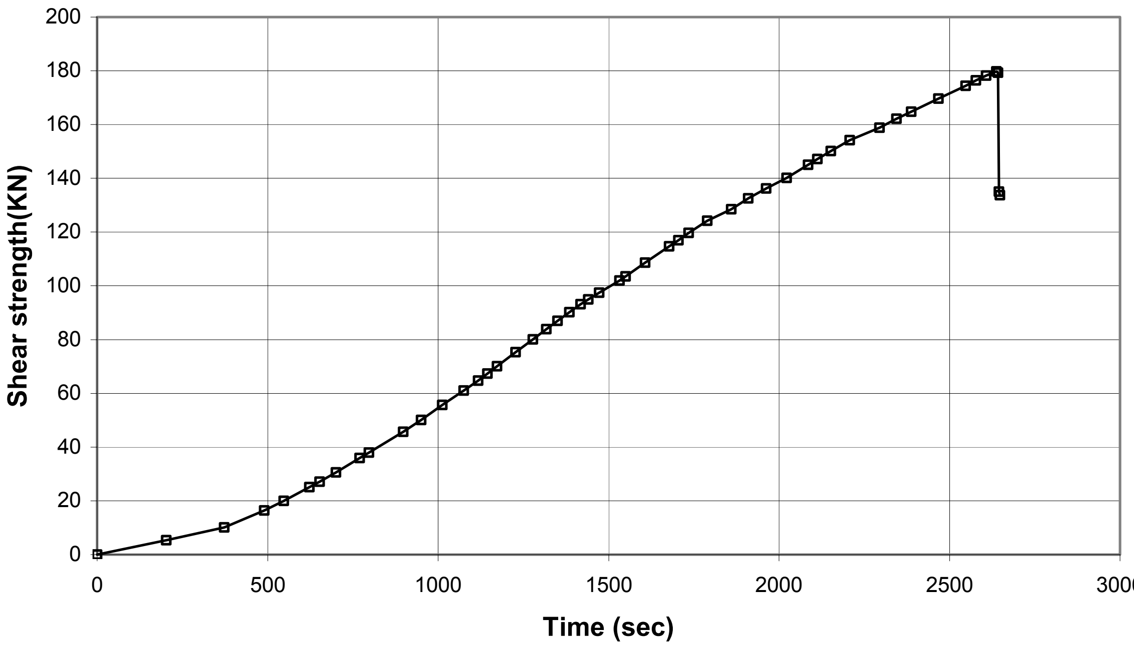
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 0.747 MPa stirrups ϕ6 @ 200 mm

Cast: February 23, 2001
Tested: April 19, 2001
Test duration: 45 min
Test control: 0.005 mm/s



Summary of Test Observations

Beam specimen H60/2 contained the minimum amount of shear reinforcement for a 75 MPa concrete. Flexural cracking was noticed at V = 40 KN. At load stage 3 (V = 95 KN), the first shear crack was observed. Temposonic 1 had to be readjusted during the test, but all the other instruments worked properly. Stirrup 3 yielded for V = 140 KN. The other stirrups did not yield. Failure took place for a shear strength V = 179.74 KN, when the shear crack reached the top face of the beam. The longitudinal reinforcement did not yield.



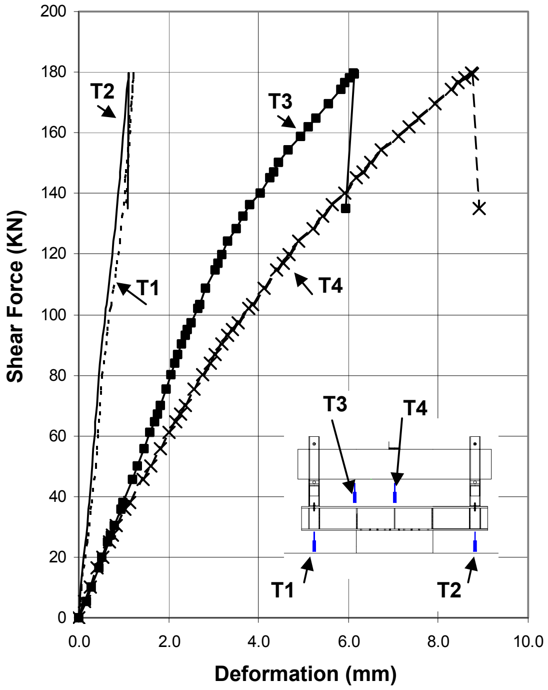
Specimen H60/2

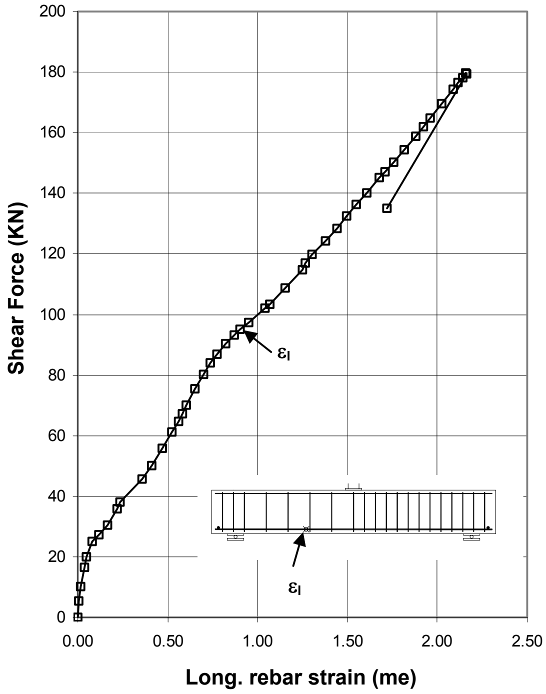
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	Mm	mm	mm	me	Me	me	me	me	me
0	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00
203	5.37	0.04	0.02	0.17	0.13	0.00		0.00	0.00	0.00	0.01
373	10.07	0.07	0.04	0.29	0.25	0.02		0.00	0.00	0.00	0.01
490	16.44	0.11	0.08	0.44	0.41	0.04		0.00	0.00	0.00	0.01
548	20.04	0.15	0.11	0.52	0.53	0.05		0.00	0.00	0.00	0.01
623	25.14	0.20	0.15	0.65	0.68	0.08		0.00	0.00	0.00	0.01
653	27.17	0.21	0.16	0.71	0.74	0.12		0.00	0.00	0.00	0.01
700	30.57	0.23	0.18	0.79	0.84	0.17		0.00	0.00	0.01	0.01
770	35.94	0.26	0.21	0.93	1.04	0.22		0.00	0.00	0.01	0.01
798	37.90	0.29	0.23	0.98	1.13	0.23		0.00	0.00	0.02	0.00
898	45.70	0.34	0.27	1.19	1.42	0.36		0.00	0.00	0.06	-0.03
950	**50.12**	**0.38**	**0.30**	**1.31**	**1.59**	**0.41**		**0.00**	**0.00**	**0.08**	**-0.04**
1013	55.74	0.41	0.33	1.45	1.82	0.47		0.01	0.00	0.10	-0.04
1075	61.09	0.42	0.35	1.58	2.01	0.52		0.01	-0.01	0.12	-0.04
1118	64.67	0.45	0.37	1.68	2.16	0.56		0.01	-0.02	0.14	-0.04
1145	67.32	0.46	0.39	1.74	2.27	0.58		0.01	-0.03	0.15	-0.04
1173	70.03	0.47	0.40	1.81	2.38	0.60		0.01	-0.03	0.16	-0.04
1228	75.29	0.50	0.43	1.94	2.56	0.65		0.01	-0.04	0.19	-0.04
1278	80.05	0.52	0.45	2.05	2.75	0.70		0.02	-0.04	0.21	-0.04
1318	**83.93**	**0.56**	**0.48**	**2.14**	**2.92**	**0.74**		**0.02**	**-0.04**	**0.23**	**-0.04**
1350	86.92	0.58	0.49	2.21	3.04	0.78		0.02	-0.04	0.25	-0.04
1385	90.21	0.61	0.52	2.29	3.17	0.82		0.02	-0.03	0.26	-0.02
1418	93.14	0.63	0.54	2.37	3.31	0.87		0.02	0.01	0.28	-0.01
1440	**94.96**	**0.64**	**0.55**	**2.42**	**3.41**	**0.90**		**0.02**	**0.06**	**0.28**	**0.00**
1473	97.39	0.66	0.57	2.51	3.56	0.95		0.02	0.15	0.29	0.05
1533	101.93	0.70	0.60	2.64	3.79	1.04		0.02	1.05	0.30	0.14
1550	103.47	0.72	0.62	2.68	3.87	1.07		0.02	1.20	0.30	0.17
1608	108.57	0.77	0.65	2.83	4.13	1.15		0.02	1.52	0.31	0.25
1678	114.64	0.83	0.70	3.03	4.41	1.25		0.02	1.92	0.32	0.41
1705	**117.01**	**0.85**	**0.72**	**3.10**	**4.54**	**1.26**		**0.02**	**2.12**	**0.32**	**0.50**
1735	119.70	0.87	0.74	3.18	4.68	1.30		0.01	2.34	0.33	0.52
1790	124.21	0.91	0.77	3.31	4.89	1.38		0.03	2.76	0.35	0.58
1860	128.51	0.95	0.81	3.50	5.22	1.44		0.81	2.98	0.41	0.66
1910	132.52	0.97	0.83	3.64	5.42	1.50		0.90	2.98	0.42	0.72
1963	136.21	1.01	0.86	3.81	5.64	1.55		0.99	2.95	0.43	0.77
2023	**140.14**	**1.03**	**0.88**	**4.03**	**5.92**	**1.61**		**1.07**	**2.98**	**0.45**	**0.82**
2085	145.03	1.03	0.91	4.24	6.18	1.68		1.19	4.49	0.47	0.87
2113	147.16	1.04	0.92	4.33	6.32	1.71		1.23	7.08	0.48	0.89
2153	150.12	1.06	0.94	4.45	6.49	1.76		1.30	12.05	0.49	0.93
2208	154.24	1.08	0.96	4.65	6.73	1.81		1.41	16.27	0.50	0.97
2295	158.87	1.11	0.99	4.93	7.12	1.88		1.48	19.15	0.53	1.02
2345	**162.12**	**1.13**	**1.01**	**5.10**	**7.35**	**1.92**		**1.52**	**17.98**	**0.56**	**1.05**
2388	164.84	1.14	1.03	5.27	7.56	1.96		1.56	14.42	0.58	1.07
2468	169.69	1.17	1.06	5.56	7.93	2.03		1.62	7.79	0.61	1.09
2548	174.46	1.19	1.08	5.83	8.29	2.09		1.68	7.47	0.65	1.12
2578	176.39	1.20	1.09	5.93	8.43	2.11		1.71	7.41	0.66	1.13
2608	178.25	1.21	1.10	6.02	8.59	2.14		1.74	7.37	0.67	1.14
2638	**179.74**	**1.22**	**1.11**	**6.11**	**8.73**	**2.16**		**1.76**	**7.36**	**0.68**	**1.15**
2643	179.25	1.22	1.11	6.13	8.75	2.16		1.76	7.39	0.69	1.14
2645	135.02	1.05	1.10	5.94	8.91	1.72		1.63	6.00	0.65	1.03
2648	133.70	1.04	1.10	5.94	8.92	1.70		1.62	6.05	0.65	1.02

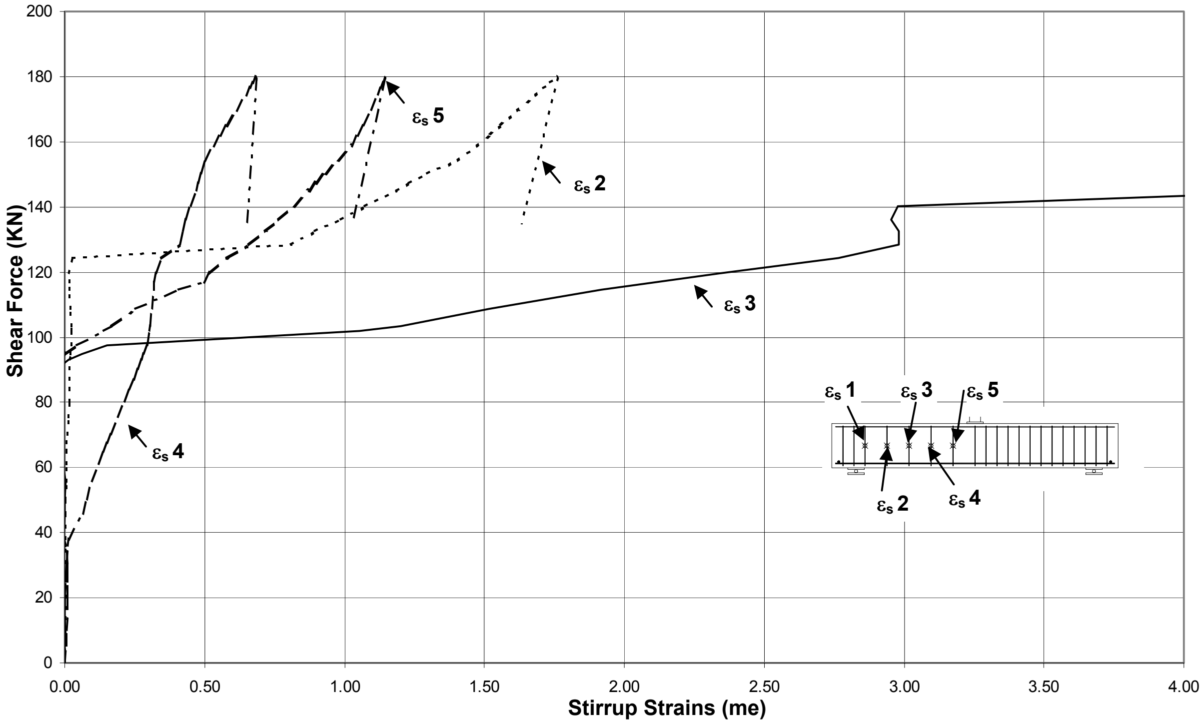
Specimen H60/2 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	0.00	0.00E+3	0.00E+3	0.00E3	0.00E3	0.00E3	0.00E3
203	5.37	3.91E-3	-1.49E-3	-2.43E-3	-2.09E-3	-3.74E-3	6.62E-3
373	10.07	4.11E-3	-1.67E-3	-4.34E-3	-1.91E-3	-3.71E-3	8.53E-3
490	16.44	0.00366	-0.0014	-0.0074	-0.002	-0.0037	0.01159
548	20.04	3.19E-3	-2.08E-3	-9.47E-3	-2.16E-3	-3.90E-3	1.35E-3
623	25.14	7.19E-3	-2.51E-3	-1.01E-3	-1.94E-3	-4.59E-3	1.59E-3
653	27.17	0.0039	0.00103	-0.0069	-0.0016	-0.0053	0.01654
700	30.57	-2.56E-3	6.70E-3	9.52E-3	-1.10E-3	-5.56E-3	1.73E-3
770	35.94	0.004	0.01718	0.00923	-0.0007	-0.0058	0.02038
798	37.90	-4.47E-3	2.05E-3	1.20E-3	-5.74E-3	-6.20E-3	2.14E-3
898	45.70	-1.32E-3	5.12E-3	5.25E-3	1.11E-3	-6.95E-3	2.48E-3
950	**50.12**	**-2.42E-3**	**3.62E-3**	**1.01E-3**	**1.58E-3**	**-7.29E-3**	**2.63E-3**
1013	55.74	-3.35E-3	1.57E-3	1.41E-3	3.02E-3	-8.76E-3	2.68E-3
1075	61.09	3.58E-3	5.84E-3	1.78E-3	2.30E-3	-9.31E-3	3.11E-3
1118	64.67	-4.66E-3	-1.03E-3	2.02E-3	2.71E-3	-1.09E-3	3.20E-3
1145	67.32	0.00384	-0.0142	0.21459	0.00272	-0.0113	0.03247
1173	70.03	-5.26E-3	-1.69E-3	2.22E-3	1.99E-3	-1.19E-3	3.31E-3
1228	75.29	-5.65E-3	-2.26E-3	2.31E-3	2.52E-3	-1.26E-3	3.24E-3
1278	80.05	-5.93E-3	-2.86E-3	2.34E-3	-1.69E-3	-1.23E-3	3.18E-3
1318	**83.93**	**-6.04E-3**	**-3.19E-3**	**2.32E-3**	**-1.49E-3**	**-1.05E-3**	**3.28E-3**
1350	86.92	0.00382	-0.0334	0.22545	0.00035	-0.0035	0.03361
1385	90.21	-5.97E-3	-3.17E-3	2.11E-3	2.05E-3	1.61E-3	3.79E-3
1418	93.14	-5.79E-3	-2.85E-3	1.95E-3	2.00E-3	-3.60E-3	4.29E-3
1440	**94.96**	**-5.60E-3**	**-2.24E-3**	**1.81E-3**	**1.57E-3**	**-1.38E-3**	**4.52E-3**
1473	97.39	0.00391	0.00522	0.13701	-0.0116	-0.0229	0.04933
1533	101.93	0.00386	0.00855	0.08626	-0.0423	-0.0213	0.0681
1550	103.47	-3.14E-3	9.27E-3	7.66E-3	-4.79E-3	-1.99E-3	7.18E-3
1608	108.57	-2.72E-3	1.10E-3	5.51E-3	-5.74E-3	-1.82E-3	8.13E-3
1678	114.64	-2.23E-3	1.39E-3	2.90E-3	-6.76E-3	-1.56E-3	9.24E-3
1705	**117.01**	**-2.05E-3**	**1.55E-3**	**1.97E-3**	**-7.11E-3**	**-1.52E-3**	**9.61E-3**
1735	119.70	0.0041	0.01863	0.01143	-0.0758	-0.0147	0.10113
1790	124.21	-1.57E-3	2.33E-3	-2.31E-3	-7.98E-3	-1.74E-3	1.07E-3
1860	128.51	0.00418	0.0248	-0.0158	-0.0046	0.02378	0.08506
1910	132.52	-1.20E-3	2.60E-3	-2.43E-3	4.55E-3	3.76E-3	8.27E-3
1963	136.21	-1.06E-3	2.71E-3	-3.23E-3	2.34E-3	7.05E-3	7.59E-3
2023	**140.14**	**-9.36E-3**	**2.99E-3**	**-3.73E-3**	**4.04E-3**	**1.21E-3**	**6.46E-3**
2085	145.03	0.00385	0.03339	-0.045	0.05741	0.17924	0.05333
2113	147.16	-7.01E-3	3.40E-3	-4.91E-3	6.55E-3	2.09E-3	4.85E-3
2153	150.12	0.00393	0.03535	-0.0539	0.0832	0.24971	0.04056
2208	154.24	-5.29E-3	3.74E-3	-5.94E-3	1.05E-3	3.13E-3	2.61E-3
2295	158.87	-4.96E-3	3.86E-3	-6.33E-3	1.38E-3	4.35E-3	-8.50E-3
2345	**162.12**	**-4.61E-3**	**4.08E-3**	**-6.61E-3**	**1.69E-3**	**5.40E-3**	**-4.42E-3**
2388	164.84	-4.42E-3	4.24E-3	-6.87E-3	1.83E-3	6.03E-3	-6.82E-3
2468	169.69	-4.15E-3	4.31E-3	-7.63E-3	2.08E-3	7.27E-3	-1.22E-3
2548	174.46	-4.03E-3	4.06E-3	-9.32E-3	2.44E-3	9.07E-3	-2.04E-3
2578	176.39	-3.89E-3	4.19E-3	-9.67E-3	2.51E-3	9.53E-3	-2.26E-3
2608	178.25	-3.74E-3	4.28E-3	-9.95E-3	2.59E-3	9.98E-3	-2.47E-3
2638	**179.74**	**-3.71E-3**	**4.41E-3**	**-1.02E-3**	**2.64E-3**	**1.04E+3**	**-2.66E-3**
2643	179.25	-3.62E-3	4.44E-3	-1.04E-3	2.67E-3	1.04E+3	-2.71E-3
2645	135.02	3.47E-3	3.23E-3	-1.78E-3	3.24E-3	9.24E-3	-3.23E-3
2648	133.70	0.00434	0.03151	-0.1795	0.32712	0.91502	-0.3216

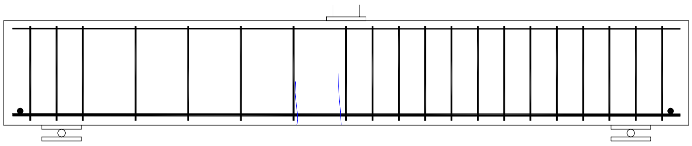
Specimen H60/2



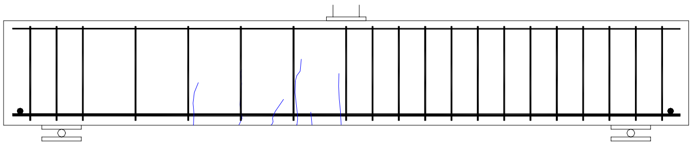




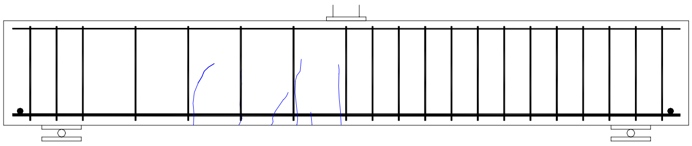
Specimen H60/2 – Cracking control



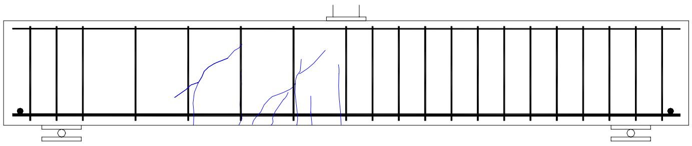
V = 50 KN



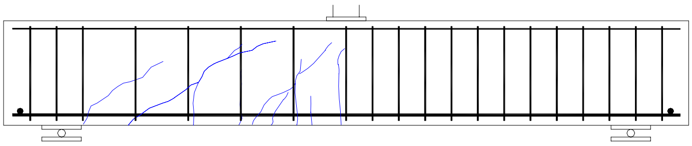
V = 84 KN



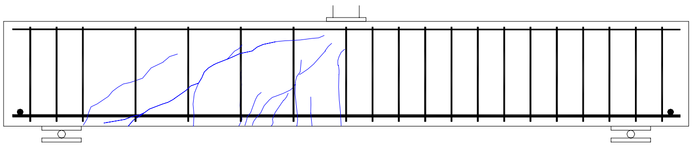
V = 95 KN



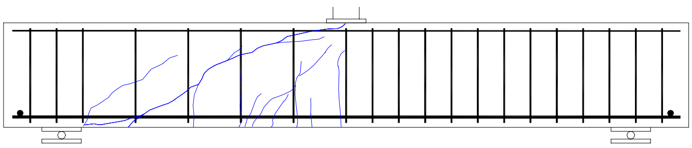
V = 117 KN



V = 140 KN



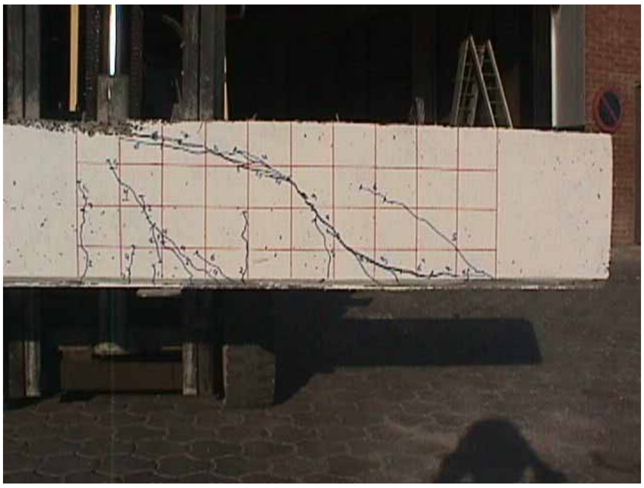
V = 162 KN



V = 180 KN
failure

Specimen H60/2

Test set-up for beam H60/2



Cracking at failure (V = 179.74 KN)

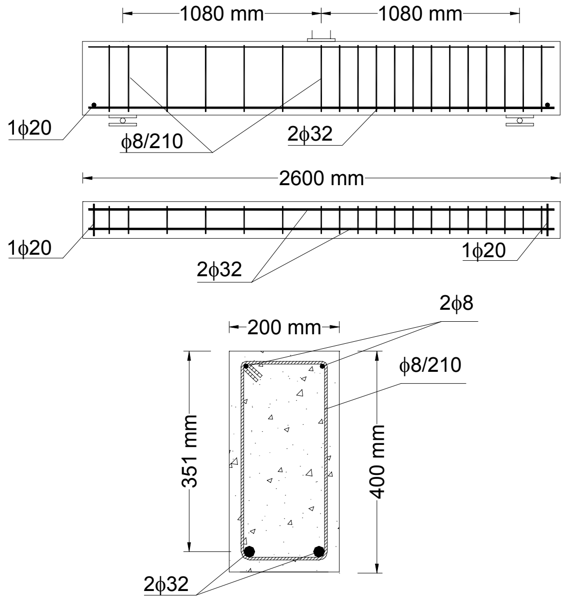
Specimen H60/3

Concrete properties
f'_c = 60.8 MPa f_{sp} = 4.2 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.29% 2 ϕ32 bars in one layer

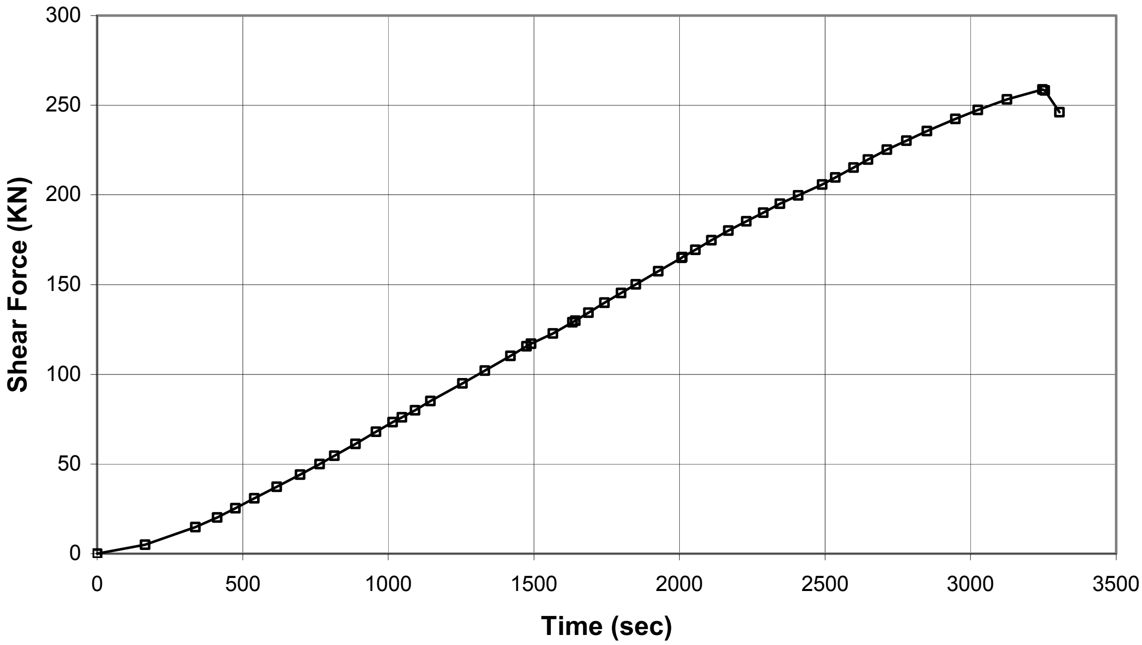
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 1.267 MPa stirrups ϕ8 @ 210 mm

Cast: February 23, 2001
Tested: April 20, 2002
Test duration: 63 min
Test control: 0.005 mm/s



Summary of Test Observations

Beam specimen H60/3 failed under a combination of high shear and flexural strains. Although stirrups 3, 4 and 5 had yielded, the shear crack did not reach the top face of the section at failure (V = 258.78 KN). The longitudinal rebar strain equalled the yielding strain just before the collapse. The failure was relatively ductile, as the shear crack did not cross completely the beam.



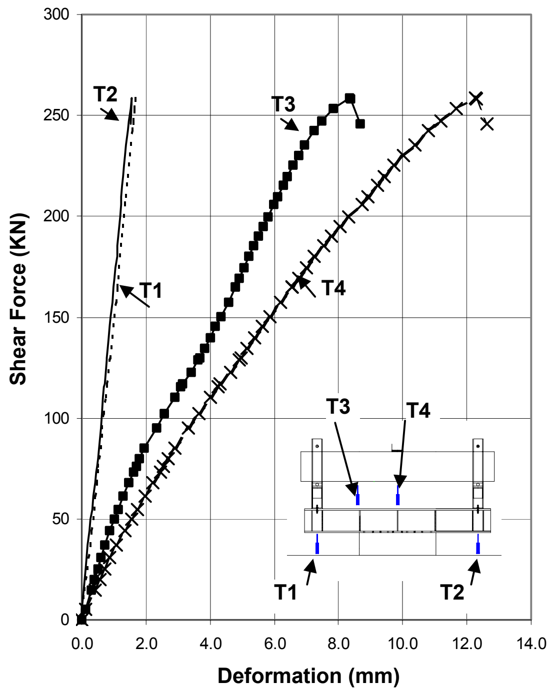
Specimen H60/3

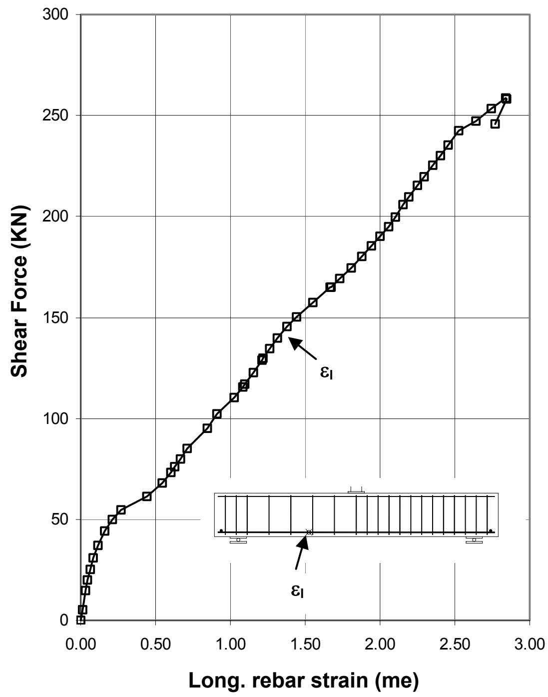
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	mm	mm	mm	me	Me	me	me	me	me
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
165	5.02	0.03	0.01	0.11	0.13	0.01	0.00	0.00	0.00	0.00	0.00
338	14.75	0.09	0.06	0.29	0.41	0.03	0.01	0.00	0.00	0.01	0.00
413	20.18	0.13	0.09	0.40	0.56	0.05	0.00	0.00	0.00	0.01	0.00
475	25.29	0.17	0.12	0.50	0.72	0.06	0.00	0.00	0.00	0.01	0.00
540	30.88	0.21	0.15	0.60	0.87	0.09	0.00	0.00	0.00	0.01	0.00
618	37.25	0.26	0.19	0.73	1.09	0.12	0.00	0.00	0.00	0.02	0.01
698	44.09	0.31	0.24	0.88	1.35	0.16	0.00	0.00	0.00	0.02	-0.01
765	**50.04**	**0.35**	**0.28**	**1.02**	**1.55**	**0.21**	**0.00**	**0.00**	**0.00**	**0.03**	**-0.03**
815	54.57	0.38	0.32	1.13	1.72	0.27	0.00	0.00	0.00	0.02	-0.04
888	61.16	0.43	0.37	1.29	1.98	0.45	0.00	0.00	0.00	0.01	-0.04
958	67.92	0.47	0.43	1.45	2.22	0.54	-0.01	0.00	-0.01	0.01	-0.05
1015	73.32	0.50	0.46	1.61	2.45	0.60	-0.01	0.00	-0.04	0.00	-0.05
1048	75.95	0.52	0.48	1.70	2.55	0.63	-0.01	0.00	0.04	0.00	-0.05
1093	**79.99**	**0.55**	**0.51**	**1.81**	**2.69**	**0.67**	**-0.01**	**0.00**	**0.01**	**0.00**	**-0.04**
1145	85.17	0.58	0.54	1.95	2.90	0.71	-0.01	0.01	-0.06	-0.01	-0.04
1255	**94.98**	**0.64**	**0.59**	**2.32**	**3.32**	**0.85**	**-0.01**	**0.01**	**0.02**	**0.01**	**0.04**
1333	102.14	0.69	0.63	2.57	3.65	0.91	-0.02	0.02	0.01	0.17	0.25
1420	110.28	0.74	0.67	2.90	4.02	1.03	-0.02	0.02	-0.05	0.84	0.41
1475	115.61	0.78	0.70	3.08	4.25	1.08	-0.02	0.03	-0.06	1.09	0.48
1490	**117.09**	**0.79**	**0.71**	**3.14**	**4.30**	**1.10**	**-0.02**	**0.03**	**-0.07**	**1.15**	**0.49**
1565	122.86	0.83	0.74	3.42	4.64	1.15	-0.02	0.03	-0.10	1.40	0.57
1633	129.01	0.88	0.77	3.63	4.92	1.21	-0.01	-0.01	-0.02	1.63	0.65
1643	**129.96**	**0.89**	**0.78**	**3.67**	**4.96**	**1.22**	**-0.01**	**-0.01**	**-0.11**	**1.66**	**0.66**
1688	134.42	0.91	0.80	3.82	5.16	1.26	-0.01	-0.01	-0.05	1.79	0.72
1743	139.84	0.95	0.84	4.00	5.40	1.32	-0.01	-0.01	0.96	1.94	0.79
1800	145.35	0.99	0.87	4.17	5.63	1.38	-0.02	-0.01	3.14	2.15	0.88
1850	150.05	1.02	0.90	4.32	5.87	1.44	-0.02	-0.01	5.71	2.35	0.97
1928	157.47	1.06	0.95	4.56	6.19	1.55	-0.02	0.00	25.50	2.54	1.09
2008	164.94	1.11	1.00	4.78	6.55	1.67	-0.02	0.00		2.71	1.22
2010	**165.19**	**1.11**	**1.00**	**4.78**	**6.56**	**1.67**	**-0.02**	**0.00**		**2.72**	**1.23**
2055	169.42	1.13	1.02	4.91	6.75	1.73	-0.02	0.01		2.81	1.30
2110	174.66	1.17	1.06	5.07	7.01	1.80	-0.02	0.01		2.93	1.39
2168	180.02	1.20	1.09	5.21	7.25	1.88	-0.02	0.01		3.04	1.50
2230	185.31	1.23	1.12	5.36	7.55	1.94	-0.02	0.02		3.12	1.63
2288	190.02	1.26	1.14	5.51	7.79	2.00	-0.02	0.02		3.18	1.81
2345	195.10	1.29	1.17	5.66	8.06	2.06	-0.02	0.02		3.27	1.91
2408	199.75	1.32	1.19	5.81	8.33	2.10	-0.02	0.03		3.49	2.04
2490	205.72	1.35	1.22	6.00	8.72	2.15	-0.02	0.03		3.67	2.19
2535	209.71	1.38	1.24	6.12	8.91	2.19	-0.02	0.03		3.71	2.26
2598	215.26	1.41	1.27	6.28	9.21	2.25	-0.02	0.03		3.77	2.36
2648	219.76	1.44	1.30	6.41	9.44	2.29	-0.02	0.03		3.84	2.44
2713	225.20	1.47	1.32	6.57	9.74	2.35	-0.02	0.04		3.91	2.54
2780	230.27	1.50	1.35	6.75	10.03	2.40	-0.02	0.04		3.99	2.65
2850	235.57	1.54	1.39	6.94	10.37	2.46	-0.02	0.04		4.12	2.74
2948	242.29	1.58	1.44	7.23	10.81	2.53	-0.03	0.05		4.57	2.86
3025	247.29	1.61	1.47	7.48	11.19	2.64	-0.03	0.05		7.08	2.96
3125	253.23	1.64	1.51	7.85	11.67	2.75	-0.03	0.06		9.85	3.10
3248	**258.78**	**1.67**	**1.55**	**8.34**	**12.26**	**2.84**	**-0.03**	**0.06**		**11.99**	**3.23**
3255	258.18	1.67	1.55	8.39	12.30	2.84	-0.03	0.06		12.08	3.23
3305	246.03	1.62	1.53	8.66	12.64	2.77	-0.03	0.06		12.20	3.26

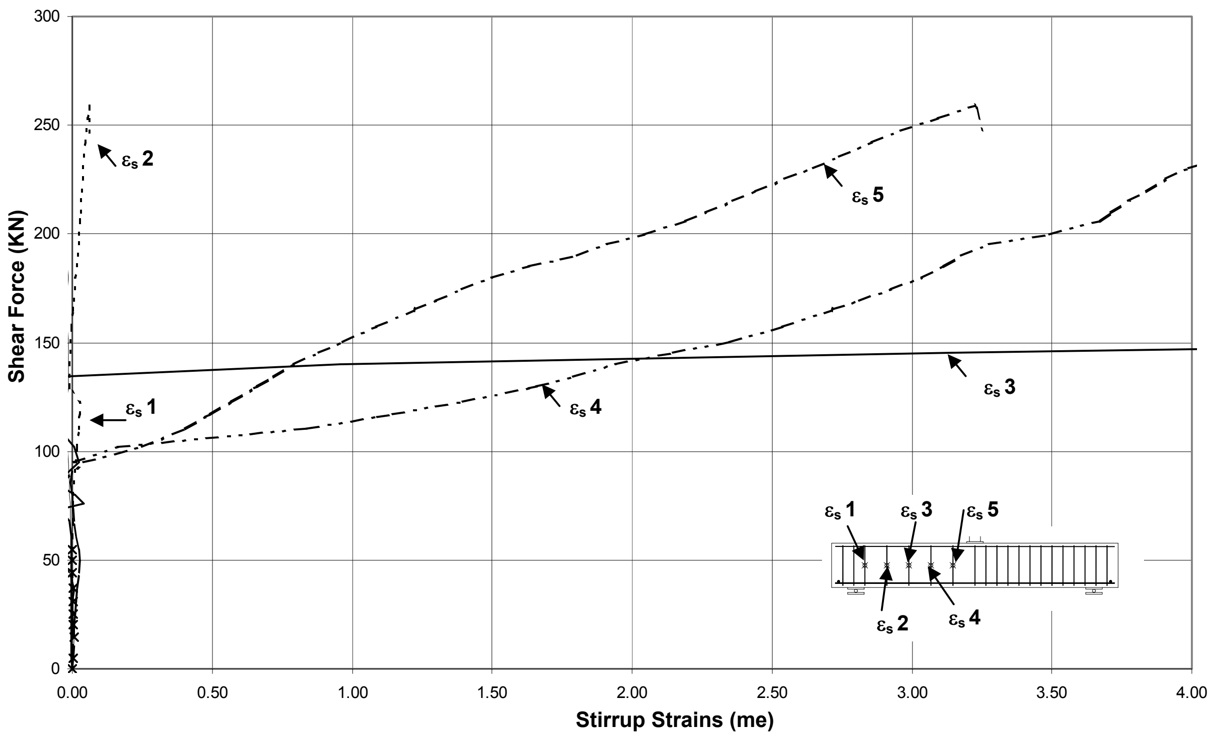
Specimen H60/3 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	0.00	0.00E3	0.00E3	0.00E3	0.00E3	0.00E3	0.00E3
165	5.02	5.75E-3	-8.01E-3	-5.89E-3	-2.62E-3	2.65E-3	7.50E-3
338	14.75	2.46E-3	-1.66E-3	-1.70E-3	-2.64E-3	2.21E-3	1.84E-3
413	20.18	3.15E-3	-1.94E-3	-2.28E-3	-2.47E-3	1.96E-3	2.43E-3
475	25.29	4.30E-3	-1.45E-3	-2.75E-3	-1.86E-3	1.31E-3	2.92E-3
540	30.88	2.90E-3	-1.94E-3	-3.18E-3	-8.05E-3	6.76E-3	3.51E-3
618	37.25	9.96E-3	-3.17E-3	-3.49E-3	7.13E-3	3.01E-3	4.14E-3
698	44.09	1.61E-3	-2.28E-3	-3.29E-3	1.89E-3	-5.98E-3	4.79E-3
765	**50.04**	**6.16E-3**	**-4.42E-3**	**-3.28E-3**	**2.78E-3**	**-1.25E-3**	**5.33E-3**
815	54.57	-2.59E-3	-7.23E-3	-3.21E-3	4.00E-3	-1.48E-3	5.70E-3
888	61.16	-1.93E-3	-1.60E-3	1.70E-3	3.05E-3	-1.55E-3	6.22E-3
958	67.92	-4.65E-3	-1.45E-3	2.84E-3	4.09E-3	-3.38E-3	6.84E-3
1015	73.32	-5.88E-3	-1.42E-3	2.57E-3	4.65E-3	-6.32E-3	7.23E-3
1048	75.95	-6.35E-3	-1.62E-3	2.42E-3	1.81E-3	-7.03E-3	7.70E-3
1093	**79.99**	**-6.99E-3**	**-1.95E-3**	**1.95E-3**	**4.44E-3**	**-2.17E-3**	**7.92E-3**
1145	85.17	-7.81E-3	-1.44E-3	1.45E-3	-1.03E-3	-2.66E-3	7.05E-3
1255	**94.98**	**-7.60E-3**	**-1.35E-3**	**-3.21E-3**	**-1.60E-3**	**-2.29E-3**	**7.18E-3**
1333	102.14	-8.61E-3	1.41E-3	-2.96E-3	-2.02E-3	-2.00E-3	8.08E-3
1420	110.28	-1.28E3	1.28E3	-8.62E-3	-3.26E-3	-1.34E-3	9.23E-3
1475	115.61	-1.28E3	1.27E3	-9.90E-3	-4.03E-3	-4.81E-3	9.96E-3
1490	**117.09**	**-1.28E3**	**1.27E3**	**-1.02E-3**	**-4.22E-3**	**-2.40E-3**	**1.01E-3**
1565	122.86	-1.28E3	1.27E3	-1.14E-3	-5.71E-3	1.89E-3	1.15E-3
1633	129.01	-1.28E3	1.27E3	-1.30E-3	-9.93E-3	1.48E-3	1.14E-3
1643	**129.96**	**-1.28E3**	**1.27E3**	**-1.33E-3**	**-1.03E-3**	**1.23E-3**	**1.17E-3**
1688	134.42	-1.28E3	1.27E3	-1.43E-3	-1.16E-3	6.06E-3	1.26E-3
1743	139.84	-1.28E3	1.27E3	-1.54E-3	-1.27E-3	4.34E-3	1.33E-3
1800	145.35	-1.28E3	1.27E3	-1.69E-3	-1.38E-3	5.83E-3	1.38E-3
1850	150.05	-1.28E3	1.27E3	-1.85E-3	-1.53E-3	7.33E-3	1.45E-3
1928	157.47	-1.28E3	1.27E3	-2.06E-3	-1.66E-3	5.72E-3	1.65E-3
2008	164.94	-1.28E3	1.27E3	-2.33E-3	-1.87E-3	4.30E-3	1.95E-3
2010	**165.19**	**-1.28E3**	**1.27E3**	**-2.34E-3**	**-1.87E-3**	**4.31E-3**	**1.95E-3**
2055	169.42	-1.28E3	1.27E3	-2.45E-3	-1.96E-3	4.79E-3	2.04E-3
2110	174.66	-1.28E3	1.27E3	-2.61E-3	-2.04E-3	6.00E-3	2.13E-3
2168	180.02	-1.28E3	1.27E3	-2.79E-3	-2.13E-3	8.40E-3	2.20E-3
2230	185.31	-1.28E3	1.27E3	-2.88E-3	-2.25E-3	1.36E-3	2.31E-3
2288	190.02	-1.28E3	1.27E3	-3.02E-3	-2.29E-3	8.51E-3	2.39E-3
2345	195.10	-1.28E3	1.27E3	-3.13E-3	-2.17E-3	-2.14E-3	2.57E-3
2408	199.75	-1.28E3	1.27E3	-3.30E-3	-2.04E-3	-4.01E-3	2.65E-3
2490	205.72	-1.28E3	1.27E3	-2.95E-3	-2.36E-3	-2.23E-3	2.59E-3
2535	209.71	-1.28E3	1.27E3	-2.83E-3	-2.40E-3	-2.04E-3	2.60E-3
2598	215.26	-1.28E3	1.27E3	-2.85E-3	-2.45E-3	-1.94E-3	2.64E-3
2648	219.76	-1.28E3	1.27E3	-2.77E-3	-2.50E-3	-1.77E-3	2.65E-3
2713	225.20	-1.28E3	1.27E3	-2.71E-3	-2.57E-3	-1.67E-3	2.68E-3
2780	230.27	-1.28E3	1.27E3	-2.67E-3	-2.64E-3	-1.56E-3	2.71E-3
2850	235.57	-1.28E3	1.27E3	-2.61E-3	-2.70E-3	-1.43E-3	2.74E-3
2948	242.29	-1.28E3	1.27E3	-2.58E-3	-2.78E-3	-1.11E-3	2.75E-3
3025	247.29	-1.28E3	1.27E3	-2.66E-3	-2.84E-3	-7.64E-3	2.74E-3
3125	253.23	-1.28E3	1.27E3	-2.74E-3	-2.92E-3	-4.04E-3	2.75E-3
3248	**258.78**	**-1.28E3**	**1.27E3**	**-2.80E-3**	**-3.03E-3**	**-4.85E-3**	**2.76E-3**
3255	258.18	-1.28E3	1.27E3	-2.79E-3	-3.03E-3	-8.47E-3	2.76E-3
3305	246.03	-1.28E3	1.27E3	-2.62E-3	-2.99E-3	1.74E-3	2.64E-3

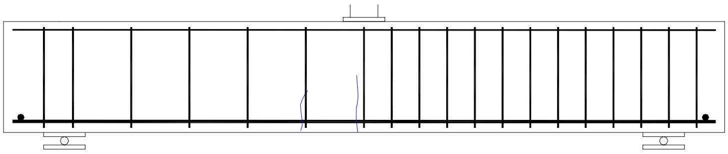
Specimen H60/3



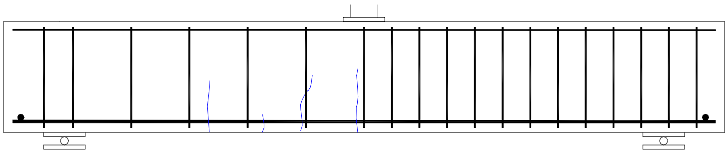




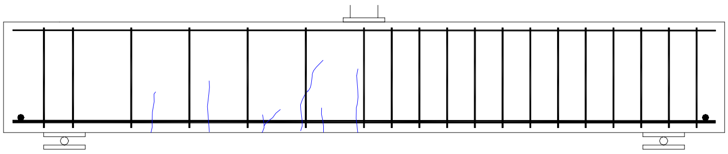
Specimen H60/3– Cracking control



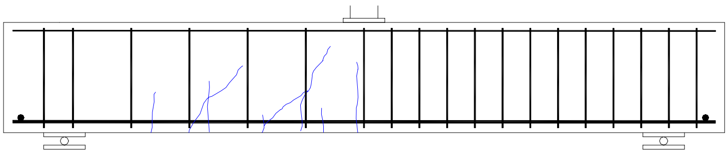
V = 50 KN



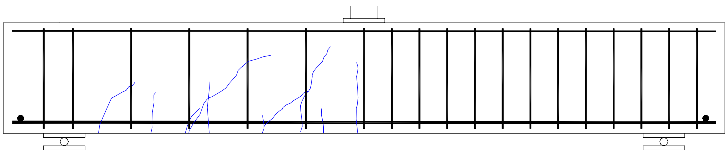
V = 80 KN



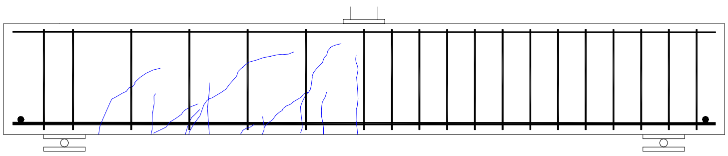
V = 95 KN



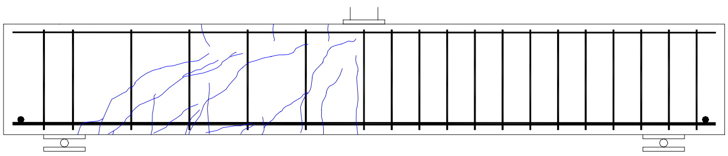
V = 117 KN



V = 130 KN

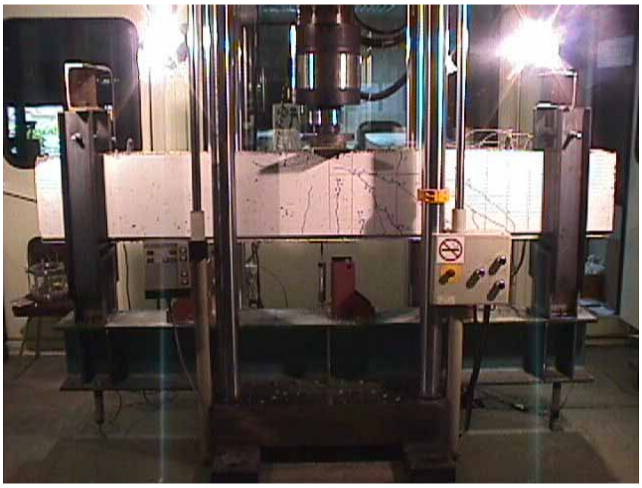


V = 165 KN

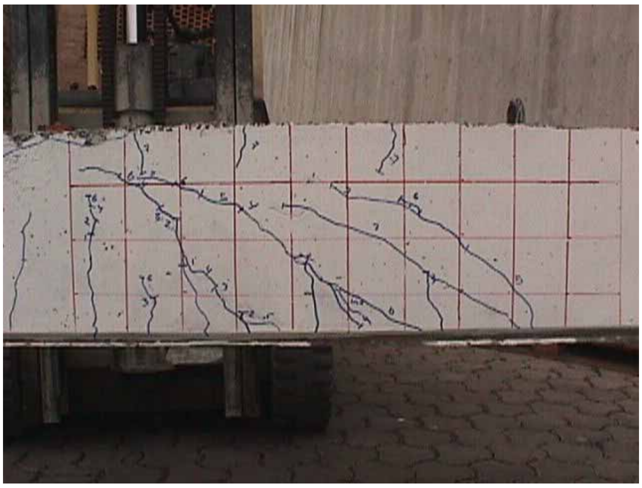


V = 258.8 KN
failure

Specimen H60/3



Test set-up for beam H60-3



Cracking at failure (V = 258.74 KN)

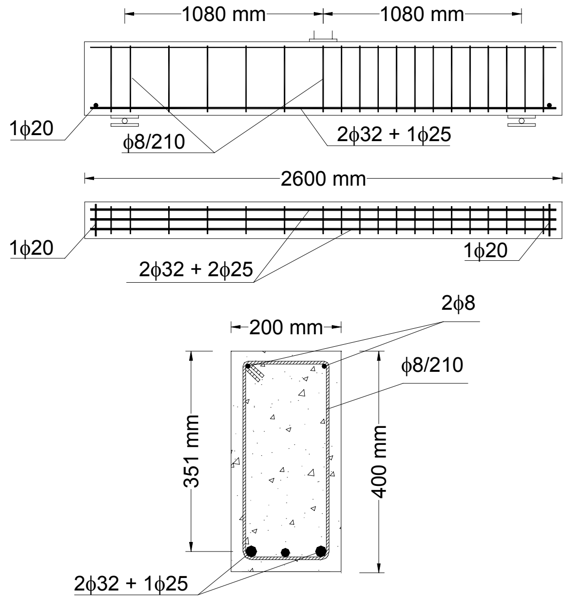
Specimen H60/4

Concrete properties
f'_c = 60.8 MPa f_{sp} = 4.2 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.99%   2 ϕ32 + 1 ϕ25 bars in one layer

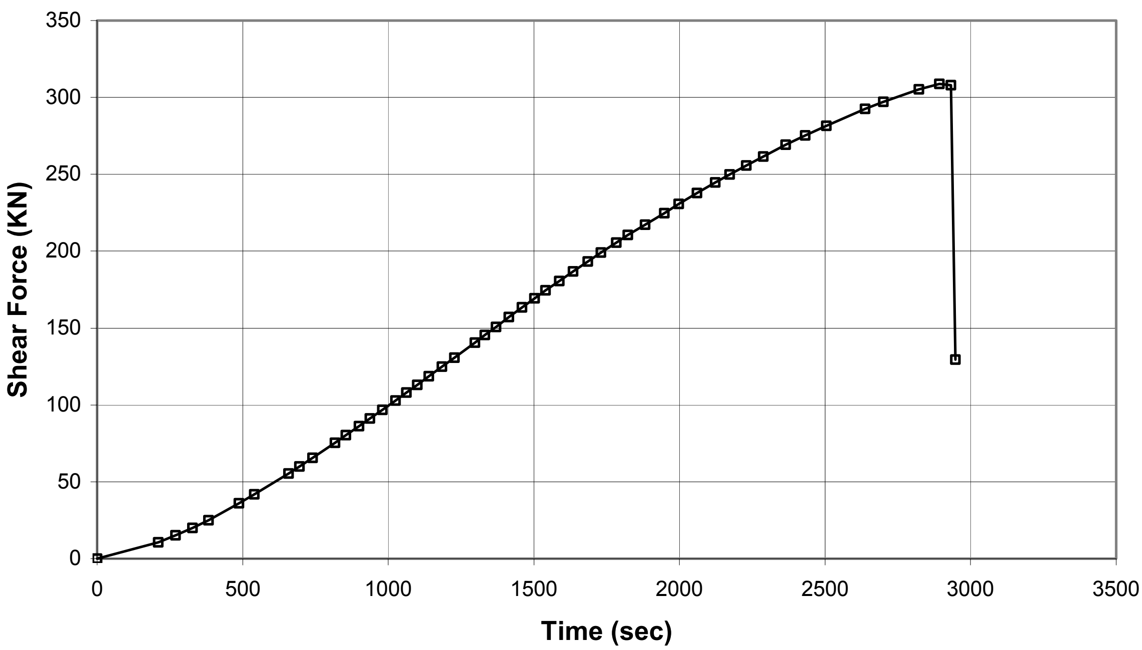
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 1.267 MPa stirrups ϕ8 @ 210 mm

Cast: February 23, 2001
Tested: April 20, 2002
Test duration: 50 min
Test control: 0.006 mm/s



Summary of Test Observations

Problems were noticed with the hydraulics, and the beam specimen was heavily loaded by accident before testing it. It was possible to stop the force and the beam did not collapse, although it was completely cracked. Therefore, the cracks were not controlling during the test. The failure happened with a surprisingly high V = 308.71 KN, after the longitudinal reinforcement yielding. Strain gauges at stirrups 2, 4 and 5 did not report significant data.



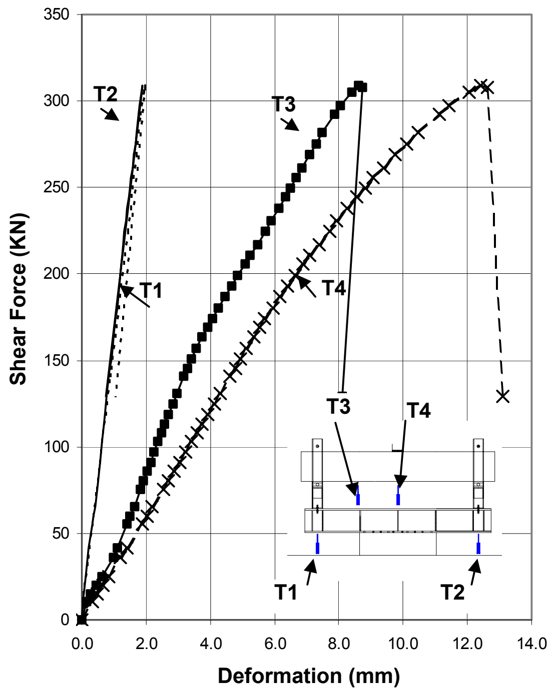
Specimen H60/4

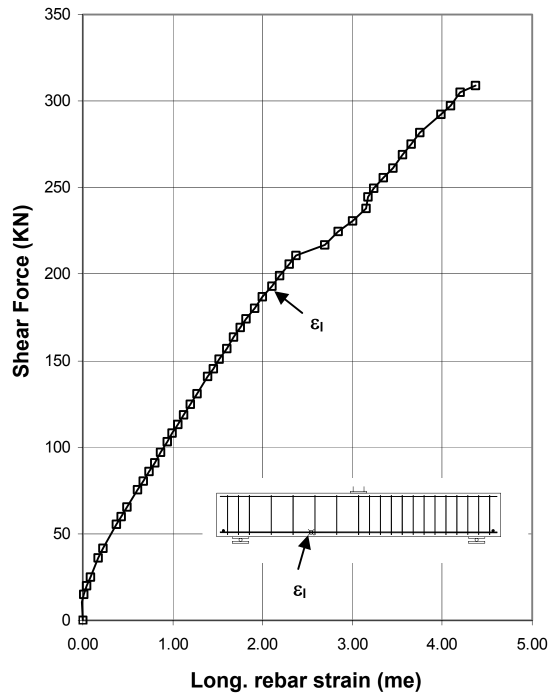
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	mm	mm	mm	me	Me	me	me	me	me
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		
210	10.60	0.05	0.03	0.14	0.33	-0.01	0.00		0.01		
270	15.11	0.07	0.05	0.28	0.48	0.01	0.00		0.02		
328	20.00	0.10	0.08	0.44	0.65	0.05	0.00		0.05		
383	25.07	0.13	0.11	0.64	0.85	0.08	0.00		0.10		
488	36.06	0.21	0.18	1.00	1.20	0.17	0.00		0.24		
540	41.78	0.25	0.22	1.11	1.41	0.22	0.00		0.33		
658	55.38	0.34	0.33	1.41	1.87	0.37	0.00		0.54		
695	60.00	0.37	0.36	1.51	2.02	0.43	0.00		0.61		
740	65.57	0.40	0.41	1.63	2.19	0.49	0.00		0.69		
818	75.44	0.47	0.48	1.82	2.53	0.61	0.00		0.85		
855	80.29	0.50	0.51	1.92	2.68	0.67	0.00		0.93		
900	86.19	0.54	0.55	2.05	2.87	0.74	0.00		1.02		
938	91.16	0.57	0.57	2.15	3.05	0.80	0.00		1.10		
980	96.88	0.60	0.61	2.26	3.22	0.87	0.00		1.20		
1025	102.91	0.64	0.64	2.37	3.41	0.94	-0.01		1.29		
1063	108.00	0.67	0.66	2.47	3.59	1.00	-0.01		1.38		
1100	113.13	0.70	0.69	2.58	3.75	1.06	-0.01		1.46		
1140	118.65	0.73	0.72	2.70	3.92	1.12	-0.01		1.55		
1185	124.84	0.78	0.75	2.83	4.12	1.20	-0.01		1.65		
1228	130.77	0.82	0.78	2.95	4.31	1.27	-0.01		1.74		
1298	140.61	0.89	0.84	3.19	4.61	1.39	-0.01		1.90		
1333	145.54	0.92	0.88	3.30	4.77	1.45	-0.01		1.98		
1370	150.81	0.95	0.91	3.42	4.93	1.52	-0.01		2.07		
1415	157.16	1.00	0.96	3.57	5.12	1.60	-0.01		2.17		
1460	163.42	1.04	1.00	3.75	5.34	1.68	-0.01		2.28		
1503	169.34	1.08	1.03	3.92	5.53	1.75	-0.02		2.38		
1540	174.42	1.11	1.06	4.06	5.69	1.82	-0.01		2.48		
1588	180.54	1.15	1.10	4.24	5.94	1.91	-0.02		2.62		
1635	186.81	1.19	1.13	4.46	6.15	2.00	-0.02		2.81		
1685	193.27	1.23	1.16	4.65	6.41	2.10	-0.02		3.03		
1730	199.00	1.26	1.19	4.85	6.63	2.19	-0.03		3.27		
1783	205.55	1.30	1.22	5.08	6.88	2.29	-0.03		3.63		
1823	210.53	1.33	1.25	5.23	7.10	2.37	-0.03		4.00		
1883	217.07	1.38	1.28	5.47	7.38	2.69	-0.04		4.60		
1948	224.71	1.43	1.33	5.72	7.71	2.85	-0.04		5.47		
1998	230.73	1.46	1.36	5.89	7.94	3.00	0.08		6.19		
2060	237.85	1.51	1.41	6.12	8.26	3.15	-0.08		7.17		
2123	244.69	1.55	1.46	6.33	8.55	3.17	-0.05		8.30		
2173	249.86	1.58	1.49	6.48	8.81	3.24	-0.04		9.34		
2230	255.66	1.61	1.53	6.68	9.08	3.35	-0.05		10.66		
2288	261.52	1.65	1.58	6.85	9.38	3.45	0.05		12.00		
2365	269.16	1.69	1.63	7.09	9.75	3.56	-0.05		13.84		
2433	275.26	1.73	1.66	7.29	10.10	3.66	-0.06		15.50		
2505	281.50	1.76	1.70	7.48	10.46	3.75	-0.06		17.17		
2638	292.50	1.83	1.76	7.87	11.13	3.99	-0.06		20.19		
2700	297.20	1.87	1.79	8.04	11.42	4.09	-0.06		21.22		
2823	305.19	1.93	1.85	8.41	12.06	4.20	-0.01		17.68		
2893	**308.71**	**1.96**	**1.88**	**8.62**	**12.42**	**4.37**	**-0.07**		**7.58**		
2933	307.94	1.97	1.88	8.73	12.62		0.01		7.37		
2948	129.42	1.05	0.73	8.12	13.10		0.03		7.46		

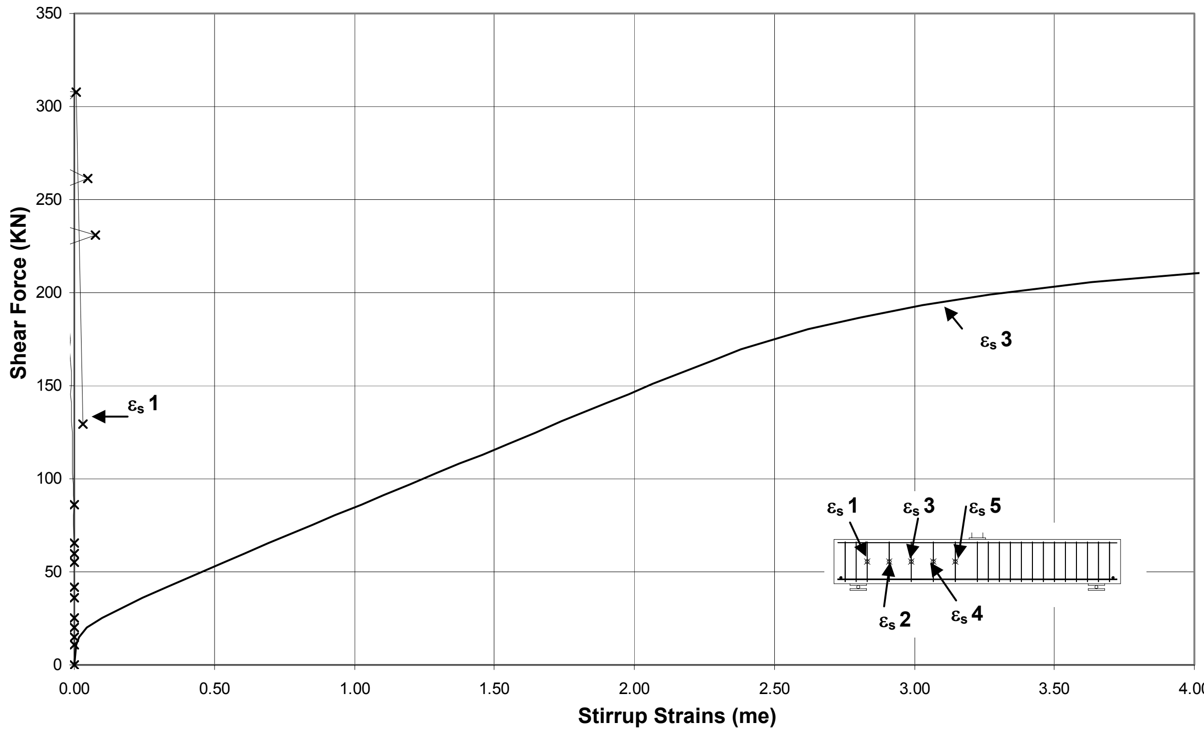
Specimen H60/4 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	0.00	0	0	0	0	0	0
210	10.60	0.001928	0.00303	-0.01096	0.0007559	-0.00162	0.01589
270	15.11	0.001881	0.00451	-0.01485	0.0017006	-0.00197	0.02131
328	20.00	0.002449	0.00747	-0.0172	0.0024475	-0.00193	0.02651
383	25.07	0.005134	0.01114	-0.0188	0.0026817	-0.00174	0.03158
488	36.06	0.012133	0.01911	-0.02291	0.0010068	-0.00194	0.04113
540	41.78	0.016303	0.02186	-0.02533	-0.000148	-0.00208	0.04557
658	55.38	0.025672	0.02533	-0.03364	-0.003017	-0.00252	0.05631
695	60.00	0.028863	0.02631	-0.03624	-0.003869	-0.00244	0.05991
740	65.57	0.032386	0.02735	-0.03961	-0.005165	-0.0025	0.06371
818	75.44	0.038869	0.02881	-0.04528	-0.0074	-0.00254	0.07098
855	80.29	0.042025	0.02946	-0.04843	-0.008287	-0.00232	0.07448
900	86.19	0.045722	0.03044	-0.0517	-0.009441	-0.00231	0.07849
938	91.16	0.048808	0.03077	-0.05503	-0.010553	-0.00212	0.0819
980	96.88	0.052537	0.03174	-0.05823	-0.011973	-0.00238	0.08619
1025	102.91	0.05641	0.03205	-0.06203	-0.013412	-0.00239	0.09047
1063	108.00	0.059926	0.0331	-0.06506	-0.014564	-0.00239	0.09427
1100	113.13	0.063355	0.0333	-0.06886	-0.015772	-0.00251	0.09795
1140	118.65	0.067223	0.03428	-0.0717	-0.01688	-0.00245	0.10211
1185	124.84	0.071705	0.03498	-0.07636	-0.018562	-0.00245	0.10708
1228	130.77	0.075589	0.03546	-0.0798	-0.019892	-0.00241	0.11146
1298	140.61	0.083013	0.03673	-0.08647	-0.021719	-0.00209	0.11851
1333	145.54	0.08667	0.03717	-0.08934	-0.023072	-0.00207	0.12207
1370	150.81	0.090925	0.03794	-0.09334	-0.024303	-0.00165	0.12595
1415	157.16	0.096057	0.03855	-0.09752	-0.026081	-0.00117	0.13081
1460	163.42	0.1011	0.03888	-0.10237	-0.02767	-0.00102	0.13575
1503	169.34	0.10539	0.03881	-0.10626	-0.029479	-0.00058	0.13968
1540	174.42	0.109102	0.03946	-0.11043	-0.030911	9.33E-06	0.14382
1588	180.54	0.113844	0.03944	-0.11435	-0.032959	-0.00036	0.14806
1635	186.81	0.119911	0.03979	-0.11962	-0.035616	-0.00347	0.1517
1685	193.27	0.125761	0.04182	-0.12348	-0.03808	-0.00811	0.15553
1730	199.00	0.13039	0.04293	-0.12739	-0.041001	-0.01062	0.15864
1783	205.55	0.131557	0.0451	-0.12886	-0.044655	-0.01309	0.16198
1823	210.53	0.134808	0.04941	-0.13073	-0.047779	-0.01359	0.16492
1883	217.07	0.147991	0.05938	-0.13526	-0.053512	-0.01292	0.16731
1948	224.71	0.149564	0.06441	-0.13584	-0.060968	-0.01071	0.17042
1998	230.73	0.150319	0.06556	-0.13631	-0.065879	-0.00484	0.17005
2060	237.85	0.150877	0.06625	-0.13582	-0.068309	0.034966	0.14591
2123	244.69	0.152009	0.0757	-0.13718	-0.064517	0.14013	0.0926
2173	249.86	0.152169	0.08554	-0.13799	0.1795119	12.80035	-0.22466
2230	255.66	0.151334	0.10655	-0.13609	0.5039659	12.76882	-12.8268
2288	261.52	0.147179	0.12568	-0.13171	2.792754	12.75714	-12.8016
2365	269.16	0.146773	0.12678	-0.12508	12.77359	12.74854	-12.788
2433	275.26	0.141172	0.13563	-0.11523	12.76436	12.74535	-12.7841
2505	281.50	0.138914	0.13547	-0.11061	12.75947	12.74365	-12.7824
2638	292.50	0.140197	0.13121	-0.10732	12.75661	12.74248	-12.7817
2700	297.20	0.139719	0.13029	-0.10709	12.75607	12.74248	-12.7818
2823	305.19	0.134313	0.13145	-0.10571	12.75565	12.74216	-12.7821
2893	**308.71**	**0.133248**	**0.12757**	**-0.10305**	**12.75554**	**12.74248**	**-12.7824**
2933	307.94	0.133851	0.12675	-0.10268	12.75576	12.74238	-12.7827
2948	129.42	0.228417	0.1351	-0.16327	12.75554	12.74216	-12.7825

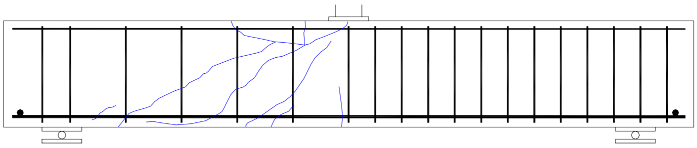
Specimen H60/4





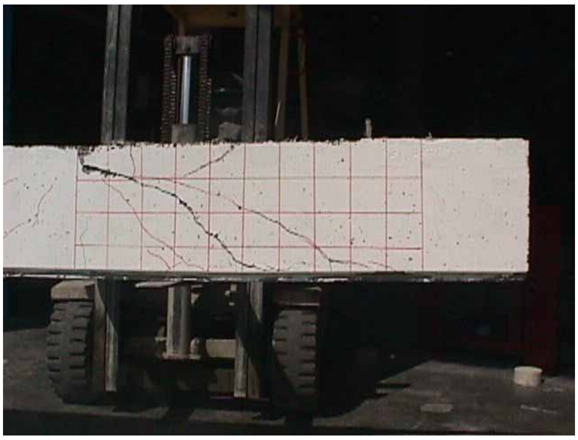


Specimen H60/4– Cracking control



V = 309 KN
failure

Test set-up for beam H60/4



Cracking at failure (V = 259 KN)

Detail of the compression flange at failure

A.48

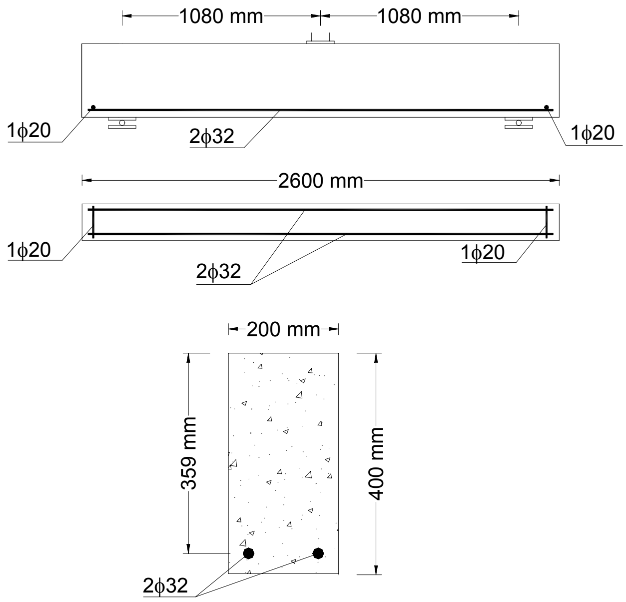
Specimen H75/1

Concrete properties
f'_c = 68.9 MPa f_{sp} = 4.0 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 φ32 bars in one layer

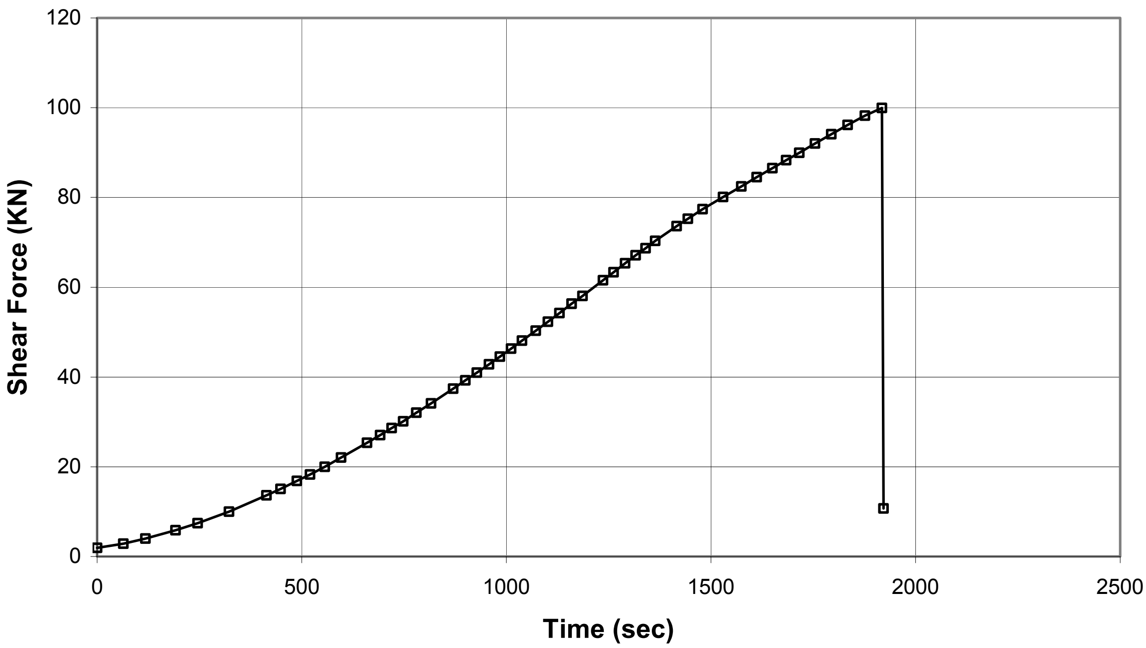
Transversal reinforcement
None

Cast: February 23, 2001
Tested: April 4, 2001
Test duration: 33 min
Test control: 0.003 mm/s



Summary of Test Observations

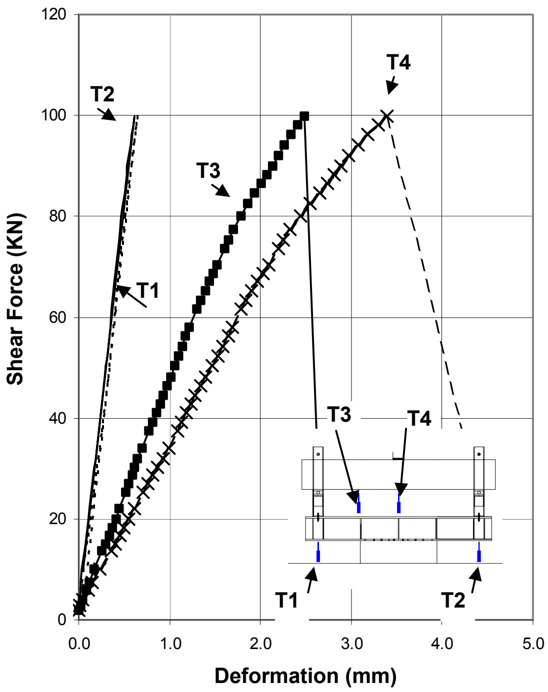
Beam specimen H75/1 did not contain transversal reinforcement. Cracks were not observed from a near position for security reasons. The specimen failed very briskly for V = 99.93 KN, and the crack clearly divided the beam in two pieces. At failure, the longitudinal reinforcement strain at the critical section was equal to $0.84 \cdot 10^{-3}$.

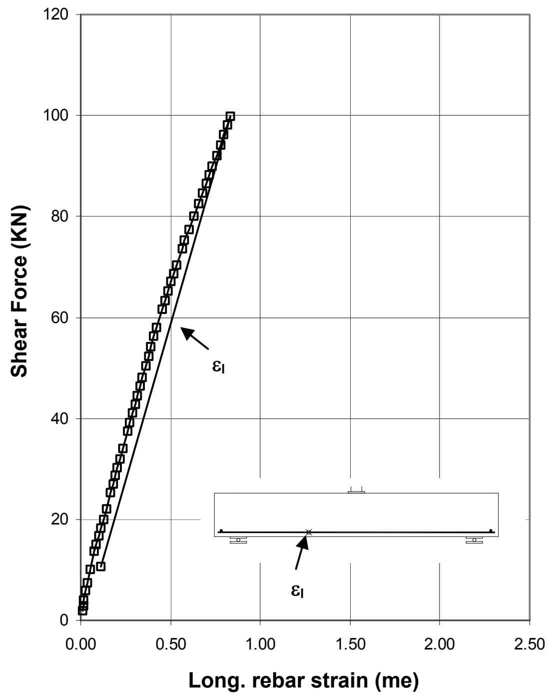


Specimen H75/1

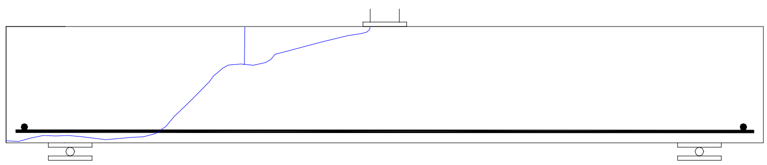
Time	Shear	Deformations				Long rein	Concrete strains 1			Concrete strains 2		
		T1	T2	T3	T4	ε_l	ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	mm	mm	mm	mm	me	me	me	me	me	me	me
0	1.96	0.00	0.00	0.00	0.00	0.01	0.0379	0.01604	0.00585	-0.01698	0.01384	0.0064
64	2.85	0.01	0.00	0.03	0.02	0.01	0.0378	0.01731	0.00538	-0.01644	0.01409	0.007
118	4.00	0.01	0.01	0.04	0.05	0.02	0.0379	0.01805	0.00423	-0.01522	0.0143	0.0084
192	5.84	0.02	0.02	0.08	0.10	0.03	0.0383	0.01749	0.00255	-0.01599	0.01415	0.0102
246	7.44	0.03	0.02	0.12	0.15	0.04	0.0385	0.01752	0.00101	-0.01653	0.01417	0.0121
322	10.03	0.05	0.04	0.17	0.23	0.05	0.0392	0.01702	-0.0011	-0.01723	0.01417	0.0147
414	13.62	0.08	0.06	0.25	0.36	0.08	0.0407	0.0176	-0.0039	-0.01735	0.01428	0.018
448	15.05	0.09	0.07	0.29	0.40	0.09	0.0415	0.01732	-0.0052	-0.01716	0.01444	0.0193
488	16.82	0.10	0.09	0.34	0.46	0.10	0.0427	0.01766	-0.0066	-0.01771	0.01434	0.0211
520	18.30	0.11	0.10	0.37	0.50	0.11	0.0434	0.01719	-0.0076	-0.01866	0.01433	0.0224
556	20.01	0.13	0.10	0.41	0.55	0.13	0.0446	0.01731	-0.009	-0.01981	0.01434	0.0241
596	22.03	0.14	0.11	0.45	0.61	0.14	0.0458	0.01818	-0.0109	-0.0207	0.01438	0.026
660	25.31	0.17	0.14	0.52	0.70	0.17	0.0479	0.01819	-0.0135	-0.02071	0.01465	0.0288
692	27.06	0.18	0.15	0.55	0.76	0.18	0.0492	0.01785	-0.0148	-0.02032	0.0147	0.0303
720	28.63	0.19	0.16	0.59	0.81	0.19	0.0502	0.01872	-0.0159	-0.02017	0.01481	0.0318
748	30.16	0.20	0.17	0.61	0.87	0.20	0.0513	0.01883	-0.0172	-0.02012	0.01493	0.033
780	32.03	0.22	0.19	0.65	0.93	0.22	0.0526	0.02203	-0.0185	-0.02001	0.01509	0.0346
816	34.10	0.23	0.21	0.70	0.99	0.24	0.0539	0.01961	-0.0199	-0.02063	0.01534	0.0358
870	37.38	0.26	0.22	0.77	1.09	0.26	0.0565	0.02012	-0.0224	-0.02189	0.01543	0.0389
900	39.23	0.27	0.23	0.81	1.13	0.27	0.0577	0.01988	-0.0239	-0.02367	0.01545	0.0401
928	40.99	0.28	0.25	0.86	1.18	0.29	0.0589	0.02	-0.0252	-0.02425	0.01543	0.042
958	42.87	0.29	0.26	0.90	1.24	0.30	0.0603	0.02018	-0.0267	-0.02454	0.01538	0.0435
984	44.57	0.30	0.27	0.93	1.28	0.32	0.0615	0.02021	-0.028	-0.02567	0.01552	0.0449
1012	46.33	0.31	0.28	0.98	1.34	0.33	0.063	0.0205	-0.0294	-0.02691	0.01564	0.0464
1038	48.09	0.32	0.29	1.01	1.40	0.34	0.0643	0.02349	-0.0308	-0.02794	0.01579	0.0478
1072	50.35	0.34	0.30	1.06	1.47	0.36	0.0661	0.02031	-0.0328	-0.02985	0.01614	0.0493
1102	52.32	0.35	0.31	1.10	1.53	0.38	0.068	0.02104	-0.0339	-0.03089	0.01622	0.0515
1130	54.23	0.36	0.32	1.14	1.59	0.39	0.069	0.02158	-0.0354	-0.03116	0.01639	0.0527
1160	56.32	0.37	0.34	1.18	1.65	0.41	0.0708	0.02205	-0.037	-0.03141	0.01643	0.0538
1186	58.07	0.38	0.35	1.22	1.69	0.42	0.0724	0.02203	-0.0383	-0.03183	0.01673	0.0557
1236	61.55	0.40	0.36	1.30	1.79	0.45	0.0759	0.02302	-0.0412	-0.03204	0.01693	0.0584
1262	63.33	0.41	0.38	1.34	1.84	0.47	0.078	0.02299	-0.043	-0.03224	0.01697	0.0599
1290	65.29	0.42	0.39	1.39	1.91	0.49	0.0802	0.02318	-0.0445	-0.03183	0.01707	0.0612
1316	67.08	0.43	0.39	1.44	1.97	0.50	0.0825	0.02403	-0.0462	-0.03162	0.01731	0.0629
1340	68.66	0.45	0.40	1.48	2.03	0.52	0.0852	0.0238	-0.0479	-0.03298	0.0174	0.0641
1364	70.29	0.46	0.41	1.52	2.09	0.53	0.0879	0.02495	-0.0498	-0.03306	0.01746	0.0653
1416	73.61	0.47	0.43	1.61	2.20	0.56	0.0969	0.02702	-0.0541	-0.02778	0.01487	0.0696
1444	75.25	0.48	0.44	1.65	2.25	0.58	0.1027	0.02867	-0.0563	-0.02665	0.01271	0.072
1480	77.35	0.49	0.45	1.71	2.33	0.60	0.111	0.02944	-0.0587	-0.02367	0.00764	0.0749
1530	80.07	0.51	0.47	1.79	2.44	0.63	0.1251	0.03168	-0.0633	-0.00113	-0.0276	0.0759
1574	82.46	0.53	0.49	1.86	2.55	0.66	0.1359	0.03109	-0.0667	-0.01158	-0.0399	0.0759
1612	84.54	0.54	0.50	1.94	2.65	0.68	0.1435	0.03154	-0.0707	-0.01703	-0.0434	0.0751
1650	86.50	0.55	0.52	2.00	2.74	0.70	0.1505	0.03292	-0.0756	-0.02212	-0.0445	0.0762
1684	88.32	0.57	0.52	2.07	2.82	0.72	0.1566	0.0341	-0.0791	-0.03177	-0.0446	0.0773
1716	89.93	0.58	0.53	2.13	2.89	0.73	0.1607	0.03457	-0.0805	-0.03982	-0.0456	0.0804
1754	92.03	0.59	0.55	2.20	2.97	0.76	0.1653	0.03419	-0.0813	-0.04767	-0.0454	0.0841
1794	94.09	0.60	0.57	2.26	3.08	0.78	0.1686	0.03429	-0.0812	-0.05525	-0.0442	0.0877
1834	96.18	0.62	0.58	2.33	3.19	0.80	0.173	0.03494	-0.0839	-0.06073	-0.044	0.0912
1876	98.22	0.63	0.60	2.41	3.30	0.82	0.1781	0.03575	-0.0855	-0.07193	-0.0395	0.0944
1918	**99.93**	**0.65**	**0.61**	**2.49**	**3.40**	**0.84**	**0.1825**	**0.03432**	**-0.0878**	**-0.08597**	**-0.0307**	**0.103**
1922	10.69	0.10	0.05	2.67	4.58	0.11	0.0897	-0.0019	-0.0421	-0.04914	-0.0005	0.0068

Specimen H75/1





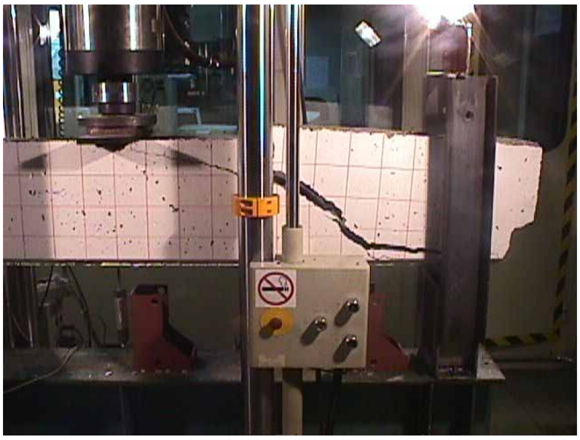
Specimen H75/1 – Cracking control



V = 99.9 KN
failure

Specimen H75/1

Test set-up for beam H75/1



Cracking at failure (V = 99.93 KN)

Detail of the crack surface

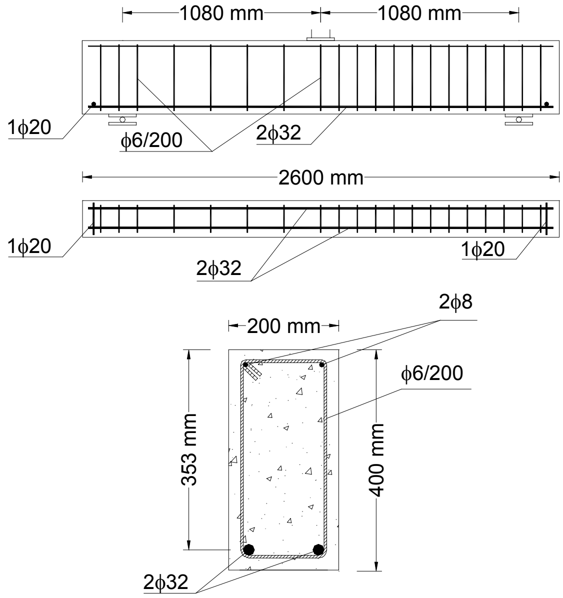
Specimen H75/2

Concrete properties
f'_c = 68.9 MPa f_{sp} = 4.0 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.28%   2 ϕ32 bars in one layer

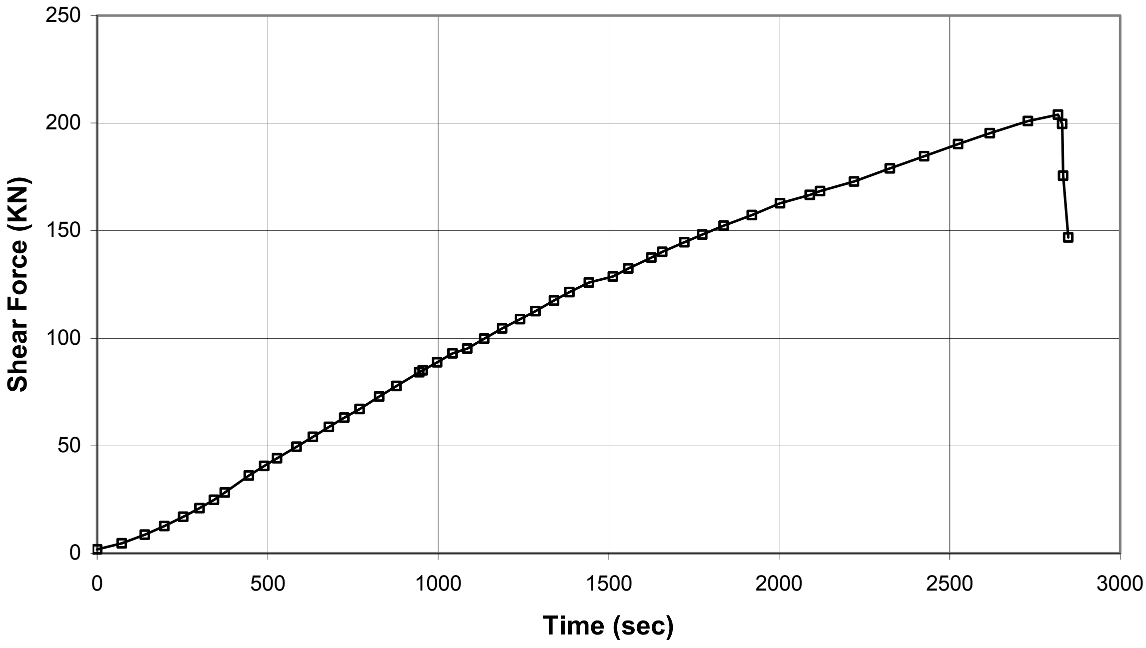
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 0.747 MPa stirrups ϕ6 @ 200 mm

Cast: February 23, 2001
Tested: April 5, 2001
Test duration: 50 min
Test control: 0.005 mm/s



Summary of Test Observations

Beam specimen H75/2 contained the minimum amount of shear reinforcement for a 75 MPa concrete beam. At load stage 3, the first shear crack was observed (V = 95 KN). No problem happened during the test. Stirrups 4 and 5 yielded for a very low load, even before that shear cracking was observed. Stirrup 3 yielded for a shear force of 130 KN. The failure took place for a shear strength of 203.94 KN, just after the yielding of the longitudinal reinforcement. It could be appreciate local crushing of the concrete just below the load application zone.



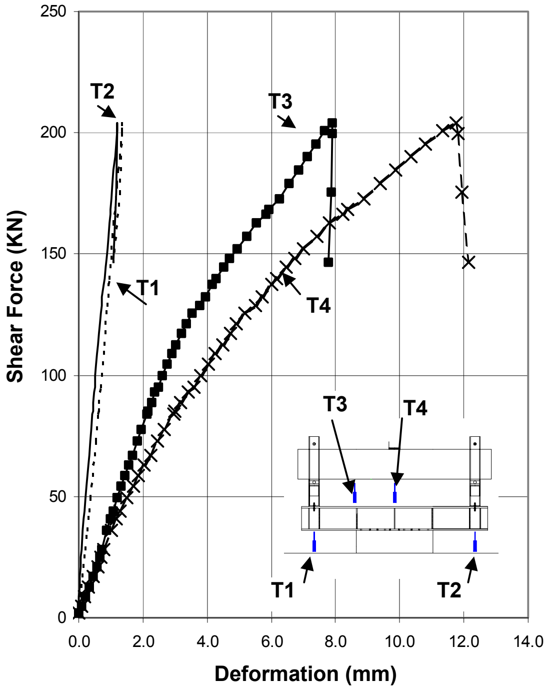
Specimen H75/2

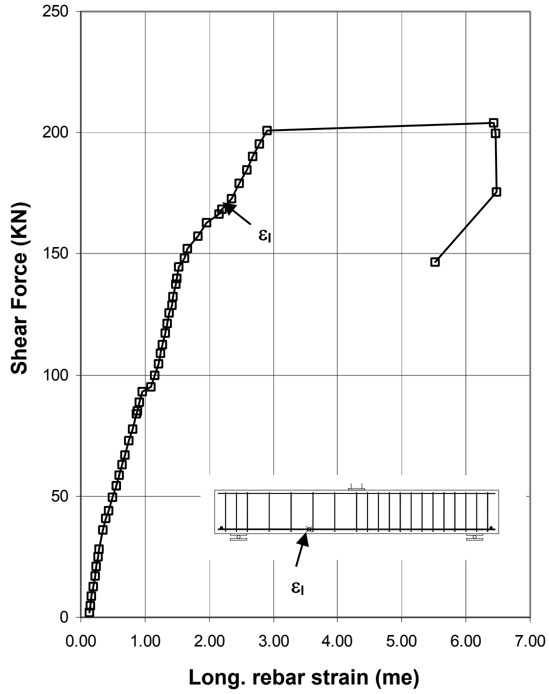
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	Mm	mm	mm	me	Me	me	me	me	me
0	**1.83**	**0.00**	**0.00**	**0.00**	**0.00**	**0.13**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
73	4.60	0.01	0.00	0.08	0.08	0.15	0.00	0.00	0.00	0.01	0.01
140	8.56	0.04	0.01	0.20	0.19	0.17	0.00	0.00	0.00	0.01	0.02
198	12.64	0.07	0.02	0.32	0.31	0.19	-0.01	0.00	0.00	0.01	0.02
253	16.90	0.11	0.04	0.45	0.46	0.22	-0.01	0.00	0.00	0.02	0.04
300	20.93	0.15	0.05	0.56	0.59	0.24	-0.01	0.00	0.00	0.05	0.05
343	24.84	0.18	0.07	0.65	0.70	0.27	-0.01	0.00	0.00	0.09	0.11
375	28.32	0.21	0.08	0.72	0.78	0.29	-0.01	0.00	0.00	0.12	0.20
445	36.16	0.27	0.12	0.87	1.01	0.35	-0.01	0.00	0.00	0.38	0.70
490	40.62	0.31	0.14	0.98	1.17	0.39	-0.01	0.00	0.01	0.20	0.80
528	44.13	0.33	0.17	1.07	1.29	0.44	-0.02	0.00	0.01	0.34	0.80
585	49.57	0.37	0.20	1.21	1.50	0.49	-0.02	0.00	0.01	0.15	0.80
633	54.16	0.40	0.24	1.31	1.70	0.55	-0.02	0.00	0.02	0.49	0.80
680	58.78	0.44	0.27	1.43	1.86	0.60	-0.02	0.00	0.02	0.55	0.80
725	63.02	0.46	0.30	1.56	2.03	0.65	-0.02	0.00	0.02	0.96	0.80
770	**67.12**	**0.49**	**0.32**	**1.67**	**2.24**	**0.69**	**-0.02**	**-0.01**	**0.03**	**1.46**	0.80
828	72.85	0.53	0.36	1.82	2.46	0.75	-0.02	-0.01	0.03	2.18	0.80
878	77.71	0.57	0.40	1.94	2.67	0.80	-0.02	-0.01	0.04	3.95	0.80
945	84.11	0.61	0.43	2.12	2.97	0.87	-0.02	0.00	0.04	3.01	0.85
955	**85.01**	**0.61**	**0.44**	**2.14**	**3.00**	**0.88**	**-0.02**	**0.00**	**0.04**	**3.83**	**1.49**
998	88.85	0.64	0.46	2.26	3.18	0.91	-0.02	0.00	0.04	5.08	5.20
1043	92.92	0.67	0.48	2.37	3.40	0.95	-0.02	0.00	0.04	8.00	12.07
1085	**95.22**	**0.68**	**0.50**	**2.47**	**3.58**	**1.09**	**-0.02**	**0.00**	**0.06**	**12.51**	
1135	99.82	0.72	0.52	2.60	3.80	1.15	-0.02	0.00	0.06	12.50	
1188	104.51	0.74	0.55	2.76	4.05	1.20	-0.02	0.00	0.06		
1240	108.90	0.77	0.57	2.91	4.26	1.24	-0.02	0.00	0.06		
1285	112.65	0.79	0.60	3.03	4.48	1.28	-0.02	-0.01	0.07		
1340	**117.44**	**0.82**	**0.63**	**3.20**	**4.71**	**1.32**	**-0.02**	**-0.02**	**0.08**		
1385	121.32	0.85	0.65	3.35	4.90	1.34	-0.02	-0.02	0.12		
1443	125.78	0.87	0.68	3.54	5.18	1.38	-0.02	-0.02	0.28		
1513	128.67	0.89	0.71	3.77	5.50	1.41	-0.02	0.01	2.34		
1558	132.39	0.91	0.73	3.94	5.72	1.44	-0.02	0.01	2.43		
1625	137.43	0.94	0.77	4.15	6.01	1.48	-0.02	0.02	2.52		
1658	**140.05**	**0.96**	**0.79**	**4.27**	**6.17**	**1.50**	**-0.02**	**0.02**	**2.56**		
1723	144.58	0.98	0.83	4.52	6.46	1.53	-0.02	0.03	2.71		
1775	148.12	1.01	0.86	4.71	6.72	1.61	-0.02	0.04	3.19		
1838	152.24	1.03	0.89	4.93	7.01	1.66	-0.03	0.04	4.16		
1920	157.13	1.06	0.93	5.23	7.43	1.83	-0.03	0.04	8.82		
2003	162.72	1.09	0.96	5.54	7.81	1.95	-0.03	0.05	11.41		
2090	**166.53**	**1.11**	**0.98**	**5.85**	**8.23**	**2.15**	**-0.03**	**0.05**	**12.70**		
2120	168.41	1.13	1.00	5.94	8.39	2.20	-0.03	0.05			
2220	172.75	1.16	1.02	6.25	8.87	2.34	-0.03	0.06			
2325	178.95	1.20	1.06	6.55	9.39	2.47	-0.03	0.07			
2425	184.64	1.23	1.09	6.84	9.88	2.58	-0.03	0.08			
2525	190.15	1.27	1.12	7.11	10.36	2.68	-0.03	0.08			
2618	195.23	1.30	1.15	7.37	10.79	2.78	-0.03	0.09			
2730	200.93	1.34	1.19	7.66	11.33	2.90	-0.03	0.09			
2818	**203.94**	**1.36**	**1.20**	**7.89**	**11.74**	**6.42**	**-0.03**	**0.10**			
2830	199.61	1.35	1.20	7.91	11.83	6.46	-0.03	0.10			
2833	175.44	1.29	1.17	7.86	11.93	6.47	-0.03	0.09			
2848	146.79	1.08	1.07	7.77	12.16	5.51	-0.02	0.07			

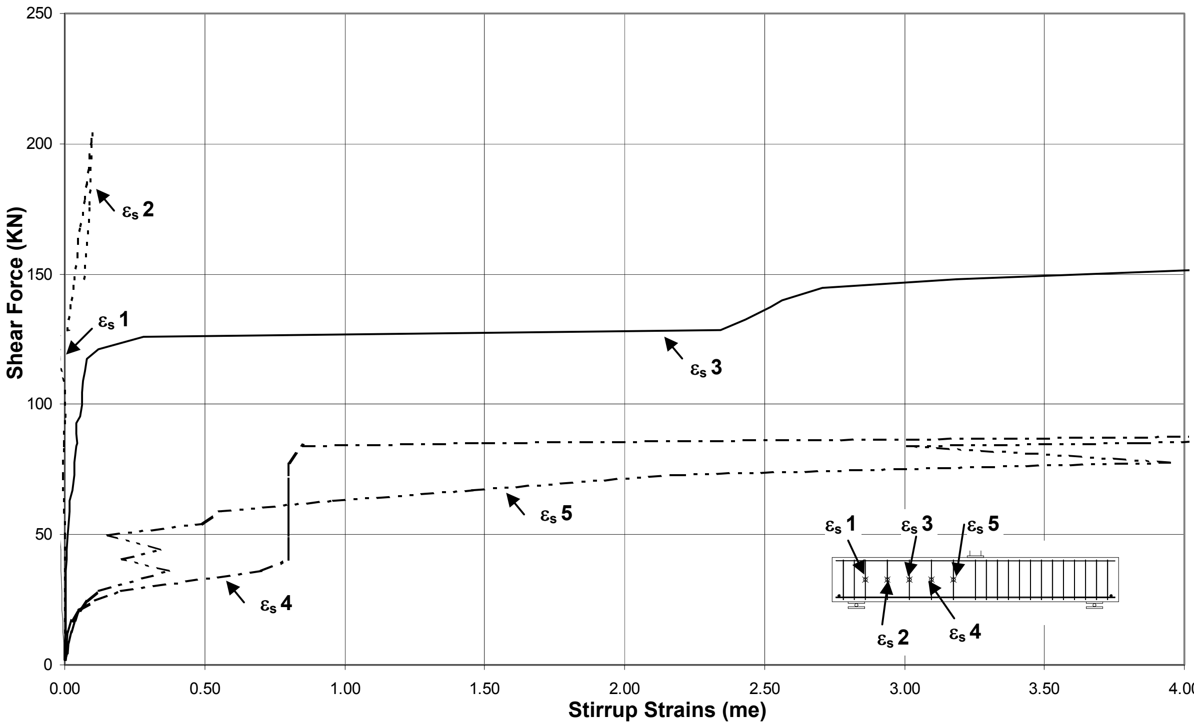
Specimen H75/2 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	**1.83**	**-0.06495**	**-0.00938**	**-0.00996**	**-0.005498**	**-0.00161**	**0.00242**
73	4.60	-0.06491	-0.00924	-0.01014	-0.006248	-0.00121	0.00325
140	8.56	-0.0668	-0.00934	-0.01013	-0.00727	-0.00114	0.00456
198	12.64	-0.06959	-0.00889	-0.00996	-0.007912	-0.00072	0.00588
253	16.90	-0.07315	-0.00869	-0.0098	-0.00854	-0.00077	0.00685
300	20.93	-0.07664	-0.00895	-0.00992	-0.009237	-0.0004	0.0076
343	24.84	-0.0799	-0.00892	-0.01032	-0.010152	-0.00044	0.00947
375	28.32	-0.08243	-0.00898	-0.01151	-0.011006	-0.00063	0.01095
445	36.16	-0.07971	-0.00653	-0.02161	-0.012058	-0.00093	0.01555
490	40.62	-0.0745	-0.00166	-0.03275	-0.01282	-0.0012	0.01793
528	44.13	-0.06868	0.00255	-0.03997	-0.012465	-0.0027	0.01968
585	49.57	-0.03493	0.01345	-0.05664	-0.014172	-0.00532	0.02296
633	54.16	-0.02294	0.02254	-0.06657	-0.014814	-0.00995	0.02377
680	58.78	-0.01423	0.03151	-0.07327	-0.013863	-0.01349	0.02197
725	63.02	-0.01054	0.04068	-0.077	-0.015301	-0.01668	0.02028
770	**67.12**	**-0.00825**	**0.0475**	**-0.08092**	**-0.045584**	**-0.01443**	**0.01699**
828	72.85	-0.00629	0.05579	-0.0837	-0.05464	-0.0141	0.0205
878	77.71	-0.00592	0.06082	-0.08497	-0.060669	-0.01366	0.02521
945	84.11	0.006104	0.064	-0.08026	-0.032317	-0.03175	0.03403
955	**85.01**	**0.008439**	**0.06404**	**-0.07995**	**-0.019849**	**-0.04156**	**0.03209**
998	88.85	0.013904	0.06783	-0.0797	-0.021085	-0.05782	0.02421
1043	92.92	0.01357	0.06615	-0.07983	-0.047344	-0.05615	0.02934
1085	**95.22**	**0.076242**	**0.02345**	**-0.07192**	**-0.064854**	**-0.05278**	**0.03525**
1135	99.82	0.113605	0.00325	-0.09031	-0.068337	-0.06002	0.03839
1188	104.51	0.143992	-0.00113	-0.10231	-0.071862	-0.06574	0.04262
1240	108.90	0.177907	0.00619	-0.1139	-0.074648	-0.06455	0.03671
1285	112.65	0.203301	0.00354	-0.12379	-0.083211	-0.04403	0.03131
1340	**117.44**	**0.220058**	**0.01147**	**-0.12937**	**-0.091105**	**-0.02481**	**0.03683**
1385	121.32	0.226153	0.06045	-0.13154	-0.097492	-0.01036	0.04323
1443	125.78	0.228395	0.17515	-0.13467	-0.105679	0.011862	0.06806
1513	128.67	-12.8093	0.40552	-0.14512	-0.190965	-0.04727	0.15104
1558	132.39	-12.7966	0.4593	-0.14795	-0.205878	-0.0393	0.16561
1625	137.43	-12.7876	0.6563	-0.14897	-0.227422	12.76372	0.18872
1658	**140.05**	**-12.7855**	**0.7925**	**-0.14797**	**-0.235788**	**12.75661**	**0.19836**
1723	144.58	-12.7834	1.41208	-0.14978	-0.255099	12.74896	0.21778
1775	148.12	-12.7823	12.7681	-0.15418	-0.268597	12.74588	0.23164
1838	152.24	-12.7818	12.7546	-0.16632	-0.282718	12.74397	0.24486
1920	157.13	-12.7817	12.7469	-0.18178	-0.301577	12.74259	0.26177
2003	162.72	-12.7816	12.7444	-0.17958	-0.31869	12.74185	0.27951
2090	**166.53**	**-12.7821**	**12.7433**	**-0.18091**	**-0.339771**	**12.74174**	**0.29676**
2120	168.41	-12.782	12.7432	-0.17889	-0.346955	12.74174	0.30434
2220	172.75	-12.7821	12.743	-0.17059	-0.382511	12.74163	0.33154
2325	178.95	-12.7824	12.743	-0.16875	-0.412075	12.74174	0.36
2425	184.64	-12.7825	12.743	-0.1672	-0.438965	12.74174	0.38449
2525	190.15	-12.7827	12.7433	-0.16648	-0.469077	12.74163	0.40779
2618	195.23	-12.7831	12.7435	-0.16643	-0.492527	12.74216	0.42666
2730	200.93	-12.783	12.7438	-0.16703	-0.516849	12.74216	0.44501
2818	**203.94**	**-12.7831**	**12.744**	**-0.16476**	**-0.530875**	**12.74206**	**0.45645**
2830	199.61	-12.7834	12.7439	-0.15615	-0.534746	12.74227	0.46014
2833	175.44	-12.7833	12.744	-0.14765	-0.534151	12.74195	0.45953
2848	146.79	-12.7834	12.7438	-0.16337	-0.474912	12.74227	0.40224

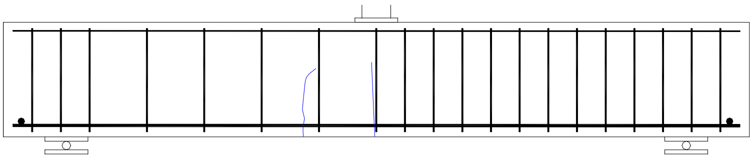
Specimen H75/2



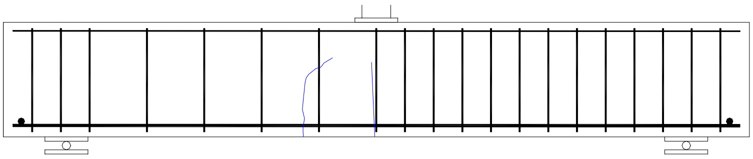




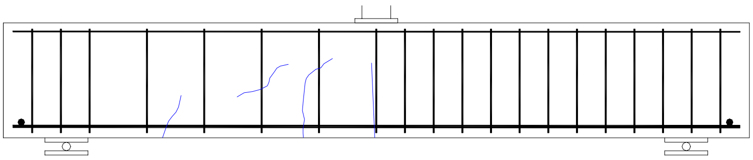
Specimen H75/2 – Cracking control



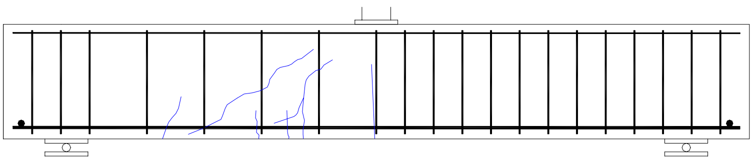
V = 67 KN



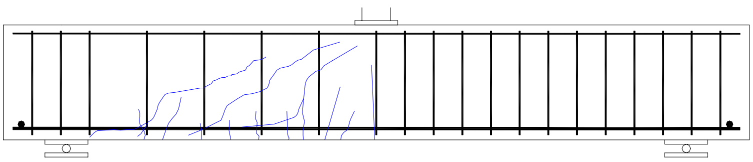
V = 85 KN



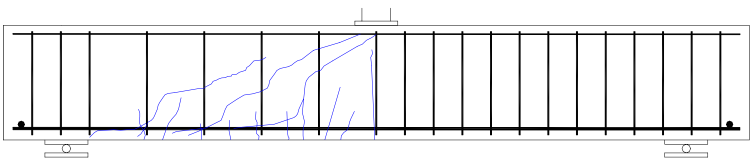
V = 95 KN



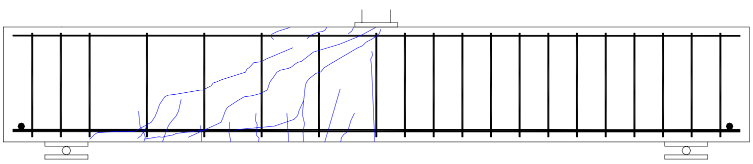
V = 117 KN



V = 140 KN

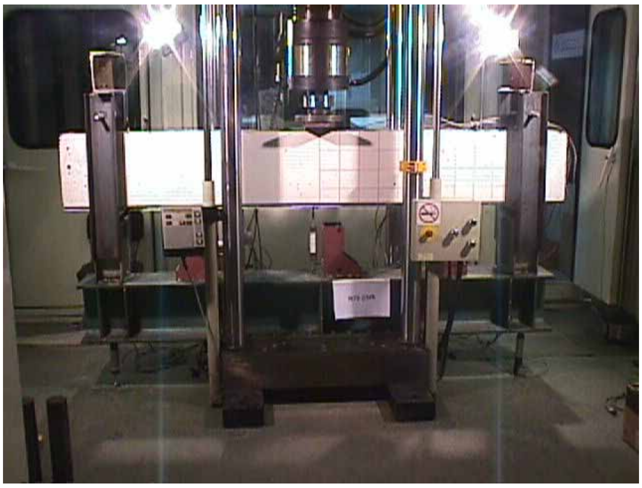


V = 167 KN

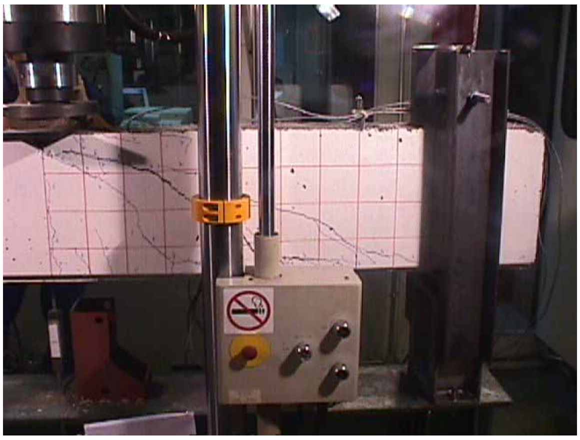


V = 204 KN
failure

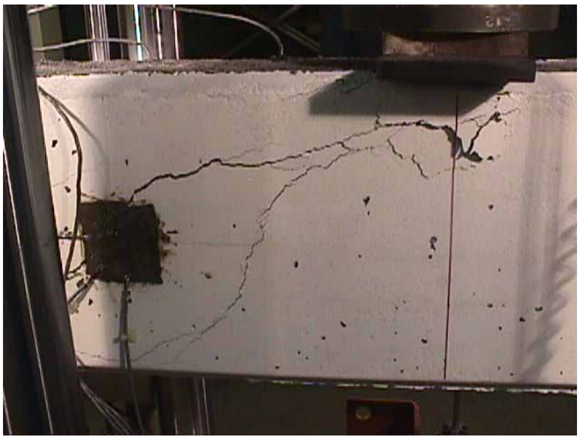
Specimen H75/2



Test set-up for beam H75/2



Cracking at failure (V = 203.94 KN)



Local crushing of the concrete

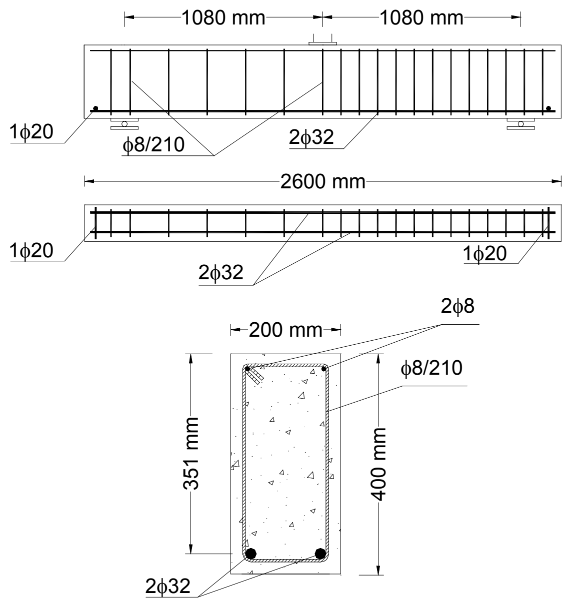
Specimen H75/3

Concrete properties
f'_c = 68.9 MPa f_{sp} = 4.0 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.29%   2 ϕ32 bars in one layer

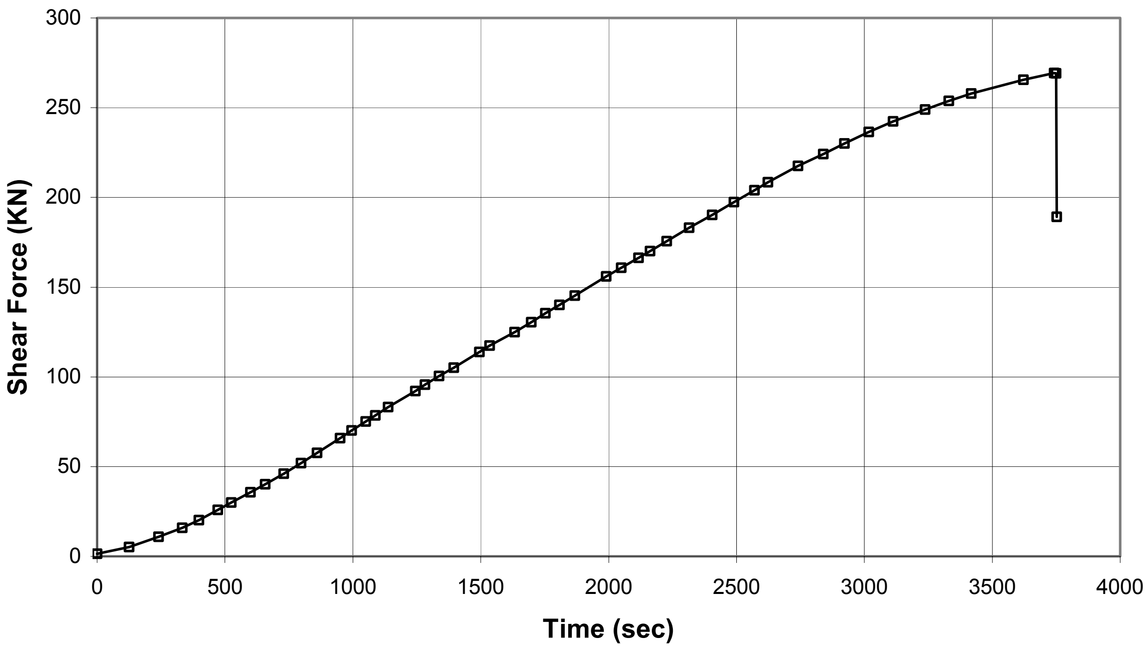
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 1.267 MPa stirrups ϕ8 @ 210 mm

Cast: February 23, 2001
Tested: April 5, 2001
Test duration: 63 min
Test control: 0.005 mm/s



Summary of Test Observations

The strain gauge attached to stirrup 1 did not work properly. At load stage 3 (V = 95 KN), the first shear crack was observed. Furthermore, the stirrup strain graph shows that stirrups 3, 4 and 5 increased considerably their strain for V = 85 KN, and yielded for V ≈ 150 KN. The beam failed briskly for V = 269.35 KN.



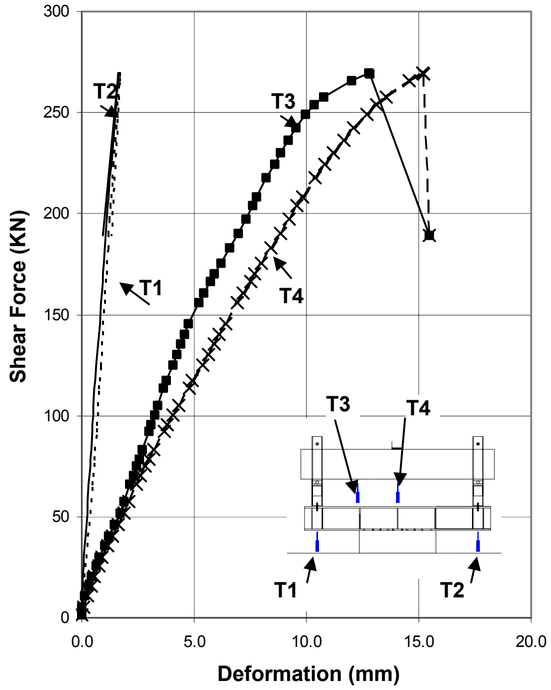
Specimen H75/3

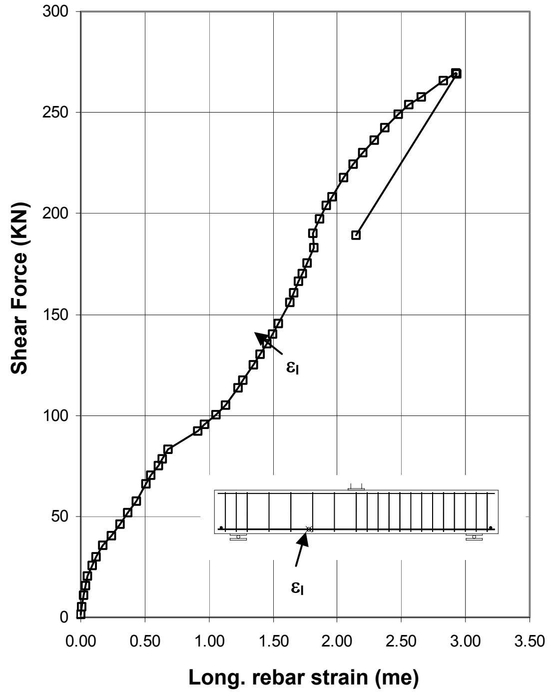
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	Mm	mm	mm	me	Me	me	me	me	me
0	1.49	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
125	5.16	0.02	0.00	0.02	0.10	0.01		0.00	0.00	0.00	0.00
240	10.84	0.05	0.02	0.14	0.28	0.02		0.01	0.00	0.00	0.01
333	15.87	0.09	0.04	0.29	0.43	0.04		0.00	0.00	0.00	0.01
398	20.22	0.13	0.05	0.44	0.57	0.06		0.00	0.00	0.01	0.01
473	25.84	0.17	0.08	0.63	0.77	0.09		0.01	0.00	0.01	0.01
525	30.01	0.20	0.11	0.76	0.90	0.12		0.00	0.00	0.01	0.01
600	35.72	0.24	0.14	1.01	1.14	0.17		0.00	0.00	0.02	0.01
658	40.19	0.28	0.17	1.21	1.36	0.24		0.00	0.00	0.02	0.01
730	45.96	0.32	0.21	1.44	1.60	0.31		0.00	0.00	0.02	-0.01
798	51.95	0.36	0.24	1.70	1.87	0.37		0.00	0.00	0.02	-0.01
860	**57.57**	**0.41**	**0.27**	**1.89**	**2.08**	**0.43**		**0.00**	**0.00**	**0.01**	**-0.02**
950	65.88	0.47	0.32	2.16	2.44	0.51		0.00	0.01	0.00	-0.02
995	70.13	0.51	0.34	2.29	2.61	0.55		0.00	0.01	0.00	-0.03
1050	75.05	0.55	0.37	2.45	2.82	0.60		0.01	0.01	0.00	-0.03
1088	78.61	0.57	0.39	2.55	3.00	0.64		0.01	0.01	0.02	-0.03
1138	**83.13**	**0.61**	**0.41**	**2.70**	**3.19**	**0.68**		**0.01**	**0.02**	**0.05**	**-0.04**
1245	92.16	0.66	0.45	2.99	3.66	0.91		0.02	0.16	0.10	0.23
1283	**95.66**	**0.68**	**0.47**	**3.09**	**3.81**	**0.97**		**0.02**	**0.25**	**0.12**	**0.35**
1338	100.52	0.71	0.50	3.23	4.06	1.06		0.03	0.47	0.14	0.64
1395	105.19	0.74	0.53	3.37	4.31	1.13		0.03	0.59	0.15	0.89
1495	113.81	0.79	0.57	3.65	4.77	1.23		0.04	1.11	0.18	1.20
1535	**117.45**	**0.81**	**0.60**	**3.76**	**4.93**	**1.27**		**0.04**	**1.26**	**0.20**	**1.31**
1633	124.95	0.85	0.65	4.07	5.38	1.34		0.03	2.09	0.29	1.51
1698	130.45	0.88	0.69	4.24	5.64	1.40		0.03	2.32	0.34	1.62
1753	135.42	0.91	0.73	4.40	5.91	1.45		0.03	2.59	0.42	1.74
1808	**140.10**	**0.93**	**0.76**	**4.58**	**6.12**	**1.49**		**0.03**	**2.87**	**0.63**	**1.87**
1868	145.33	0.96	0.81	4.75	6.39	1.54		0.03	3.19	0.87	2.01
1990	155.91	1.01	0.87	5.21	6.93	1.63		0.03	3.70	1.75	2.35
2050	160.75	1.04	0.91	5.44	7.19	1.66		0.03	3.93	2.45	2.56
2118	**166.40**	**1.08**	**0.94**	**5.73**	**7.50**	**1.70**		**0.03**	**4.36**	**2.99**	**2.76**
2163	170.15	1.10	0.96	5.91	7.71	1.73		0.04	4.80	3.48	2.87
2228	175.63	1.13	0.99	6.21	8.00	1.77		0.04	5.97	4.33	3.07
2315	183.04	1.18	1.03	6.57	8.41	1.82		0.04	8.16	5.76	3.41
2405	190.27	1.22	1.07	6.96	8.84	1.81		0.05	10.14	6.33	4.17
2490	197.43	1.26	1.12	7.30	9.24	1.86		0.05	12.24	6.63	4.90
2570	204.07	1.30	1.16	7.59	9.59	1.92		0.07	12.74	7.11	5.62
2623	208.43	1.32	1.19	7.79	9.85	1.96		0.07	12.75	7.56	6.17
2740	217.53	1.37	1.25	8.21	10.38	2.05		0.19	12.76	9.02	7.51
2840	224.17	1.41	1.31	8.59	10.83	2.13		0.73	12.76	10.29	8.87
2923	230.13	1.45	1.36	8.86	11.21	2.20		0.81	12.75	12.16	10.06
3018	236.50	1.48	1.40	9.19	11.67	2.29		0.90	12.75	12.76	11.37
3113	242.39	1.52	1.45	9.51	12.11	2.37		0.98	12.75	12.65	12.59
3238	249.03	1.57	1.49	9.97	12.70	2.47		1.08	12.75	12.56	12.72
3330	253.70	1.60	1.52	10.35	13.13	2.56		1.14	12.75	11.47	12.73
3418	257.87	1.63	1.55	10.75	13.55	2.66		1.19	12.75	9.52	12.74
3623	265.59	1.69	1.60	12.02	14.57	2.82		1.23	12.75	7.33	12.73
3743	**269.35**	**1.72**	**1.63**	**12.77**	**15.16**	**2.93**		**1.25**	**12.75**	**6.96**	**12.73**
3750	269.14	1.72	1.63	12.83	15.20	2.93		1.25	12.75	6.98	12.73
3753	189.12	1.32	0.94	15.48	15.49	2.14		1.18	12.75	6.51	12.70
0	1.49	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00

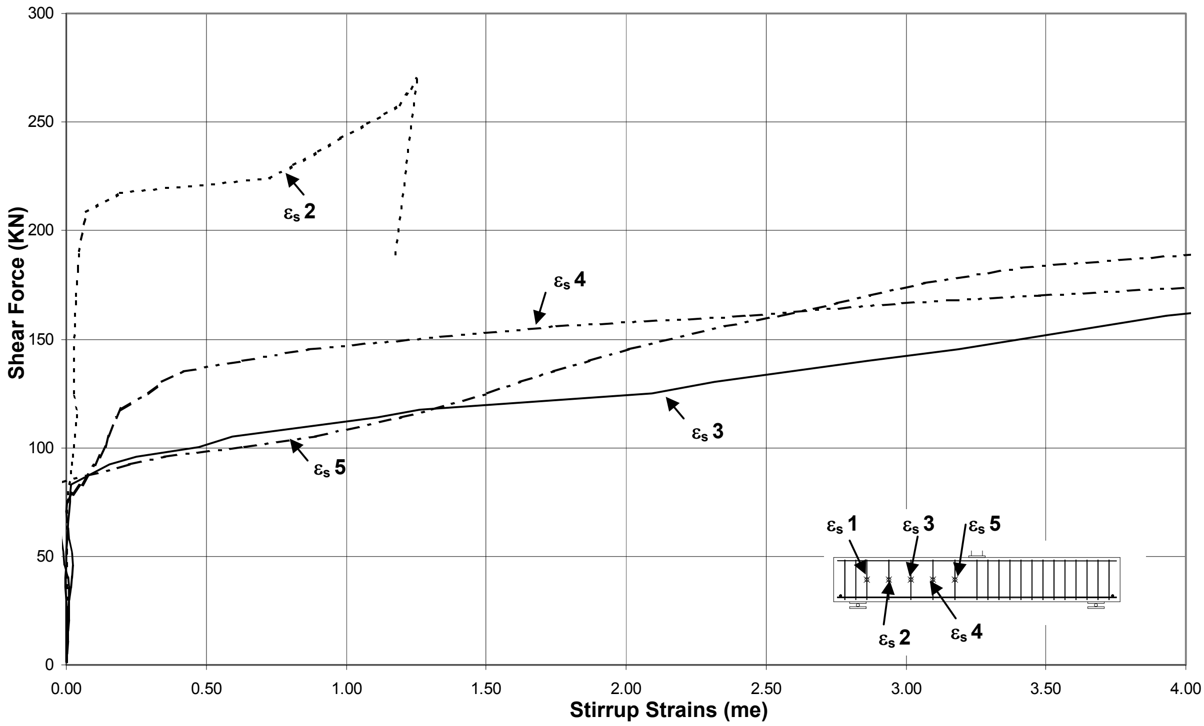
Specimen H75/3 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	1.49	0.004104	-8.6E-05	-0.00491	-0.004004	-0.00297	0.00494
125	5.16	0.005307	0.00023	-0.0088	-0.005058	-0.00329	0.00856
240	10.84	0.006245	0.00026	-0.01396	-0.00674	-0.00351	0.01426
333	15.87	0.004313	-0.00128	-0.01684	-0.007931	-0.00356	0.01901
398	20.22	0.004682	-0.0019	-0.02028	-0.00915	-0.00429	0.02451
473	25.84	0.005767	-0.00127	-0.02265	-0.010048	-0.00529	0.03051
525	30.01	0.00472	-0.0014	-0.02341	-0.010859	-0.00591	0.03416
600	35.72	0.008714	-0.00035	-0.02086	-0.011661	-0.00661	0.0406
658	40.19	0.004515	0.00063	-0.01888	-0.011824	-0.00701	0.04449
730	45.96	-0.01805	-0.00226	-0.02583	-0.012994	-0.0069	0.04929
798	51.95	-0.0812	0.00557	-0.05647	-0.013039	-0.00801	0.05438
860	**57.57**	**-0.30301**	**0.04433**	**-0.09669**	**-0.012101**	**-0.01124**	**0.05838**
950	65.88	-0.52593	0.12501	-0.11803	-0.01311	-0.01285	0.06434
995	70.13	-0.62987	0.12079	-0.1272	-0.013859	-0.01369	0.06638
1050	75.05	-0.74613	0.15178	-0.14517	-0.015633	-0.0158	0.06244
1088	78.61	-0.78313	0.15726	-0.14998	-0.016721	-0.01556	0.06268
1138	**83.13**	**-0.68593**	**0.21583**	**-0.15164**	**-0.003864**	**-0.01293**	**0.06293**
1245	92.16	-0.55037	0.25197	-0.1331	0.0325939	-0.06491	0.04527
1283	**95.66**	**-0.51965**	**0.26072**	**-0.13218**	**0.0287257**	**-0.07361**	**0.04546**
1338	100.52	-0.47592	0.27382	-0.13171	0.0130569	-0.08047	0.05425
1395	105.19	-0.43955	0.28077	-0.13274	-6.51E-05	-0.08565	0.06615
1495	113.81	-0.38332	0.2978	-0.13443	-0.070505	-0.11842	0.15172
1535	**117.45**	**-0.36527**	**0.29911**	**-0.13351**	**-0.099523**	**-0.12587**	**0.17696**
1633	124.95	-0.32312	0.27685	-0.122	-0.200994	-0.13428	0.22709
1698	130.45	-0.3191	0.27274	-0.12366	-0.229674	-0.13886	0.2447
1753	135.42	-0.31678	0.27121	-0.12517	-0.250924	-0.14314	0.26118
1808	**140.10**	**-0.32261**	**0.27415**	**-0.12808**	**-0.271387**	**-0.14485**	**0.27772**
1868	145.33	-0.33914	0.2833	-0.12735	-0.293657	-0.14651	0.29087
1990	155.91	-12.8104	0.97339	-0.07592	-0.331325	-0.15255	0.31095
2050	160.75	-12.797	12.7707	-0.15074	-0.350305	-0.15462	0.32146
2118	**166.40**	**-12.7908**	**12.7579**	**-0.19818**	**-0.366546**	**-0.15711**	**0.33379**
2163	170.15	-12.7888	12.754	-0.21448	-0.376176	-0.15979	0.34247
2228	175.63	-12.787	12.7509	-0.22013	-0.38901	-0.16179	0.35451
2315	183.04	-12.7862	12.7493	-0.22267	-0.399655	-0.16642	0.36562
2405	190.27	-12.786	12.7485	-0.23724	-0.410362	-0.16933	0.37311
2490	197.43	-12.7859	12.7481	-0.24925	-0.416779	-0.1728	0.38241
2570	204.07	-12.7862	12.748	-0.25511	-0.421384	-0.1764	0.39268
2623	208.43	-12.7862	12.7482	-0.25515	-0.426989	-0.17823	0.40049
2740	217.53	-12.7861	12.748	-0.25238	-0.436186	-0.20325	0.41978
2840	224.17	-12.7863	12.7477	-0.2436	-0.473516	-0.2267	0.41514
2923	230.13	-12.7864	12.7477	-0.2301	-0.490717	-0.21584	0.43484
3018	236.50	-12.7865	12.7475	-0.21093	-0.512243	-0.19117	0.46369
3113	242.39	-12.7867	12.7474	-0.19703	-0.535683	-0.14851	0.49346
3238	249.03	-12.7873	12.7473	-0.18177	-0.560154	-0.01899	0.5382
3330	253.70	-12.7876	12.7477	-0.17229	-0.587227	0.025623	0.56076
3418	257.87	-12.7877	12.7478	-0.16443	-0.612123	0.043439	0.57749
3623	265.59	-12.788	12.7483	-0.15015	-0.658447	0.110232	0.61591
3743	**269.35**	**-12.7879**	**12.7477**	**-0.14875**	**-0.667057**	**0.130101**	**0.62441**
3750	269.14	-12.7878	12.7478	-0.14865	-0.66365	0.132681	0.62201
3753	189.12	-12.788	12.7478	-0.12683	-0.970372	0.088174	0.44686
0	1.49	0.004104	-8.6E-05	-0.00491	-0.004004	-0.00297	0.00494

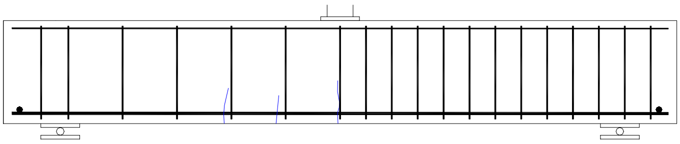
Specimen H75/3



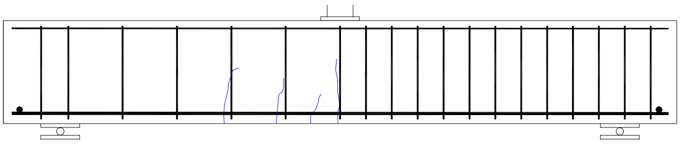




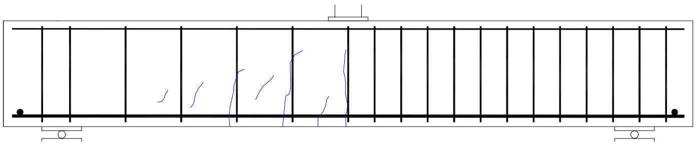
Specimen H75/3 – Cracking control



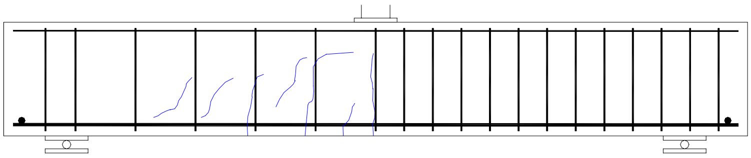
V = 58 KN



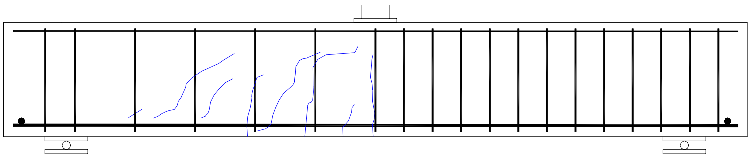
V = 83 KN



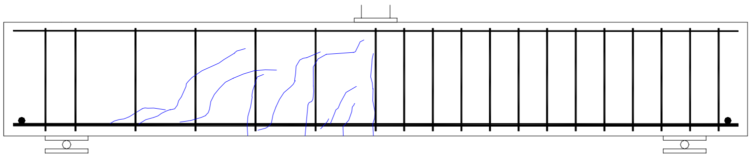
V = 95 KN



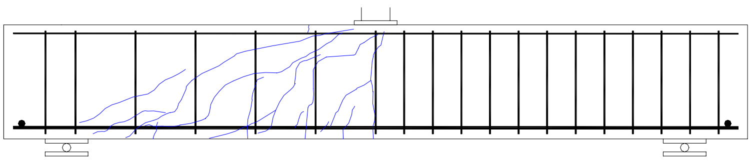
V = 117 KN



V = 140 KN

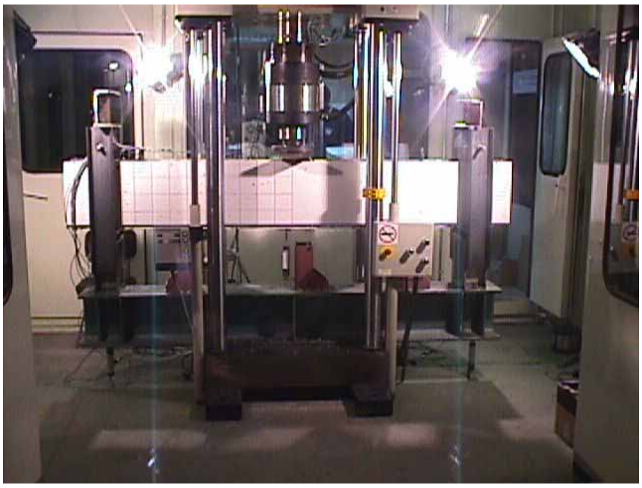


V = 167 KN

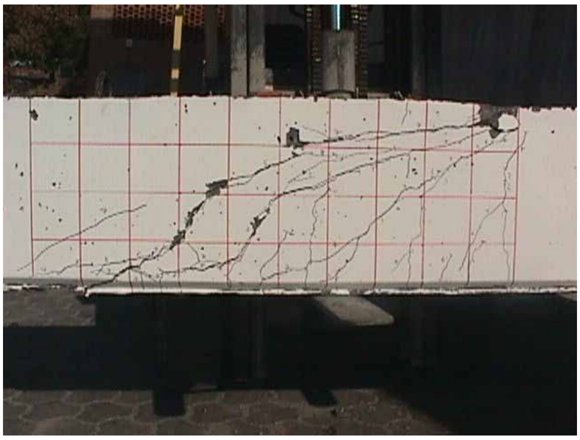


V = 269.3 KN
failure

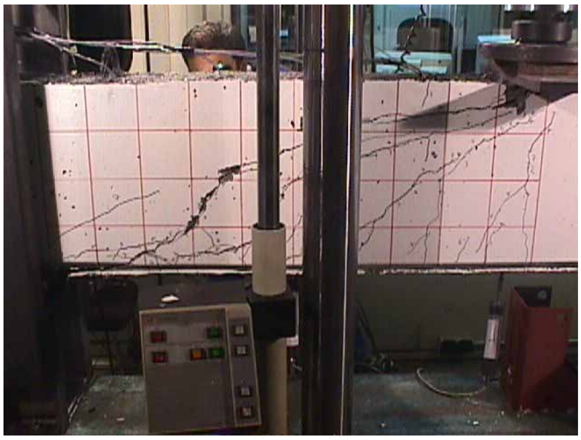
Specimen H75/3



Test set-up for beam H75/3



Cracking at failure (V = 269.35 KN)



Detail of the crack at failure

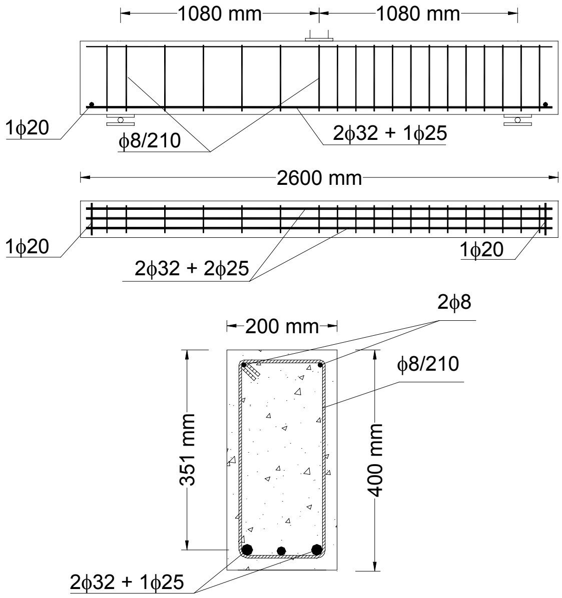
Specimen H75/4

Concrete properties
f'_c = 68.9 MPa f_{sp} = 4.0 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.99%   2 ϕ32 + 1 ϕ25 bars in one layer

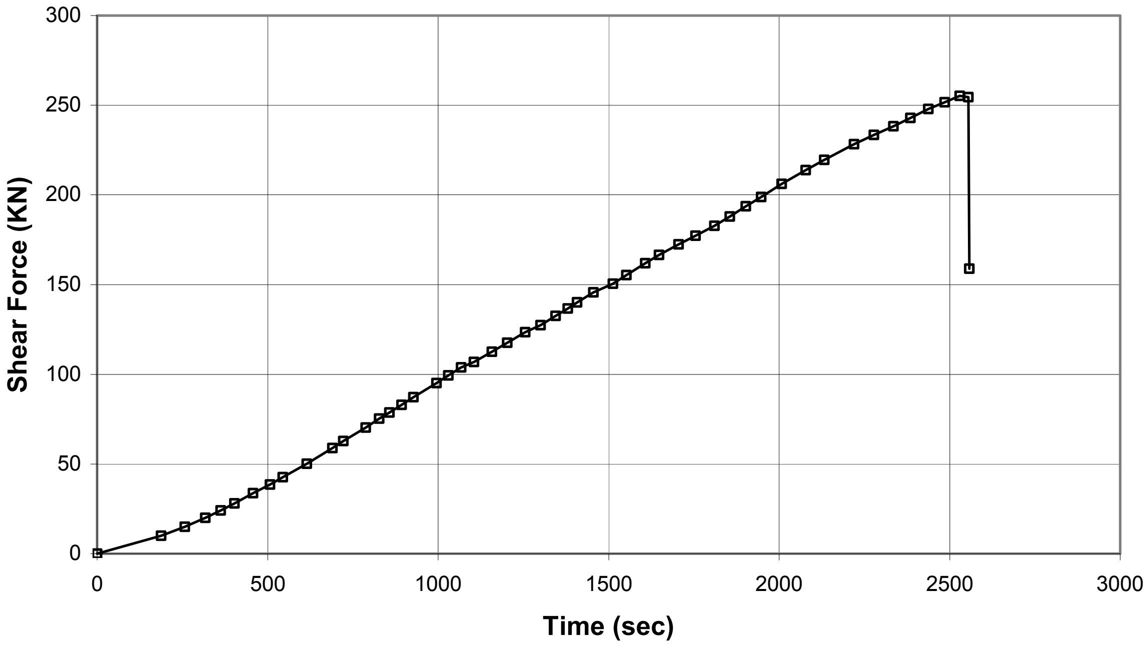
Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 1.267 MPa stirrups ϕ8 @ 210 mm

Cast: February 23, 2001
Tested: April 20, 2001
Test duration: 44 min
Test control: 0.006 mm/s



Summary of Test Observations

All the instrumentation performed correctly in this test, except the gauge on the longitudinal reinforcement, which behaved oddly for V = 205 KN. Between load stages 3 and 4 (V = 95-117 KN) the first shear cracks were observed. Stirrup 3 yielded suddenly for a shear strength V = 105 KN. The other stirrups did not reach the yield strain. The beam failed briskly for V = 255.23 KN.



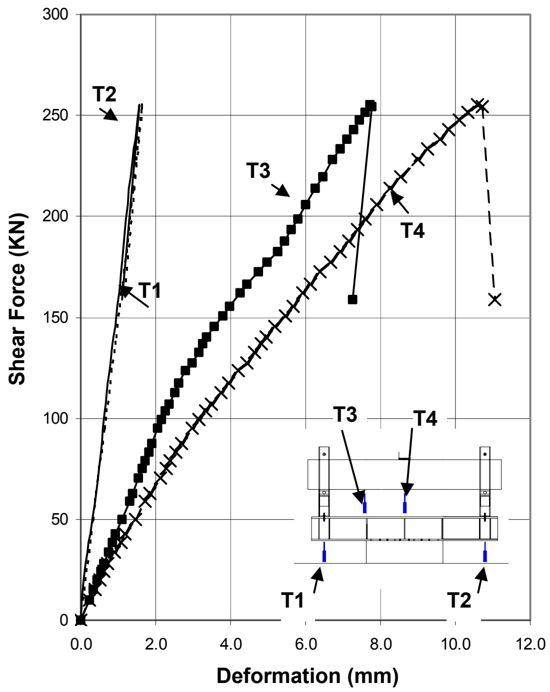
Specimen H75/4

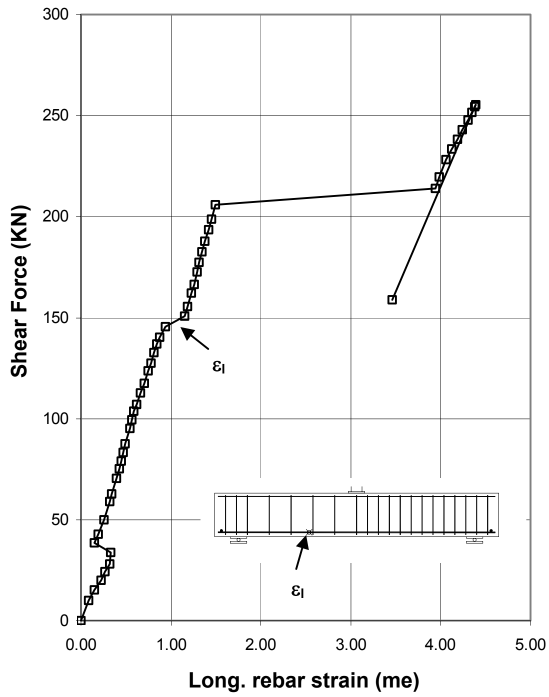
Time	Shear	Deformations				Long reinf	Transversal reinforcement				
		T1	T2	T3	T4	ε	ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}
sec	KN	mm	Mm	mm	mm	me	Me	me	me	me	me
0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
188	9.94	0.05	0.02	0.23	0.23	0.08	0.00	0.00	0.00	0.00	0.00
258	15.04	0.09	0.06	0.34	0.39	0.15	0.00	0.00	0.00	0.00	0.00
318	20.04	0.13	0.09	0.45	0.52	0.22	0.00	0.00	0.00	0.00	0.00
363	24.07	0.15	0.11	0.53	0.62	0.26	0.00	0.00	0.00	0.01	0.00
403	28.04	0.18	0.14	0.62	0.72	0.32	-0.01	0.00	0.00	0.01	0.00
458	33.73	0.22	0.18	0.74	0.90	0.33	-0.01	0.00	0.00	0.01	0.00
508	38.50	0.25	0.21	0.85	1.08	0.15	-0.01	0.00	0.01	0.01	-0.01
545	42.57	0.28	0.25	0.93	1.19	0.19	-0.01	0.00	0.00	0.01	-0.01
615	**50.14**	**0.33**	**0.31**	**1.11**	**1.46**	**0.25**	**-0.01**	**0.00**	**0.00**	**0.01**	**-0.03**
690	58.93	0.38	0.38	1.30	1.73	0.32	-0.01	0.00	0.00	-0.02	-0.04
723	**62.86**	**0.41**	**0.41**	**1.38**	**1.84**	**0.35**	**-0.02**	**0.00**	**0.00**	**-0.02**	**-0.04**
788	70.35	0.46	0.46	1.53	2.12	0.40	-0.02	0.01	0.00	-0.02	-0.05
828	75.25	0.50	0.49	1.64	2.27	0.43	-0.02	0.01	-0.01	-0.02	-0.06
858	78.79	0.52	0.51	1.72	2.39	0.45	-0.02	0.01	-0.01	-0.02	-0.07
893	83.06	0.56	0.53	1.81	2.54	0.47	-0.02	0.01	-0.01	-0.02	-0.07
928	87.31	0.59	0.56	1.90	2.70	0.50	-0.02	0.01	-0.01	-0.02	-0.08
995	**95.19**	**0.64**	**0.60**	**2.06**	**2.97**	**0.54**	**-0.02**	**0.02**	**-0.01**	**-0.02**	**-0.09**
1030	99.43	0.67	0.62	2.15	3.15	0.57	-0.02	0.02	0.00	-0.02	-0.09
1068	103.86	0.70	0.65	2.25	3.32	0.59	-0.02	0.02	0.06	-0.01	-0.10
1105	106.85	0.73	0.67	2.36	3.48	0.62	-0.02	0.03	8.39	0.06	-0.09
1158	112.67	0.76	0.70	2.50	3.75	0.66	-0.02	0.02	25.52	0.08	-0.08
1203	**117.58**	**0.79**	**0.73**	**2.63**	**3.96**	**0.70**	**-0.02**	**0.02**	**25.49**	**0.09**	**-0.07**
1255	123.54	0.83	0.77	2.79	4.20	0.74	-0.01	0.02	25.48	0.11	-0.06
1300	127.49	0.86	0.79	2.97	4.44	0.78	-0.01	0.01	25.48	0.16	-0.05
1345	132.52	0.89	0.83	3.14	4.64	0.81	-0.01	0.01	25.48	0.19	-0.05
1380	136.74	0.91	0.86	3.26	4.81	0.85	-0.01	0.01	25.48	0.22	-0.05
1408	**140.03**	**0.94**	**0.88**	**3.37**	**4.96**	**0.88**	**-0.01**	**0.01**	**25.48**	**0.24**	**-0.05**
1455	145.65	0.98	0.92	3.57	5.17	0.94	-0.02	0.02	25.47	0.28	-0.04
1513	150.50	1.01	0.95	3.79	5.47	1.15	-0.02	0.02	25.48	0.31	0.83
1553	155.30	1.04	0.98	3.98	5.66	1.19	-0.02	0.02	25.48	0.32	1.02
1608	161.92	1.09	1.02	4.25	5.91	1.23	-0.03	0.02	25.48	0.34	1.22
1648	**166.49**	**1.12**	**1.04**	**4.43**	**6.13**	**1.26**	**-0.03**	**0.02**	**25.48**	**0.37**	**1.35**
1705	172.49	1.16	1.07	4.75	6.39	1.29	-0.03	0.02	25.48	0.42	1.52
1755	177.20	1.19	1.10	4.98	6.66	1.32	-0.03	0.10	25.48	0.47	1.64
1810	182.67	1.22	1.13	5.25	6.92	1.35	-0.05	0.47	25.48	0.64	1.80
1855	187.91	1.25	1.15	5.43	7.15	1.38	-0.05	0.56	25.48	0.85	1.93
1903	193.58	1.29	1.18	5.62	7.39	1.42	-0.05	0.64	25.48	1.01	2.06
1948	198.87	1.32	1.21	5.81	7.59	1.45	-0.05	0.71	25.48	1.20	2.17
2008	206.06	1.36	1.24	6.01	7.91	1.50	-0.05	0.81	25.48	1.37	2.32
2078	213.74	1.40	1.29	6.26	8.25	3.94	-0.06	0.92	25.48	1.56	2.50
2133	219.48	1.43	1.32	6.45	8.54	3.99	-0.06	1.08	25.48	1.71	2.64
2220	228.34	1.48	1.38	6.73	8.99	4.06	-0.06	1.43	25.48	1.90	2.91
2278	233.35	1.51	1.42	6.92	9.27	4.12	-0.06	1.43	25.48	1.99	3.07
2335	238.19	1.54	1.45	7.11	9.58	4.19	-0.06	1.54	25.48	2.06	3.21
2385	242.87	1.56	1.48	7.27	9.82	4.24	-0.06	1.60	25.48	2.11	3.33
2438	247.85	1.60	1.52	7.45	10.11	4.30	-0.06	1.63	25.48	2.16	3.46
2485	251.71	1.62	1.54	7.58	10.34	4.35	-0.06	1.71	25.48	2.21	3.53
2530	**255.23**	**1.64**	**1.57**	**7.71**	**10.58**	**4.39**	**-0.06**	**1.82**	**25.48**	**2.25**	**3.60**
2555	254.49	1.64	1.57	7.76	10.73	4.38	-0.06	1.78	25.48	2.28	3.55
2558	158.80	1.15	1.10	7.26	11.04	3.46	-0.04	1.57	25.48	1.61	1.21

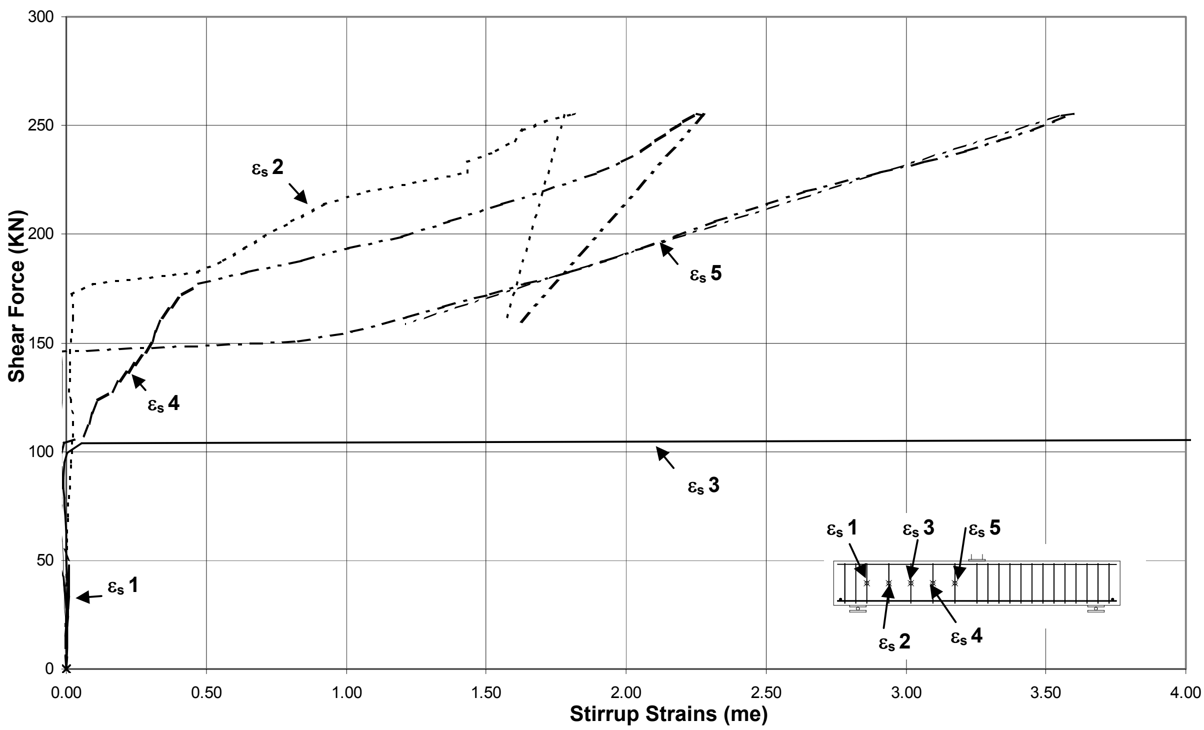
Specimen H75/4 - Continuation

Time	Shear	Concrete strains 1			Concrete strains 2		
		ε_{x1}	ε_{y1}	ε_{xy1}	ε_{x2}	ε_{y2}	ε_{xy2}
sec	KN	me	me	me	me	me	me
0	**0.00**	**0**	**0**	**0**	**0**	**0**	**0**
188	9.94	0.004845	0.00021	-0.01225	-0.004678	0.000855	0.01335
258	15.04	0.003843	-6.7E-05	-0.01709	-0.005947	0.000668	0.01852
318	20.04	0.001271	-0.00057	-0.02177	-0.007136	7.34E-05	0.02297
363	24.07	-0.00082	-0.00153	-0.028	-0.0086	-0.00028	0.02745
403	28.04	-0.00364	-0.00132	-0.0309	-0.009393	-0.00051	0.03121
458	33.73	-0.00753	-0.00214	-0.03536	-0.01051	-0.0007	0.03701
508	38.50	-0.03679	0.00731	-0.02609	-0.011966	-0.00088	0.04147
545	42.57	-0.07304	0.02735	-0.01243	-0.013967	-0.00062	0.04702
615	**50.14**	**-0.16307**	**0.10241**	**0.010398**	**-0.016313**	**-0.00056**	**0.05555**
690	58.93	-0.21573	0.16286	0.003456	-0.018527	-0.00069	0.06454
723	**62.86**	**-0.24761**	**0.18941**	**0.003625**	**-0.019352**	**-0.00078**	**0.06846**
788	70.35	-0.30871	0.24593	0.001646	-0.020443	-0.00123	0.07311
828	75.25	-0.34581	0.29113	-0.01173	-0.024845	-0.00094	0.07181
858	78.79	-0.39257	0.34776	-0.02846	-0.030846	-0.00112	0.07204
893	83.06	-0.43451	0.40403	-0.04369	-0.033944	-0.00155	0.0742
928	87.31	-0.46557	0.46394	-0.06339	-0.035679	-0.00768	0.07733
995	**95.19**	**-0.51023**	**0.60529**	**-0.09715**	**-0.037172**	**-0.02897**	**0.07943**
1030	99.43	-0.53672	0.67923	-0.11001	-0.042618	-0.03358	0.08307
1068	103.86	-0.55548	0.75933	-0.11853	-0.054237	-0.03483	0.08896
1105	106.85	-0.54208	0.86561	-0.09342	-0.083319	-0.02287	0.11089
1158	112.67	-0.52062	0.9075	-0.08668	-0.095901	-0.02129	0.12632
1203	**117.58**	**-0.5154**	**0.9326**	**-0.1022**	**-0.105314**	**-0.02384**	**0.13634**
1255	123.54	-0.51564	0.9712	-0.12823	-0.115276	-0.02508	0.1477
1300	127.49	-0.53709	1.02397	-0.1551	-0.124739	-0.0201	0.1568
1345	132.52	-0.55003	1.07038	-0.16783	-0.130765	-0.01777	0.1633
1380	136.74	-0.56046	1.11671	-0.1807	-0.136434	-0.01512	0.16837
1408	**140.03**	**-0.57102**	**1.15162**	**-0.1879**	**-0.140211**	**-0.01371**	**0.17297**
1455	145.65	-0.56584	1.19077	-0.19758	-0.14407	-0.00757	0.17618
1513	150.50	-0.38428	1.16637	-0.2262	-0.15156	0.003628	0.17676
1553	155.30	-0.37587	1.18916	-0.23398	-0.156032	0.00978	0.17969
1608	161.92	-0.36753	1.22056	-0.24269	-0.159909	0.021383	0.1803
1648	**166.49**	**-0.35542**	**1.25025**	**-0.25389**	**-0.148506**	**0.050655**	**0.16489**
1705	172.49	-0.34704	1.27537	-0.26768	-0.109503	0.156673	0.12437
1755	177.20	-0.34793	1.25997	-0.28028	0.5216654	2.746219	-0.31016
1810	182.67	-0.32777	1.1179	-0.28801	12.77359	12.76138	-0.65893
1855	187.91	-0.27908	1.08197	-0.29274	12.76372	12.75193	-0.72212
1903	193.58	-0.24685	1.07379	-0.29877	12.75788	12.74641	-0.78983
1948	198.87	-0.21068	1.0644	-0.30322	12.75469	12.74323	-0.85942
2008	206.06	-0.17473	1.06229	-0.30807	12.75225	12.74089	-0.96134
2078	213.74	-0.13909	1.06521	-0.30589	12.75066	12.73951	-1.10498
2133	219.48	-0.11704	1.06937	-0.30265	12.75013	12.73898	-1.23923
2220	228.34	-0.08903	1.07231	-0.30286	12.7497	12.73866	-1.54891
2278	233.35	-0.07147	1.07117	-0.30341	12.74949	12.73845	-1.85211
2335	238.19	-0.05866	1.07376	-0.3018	12.74854	12.73686	-12.8106
2385	242.87	-0.04626	1.07624	-0.30346	12.74854	12.73643	-12.791
2438	247.85	-0.03088	1.07868	-0.30675	12.74875	12.73611	-12.7821
2485	251.71	-0.01829	1.07989	-0.3102	12.74864	12.73558	-12.7783
2530	**255.23**	**-0.00269**	**1.08032**	**-0.32186**	**12.74875**	**12.73558**	**-12.7762**
2555	254.49	0.01864	1.07764	-0.34228	12.74864	12.73526	-12.7752
2558	158.80	0.210109	0.78116	-0.57291	12.748	12.73452	-12.7748

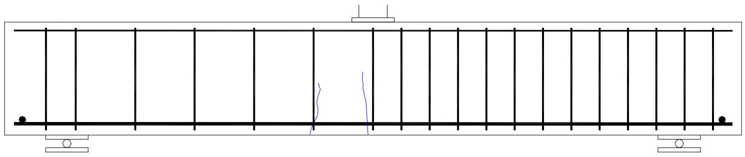
Specimen H75/4



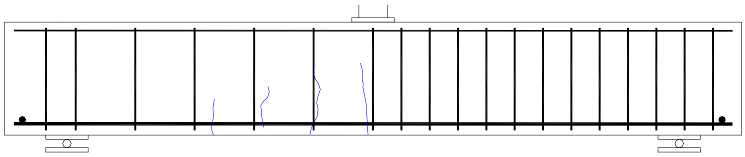




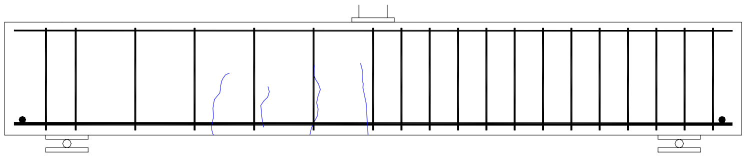
Specimen H75/4 – Cracking control



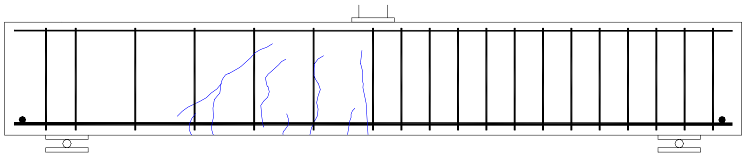
V = 50 KN



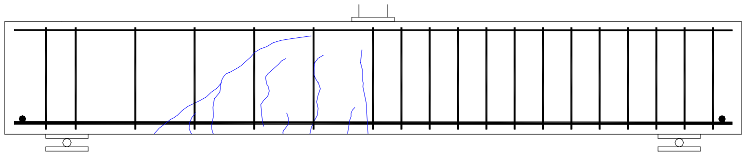
V = 83 KN



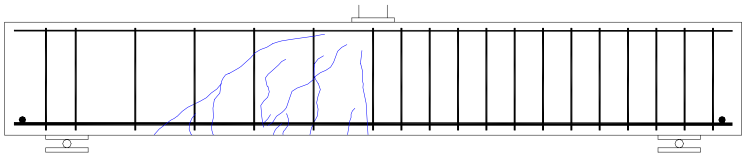
V = 95 KN



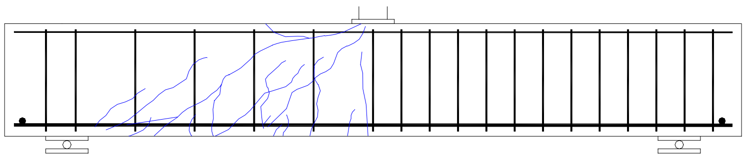
V = 117 KN



V = 140 KN



V = 167 KN



V = 255.2 KN
failure

Specimen H75/4

Test set-up for beam H75/4

Cracking at failure (V = 255.23 KN)

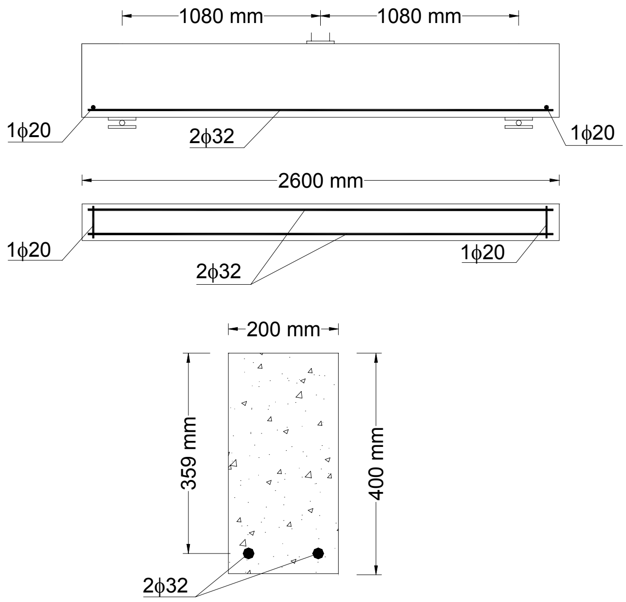
Detail of the compression flange at failure

Specimen H100/1

Concrete properties
f'_c = 87.0 MPa f_{sp} = 4.1 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 ϕ32 bars in one layer

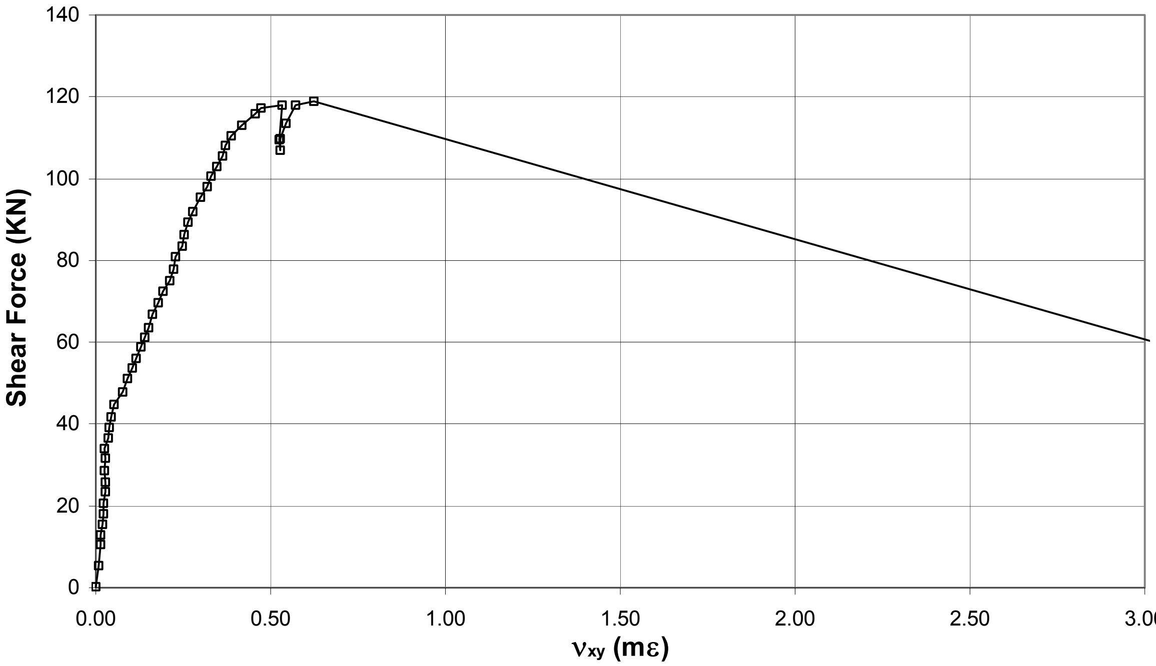
Transversal reinforcement
None



Cast: Jan 11, 2002
Tested: Apr 9, 2002
Test duration: 50 min
Test control: 0.003 mm/s

Summary of Test Observations

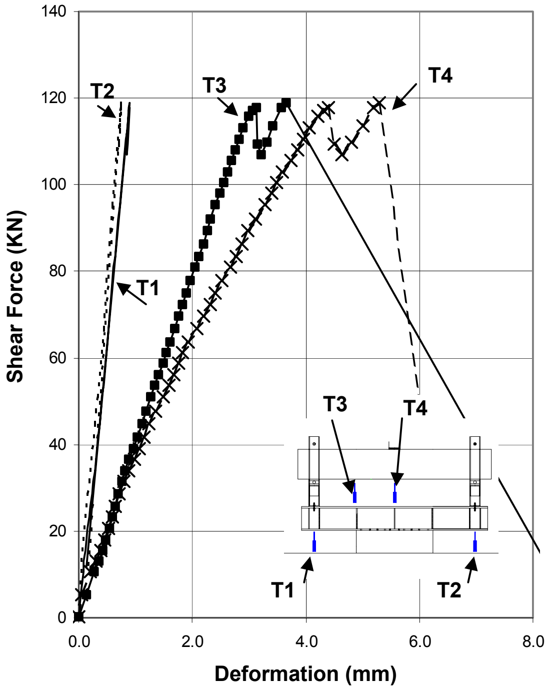
Beam specimen H100/1 did not contain shear reinforcement. For personal safety reasons, as a fragile failure was expected, the crack control was not carried out. At the formation of a first shear crack on the right side, the beam loosed load, although as it can be seen in the shear strain graph, it took it again until the collapse. In §4.3 it is explained this behaviour. It has been considered that the collapse happened at the first peak for V =117.85 KN. The collapse was the most fragile observed.

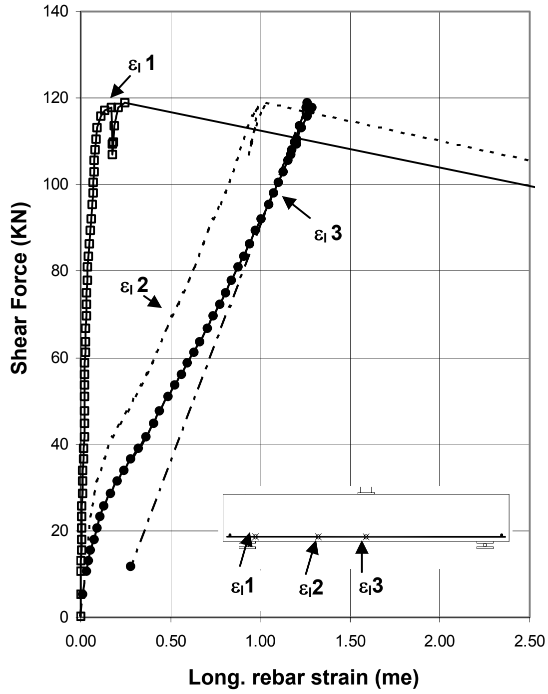


Specimen H100/1

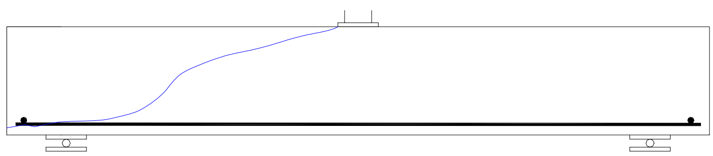
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-0.08**	**0.00**
552	5.31	0.01	0.02	0.03	0.13	0.06	0.01	0.00	0.00	0.01	0.01
778	10.54	0.01	0.04	0.08	0.27	0.21	0.01	0.00	0.00	0.03	0.03
854	13.00	0.01	0.06	0.09	0.35	0.30	0.01	0.00	0.00	0.03	0.04
926	15.52	0.02	0.07	0.11	0.41	0.38	0.01	0.00	0.00	0.04	0.05
990	18.05	0.02	0.09	0.14	0.48	0.46	0.01	0.00	0.00	0.04	0.07
1050	20.66	0.02	0.10	0.16	0.54	0.52	0.01	0.00	0.00	0.05	0.09
1106	23.34	0.03	0.12	0.18	0.59	0.58	0.01	0.00	0.00	0.05	0.11
1154	25.81	0.03	0.14	0.20	0.65	0.64	0.01	0.00	0.01	0.06	0.13
1206	28.61	0.02	0.16	0.23	0.69	0.71	0.01	0.00	0.01	0.08	0.16
1256	31.61	0.03	0.18	0.26	0.76	0.79	0.02	0.00	0.01	0.09	0.20
1298	34.03	0.03	0.20	0.28	0.82	0.88	0.02	0.00	0.01	0.11	0.24
1344	36.57	0.04	0.22	0.30	0.89	0.98	0.02	0.00	0.01	0.13	0.28
1388	39.05	0.04	0.24	0.33	0.96	1.06	0.02	0.00	0.02	0.15	0.32
1438	41.79	0.04	0.27	0.35	1.04	1.14	0.02	0.00	0.02	0.18	0.36
1494	44.86	0.05	0.28	0.37	1.12	1.24	0.03	0.00	0.02	0.22	0.41
1542	47.78	0.08	0.31	0.39	1.19	1.35	0.04	0.00	0.02	0.26	0.44
1596	51.06	0.09	0.33	0.41	1.27	1.49	0.04	0.00	0.02	0.31	0.49
1638	53.61	0.11	0.35	0.43	1.33	1.59	0.05	0.00	0.02	0.34	0.52
1678	56.16	0.11	0.37	0.45	1.40	1.67	0.05	0.00	0.02	0.37	0.56
1720	58.76	0.13	0.39	0.47	1.48	1.76	0.06	0.00	0.02	0.40	0.60
1760	61.19	0.14	0.40	0.48	1.54	1.83	0.06	0.01	0.03	0.42	0.63
1802	63.65	0.15	0.42	0.50	1.61	1.93	0.07	0.01	0.03	0.45	0.66
1852	66.88	0.16	0.43	0.52	1.69	2.09	0.07	0.00	0.03	0.48	0.70
1896	69.59	0.18	0.45	0.54	1.75	2.20	0.08	0.00	0.03	0.51	0.74
1948	72.44	0.19	0.47	0.56	1.83	2.31	0.09	0.00	0.03	0.55	0.78
1986	75.02	0.21	0.48	0.57	1.89	2.40	0.09	0.00	0.03	0.57	0.81
2028	77.77	0.22	0.50	0.59	1.96	2.52	0.10	0.00	0.04	0.60	0.84
2074	80.88	0.23	0.52	0.61	2.05	2.67	0.10	0.01	0.04	0.63	0.88
2112	83.51	0.25	0.53	0.64	2.11	2.77	0.11	0.00	0.04	0.66	0.91
2158	86.40	0.25	0.54	0.65	2.19	2.88	0.11	0.00	0.05	0.68	0.94
2200	89.32	0.26	0.57	0.67	2.26	2.98	0.12	0.00	0.05	0.71	0.97
2240	92.03	0.28	0.58	0.69	2.32	3.11	0.12	0.00	0.06	0.74	1.01
2290	95.40	0.30	0.59	0.72	2.40	3.28	0.13	0.00	0.06	0.78	1.04
2340	98.14	0.32	0.61	0.74	2.48	3.40	0.14	0.00	0.07	0.81	1.07
2376	100.52	0.33	0.63	0.76	2.55	3.48	0.14	0.00	0.07	0.83	1.10
2414	102.97	0.35	0.64	0.78	2.62	3.59	0.15	0.00	0.07	0.85	1.13
2454	105.54	0.36	0.66	0.80	2.69	3.73	0.16	0.00	0.08	0.87	1.15
2494	108.00	0.37	0.67	0.82	2.76	3.86	0.16	0.00	0.08	0.89	1.18
2536	110.49	0.39	0.69	0.83	2.83	3.96	0.17	0.00	0.09	0.91	1.20
2578	113.06	0.42	0.71	0.85	2.89	4.06	0.18	0.00	0.09	0.93	1.23
2628	115.83	0.46	0.72	0.87	2.99	4.20	0.20	0.00	0.11	0.96	1.26
2658	117.21	0.47	0.73	0.88	3.05	4.31	0.20	0.00	0.13	0.97	1.28
2686	**117.85**	**0.53**	**0.74**	**0.89**	**3.13**	**4.40**	**0.23**	**0.00**	**0.17**	**0.99**	**1.29**
2708	109.46	0.53	0.71	0.86	3.15	4.51	0.23	0.00	0.18	0.95	1.20
2746	106.91	0.53	0.70	0.84	3.22	4.63	0.23	0.00	0.18	0.94	1.17
2804	109.85	0.53	0.71	0.85	3.32	4.81	0.23	0.00	0.18	0.95	1.19
2870	113.56	0.54	0.73	0.86	3.42	5.00	0.23	0.00	0.19	0.98	1.22
2954	117.90	0.57	0.74	0.89	3.56	5.19	0.25	0.00	0.21	1.01	1.25
2996	**118.87**	**0.62**	**0.75**	**0.90**	**3.65**	**5.30**	**0.27**	**0.00**	**0.25**	**1.03**	**1.26**
3002	11.84	5.00	0.18	0.13	8.28	6.39	66.35	1.93	12.80	12.83	0.28

Specimen H100/1

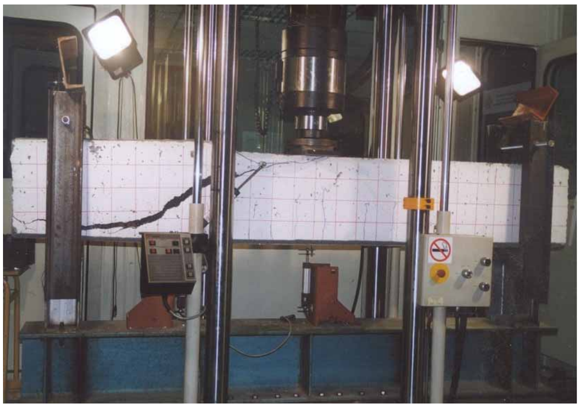




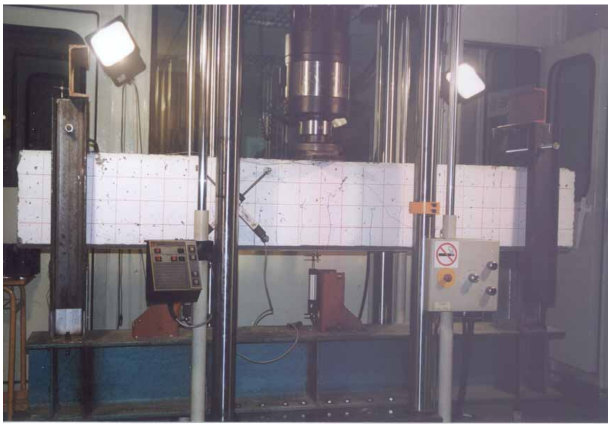
Specimen H100/1 – Cracking control



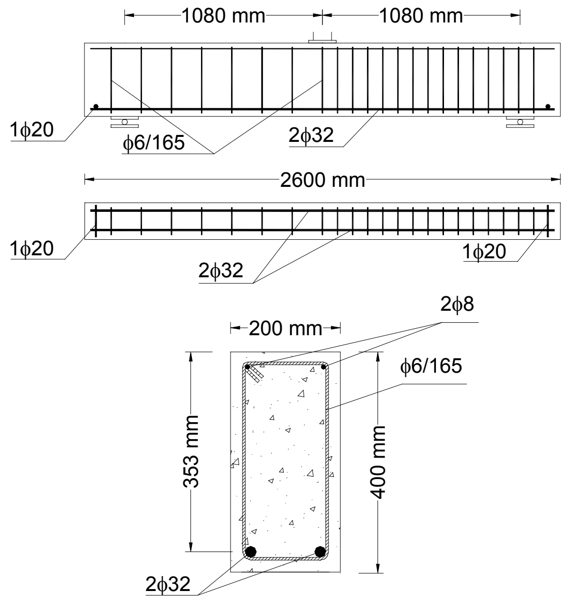
V = 118 KN
(failure)


Test set-up and cracking for beam H100/1


Crack surface at failure


Shear cracking on the right side before failure

Specimen H100/2



Concrete properties
f'_c = 87.0 MPa f_{sp} = 4.1 MPa

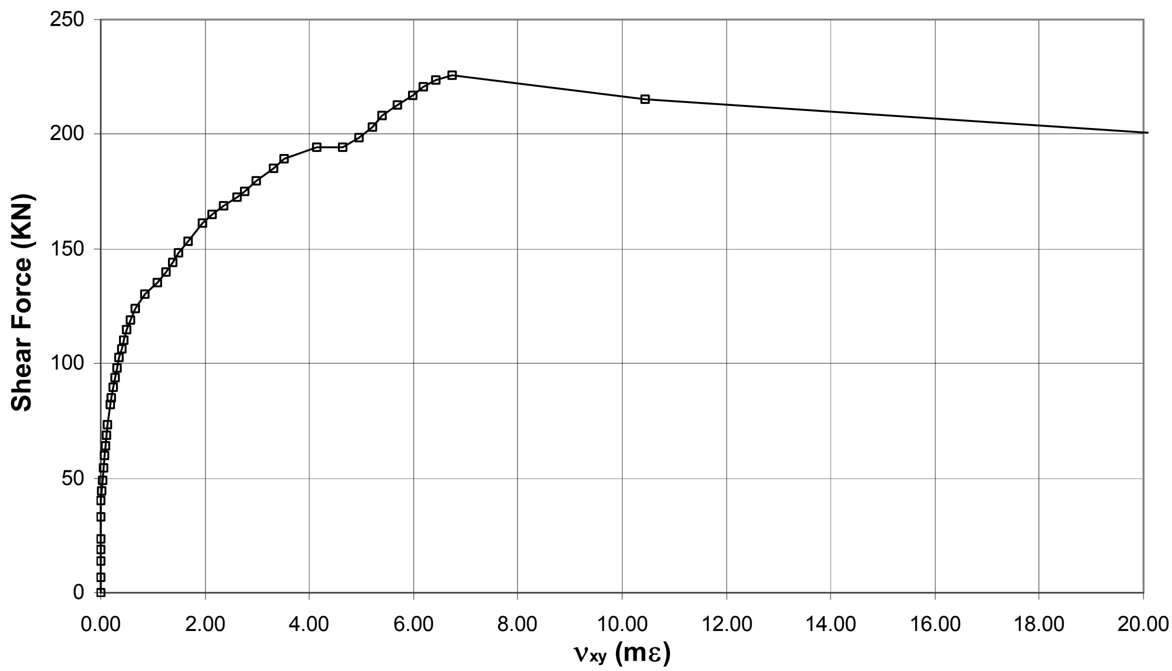
Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.28%   2 φ32 bars in one layer

Transversal reinforcement
B-500-S f_y = 530 MPa
ρ_w = 0.906 MPa stirrups φ6 @ 165 mm

Cast: Jan 11, 2002
Tested: Apr 10, 2002
Test duration: 47 min
Test control: 0.005 mm/s

Summary of Test Observations

Beam specimen H100/2 contained the minimum amount of web reinforcement proposed in this document for a 100 MPa concrete. The first flexural crack was noticed for V = 40 KN. At load stage 4 (V = 110 KN), a shear crack was reported. Strain of the stirrup flattened suddenly for V = 130 KN. The beam specimen failed at a shear strength of 225.55 KN. The longitudinal reinforcement did not reach the yielding strain.



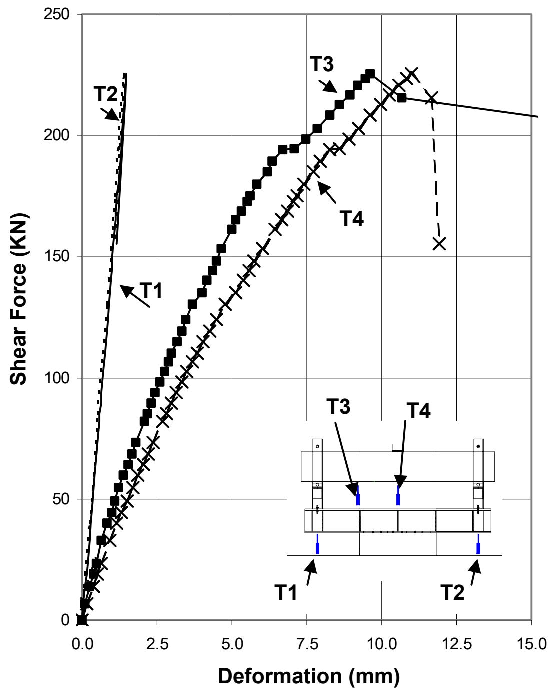
Specimen H100/2

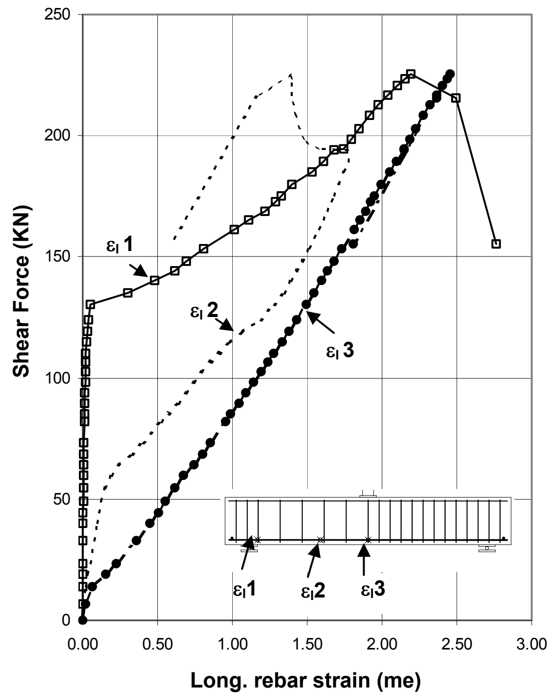
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.11**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
60	6.56	0.00	0.03	0.04	0.10	0.17	0.00	0.00	0.00	0.01	0.02
165	14.01	0.01	0.07	0.10	0.26	0.39	0.00	0.00	0.00	0.02	0.06
225	18.88	0.00	0.10	0.15	0.38	0.53	0.00	0.00	0.00	0.03	0.15
276	23.55	0.00	0.14	0.18	0.49	0.65	0.00	0.00	0.00	0.05	0.22
369	32.91	0.01	0.21	0.26	0.65	0.94	0.01	0.00	0.00	0.08	0.36
441	**40.02**	**0.01**	**0.26**	**0.30**	**0.84**	**1.17**	**0.01**	**0.00**	**0.00**	**0.10**	**0.45**
489	44.54	0.02	0.30	0.33	0.98	1.33	0.01	0.00	0.00	0.11	0.50
534	49.09	0.04	0.32	0.36	1.10	1.50	0.02	0.00	0.00	0.12	0.55
588	54.57	0.06	0.36	0.39	1.22	1.69	0.03	0.00	0.01	0.15	0.61
639	**59.98**	**0.08**	**0.39**	**0.43**	**1.37**	**1.87**	**0.03**	**0.00**	**0.01**	**0.19**	**0.67**
684	64.23	0.09	0.42	0.45	1.54	2.06	0.04	0.00	0.01	0.25	0.74
726	68.62	0.11	0.44	0.48	1.66	2.21	0.05	0.00	0.01	0.33	0.80
771	73.32	0.14	0.47	0.51	1.78	2.37	0.06	0.00	0.01	0.40	0.85
855	82.02	0.18	0.52	0.57	2.09	2.71	0.08	0.00	0.01	0.52	0.95
885	**85.09**	**0.21**	**0.53**	**0.59**	**2.19**	**2.82**	**0.09**	**0.00**	**0.01**	**0.57**	**0.99**
930	89.61	0.25	0.56	0.63	2.32	2.98	0.10	0.00	0.01	0.64	1.04
969	93.73	0.27	0.59	0.66	2.44	3.15	0.11	0.00	0.02	0.69	1.09
1011	98.14	0.31	0.61	0.69	2.61	3.32	0.13	0.00	0.02	0.74	1.14
1056	102.51	0.36	0.64	0.72	2.76	3.49	0.15	0.00	0.02	0.79	1.19
1101	106.47	0.41	0.67	0.75	2.89	3.69	0.17	0.00	0.02	0.86	1.24
1137	**109.96**	**0.44**	**0.69**	**0.78**	**2.99**	**3.85**	**0.19**	**0.00**	**0.02**	**0.91**	**1.28**
1188	114.83	0.50	0.73	0.81	3.17	4.05	0.21	0.00	0.03	0.99	1.33
1233	119.11	0.57	0.76	0.83	3.33	4.25	0.24	0.00	0.03	1.07	1.38
1287	124.11	0.67	0.80	0.87	3.48	4.49	0.28	0.00	0.04	1.19	1.43
1356	**130.21**	**0.84**	**0.84**	**0.90**	**3.70**	**4.79**	**0.33**	**-0.02**	**0.05**	**1.28**	**1.49**
1431	135.08	1.09	0.87	0.93	4.01	5.14	0.42	-0.04	0.30	1.35	1.54
1485	**140.06**	**1.25**	**0.90**	**0.96**	**4.18**	**5.38**	**0.49**	**-0.04**	**0.48**	**1.39**	**1.59**
1530	144.17	1.39	0.93	0.99	4.35	5.59	0.55	-0.04	0.62	1.43	1.64
1572	148.10	1.49	0.95	1.01	4.48	5.75	0.59	-0.05	0.69	1.47	1.68
1632	153.17	1.68	0.98	1.04	4.64	6.03	0.65	-0.06	0.81	1.52	1.73
1728	161.21	1.95	1.02	1.08	4.99	6.43	0.76	-0.06	1.01	1.58	1.81
1776	**165.12**	**2.13**	**1.04**	**1.11**	**5.14**	**6.65**	**0.84**	**-0.07**	**1.11**	**1.61**	**1.85**
1824	168.85	2.36	1.06	1.13	5.31	6.85	0.94	-0.06	1.22	1.64	1.89
1869	172.56	2.62	1.08	1.15	5.51	7.04	1.05	-0.06	1.29	1.66	1.92
1899	**175.16**	**2.77**	**1.09**	**1.17**	**5.61**	**7.18**	**1.11**	**-0.06**	**1.33**	**1.68**	**1.95**
1953	179.85	2.98	1.11	1.20	5.83	7.41	1.20	-0.06	1.40	1.71	1.99
2025	185.16	3.31	1.14	1.24	6.17	7.73	1.34	-0.06	1.54	1.74	2.05
2076	189.47	3.52	1.17	1.27	6.35	7.95	1.43	-0.06	1.61	1.78	2.10
2145	194.31	4.14	1.19	1.30	6.70	8.28	1.63	-0.12	1.68	1.77	2.15
2205	194.40	4.65	1.21	1.31	7.08	8.58	1.93	-0.04	1.75	1.58	2.15
2268	198.51	4.95	1.22	1.33	7.46	8.92	2.20	0.10	1.79	1.48	2.18
2331	203.00	5.22	1.25	1.35	7.86	9.22	2.38	0.17	1.85	1.45	2.23
2406	208.28	5.40	1.29	1.39	8.26	9.61	2.54	0.25	1.91	1.43	2.28
2472	212.89	5.69	1.32	1.41	8.58	9.95	2.73	0.31	1.98	1.41	2.32
2532	216.85	5.98	1.34	1.43	8.93	10.25	2.90	0.36	2.04	1.40	2.36
2592	220.64	6.18	1.37	1.45	9.18	10.56	3.03	0.41	2.10	1.40	2.40
2646	223.58	6.42	1.39	1.47	9.46	10.83	3.15	0.43	2.15	1.39	2.43
2682	**225.55**	**6.75**	**1.40**	**1.48**	**9.62**	**11.00**	**3.29**	**0.42**	**2.19**	**1.39**	**2.45**
2811	215.35	10.45	1.37	1.44	10.67	11.68	4.55	0.12	2.49	1.16	2.36
2814	155.24	50.00	1.09	1.15	45.81	11.92	3.63	77.32	2.76	0.59	1.81

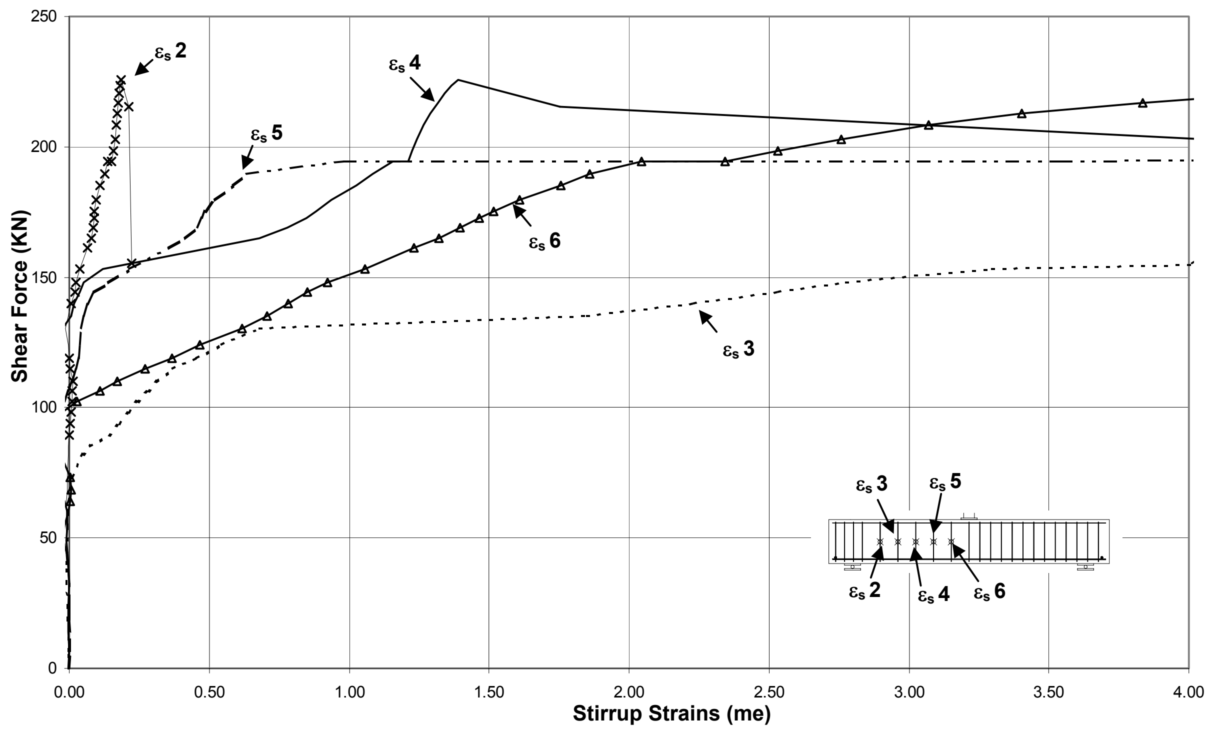
Specimen H100/2 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains				
			ε_{s2}	ε_{s3}	ε_{s4}	ε_{s5}	ε_{s6}
sec	KN	me	me	me	me	me	me
0	**0.11**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-0.05**
60	6.56	0.00	0.00	0.00	0.00	0.00	-0.05
165	14.01	0.01	0.00	0.00	0.00	0.00	-0.06
225	18.88	0.00	0.00	-0.01	0.00	0.00	-0.06
276	23.55	0.00	0.00	-0.01	0.00	0.00	-0.07
369	32.91	0.01	0.00	-0.01	0.00	0.00	-0.06
441	**40.02**	**0.01**	**-0.01**	**-0.01**	**0.00**	**-0.01**	**-0.04**
489	44.54	0.02	-0.01	-0.01	-0.01	-0.01	-0.03
534	49.09	0.04	-0.01	-0.01	-0.01	-0.02	-0.02
588	54.57	0.06	-0.01	-0.01	-0.01	-0.03	-0.02
639	**59.98**	**0.08**	**-0.01**	**0.00**	**-0.01**	**-0.04**	**0.00**
684	64.23	0.09	-0.01	0.00	-0.02	-0.04	0.00
726	68.62	0.11	-0.01	0.00	-0.03	-0.04	0.01
771	73.32	0.14	-0.01	0.01	-0.04	-0.05	0.00
855	82.02	0.18	0.00	0.05	-0.05	-0.05	-0.03
885	**85.09**	**0.21**	**0.00**	**0.08**	**-0.05**	**-0.04**	**-0.03**
930	89.61	0.25	0.00	0.14	-0.06	-0.04	-0.04
969	93.73	0.27	0.00	0.18	-0.06	-0.03	-0.03
1011	98.14	0.31	0.01	0.21	-0.06	-0.03	-0.02
1056	102.51	0.36	0.01	0.24	-0.06	-0.02	0.03
1101	106.47	0.41	0.01	0.28	-0.06	0.00	0.11
1137	**109.96**	**0.44**	**0.01**	**0.32**	**-0.06**	**0.01**	**0.17**
1188	114.83	0.50	0.00	0.37	-0.06	0.02	0.27
1233	119.11	0.57	0.00	0.46	-0.04	0.03	0.37
1287	124.11	0.67	0.00	0.55	-0.04	0.04	0.47
1356	**130.21**	**0.84**	**-0.01**	**0.68**	**-0.02**	**0.04**	**0.62**
1431	135.08	1.09	0.00	1.85	0.01	0.05	0.71
1485	**140.06**	**1.25**	**0.01**	**2.23**	**0.02**	**0.07**	**0.78**
1530	144.17	1.39	0.02	2.53	0.04	0.09	0.85
1572	148.10	1.49	0.03	2.77	0.05	0.14	0.92
1632	153.17	1.68	0.04	3.30	0.12	0.22	1.06
1728	161.21	1.95	0.07	7.33	0.51	0.36	1.23
1776	**165.12**	**2.13**	**0.08**	**10.53**	**0.68**	**0.41**	**1.32**
1824	168.85	2.36	0.09	12.74	0.78	0.46	1.39
1869	172.56	2.62	0.09	12.77	0.85	0.47	1.46
1899	**175.16**	**2.77**	**0.09**	**12.77**	**0.88**	**0.49**	**1.52**
1953	179.85	2.98	0.09	12.76	0.94	0.52	1.61
2025	185.16	3.31	0.11	12.76	1.03	0.59	1.76
2076	189.47	3.52	0.13	12.76	1.08	0.63	1.86
2145	194.31	4.14	0.14	12.76	1.16	0.98	2.05
2205	194.40	4.65	0.15	12.76	1.21	3.54	2.34
2268	198.51	4.95	0.16	12.76	1.23	8.56	2.53
2331	203.00	5.22	0.16	12.76	1.24	12.76	2.76
2406	208.28	5.40	0.17	12.76	1.27	12.76	3.07
2472	212.89	5.69	0.17	12.76	1.29	12.75	3.40
2532	216.85	5.98	0.18	12.76	1.32	12.75	3.83
2592	220.64	6.18	0.18	12.76	1.34	12.75	4.30
2646	223.58	6.42	0.18	12.76	1.37	12.75	4.70
2682	**225.55**	**6.75**	**0.19**	**12.76**	**1.39**	**12.75**	**4.99**
2811	215.35	10.45	0.21	12.76	1.75	12.75	4.95
2814	155.24	50.00	0.22	12.75	12.82	12.74	3.58

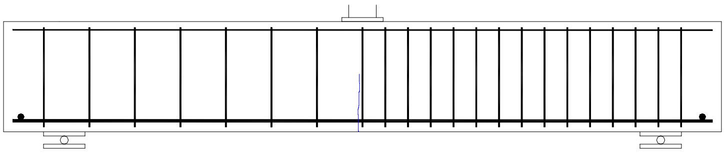
Specimen H100/2



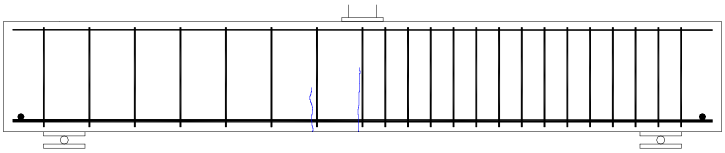




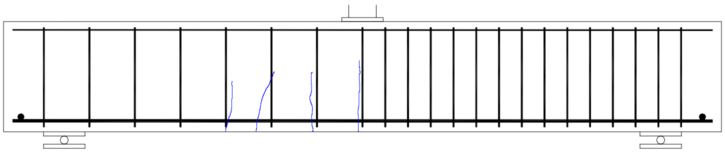
Specimen H100/2 – Cracking control



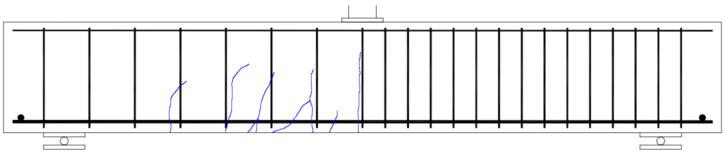
V = 40 KN



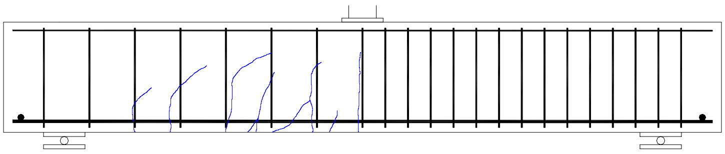
V = 60 KN



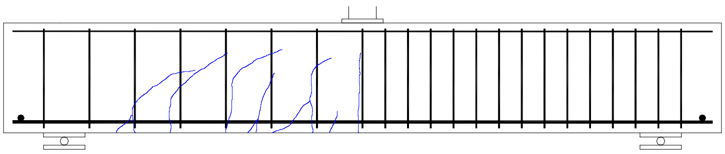
V = 85 KN



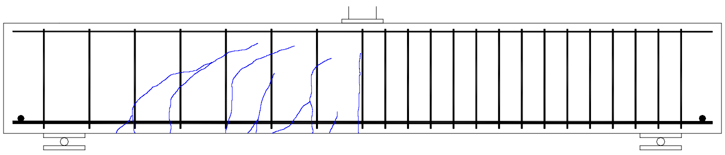
V = 110 KN



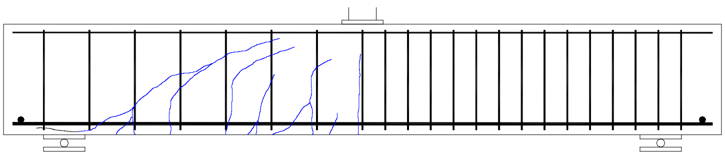
V = 130 KN



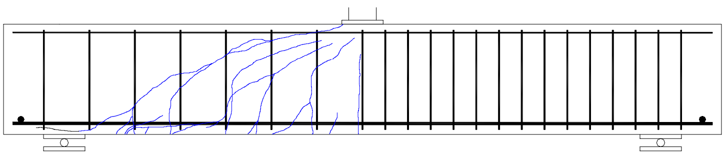
V = 140 KN



V = 165 KN

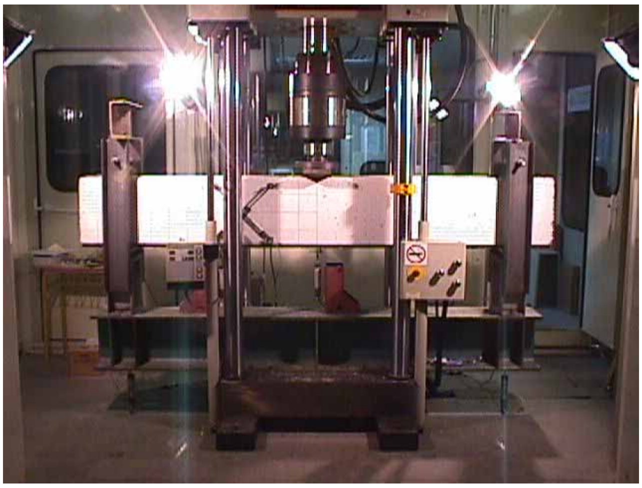


V = 175 KN

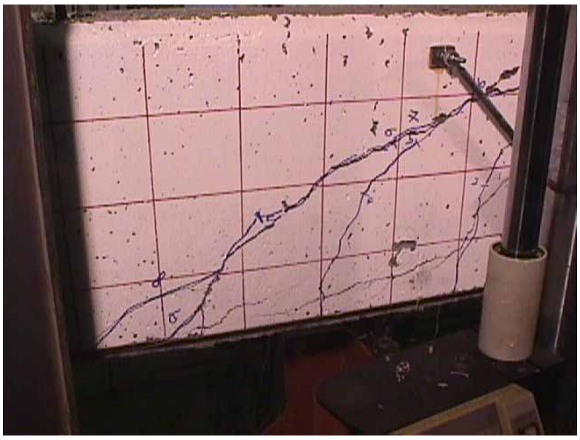


V = 225.5 KN
failure

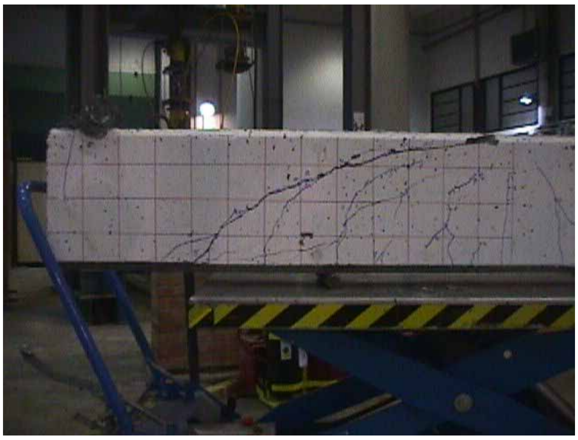
Specimen H100/2



Test set-up for beam 100/2

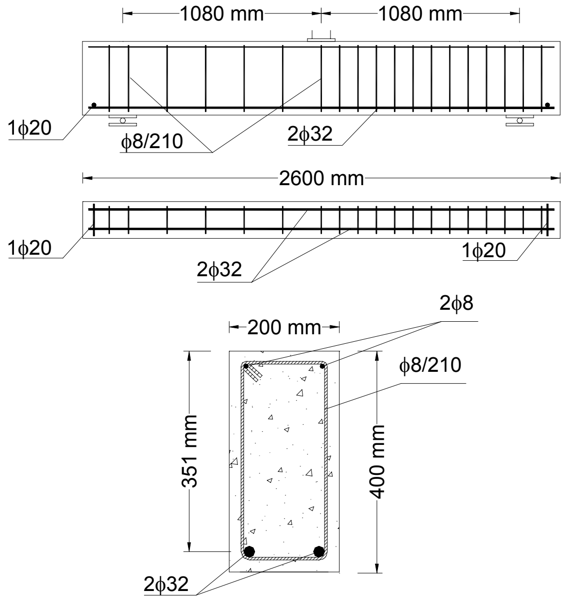


Detail of the web cracking at failure



Cracking at failure (V = 225.55 KN)

Specimen H100/3



Concrete properties
f'_c = 87.0 MPa f_{sp} = 4.1 MPa

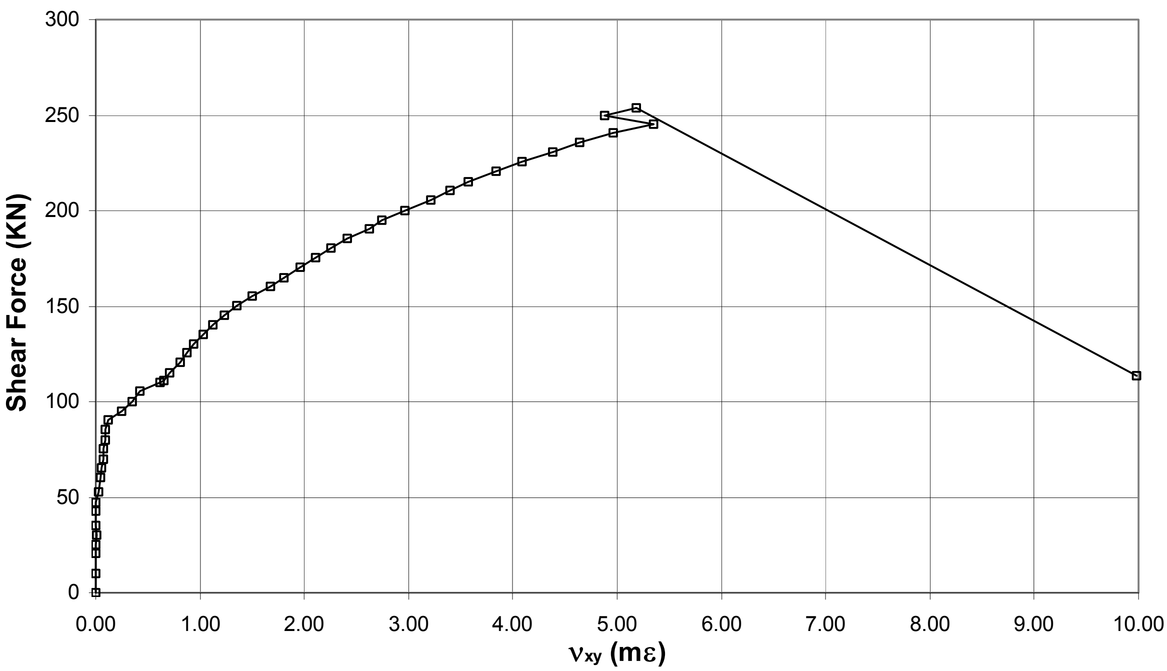
Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.29%   2 φ32 bars in one layer

Transversal reinforcement
B-500-S f_y = 540 MPa
ρ_w = 1.291 MPa stirrups φ8 @ 210 mm

Cast: Jan 11, 2002
Tested: Apr 11, 2002
Test duration: 51 min
Test control: 0.006 mm/s

Summary of Test Observations

Transducer T5 had to be readjusted at the beginning of the test before flexural cracking. First flexural crack was noticed for a shear force V = 42 KN, although it had happened earlier. The first shear crack was reported at V = 110 KN, when stirrups 1, 2 and 4 started working. Stirrup 3 had started for V = 85 KN. The longitudinal reinforcement at mid span yielded for V = 230 KN. The specimen failed when the shear force equalled 253.64 KN.



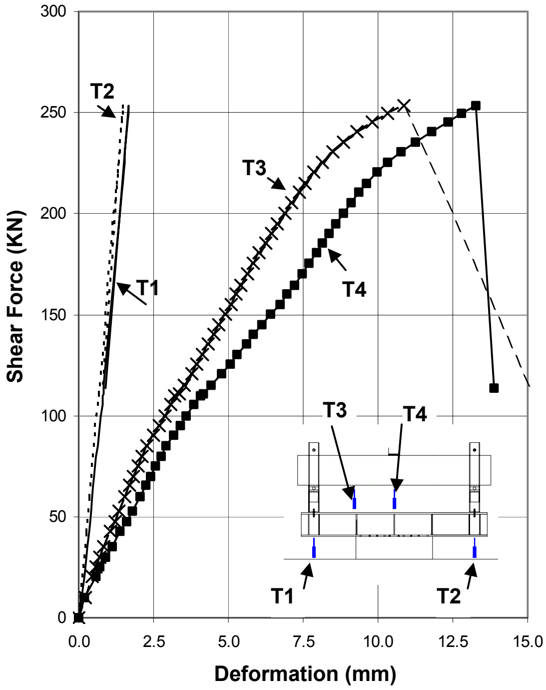
Specimen H100/3

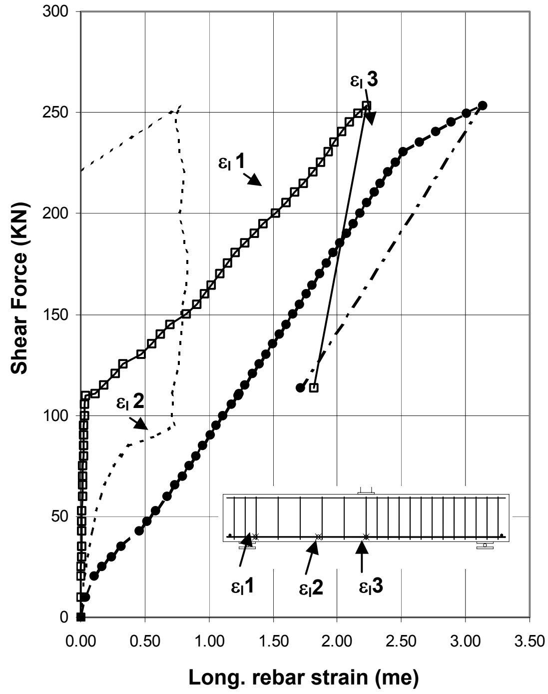
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
148	10.06	0.00	0.06	0.09	0.18	0.22	0.00	0.00	0.00	0.01	0.04
284	20.62	0.00	0.13	0.18	0.56	0.45	0.00	0.00	0.00	0.03	0.11
336	25.01	0.00	0.16	0.22	0.71	0.58	0.00	0.00	0.00	0.04	0.16
392	30.04	0.01	0.19	0.25	0.89	0.71	0.00	0.00	0.00	0.05	0.24
448	35.19	0.00	0.22	0.29	1.11	0.83	0.00	0.00	0.01	0.07	0.32
532	**42.70**	**0.00**	**0.26**	**0.34**	**1.38**	**1.07**	**0.00**	**0.00**	**0.01**	**0.09**	**0.46**
580	47.39	0.00	0.29	0.37	1.59	1.21	0.00	0.00	0.01	0.10	0.52
636	52.67	0.03	0.33	0.41	1.78	1.36	0.01	0.00	0.01	0.12	0.58
708	**60.07**	**0.04**	**0.36**	**0.45**	**2.04**	**1.55**	**0.02**	**0.00**	**0.01**	**0.16**	**0.67**
760	65.40	0.05	0.39	0.49	2.25	1.71	0.02	0.00	0.01	0.19	0.74
804	70.05	0.07	0.42	0.52	2.39	1.84	0.03	0.00	0.02	0.22	0.79
852	75.34	0.07	0.44	0.56	2.56	1.97	0.03	0.00	0.02	0.25	0.85
896	80.02	0.09	0.47	0.59	2.76	2.12	0.04	0.00	0.02	0.32	0.90
944	**85.24**	**0.09**	**0.50**	**0.63**	**2.93**	**2.29**	**0.04**	**0.00**	**0.02**	**0.38**	**0.95**
1000	90.49	0.12	0.53	0.67	3.16	2.49	0.06	0.01	0.02	0.60	1.01
1052	95.07	0.24	0.56	0.71	3.41	2.69	0.10	0.00	0.03	0.73	1.05
1100	99.83	0.35	0.59	0.74	3.59	2.89	0.15	0.00	0.03	0.71	1.11
1152	105.40	0.43	0.63	0.79	3.85	3.06	0.19	0.00	0.03	0.72	1.18
1200	**109.99**	**0.62**	**0.66**	**0.81**	**4.06**	**3.22**	**0.27**	**0.00**	**0.04**	**0.72**	**1.22**
1224	110.86	0.65	0.67	0.82	4.16	3.36	0.28	0.00	0.11	0.71	1.24
1268	115.17	0.71	0.70	0.84	4.41	3.53	0.31	0.00	0.18	0.73	1.28
1344	120.73	0.81	0.74	0.88	4.78	3.78	0.34	0.00	0.27	0.75	1.34
1388	125.42	0.87	0.77	0.91	5.06	3.95	0.37	0.00	0.33	0.76	1.39
1436	**130.16**	**0.94**	**0.80**	**0.94**	**5.28**	**4.13**	**0.40**	**0.00**	**0.47**	**0.77**	**1.44**
1488	135.38	1.03	0.83	0.96	5.60	4.31	0.44	0.00	0.55	0.78	1.50
1536	140.27	1.12	0.86	0.99	5.83	4.51	0.48	0.00	0.62	0.79	1.55
1584	145.03	1.23	0.88	1.02	6.13	4.69	0.53	0.00	0.70	0.79	1.60
1644	**150.26**	**1.35**	**0.91**	**1.05**	**6.42**	**4.90**	**0.58**	**0.01**	**0.82**	**0.79**	**1.65**
1696	155.19	1.50	0.93	1.09	6.73	5.10	0.65	0.01	0.91	0.79	1.71
1748	160.11	1.68	0.95	1.12	6.96	5.27	0.72	0.01	0.97	0.81	1.76
1796	164.71	1.81	0.98	1.15	7.21	5.42	0.78	0.01	1.02	0.82	1.80
1852	170.31	1.97	1.00	1.19	7.46	5.64	0.85	0.01	1.08	0.83	1.86
1904	175.33	2.11	1.03	1.23	7.70	5.84	0.92	0.02	1.14	0.83	1.91
1956	180.47	2.26	1.06	1.26	7.94	6.02	0.98	0.03	1.21	0.83	1.97
2008	185.37	2.41	1.08	1.30	8.13	6.24	1.06	0.04	1.28	0.81	2.02
2060	190.20	2.63	1.11	1.32	8.38	6.44	1.14	0.03	1.35	0.80	2.07
2112	**194.92**	**2.74**	**1.14**	**1.36**	**8.58**	**6.64**	**1.23**	**0.06**	**1.42**	**0.78**	**2.12**
2172	200.13	2.97	1.17	1.39	8.85	6.90	1.35	0.09	1.52	0.77	2.18
2232	205.47	3.21	1.20	1.42	9.12	7.13	1.46	0.10	1.60	0.78	2.23
2288	210.53	3.40	1.24	1.45	9.36	7.37	1.56	0.12	1.67	0.79	2.28
2340	215.03	3.57	1.27	1.47	9.63	7.57	1.66	0.14	1.73	0.80	2.33
2408	220.65	3.84	1.30	1.50	9.96	7.86	1.80	0.17	1.81	0.81	2.39
2476	225.54	4.09	1.33	1.53	10.33	8.14	1.94	0.21	1.87	0.80	2.45
2548	230.59	4.38	1.36	1.55	10.78	8.50	2.13	0.27	1.93	0.77	2.51
2620	235.50	4.64	1.39	1.58	11.25	8.85	2.31	0.34	1.97	0.76	2.64
2708	240.50	4.97	1.42	1.61	11.80	9.30	2.54	0.43	2.03	0.75	2.76
2800	245.33	5.35	1.44	1.64	12.33	9.81	2.81	0.54	2.10	0.74	2.89
2892	249.71	4.88	1.47	1.66	12.80	10.32	2.72	0.65	2.16	0.75	3.01
2988	**253.64**	**5.19**	**1.49**	**1.68**	**13.26**	**10.86**	**2.99**	**0.79**	**2.23**	**0.77**	**3.13**
2996	113.60	9.98	0.82	0.91	13.88	15.09	2.87	-1.37	1.82	-2.64	1.71

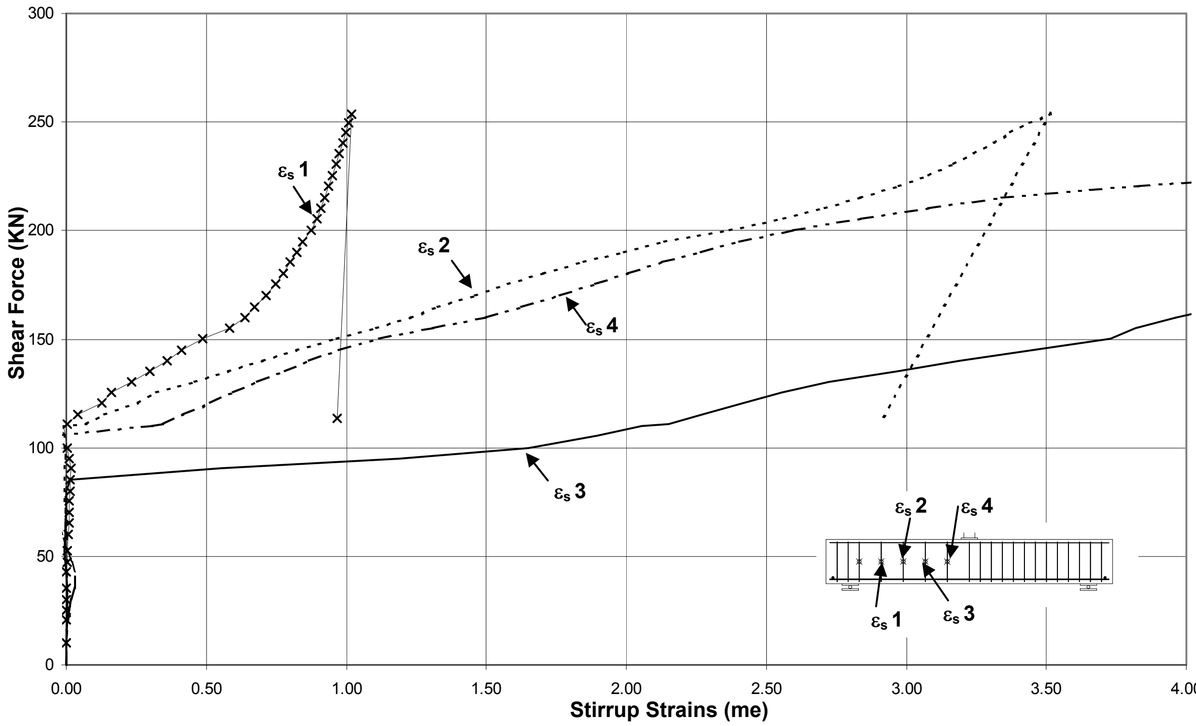
Specimen H100/3 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains			
			ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}
sec	KN	me	me	me	me	me
0	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
148	10.06	0.00	0.00	0.00	0.00	0.00
284	20.62	0.00	0.00	0.00	0.00	0.01
336	25.01	0.00	0.00	0.00	0.00	0.01
392	30.04	0.01	0.00	0.00	0.00	0.02
448	35.19	0.00	0.00	0.00	0.00	0.03
532	**42.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**
580	47.39	0.00	0.00	0.00	0.00	0.02
636	52.67	0.03	0.00	0.00	-0.01	0.00
708	**60.07**	**0.04**	**0.01**	**0.00**	**0.00**	**-0.01**
760	65.40	0.05	0.01	0.00	0.00	-0.03
804	70.05	0.07	0.01	0.00	0.00	-0.03
852	75.34	0.07	0.01	-0.01	0.00	-0.05
896	80.02	0.09	0.01	-0.01	0.00	-0.05
944	**85.24**	**0.09**	**0.01**	**-0.01**	**0.01**	**-0.06**
1000	90.49	0.12	0.02	-0.01	0.55	-0.09
1052	95.07	0.24	0.01	0.00	1.19	-0.09
1100	99.83	0.35	0.00	-0.01	1.65	-0.06
1152	105.40	0.43	0.00	-0.01	1.90	-0.04
1200	**109.99**	**0.62**	**-0.01**	**-0.01**	**2.06**	**0.31**
1224	110.86	0.65	0.00	0.07	2.15	0.35
1268	115.17	0.71	0.04	0.14	2.27	0.42
1344	120.73	0.81	0.13	0.26	2.42	0.51
1388	125.42	0.87	0.16	0.32	2.56	0.60
1436	**130.16**	**0.94**	**0.23**	**0.46**	**2.72**	**0.68**
1488	135.38	1.03	0.30	0.58	2.97	0.78
1536	140.27	1.12	0.36	0.70	3.19	0.87
1584	145.03	1.23	0.41	0.82	3.45	0.97
1644	**150.26**	**1.35**	**0.49**	**0.97**	**3.73**	**1.12**
1696	155.19	1.50	0.58	1.11	3.82	1.31
1748	160.11	1.68	0.64	1.23	3.96	1.50
1796	164.71	1.81	0.67	1.33	4.13	1.63
1852	170.31	1.97	0.71	1.46	4.54	1.76
1904	175.33	2.11	0.75	1.58	5.04	1.89
1956	180.47	2.26	0.78	1.70	5.71	2.01
2008	185.37	2.41	0.80	1.85	6.60	2.13
2060	190.20	2.63	0.82	1.99	7.55	2.27
2112	**194.92**	**2.74**	**0.84**	**2.14**	**8.65**	**2.40**
2172	200.13	2.97	0.87	2.37	10.03	2.60
2232	205.47	3.21	0.89	2.56	11.19	2.84
2288	210.53	3.40	0.91	2.71	12.22	3.08
2340	215.03	3.57	0.92	2.84	12.77	3.34
2408	220.65	3.84	0.94	2.98	12.79	3.83
2476	225.54	4.09	0.95	3.08	12.28	4.37
2548	230.59	4.38	0.96	3.17	11.12	5.20
2620	235.50	4.64	0.98	3.24	10.38	6.11
2708	240.50	4.97	0.99	3.31	10.17	7.12
2800	245.33	5.35	1.00	3.37	8.81	8.12
2892	249.71	4.88	1.01	3.44	8.03	8.82
2988	**253.64**	**5.19**	**1.02**	**3.52**	**6.90**	**9.53**
2996	113.60	9.98	0.97	2.91	12.81	12.78

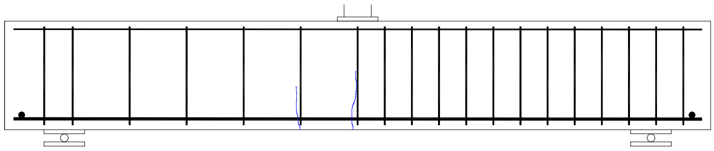
Specimen H100/3



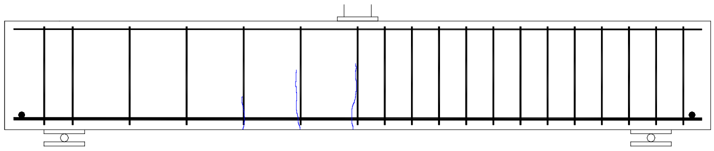




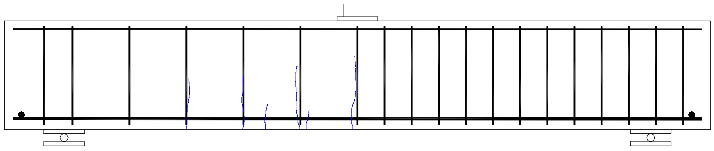
Specimen H100/3 – Cracking control



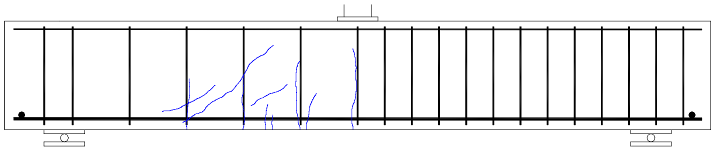
V = 42 KN



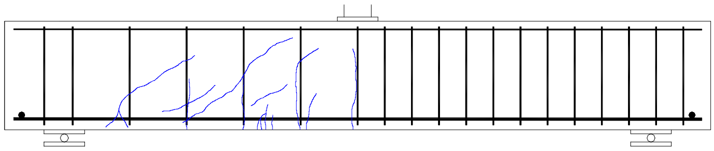
V = 60 KN



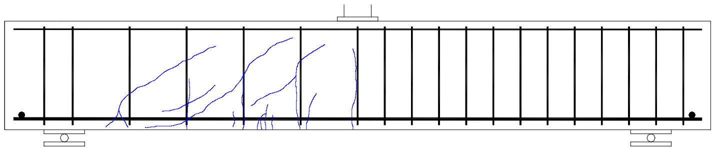
V = 85 KN



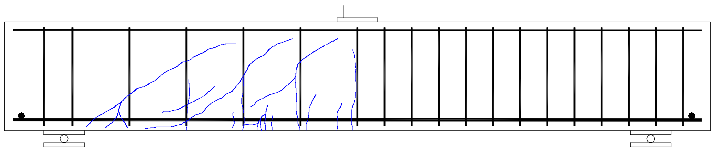
V = 110 KN



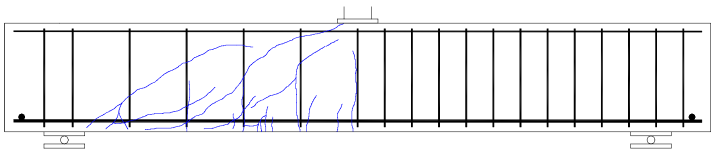
V = 130 KN



V = 150 KN

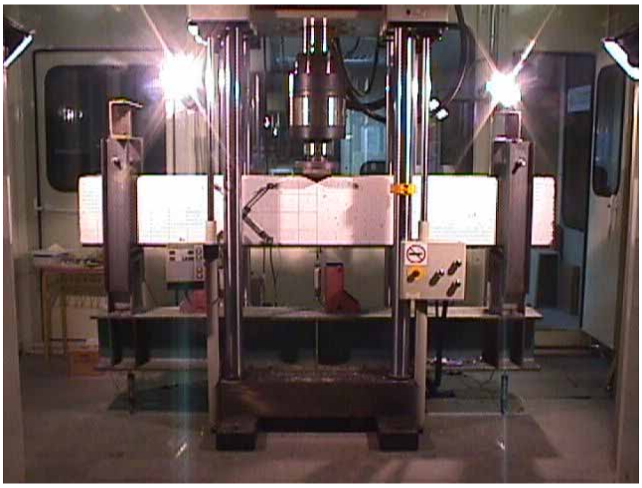


V = 195 KN



V = 253.6 KN
failure

Specimen H100/3



Test set-up for beam H100/3

Cracking at failure (V = 253.64 KN)

Detail of the shear crack

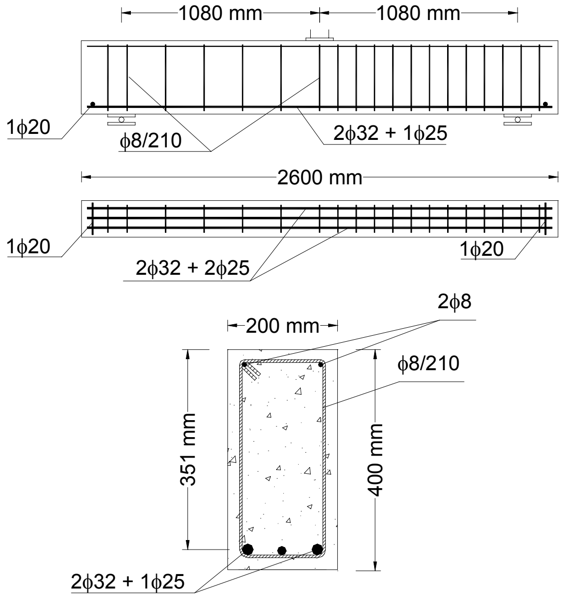
Specimen H100/4

Concrete properties
f'_c = 87.0 MPa f_{sp} = 4.1 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.99%   2 ϕ32 + 1 ϕ25 bars in one layer

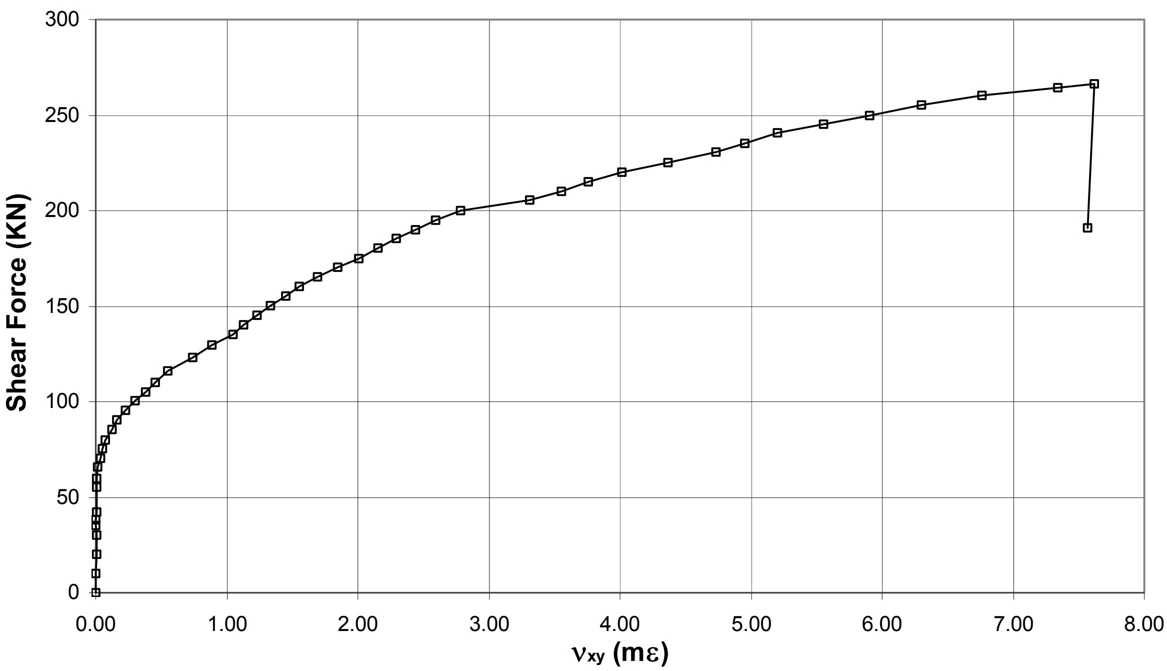
Transversal reinforcement
B-500-S f_y = 540 MPa
ρ_w = 1.291 MPa stirrups ϕ8 @ 210 mm

Cast: Jan 11, 2002
Tested: Apr 15, 2002
Test duration: 43 min
Test control: 0.006 mm/s



Summary of Test Observations

First flexural crack was reported in beam specimen H100/4 for a shear force V = 35 KN. A shear crack started to develop at V = 85 KN, although it was when the shear force equalled to 110 KN when the strain of the stirrup 2 increased considerably. The longitudinal reinforcement did not reach the yielding strain. The specimen collapsed at V = 266.53 KN.



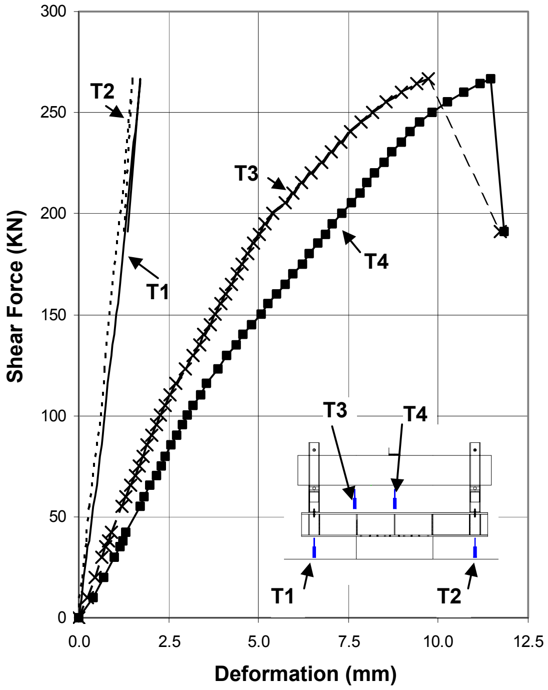
Specimen H100/4

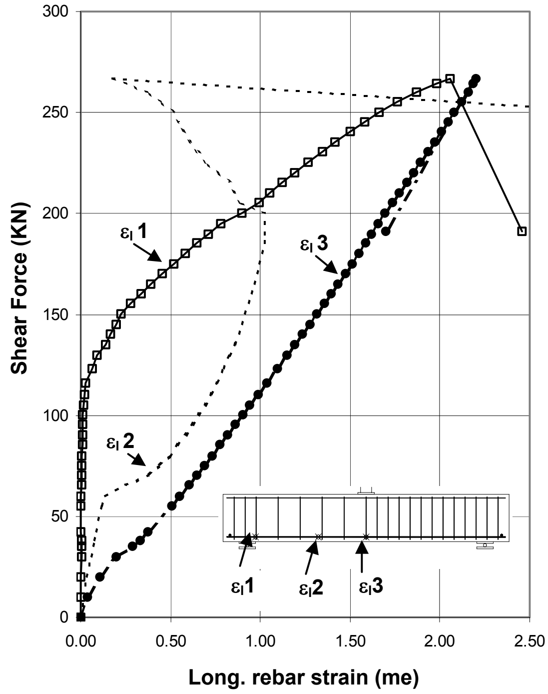
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	me	mm	mm	mm	mm	mm	mm	me	me	Me
0	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
128	10.22	0.00	0.00	0.07	0.40	0.24	0.00	0.00	0.00	0.02	0.04
232	20.04	0.00	0.11	0.14	0.70	0.46	0.00	0.00	0.00	0.03	0.11
316	30.06	0.01	0.16	0.22	0.99	0.65	0.00	0.00	0.00	0.06	0.20
356	**35.00**	**0.00**	**0.18**	**0.25**	**1.15**	**0.75**	**0.00**	**0.00**	**0.00**	**0.07**	**0.29**
380	38.18	0.00	0.20	0.28	1.22	0.82	0.00	0.00	0.00	0.07	0.33
412	**42.34**	**0.00**	**0.22**	**0.31**	**1.32**	**0.91**	**0.00**	**0.00**	**0.00**	**0.08**	**0.38**
508	55.14	0.01	0.30	0.41	1.71	1.20	0.00	0.00	0.00	0.12	0.51
544	**59.99**	**0.01**	**0.32**	**0.45**	**1.83**	**1.30**	**0.01**	**0.00**	**0.00**	**0.14**	**0.55**
588	65.82	0.01	0.36	0.50	1.99	1.44	0.01	0.00	0.00	0.25	0.61
624	70.46	0.03	0.40	0.53	2.16	1.57	0.02	0.00	0.01	0.38	0.65
660	75.32	0.05	0.43	0.56	2.30	1.68	0.02	0.00	0.01	0.44	0.69
696	80.01	0.07	0.46	0.59	2.42	1.78	0.04	0.01	0.01	0.50	0.73
736	**85.38**	**0.13**	**0.50**	**0.63**	**2.57**	**1.91**	**0.06**	**0.01**	**0.01**	**0.54**	**0.78**
772	90.25	0.16	0.54	0.66	2.73	2.04	0.07	0.00	0.01	0.59	0.82
812	95.70	0.23	0.58	0.69	2.89	2.17	0.10	0.00	0.01	0.62	0.86
848	100.48	0.30	0.61	0.72	3.01	2.28	0.13	0.00	0.01	0.66	0.90
888	105.10	0.38	0.63	0.75	3.19	2.39	0.16	0.00	0.01	0.70	0.94
928	**110.21**	**0.45**	**0.66**	**0.78**	**3.38**	**2.53**	**0.19**	**0.00**	**0.02**	**0.73**	**0.99**
972	115.89	0.55	0.69	0.81	3.55	2.69	0.23	0.00	0.03	0.76	1.04
1040	122.97	0.74	0.73	0.86	3.88	2.96	0.32	0.01	0.06	0.80	1.09
1096	**129.88**	**0.89**	**0.76**	**0.91**	**4.11**	**3.17**	**0.38**	**0.01**	**0.09**	**0.83**	**1.15**
1144	135.22	1.05	0.79	0.95	4.37	3.36	0.45	0.01	0.14	0.86	1.19
1184	140.12	1.13	0.81	0.98	4.57	3.48	0.48	0.00	0.16	0.88	1.23
1236	145.16	1.23	0.83	1.02	4.82	3.65	0.53	0.01	0.20	0.90	1.28
1276	**150.11**	**1.34**	**0.86**	**1.05**	**5.06**	**3.80**	**0.57**	**0.01**	**0.23**	**0.91**	**1.31**
1320	155.29	1.45	0.88	1.09	5.27	3.95	0.62	0.01	0.28	0.93	1.36
1360	160.20	1.55	0.91	1.12	5.51	4.08	0.66	0.01	0.33	0.95	1.39
1400	165.08	1.69	0.94	1.15	5.73	4.23	0.72	0.00	0.39	0.97	1.43
1444	170.37	1.85	0.97	1.17	5.96	4.41	0.79	0.01	0.45	0.98	1.47
1484	175.05	2.01	1.00	1.20	6.21	4.55	0.86	0.00	0.52	0.99	1.51
1528	180.42	2.15	1.04	1.23	6.41	4.70	0.91	0.00	0.58	1.01	1.55
1568	185.19	2.29	1.07	1.25	6.65	4.86	0.97	0.00	0.65	1.02	1.58
1608	189.91	2.44	1.10	1.28	6.86	5.02	1.02	-0.01	0.71	1.03	1.62
1652	**195.02**	**2.59**	**1.13**	**1.30**	**7.05**	**5.19**	**1.08**	**-0.02**	**0.78**	**1.03**	**1.66**
1700	200.12	2.79	1.16	1.33	7.32	5.40	1.15	-0.03	0.89	1.02	1.69
1764	205.54	3.31	1.19	1.36	7.59	5.76	1.37	-0.03	0.99	0.89	1.74
1808	210.27	3.55	1.22	1.39	7.81	5.97	1.48	-0.03	1.05	0.86	1.77
1856	215.19	3.76	1.24	1.41	8.02	6.20	1.58	-0.02	1.12	0.83	1.81
1908	**220.14**	**4.02**	**1.27**	**1.44**	**8.23**	**6.45**	**1.70**	**0.00**	**1.19**	**0.77**	**1.85**
1964	225.23	4.37	1.29	1.47	8.50	6.75	1.88	0.03	1.26	0.69	1.89
2020	230.49	4.73	1.32	1.50	8.71	7.02	2.06	0.06	1.34	0.65	1.93
2072	**235.26**	**4.95**	**1.34**	**1.53**	**8.97**	**7.29**	**2.19**	**0.09**	**1.42**	**0.61**	**1.97**
2132	240.54	5.20	1.37	1.57	9.22	7.57	2.35	0.15	1.50	0.57	2.01
2184	245.09	5.55	1.39	1.59	9.48	7.84	2.55	0.19	1.58	0.54	2.04
2256	249.91	5.90	1.41	1.62	9.82	8.16	2.76	0.26	1.66	0.51	2.08
2332	255.29	6.30	1.44	1.66	10.25	8.56	3.04	0.36	1.76	0.45	2.12
2408	260.24	6.77	1.46	1.68	10.71	8.98	3.37	0.50	1.87	0.38	2.16
2480	264.13	7.34	1.49	1.70	11.17	9.41	3.77	0.66	1.98	0.26	2.19
2528	**266.53**	**7.62**	**1.50**	**1.72**	**11.47**	**9.71**	**4.01**	**0.77**	**2.06**	**0.18**	**2.20**
2532	191.03	7.56	1.26	1.37	11.83	11.71	3.85	0.64	2.46	12.82	1.70

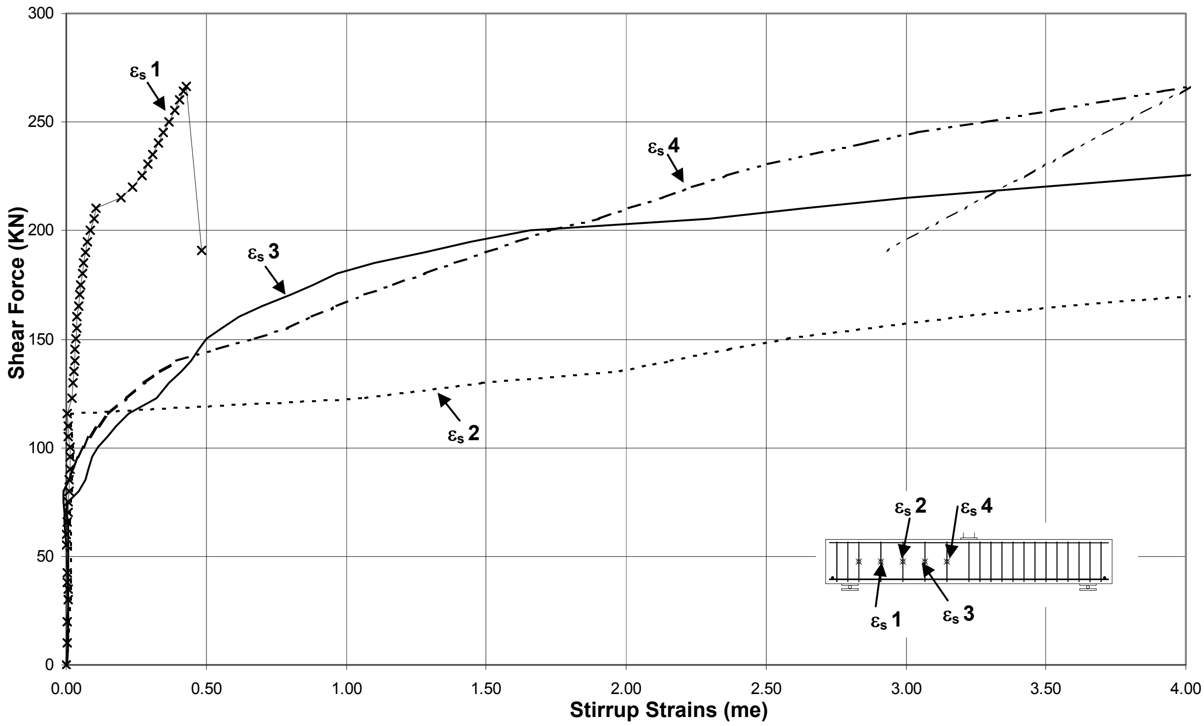
Specimen H100/4 - Continuation

Time	Shear	Shear strain ν_{xy}	Transversal reinforcement strains			
			ε_{s1}	ε_{s2}	ε_{s3}	ε_{s4}
sec	KN	me	me	me	me	me
0	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
128	10.22	0.00	0.00	0.01	0.01	0.00
232	20.04	0.00	0.00	0.01	0.01	0.00
316	30.06	0.01	0.01	0.02	0.01	0.01
356	**35.00**	**0.00**	**0.01**	**0.02**	**0.01**	**0.01**
380	38.18	0.00	0.00	0.02	0.01	0.01
412	**42.34**	**0.00**	**0.00**	**0.02**	**0.01**	**0.01**
508	55.14	0.01	0.00	0.02	0.01	0.00
544	**59.99**	**0.01**	**0.00**	**0.02**	**0.01**	**0.00**
588	65.82	0.01	0.00	0.01	0.01	-0.01
624	70.46	0.03	0.01	0.01	0.00	-0.01
660	75.32	0.05	0.01	0.02	0.01	-0.01
696	80.01	0.07	0.01	0.02	0.05	-0.01
736	**85.38**	**0.13**	**0.01**	**0.02**	**0.07**	**0.01**
772	90.25	0.16	0.01	0.02	0.08	0.02
812	95.70	0.23	0.01	0.02	0.09	0.04
848	100.48	0.30	0.01	0.02	0.11	0.06
888	105.10	0.38	0.01	0.02	0.15	0.08
928	**110.21**	**0.45**	**0.01**	**0.02**	**0.18**	**0.11**
972	115.89	0.55	0.00	0.02	0.22	0.15
1040	122.97	0.74	0.02	1.07	0.32	0.22
1096	**129.88**	**0.89**	**0.02**	**1.48**	**0.37**	**0.28**
1144	135.22	1.05	0.03	1.98	0.41	0.34
1184	140.12	1.13	0.03	2.16	0.44	0.39
1236	145.16	1.23	0.03	2.37	0.47	0.54
1276	**150.11**	**1.34**	**0.03**	**2.58**	**0.50**	**0.68**
1320	155.29	1.45	0.04	2.87	0.56	0.79
1360	160.20	1.55	0.04	3.19	0.62	0.88
1400	165.08	1.69	0.04	3.56	0.70	0.97
1444	170.37	1.85	0.05	4.09	0.80	1.07
1484	175.05	2.01	0.05	4.63	0.88	1.17
1528	180.42	2.15	0.06	5.27	0.97	1.28
1568	185.19	2.29	0.06	5.97	1.10	1.39
1608	189.91	2.44	0.07	6.60	1.28	1.50
1652	**195.02**	**2.59**	**0.08**	**7.35**	**1.45**	**1.61**
1700	200.12	2.79	0.08	8.51	1.66	1.73
1764	205.54	3.31	0.10	8.83	2.30	1.90
1808	210.27	3.55	0.11	9.22	2.64	2.01
1856	215.19	3.76	0.19	9.99	3.01	2.13
1908	**220.14**	**4.02**	**0.24**	**10.92**	**3.47**	**2.24**
1964	225.23	4.37	0.27	12.03	3.99	2.36
2020	230.49	4.73	0.29	12.72	4.46	2.51
2072	**235.26**	**4.95**	**0.31**	**12.74**	**4.89**	**2.66**
2132	240.54	5.20	0.33	12.74	5.43	2.86
2184	245.09	5.55	0.35	12.74	5.96	3.04
2256	249.91	5.90	0.37	12.74	6.64	3.29
2332	255.29	6.30	0.39	11.87	7.57	3.53
2408	260.24	6.77	0.40	9.93	8.63	3.74
2480	264.13	7.34	0.42	9.39	9.63	3.92
2528	**266.53**	**7.62**	**0.43**	**9.19**	**10.12**	**4.02**
2532	191.03	7.56	0.48	12.75	12.79	2.93

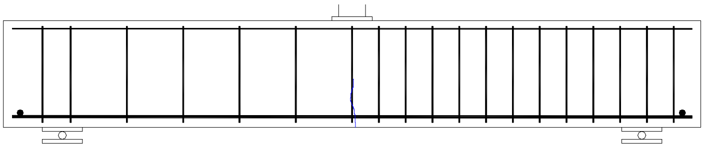
Specimen H100/4



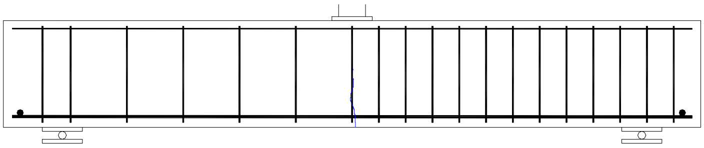




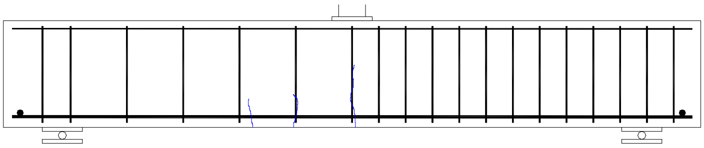
Specimen H100/4 – Cracking control



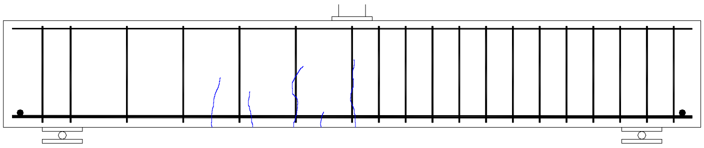
V = 35 KN



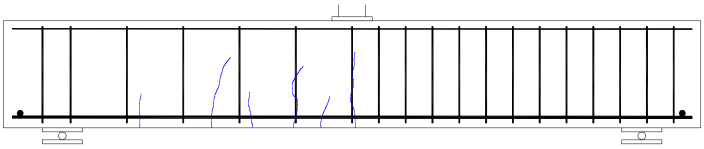
V = 42 KN



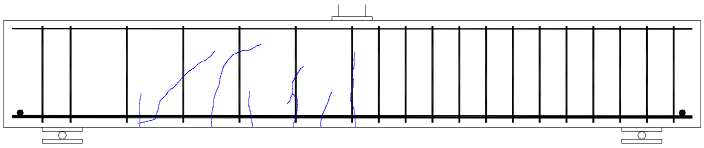
V = 60 KN



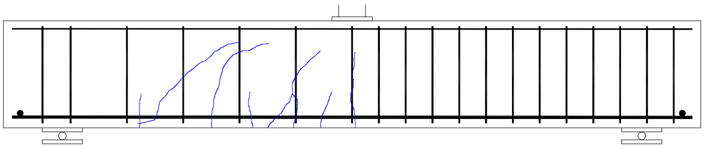
V = 85 KN



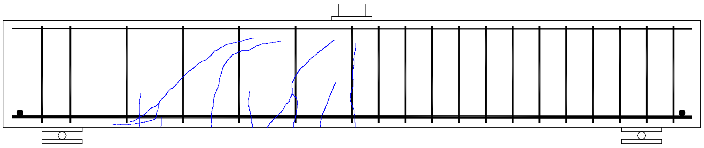
V = 110 KN



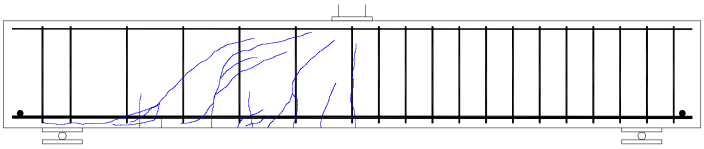
V = 130 KN



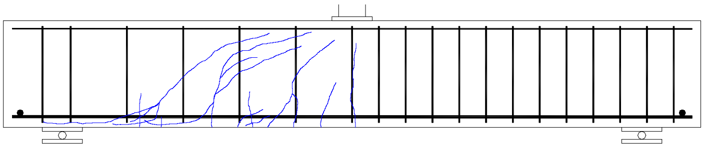
V = 150 KN



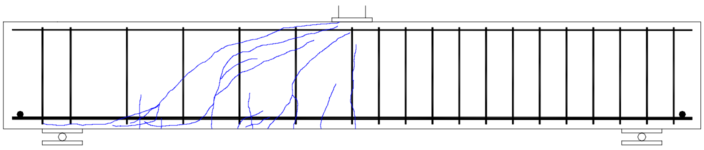
V = 195 KN



V = 220 KN

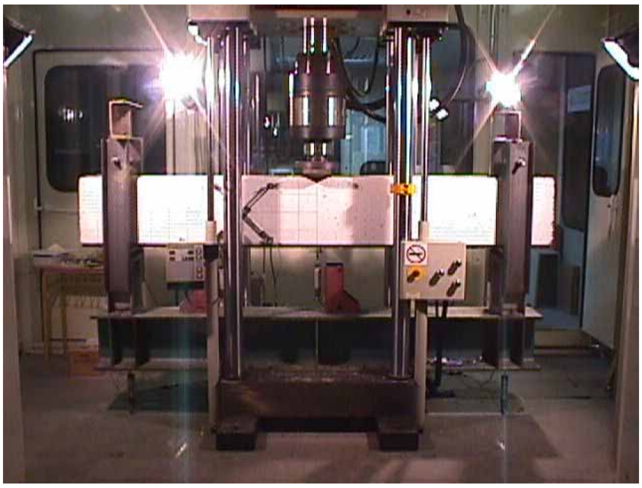


V = 235 KN



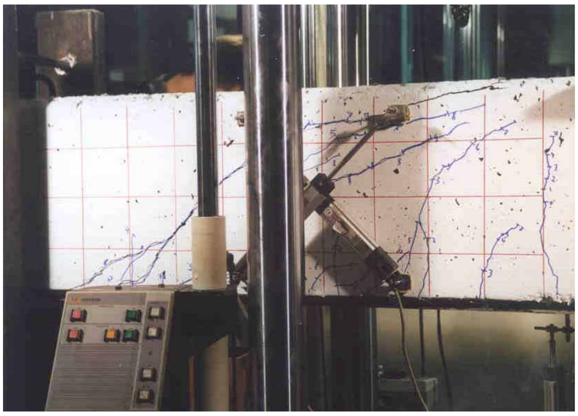
V = 266.5 KN
failure

Specimen H100/4



Test set-up for beam H100/4

Shear crack prior to the beam failure



Cracking at failure (V = 266.53 KN)

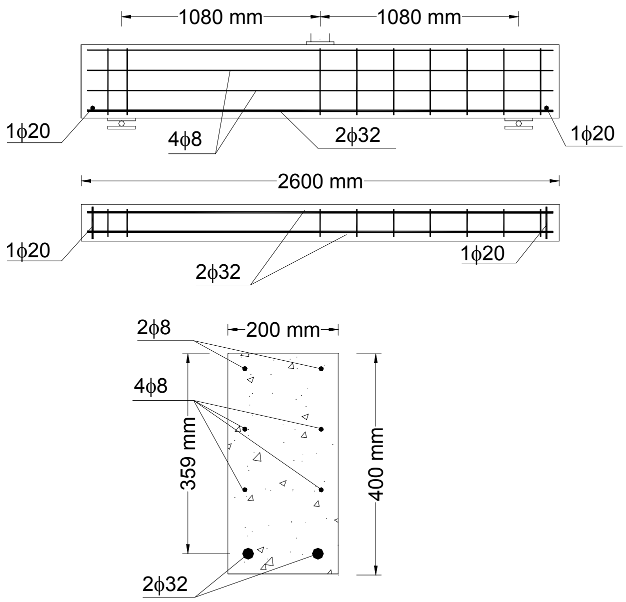
Specimen H100/5

Concrete properties
f'$_c$ = 87.0 MPa f_{sp} = 4.1 MPa

Longitudinal reinforcement
B-500-S f_{yk} = 500MPa
ρ_l = 2.24%   2 ϕ32 bars in one layer

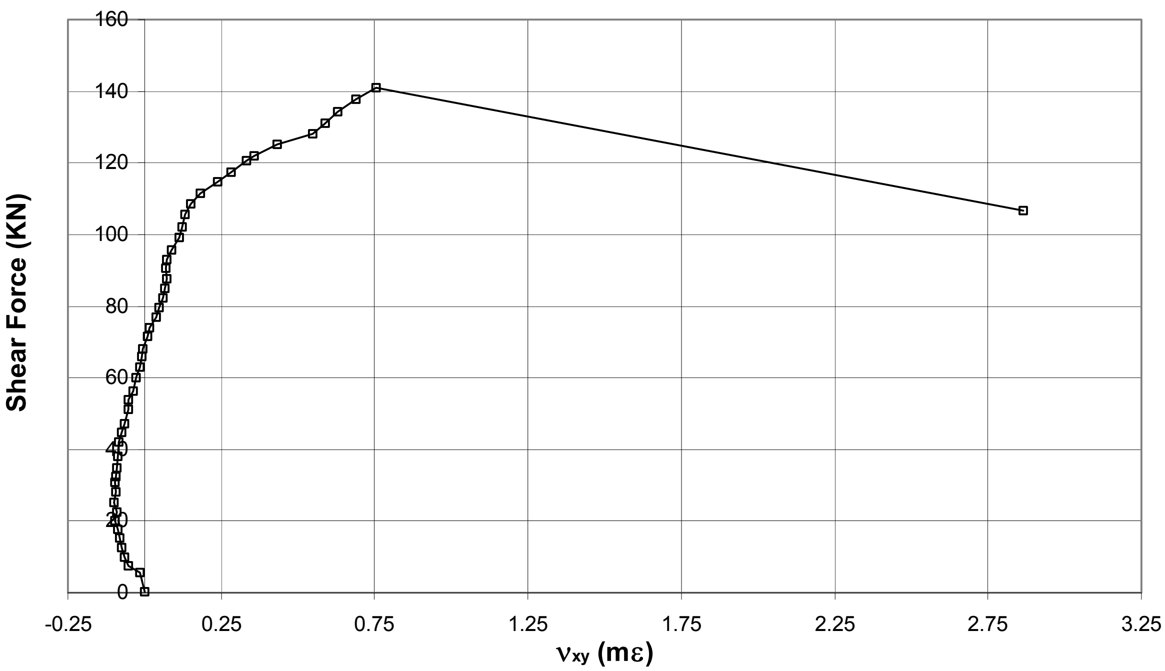
Transversal reinforcement
No stirrups at the tested zone
4 ϕ8 bars distributed along the web

Cast: Apr 16, 2002
Tested: Feb 26, 2002
Test duration: 42 min
Test control: 0.003 mm/s



Summary of Test Observations

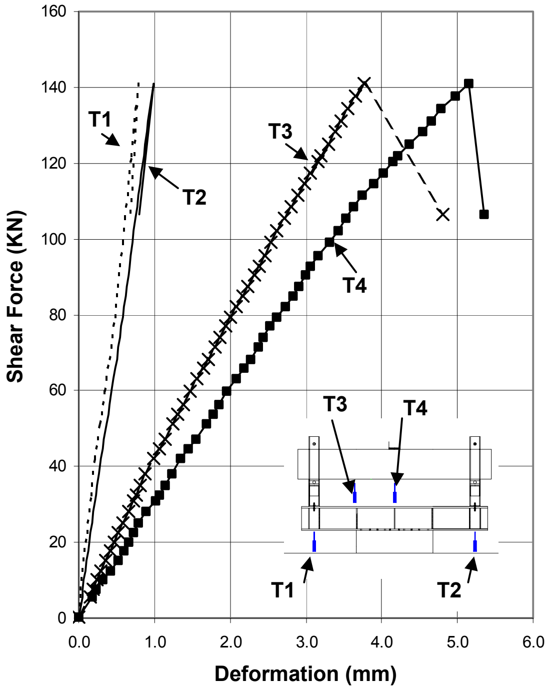
Beam specimen H100/5 did not contain stirrups but longitudinal bars distributed along the web. First flexural crack was reported at V = 25 KN. A shear crack was observed for a shear force V = 85 KN. The beam collapsed briskly for V = 140.90 KN.

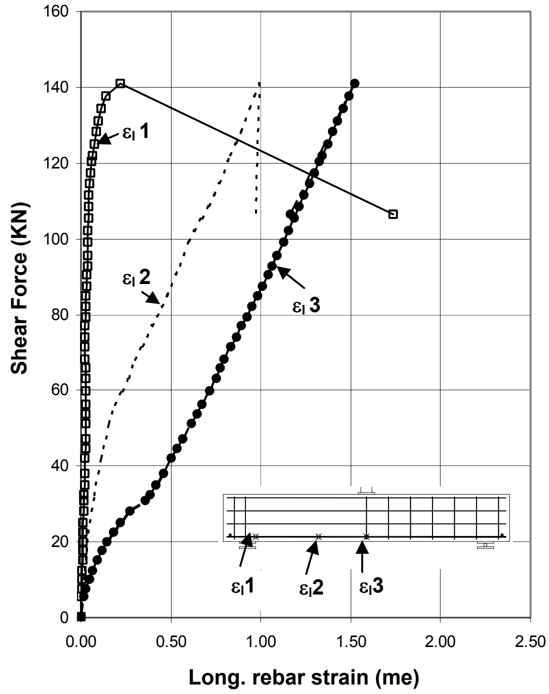


Specimen H100/5

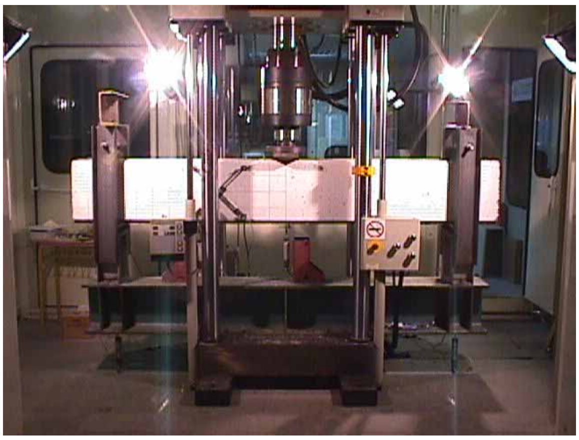
Time	Shear	Shear strain ν_{xy}	Deformations						Longitudinal reinforcement		
			T1	T2	T3	T4	T5	T6	ε_{l1}	ε_{l2}	ε_{l3}
sec	KN	Me	mm	mm	mm	mm	mm	mm	me	me	me
0	**0.14**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
42	5.53	-0.01	0.02	0.05	0.18	0.15	0.00	0.00	0.00	0.01	0.02
135	7.57	-0.05	0.03	0.05	0.23	0.19	-0.02	0.01	0.00	0.01	0.03
201	10.03	-0.07	0.04	0.07	0.32	0.24	-0.02	0.01	0.01	0.02	0.05
261	12.53	-0.08	0.05	0.09	0.42	0.29	-0.02	0.01	0.01	0.02	0.07
321	15.26	-0.08	0.07	0.11	0.53	0.36	-0.02	0.01	0.01	0.03	0.09
369	17.68	-0.09	0.08	0.12	0.60	0.41	-0.02	0.01	0.01	0.03	0.12
414	20.04	-0.10	0.09	0.14	0.66	0.47	-0.03	0.01	0.01	0.04	0.14
459	22.50	-0.09	0.11	0.15	0.73	0.52	-0.03	0.01	0.01	0.04	0.18
504	**25.08**	**-0.10**	**0.12**	**0.17**	**0.79**	**0.58**	**-0.03**	**0.02**	**0.01**	**0.05**	**0.22**
555	28.09	-0.09	0.14	0.19	0.89	0.65	-0.02	0.02	0.02	0.06	0.27
606	30.83	-0.10	0.15	0.21	1.01	0.72	-0.02	0.02	0.02	0.07	0.36
633	32.50	-0.09	0.16	0.23	1.07	0.76	-0.02	0.02	0.02	0.07	0.38
672	**34.96**	**-0.09**	**0.17**	**0.24**	**1.15**	**0.81**	**-0.02**	**0.02**	**0.02**	**0.08**	**0.42**
723	38.14	-0.09	0.19	0.27	1.24	0.88	-0.02	0.02	0.02	0.10	0.46
789	**41.99**	**-0.09**	**0.22**	**0.30**	**1.35**	**0.98**	**-0.02**	**0.02**	**0.02**	**0.11**	**0.50**
834	44.63	-0.07	0.23	0.31	1.44	1.07	-0.01	0.02	0.02	0.13	0.53
876	47.26	-0.07	0.25	0.34	1.55	1.14	-0.01	0.02	0.03	0.14	0.57
939	51.14	-0.05	0.28	0.37	1.69	1.24	0.00	0.02	0.03	0.16	0.61
984	53.79	-0.05	0.30	0.39	1.77	1.31	0.00	0.02	0.03	0.17	0.64
1029	56.37	-0.04	0.32	0.41	1.85	1.38	0.01	0.02	0.03	0.19	0.67
1086	**59.93**	**-0.03**	**0.34**	**0.44**	**1.96**	**1.47**	**0.01**	**0.02**	**0.03**	**0.23**	**0.72**
1137	63.06	-0.01	0.36	0.46	2.08	1.56	0.02	0.02	0.03	0.26	0.75
1176	65.86	-0.01	0.38	0.48	2.18	1.64	0.02	0.02	0.02	0.28	0.77
1215	68.20	0.00	0.40	0.50	2.27	1.71	0.02	0.02	0.02	0.30	0.80
1269	71.49	0.01	0.43	0.53	2.37	1.80	0.02	0.02	0.02	0.34	0.83
1308	74.06	0.02	0.44	0.55	2.44	1.87	0.03	0.02	0.02	0.37	0.86
1353	76.97	0.04	0.46	0.56	2.53	1.94	0.03	0.02	0.02	0.39	0.89
1392	79.47	0.05	0.48	0.58	2.62	2.00	0.04	0.02	0.03	0.42	0.92
1434	82.16	0.06	0.49	0.60	2.72	2.08	0.04	0.02	0.03	0.45	0.95
1479	**85.01**	**0.07**	**0.51**	**0.62**	**2.83**	**2.16**	**0.04**	**0.01**	**0.03**	**0.48**	**0.98**
1518	87.59	0.07	0.52	0.64	2.91	2.24	0.04	0.01	0.03	0.50	1.01
1563	90.56	0.07	0.54	0.66	3.00	2.32	0.04	0.02	0.03	0.53	1.04
1599	92.87	0.07	0.55	0.67	3.06	2.39	0.05	0.01	0.04	0.55	1.06
1641	95.56	0.09	0.56	0.69	3.16	2.45	0.05	0.02	0.04	0.57	1.09
1695	99.03	0.11	0.58	0.71	3.31	2.53	0.06	0.01	0.04	0.60	1.12
1743	**102.13**	**0.12**	**0.60**	**0.73**	**3.42**	**2.62**	**0.07**	**0.01**	**0.04**	**0.63**	**1.15**
1797	105.53	0.13	0.61	0.75	3.53	2.72	0.07	0.01	0.04	0.67	1.19
1842	108.49	0.15	0.63	0.77	3.62	2.80	0.08	0.01	0.04	0.71	1.21
1890	111.51	0.18	0.64	0.79	3.74	2.89	0.09	0.01	0.04	0.74	1.24
1941	114.66	0.24	0.66	0.81	3.90	2.98	0.11	0.01	0.05	0.77	1.27
1992	117.51	0.28	0.67	0.82	4.02	3.05	0.13	0.01	0.05	0.79	1.30
2052	120.52	0.33	0.69	0.85	4.15	3.16	0.15	0.01	0.06	0.82	1.32
2076	**122.00**	**0.36**	**0.69**	**0.86**	**4.21**	**3.20**	**0.17**	**0.01**	**0.06**	**0.83**	**1.34**
2127	125.13	0.43	0.71	0.87	4.37	3.29	0.20	0.01	0.08	0.86	1.37
2184	128.19	0.55	0.72	0.90	4.55	3.38	0.24	0.01	0.09	0.89	1.40
2229	131.12	0.59	0.74	0.92	4.65	3.47	0.26	0.01	0.10	0.92	1.43
2280	134.28	0.63	0.75	0.94	4.78	3.56	0.28	0.01	0.11	0.94	1.46
2337	**137.78**	**0.69**	**0.77**	**0.97**	**4.98**	**3.66**	**0.30**	**0.01**	**0.14**	**0.97**	**1.49**
2394	**140.90**	**0.76**	**0.79**	**0.99**	**5.15**	**3.76**	**0.33**	**0.01**	**0.22**	**1.00**	**1.52**
2403	106.58	2.86	0.68	0.80	5.36	4.81	1.98	0.76	1.74	0.97	1.16

Specimen H100/5





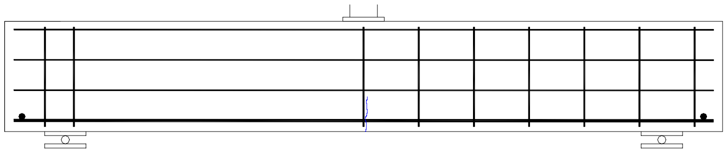
Photographs of the beam specimen



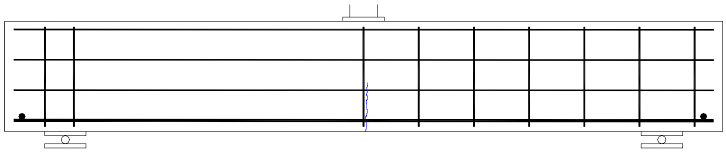
Test set-up for beam H100/5

Cracking at failure (V = 140.90 KN)

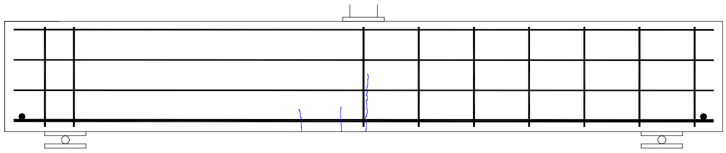
Specimen H100/5 – Cracking control



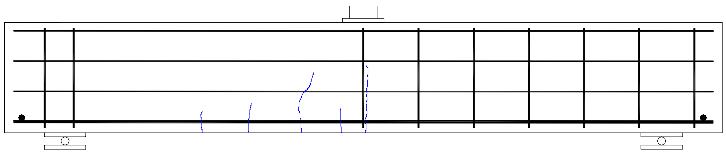
V = 25 KN



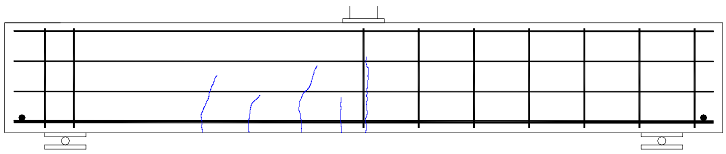
V = 35 KN



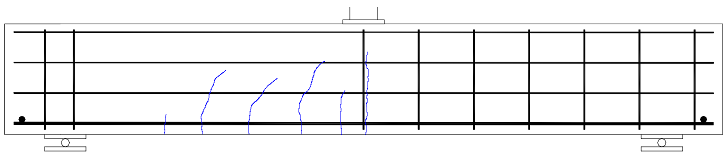
V = 42 KN



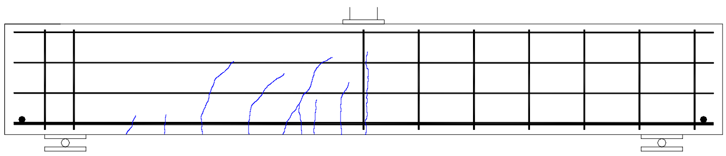
V = 60 KN



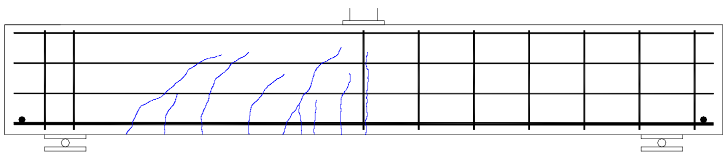
V = 85 KN



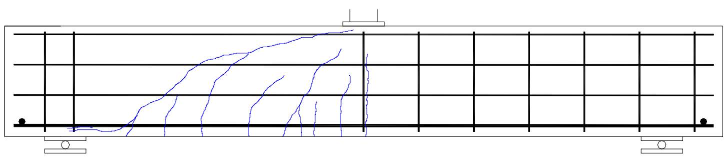
V = 102 KN



V = 122 KN



V = 137 KN



V = 140.9 KN
failure

Annex B

MATERIAL PROPERTIES

B.1 Concrete properties

B.2 Reinforcement steel properties

B.1 Concrete properties

Standard 150 mm x 300 mm cylinders were tested to obtain the concrete compressive and splitting strength at the age of the tests. Figure B.1 shows details of the test configuration.

Test results for each cylinder are summarized in Table B.1. Concrete compressive strength equalled 49.9 MPa for concrete mix H50, 60.8 MPa for H60, 68.9 for H75, and 87 MPA for concrete mix H100. The standard deviation was equal to, respectively, 1.38 MPa, 1.56 MPa, 1.65 MPa, and 1.90 MPa. The cylinders had been polished in one face, in order to have two parallel surfaces.

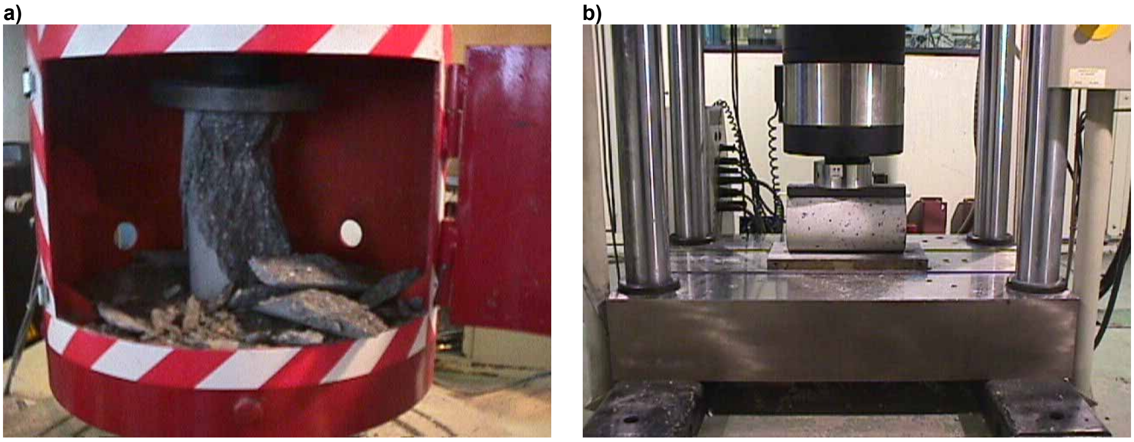


Figure B.1:Concrete properties. a) Compression test; b) Splitting test

Compression tests							
H50		H60		H75		H100	
Failure load	Strength	Failure load	Strength	Failure load	Strength	Failure load	Strength
84.5	47.8	108.1	61.2	122.0	69.1	150.2	85.0
89.4	50.6	110.9	62.8	125.5	71.0	157.1	88.9
89.2	50.5	104.4	59.1	199.9	67.8	156.7	88.7
89.4	50.6	108.9	61.6	121.3	68.6	154.6	87.5
		104.9	59.3	124.2	70.3	150.2	85.0
Average	**49.9**		**60.8**		**68.9**		**87.0**
Est. dev.	**1.38**		**1.56**		**1.65**		**1.90**
Splitting tests							
254.8	3.60	332.4	4.70	285.8	4.04	273.0	3.86
271.7	3.84	266.4	3.77	212.4	3.00	265.1	3.75
209.1	2.96	332.9	4.71	284.3	4.02	287.6	4.07
242.1	3.43	293.6	4.15	279.5	3.95	320.3	4.53
		279.4	3.95	220.9	3.13		
		284.7	4.03	281.7	3.99		
Average	**3.46**		**4.22**		**3.69**		**4.05**
Est. dev.	**0.37**		**0.40**		**0.49**		**0.34**

Table B.1: Concrete properties. Summary of test results.

The splitting strength is represented in Figure B.2 versus the concrete compressive strength. It can be seen that it increased as the concrete compressive strength increased, but the increase seemed proportional to the square root of the compressive strength and not to the 2/3 power. However, it is not possible to extract conclusions with only four concretes. The standard deviation was similar for the four concrete mixes (Table B.1).

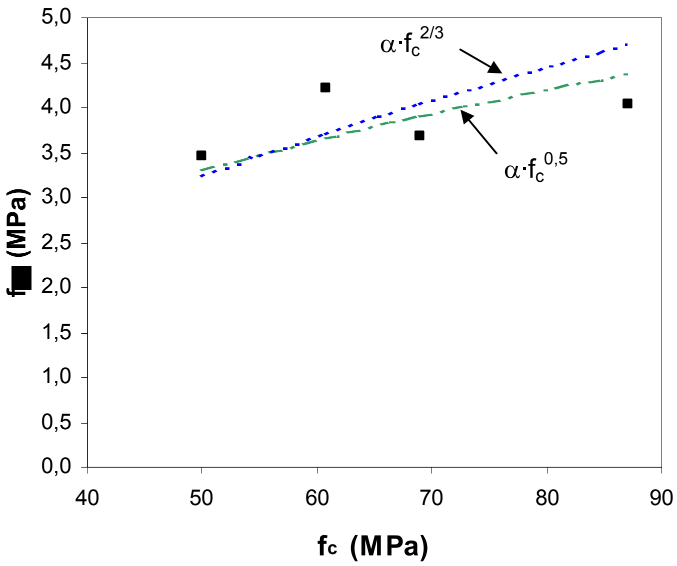


Figure B.2:Concrete splitting strength vs. compressive strength.

B.2 Reinforcement steel properties

Rebars utilized as shear reinforcement were tested in the Structural Technology Laboratory. The test procedure followed EN 10002-1 and UNE 4-474-92 Standards. Photographs in Figure B.3 give details of the test set-up.

a) b)

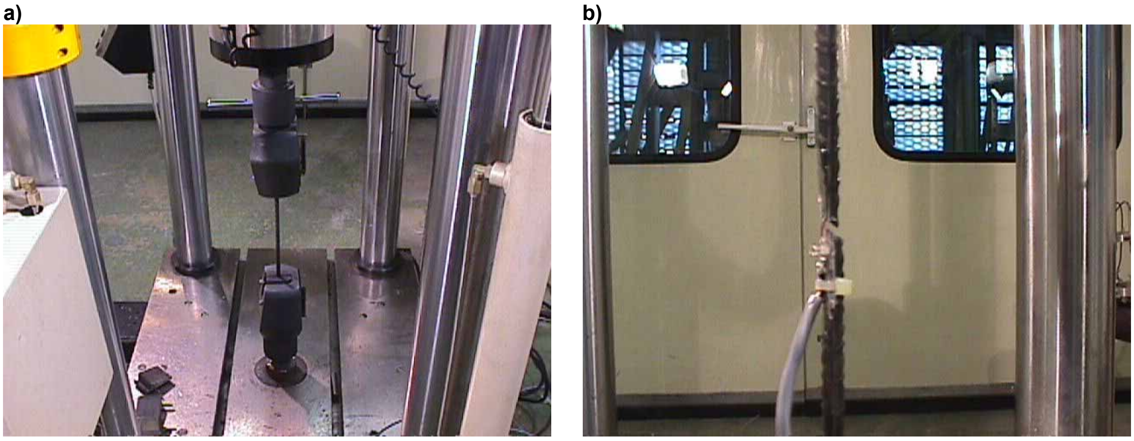


Figure B.3:Reinforcement steel properties. a) Tension test; b) Detail of the failure of a reinforcing bar.

During the first phase of the experimental campaign some problems happened when testing the shear reinforcement. Results were very different when a strain gauge was attached. During the second phase this error was corrected, and some rebars of the first phase were tested again.

Figure B.4 shows the force-deformation curve for two different 8-mm rebar and the actual yield strength. It can be seen that the curves are practically identical.

Table B.2 summarizes the experimental results.

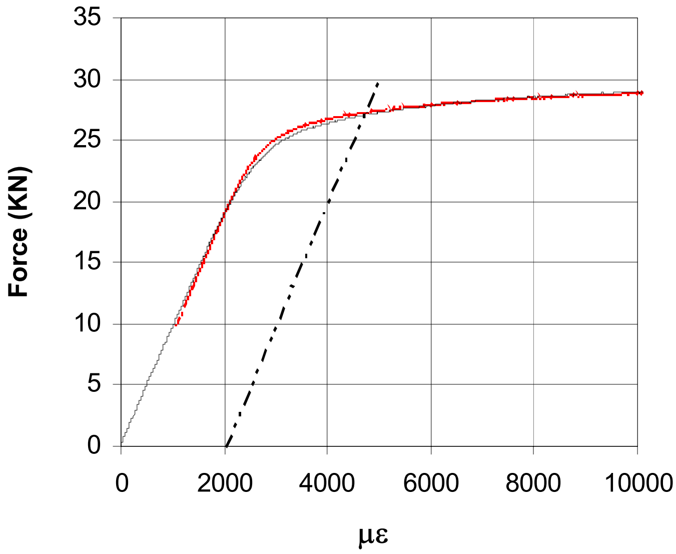


Figure B.4:Reinforcement steel properties. Force-deformation curve for two 8-mm bar diameter.

Size - series	Area mm^2	f_y MPa	f_u MPa
ϕ6 - H60 and H75	28.27	530	680
ϕ8 - H60 and H75	50.27	530	685
ϕ6 - H50 and H100	28.27	530	680
ϕ8 - H50 and H100	50.27	540	672

Table B.2: Properties of web reinforcing bars

Annex C

EXPERIMENTAL DATABASE

Beams without web reinforcement									V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Morrow Viest (1957)	b40b4	V	305	368	34.8	1.85	2.76	155.7	117.2	140.7	121.6	114.8	110.4	141.5	136.7	116.1	124.1	1.33	1.11	1.28	1.36	1.41	1.10	1.14	1.34	1.25
	b56b2	T	305	368	14.7	1.85	3.86	100.1	88.0	105.5	80.1	73.9	71.7	93.5	118.5	103.4	104.5	1.14	0.95	1.25	1.35	1.40	1.07	0.84	0.97	0.96
	b56a4	T	305	375	25	2.41	3.8	137.9	109.4	131.2	106.1	98.6	95.3	125.4	141.6	123.2	134.6	1.26	1.05	1.30	1.40	1.45	1.10	0.97	1.12	1.02
	b56b4	T	305	368	27.2	1.85	3.86	122.3	108.0	129.6	100.3	96.1	97.6	118.8	125.0	108.8	118.2	1.13	0.94	1.22	1.27	1.25	1.03	0.98	1.12	1.04
	b56e4	T	305	368	28.4	1.24	3.86	109	95.9	115.0	90.8	93.8	99.7	103.8	108.2	90.1	97.6	1.14	0.95	1.20	1.16	1.09	1.05	1.01	1.21	1.12
	b56a6	T	308	356	39.9	3.79	4	177.9	123.9	148.7	135.8	122.7	115.4	161.8	165.9	146.0	154.4	1.44	1.20	1.31	1.45	1.54	1.10	1.07	1.22	1.15
	b56b6	T	305	372	45.7	1.83	3.83	136.8	129.0	154.8	121.0	122.2	127.8	142.5	135.3	124.9	131.5	1.06	0.88	1.13	1.12	1.07	0.96	1.01	1.10	1.04
	b113b4	T	305	365	32.6	1.87	7.86	104.3	114.4	137.2	84.1	96.0	105.9	97.5	97.9	114.1	122.4	0.91	0.76	1.24	1.09	0.98	1.07	1.07	0.91	0.85
	b70b2	T	305	365	16.3	1.87	4.87	88.96	90.8	108.9	76.7	73.4	74.9	89.0	111.4	103.9	106.6	0.98	0.82	1.16	1.21	1.19	1.00	0.80	0.86	0.83
	b70a4	V	305	368	27.2	2.46	4.83	132.3	110.8	133.0	101.0	96.0	97.6	119.2	132.3	125.5	136.3	1.19	1.00	1.31	1.38	1.36	1.11	1.00	1.05	0.97
	b70a6	T	305	356	45	3.83	5	177.9	127.7	153.2	130.8	121.9	121.4	158.9	157.4	152.0	159.5	1.39	1.16	1.36	1.46	1.47	1.12	1.13	1.17	1.12
	b84b4	T	305	363	27.2	1.88	5.87	111.2	107.4	128.9	86.9	89.8	96.2	102.0	109.1	108.6	117.9	1.04	0.86	1.28	1.24	1.16	1.09	1.02	1.02	0.94
Elzanaty Nilson Slate (1986)	F11	T	177.8	273	20.6	1.2	4	44.81	39.4	47.2	33.9	34.8	36.7	40.7	44.6	39.5	41.7	1.14	0.95	1.32	1.29	1.22	1.10	1.01	1.13	1.08
	F12	V	177.8	273	20.6	2.5	4	54.48	46.7	56.0	41.6	38.4	36.7	49.5	63.4	56.0	59.1	1.17	0.97	1.31	1.42	1.48	1.10	0.86	0.97	0.92
	F8	T	177.8	273	39.9	1	4	45.97	46.2	55.4	40.3	46.6	51.1	44.2	47.7	41.8	43.4	1.00	0.83	1.14	0.99	0.90	1.04	0.96	1.10	1.06
	F13	T	177.8	273	39.9	1.2	4	46.35	49.1	58.9	42.9	47.1	51.1	51.5	50.9	45.8	47.6	0.94	0.79	1.08	0.98	0.91	0.90	0.91	1.01	0.97
	F14	T	177.8	273	39.9	2.5	4	64.93	58.2	69.8	52.8	50.7	51.1	61.3	71.2	66.2	68.7	1.12	0.93	1.23	1.28	1.27	1.06	0.91	0.98	0.95
	F1	T	177.8	273	65.5	1.2	4	58.69	56.2	69.5	50.6	59.4	65.5	57.5	59.4	53.0	51.6	1.04	0.84	1.16	0.99	0.90	1.02	0.99	1.11	1.14
	F2	T	177.8	273	65.5	2.5	4	67.21	66.7	82.4	62.8	63.1	65.5	71.5	82.3	76.6	74.5	1.01	0.82	1.07	1.07	1.03	0.94	0.82	0.88	0.90
	F9	T	177.8	273	79.2	1.6	4	63.67	61.9	81.4	53.1	62.5	67.7	67.0	71.3	64.4	59.6	1.03	0.78	1.20	1.02	0.94	0.95	0.89	0.99	1.07
	F10	T	177.8	273	65.5	3.3	4	78.53	66.7	82.4	68.3	65.3	65.5	78.5	94.1	88.0	85.6	1.18	0.95	1.15	1.20	1.20	1.00	0.83	0.89	0.92
	F15	T	177.8	273	79.2	2.5	4	68.29	66.7	87.7	60.4	64.9	67.7	75.0	88.2	80.6	74.5	1.02	0.78	1.13	1.05	1.01	0.91	0.77	0.85	0.92
	F6	T	177.8	273	63.4	2.5	6	61.9	66.7	81.5	54.8	59.4	64.4	63.8	67.1	75.9	74.5	0.93	0.76	1.13	1.04	0.96	0.97	0.92	0.82	0.83
Mphonde Frantz (1984)	A0-3-3b	T	152	298	22.6	3.36	3.6	64.6	44.0	52.8	45.2	40.8	35.9	53.8	67.1	51.8	55.5	1.47	1.22	1.43	1.58	1.80	1.20	0.96	1.25	1.16
	A0-3-3c	T	152	298	29.5	2.32	3.6	66.8	48.1	57.7	48.8	42.1	41.0	57.6	57.3	53.1	56.9	1.39	1.16	1.37	1.59	1.63	1.16	1.17	1.26	1.17
	A0-7-3a	T	152	298	40.9	3.36	3.6	82.16	53.7	64.4	56.7	51.4	48.3	67.3	75.1	64.3	67.0	1.53	1.28	1.45	1.60	1.70	1.22	1.09	1.28	1.23
	A0-7-3b	T	152	298	45.2	3.36	3.6	82.79	55.5	66.6	58.7	53.5	50.8	69.6	77.0	67.2	69.4	1.49	1.24	1.41	1.55	1.63	1.19	1.07	1.23	1.19
	A0-11-3a	V	152	298	81.4	3.36	3.6	89.69	61.0	81.0	63.6	64.2	63.2	76.7	94.5	84.4	79.0	1.47	1.11	1.41	1.40	1.42	1.17	0.95	1.06	1.14
	A0-11-3b	T	152	298	81.1	3.36	3.6	89.38	61.0	80.9	63.4	64.2	63.2	76.4	94.3	84.4	79.0	1.47	1.10	1.41	1.39	1.42	1.17	0.95	1.06	1.13
	A0-15-3a	T	152	298	88.4	3.36	3.6	93.45	61.0	83.2	65.3	64.2	63.2	78.5	97.9	85.9	79.0	1.53	1.12	1.43	1.46	1.48	1.19	0.95	1.09	1.18

Beams without web reinforcement										V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Mphonde Frantz (1984)	A0-15-3b	T	152	298	101.8	3.36	3.6	100	61.0	86.7	68.5	64.2	63.2	82.7	104.1	87.7	79.0	1.64	1.15	1.46	1.56	1.58	1.21	0.96	1.14	1.27
	A0-15-3c	T	152	298	99.8	3.36	3.6	97.84	61.0	86.7	68.4	64.2	63.2	82.2	103.2	87.9	79.0	1.60	1.13	1.43	1.52	1.55	1.19	0.95	1.11	1.24
	A0-3-2	T	152	298	22.4	3.36	2.5	77.77	43.9	52.7	49.9	48.0	35.7	55.2	74.8	51.8	55.3	1.77	1.48	1.56	1.62	2.18	1.41	1.04	1.50	1.41
	A0-7-2	V	152	298	49.1	3.36	2.5	117.9	57.0	68.4	67.0	62.7	52.9	77.1	87.8	69.7	71.5	2.07	1.72	1.76	1.88	2.23	1.53	1.34	1.69	1.65
	A0-11-2	T	152	298	86.2	3.36	2.5	111.3	61.0	82.6	73.2	71.5	63.2	86.3	106.2	85.5	79.0	1.83	1.35	1.52	1.56	1.76	1.29	1.05	1.30	1.41
Islam Pam Kwan (1998)	M100-S0	T	150	203	83.3	3.22	3.94	65	44.9	60.1	44.2	42.1	42.5	46.1	73.1	66.2	57.1	1.45	1.08	1.47	1.54	1.53	1.41	0.89	0.98	1.14
	M100-S3	T	150	203	83.3	3.22	2.96	96.9	44.9	60.1	48.7	45.0	42.5	51.5	80.9	66.2	57.1	2.16	1.61	1.99	2.15	2.28	1.88	1.20	1.46	1.70
	M100-S4	T	150	203	83.3	3.22	3.94	80.7	44.9	60.1	44.3	42.1	42.5	46.1	73.1	66.2	57.1	1.80	1.34	1.82	1.92	1.90	1.75	1.10	1.22	1.41
	M80-S0	V	150	203	72.2	3.22	3.94	58	44.9	57.3	43.3	42.1	42.5	45.0	68.3	63.2	57.1	1.29	1.01	1.34	1.38	1.37	1.29	0.85	0.92	1.02
	M80-S4	T	150	203	72.2	3.22	3.94	72.1	44.9	57.3	43.4	42.1	42.5	45.1	68.2	63.2	57.1	1.61	1.26	1.66	1.71	1.70	1.60	1.06	1.14	1.26
	M60-S0	T	150	207	50.8	2.02	3.86	45.5	43.1	51.7	36.1	35.4	36.9	38.2	47.3	44.9	44.4	1.06	0.88	1.26	1.29	1.23	1.19	0.96	1.01	1.03
	M60-S4	T	150	207	50.8	2.02	3.86	51.9	43.1	51.7	36.0	35.4	36.9	38.2	47.3	44.9	44.4	1.20	1.00	1.44	1.47	1.41	1.36	1.10	1.16	1.17
	M40-S0	T	150	205	34.4	3.19	3.9	55	37.6	45.1	35.0	31.6	30.1	37.2	53.5	45.1	47.0	1.46	1.22	1.57	1.74	1.83	1.48	1.03	1.22	1.17
	M25-S0	T	150	207	26.6	2.02	3.86	47.5	34.7	41.7	28.6	26.6	26.7	30.8	39.8	36.2	39.0	1.37	1.14	1.66	1.78	1.78	1.54	1.19	1.31	1.22
	M25-S3	T	150	207	26.6	2.02	2.9	56.5	34.7	41.7	31.2	28.5	26.7	34.0	44.3	36.2	39.0	1.63	1.36	1.81	1.98	2.12	1.66	1.27	1.56	1.45
Collins Kuchma (1999)	B100	T	300	925	36	1	2.92	225	201.4	241.6	189.1	262.6	277.5	197.5	233.1	163.5	190.5	1.12	0.93	1.19	0.86	0.81	1.14	0.97	1.38	1.18
	B100-R	T	300	925	36	1	2.92	249	201.4	241.6	190.1	262.6	277.5	197.5	233.1	163.5	190.5	1.24	1.03	1.31	0.95	0.90	1.26	1.07	1.52	1.31
	B100L	T	300	925	39	1	2.92	223	206.8	248.2	193.9	272.3	288.8	183.5	232.2	165.4	193.6	1.08	0.90	1.15	0.82	0.77	1.22	0.96	1.35	1.15
	B100L-R	T	300	925	39	1	2.92	235	206.8	248.2	194.2	272.3	288.8	183.6	232.2	165.4	193.6	1.14	0.95	1.21	0.86	0.81	1.28	1.01	1.42	1.21
	B100B	T	300	925	39	1	2.92	204	206.8	248.2	194.3	272.3	288.8	197.3	232.2	165.4	193.6	0.99	0.82	1.05	0.75	0.71	1.03	0.88	1.23	1.05
	BN100	V	300	925	37	0.75	2.92	192	184.6	221.5	173.0	259.7	281.3	202.1	216.9	142.2	165.9	1.04	0.87	1.11	0.74	0.68	0.95	0.89	1.35	1.16
	BN50	T	300	450	37	0.81	3	131.7	104.8	125.8	102.1	126.7	136.9	116.8	124.5	88.6	95.8	1.26	1.05	1.29	1.04	0.96	1.13	1.06	1.49	1.37
	BN25	T	300	225	37	0.88	3	72.9	62.8	75.4	59.8	63.7	68.4	71.2	65.1	56.5	58.5	1.16	0.97	1.22	1.14	1.07	1.02	1.12	1.29	1.25
	BN12	T	300	110	37	0.9	3.07	40	37.4	38.2	32.3	31.1	33.5	37.6	37.6	34.3	35.1	1.07	1.05	1.24	1.28	1.20	1.06	1.06	1.16	1.14
	SE100A-45	V	295	920	50	1.03	2.5	200.8	222.1	266.5	223.1	306.1	319.8	242.0	225.6	169.5	202.1	0.90	0.75	0.90	0.66	0.63	0.83	0.89	1.18	0.99
	SE100A-45-R	T	295	920	50	1.03	2.5	235.7	222.1	266.5	222.4	306.1	319.8	242.0	225.6	169.5	202.1	1.06	0.88	1.06	0.77	0.74	0.97	1.04	1.39	1.17
	SE50A-45	T	169	459	53	1.03	2.72	68.6	73.3	87.9	73.8	88.6	94.1	77.7	77.7	61.8	66.5	0.94	0.78	0.93	0.77	0.73	0.88	0.88	1.11	1.03
	SE50A-45-R	T	169	459	53	1.03	2.72	80.5	73.3	87.9	73.2	88.6	94.1	77.7	77.7	61.8	66.5	1.10	0.92	1.10	0.91	0.86	1.04	1.04	1.30	1.21
	SE100A-83	T	295	920	86	1.03	2.5	184	236.0	319.3	143.3	356.3	378.4	164.3	210.0	170.1	209.6	0.78	0.58	1.28	0.52	0.49	1.12	0.88	1.08	0.88
	SE50A-83	V	169	459	91	1.03	2.72	73.1	76.4	105.3	64.3	100.7	108.2	76.9	85.4	66.9	68.1	0.96	0.69	1.14	0.73	0.68	0.95	0.86	1.09	1.07

Beams without web reinforcement									V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Collins Kuchma (1999)	B100H	V	300	925	98	1	2.92	193	238.7	337.4	225.5	356.5	387.0	264.4	207.4	167.5	211.0	0.81	0.57	0.86	0.54	0.50	0.73	0.93	1.15	0.91
	B100HE	T	300	925	98	1	2.92	217	238.7	337.4	225.3	356.5	387.0	261.4	207.4	167.5	211.0	0.91	0.64	0.96	0.61	0.56	0.83	1.05	1.30	1.03
	BH100	T	300	925	99	0.75	2.92	193	216.9	307.6	204.7	350.3	387.0	257.3	191.1	144.8	182.7	0.89	0.63	0.94	0.55	0.50	0.75	1.01	1.33	1.06
	BH50	T	300	450	99	0.81	3	131.7	123.2	174.6	125.1	170.7	188.2	144.7	132.9	104.7	105.6	1.07	0.75	1.05	0.77	0.70	0.91	0.99	1.26	1.25
	BH25	T	300	225	99	0.88	3	84.8	73.8	104.6	81.3	85.8	94.1	82.3	84.4	77.0	64.4	1.15	0.81	1.04	0.99	0.90	1.03	1.01	1.10	1.32
	BRL100	T	300	925	94	0.5	2.92	163	189.5	264.1	172.7	344.1	387.0	209.0	178.5	119.3	149.2	0.86	0.62	0.94	0.47	0.42	0.78	0.91	1.37	1.09
Ahmad Khaloo Poveda (1986)	A8	T	127	208	60.8	1.77	3	48.92	37.2	44.8	34.9	33.4	34.3	41.8	41.7	38.0	36.5	1.32	1.09	1.40	1.46	1.43	1.17	1.17	1.29	1.34
	A1	T	127	203	60.8	3.93	4	57.83	38.0	45.8	38.8	34.5	33.5	41.9	56.1	50.4	48.3	1.52	1.26	1.49	1.68	1.73	1.38	1.03	1.15	1.20
	A2	T	127	203	60.8	3.93	3	68.95	38.0	45.8	42.3	37.4	33.5	46.3	63.4	50.4	48.3	1.81	1.51	1.63	1.84	2.06	1.49	1.09	1.37	1.43
	A3	T	127	203	60.8	3.93	2.7	68.95	38.0	45.8	43.4	38.9	33.5	47.6	65.7	50.4	48.3	1.81	1.51	1.59	1.77	2.06	1.45	1.05	1.37	1.43
	B1	T	127	202	67	5.04	4	51.21	37.9	47.1	42.3	37.4	35.0	44.5	62.3	52.9	49.0	1.35	1.09	1.21	1.37	1.46	1.15	0.82	0.97	1.04
	B2	T	127	202	67	5.04	3	68.94	37.9	47.1	45.7	41.1	35.0	48.9	70.5	52.9	49.0	1.82	1.46	1.51	1.68	1.97	1.41	0.98	1.30	1.41
	C1	T	127	184	64.3	6.64	4	54.28	35.3	42.5	45.2	35.6	31.2	44.5	54.8	48.9	45.4	1.54	1.28	1.20	1.52	1.74	1.22	0.99	1.11	1.20
	C2	V	127	184	64.3	6.64	3	75.63	35.3	42.5	49.1	40.1	31.2	43.7	62.2	48.9	45.4	2.14	1.78	1.54	1.89	2.42	1.73	1.22	1.55	1.67
	C3	T	127	184	64.3	6.64	2.7	68.95	35.3	42.5	50.7	42.4	31.2	43.6	64.6	48.9	45.4	1.95	1.62	1.36	1.63	2.21	1.58	1.07	1.41	1.52
	C7	T	127	207	64.3	3.26	4	45.39	38.6	47.4	38.1	35.0	35.1	45.8	52.9	52.4	49.3	1.18	0.96	1.19	1.30	1.29	0.99	0.86	0.87	0.92
	C8	T	127	207	64.3	3.26	3	44.48	38.6	47.4	41.6	37.5	35.1	49.4	59.6	52.4	49.3	1.15	0.94	1.07	1.19	1.27	0.90	0.75	0.85	0.90
	C9	T	127	207	64.3	3.26	2.7	45.39	38.6	47.4	42.8	38.8	35.1	50.4	61.7	52.4	49.3	1.18	0.96	1.06	1.17	1.29	0.90	0.74	0.87	0.92
	B7	V	127	208	66.9	2.25	4	44.62	38.7	48.2	35.7	34.3	36.0	43.3	43.8	44.2	41.1	1.15	0.93	1.25	1.30	1.24	1.03	1.02	1.01	1.09
	B8	T	127	208	66.9	2.25	3	46.7	38.7	48.2	38.9	36.0	36.0	47.2	49.4	44.2	41.1	1.21	0.97	1.20	1.30	1.30	0.99	0.95	1.06	1.14
Yoon Cook Mitchell (1996)	N1-S	T	375	655	36	2.8	3.23	249	238.0	285.6	254.1	263.4	245.6	168.2	299.9	263.5	295.3	1.05	0.87	0.98	0.95	1.01	1.48	0.83	0.94	0.84
	M1-S	T	375	655	67	2.8	3.23	296	282.1	351.3	293.1	340.1	335.1	205.6	307.0	293.3	331.9	1.05	0.84	1.01	0.87	0.88	1.44	0.96	1.01	0.89
	H1-S	T	375	655	87	2.8	3.23	327	282.1	383.2	292.0	346.4	342.5	219.5	307.4	295.9	331.9	1.16	0.85	1.12	0.94	0.95	1.49	1.06	1.10	0.99
Ahmad et al (1995)	LNN-3	T	127	215.9	40.3	1.04	3	22.64	28.0	33.6	26.0	27.3	29.0	29.8	28.5	26.0	26.5	0.81	0.67	0.87	0.83	0.78	0.76	0.79	0.87	0.85
	LHN-3	T	127	215.9	89.1	2.07	3	43.39	39.8	54.5	39.1	37.6	38.2	44.3	54.8	47.5	40.6	1.09	0.80	1.11	1.15	1.13	0.98	0.79	0.91	1.07
Kim Park (1994)	CTL-1	T	170	270	53.7	1.87	3	70.68	59.5	71.5	59.4	55.4	56.1	68.6	68.8	59.4	59.7	1.19	0.99	1.19	1.28	1.26	1.03	1.03	1.19	1.18
	CTl-2	V	170	270	53.7	1.87	3	71.6	59.5	71.5	59.7	55.4	56.1	68.2	68.8	59.4	59.7	1.20	1.00	1.20	1.29	1.28	1.05	1.04	1.21	1.20
	P1.0-1	T	170	272	53.7	1.01	3	58.26	48.8	58.5	50.2	52.4	56.5	57.1	54.1	43.8	44.2	1.19	1.00	1.16	1.11	1.03	1.02	1.08	1.33	1.32
	P1.0-2	T	170	272	53.7	1.01	3	56.41	48.8	58.5	50.4	52.4	56.5	57.0	54.1	43.8	44.2	1.16	0.96	1.12	1.08	1.00	0.99	1.04	1.29	1.28
	P3.4-1	T	170	267	53.7	3.35	3	78.07	60.4	72.4	69.1	60.6	55.4	78.9	91.6	75.6	76.0	1.29	1.08	1.13	1.29	1.41	0.99	0.85	1.03	1.03

Beams without web reinforcement									V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Kim Park (1994)	P3.4-2	T	170	267	53.7	3.35	3	78.52	60.4	72.4	68.9	60.6	55.4	78.5	91.6	75.6	76.0	1.30	1.08	1.14	1.30	1.42	1.00	0.86	1.04	1.03
	P4.6-1	T	170	255	53.7	4.68	3	89.73	58.3	69.9	71.8	62.8	52.9	76.0	98.2	73.3	73.3	1.54	1.28	1.25	1.43	1.69	1.18	0.91	1.22	1.22
	P4.6-2	T	170	255	53.7	4.68	3	95.37	58.3	69.9	71.7	62.8	52.9	76.3	98.2	73.3	73.3	1.64	1.36	1.33	1.52	1.80	1.25	0.97	1.30	1.30
	A4.5-1	V	170	270	53.7	1.87	4.5	66.55	59.5	71.5	52.4	52.3	56.1	61.1	59.8	59.4	59.7	1.12	0.93	1.27	1.27	1.19	1.09	1.11	1.12	1.11
	A4.5-2	T	170	270	53.7	1.87	4.5	63.8	59.5	71.5	52.7	52.3	56.1	60.8	59.8	59.4	59.7	1.07	0.89	1.21	1.22	1.14	1.05	1.07	1.07	1.07
	D142-1	T	170	142	53.7	1.87	3	41.03	36.8	40.4	33.0	29.1	29.5	41.9	48.6	39.0	37.1	1.11	1.02	1.24	1.41	1.39	0.98	0.84	1.05	1.11
	D142-2	T	170	142	53.7	1.87	3	39.34	36.8	40.4	33.0	29.1	29.5	41.9	48.6	39.0	37.1	1.07	0.97	1.19	1.35	1.33	0.94	0.81	1.01	1.06
	D550-1	T	300	550	53.7	1.87	3	226.1	184.4	221.3	191.6	199.2	201.5	194.9	202.5	166.9	184.2	1.23	1.02	1.18	1.13	1.12	1.16	1.12	1.35	1.23
	D550-2	T	300	550	53.7	1.87	3	214.5	184.4	221.3	191.5	199.2	201.5	195.0	202.5	166.9	184.2	1.16	0.97	1.12	1.08	1.06	1.10	1.06	1.29	1.16
	D915-1	V	300	915	53.7	1.87	3	299.2	280.9	337.0	287.7	331.4	335.3	285.0	282.7	232.8	279.7	1.07	0.89	1.04	0.90	0.89	1.05	1.06	1.29	1.07
	D915-2	T	300	915	53.7	1.87	3	332.1	280.9	337.0	286.3	331.4	335.3	286.3	282.7	232.8	279.7	1.18	0.99	1.16	1.00	0.99	1.16	1.17	1.43	1.19
Bazant Kazemi (1991)	I-4		38.1	40.6	46.8	1.65	3	3.24	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	1.02	1.37	1.65	1.87	1.84	1.22		1.28	1.22
	I-5		38.1	40.6	46.8	1.65	3	2.95	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	0.93	1.24	1.50	1.70	1.67	1.11		1.17	1.11
	I-6		38.1	40.6	46.8	1.65	3	3.09	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	0.97	1.30	1.57	1.79	1.75	1.16		1.22	1.16
	I-7		38.1	81.2	46.8	1.65	3	5.49	5.1	4.7	3.9	3.5	3.5	5.3		5.1	5.1	1.08	1.16	1.40	1.59	1.56	1.03		1.09	1.07
	I-8		38.1	81.2	46.8	1.65	3	5.58	5.1	4.7	3.9	3.5	3.5	5.3		5.1	5.1	1.10	1.18	1.42	1.61	1.58	1.05		1.10	1.09
	I-9		38.1	81.2	46.8	1.65	3	5.18	5.1	4.7	3.9	3.5	3.5	5.3		5.1	5.1	1.02	1.09	1.32	1.50	1.47	0.97		1.02	1.01
	I-10		38.1	162.5	46.8	1.65	3	9.07	8.3	9.5	7.2	6.9	7.1	8.9		8.5	8.4	1.09	0.96	1.26	1.31	1.28	1.02		1.07	1.08
	I-11		38.1	162.5	46.8	1.65	3	9.78	8.3	9.5	7.2	6.9	7.1	8.9		8.5	8.4	1.17	1.03	1.36	1.41	1.39	1.10		1.15	1.17
	I-12		38.1	162.5	46.8	1.65	3	10.14	8.3	9.5	7.2	6.9	7.1	8.9		8.5	8.4	1.22	1.07	1.41	1.46	1.44	1.14		1.19	1.21
	II-4		38.1	41.2	46.1	1.62	3	2.93	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	0.92	1.23	1.48	1.68	1.65	1.10		1.16	1.10
	II-5		38.1	41.2	46.1	1.62	3	2.69	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	0.85	1.13	1.36	1.55	1.51	1.01		1.06	1.01
	II-6		38.1	41.2	46.1	1.62	3	3.18	3.2	2.4	2.0	1.7	1.8	2.7		2.5	2.7	1.00	1.34	1.60	1.83	1.79	1.19		1.26	1.20
	II-7		38.1	82.5	46.1	1.62	3	5.4	5.1	4.8	4.0	3.5	3.6	5.3		5.1	5.1	1.06	1.13	1.36	1.55	1.52	1.01		1.07	1.06
	II-8		38.1	82.5	46.1	1.62	3	5.02	5.1	4.8	4.0	3.5	3.6	5.3		5.1	5.1	0.99	1.05	1.27	1.44	1.41	0.94		0.99	0.98
	II-9		38.1	82.5	46.1	1.62	3	4.44	5.1	4.8	4.0	3.5	3.6	5.3		5.1	5.1	0.87	0.93	1.12	1.27	1.25	0.83		0.88	0.87
	II-10		38.1	165.1	46.1	1.62	3	7.29	8.3	9.5	7.2	7.0	7.1	8.9		8.5	8.4	0.87	0.76	1.01	1.05	1.02	0.82		0.86	0.87
	II-11		38.1	165.1	46.1	1.62	3	8.38	8.3	9.5	7.2	7.0	7.1	8.9		8.5	8.4	1.00	0.88	1.16	1.20	1.18	0.94		0.99	1.00
	II-12		38.1	165.1	46.1	1.62	3	8.2	8.3	9.5	7.3	7.0	7.1	8.9		8.5	8.4	0.98	0.86	1.13	1.18	1.15	0.92		0.97	0.98

Beams without web reinforcement									V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Thorentfeldt Drangsholt (1990)	B21	T	150	221	77.8	1.82	3	67.93	46.4	60.7	43.0	44.8	46.2	46.5	60.3	51.1	45.7	1.46	1.12	1.58	1.52	1.47	1.46	1.13	1.33	1.49
	B11	T	150	221	54	1.82	3	58.12	44.8	53.7	42.4	40.0	40.6	44.4	52.1	45.4	44.8	1.30	1.08	1.37	1.45	1.43	1.31	1.12	1.28	1.30
	B13	V	150	207	54	3.23	4	70.46	44.0	52.8	43.0	38.3	38.0	45.8	60.9	56.6	55.4	1.60	1.34	1.64	1.84	1.85	1.54	1.16	1.24	1.27
	B14	T	150	207	54	3.23	3	82.63	44.0	52.8	46.9	41.2	38.0	49.2	68.1	56.6	55.4	1.88	1.57	1.76	2.01	2.17	1.68	1.21	1.46	1.49
	B23	T	150	207	77.8	3.23	4	77.82	45.6	59.6	43.7	42.8	43.3	48.0	71.0	65.6	58.0	1.71	1.31	1.78	1.82	1.80	1.62	1.10	1.19	1.34
	B24	T	150	207	77.8	3.23	3	82.63	45.6	59.6	48.0	45.7	43.3	52.3	78.9	65.6	58.0	1.81	1.39	1.72	1.81	1.91	1.58	1.05	1.26	1.43
	B33	T	150	207	58	3.23	4	68.01	45.0	54.1	44.2	39.5	39.4	46.9	62.5	58.8	57.0	1.51	1.26	1.54	1.72	1.73	1.45	1.09	1.16	1.19
	B34	T	150	207	58	3.23	3	82.63	45.0	54.1	48.0	42.4	39.4	50.1	69.8	58.8	57.0	1.83	1.53	1.72	1.95	2.10	1.65	1.18	1.41	1.45
	B43	T	150	207	86.4	3.23	4	86.16	45.6	61.7	45.3	42.8	43.3	49.8	74.8	67.8	58.0	1.89	1.40	1.90	2.01	1.99	1.73	1.15	1.27	1.49
	B44	T	150	207	86.4	3.23	3	107.2	45.6	61.7	50.1	45.7	43.3	54.4	82.8	67.8	58.0	2.35	1.74	2.14	2.34	2.47	1.97	1.29	1.58	1.85
	B53	T	150	207	97.7	3.23	4	76.84	45.6	64.3	47.4	42.8	43.3	51.9	79.8	70.4	58.0	1.69	1.19	1.62	1.79	1.77	1.48	0.96	1.09	1.33
	B54	T	150	207	97.7	3.23	3	77.72	45.6	64.3	52.2	45.7	43.3	56.7	88.0	70.4	58.0	1.71	1.21	1.49	1.70	1.80	1.37	0.88	1.10	1.34
	B63	T	300	414	77.8	3.23	4	229.4	155.8	203.8	151.9	171.4	173.2	159.3	206.2	195.3	197.4	1.47	1.13	1.51	1.34	1.32	1.44	1.11	1.17	1.16
	B64	T	300	414	77.8	3.23	3	280.7	155.8	203.8	174.3	182.8	173.2	176.5	214.9	195.3	197.4	1.80	1.38	1.61	1.54	1.62	1.59	1.31	1.44	1.42
	B51	V	150	221	97.7	1.82	3	56.16	46.4	65.5	46.8	44.8	46.2	50.1	66.6	54.7	45.7	1.21	0.86	1.20	1.25	1.21	1.12	0.84	1.03	1.23
	B61	T	300	442	77.8	1.82	3	180.3	159.0	208.1	149.0	179.2	184.9	155.4	172.8	152.2	156.0	1.13	0.87	1.21	1.01	0.98	1.16	1.04	1.18	1.16
Kani Huggins Wiltkopp (1979)	1	T	150	137	28	2.75	5.93	28.7	26.0	28.3	20.3	17.5	18.1	23.5	31.0	30.5	32.8	1.10	1.01	1.41	1.64	1.58	1.22	0.92	0.94	0.88
	2	T	150	137	25	2.73	3.93	28.6	25.1	27.3	21.9	18.0	17.1	26.6	38.3	29.0	31.6	1.14	1.05	1.31	1.59	1.67	1.08	0.75	0.99	0.90
	3	T	150	137	25	2.8	3.02	32.7	25.1	27.3	23.2	19.6	17.1	28.7	43.2	29.0	31.6	1.30	1.20	1.41	1.67	1.91	1.14	0.76	1.13	1.03
	4	T	156	270	27	2.74	3	65.1	44.4	53.3	45.9	41.2	36.5	55.6	64.0	51.7	55.7	1.47	1.22	1.42	1.58	1.78	1.17	1.02	1.26	1.17
	5	V	151	270	27	2.84	4	55.4	43.0	51.6	41.1	36.9	35.3	50.4	56.2	50.1	53.9	1.29	1.07	1.35	1.50	1.57	1.10	0.99	1.11	1.03
	6	V	155	270	30	2.66	6.46	53.6	45.7	54.9	37.9	36.2	38.2	45.3	44.3	53.6	57.2	1.17	0.98	1.41	1.48	1.40	1.18	1.21	1.00	0.94
	7	T	156	543	26	2.77	4	93.1	76.2	91.5	74.3	75.1	72.0	98.5	100.8	85.8	95.2	1.22	1.02	1.25	1.24	1.29	0.95	0.92	1.08	0.98
	8	T	156	543	27	2.77	3.12	107.8	77.2	92.6	80.5	81.9	73.4	106.0	107.8	86.9	96.3	1.40	1.16	1.34	1.32	1.47	1.02	1.00	1.24	1.12
	9	V	156	543	26	2.72	6.84	84.6	76.2	91.5	60.8	68.5	72.0	79.1	79.8	85.8	95.2	1.11	0.93	1.39	1.24	1.18	1.07	1.06	0.99	0.89
	10	V	154	1090	27	2.71	3	164.4	135.9	163.1	143.5	163.6	145.4	177.7	163.2	144.0	168.9	1.21	1.01	1.15	1.00	1.13	0.93	1.01	1.14	0.97
	11	T	152	1090	30	2.72	3.98	158	139.0	166.8	122.1	155.6	151.2	157.7	155.8	146.3	172.3	1.14	0.95	1.29	1.02	1.04	1.00	1.01	1.08	0.92
	12	T	155	1090	27	2.7	7	153.6	136.8	164.2	105.5	138.4	146.3	135.2	149.6	145.0	170.0	1.12	0.94	1.46	1.11	1.05	1.14	1.03	1.06	0.90
	15	T	152	270	17	0.5	2.98	27.2	23.4	28.1	24.0	25.9	28.2	27.2	29.2	21.4	21.9	1.16	0.97	1.13	1.05	0.96	1.00	0.93	1.27	1.24
	16	T	152	270	17	0.5	3.53	24.5	23.4	28.1	20.0	25.6	28.2	23.4	27.4	21.4	21.9	1.05	0.87	1.23	0.96	0.87	1.05	0.90	1.14	1.12

Beams without web reinforcement									Vpred (KN)									Vtest/Vpred								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Kani Huggins Wiltkopp (1979)	17	T	152	270	28	0.5	3.47	25.4	27.6	33.1	20.0	32.4	36.2	24.6	30.4	22.6	24.2	0.92	0.77	1.27	0.78	0.70	1.03	0.83	1.12	1.05
	20	T	152	270	35	0.5	2.57	33.6	29.7	35.7	28.0	36.9	40.5	35.2	35.7	24.1	25.4	1.13	0.94	1.20	0.91	0.83	0.95	0.94	1.39	1.33
	21	T	152	270	35	0.5	3.52	24.9	29.7	35.7	20.0	36.1	40.5	24.7	32.1	24.1	25.4	0.84	0.70	1.25	0.69	0.62	1.01	0.78	1.03	0.98
	23	V	152	270	17	0.8	3.96	30.2	27.3	32.8	24.9	26.1	28.2	30.7	29.2	27.1	27.8	1.10	0.92	1.21	1.16	1.07	0.99	1.03	1.12	1.09
	24	T	152	270	17	0.8	5.02	27.3	27.3	32.8	19.3	25.6	28.2	24.6	25.7	27.1	27.8	1.00	0.83	1.42	1.07	0.97	1.11	1.06	1.01	0.98
	28	T	152	270	17	0.8	2.48	35.6	27.3	32.8	30.4	28.0	28.2	39.2	34.6	27.1	27.8	1.30	1.09	1.17	1.27	1.26	0.91	1.03	1.31	1.28
	29	T	152	270	17	0.8	3.02	32.5	27.3	32.8	27.9	27.0	28.2	35.4	32.6	27.1	27.8	1.19	0.99	1.16	1.21	1.15	0.92	1.00	1.20	1.17
	30	T	152	270	17	0.8	2.99	32.8	27.3	32.8	28.4	27.0	28.2	36.0	32.7	27.1	27.8	1.20	1.00	1.16	1.21	1.16	0.91	1.00	1.21	1.18
	32	V	152	270	26	0.8	2.98	38.8	31.5	37.8	33.3	32.7	34.9	41.8	35.3	28.0	30.2	1.23	1.03	1.17	1.19	1.11	0.93	1.10	1.39	1.28
	33	T	152	270	26	0.8	4.03	33.6	31.5	37.8	27.7	31.8	34.9	31.3	31.3	28.0	30.2	1.07	0.89	1.22	1.06	0.96	1.08	1.07	1.20	1.11
	34	T	152	270	26	0.8	2.5	41.5	31.5	37.8	33.6	33.6	34.9	43.6	37.2	28.0	30.2	1.32	1.10	1.24	1.23	1.19	0.95	1.12	1.48	1.37
	35	T	152	270	26	0.8	2.53	44.6	31.5	37.8	34.4	33.6	34.9	47.0	37.0	28.0	30.2	1.42	1.18	1.30	1.33	1.28	0.95	1.20	1.59	1.48
	36	T	152	270	26	0.8	5.08	25.7	31.5	37.8	23.8	31.3	34.9	24.9	27.6	28.0	30.2	0.82	0.68	1.08	0.82	0.74	1.03	0.93	0.92	0.85
	37	T	152	270	26	0.8	5.05	27.9	31.5	37.8	22.0	31.3	34.9	23.9	27.7	28.0	30.2	0.89	0.74	1.27	0.89	0.80	1.17	1.01	1.00	0.92
	38	V	152	270	26	0.8	2.49	43.3	31.5	37.8	34.2	33.7	34.9	43.8	37.2	28.0	30.2	1.37	1.15	1.27	1.29	1.24	0.99	1.16	1.55	1.43
	39	T	152	270	26	0.8	2.49	39.4	31.5	37.8	34.1	33.7	34.9	44.1	37.2	28.0	30.2	1.25	1.04	1.16	1.17	1.13	0.89	1.06	1.41	1.30
	42	V	152	270	26	0.8	3.01	39.3	31.5	37.8	31.5	32.7	34.9	38.5	35.2	28.0	30.2	1.25	1.04	1.25	1.20	1.13	1.02	1.12	1.41	1.30
	43	T	152	270	26	0.8	3.96	32.6	31.5	37.8	27.6	31.8	34.9	30.0	31.5	28.0	30.2	1.03	0.86	1.18	1.03	0.93	1.09	1.03	1.17	1.08
Cladera (2002)	H50/1	T	200	359	49.9	2.24	3.01	99.69	87.2	104.7	90.0	86.2	84.5	91.0	109.2	90.4	94.4	1.14	0.95	1.11	1.16	1.18	1.10	0.91	1.10	1.06
	H60/1	T	200	359	60.8	2.24	3.01	108.1	92.8	111.8	95.0	93.7	93.3	97.0	114.0	94.9	98.0	1.17	0.97	1.14	1.15	1.16	1.11	0.95	1.14	1.10
	H75/1	V	200	359	68.9	2.24	3.01	99.93	92.8	116.6	101.0	98.9	99.3	99.0	117.3	97.5	98.0	1.08	0.86	0.99	1.01	1.01	1.01	0.85	1.02	1.02
	H100/1	T	200	359	87	2.24	3.01	117.9	92.8	126.0	110.0	99.5	100.1	100.0	124.0	101.8	98.0	1.27	0.94	1.07	1.18	1.18	1.18	0.95	1.16	1.20
Adebar Collins (1996)	ST1	T	360	278	52.5	1.57	2.88	128	120.7	144.9	120.8	117.9	120.9	128.6	113.1	116.6	118.0	1.06	0.88	1.06	1.09	1.06	1.00	1.13	1.10	1.08
	ST2	T	360	278	52.5	1.57	2.88	119	120.7	144.9	121.4	117.9	120.9	128.2	113.1	116.6	118.0	0.99	0.82	0.98	1.01	0.98	0.93	1.05	1.02	1.01
	ST3	T	290	278	49.3	1.95	2.88	108	102.4	122.9	100.9	95.2	94.3	135.7	109.9	102.8	104.6	1.05	0.88	1.07	1.13	1.14	0.80	0.98	1.05	1.03
	ST8	T	290	278	46.2	1.95	2.88	81	100.2	120.2	57.4	92.6	91.3	62.8	108.5	100.8	103.3	0.81	0.67	1.41	0.87	0.89	1.29	0.75	0.80	0.78
	ST16	T	290	178	51.5	3.04	4.49	74.3	74.8	87.1	68.8	60.6	61.7	77.4	80.6	96.6	94.2	0.99	0.85	1.08	1.23	1.20	0.96	0.92	0.77	0.79
	ST23	V	290	278	58.9	1	2.88	90	87.0	104.4	89.1	95.7	103.1	101.5	89.2	77.5	77.6	1.03	0.86	1.01	0.94	0.87	0.89	1.01	1.16	1.16
Johnson	6	T	305	610	55.8	2.49	3.1	191.3	211.3	253.6	201.3	236.4	231.6	205.7	251.8	210.7	236.8	0.91	0.75	0.95	0.81	0.83	0.93	0.78	0.91	0.81

Beams without web reinforcement									V_{pred} (KN)									V_{test}/V_{pred}								
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	Eq. 6.1	Eq. 6.3
Ahmad et al (1995)	B7H	T	102	178	76.6	1.39	3.7	24.51	24.5	31.0	19.1	23.3	25.3	20.4	26.0	26.7	23.1	1.00	0.79	1.28	1.05	0.97	1.20	0.94	0.92	1.06
	B8H	T	102	178	79.3	1.39	3.7	19.79	24.5	31.3	15.6	23.3	25.3	16.6	26.6	27.0	23.1	0.81	0.63	1.27	0.85	0.78	1.19	0.74	0.73	0.86
Xie et al. (1994)	NNN-3	V	127	215.9	37.7	2.07	3	36.68	34.1	40.9	32.5	28.9	28.1	37.1	38.4	35.8	37.0	1.08	0.90	1.13	1.27	1.31	0.99	0.95	1.02	0.99
	NHN-3	T	127	215.9	98.9	2.07	3	45.72	39.8	56.4	40.5	37.6	38.2	46.2	57.9	48.9	40.6	1.15	0.81	1.13	1.21	1.20	0.99	0.79	0.93	1.13
Salandra Ahmad (1989)	LR-2.59-NS	V	101.6	171.4	53.7	1.45	2.59	26.68	23.2	26.8	22.6	21.0	21.3	27.5	25.1	23.2	22.4	1.15	1.00	1.18	1.27	1.25	0.97	1.06	1.15	1.19
	LR-3.63-NS	T	101.6	171.4	52.1	1.45	3.63	21.79	23.0	26.5	20.0	19.6	20.9	23.9	21.0	22.9	22.2	0.95	0.82	1.09	1.11	1.04	0.91	1.04	0.95	0.98
	HR-3.63-NS	T	101.6	171.4	69.1	1.45	3.63	20.02	24.1	29.1	21.5	22.3	24.1	22.8	24.8	25.5	22.9	0.83	0.69	0.93	0.90	0.83	0.88	0.81	0.78	0.87
	HR-2.59-NS	T	101.6	171.4	66.8	1.45	2.59	29.8	24.1	28.8	24.2	23.1	23.7	25.7	28.3	25.2	22.9	1.24	1.04	1.23	1.29	1.26	1.16	1.05	1.18	1.30
Kulkarni Shah (1998)	B4JL20-S	T	102	152	41.9	1.37	5	19.52	19.3	21.5	14.6	15.2	16.7	18.1	14.9	19.0	19.0	1.01	0.91	1.34	1.28	1.17	1.08	1.31	1.03	1.03
	B3NO15-S	T	102	152	43	1.37	4	22.66	19.4	21.7	15.7	15.7	16.9	19.5	17.9	19.2	19.1	1.17	1.04	1.44	1.44	1.34	1.16	1.27	1.18	1.18
	B3NO30-S	T	102	152	45	1.37	3.5	24.24	19.7	22.0	16.8	16.3	17.3	20.7	19.8	19.5	19.3	1.23	1.10	1.44	1.49	1.40	1.17	1.22	1.24	1.26
González (2002)	V10HC	T	202	306	40.2	2.88	3.27	88.86	72.4	86.8	75.6	69.4	65.3	97.7	102.3	86.4	90.3	1.23	1.02	1.18	1.28	1.36	0.91	0.87	1.03	0.98
	V10HCS	T	203	306	46.77	2.87	3.27	100.5	76.5	91.8	79.8	74.2	70.8	92.5	106.1	91.7	94.6	1.31	1.10	1.26	1.36	1.42	1.09	0.95	1.10	1.06
	V10HR	T	200	305	39.65	2.93	3.28	90.64	71.1	85.4	75.0	68.3	64.0	96.4	101.5	84.9	88.8	1.27	1.06	1.21	1.33	1.42	0.94	0.89	1.07	1.02
	V10HRS	T	199	305	41.45	2.93	3.28	83.88	71.8	86.2	76.2	69.2	65.1	92.6	101.9	86.1	89.7	1.17	0.97	1.10	1.21	1.29	0.91	0.82	0.97	0.94
																	Average	**1.23**	**1.02**	**1.28**	**1.28**	**1.29**	**1.13**	**1.00**	**1.15**	**1.13**
																	Standard deviation	**0.29**	**0.23**	**0.22**	**0.34**	**0.40**	**0.23**	**0.13**	**0.18**	**0.19**
																	Coef. of variation	**23.61**	**22.03**	**16.80**	**26.36**	**31.21**	**20.00**	**12.75**	**15.73**	**16.42**

V beam used for the verification process of the ANN

T beam used for the training process of the ANN

Beams with stirrups										Vpred (KN)										Vtest/Vpred									
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	ρ_w MPa	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4
Angelakos (1999)	DB120M	T	300	925	21	1	0.46	2.7	282	254	285	361	337	339	346	282	304	284	293	1.11	0.99	0.78	0.84	0.83	0.82	1.00	0.93	0.99	0.96
	DB140M	T	300	925	38	1	0.46	2.7	277	285	285	399	399	412	346	327	322	306	317	0.97	0.97	0.69	0.69	0.67	0.80	0.85	0.86	0.91	0.87
	DB165M	V	300	925	65	1	0.46	2.7	452	313	285	395	474	500	415	380	339	327	336	1.44	1.58	1.14	0.95	0.90	1.09	1.19	1.33	1.38	1.35
	DB180M	T	300	925	80	1	0.46	2.7	395	313	285	395	487	514	415	396	346	337	344	1.26	1.38	1.00	0.81	0.77	0.95	1.00	1.14	1.17	1.15
	DB0530M	T	300	925	32	0.5	0.46	2.7	263	242	285	207	365	389	244	264	250	250	264	1.09	0.92	1.27	0.72	0.68	1.08	1.00	1.05	1.05	1.00
Yoon Cook Mitchell (1996)	N1-N	T	375	655	36	2.8	0.34	3.23	457	274	190	312	348	330	339	421	410	368	346	1.67	2.40	1.47	1.31	1.38	1.35	1.09	1.12	1.24	1.32
	N2-S	V	375	655	36	2.8	0.34	3.23	363	274	190	417	348	330	336	421	410	368	346	1.32	1.91	0.87	1.04	1.10	1.08	0.86	0.89	0.99	1.05
	N2-N	T	375	655	36	2.8	0.47	3.23	483	303	261	464	380	362	424	491	461	416	397	1.59	1.85	1.04	1.27	1.33	1.14	0.98	1.05	1.16	1.22
	M2-S	T	375	655	67	2.8	0.47	3.23	552	340	261	546	456	451	516	521	507	465	431	1.63	2.11	1.01	1.21	1.22	1.07	1.06	1.09	1.19	1.28
	M2-N	T	375	655	67	2.8	0.69	3.23	689	387	380	604	509	504	636	644	586	546	512	1.78	1.81	1.14	1.35	1.37	1.08	1.07	1.18	1.26	1.34
	H1-N	T	375	655	87	2.8	0.34	3.23	483	311	190	546	431	427	436	450	474	439	393	1.55	2.54	0.88	1.12	1.13	1.11	1.07	1.02	1.10	1.23
	H2-S	V	375	655	87	2.8	0.6	3.23	598	368	333	612	494	490	605	592	576	537	497	1.62	1.80	0.98	1.21	1.22	0.99	1.01	1.04	1.11	1.20
	H2-N	T	375	655	87	2.8	0.99	3.23	721	454	547	720	589	585	750	802	697	676	637	1.59	1.32	1.00	1.22	1.23	0.96	0.90	1.03	1.07	1.13
	M I-N	T	375	655	67	2.8	0.34	3.23	405	311	190	338	425	420	409	450	453	416	378	1.30	2.13	1.20	0.95	0.97	0.99	0.90	0.89	0.97	1.07
Collins Kuchma (1999)	SE50A-M-69	T	169	459	75	1.03	0.65	2.72	139	109	114	143	151	159	142	121	125	125	137	1.27	1.22	0.97	0.92	0.88	0.98	1.15	1.11	1.11	1.01
	SE100A-M-69	T	295	920	71	1.03	0.78	5	516	388	478	537	549	591	499	542	453	452	459	1.33	1.08	0.96	0.94	0.87	1.03	0.95	1.14	1.14	1.13
	BM100	T	300	925	47	0.75	0.36	2.92	342	255	222	377	389	416	340	292	252	248	261	1.34	1.54	0.91	0.88	0.82	1.01	1.17	1.36	1.38	1.31
Adebar Collins (1996)	ST4	T	290	278	49.3	1.95	0.47	2.88	158	120	86	161	133	132	165	164	155	144	154	1.32	1.84	0.98	1.18	1.19	0.96	0.96	1.02	1.09	1.03
	ST5	V	290	278	49.3	1.95	0.96	2.88	169	155	175	186	173	172	219	205	205	202	201	1.09	0.97	0.91	0.98	0.98	0.77	0.82	0.82	0.84	0.84
	ST6	T	290	278	49.3	1.95	1.2	2.88	230	175	218	226	192	191	247	220	226	226	223	1.32	1.05	1.02	1.20	1.20	0.93	1.05	1.02	1.02	1.03
	ST18	T	290	278	49.8	1.95	0.92	2.88	246	152	167	194	170	169	215	203	202	197	199	1.62	1.48	1.27	1.45	1.46	0.93	1.22	1.22	1.25	1.24
	ST19	T	290	278	50.8	1.95	0.92	2.88	201	153	167	195	171	170	216	204	202	198	199	1.32	1.21	1.03	1.18	1.19	0.93	0.99	1.00	1.02	1.01
Tan Kong Teng Weng (1997)	1-2.00/2.50	T	110	448	74.1	2	1.85	2.79	195	164	205	178	159	160	209	173	176	176	171	1.19	0.95	1.10	1.22	1.22	0.93	1.12	1.11	1.11	1.14
	2-2.58/0.25	V	110	443	54.7	2.58	2.39	2.82	155	210	262	167	180	177	199	204	203	203	191	0.74	0.59	0.93	0.86	0.88	0.78	0.76	0.76	0.76	0.81
	4-5.80/2.50	T	110	398	74.1	5.8	2.58	3.14	265	203	254	189	185	174	239	273	234	217	207	1.30	1.04	1.40	1.43	1.52	1.11	0.97	1.13	1.22	1.28
	G-2.70-5.38	T	110	463	42.8	1.23	1.85	2.7	105	170	212	135	148	150	135	106	156	156	141	0.62	0.50	0.78	0.71	0.70	0.78	0.99	0.67	0.67	0.74
Kong Rangan (1998)	S1-1	T	250	292	63.6	2.8	0.85	2.5	228	138	140	205	169	159	233	247	217	202	200	1.65	1.63	1.11	1.35	1.43	0.98	0.93	1.05	1.13	1.14
	S1-2	T	250	292	63.6	2.8	0.85	2.5	208	138	140	205	169	159	234	247	217	202	200	1.51	1.49	1.02	1.23	1.31	0.89	0.84	0.96	1.03	1.04
	S1-3	T	250	292	63.6	2.8	0.85	2.5	206	138	140	205	169	159	233	247	217	202	200	1.49	1.47	1.01	1.22	1.29	0.88	0.84	0.95	1.02	1.03

Beams with stirrups										V_{pred} (KN)										V_{test}/V_{pred}									
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	ρ_w MPa	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4
Kong Rangan (1998)	S1-4	V	250	292	63.6	2.8	0.85	2.5	278	138	140	205	169	159	248	247	218	202	200	2.01	1.98	1.36	1.65	1.74	1.13	1.13	1.28	1.38	1.39
	S1-5	T	250	292	63.6	2.8	0.85	2.5	253	138	140	205	169	159	233	247	217	202	200	1.83	1.81	1.24	1.50	1.59	1.09	1.03	1.16	1.25	1.26
	S1-6	T	250	292	63.6	2.8	0.85	2.5	224	138	140	205	169	159	233	247	217	202	200	1.62	1.60	1.09	1.33	1.41	0.96	0.91	1.03	1.11	1.12
	S2-1	T	250	292	72.5	2.8	0.57	2.5	260	120	93	185	152	143	171	229	193	176	181	2.18	2.79	1.41	1.71	1.82	1.52	1.14	1.35	1.48	1.44
	S2-2	T	250	292	72.5	2.8	0.68	2.5	233	127	112	196	160	152	189	241	205	189	191	1.83	2.07	1.19	1.45	1.53	1.23	0.96	1.13	1.23	1.22
	S2-3	T	250	292	72.5	2.8	0.85	2.5	253	138	140	212	173	164	218	258	221	205	205	1.83	1.81	1.19	1.46	1.54	1.16	0.98	1.15	1.23	1.24
	S2-4	T	250	292	72.5	2.8	0.85	2.5	219	138	140	212	173	164	217	258	221	205	205	1.59	1.57	1.03	1.27	1.34	1.01	0.85	0.99	1.07	1.07
	S2-5	V	250	292	72.5	2.8	1.14	2.5	282	157	187	237	194	185	269	279	245	230	228	1.80	1.51	1.19	1.46	1.53	1.05	1.01	1.15	1.23	1.24
	S3-2	T	250	297	67.4	1.65	0.57	2.49	178	116	95	171	143	144	172	184	149	140	151	1.53	1.87	1.04	1.24	1.24	1.03	0.97	1.19	1.28	1.18
	S3-3	T	250	293	67.4	2.79	0.57	2.49	229	120	94	189	151	142	193	223	191	174	179	1.91	2.44	1.21	1.51	1.61	1.19	1.02	1.19	1.32	1.27
	S3-4	T	250	293	67.4	2.79	0.57	2.49	175	120	94	189	151	142	193	223	191	174	179	1.46	1.87	0.93	1.16	1.23	0.91	0.78	0.91	1.01	0.97
	S4-4	T	250	292	87.3	2.8	0.85	2.5	258	138	140	221	173	164	217	272	225	210	211	1.87	1.84	1.17	1.49	1.57	1.19	0.95	1.15	1.23	1.22
	S4-6	T	250	198	87.3	2.78	0.85	2.53	203	99	95	221	117	111	147	206	161	152	151	2.05	2.13	0.92	1.74	1.82	1.38	0.99	1.26	1.34	1.34
	S5-1	V	250	292	89.4	2.8	0.85	3.01	242	138	140	213	167	164	230	250	219	211	211	1.75	1.72	1.13	1.45	1.47	1.05	0.97	1.10	1.15	1.14
	S5-2	T	250	292	89.4	2.8	0.85	2.74	260	138	140	218	170	164	236	263	222	211	211	1.88	1.85	1.19	1.53	1.58	1.10	0.99	1.17	1.23	1.23
	S5-3	T	250	292	89.4	2.8	0.85	2.5	244	138	140	223	173	164	218	273	226	211	211	1.76	1.74	1.09	1.41	1.49	1.12	0.89	1.08	1.16	1.15
	S6-3	T	250	293	68.9	2.79	0.45	2.73	178	112	74	147	140	134	177	206	175	161	166	1.59	2.39	1.21	1.27	1.33	1.01	0.86	1.02	1.11	1.07
	S6-4	T	250	293	68.9	2.79	0.45	2.73	214	112	74	147	140	134	177	206	175	161	166	1.91	2.88	1.46	1.53	1.59	1.21	1.04	1.22	1.33	1.29
	S6-5	T	250	299	68.9	3.69	0.44	2.64	297	114	74	161	151	136	181	242	205	188	186	2.62	4.00	1.84	1.97	2.18	1.64	1.23	1.45	1.58	1.60
	S6-6	V	250	299	68.9	3.69	0.44	2.64	287	114	74	161	151	136	181	242	205	188	186	2.53	3.86	1.78	1.91	2.10	1.59	1.19	1.40	1.53	1.54
	S7-1	T	250	294	74.8	4.46	0.43	3.3	217	111	72	142	144	134	171	240	209	196	191	1.95	3.03	1.53	1.51	1.62	1.27	0.91	1.04	1.11	1.14
	S7-2	T	250	294	74.8	4.46	0.52	3.3	205	117	86	148	150	141	192	248	218	204	203	1.75	2.39	1.39	1.37	1.46	1.07	0.83	0.94	1.01	1.01
	S7-3	T	250	294	74.8	4.46	0.65	3.3	247	126	107	218	160	150	220	258	231	216	216	1.96	2.29	1.13	1.54	1.64	1.12	0.96	1.07	1.14	1.14
	S7-4	T	250	294	74.8	4.46	0.82	3.3	274	137	136	238	173	163	256	270	247	231	231	2.00	2.01	1.15	1.58	1.68	1.07	1.01	1.11	1.19	1.18
	S7-5	T	250	294	74.8	4.46	0.95	3.3	304	146	158	252	182	173	277	277	259	242	242	2.09	1.93	1.21	1.67	1.76	1.10	1.10	1.17	1.26	1.26
	S7-6	T	250	294	74.8	4.46	1.13	3.3	311	157	186	270	195	185	308	284	274	257	257	1.98	1.67	1.15	1.59	1.68	1.01	1.10	1.13	1.21	1.21
	S8-1	V	250	292	74.6	2.8	0.57	2.5	272	120	93	187	152	143	161	232	194	177	182	2.27	2.91	1.46	1.79	1.90	1.69	1.18	1.40	1.54	1.50
	S8-2	T	250	292	74.6	2.8	0.68	2.5	251	127	112	198	160	152	182	244	206	190	192	1.97	2.24	1.27	1.56	1.66	1.38	1.03	1.22	1.32	1.31
	S8-3	T	250	292	74.6	2.8	0.68	2.5	310	127	111	211	160	151	220	243	205	189	191	2.44	2.78	1.47	1.93	2.05	1.41	1.27	1.51	1.64	1.62
	S8-4	T	250	292	74.6	2.8	0.85	2.5	266	138	140	214	173	164	220	260	221	206	206	1.92	1.90	1.24	1.54	1.62	1.21	1.02	1.20	1.29	1.29

Beams with stirrups										V_{pred} (KN)										V_{test}/V_{pred}									
Author	**ID**	ANN	**b mm**	**d mm**	**f_c MPa**	**ρ_l %**	**ρ_w MPa**	**a/d**	**V_{test} KN**	**EHE**	**EC-2**	**LRFD**	**ACI 11-5**	**ACI 11-3**	**Resp**	**ANN**	**6.2.2**	**6.2.3**	**6.2.4**	**EHE**	**EC-2**	**LRFD**	**ACI 11-5**	**ACI 11-3**	**Resp**	**ANN**	**6.2.2**	**6.2.3**	**6.2.4**
Kong et al. (1998)	S8-5	T	250	292	74.6	2.8	1.08	2.5	289	153	178	233	190	181	254	278	241	226	224	1.89	1.63	1.24	1.53	1.60	1.14	1.04	1.20	1.28	1.29
	S8-6	T	250	292	74.6	2.8	1.25	2.5	284	165	206	247	202	193	284	288	255	241	238	1.73	1.38	1.15	1.41	1.47	1.00	0.99	1.11	1.18	1.19
Jonhson Ramirez (1989)	1	T	305	539	36.4	2.49	0.73	3.1	338	246	271	341	296	286	389	369	361	334	341	1.37	1.25	0.99	1.14	1.18	0.87	0.92	0.94	1.01	0.99
	2	T	305	539	36.4	2.49	0.37	3.1	222	192	136	212	235	225	259	238	274	247	252	1.16	1.64	1.05	0.95	0.99	0.86	0.93	0.81	0.90	0.88
	3	T	305	539	72.3	2.49	0.34	3.1	262	212	124	340	285	284	328	269	297	274	266	1.24	2.12	0.77	0.92	0.92	0.80	0.98	0.88	0.96	0.99
	4	V	305	539	72.3	2.49	0.34	3.1	316	212	124	340	285	284	329	269	297	274	266	1.49	2.55	0.93	1.11	1.11	0.96	1.18	1.06	1.15	1.19
	5	T	305	539	55.8	2.49	0.73	3.1	383	268	271	379	329	325	455	401	384	360	363	1.43	1.41	1.01	1.16	1.18	0.84	0.95	1.00	1.06	1.05
	7	T	305	539	51.2	2.49	0.37	3.1	280	209	136	232	262	256	292	259	289	264	264	1.34	2.07	1.21	1.07	1.09	0.96	1.08	0.97	1.06	1.06
	8	T	305	539	51.2	2.49	0.37	3.1	258	209	136	232	262	256	293	259	289	264	264	1.24	1.90	1.11	0.99	1.01	0.88	1.00	0.89	0.98	0.98
Ozcebe Ersoy Tankut (1999)	ACI56	T	150	310	58	3.45	0.33	5	93.6	65	35	88	73	74	88	89	102	100	98	1.44	2.70	1.06	1.28	1.26	1.07	1.05	0.92	0.94	0.96
	TH56	T	150	310	63	3.45	0.41	5	104	69	43	98	79	80	101	94	109	107	106	1.50	2.42	1.06	1.32	1.29	1.02	1.10	0.95	0.97	0.97
	ACI36	V	150	310	75	2.59	0.33	3	105	66	35	100	81	80	92	130	96	90	91	1.61	3.04	1.05	1.29	1.31	1.14	0.81	1.09	1.17	1.16
	TH36	T	150	310	75	2.59	0.41	3	141	69	43	104	85	84	104	137	102	96	98	2.05	3.30	1.36	1.66	1.68	1.36	1.03	1.38	1.47	1.44
	TS36	T	150	310	75	2.59	0.59	3	156	76	61	114	93	92	128	152	116	109	112	2.04	2.54	1.37	1.67	1.69	1.22	1.03	1.35	1.44	1.39
	ACI39	T	150	310	73	3.08	0.33	3	112	66	35	102	83	80	92	140	106	98	97	1.71	3.22	1.10	1.34	1.39	1.22	0.80	1.06	1.14	1.15
	TH39	T	150	310	73	3.08	0.51	3	143	73	53	112	92	89	119	156	120	112	113	1.96	2.68	1.28	1.56	1.61	1.20	0.92	1.19	1.28	1.27
	TS39	T	150	310	73	3.08	0.69	3	179	81	72	122	100	97	142	172	132	124	125	2.23	2.49	1.47	1.79	1.85	1.26	1.04	1.36	1.44	1.43
	ACI59	T	150	310	82	4.43	0.55	5	96.5	75	58	73	90	91	92	114	134	132	132	1.29	1.67	1.33	1.07	1.07	1.05	0.85	0.72	0.73	0.73
	TH59	T	150	310	75	4.43	0.77	5	119	84	80	74	100	100	107	120	144	142	141	1.43	1.49	1.62	1.19	1.19	1.11	0.99	0.83	0.84	0.84
	TS59	T	150	310	82	4.43	1.15	5	125	100	120	81	118	118	138	129	165	164	163	1.26	1.04	1.54	1.06	1.06	0.91	0.97	0.76	0.76	0.77
Roller Russell (1990)	1	T	356	559	120	1.64	0.33	2.5	297	242	148	283	340	343	330	276	324	301	279	1.23	2.01	1.05	0.87	0.87	0.90	1.08	0.92	0.99	1.07
	6	T	457	871	72.4	1.52	0.36	3	666	460	322	758	671	698	616	637	537	500	470	1.45	2.06	0.88	0.99	0.95	1.08	1.05	1.24	1.33	1.42
	7	V	457	871	72.4	1.65	0.7	3	788	591	626	902	810	833	848	853	738	716	678	1.33	1.26	0.87	0.97	0.95	0.93	0.92	1.07	1.10	1.16
	8	T	457	762	125	1.88	0.39	3	483	439	303	447	607	621	644	526	605	572	494	1.10	1.59	1.08	0.80	0.78	0.75	0.92	0.80	0.84	0.98
	9	T	457	762	125	2.35	0.72	3	749	552	568	528	739	738	986	792	836	804	714	1.36	1.32	1.42	1.01	1.01	0.76	0.95	0.90	0.93	1.05
	10	T	457	762	125	2.88	1.07	3	1172	669	837	1149	874	858	1221	1020	1042	999	927	1.75	1.40	1.02	1.34	1.37	0.96	1.15	1.12	1.17	1.26
Cladera (2002)	H50/2	T	200	353	49.9	2.28	0.58	3.06	178	108	92	138	125	124	162	158	150	141	149	1.64	1.94	1.29	1.42	1.43	1.10	1.12	1.18	1.26	1.19
	H50/3	V	200	351	49.9	2.29	1.29	3.08	242	163	204	179	175	173	228	239	207	206	200	1.48	1.19	1.35	1.39	1.40	1.06	1.01	1.17	1.17	1.21
	H50/4	T	200	351	49.9	2.99	1.29	3.08	246	163	204	197	179	173	259	266	228	220	215	1.51	1.21	1.25	1.38	1.42	0.95	0.93	1.08	1.12	1.15

Beams with stirrups										V_{pred} (KN)										V_{test}/V_{pred}									
Author	ID	ANN	b mm	d mm	f_c MPa	ρ_l %	ρ_w MPa	a/d	V_{test} KN	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4
Cladera (2002)	H60/2	T	200	353	60.8	2.28	0.75	3.06	180	124	119	156	145	145	197	192	171	163	168	1.45	1.51	1.15	1.24	1.24	0.91	0.94	1.05	1.10	1.07
	H60/3	T	200	351	60.8	2.29	1.27	3.08	259	160	200	182	180	180	229	251	211	210	206	1.62	1.29	1.42	1.43	1.44	1.13	1.03	1.23	1.23	1.26
	H60/4	T	200	351	60.8	2.99	1.27	3.08	309	160	200	214	184	180	278	278	232	225	221	1.93	1.54	1.44	1.67	1.71	1.11	1.11	1.33	1.37	1.40
	H75/2	T	200	353	68.9	2.28	0.75	3.06	204	124	119	160	150	150	206	201	174	167	171	1.65	1.72	1.27	1.36	1.36	0.99	1.01	1.17	1.22	1.19
	H75/3	T	200	351	68.9	2.29	1.27	3.08	269	160	200	185	185	186	230	260	214	214	210	1.68	1.35	1.46	1.45	1.45	1.17	1.03	1.26	1.26	1.28
	H75/4	T	200	351	68.9	2.99	1.27	3.08	255	160	200	206	189	186	284	286	236	229	226	1.59	1.28	1.24	1.35	1.37	0.90	0.89	1.08	1.11	1.13
	H100/2	V	200	353	49.9	2.28	0.91	3.06	226	129	144	175	149	147	215	197	180	174	174	1.74	1.57	1.29	1.52	1.53	1.05	1.14	1.25	1.29	1.30
	H100/3	T	200	351	49.9	2.29	1.29	3.08	254	163	204	192	175	173	229	239	207	206	200	1.56	1.24	1.32	1.45	1.46	1.11	1.06	1.23	1.23	1.26
	H100/4	T	200	351	49.9	2.99	1.29	3.08	267	163	204	215	179	173	284	266	228	220	215	1.63	1.31	1.24	1.49	1.54	0.94	1.00	1.17	1.21	1.24
Lyngberg (1976)	5A-0	T	120	540	25.7	3.88	3.57	2.78	435	416	521	358	302	286	354	435	320	311	307	1.04	0.84	1.21	1.44	1.52	1.23	1.00	1.36	1.40	1.42
	5B-0	T	120	540	26.6	3.88	3.43	2.78	435	400	500	352	294	278	351	431	317	307	299	1.09	0.87	1.24	1.48	1.56	1.24	1.01	1.37	1.42	1.45
Ahmad Khaloo Poveda (1994)	LNW-3	T	127	216	44.6	2.07	1.59	3	63.3	79	98	79	75	74	72	113	91	91	83	0.81	0.64	0.80	0.85	0.85	0.88	0.56	0.70	0.70	0.76
	LHW-3a	T	127	198	88.1	4.54	2.73	3	107	124	155	141	109	104	116	114	144	141	134	0.86	0.69	0.76	0.99	1.03	0.92	0.94	0.74	0.76	0.80
	LHW-3b	T	127	198	86.9	4.54	3.28	3	121	149	186	128	122	118	145	111	155	155	147	0.81	0.65	0.94	0.99	1.03	0.83	1.09	0.78	0.78	0.82
	LHW-4	V	127	198	82.9	4.54	2.14	4	94.8	97	121	97	91	89	105	96	124	123	119	0.98	0.78	0.98	1.05	1.06	0.90	0.98	0.77	0.77	0.80
Sarsam Al-Musawi (1992)	BL2-H	T	180	233	75.7	2.81	0.49	4	138	68	46	104	77	79	126	128	104	102	105	2.03	3.00	1.33	1.79	1.75	1.10	1.08	1.33	1.35	1.32
	BS2-H	T	180	233	73.9	2.81	0.49	2.5	224	68	46	114	84	79	129	175	111	102	105	3.27	4.85	1.96	2.66	2.83	1.73	1.27	2.01	2.20	2.14
	BS4-H	T	180	233	80.1	2.81	0.98	2.5	207	87	92	152	105	99	207	203	139	130	129	2.39	2.24	1.36	1.98	2.08	1.00	1.02	1.49	1.59	1.61
	CL2-H	T	180	233	70.1	3.5	0.49	4	147	68	46	106	79	79	130	134	116	113	113	2.16	3.19	1.39	1.86	1.86	1.13	1.10	1.27	1.31	1.30
	CS3-H	T	180	233	74.2	3.5	0.71	2.5	247	76	67	139	97	88	180	203	135	125	124	3.23	3.71	1.78	2.56	2.81	1.37	1.22	1.83	1.98	1.99
	CS4-H	T	180	233	75.7	3.5	0.98	2.5	221	87	92	158	108	99	214	212	150	139	137	2.55	2.39	1.40	2.05	2.22	1.03	1.04	1.47	1.59	1.61
Etxeberria (2002)	HN-V2	T	200	303	41.9	2.99	1.15	3.3	213	125	157	152	139	135	193	200	185	179	174	1.70	1.36	1.40	1.53	1.58	1.10	1.06	1.15	1.19	1.22
	HN-V3	V	200	303	41.9	2.99	0.88	3.3	177	108	120	137	123	119	165	182	169	161	158	1.64	1.48	1.29	1.44	1.49	1.08	0.97	1.05	1.10	1.12
	HN-V4	T	200	303	41.9	2.99	0.63	3.3	188	94	85	120	107	103	131	162	149	139	143	1.99	2.20	1.56	1.75	1.82	1.43	1.16	1.26	1.35	1.32
González (2002)	V13HC	V	199	307	37.7	2.9	1.05	3.25	190	116	144	172	131	127	198	189	176	169	165	1.64	1.32	1.11	1.45	1.50	0.96	1.01	1.08	1.12	1.16
	V17HC	T	199	306	39.1	2.92	0.8	3.27	151	103	110	153	117	112	170	172	161	151	151	1.47	1.38	0.98	1.29	1.34	0.89	0.88	0.94	1.00	1.00
	V24HC	T	195	306	39.2	2.99	0.6	3.27	128	90	81	132	103	98	137	155	143	133	137	1.42	1.59	0.97	1.25	1.30	0.93	0.83	0.89	0.96	0.93
	V13HCS	V	200	308	42.8	2.9	1.05	3.25	220	119	146	177	136	132	208	197	181	174	170	1.84	1.51	1.24	1.62	1.67	1.06	1.12	1.22	1.26	1.29
	V17HCS	T	200	312	45.2	2.86	0.8	3.21	200	108	112	161	124	120	181	182	167	158	157	1.85	1.78	1.24	1.62	1.67	1.11	1.10	1.19	1.27	1.27

Beams with stirrups										V_{pred} (KN)										V_{test}/V_{pred}									
Author	**ID**	**ANN**	**b mm**	**d mm**	**f_c MPa**	**ρ_l %**	**ρ_w MPa**	**a/d**	**V_{test} KN**	**EHE**	**EC-2**	**LRFD**	**ACI 11-5**	**ACI 11-3**	**Resp**	**ANN**	**6.2.2**	**6.2.3**	**6.2.4**	**EHE**	**EC-2**	**LRFD**	**ACI 11-5**	**ACI 11-3**	**Resp**	**ANN**	**6.2.2**	**6.2.3**	**6.2.4**
González (2002)	V24HCS	T	200	302	43.7	2.95	0.6	3.3	150	93	82	135	107	103	140	161	147	137	141	1.61	1.84	1.11	1.41	1.46	1.07	0.93	1.02	1.10	1.06
	V13HR	T	200	307	40.5	2.9	1.05	3.26	234	118	145	175	134	130	203	193	179	172	168	1.98	1.61	1.34	1.75	1.80	1.15	1.21	1.31	1.36	1.39
	V17HR	T	200	306	41.5	2.91	0.8	3.27	177	104	110	155	119	115	173	175	163	153	153	1.70	1.61	1.14	1.49	1.54	1.02	1.01	1.09	1.15	1.16
	V24HR	T	201	306	39.2	2.9	0.6	3.27	164	93	83	134	105	101	138	156	145	135	140	1.77	1.98	1.22	1.56	1.63	1.19	1.05	1.13	1.22	1.18
	V13HRS	T	199	305	41.4	2.93	1.05	3.28	202	117	143	174	133	129	204	193	178	171	167	1.73	1.41	1.16	1.52	1.57	0.99	1.05	1.14	1.18	1.21
	V17HRS	T	199	305	44.5	2.93	0.8	3.28	193	105	109	157	120	116	176	178	164	155	154	1.84	1.77	1.23	1.61	1.66	1.10	1.08	1.18	1.25	1.25
	V24HRS	T	199	307	43.2	2.91	0.6	3.25	147	94	82	137	108	104	142	161	147	137	141	1.57	1.79	1.08	1.37	1.42	1.04	0.92	1.00	1.08	1.04

V beam used for the verification process of the ANN

T beam used for the training process of the ANN

	EHE	EC-2	LRFD	ACI 11-5	ACI 11-3	Resp	ANN	6.2.2	6.2.3	6.2.4
Average	**1.64**	**1.83**	**1.18**	**1.36**	**1.41**	**1.07**	**1.00**	**1.11**	**1.17**	**1.18**
Standard deviation	**0.43**	**0.74**	**0.23**	**0.34**	**0.38**	**0.19**	**0.11**	**0.21**	**0.23**	**0.22**
Coef. of variation	**26.26**	**40.29**	**19.23**	**24.60**	**26.70**	**17.39**	**11.32**	**18.77**	**19.56**	**18.71**

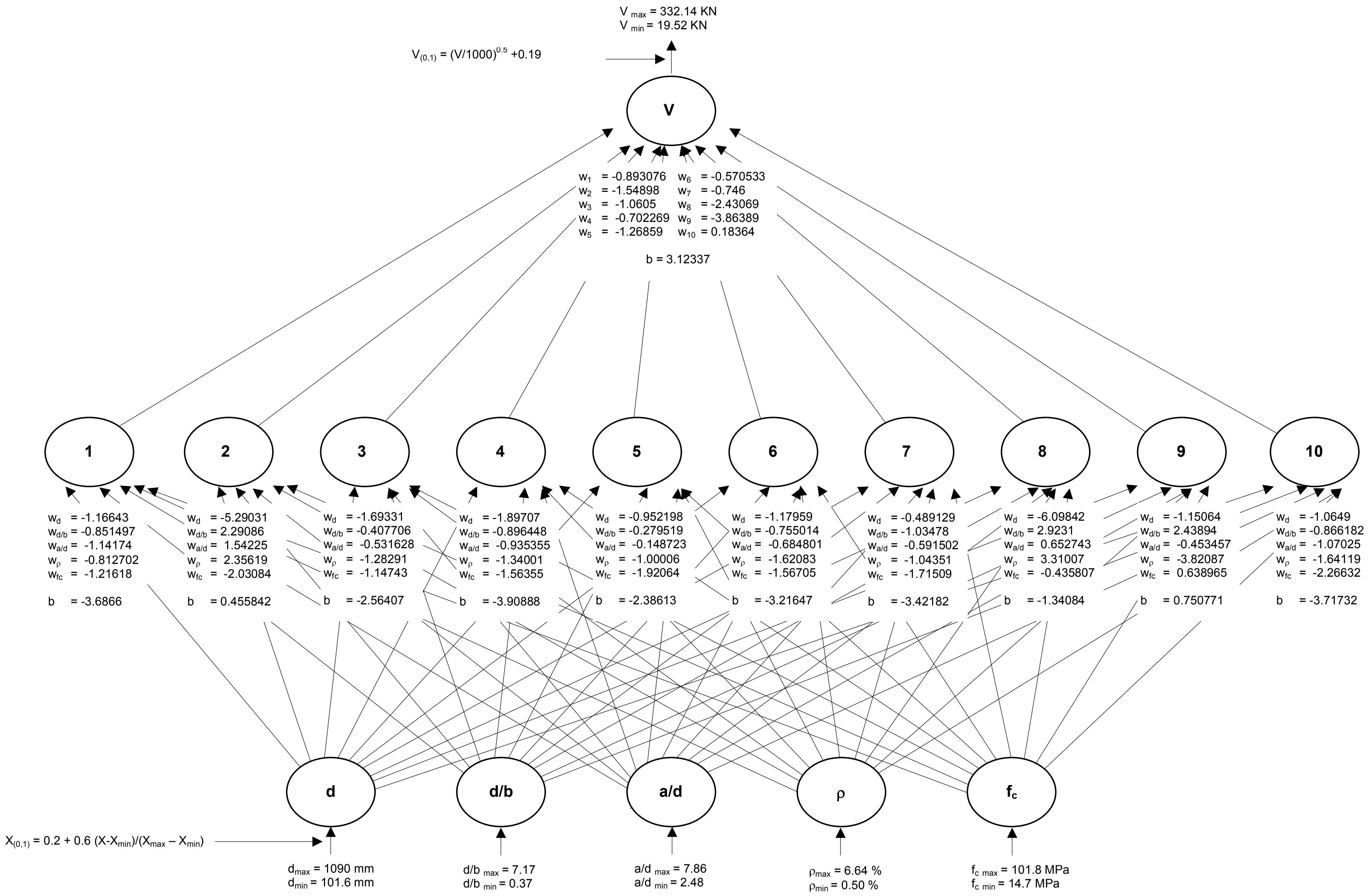
Annex D

ARTIFICIAL NEURAL NETWORKS. WEIGHTS AND BIASES

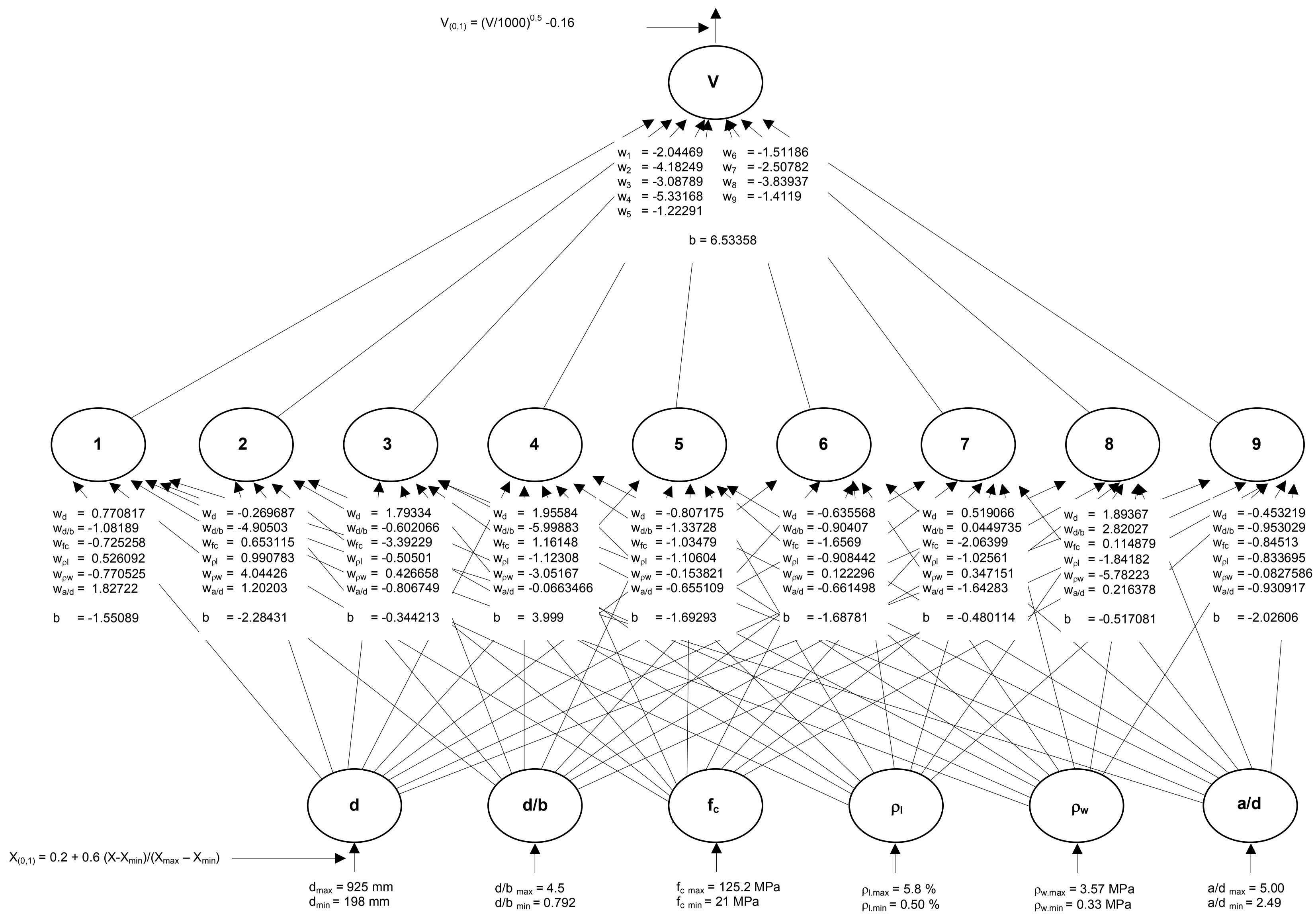
D.1 Artificial neural network for beams without web reinforcement

D.2 Artificial neural network for beams with stirrups

D.1 Neural network for beams without web reinforcement



D.2 Neural network for beams with stirrups



Annex E

NON LINEAR FINITE ELEMENT ANALYSES

E.1 Introduction

Sixteen beam specimens tested for this thesis have been studied using a non linear finite element model, Program Vector 2, developed by Prof. Vecchio and implemented in the University of Toronto. The results from the analyses are briefly discussed in this annex. Program Vector 2 is a non-linear finite element program based on an iterative, secant stiffness approach, and it includes the constitutive formulation of the Disturbed Stress Field Model (DSFM) developed by Vecchio (2000. 2001). The main features of the DSFM have been described in §2.3.2.

Program Augustus, by Dr. Bentz from the University of Toronto, was used to post-process the enormous amount of data generated by program Vector 2. The Figures given in these annex were plotted using this post-processor.

E.2 Description of the Model

Figure E.1 shows the finite element model used for the analyses. A denser mesh was used for elements without web reinforcement, as it was observed that for those beams the failure shear strength obtained by the model was more influenced by the mesh size.

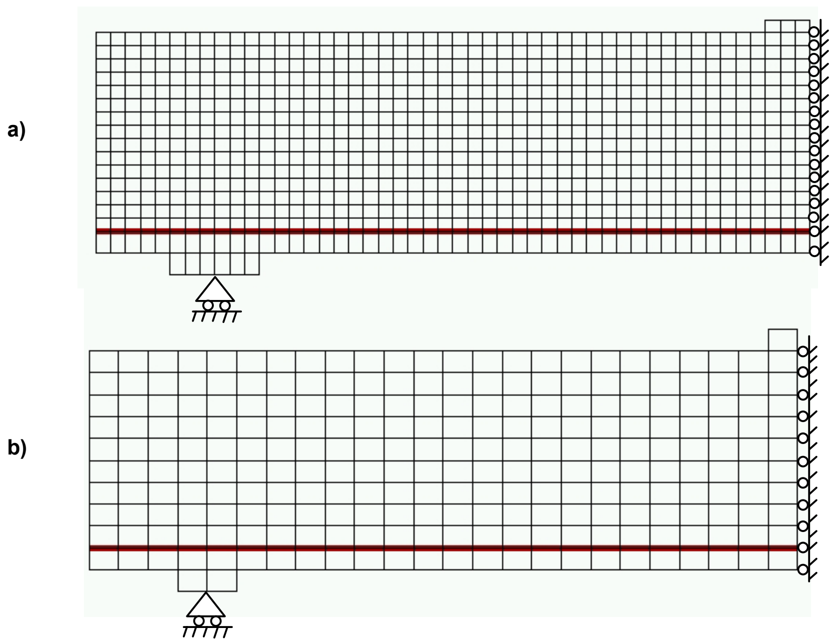


Figure E.1: Finite Element Model: a) Beams without web reinforcement. b) Beams with stirrups.

Four-nodded plane stress elements were used, as well as, truss bars to model the longitudinal reinforcement. For beams without web reinforcement, the mesh consisted of 777 rectangular concrete elements, 48 truss bar elements, and 884 nodes. For beams with stirrups, it consisted of 243 rectangular smeared reinforced concrete elements, 24 truss bar elements and 280 nodes. Bearing and loading plates were modelled with a stronger material. Concentrated loads were applied at the loading plate by means of displacement control.

The actual concrete compressive and tensile strength obtained in the test were utilized, and the stiffness of the concrete was computed by the relationship given by Carrasquillo:

$$E_c = 3320\sqrt{f'_c} + 6900 \quad MPa$$

Concrete compression pre-peak and post-peak response was calculated using Popovics' expression, since beams specimens were made of high-strength concrete:

$$\sigma_c = f_{cm} \frac{n(\varepsilon_c / \varepsilon_{c1})}{n - 1 + (\varepsilon_c / \varepsilon_{c1})^{nk}}$$

$$n = 0.8 + \frac{f_{cm}}{17}$$

$$k = \begin{cases} si(\varepsilon_c / \varepsilon_{c1}) \le 1 \Rightarrow k = 1.0 \\ si(\varepsilon_c / \varepsilon_{c1}) \le 1 \Rightarrow k = 0.67 + \dfrac{f_{cm}}{62} \end{cases}$$

$$\varepsilon_{c1} = \frac{f_{cm}}{E_c} \frac{n}{n-1}$$

Concrete compression softening model and tension stiffening model were accounted for by Vecchio (1992) and Bentz (2002) models respectively. For the highest concrete compressive strength considered, i.e. 87 MPa, the maximum aggregate size was taken equal to 0, to take into account the reduction in aggregate interlock. For the other concretes, the real maximum aggregate size (12 mm) was used in the model.

E.3 Comparison with Test Results

Table E.1 shows the results obtained from the Vector2 analyses. Predictions are satisfactory, with an average of the ratio $V_{test}/V_{vector2}$ equal to 0.98 and a standard deviation of 0.07. Vector2 predictions are slightly unconservative, probably because the aggregate interlock capacity of high-strength members is not yet absolutely determined.

Beam	f_c MPa	f_{sp} MPa	b mm	d mm	a/d	Shear reinf. Stirrup/spacing mm	Shear reinf. ρ_w MPa	Long. Reinf. Longitudinal reinforcement	Long. Reinf. ρ_l	V_{test} (KN)	V_{vect} (KN)	V_{test}/V_{vect}
H50/1	49.9	3.46	200	359	3.01	-	0	2ϕ32	2.24	100	97	1.03
H50/2	49.9	3.46	200	353	3.06	ϕ6/260	0.577	2ϕ32	2.28	178	177	1.01
H50/3	49.9	3.46	200	351	3.08	ϕ8/210	1.291	2ϕ32	2.29	242	237	1.02
H50/4	49.9	3.46	200	351	3.08	ϕ8/210	1.291	2ϕ32 + 1ϕ25	2.99	246	270	0.91
H60/1	60.8	4.22	200	359	3.01	-	0	2ϕ32	2.24	108	117	0.92
H60/2	60.8	4.22	200	353	3.06	ϕ6/200	0.747	2ϕ32	2.28	180	207	0.87
H60/3	60.8	4.22	200	351	3.08	ϕ8/210	1.267	2ϕ32	2.29	259	251	1.03
H60/4	60.8	4.22	200	351	3.08	ϕ8/210	1.267	2ϕ32 + 1ϕ25	2.99	309	272	1.14
H75/1	68.9	3.69	200	359	3.01	-	0	2ϕ32	2.24	100	106	0.94
H75/2	68.9	3.69	200	353	3.06	ϕ6/200	0.747	2ϕ32	2.28	204	214	0.95
H75/3	68.9	3.69	200	351	3.08	ϕ8/210	1.267	2ϕ32	2.29	269	257	1.05
H75/4	68.9	3.69	200	351	3.08	ϕ8/210	1.267	2ϕ32 + 1ϕ25	2.99	255	279	0.91
H100/1	87.0	4.05	200	359	3.01	-	0	2ϕ32	2.24	118	109	1.08
H100/2	87.0	4.05	200	353	3.06	ϕ6/165	0.906	2ϕ32	2.28	226	232	0.97
H100/3	87.0	4.05	200	351	3.08	ϕ8/210	1.291	2ϕ32	2.29	254	260	0.98
H100/4	87.0	4.05	200	351	3.08	ϕ8/210	1.291	2ϕ32 + 1ϕ25	2.99	267	288	0.93
										Average		**0.98**
										Standard deviation		**0.07**
										Coef. of variation		**7.24**

Table E.1: Summary of experimental results

Figure E.2 compares the test results with the failure shear strength obtained by the Vector2 analyses. It is remarkable that the non linear finite element model reproduces the observed behaviour that beam specimen H60/1 failed at a higher shear strength than beam H75/1. This clearly indicates that for beam without web reinforcement the beam failure is governed by the tensile strength rather than by the concrete compressive strength. Concrete splitting strength of the H60 concrete mix was higher than for the H70 mix, as it can be seen in Table E.1.

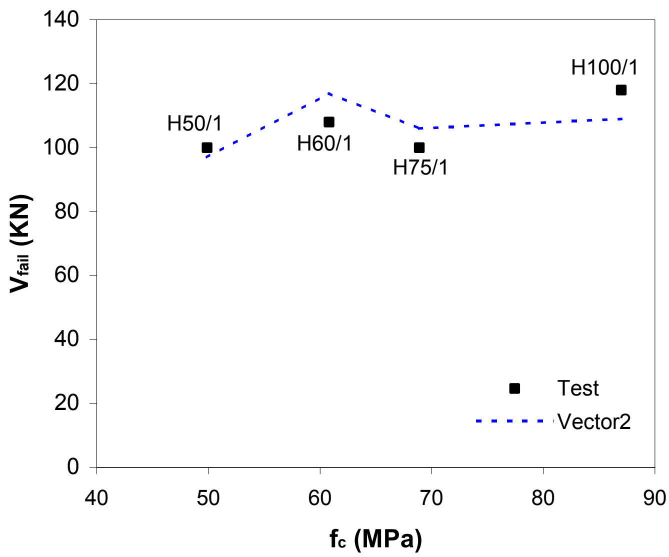


Figure E.2: Comparison of the failure shear strength calculated by the non linear finite element model with the real test for beams without web reinforcement H50/1, H60/1, H75/1 and H100/1.

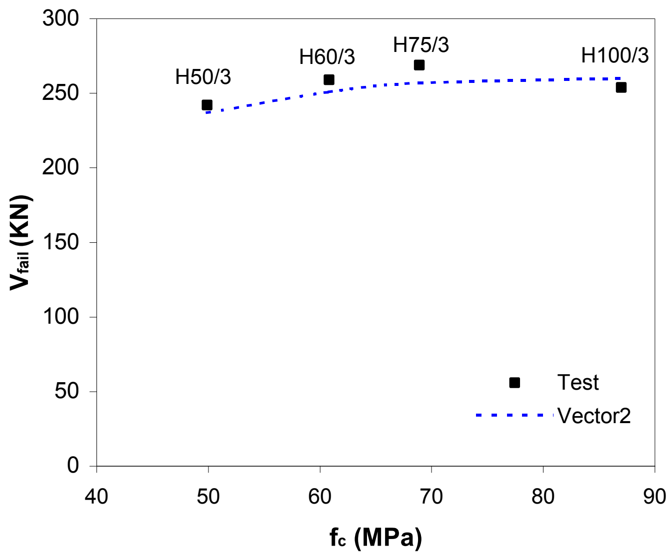


Figure E.3: Comparison of the failure shear strength calculated by the non linear finite element model with the real test for beams with stirrups H50/3, H60/3, H75/3 and H100/3.

For beams with web reinforcement, the model predicts an increase in shear strength when the concrete compressive strength increases. Figure E.3 shows the good agreement with the test results.

E.4 Influence of the bearing conditions

Beam specimens were supported by a sliding pin bearing in the real test and, as represented in Figure E.1. The same bearing was reproduced on the finite element model. In this section, results obtained in §E.3 are compared with results calculated considering a fixed pin bearing instead of a sliding one.

Table E.2 compares the results of the two different models. For beams without web reinforcement, the increase in failure shear strength due to the fixed bearing, V_{vt2}, is greater than 100% in percentage than the failure shear strength of the real beam with an sliding pin bearing, V_{vt1}. The formation of a clear arch mechanism is the cause of this increase, as it can be seen in Figure E.4 a) and b). However, it is important to highlight that in a laboratory test, this value could be reach only if the horizontal reaction can be attained. Under normal testing conditions of a steel supporting plate, the friction coefficient between steel and concrete can be taken as 0.3, and therefore the maximum value of the ratio H/V would be also 0.3, hence the ultimate shear strength would be an intermediate value.

Beam	f_c MPa	b mm	d mm	a/d	ρ_w	ρ_l	V_{test} KN	V_{vt1} KN	V_{vt2} KN	H_{vt2} KN	ΔV %	H_{vt2} / V_{vt2}
H50/1	49.9	200	359	3.01	0	2.24	100	97	197	383	103	1.94
H50/2	49.9	200	353	3.06	0.577	2.28	178	177	280	563	58	2.01
H50/3	49.9	200	351	3.08	1.291	2.29	242	237	384	718	62	1.87
H50/4	49.9	200	351	3.08	1.291	2.99	246	270	385	705	43	1.83
H60/1	60.8	200	359	3.01	0	2.24	108	117	235	461	101	1.96
H60/2	60.8	200	353	3.06	0.747	2.28	180	207	341	646	65	1.89
H60/3	60.8	200	351	3.08	1.267	2.29	259	251	370	699	47	1.89
H60/4	60.8	200	351	3.08	1.267	2.99	309	272	392	721	44	1.84
H75/1	68.9	200	359	3.01	0	2.24	100	106	220	439	108	2.00
H75/2	68.9	200	353	3.06	0.747	2.28	204	214	339	653	58	1.93
H75/3	68.9	200	351	3.08	1.267	2.29	269	257	361	696	40	1.93
H75/4	68.9	200	351	3.08	1.267	2.99	255	279	378	708	35	1.87
H100/1	87.0	200	359	3.01	0	2.24	118	109	237	479	117	2.02
H100/2	87.0	200	353	3.06	0.906	2.28	226	232	349	693	50	1.99
H100/3	87.0	200	351	3.08	1.291	2.29	254	260	353	697	36	1.97
H100/4	87.0	200	351	3.08	1.291	2.99	267	288	366	706	27	1.93

Table E.2: Influence of the bearing conditions in the non linear finite element analyses.

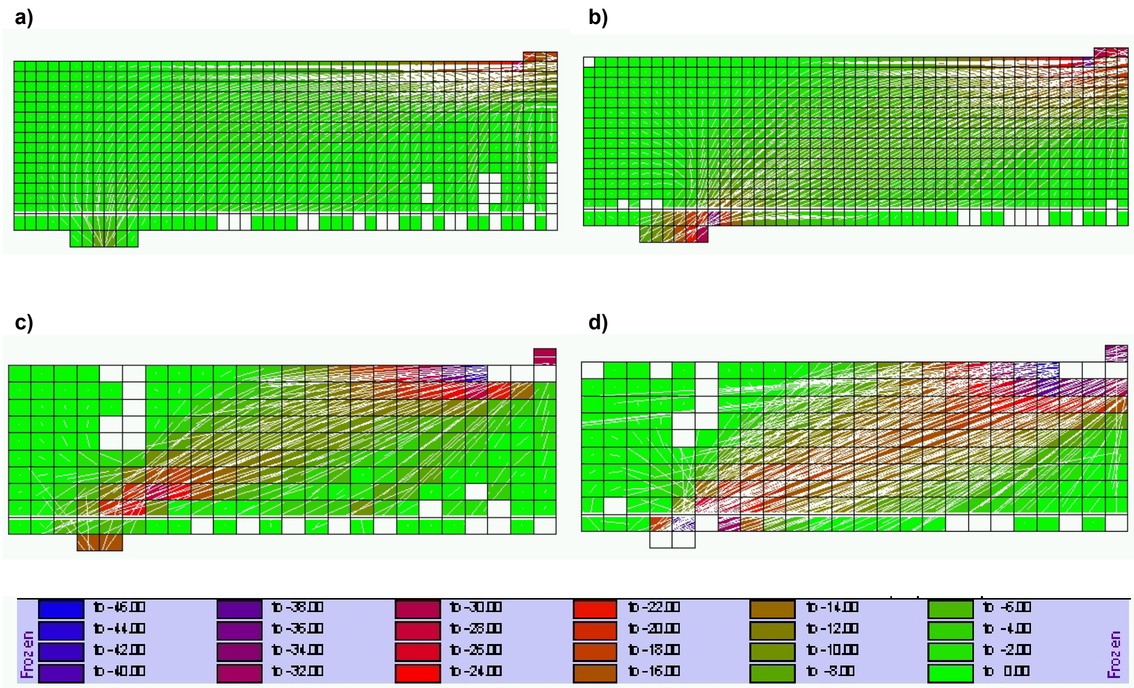


Figure E.4: Principal compressive stresses at failure. a) Beam specimen without web reinforcement (H50/1) supported by a sliding pin bearing. b) Beam specimen without web reinforcement (H50/1) supported by a fixed pin bearing. c) Beam specimen with stirrups (H50/3) supported by a sliding pin bearing. d) Beam specimen with stirrups (H50/3) supported by a fixed pin bearing.

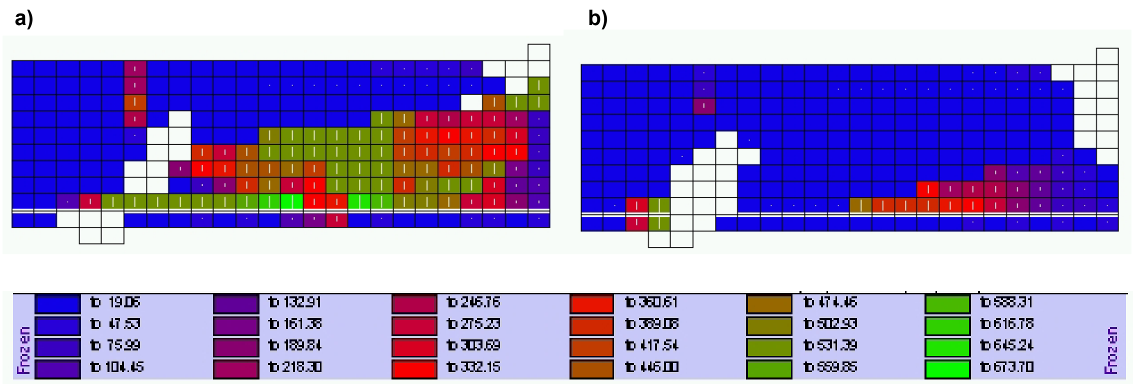


Figure E.5: Steel stress at a crack in beam H50/3 for a shear load equal to 235 KN. a) Beam specimen supported by a sliding pin bearing. b) Beam specimen supported by a fixed pin bearing.

For beams with stirrups, the increase is also important, but not so significant, as the arch action effect and the contribution of the stirrups are not two independent components. The more reinforcement the lesser failure shear strength increase. Figure E.4 c) and d) shows the arch action for beam specimen H50/3 assuming a sliding pin bearing and a fixed pin bearing. The horizontal compressive reaction delays the shear cracking, and stirrups take high tensile stresses later, as it can be seen in Figure E.5.