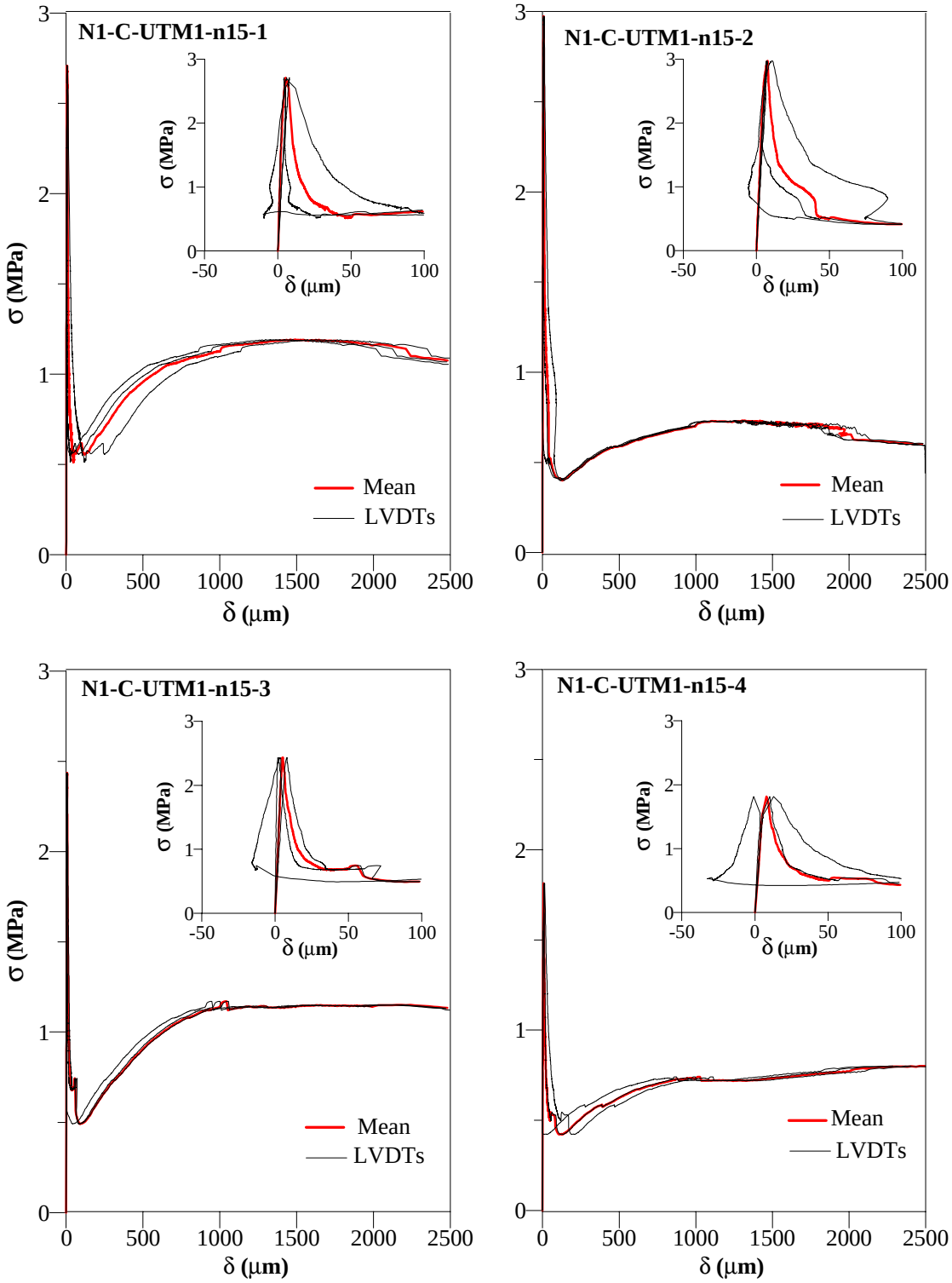
ANNEX B

Parametric Study Test Data

Figure B.1. Effect of h/∅ ratio. Stress - δ curves for specimens with h/∅ = 1 (h = 150 mm; ∅ = 150 mm; notch depth = 15 mm)



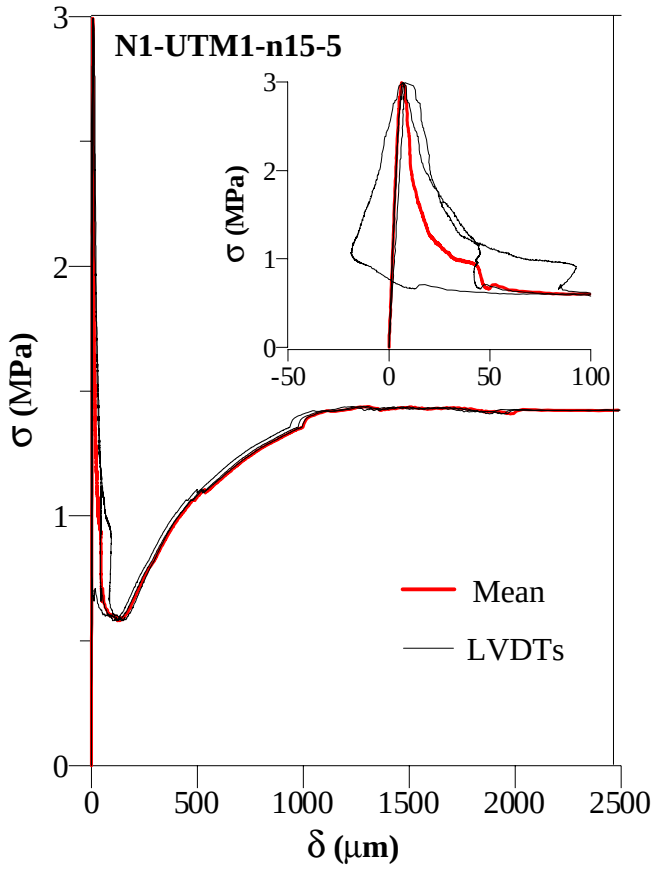
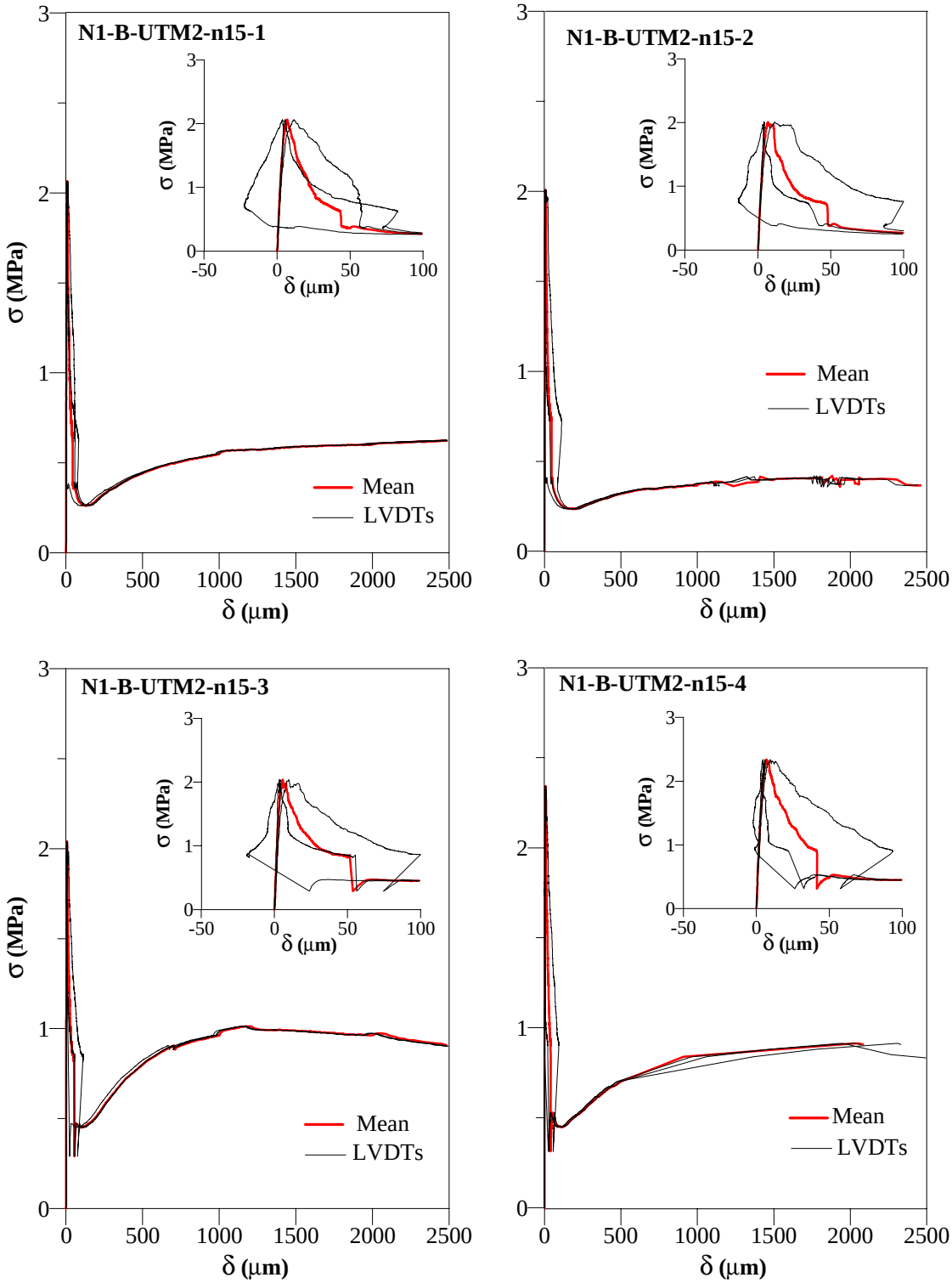


Table B.1. Effect of slenderness. Results for specimens with h/Ø = 1 (h = 150 mm; Ø = 150 mm; notch depth = 15 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (MPa)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-C-UTM 1-n15-1	2.7	5	0.51	41	2.24	2.05	1.1	1.2	0.91	2.08	0.91	1.04	66 / 37
N1-C-UTM 1-n15-2	3.0	8	0.40	122	2.36	0.58	0.7	0.7	0.60	1.32	0.60	0.66	45 / 21
N1-C-UTM 1-n15-3	2.4	5	0.49	85	3.85	0.67	1.2	1.1	0.88	2.02	0.88	1.01	73 / 41
N1-C-UTM 1-n15-4	1.8	8	0.42	120	8.83	1.77	0.7	0.8	0.62	1.36	0.62	0.68	59 / 23
N1-C-UTM 1-n15-5	3.1	7	0.58	125	1.94	0.63	1.4	1.4	1.03	2.46	1.03	1.23	66 / 47
Mean	***2.6***	***7***	***0.48***	***99***	***3.84***	***1.14***	***1.0***	***1.0***	***0.81***	***1.84***	***0.81***	***0.92***	***62 / 34***
Std. deviation	***0.5***	***1***	***0.07***	***36***	***2.88***	***0.71***	***0.3***	***0.3***	***0.19***	***0.50***	***0.19***	***0.25***	***11 / 11***
Coefficient of variation (%)	***20***	***18***	***15***	***37***	***75***	***63***	***28***	***30***	***23***	***27***	***23***	***27***	***17 / 34***

Figure B.2. Effect of h/∅ ratio. Stress - δ curves for specimens with h/∅ = 2 (h = 300 mm; ∅ = 150 mm; notch depth = 15 mm)



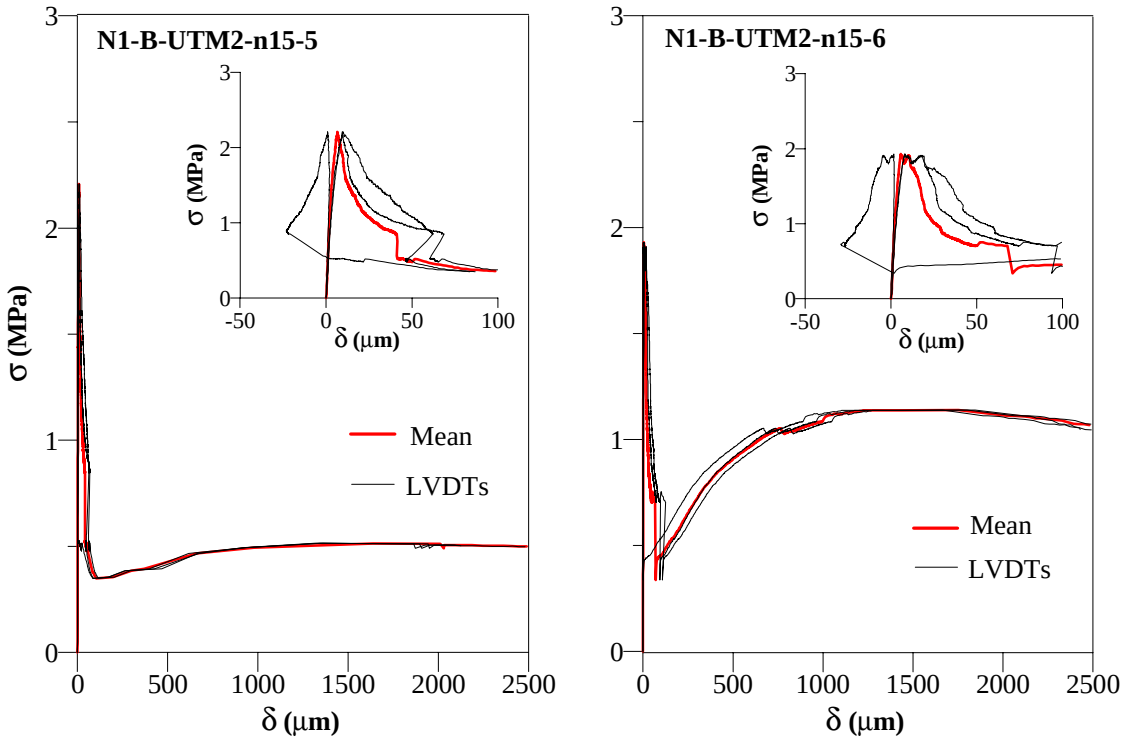
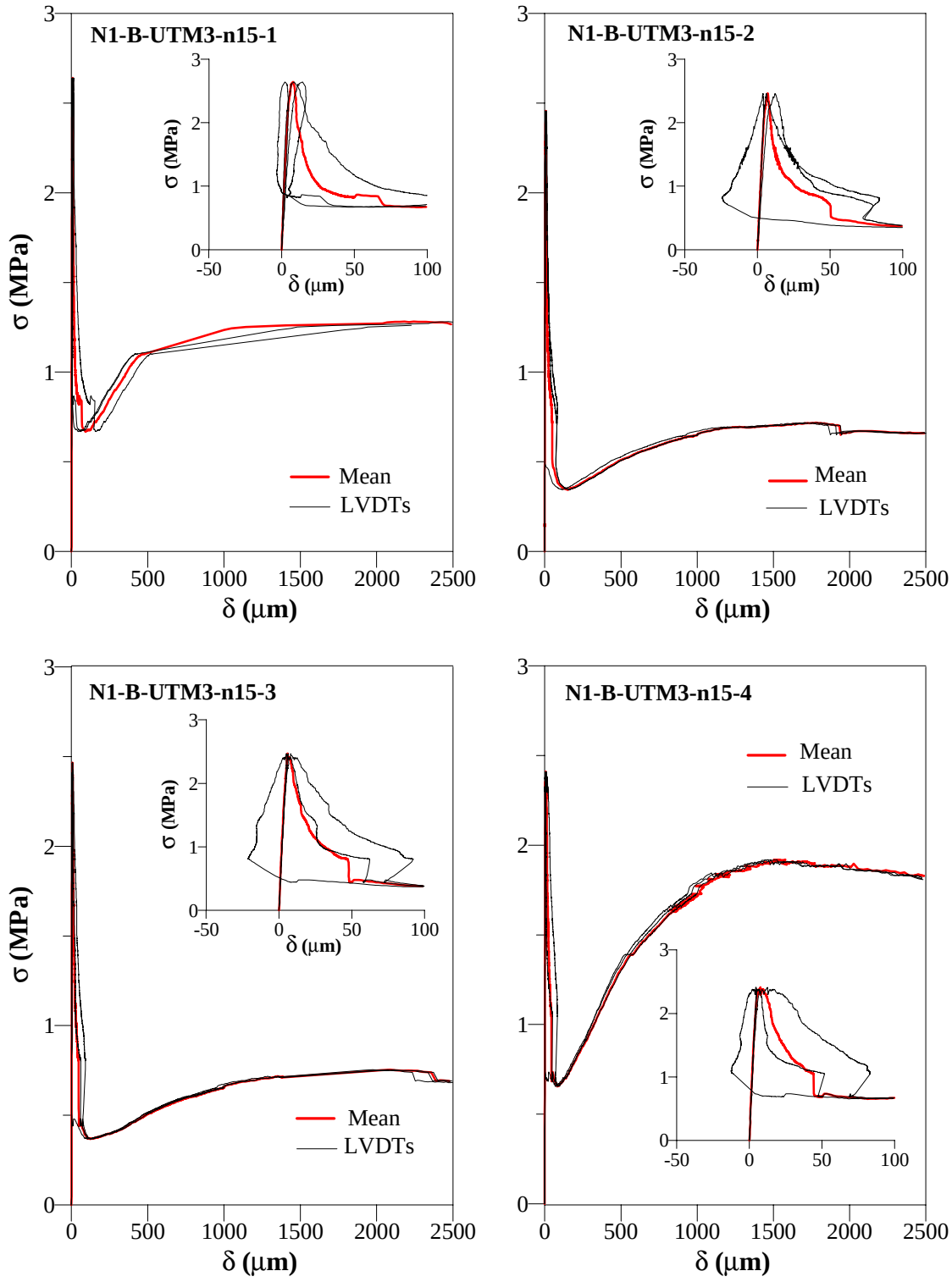


Table B.2. Effect of slenderness. Results for specimens with h/Ø = 2 (h = 300 mm; Ø = 150 mm; notch depth = 15 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (MPa)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-B-UTM 2-n15-1	2.0	7	0.26	122	5.00	0.64	0.6	0.6	0.45	1.04	0.45	0.52	44 / 21
N1-B-UTM 2-n15-2	2.0	7	0.23	197	5.06	0.77	0.4	0.4	0.35	0.74	0.35	0.37	37 / 14
N1-B-UTM 2-n15-3	2.0	6	0.29	48	4.28	0.79	1.0	1.0	0.78	1.76	0.78	0.88	53 / 28
N1-B-UTM 2-n15-4	2.3	7	0.31	35	3.12	0.60	0.9	0.9	0.70	1.58	0.70	0.79	56 / 33
N1-B-UTM 2-n15-5	2.2	7	0.35	97	6.26	0.61	0.5	0.5	0.46	0.96	0.46	0.48	48 / 17
N1-B-UTM 2-n15-6	1.9	6	0.34	65	4.50	1.44	1.1	1.0	0.87	2.00	0.87	1.00	49 / 35
Mean	***2.1***	***7***	***0.30***	***94***	***4.70***	***0.81***	***0.7***	***0.7***	***0.60***	***1.34***	***0.60***	***0.67***	***48 / 25***
Std. deviation	***0.2***	***1***	***0.1***	***60***	***1.04***	***0.32***	***0.3***	***0.3***	***0.21***	***0.50***	***0.21***	***0.25***	***7 / 9***
Coefficient of variation (%)	***7***	***10***	***16***	***64***	***0.22***	***40***	***41***	***38***	***35***	***37***	***35***	***37***	***14 /35***

Figure B.3. Effect of h/∅ ratio. Stress - δ curves for specimens with h/∅=3 (h = 450 mm; ∅ = 150 mm; notch depth = 15 mm)



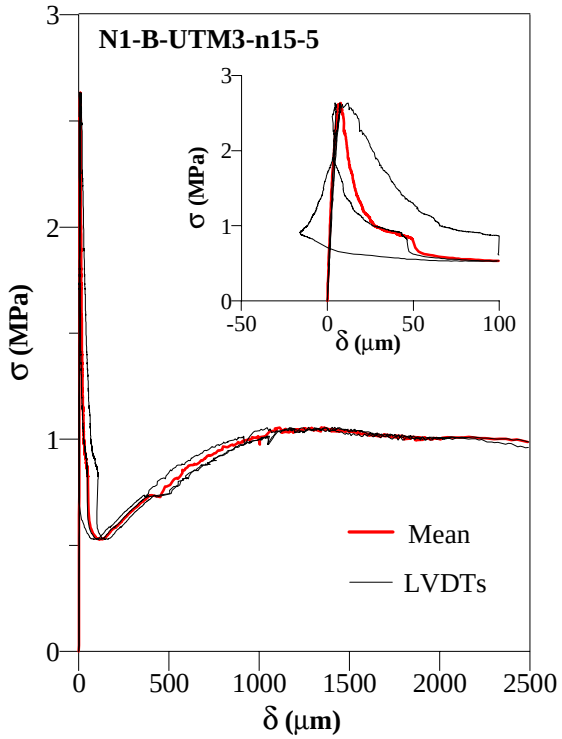
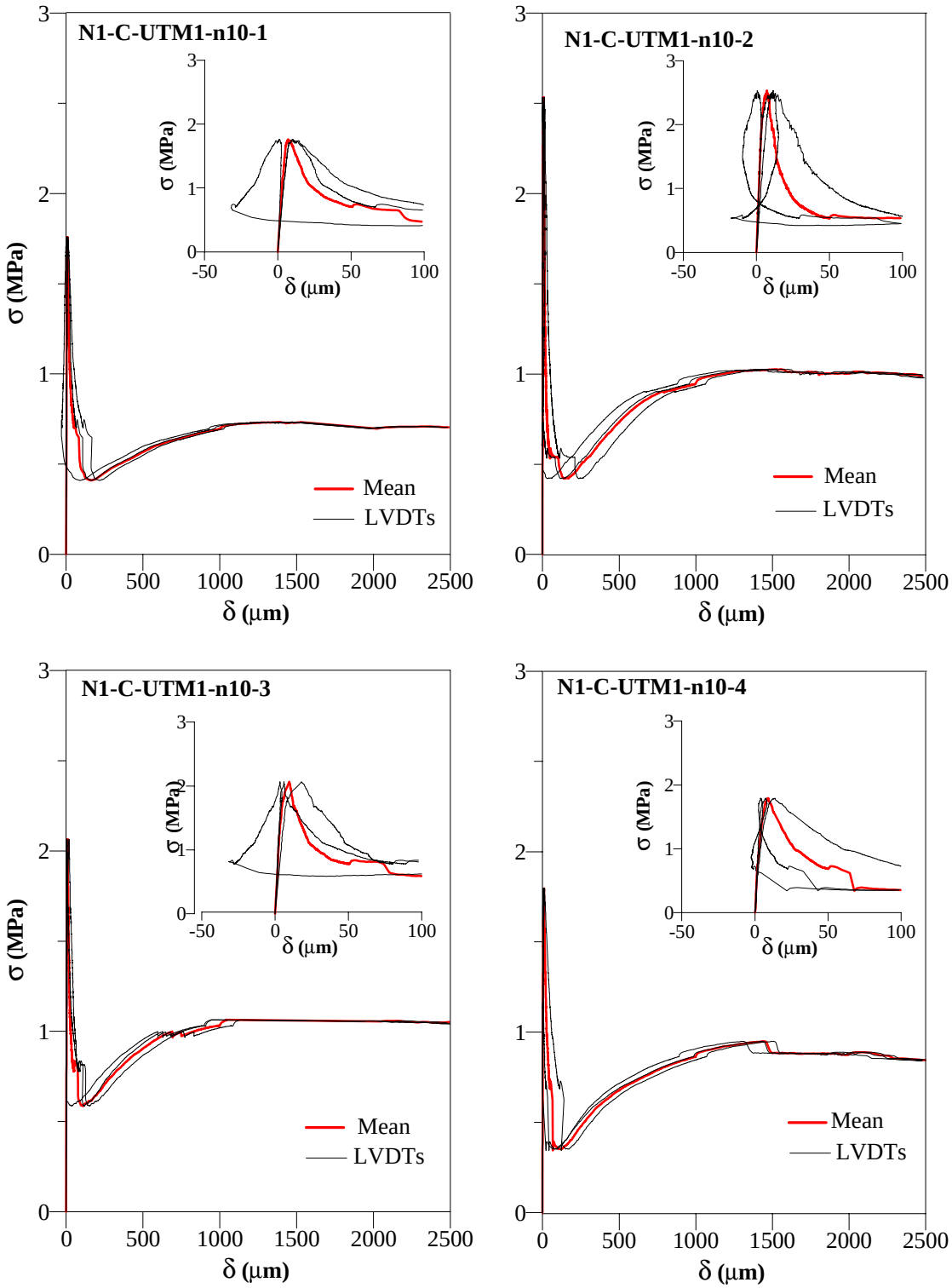


Table B.3. Effect of slenderness. Results for specimens with h/Ø = 3 (h = 450 mm; Ø = 150 mm; notch depth = 15 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-B-UTM 3-n15-1	2.6	8	0.67	185	7.40	0.97	1.2	1.3	1.04	2.30	1.04	1.15	93 / 48
N1-B-UTM 3-n15-2	2.5	7	0.34	145	5.22	0.71	0.7	0.7	0.53	1.22	0.53	0.61	50 / 27
N1-B-UTM 3-n15-3	2.5	6	0.37	117	1.70	0.87	0.7	0.8	0.54	1.26	0.54	0.63	37 / 31
N1-B-UTM 3-n15-4	2.5	8	0.65	74	5.53	0.59	1.7	1.9	1.27	3.14	1.27	1.57	90 / 66
N1-B-UTM 3-n15-5	2.7	8	0.53	109	4.74	0.71	1.0	1.0	0.81	1.84	0.81	0.92	78 / 35
Mean	***2.5***	***7***	***0.51***	***126***	***4.92***	***0.77***	***1.1***	***1.1***	***0.84***	***1.96***	***0.84***	***0.98***	***70 / 41***
Std. deviation	***0.1***	***1***	***0.15***	***42***	***2.06***	***0.15***	***0.4***	***0.5***	***0.32***	***0.80***	***0.32***	***0.40***	***25 / 16***
Coefficient of variation (%)	***5***	***11***	***30***	***33***	***42***	***0.20***	***42***	***44***	***38***	***41***	***38***	***41***	***36 / 38***

Figure B.4. Effect of notch depth. Stress - δ curves for specimens with notch depth = 10 mm (h = 150 mm; ∅ = 150 mm)



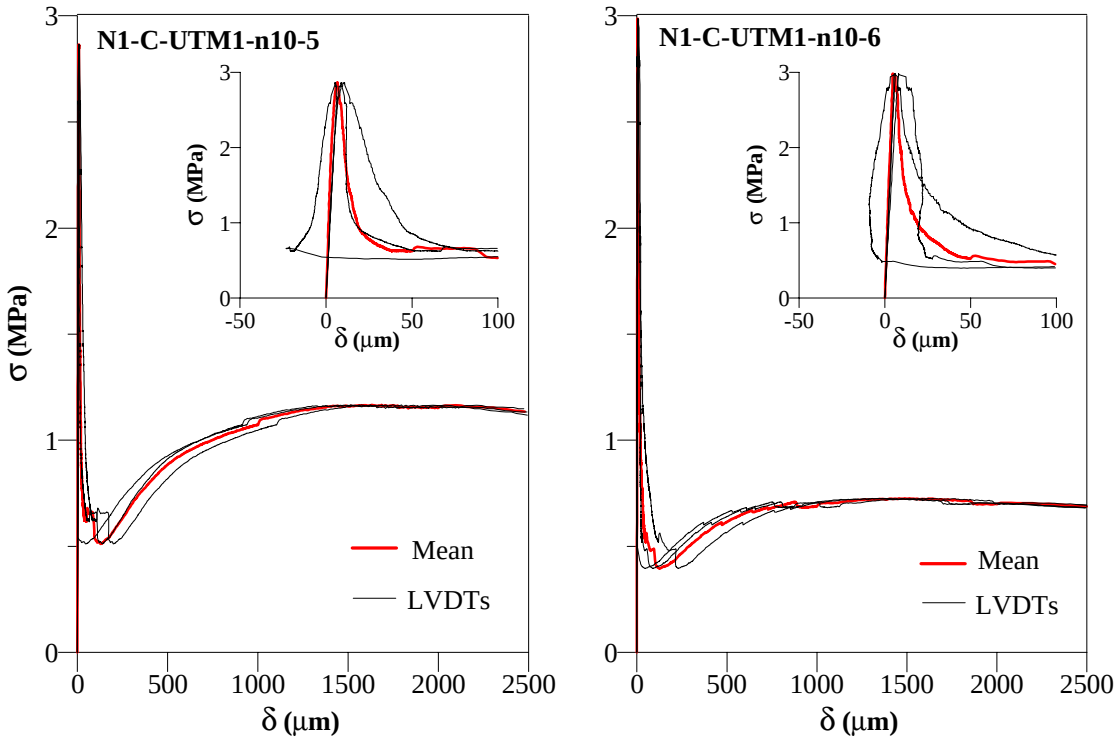
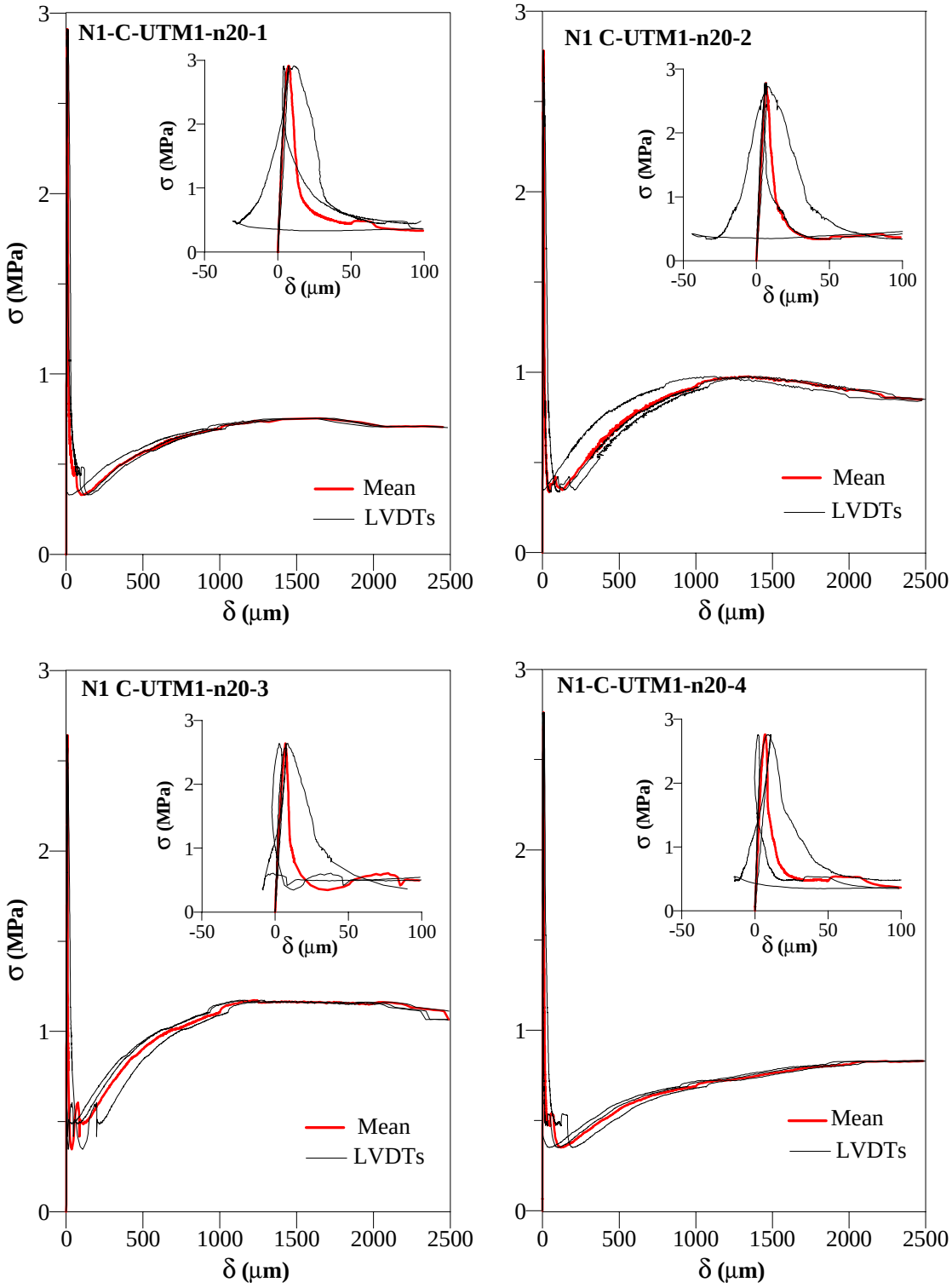


Table B.4. Effect of notch depth. Results for specimens with notch depth= 10 mm (h = 150 mm; Ø = 150 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-C-UTM 1-n10-1	1.8	7	0.41	155	6.33	1.22	0.7	0.7	0.59	1.32	0.59	0.66	47 / 28
N1-C-UTM 1-n10-2	2.5	7	0.42	136	7.56	1.38	1.0	1.0	0.73	1.74	0.73	0.87	69 / 37
N1-C-UTM 1-n10-3	2.1	10	0.59	97	9.47	1.53	1.1	1.1	0.88	1.94	0.88	0.97	74 / 36
N1-C-UTM 1-n10-4	1.8	9	0.34	59	5.98	1.22	0.9	0.9	0.67	1.58	0.67	0.79	54 / 31
N1-C-UTM 1-n10-5	2.9	7	0.51	122	3.07	1.51	1.1	1.2	0.86	2.00	0.86	1.00	61 / 44
N1-C-UTM 1-n10-6	3.3	5	0.40	122	2.78	1.91	0.7	0.7	0.61	1.32	0.61	0.66	45 / 24
Mean	***2.4***	***7***	***0.45***	***115***	***5.87***	***1.46***	***0.9***	***0.9***	***0.72***	***1.66***	***0.72***	***0.83***	***58 / 33***
Std. deviation	***0.6***	***2***	***0.09***	***33***	***2.59***	***0.26***	***0.2***	***0.2***	***0.12***	***0.30***	***0.12***	***0.15***	***12 / 7***
Coefficient of variation (%)	***26***	***22***	***20***	***29***	***44***	***18***	***19***	***21***	***17***	***18***	***17***	***18***	***20 / 21***

Figure B.5. Effect notch depth. Stress - δ curves for specimens with notch depth = 20 mm (h = 150 mm; ∅ = 150 mm)



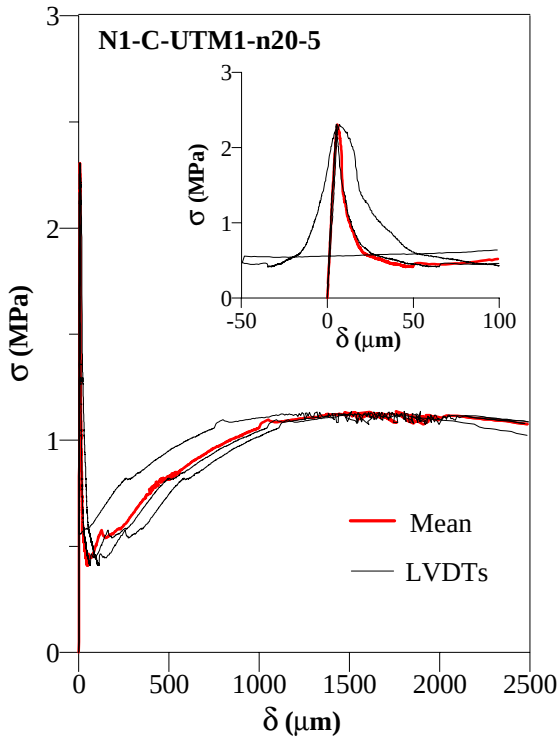
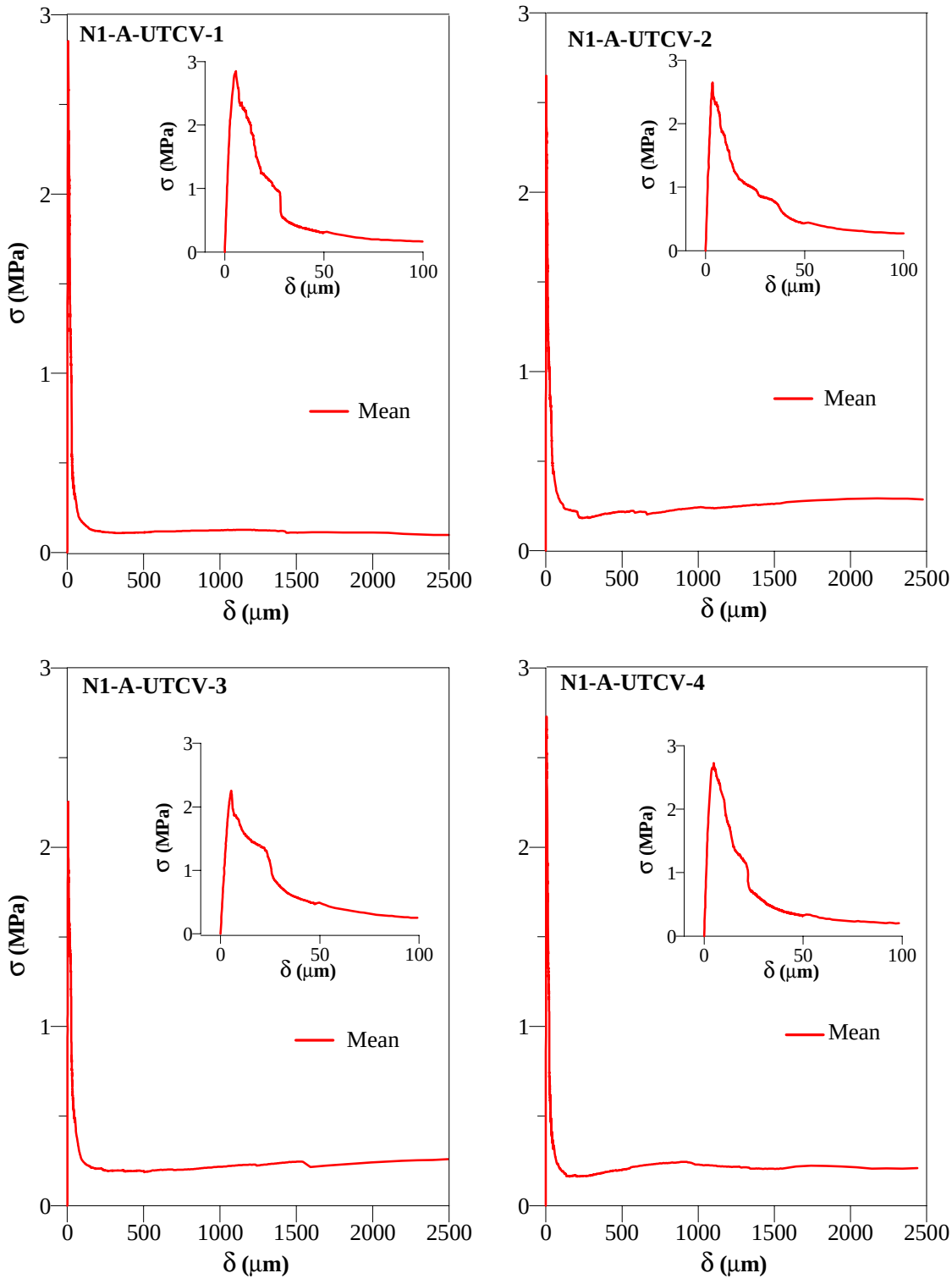


Table B.5. Effect of notch depth. Results for specimens with notch depth = 20 mm (h = 150 mm; Ø = 150 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-C-UTM 1-n20-1	2.9	7	0.33	93	4.54	1.91	0.7	0.7	0.56	1.30	0.56	0.65	48 / 23
N1-C-UTM 1-n20-2	2.8	6	0.34	38	0.89	1.08	0.9	0.9	0.68	1.62	0.68	0.81	34 / 23
N1-C-UTM 1-n20-3	2.6	7	0.35	29	3.82	1.32	1.1	1.2	0.85	2.02	0.85	1.01	46 / 34
N1-C-UTM 1-n20-4	2.8	7	0.35	114	5.58	2.51	0.7	0.8	0.56	1.32	0.56	0.66	39 / 26
N1-C-UTM 1-n20-5	2.3	6	0.41	43	1.25	0.96	1.1	1.1	0.81	1.92	0.81	0.96	56 / 31
Mean	***2.7***	***7***	***0.36***	***63***	***2.98***	***1.60***	***0.9***	***0.9***	***0.69***	***1.64***	***0.69***	***0.82***	***45 / 27***
Std. deviation	***0.2***	***1***	***0.10***	***38***	***1.93***	***0.59***	***0.2***	***0.2***	***0.14***	***0.34***	***0.14***	***0.17***	***8 / 5***
Coefficient of variation (%)	***9***	***10***	***9***	***59***	***65***	***37***	***23***	***21***	***20***	***20***	***20***	***20***	***19 /18***

Figure B.6. Effect of fiber orientation. Stress - δ curves for cores extracted in the casting direction (vertical, h = 100 mm; ∅ = 93 mm; notch depth = 9.5 mm)



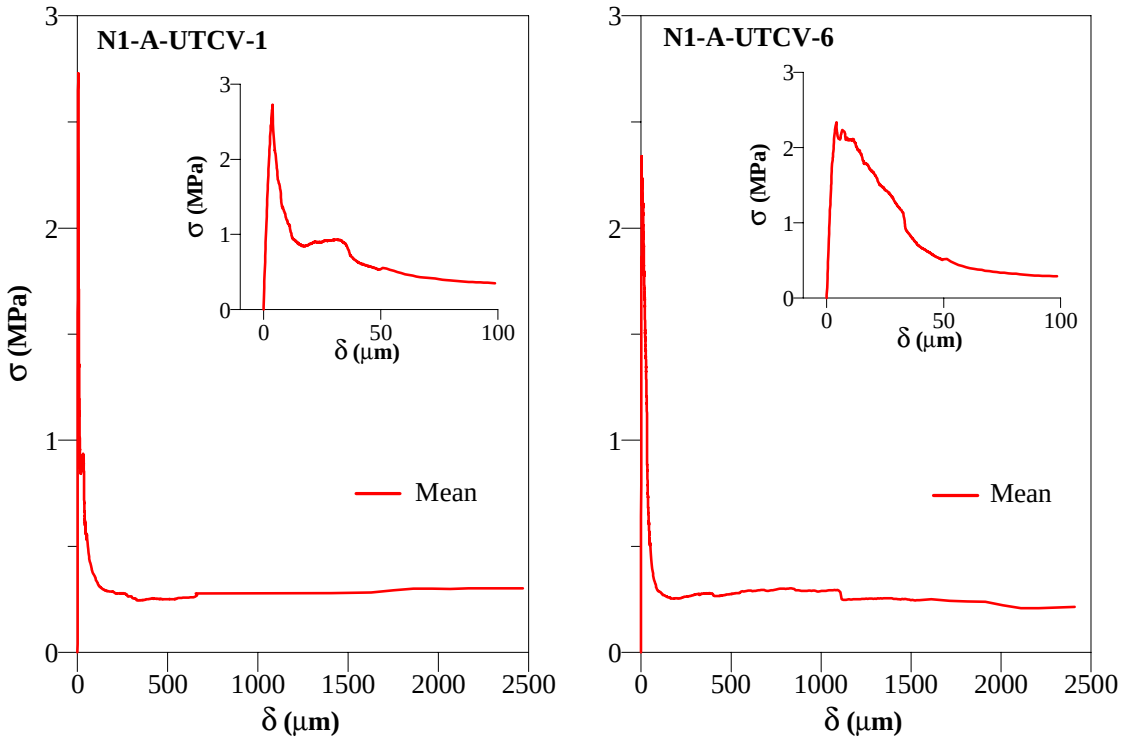
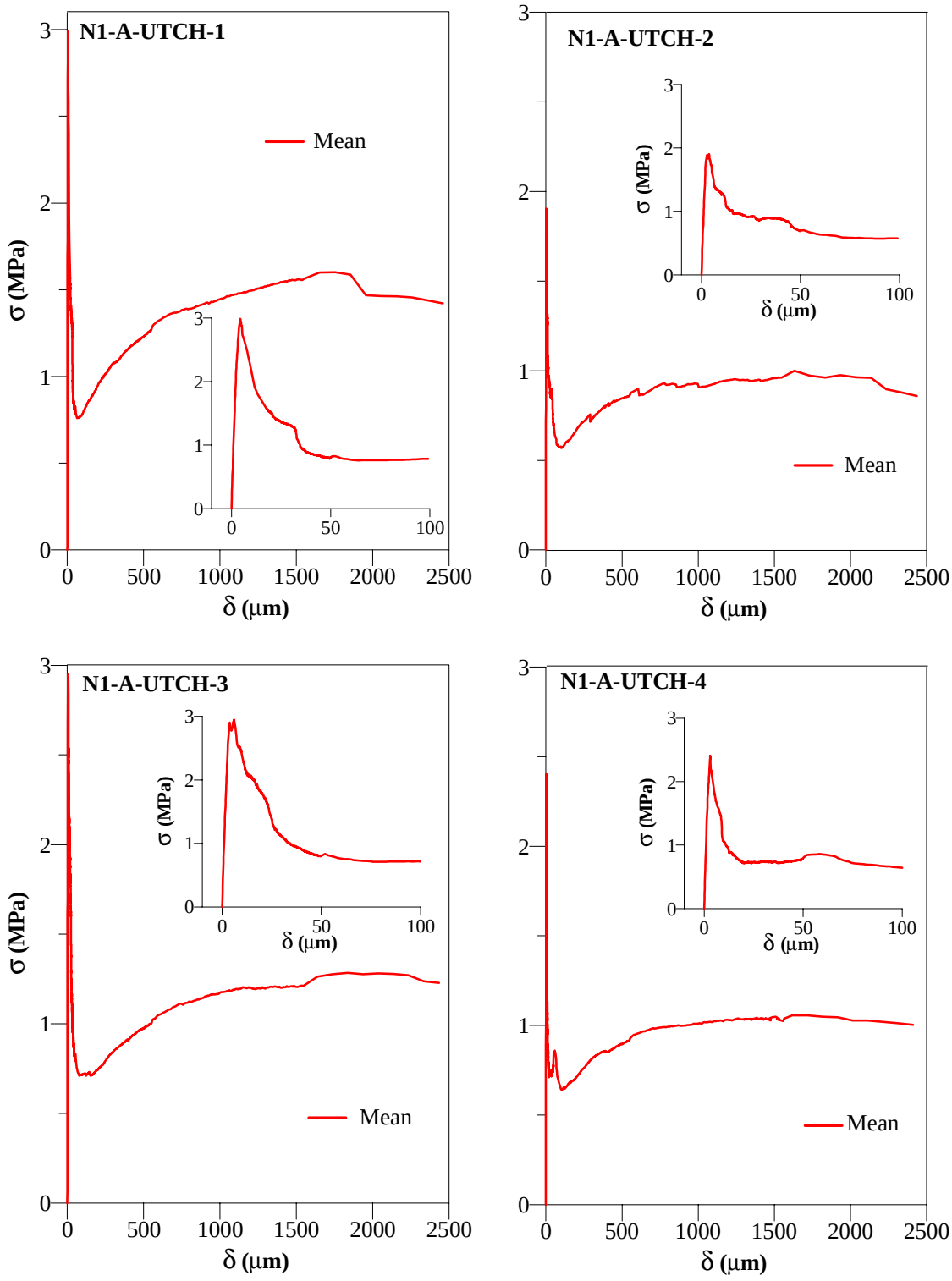


Table B.6. Effect of fiber orientation. Results for cores extracted in the casting direction (vertical, h = 100 mm; ∅ = 93 mm; notch depth = 9.5 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (MPa)	σ_{min} (MPa)	w_{min} (μm)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-A-UTCV -1	2.9	6	0.11	317	0.1	0.1	0.16	0.28	0.16	0.14	14 / 2
N1-A-UTCV -2	2.7	4	0.18	238	0.2	0.3	0.26	0.52	0.26	0.26	15 / 4
N1-A-UTCV -3	2.3	5	0.19	497	0.2	0.2	0.25	0.48	0.25	0.24	15 / 4
N1-A-UTCV -4	2.7	5	0.16	211	0.2	0.2	0.24	0.46	0.24	0.23	20 / 1
N1-A-UTCV -5	2.7	4	0.24	329	0.3	0.3	0.31	0.60	0.31	0.30	14 / 2
N1-A-UTCV -6	2.4	4	0.25	165	0.3	0.2	0.33	0.58	0.33	0.29	19 / 1
Mean	***2.6***	***5***	***0.19***	***293***	***0.2***	***0.2***	***1.10***	***0.48***	***0.26***	***0.24***	***16 / 2***
Std. deviation	***0.2***	***1***	***0.05***	***118***	***0.1***	***0.1***	***0.30***	***0.12***	***0.06***	***0.06***	***3 / 1***
Coefficient of variation (%)	***9***	***19***	***28***	***40***	***26***	***30***	***23***	***24***	***23***	***24***	***16 / 59***

Figure B.7. Effect of fiber orientation. Stress - δ curves for cores extracted in a plane normal to the casting direction (horizontal, h = 100 mm; ∅= 93 mm; notch depth = 9.5 mm)



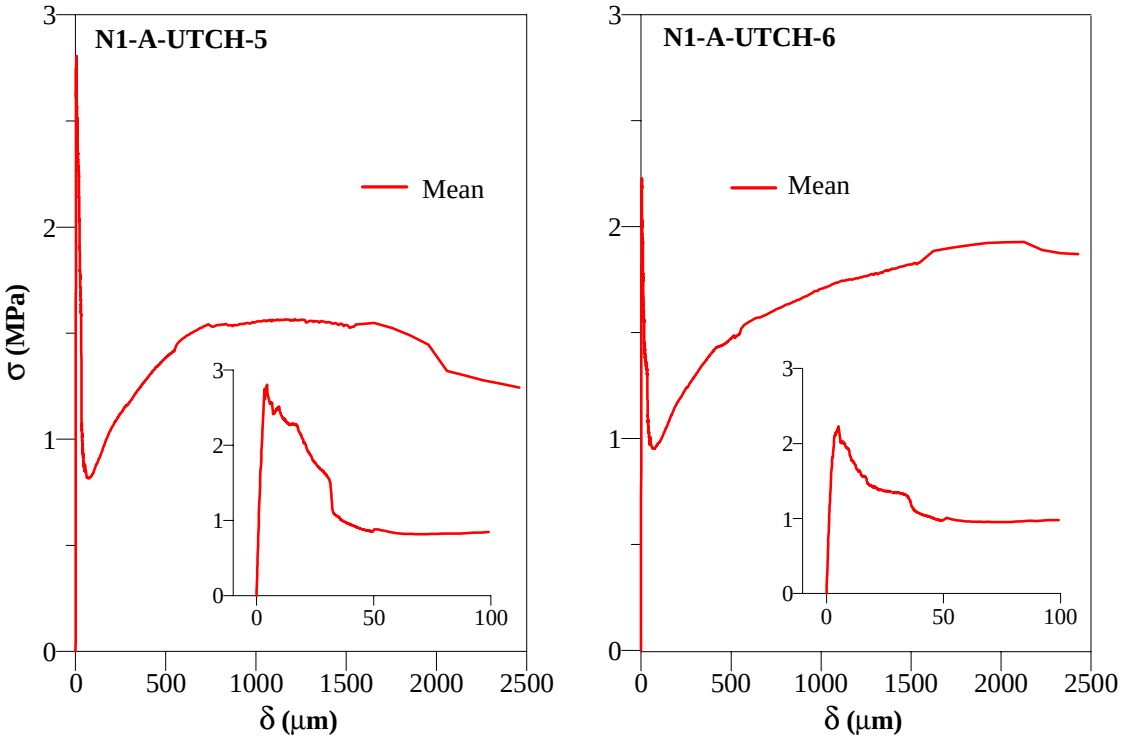
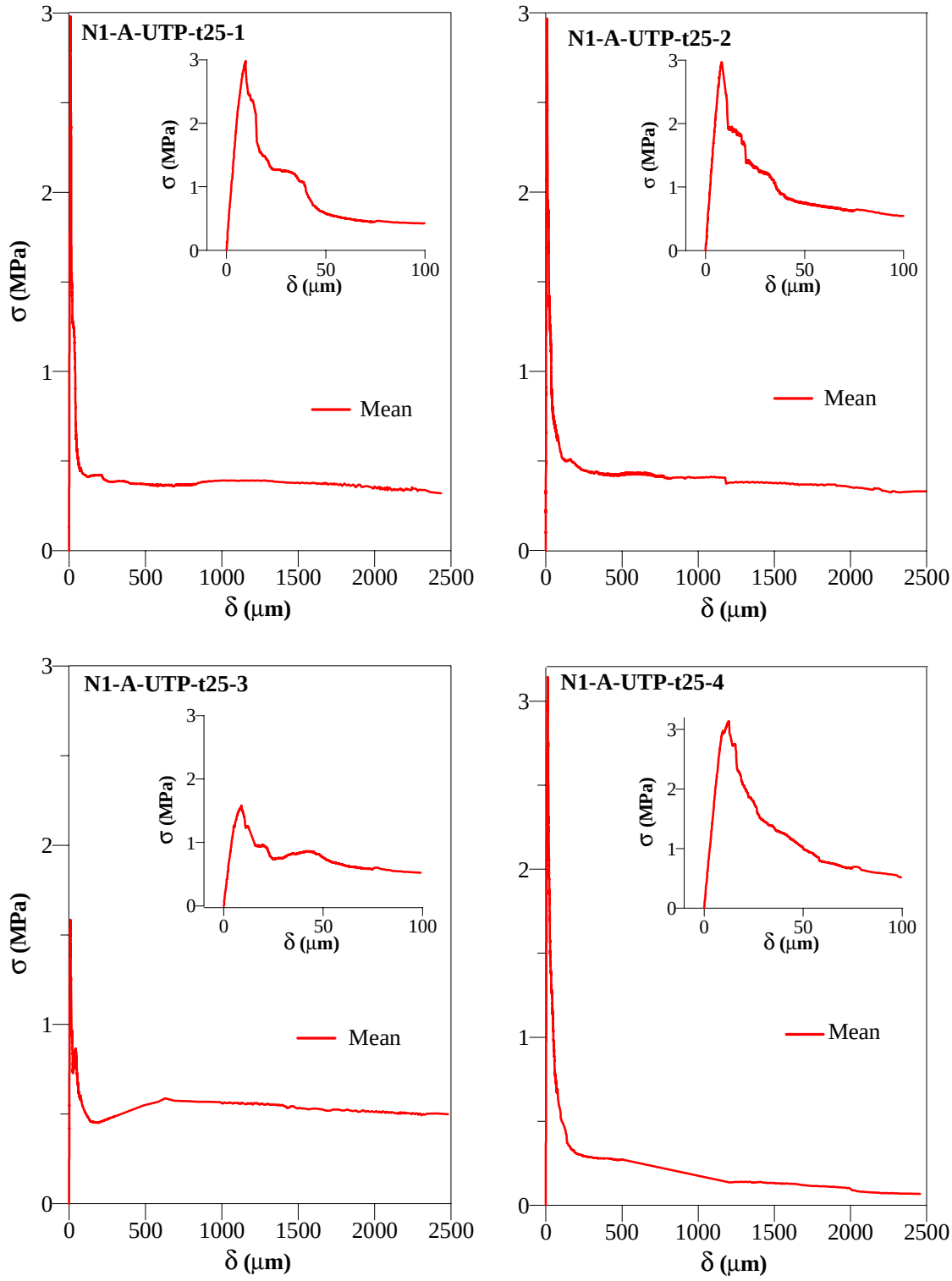


Table B.7. Effect of fiber orientation. Results for cores extracted in a plane normal to the casting direction (horizontal, h = 100 mm; ∅ = 93 mm; notch depth = 9.5 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-A-UTCH -1	2.9	4	0.76	60	1.5	1.5	1.21	2.74	1.21	1.37	32 / 20
N1-A-UTCH -2	1.9	4	0.57	100	0.9	1.0	0.82	1.78	0.82	0.89	30 / 5
N1-A-UTCH -3	3.0	6	0.71	148	1.2	1.3	0.99	2.22	0.99	1.11	32 / 12
N1-A-UTCH -4	2.4	3	0.64	103	1.0	1.0	0.89	1.92	0.89	0.96	30 / 13
N1-A-UTCH -5	2.8	5	0.82	68	1.6	1.4	1.34	2.84	1.34	1.42	29 / 15
N1-A-UTCH -6	2.2	5	0.95	62	1.7	1.9	1.43	3.26	1.43	1.63	37 / 18
Mean	***2.0***	***4***	***0.74***	***90***	***1.3***	***1.3***	***1.11***	***2.46***	***1.11***	***1.23***	***32 / 14***
Std. deviation	***0.4***	***1***	***0.13***	***34***	***0.3***	***0.3***	***0.25***	***0.58***	***0.25***	***0.29***	***3 / 5***
Coefficient of variation (%)	***17***	***23***	***18***	***38***	***24***	***26***	***22***	***24***	***22***	***24***	***9 / 38***

Figure B.8. Effect of the shape. Stress - δ curves for 25 mm wide panels.
(h = 150 mm; b = 150 mm; notch depth = 15mm)



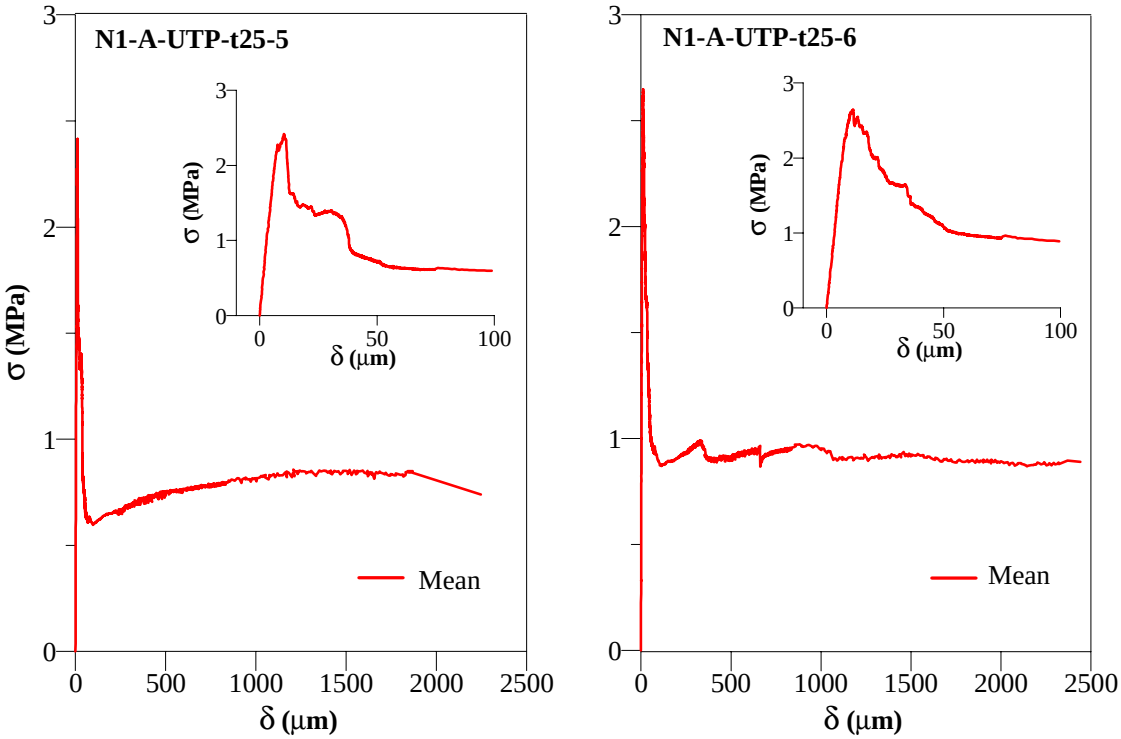
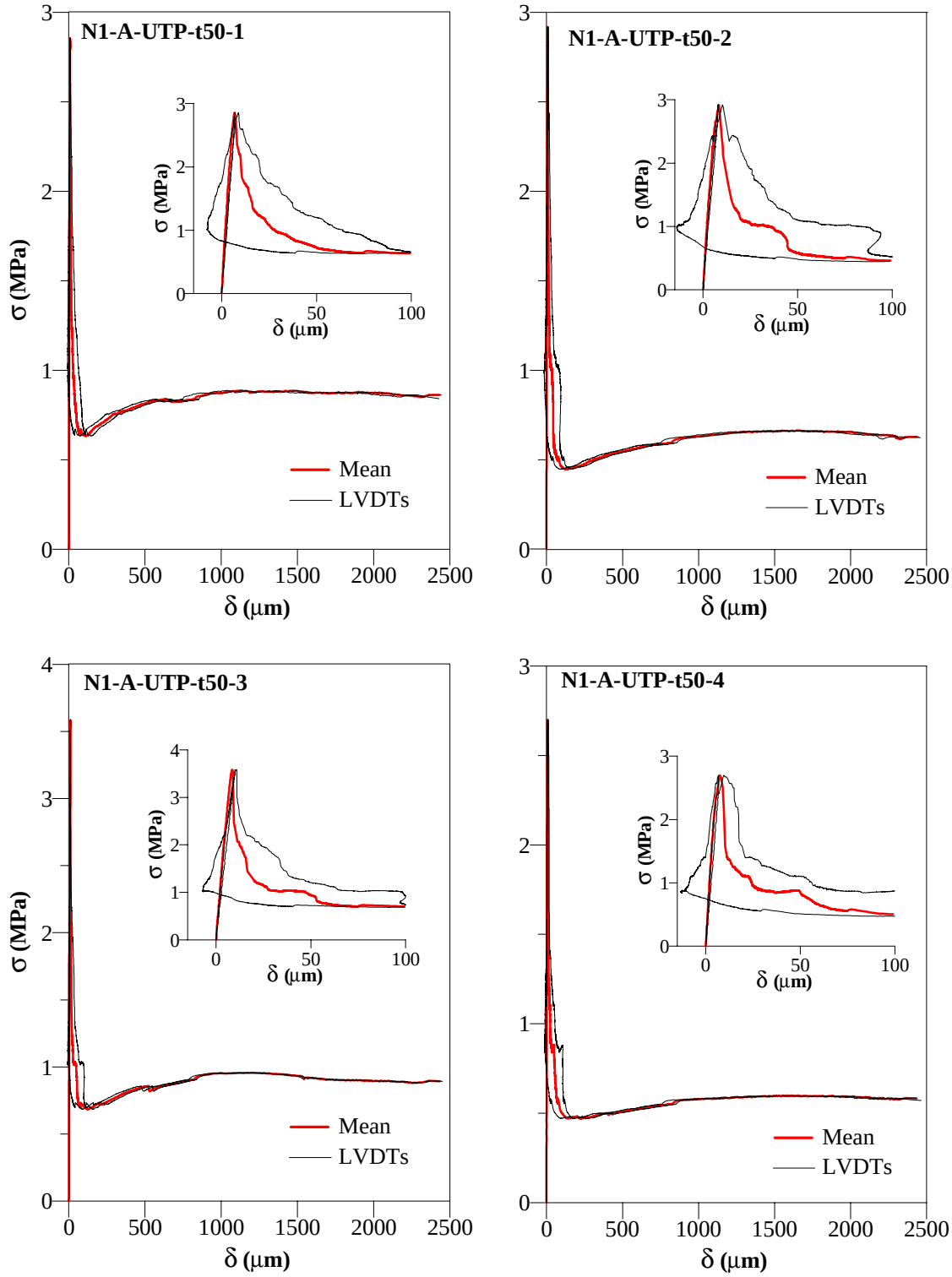


Table B.8. Effect of the shape. Results for 25 mm wide panels (h = 150 mm; b = 150 mm; notch depth = 15mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-A-UTP-t 25-1	3.0	10	0.40	N.H.	0.4	0.4	0.42	0.80	0.42	0.40	16 / 2
N1-A-UTP-t 25-2	3.3	10	0.40	N.H.	0.4	0.4	0.48	0.86	0.48	0.43	20 / 4
N1-A-UTP-t 25-3	1.6	9	0.45	183	0.6	0.5	0.56	1.10	0.56	0.55	12 / 3
N1-A-UTP-t 25-4	3.1	12	0.10	N.H.	0.2	0.1	0.34	0.46	0.34	0.23	11 / 1
N1-A-UTP-t 25-5	2.4	10	0.60	86	0.8	0.8	0.76	1.60	0.76	0.80	18 / 6
N1-A-UTP-t 25-6	2.7	11	0.87	103	1.0	0.9	0.96	1.86	0.96	0.93	25 / 8
Mean	***2.7***	***10***	***0.47***	***124***	***0.6***	***0.5***	***1.70***	***1.12***	***0.59***	***0.56***	***17 / 4***
Std. deviation	***0.6***	***1***	***0.25***	***52***	***0.3***	***0.3***	***0.70***	***0.52***	***0.23***	***0.26***	***5 / 3***
Coefficient of variation (%)	***23***	***13***	***54***	***42***	***61***	***61***	***40***	***47***	***40***	***47***	***31 / 65***

N.H.= No hardening after first peak

Figure B.9. Effect of the shape. Stress - δ curves for 50 mm wide panels (h = 150 mm; b = 150 mm; notch depth = 15 mm)



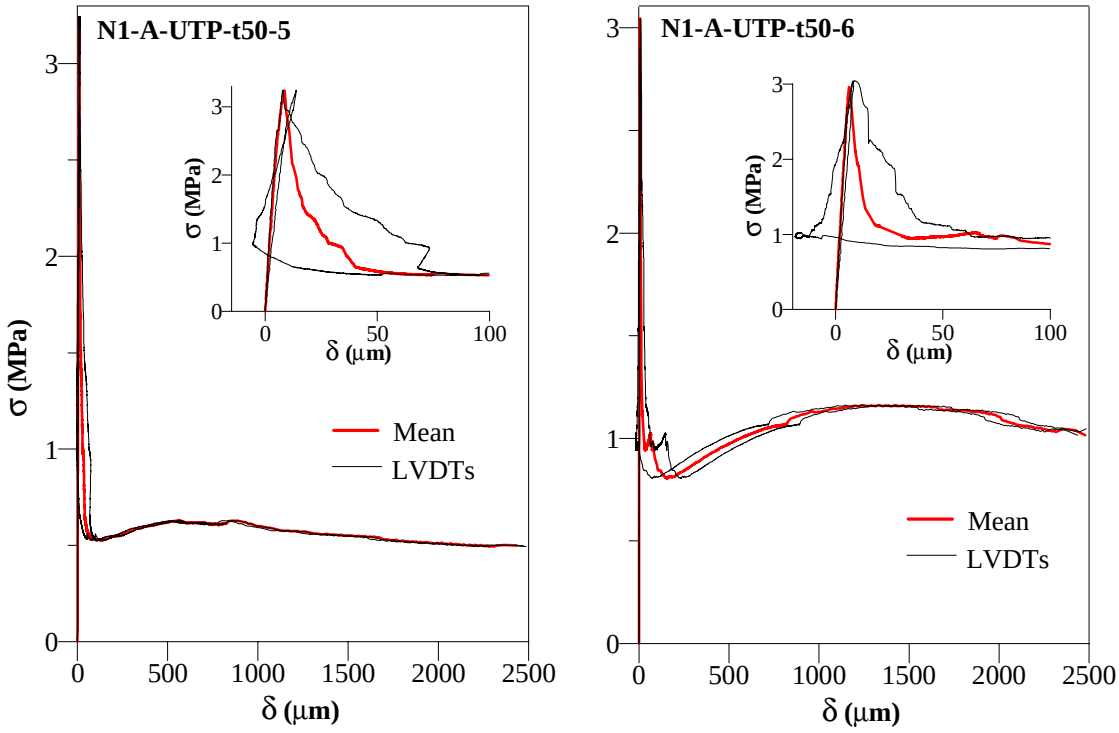


Table B.9. Effect of the shape. Results for 50 mm wide panels (h = 150 mm; b = 150 mm; notch depth = 15 mm)

Specimen	σ_{peak} (MPa)	δ_{peak} (μm)	σ_{min} (MPa)	w_{min} (μm)	α_{peak} (10^{-5} rad)	α_{max} (10^{-3} rad)	σ_{1000} (MPa)	σ_{2000} (MPa)	G_F^{1000} (N/mm)	G_F^{2000} (N/mm)	$f_{eq}^{t,1000}$ (MPa)	$f_{eq}^{t,2000}$ (MPa)	**Fibers** *Tot. /Effec.*
N1-A-UTP-t 50-1	2.9	7	0.63	105	1.00	0.74	0.9	0.9	0.81	1.68	0.81	0.84	32 / 9
N1-A-UTP–t 50-2	2.9	8	0.45	118	1.29	0.55	0.6	0.7	0.57	1.22	0.57	0.61	30 / 7
N1-A-UTP–t 50-3	3.6	9	0.68	117	0.38	0.65	1.0	0.9	0.85	1.78	0.85	0.89	40 / 10
N1-A-UTP-t 50-4	2.7	7	0.47	218	1.48	0.42	0.6	0.6	0.55	1.14	0.55	0.57	19 / 7
N1-A-UTP-t 50-5	3.2	9	0.52	120	3.25	1.06	0.6	0.5	0.62	1.16	0.62	0.58	29 / 7
N1-A-UTP-t 50-6	3.0	7	0.80	148	0.28	0.73	1.1	1.1	0.99	2.14	0.99	1.07	33 / 14
Mean	***3.1***	***8***	***0.59***	***138***	***1.28***	***0.69***	***0.8***	***0.8***	***0.73***	***1.52***	***0.73***	***0.76***	***35 / 10***
Std. deviation	***0.3***	***1***	***0.14***	***42***	***1.08***	***0.22***	***0.2***	***0.2***	***0.18***	***0.42***	***0.18***	***0.21***	***12 / 4***
Coefficient of variation (%)	***10***	***12***	***23***	***30***	***84***	***0.31***	***28***	***29***	***24***	***27***	***24***	***27***	***36 / 41***

Figure B.10. Flexure tests on beams (150×150×500 mm). Load-Deflection curves.

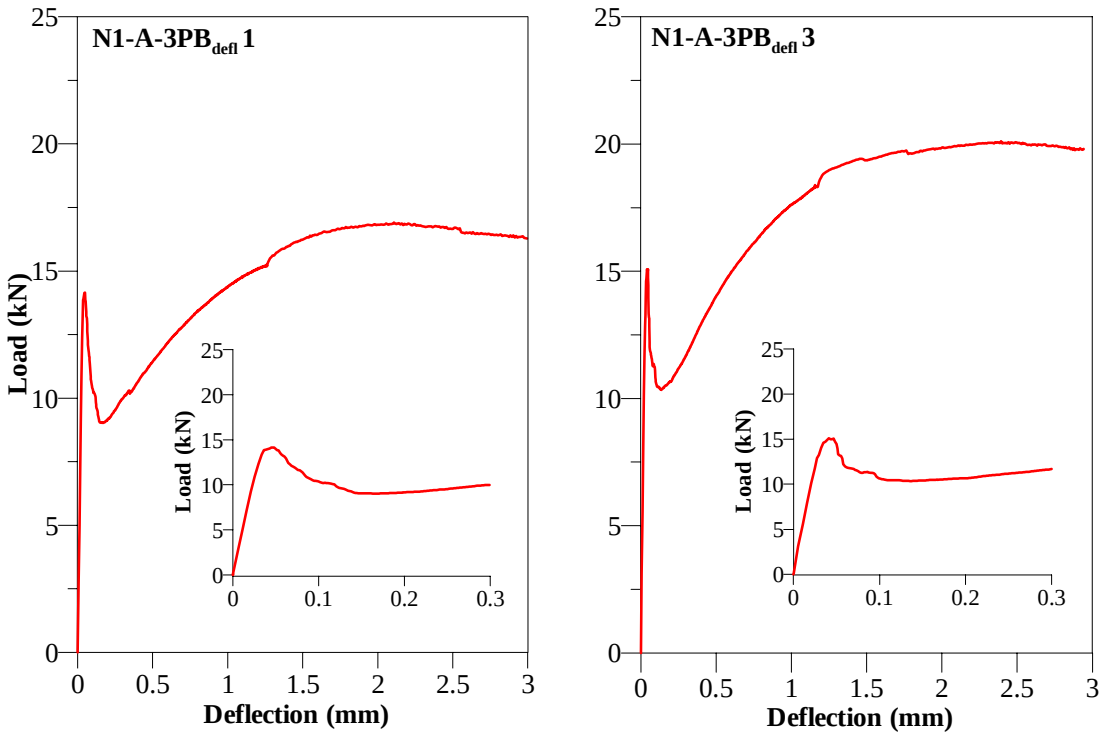


Table B.10. Results of flexural tests on beams from the load-deflection response. RILEM (2000)

Specimen	$f_{ct,fl}$ (MPa)	δ_{Fu} (μm)	$f_{ct,fl}^{min}$ (MPa)	δ_{min} (μm)	$G_{F,fl}^{1000}$ (N/mm)	$G_{F,fl}^{2000}$ (N/mm)	$f_{eq}^{fl,1000}$ (MPa)	$f_{eq}^{fl,2000}$ (MPa)	$f_{eq,2}$ (MPa)	$f_{eq,3}$ (MPa)	**Number of fibres** Tot./Effect
N1-A-3PB-1	4.56	48	2.91	115	3.83	9.05	3.83	4.53	3.25	4.72	115 / 93
N1-A-3PB-2	4.45	-	4.13	-	-	-	-	-	-	-	155 / 102
N1-A-3PB-3	4.35	41	2.98	137	4.10	9.66	4.10	4.83	3.53	5.05	150 / 112
Mean	***4.45***	***45***	***3.34***	***126***	***3.97***	***9.36***	***0.64***	***0.76***	***3.39***	***4.89***	***140 / 102***
Std. Deviation	***0.1***	-	***0.7***	-	-	-	-	-	-	-	***22 / 10***
Coefficient of Variation (%)	***2***	-	***21***	-	-	-	-	-	-	-	***16 / 9***

Figure B.11. Flexure tests on beams (150×150×500 mm). Load-CMOD curves.

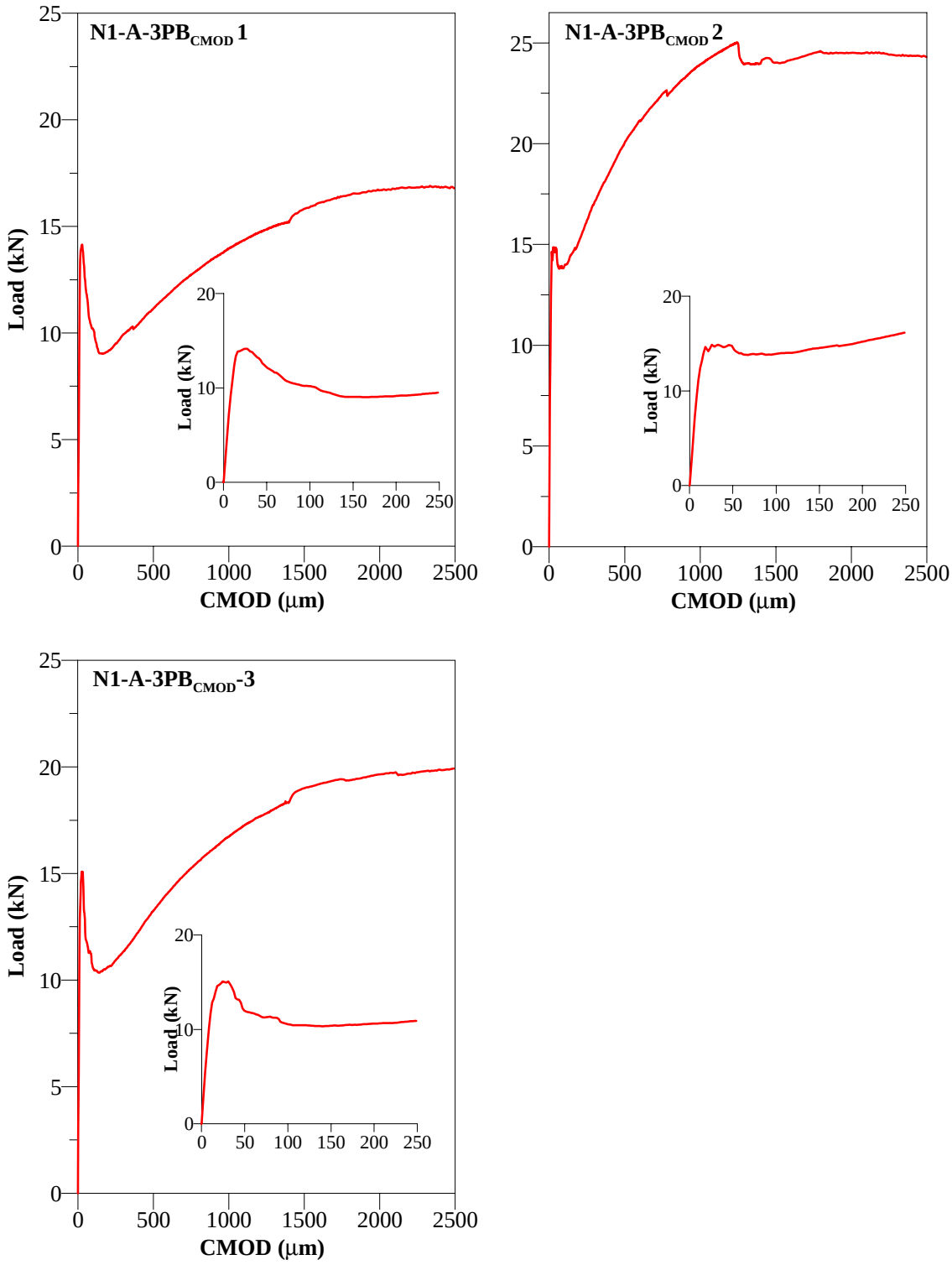


Table B.11. Results of flexural tests on beams from the load-CMOD response. RILEM (2000)

Specimen	$f_{ct,fl}$ (MPa)	$CMOD_{Fu}$ (μm)	$f_{ct,fl}^{min}$ (MPa)	$CMOD_{min}$ (μm)	$G_{F,fl}^{1000}$ (N/mm)	$G_{F,fl}^{2000}$ (N/mm)	$f_{eq}^{fl,1000}$ (MPa)	$f_{eq}^{fl,2000}$ (MPa)	$f_{eq,2}$ (MPa)	$f_{eq,3}$ (MPa)	**Number of fibres** Tot./Effect	
N1-A-3PB-1	4.56	28	2.91	161	3.72	8.76	3.72	4.38	3.16	-	115	93
N1-A-3PB-2	4.45	26	4.13	67	5.86	13.2	5.86	6.60	5.36	6.75	155	102
N1-A-3PB-3	4.35	25	2.98	141	3.90	9.26	3.90	4.63	3.34	-	150	112
Mean	***4.45***	***26***	***3.34***	***123***	***4.49***	***10.4***	***4.49***	***5.2***	***3.95***	***6.75***	***140***	***102***
Std. Deviat.	***0.1***	***1.5***	***0.7***	***50***	***1.2***	***2.4***	***1.2***	***1.2***	***1.22***	***-***	***22***	***10***
Coefficient of Variation (%)	***2***	***6***	***21***	***40***	***26***	***23***	***26***	***23***	***31***	***-***	***16***	***9***

Figure B.12. Splitting tension tests on discs. Stress-δ curves. (∅ = 150 mm; l = 100 mm)

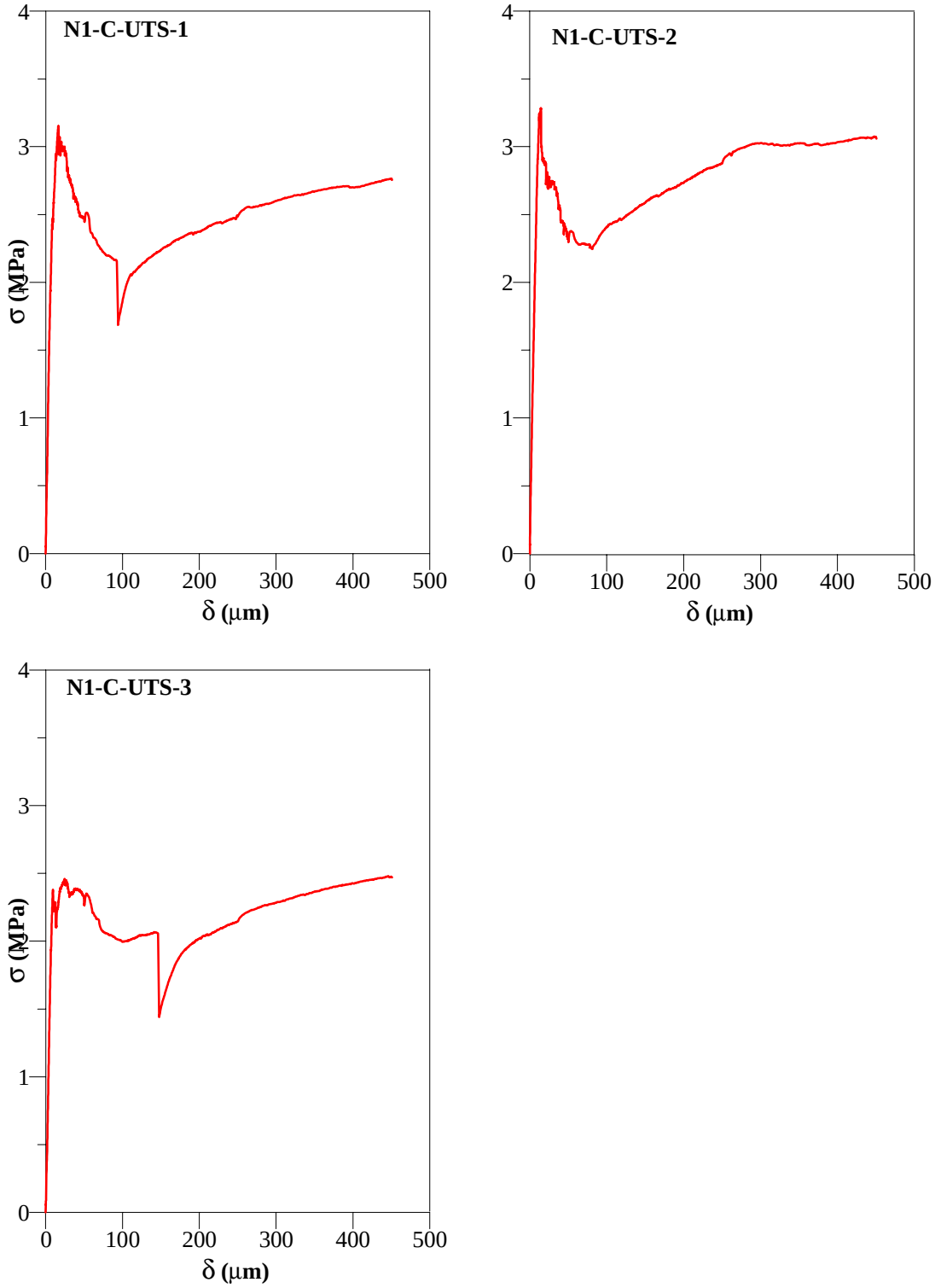


Table B.12. Results of splitting tension tests on discs (∅= 150 mm; l= 100 mm)

Specimen	**σ_{peak}** (MPa)	**$CMOD_{peak}$** (μm)
N1-C-S-1	3.2	16
N1-C-S-2	3.3	15
N1-C-S-2	2.5	25
Mean	***3.0***	***19***
Std. deviation	***0.4***	***5***
Coefficient of variation (%)	***15***	***29***